

# **Arkansas Governor's Commission on Global Warming**

**Final Report  
October 2008**



**October 30, 2008**

Dear Governor Beebe,

It is our honor to transmit to you the final report of the Governor's Commission on Global Warming, representing the fulfillment of Act 696 (HB 2460), signed into law by you and approved by the 86<sup>th</sup> General Assembly.

You will see in this report that -- for the past year -- the members of the Governor's Commission on Global Warming (GCGW) have worked hard to answer your charge to "place Arkansas in a position to help stabilize global climate, to allow Arkansas to lead the nation in attracting clean and renewable energy industries to the state, and to reduce consumer energy dependence on current carbon-generating technologies and expenditures."

Based on this work, the Commission recommends that Arkansas adopt a statewide global warming pollutant goal to reduce the state's gross greenhouse gas (GHG) emissions below 2000 levels accordingly: 20% by 2020; 35% by 2025; and 50% by 2035. Specifically, to meet these goals, the Commission recommends adoption of a comprehensive set of 54 policies to address climate, energy, and commerce related issues in Arkansas.

To reach agreement on these 54 policies, the Commission identified, designed and analyzed a full suite of Arkansas specific actions, including assessment of GHG reduction potential, cost and cost savings, potential co-benefits, and consideration of numerous feasibility issues. The Commission also developed and approved the first comprehensive, statewide GHG inventory and forecast developed for Arkansas, covering the years 1990 through 2025.

Furthermore, during these proceedings, the Commission reviewed the physical science of climate change as well as recent developments in U.S. law. This review included the Intergovernmental Panel on Climate Change Fourth Assessment Report, and that Panel's study and assessment of impacts on the southern United States, as well as a review of the current status of international, federal and state law and policy on climate change and the treatment of science under the law.

Finally, we want to specifically offer our thanks and gratitude to the 21 appointed members of your Commission, the Members of the Beebe Administration serving on the Advisory Group, legislative staff, members of the public, and especially the Center for Climate Strategies for their independent facilitation, technical assistance, and expertise. Their public service to our state will leave a lasting legacy.

This initiative marks an exciting beginning for Arkansas. As we establish our own course for state, regional and national leadership on global climate change, this report provides a roadmap for substantial new opportunities for our economy, our energy needs, and our environment.

We look forward to working with you, your Administration, Members of the General Assembly, the private sector, and many others as we seek to implement the work of this Commission. We also seek a complete follow-through on this report through further tracking, review, and public collaboration, to ensure that both current and future generations of Arkansans fully benefit from its recommendations.

On behalf of the Commission, we want to thank you for the opportunity to serve on behalf of this critical and historic effort for our state.

Sincerely,

Hon. Kathy Webb

Kevin Smith

Co-Chair

Co-Chair

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Special thanks to Representative Kathy Webb, Kevin Smith and Pearlie Reed, Co-chairs of the GCGW, for their leadership throughout the process.<sup>1</sup> Special thanks also to the members of the Advisory Body who provided valuable technical expertise and time during Commission and Technical Work Group meetings. The GCGW also recognizes the many individuals who participated in the sector-based Technical Work Groups, all of whom are listed in Appendix C. Although this report is intended to represent the results of the GCGW's work, the GCGW would be remiss if it did not recognize and express appreciation for the time and effort each Technical Work Group member spent in discussion, study, and deliberation during this process.

Many thanks to Jillian Hicks, Andrew Parker, and Marc Harrison of the Arkansas Governor's Office, who coordinated and supervised all activities associated with the GCGW process, served as liaisons to the Technical Work Groups, and arranged meetings. Many thanks also to Carol Stapleton, Senior Legislative Analyst, and Gina Mercer, Legislative Committee Secretary, of the Bureau of Legislative Research, who assisted in arranging meeting facilities, recording meetings, and other meeting support logistics throughout the process.

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Lewis Lem	Randy Strait
Kathy Leotta	Brad Strode
Jason Miles	June Taylor
Katie Pasko	

Finally, the GCGW would like to thank a number of donor organizations that supported the service of CCS to the GCGW including the state of Arkansas, Blue Moon Fund, Rockefeller Brothers Fund, New York Community Trust, Energy Foundation, and Sandler Family Supporting Foundation.

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<sup>1</sup> Pearlie Reed served as co-chair of the GCGW until June 17, 2008. Kevin Smith was elected by the Commission to serve as co-chair for the remainder of the GCGW process.

# Members of the Governor's Commission on Global Warming and Advisory Body

**Aubra Anthony, Jr.**, President and Chief Executive Officer, Anthony Forest Products Company

**Nick Brown**, President and Chief Executive Officer, Southwest Power Pool, Inc.

**Joan Cash**, State Legislator / Vice President and Owner, Farm Equipment Sales and Services

**Steve Cousins**, Vice President of Refining, Lion Oil Company

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**Richard Bell**, Agriculture Department

**Lawrence Bengal**, Oil and Gas Commission

**John Bethel**, Public Service Commission

**Richard Davies**, Department of Parks and Tourism

**Maria Haley**, Department of Economic Development

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<sup>1</sup> Pearlie Reed served as co-chair of the Governor's Commission on Global Warming (GCGW) and on the Residential, Commercial, and Industrial (RCI) and Agriculture, Forestry, and Waste Management (AFW) Technical Work Groups (TWGs) until June 17, 2008. Kevin Smith was elected by the Commission to serve as co-chair, and Annette Pagan was appointed by the Governor to serve as Mr. Reed's replacement on the RCI and AFW TWGs, for the remainder of the GCGW process.

**Nancy Ledbetter**, Game and Fish Commission

**Lynn Malbrough**, Highway and Transportation Department

**Teresa Marks**, Department of Environmental Quality

**John Shannon**, Forestry Commission

**Randy Young**, Natural Resources Commission

## Acronyms and Abbreviations

\$/kWh	dollars per kilowatt-hour
\$/MM	millions of dollars
\$/MWh	dollars per megawatt-hour
\$/t	dollars per metric ton
\$/tCO <sub>2</sub> e	dollars per metric ton of carbon dioxide equivalent
ac	acre
ADEQ	Arkansas Department of Environmental Quality
AEO	Arkansas Energy Office
AEO2007	<i>Annual Energy Outlook 2007</i>
AEO2008	<i>Annual Energy Outlook 2008</i>
AFW	Agriculture, Forestry, and Waste Management [Technical Work Group]
AgBMP	[Minnesota] Agriculture Best Management Practices [program]
AHTD	Arkansas State Highway and Transportation Department
APSC	Arkansas Public Service Commission
AR	Arkansas
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
BAU	business as usual
BBtu	billion British thermal units
BMP	best management practice
Btu	British thermal unit
C	carbon
CAA	Clean Air Act
CAFE	corporate average fuel economy
CC	Cross-Cutting Issues [Technical Work Group]
CCS	carbon capture and storage
CCSR	carbon capture and storage or reuse
CCX	Chicago Climate Exchange
cf	cubic feet
CFL	compact fluorescent light
CH <sub>4</sub>	methane
CHP	combined heat and power
CO	carbon monoxide
CO <sub>2</sub>	carbon dioxide
CO <sub>2</sub> e	carbon dioxide equivalent
CRP	Conservation Reserve Program [USDA]
CSA	community-supported agriculture
CUTR	Center for Urban Transportation Research
DEQ	[Arkansas] Department of Environmental Quality
DG	distributed generation
DOE	[United States] Department of Energy

DSM	demand-side management
E10	fuel blend of 10% ethanol and 90% gasoline
E85	fuel blend of 85% ethanol and 15% gasoline
EE	energy efficiency
eGRID	Emissions & Generation Resource Integrated Database
EIA	Energy Information Administration [US DOE]
EISA	Energy Independence and Security Act of 2007
EOR	enhanced oil recovery
EPA	[United States] Environmental Protection Agency
EPRI	Electric Power Research Institute
EPS	environmental portfolio standard
ES	Energy Supply [Technical Work Group]
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FIA	Forest Inventory and Analysis [USFS]
ft	foot
FTE	full-time-equivalent
FY	fiscal year
gal	gallon
GAP	Gap Analysis Program
GCGW	[Arkansas] Governor's Commission on Global Warming
GHG	greenhouse gas
GJ	gigajoule
GM	genetically modified
GPS	global positioning system
REET	Greenhouse gases, Regulated Emissions and Energy use in Transportation [model]
GWh	gigawatt-hour [one million kilowatt-hours]
GWP	global warming potential
HB	House Bill
HB 1055	Act 94 of the Arkansas 86 <sup>th</sup> General Assembly
HB 1379	Act 873 of the Arkansas 86 <sup>th</sup> General Assembly
HB 1654	Act 1061 of the Arkansas 86 <sup>th</sup> General Assembly
HB 2460	Act 696 of the Arkansas 86 <sup>th</sup> General Assembly
HDPE	high-density polyethylene
HDV	heavy-duty vehicle
HFC	hydrofluorocarbon
HOV	high-occupancy vehicle
HR	House Resolution
HUD	[United States] Department of Housing and Urban Development
HVAC	heating, ventilation, and air conditioning
HWP	harvested wood product
I&F	Inventory and Forecast

ICLEI	Local Governments for Sustainability [formerly International Council for Local Environmental Initiatives]
IECC	International Energy Conservation Code
IESNA	Illuminating Engineering Society of North America
IGCC	integrated gasification combined cycle
IPCC	Intergovernmental Panel on Climate Change
K-12	kindergarten through 12th grade
kg	kilogram
kW	kilowatt
kWh	kilowatt-hour
lb	pound
LDPE	low-density polyethylene
LDV	light-duty vehicle
LED	light-emitting diode
LEED	Leadership in Energy and Environmental Design [Green Building Rating System™]
LEED-ND	Leadership in Energy and Environmental Design for Neighborhood Development
LFG	landfill gas
LFGcost	landfill gas cost model
LFGTE	landfill gas-to-energy
LNG	liquefied natural gas
LULC	land use land cover
MAC	mitigation abatement cost
metric ton	1,000 kilograms or 22,051 pounds
MJ	megajoule
MM	million
MMBtu	millions of British thermal units
MMtCO <sub>2</sub> e	million metric tons of carbon dioxide equivalent
mpg	miles per gallon
mph	miles per hour
MS	Mississippi
MSW	municipal solid waste
MW	megawatt [one thousand kilowatts]
MWh	megawatt-hour [one thousand kilowatt-hours]
N	nitrogen
N <sub>2</sub> O	nitrous oxide
N/A	not applicable
NAS	National Academy of Sciences
NAS/NRC	National Academy of Sciences/National Research Council
NEI	National Emissions Inventory
NEMA	National Electrical Manufacturing Association
NG	natural gas

NGCC	natural gas combined cycle
NGO	nongovernmental organization
NGTT	natural gas combustion turbine
NHTS	National Household Travel Survey
NIH	National Institutes of Health
NO <sub>x</sub>	oxides of nitrogen
NOAA	National Oceanic and Atmospheric Administration
NPV	net present value
NRC	Nuclear Regulatory Commission
NRCS	[USDA] Natural Resources Conservation Service
NREL	National Renewable Energy Laboratory [US DOE]
NRI	National Resources Inventory [USDA]
NSF	National Science Foundation
O&M	operation and maintenance
ODS	ozone-depleting substance
PET	polyethylene terephthalate
PFC	perfluororocarbon
PHEV	plug-in hybrid electric vehicle
PRI	Program-Related Investment
PV	photovoltaic
R&D	research and development
RCI	Residential, Commercial, and Industrial [Technical Work Group]
REC	renewable energy certificate
RREC	[University of Arkansas] Rice Research and Extension Center
REFIT	renewable energy feed-in tariff
RPS	renewable portfolio standard
SB	Senate Bill
SB 575	Act 1325 of the Arkansas 85 <sup>th</sup> General Assembly
SB 1160	Act 2294 of the Arkansas 85 <sup>th</sup> General Assembly
SCE	Southern California Edison
SEER	seasonal energy efficiency ratio
SERC	Southeastern Reliability Council
SF <sub>6</sub>	sulfur hexafluoride
SIT	State [GHG] Inventory Tool [US EPA]
SO <sub>x</sub>	oxides of sulfur
SPP	Southwest Power Pool
STASGO	State Soil Geographic Databases
STB	Surface Transportation Board
T&D	transmission and distribution
t	metric ton
tC	metric tons of carbon

tCO <sub>2</sub>	metric tons of carbon dioxide
tCO <sub>2</sub> e	metric tons of carbon dioxide equivalent
tCO <sub>2</sub> e/MWh	metric tons of carbon dioxide equivalent per megawatt-hour
TDR	transfer of development rights
TLU	Transportation and Land Use [Technical Work Group]
TOD	transit-oriented development
TWG	Technical Work Group
UNFCCC	United Nations Framework Convention on Climate Change
USDA	United States Department of Agriculture
US DOE	United States Department of Energy
US EPA	United States Environmental Protection Agency
USFS	United States Forest Service [USDA]
USGS	United States Geological Survey [U.S. Department of the Interior]
VMT	vehicle miles traveled
VOC	volatile organic compound
WARM	Waste Reduction Model [US EPA]
WTE	waste to energy
WWTP	wastewater treatment plant
yr	year

# Executive Summary

## Background

With the signing of Act 696 of the Arkansas 86th General Assembly (HB2460),<sup>1</sup> Governor Mike Beebe established the Governor's Commission on Global Warming (GCGW). By design the Commission represents a wide diversity of views and perspectives with members coming from business, industry, environmental groups, and academia. Seventeen of the 21 members of the Commission were appointed by the Governor and two members each were appointed by the President Pro Tempore of the Arkansas State Senate and by the Speaker of the Arkansas House of Representatives.

As stated by Act 696, the purpose of the GCGW process is "to place Arkansas in a position to help stabilize global climate, to allow Arkansas to lead the nation in attracting clean and renewable energy industries to the state, and to reduce consumer energy dependence on current carbon-generating technologies and expenditures." The primary duties outlined in Act 696 task the GCGW to:

1. "Conduct an in-depth examination and evaluation of the issues related to global warming and the potential impacts of global warming on the state, its citizens, its natural resources, and its economy, including without limitation, agriculture, travel and tourism, recreation, insurance, and economic growth and development."
2. "Based on the commission's evaluation of the current global warming data, the assessment of global warming mitigation strategies, and the available global warming pollutant reduction strategies, the commission shall set forth
  - a. A global warming pollutant reduction goal; and
  - b. A comprehensive strategic plan for implementation of the global warming pollutant reduction goal."

Act 696 includes an Emergency Clause, as follows: "It is found and determined by the General Assembly of the State of Arkansas that it is imperative that Arkansas study the scientific data, literature, and research on global warming to determine whether global warming is an immediate threat to the citizens in the State of Arkansas; that the potential impact of global warming on the state and its citizens, its natural resources, and the economy necessitates a thorough review by the state and a strategy to deal with the consequences of global warming; that economic opportunities might arise from an emerging carbon market tailored to reduce carbon emissions; that failure to take necessary steps to prevent, stabilize, or mitigate the effects of global warming will cause irreparable harm to the lives and livelihoods of Arkansans; and that this act is immediately necessary to ensure the welfare and well-being of the citizens of this state. Therefore, an emergency is declared to exist and this act being immediately necessary for the preservation of the public peace, health, and safety..."

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<sup>1</sup> State of Arkansas, 86th General Assembly, Regular Session, 2007. "Act 696: An Act to Establish the Governor's Commission on Global Warming; to Direct the Commission to Study Issues Related to Global Warming and the Emerging Carbon Market; to Establish a Global Warming Pollutant Reduction Goal and Comprehensive Strategic Plan; and for Other Purposes." Available at: <http://www.arkleg.state.ar.us/ftp/root/acts/2007/public/act696.pdf>.

In fulfillment of the requirements of Act 696, the GCGW provides the following key recommendations and accomplishments:

- Recommendation of a comprehensive set of 54 specific policies to reduce GHG emissions and address climate-, energy-, and commerce-related issues in Arkansas. The GCGW members present and voting approved 28 policy actions unanimously, approved 23 by a super majority (five objections or fewer, including 19 that had only one objection), and approved 3 by a majority (fewer than half object). Explanations of objections are in Appendices F through J of this report, which contain detailed accounts of the GCGW's recommendations.
- Recommendation that Arkansas adopt a statewide, economy-wide global warming pollutant reduction goal to reduce the state's gross greenhouse gas (GHG) emissions below 2000 levels by 20% by 2020, 35% by 2025, and 50% by 2035.<sup>2</sup> The GCGW based its recommendations on its review of the potential overall emission reduction estimates (as compared to the GHG emissions inventory and forecast) for 31 of 54 policy recommendations for which emission reductions were quantified, and its review of goals and targets adopted by several other states. Of the 54 policy recommendations, 31 were analyzed quantitatively to have a cumulative effect of reducing emissions by about 35.5 million metric tons of carbon dioxide equivalent (MMtCO<sub>2</sub>e) in 2020 and 53.3 MMtCO<sub>2</sub>e in 2025. Together, if the 31 quantified policy recommendations and the recent federal actions (or their functional equivalent) are successfully implemented, the 2020 emission reduction goal would be achieved and the 2025 GHG emission reduction goal would come very close to being achieved based on results of analysis of GCGW proposals conducted through the GCGW and Technical Work Group (TWG) process. In addition, the GCGW recommends that the state report to the Governor and the state legislature every 2 years on the state's progress toward achieving the statewide GHG reduction goal and identify future actions and resource needs.
- Evaluation of the direct costs and direct cost savings of the policy recommendations in Arkansas. The GCGW analyzed quantitatively the direct costs or cost savings of 29 of its 54 policy recommendations. Although the total net cost associated with the 29 policies analyzed is estimated at about \$3.7 billion between 2009 and 2025, the weighted-average cost-effectiveness of the 29 policies is estimated to be approximately \$8.8/tCO<sub>2</sub>e reduced. Many of the policies are estimated to yield significant cost-saving opportunities for Arkansans. Other policies will incur net costs.
- Review, update, and approval of a comprehensive inventory and forecast of GHG emissions in Arkansas for 1990 through 2025. This is the first comprehensive, statewide GHG inventory and forecast that has been developed for Arkansas. It has benefited from the expertise of many GCGW, TWG, and Advisory Body members who provided state-specific data.
- A review of the physical science of climate change and potential implications for the southern United States and developments in U.S. law related to climate change issues. The GCGW held a special evening session at which a member of the Intergovernmental Panel on Climate Change presented the results of that panel's study and of the assessments of impacts

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<sup>2</sup> Year 2000 was selected as the base year for the goals because emissions inventory data are more complete for year 2000 than for previous years.

on the southeastern United States, and an environmental attorney presented the current status of international, federal and state law on the subject and the treatment of science under the law.

## **Inventory of Arkansas' Greenhouse Gas Emissions**

In May 2008, the Center for Climate Strategies (CCS) completed a draft GHG emissions inventory and reference case projection to assist the GCGW and TWGs in understanding past, current, and possible future GHG emissions in Arkansas, and thereby inform the policy development process.<sup>3</sup> The preliminary draft was improved by incorporating comments provided by the GCGW and TWGs. As shown in Figure EX-1, the inventory and projections revealed substantial emission growth rates and related mitigation challenges.

Arkansas' GHG emissions are rising faster than those of the nation as a whole. From 1990 to 2005, Arkansas' gross GHG emissions increased by 30%, while national gross emissions rose by 16%.<sup>4</sup> The state's emissions on a per-capita basis increased by about 10% between 1990 and 2005, while U.S. per-capita emissions declined slightly (2%) over this period. On a per-capita basis, Arkansans emitted about 31 metric tons (t) of gross CO<sub>2</sub>e in 2005—higher than the national average of about 24 tCO<sub>2</sub>e. The higher per capita emission rates in Arkansas are driven by emissions growth in the electricity supply, transportation, and agricultural sectors (agricultural sector emissions are twice the national average). In both Arkansas and the nation as a whole, economic growth exceeded emissions growth throughout the 1990–2005 period. From 1990 to 2005, emissions per unit of gross product dropped by 26% nationally, and by 23% in Arkansas.<sup>5</sup> Arkansans' gross GHG emissions are projected to rise fairly steeply to about 114 MMtCO<sub>2</sub>e by 2025, or 74% over 1990 levels.

The principal sources of Arkansas' GHG emissions in 2005 are electricity consumption and transportation, accounting for 32% and 26% of Arkansas' gross GHG emissions, respectively, as shown in Figure EX-2. The direct use of fuels—natural gas, oil products, coal, and wood—in the residential, commercial, and industrial (RCI) sectors accounted for another 18% of the state's emissions in 2005.

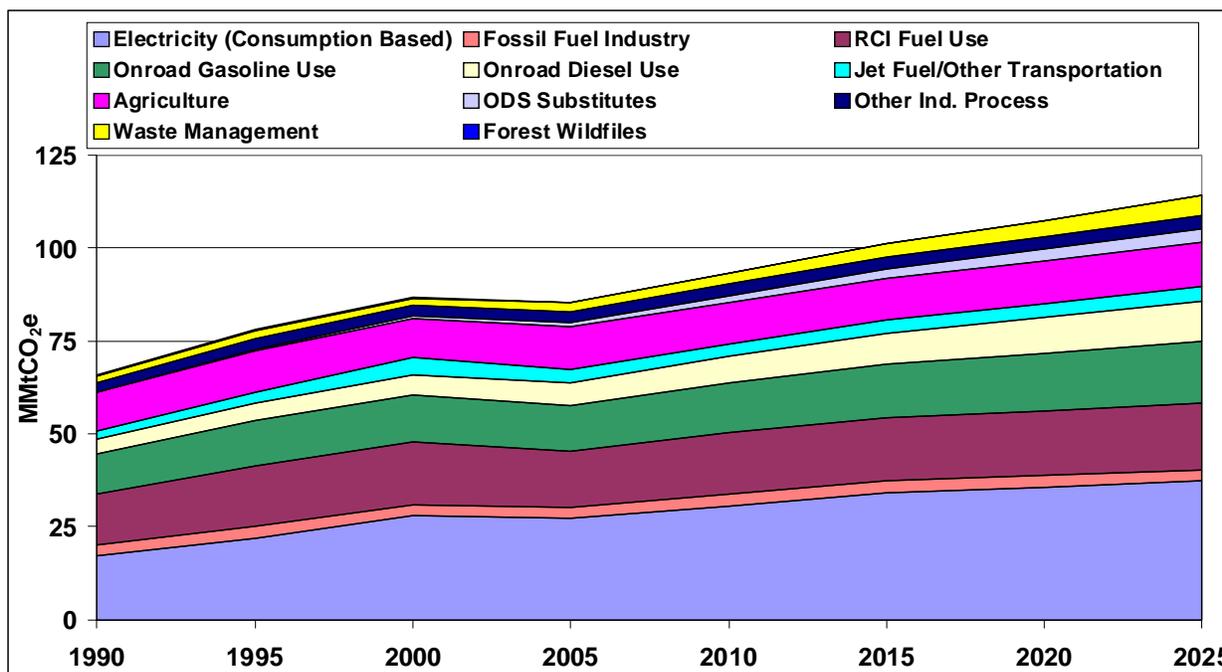
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<sup>3</sup> Center for Climate Strategies. *Draft Arkansas Greenhouse Gas Inventory and Reference Case Projections, 1990–2025*. Prepared for the Arkansas Governor's Commission on Global Warming. May 2008 ([http://www.arclimatechange.us/Inventory\\_Forecast\\_Report.cfm](http://www.arclimatechange.us/Inventory_Forecast_Report.cfm)).

<sup>4</sup> During this period, population grew by 18% in Arkansas and by 19% nationally. However, Arkansas' economy grew at a faster rate on a per capita basis (up 44% vs. 32% nationally).

<sup>5</sup> Based on real gross domestic product (millions of chained 2000 dollars) that excludes the effects of inflation. U.S. Department of Commerce, Bureau of Economic Analysis. "Gross Domestic Product by State." Available at: <http://www.bea.gov/regional/gsp/>.

**Figure EX-1. Gross GHG emissions by sector, 1990–2025: historical and projected (consumption-based approach) business-as-usual/base case**



MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; RCI = direct fuel use in the residential, commercial, and industrial sectors; ODS = ozone depleting substance; Ind. = industrial.

**Figure EX-2. Gross GHG emissions by sector, 2005: Arkansas and U.S.**

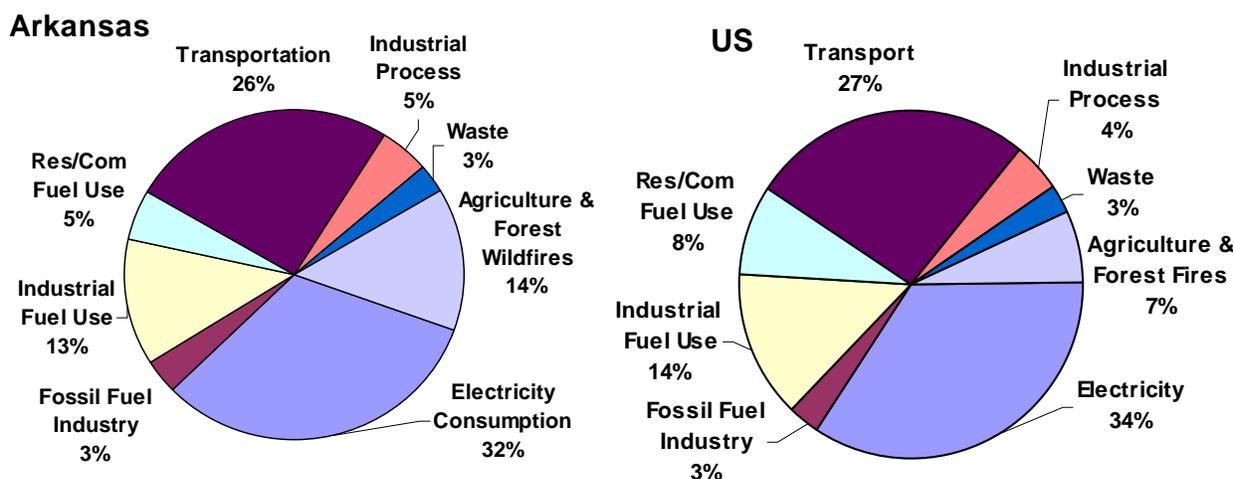


Figure EX-2 shows the agricultural and forest wildfire (including prescribed burning) sectors together accounted for 14% of the gross GHG emissions in Arkansas in 2005. These methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O) emissions primarily come from agricultural soils, rice cultivation, enteric fermentation, and manure management. Industrial process emissions accounted for another 5% of the state’s GHG emissions in 2005, and are rising due to the increasing use of hydrofluorocarbons and perfluorocarbons as substitutes for ozone-depleting

chlorofluorocarbons.<sup>6</sup> Other industrial process emissions include CO<sub>2</sub> released by cement and lime manufacturing; CO<sub>2</sub> released during soda ash, limestone, and dolomite use; CO<sub>2</sub> released during ammonia, urea, and iron and steel production; N<sub>2</sub>O released during nitric acid production; and sulfur hexafluoride released from transformers used in electricity transmission and distribution systems. Also, landfills and wastewater management facilities produce CH<sub>4</sub> and N<sub>2</sub>O emissions that accounted for 3% of total gross GHG emissions in Arkansas in 2005. Similarly, emissions associated with the production, processing, transmission, and distribution of fossil fuels accounted for 3% of the gross GHG emissions in 2005.

Forestry emissions refer to the net CO<sub>2</sub> flux<sup>7</sup> from forested lands in Arkansas, which account for about 56% of the state's land area.<sup>8</sup> Arkansas' forests are estimated to be net sinks of CO<sub>2</sub> emissions in the state, reducing net GHG emissions by 19 MMtCO<sub>2</sub>e in 2005. In addition, estimates of net carbon fluxes from agricultural soil cultivation practices are estimated to be net sinks of CO<sub>2</sub> emissions in Arkansas.

## Recent Actions

Just prior to the beginning of the GCGW process, the federal Energy Independence and Security Act of 2007 (EISA) was signed into law in December 2007. This law contains several requirements that will reduce GHG emissions as they are implemented over the next few years. Sufficient information was identified (e.g., implementation schedules) to estimate GHG emission reductions associated with implementing certain provisions of this law pertaining to increasing corporate average fuel economy for the national on-road vehicle fleet, and energy efficiency requirements for new appliances and lighting. The GHG emission reductions projected to be achieved by these actions when implemented in Arkansas were estimated and included in the baseline of related GCGW policy recommendations. Together, these federal requirements are estimated to reduce gross GHG emissions for all sectors combined in Arkansas by about 3.1 MMtCO<sub>2</sub>e (a 2.9% reduction) from the business-as-usual emissions in 2020, and by about 4.1 MMtCO<sub>2</sub>e (a 3.6% reduction) from the business-as-usual emissions in 2025. Note, however, that GHG emission reductions associated with EISA's Title IV (Energy Savings in Buildings and Industry) and Title V (Energy Savings in Government and Public Institutions) requirements have not been quantified because of the uncertainties in how they will be implemented. It is expected that these requirements will overlap with some of the RCI policy recommendations, especially RCI-2b, RCI-3a, RCI-3b, RCI-4a, and RCI-4b.

Arkansas has recently embarked on statewide energy efficiency programs in response to concerns about energy costs. Ark. Code Ann. §§23-3-401 *et seq.* authorizes the Arkansas Public

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<sup>6</sup> Chlorofluorocarbons are also potent GHGs; however, they are not included in GHG estimates because of concerns related to implementation of the Montreal Protocol on Substances That Affect the Ozone Layer. See Appendix I in the Final Inventory and Projections report for Arkansas ([http://www.arclimatechange.us/Inventory\\_Forecast\\_Report.cfm](http://www.arclimatechange.us/Inventory_Forecast_Report.cfm)).

<sup>7</sup> "Flux" refers to both emissions of CO<sub>2</sub> to the atmosphere and removal (sinks) of CO<sub>2</sub> from the atmosphere.

<sup>8</sup> Total forested acreage in Arkansas is 18.8 million acres. For acreage by forest type, see: Richard A. Birdsey and George M. Lewis. "Carbon in United States Forests and Wood Products, 1987–1997: State-by-State Estimates." Arkansas Estimate for 1987–1997. Available from the U.S. Department of Agriculture, Forest Service, Northern Global Change Research Program, at: <http://www.fs.fed.us/ne/global/pubs/books/epa/states/AR.htm>. The total land area in Arkansas is 33.3 million acres (<http://www.50states.com/arkansas.htm>).

Service Commission (APSC) to develop energy efficiency and conservation programs to address high energy costs. In January 2007, APSC issued its energy efficiency and conservation plan rules. The electric and gas utilities proposed a series of programs in July 2007, and the APSC approved several energy efficiency and conservation programs. The total cost of the initial quick-start programs is approximately \$18,530,924 for the initial 2-year period ending December 31, 2009. Municipal and cooperative electric utilities are also currently pursuing energy efficiency programs.

## **GCGW Policy Recommendations (Beyond Recent Actions)**

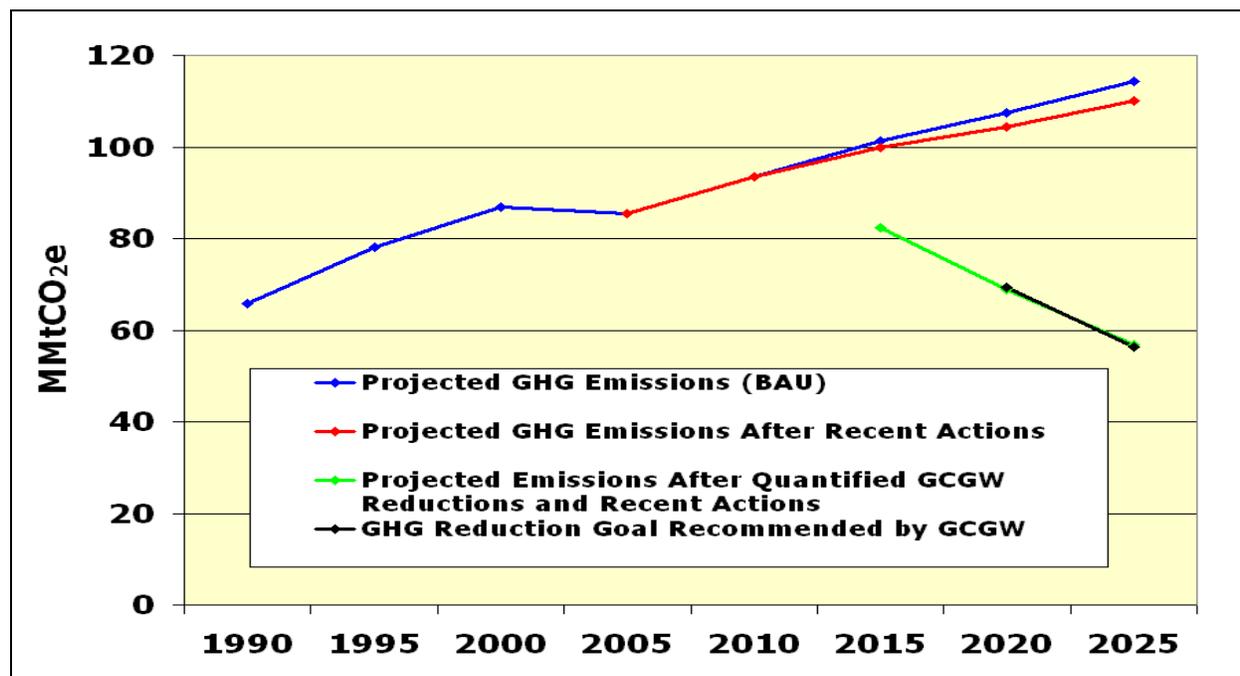
The GCGW recommended 54 policy actions. The GCGW members present and voting approved 28 policy actions unanimously, approved 23 by a super majority (five objections or fewer), and approved 3 by a majority (fewer than half object). Explanations of objections are in Appendices F through J to this report, which contain detailed accounts of the GCGW's recommendations.

A total of 31 of the 54 policy recommendations were analyzed quantitatively to estimate their effects on emissions. Of these 31 analyzed for their emission reductions, 29 were analyzed quantitatively to estimate their costs or cost savings. The 31 recommendations for which emission reductions were quantified were estimated to have a cumulative effect of reducing emissions by about 17.6 MMtCO<sub>2</sub>e in 2015, 35.5 MMtCO<sub>2</sub>e in 2020, and 53.3 MMtCO<sub>2</sub>e in 2025.

Figure EX-3 presents a graphical summary of the potential cumulative emission reductions associated with the recent federal actions and the 31 policy recommendations relative to the business-as-usual reference case projections. Table EX-1 provides the numeric estimates underlying Figure EX-3. In Figure EX-3:

- The blue line shows actual (for 1990, 1995, 2000, and 2005) and projected (for 2010, 2015, 2020, and 2025) levels of Arkansas' gross GHG emissions on a consumption basis. (The consumption-based approach accounts for emissions associated with the generation of electricity in Arkansas to meet the state's demand for electricity)
- The red line shows projected emissions associated with recent federal actions that were analyzed quantitatively.
- The green line shows projected emissions if all of the GCGW's 31 recommendations that were analyzed quantitatively with respect to their GHG reduction potential are implemented successfully and the estimated reductions are fully achieved. (Note that other GCGW recommendations would have the effect of reducing emissions, but those reductions were not analyzed quantitatively, so are not reflected in the green line.)
- The black line shows the projected emission level associated with the GCGW's recommendation for Arkansas to adopt a statewide, economy-wide global warming pollutant reduction goal to reduce the state's gross GHG emissions below 2000 levels by 20% by 2020, 35% by 2025, and 50% by 2035. Together, if the 31 quantified policy recommendations and the recent federal actions (or their equivalent) are successfully implemented, the 2020 emission reduction goal would be achieved and the 2025 GHG emission reduction goal would come very close to being achieved based on results of analysis of GCGW proposals conducted through the GCGW and TWG process.

**Figure EX-3. Annual GHG emissions: reference case projections and GCGW recommendations (consumption-basis, gross emissions)**



MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; GHG = greenhouse gas; GCGW = Governor's Commission on Global Warming.

**Table EX-1. Annual emissions: reference case projections and impact of GCGW recommendations (consumption-basis, gross emissions)**

Annual Emissions (MMtCO <sub>2</sub> e)	1990	2000	2005	2010	2015	2020	2025
Projected GHG Emissions	65.8	86.8	85.4	93.5	101.3	107.5	114.2
Reductions From Recent Actions*			0.0	0.1	1.4	3.1	4.1
Projected GHG Emissions After Recent Actions			85.4	93.4	99.9	104.4	110.1
Total GHG Reductions From 31 Analyzed GCGW Recommendations					17.6	35.5	53.3
Projected Annual Emissions After Quantified GCGW Reductions <sup>†</sup>					82.3	68.9	56.8
2020 and 2025 GHG Reduction Goal Recommended by GCGW						69.4	56.4

MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; GHG = greenhouse gas; GCGW = Governor's Commission on Global Warming.

\* Reductions from recent actions include the Energy Independence and Security Act of 2007, Title III. GHG reductions from Titles IV and V of this Act have not been quantified because of the uncertainties in how they will be implemented. It is expected that Titles IV and V measures will overlap with RCI policies.

<sup>†</sup> Projected annual emissions also include reductions from recent actions.

For the policies recommended by the GCGW to yield the levels of estimated emission reductions shown in Table EX-2, they must be implemented in a timely, aggressive, and thorough manner.

**Table EX-2. Summary by sector of estimated impacts of implementing all of the GCGW recommendations (cumulative reductions and costs/savings)**

Sector	GHG Reductions (MMtCO <sub>2</sub> e)			Net Present Value 2009–2025 (Million \$)	Cost-Effectiveness (\$/tCO <sub>2</sub> e)
	2015	2025	Total 2009–2025		
Residential, Commercial, and Industrial	2.5	9.2	69.8	–\$1,313	–\$19
Energy Supply	6.0	22.6	179.5	\$ 6,228	\$35
Transportation and Land Use	1.3	3.2	28.9	–\$2,244	\$78
Agriculture, Forestry, and Waste Management	7.8	18.3	162.2	\$1,045	\$6.4
Cross-Cutting Issues	Non-quantified, enabling options				
<b>TOTAL (includes all adjustments for overlaps)</b>	<b>17.6</b>	<b>53.3</b>	<b>440.4</b>	<b>\$ 3,717</b>	<b>\$8.8</b>

GHG = greenhouse gas; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; \$/tCO<sub>2</sub>e = dollars per metric ton of carbon dioxide equivalent.

The values in this table do not include the effects of recent actions. Negative values in the Net Present Value and the Cost-Effectiveness columns represent net cost savings associated with the policy recommendations.

Within each sector, values have been adjusted to eliminate double counting for policies or elements of policies that overlap. In addition, values associated with policies or elements of policies within a sector that overlap with policies or elements of policies in another sector have been adjusted to eliminate double counting. Appendix G (for the RCI sectors), Appendix J (for the AFW sectors), and Appendix I (for the TLU sectors) of this report provide documentation of how sector-level emission reductions and costs (or cost savings) were adjusted to eliminate double counting associated with overlaps between policies.

Figure EX-4 presents the estimated tons of reductions for each policy recommendation for which estimates were quantified, expressed as a cumulative figure for the period 2009–2025. Figure EX-5 presents the estimated dollars-per-ton cost (or cost savings, depicted as a negative number) for each policy recommendation for which cost estimates were quantified. This measure is calculated by dividing the net present value of the cost of the policy recommendation by the cumulative GHG reductions, all for the period 2009–2025.

Figure EX-6 presents a stepwise marginal cost curve for Arkansas. The horizontal axis represents the percentage of GHG emissions reduction in 2025 for each option relative to the business as usual (BAU) forecast. The vertical axis represents the marginal cost of mitigation (expressed as the cost-effectiveness of each policy recommendation on a cumulative basis, 2009–2025). In the figure, each horizontal segment represents an individual policy. The width of the segment indicates the GHG emission reduction potential of the option in percentage terms. The height of the segment relative to the x-axis shows the average cost (saving) of reducing one MMtCO<sub>2</sub>e of GHG emissions with the application of the option.

**Table EX-3. Residential, Commercial, and Industrial Policy Recommendations**

No.	Policy Recommendation	GHG Reductions (MMtCO <sub>2</sub> e)			Net Present Value 2009–2025 (Million \$)	Cost-Effectiveness (\$/tCO <sub>2</sub> e)	Level of Support
		2015	2025	Total 2009–2025			
RCI-1*	Improved Building Codes	0.2	0.6	5.3	–\$118	–\$22	Super Majority (1 objection)
RCI-2a*	Utility and Non-Utility DSM for Peak Use Electricity	0.01	0.02	0.21	–\$11	–\$52	Super Majority (1 objection)
RCI-2b*	Utility and Non-Utility DSM and Energy Efficiency for Electricity	1.1	4.1	30.5	–\$1,450	–\$48	Majority (7 objections)
RCI-3a*	Reduced Energy Use in New and Retrofitted State-Owned Buildings	0.1	0.6	4.3	–\$42	–\$10	Super Majority (1 objection)
RCI-3b*	Reduced Energy Use in State-Owned Buildings	0.2	0.4	4.2	–\$46	–\$11	Super Majority (1 objection)
RCI-4a*	Promotion and Incentives for Improved New Building Design and Construction	0.2	1.1	7.0	–\$160	–\$23	Super Majority (1 objection)
RCI-4b*	Promotion and Incentives for Improved Existing Buildings	0.0	0.3	1.7	–\$39	–\$23	Super Majority (1 objection)
RCI-5*	Education for Consumers, Industry Trades, and Professions	<i>Not Quantified</i>					Unanimous
RCI-6 <sup>†</sup>	Incentives and Funds To Promote Renewable Energy and Energy Efficiency	0.2	0.8	5.1	–\$118	–\$23	Super Majority (1 objection)
RCI-7*	Green Power Purchasing for Consumers	0.2	0.6	4.7	\$61	\$13	Unanimous
RCI-8*	Nonresidential Energy Efficiency	0.4	1.0	8.6	\$583	\$68	Unanimous
RCI-9 <sup>†</sup>	Support for Energy-Efficient Communities, Including Smart Growth	<i>Not Quantified</i>					Unanimous
RCI-10 <sup>†</sup>	Energy-Savings Sales Tax	0.0	0.1	0.7	–\$33	–\$47	Super Majority (1 objection)
	<b>Sector Total After Adjusting for Overlaps</b>	<b>2.55</b>	<b>9.24</b>	<b>69.77</b>	<b>–\$1,313</b>	<b>–\$18.8</b>	
	<b>Reductions From Recent Actions (ESIA Title II requirements for new appliances and lighting)</b>	<b>0.34</b>	<b>0.89</b>	<b>8.02</b>	<b><i>Not Quantified</i></b>		
	<b>Sector Total Plus Recent Actions</b>	<b>2.89</b>	<b>10.13</b>	<b>77.79</b>	<b>–\$1,313</b>	<b>–\$18.8</b>	

DSM = demand-side management; EISA = Energy Independence and Security Act of 2007; GHG = greenhouse gas; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; \$/tCO<sub>2</sub>e = dollars per metric ton of carbon dioxide equivalent.

Negative values in the Net Present Value and the Cost-Effectiveness columns represent net cost savings.

The numbering used to denote the above policy recommendations is for reference purposes only; it does not reflect prioritization among these important policy recommendations.

\* The GCGW approved this option at Meeting #9 (September 9, 2008); 18 members present and voting (one by phone).

<sup>†</sup> The GCGW approved this option at Meeting #10 (September 25, 2008); 21 members present and voting (none by phone).

**Table EX-3 (continued). Energy Supply Policy Recommendations**

No.	Policy Recommendation	GHG Reductions (MMtCO <sub>2</sub> e)			Net Present Value (Million \$)	Cost-Effectiveness (\$/tCO <sub>2</sub> e)	Level of Support
		2015	2025	Total 2009–2025			
ES-2*	Technology Research & Development	<i>Not Quantified</i>					Unanimous
ES-3 <sup>†</sup>	3a: Renewable Portfolio Standard (RPS)	0.3	3.6	21.9	\$548	\$25.0	Majority (10 objections)
	3b: Renewable Energy Feed-In Tariff (REFIT)	0.2	2.0	12.3	\$399	\$32.5	Super Majority (4 objections)
ES-4 <sup>†</sup>	Grid-Based Renewable Energy Incentives and/or Barrier Removal	<i>Not Quantified</i>					Unanimous
ES-5 <sup>†</sup>	Approaches Benefiting From Regional Application	<i>Not Quantified</i>					Unanimous
ES-6*	Combined Heat and Power	0.6	2.9	20.0	\$886	\$44.3	Unanimous
ES-7 <sup>†</sup>	Geological Underground Sequestration for New Plants	2.9	5.6	56.5	\$1,801	\$31.9	Majority (10 objections)
ES-8 <sup>†</sup>	Transmission System Upgrades	<i>Not Quantified</i>					Unanimous
ES-9*	Nuclear Power	0.0	9.8	58.9	\$1,574	\$26.7	Unanimous
ES-10 <sup>†</sup>	Carbon Tax	<i>Not Quantified</i>					Super Majority (4 objections)
ES-11*	Efficiency Improvements and Repowering of Existing Plants	2.3	2.3	31.8	\$1,568	\$49.3	Unanimous
	<b>Sector Total After Adjusting for Overlaps</b>	<b>6.0</b>	<b>22.6</b>	<b>179.5</b>	<b>\$6228</b>	<b>\$34.7</b>	
	<b>Reductions From Recent Actions</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>\$0</b>	<b>\$0.0</b>	
	<b>Sector Total Plus Recent Actions</b>	<b>6.0</b>	<b>22.6</b>	<b>179.5</b>	<b>\$6,228</b>	<b>\$34.7</b>	

CCS = carbon capture and storage; GHG = greenhouse gas; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; \$/tCO<sub>2</sub>e = dollars per metric ton of carbon dioxide equivalent.

Negative values in the Net Present Value and the Cost-Effectiveness columns represent net cost savings.

The numbering used to denote the above policy recommendations is for reference purposes only; it does not reflect prioritization among these important policy recommendations. ES-1 (Green Power Purchases and Marketing) was combined with RCI-7 (Green Power Purchasing for Consumers).

\* The GCGW approved this option at Meeting #9 (September 9, 2008); 18 members present and voting (one by phone).

<sup>†</sup> The GCGW approved this option at Meeting #10 (September 25, 2008); 21 members present and voting (none by phone).

**Table EX-3 (continued). Transportation and Land Use Policy Recommendations**

No.	Policy Recommendation	GHG Reductions (MMtCO <sub>2</sub> e)			Net Present Value 2009–2025 (Million \$)	Cost-Effective-ness (\$/tCO <sub>2</sub> e)	Level of Support
		2015	2025	Total 2009–2025			
TLU-1*	Study the Feasibility of Plug-In Vehicles	<i>Not Quantified—Qualitative Study Recommendation</i>					Unanimous
TLU-2 <sup>†</sup>	Research and Development of Renewable Transportation Fuels	<i>Incorporated Into Analysis for TLU-3</i>					Super Majority (1 objection)
TLU-3 <sup>†</sup>	Advanced Biofuels Development and Expansion	0.88	2.54	21.26	–\$2,293	–\$108	Super Majority (1 objection)
TLU-4*	Smart Growth, Pedestrian and Bicycle Infrastructure	0.06	0.17	1.39	≤0 (Net Savings)	≤0 (Net Savings)	Unanimous
TLU-5*	Improve and Expand Transit Service and Infrastructure	0.001	0.007	0.03	1.5	\$1,479	Unanimous
TLU-6 <sup>†</sup>	School and University Transportation Bundle	0.006	0.013	0.113	N/A	N/A	Unanimous
TLU-7*	Promote and Facilitate Freight Efficiency	0.33	0.47	6.1	\$48	\$104	Unanimous
TLU-8 <sup>†</sup>	Procurement of Efficient Fleet Vehicles (Passenger and Freight)	<i>State "Lead by Example" Qualitative Recommendation</i>					Unanimous
TLU-9 <sup>†</sup>	Fuel Efficiency: Clean Car Incentive	<i>Not Quantified—Qualitative Study Recommendation</i>					Super Majority (1 objection)
TLU-10*	Public Education	<i>Not Quantified</i>					Unanimous
	<b>Sector Total After Adjusting for Overlaps</b>	<b>1.28</b>	<b>3.2</b>	<b>28.89</b>	<b>–\$2,244</b>	<b>–\$78</b>	
	<b>Reductions From Recent Actions (Federal CAFE Requirements)</b>	<b>1.02</b>	<b>3.26</b>	<b>26.9</b>	<b>Not Quantified</b>		
	<b>Sector Total Plus Recent Actions</b>	<b>2.29</b>	<b>6.45</b>	<b>30.2</b>	<b>–\$2,244</b>	<b>–\$78</b>	

CAFE = corporate average fuel economy; GHG = greenhouse gas; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; \$/tCO<sub>2</sub>e = dollars per metric ton of carbon dioxide equivalent; N/A = not applicable.

Negative values in the Net Present Value and the Cost-Effectiveness columns represent net cost savings.

The numbering used to denote the above policy recommendations is for reference purposes only; it does not reflect prioritization among these important policy recommendations.

\* The GCGW approved this option at Meeting #9 (September 9, 2008); 18 members present and voting (one by phone).

<sup>†</sup> The GCGW approved this option at Meeting #10 (September 25, 2008); 21 members present and voting (none by phone).

**Table EX-3 (continued). Agriculture, Forestry, and Waste Management Policy Recommendations**

No.	Policy Recommendation		GHG Reductions (MMtCO <sub>2</sub> e)			Net Present Value 2009–2025 (Million \$)	Cost-Effectiveness (\$/tCO <sub>2</sub> e)	Level of Support
			2015	2025	Total 2009–2025			
AFW-1*	Manure Management		Not quantified					Unanimous
AFW-2†	Promotion of Farming Practices That Achieve GHG Benefits	Soil Carbon	0.5	1.3	11	–\$71	–\$6	Super Majority (1 objection)
		Nutrient Efficiency	0.1	0.3	2.4	–\$66	–\$27	
AFW-3†	Improved Water Management and Use	Increased Surface Water	0.005	0.01	0.10	\$86	\$835	Super Majority (1 objection)
		Improved Purification	0.001	0.001	0.01	–\$0.4	–\$39	
AFW-4†	Expanded Use of Agriculture and Forestry Biomass Feedstocks for Electricity, Heat, or Steam Production	Energy From Biomass	2.1	4.2	41	\$1,637	\$40	Super Majority (1 objection)
		Energy From Livestock Manure and Poultry Litter	0.01	0.02	0.2	\$0.8	\$4	
		Capture of Waste Heat	0.02	0.06	0.50	–\$70	–\$140	
AFW-5†	Expanded Use of Advanced Biofuels		1.4	2.2	20	\$114	\$6	Unanimous
AFW-6†	Expanded Use of Locally Produced Farm and Forest Products		0.03	0.06	0.6	\$2	\$4	Unanimous
AFW-7†	Forest Management and Establishment for Carbon Sequestration	Urban Forestry	0.02	0.1	0.4	\$17	\$41	Unanimous
		Sustainable Forest Management	4.1	10.4	91	\$1,139	\$21	
		Afforestation	0.7	1.8	16	\$201	\$12	
AFW-8†	Advanced Recovery and Recycling		1.5	4.4	36	–\$283	–\$8	Super Majority (1 objection)
AFW-9†	End-of-Use Waste Management Practices		0.02	0.02	0.4	–\$1	–\$3	Super Majority (1 objection)
	<b>Sector Total After Adjusting for Overlaps</b>		<b>7.8</b>	<b>18.3</b>	<b>162.2</b>	<b>\$1,045</b>	<b>\$6.4</b>	
	<b>Reductions From Recent Actions</b>		<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>\$0.0</b>	<b>\$0.0</b>	
	<b>Sector Total Plus Recent Actions</b>		<b>7.8</b>	<b>18.3</b>	<b>162.2</b>	<b>\$1,045</b>	<b>\$6.4</b>	

GHG = greenhouse gas; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; \$/tCO<sub>2</sub>e = dollars per metric ton of carbon dioxide equivalent.

Negative values in the Net Present Value and the Cost-Effectiveness columns represent net cost savings.

The numbering used to denote the above policy recommendations is for reference purposes only; it does not reflect prioritization among these important policy recommendations.

\* The GCGW approved this option at Meeting #8 (July 31, 2008); 19 members present and voting (two by phone).

† The GCGW approved this option at Meeting #9 (September 9, 2008); 18 members present and voting (one by phone).

**Table EX-3 (continued). Cross-Cutting Issues Policy Recommendations**

No.	Policy Recommendation	GHG Reductions (MMtCO <sub>2</sub> e)			Net Present Value 2009–2025 (Million \$)	Cost-Effectiveness (\$/tCO <sub>2</sub> e)	Level of Support
		2015	2025	Total 2009–2025			
CC-1 <sup>†</sup>	Greenhouse Gas Inventories and Forecasts	<i>Not Quantified</i>					Unanimous
CC-2 <sup>‡</sup>	State Greenhouse Gas Reporting and Registry	<i>Not Quantified</i>					Unanimous
CC-3 <sup>‡</sup>	Statewide Greenhouse Gas Reduction Goals or Targets	<i>Not Quantified</i>					Super Majority (3 objections)
CC-4*	The State's Own Greenhouse Gas Emissions (Lead by Example)	<i>Not Quantified</i>					Unanimous
CC-5*	Comprehensive Local Government Climate Action Plans	<i>Not Quantified</i>					Super Majority (1 objection)
CC-6*	State Climate Public Education and Outreach	<i>Not Quantified</i>					Super Majority (1 objection)
CC-7 <sup>‡</sup>	Optimizing Best Scale of Reduction Policies	<i>Not Quantified</i>					Unanimous
CC-8 <sup>†</sup>	Creative Financial Mechanisms	<i>Not Quantified</i>					Super Majority (1 objection)
CC-9*	Adaptation and Vulnerability	<i>Not Quantified</i>					Super Majority (1 objection)
CC-10 <sup>†</sup>	Climate Change-Related Economic Development	<i>Not Quantified</i>					Unanimous
CC-11 <sup>†</sup>	Regulatory Realignment in Government To Encourage Constructive Climate Action	<i>Not Quantified</i>					Super Majority (2 objections)

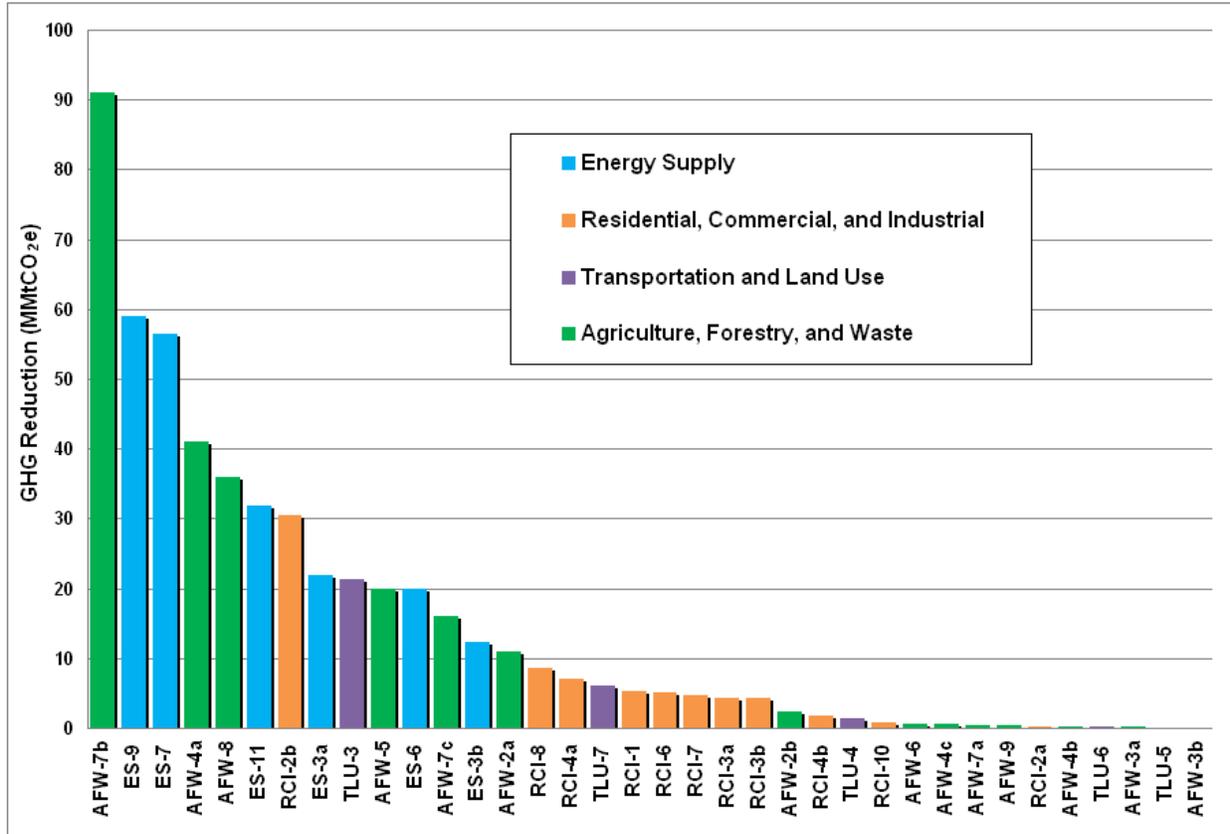
GHG = greenhouse gas; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; \$/tCO<sub>2</sub>e = dollars per metric ton of carbon dioxide equivalent.

The numbering used to denote the above policy recommendations is for reference purposes only; it does not reflect prioritization among these important policy recommendations.

\* The GCGW approved this option at Meeting #8 (July 31, 2008); 19 members present and voting (two by phone).

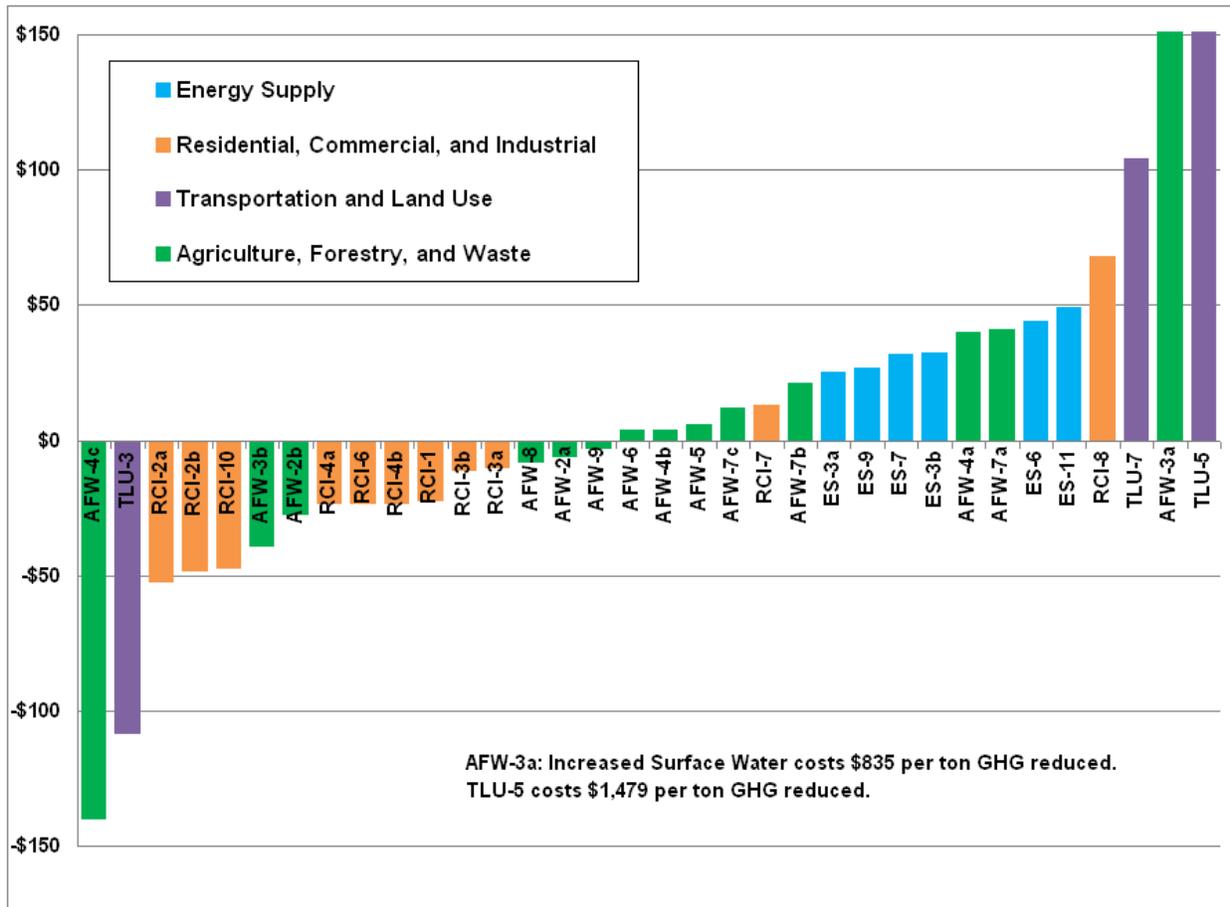
† The GCGW approved this option at Meeting #10 (September 25, 2008); 21 members present and voting (none by phone).

**Figure EX-4. GCGW policy recommendations ranked by cumulative (2009–2025) GHG reduction potential**



GHG = greenhouse gas; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; AFW = Agriculture, Forestry, and Waste Management; RCI = Residential, Commercial, and Industrial; TLU = Transportation and Land Use; ES = Energy Supply.

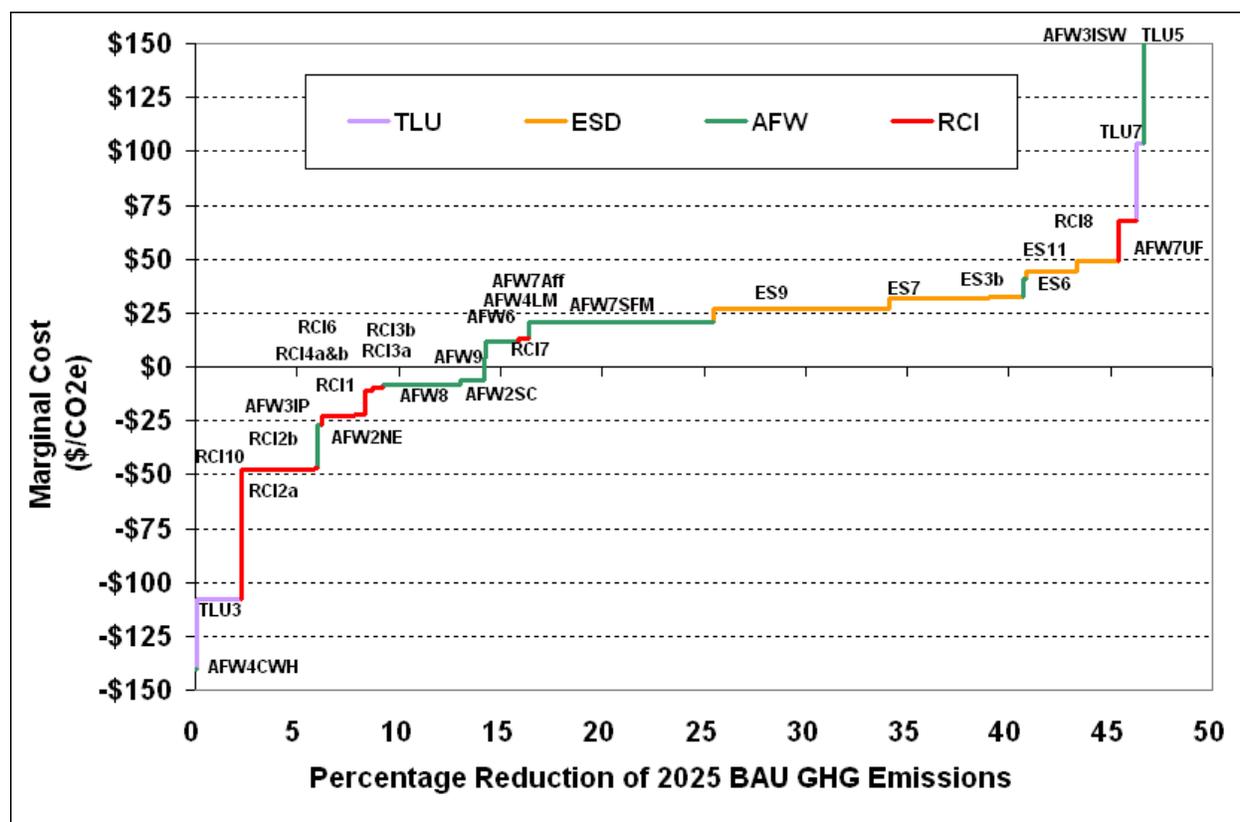
**Figure EX-5. GCGW policy recommendations ranked by cumulative (2009–2025) net cost/cost savings per ton of GHG removed**



GHG = greenhouse gas; RCI = Residential, Commercial, and Industrial; TLU = Transportation and Land Use; ES = Energy Supply; AFW = Agriculture, Forestry, and Waste Management.

Negative values represent net cost savings and positive values represent net costs associated with the policy recommendation.

Figure EX-6. Stepwise marginal cost curve for Arkansas, 2025



BAU = business as usual; GHG = greenhouse gas; tCO<sub>2</sub>e = metric tons of carbon dioxide equivalent; AFW = Agriculture, Forestry, and Waste Management; RCI = Residential, Commercial, and Industrial; TLU = Transportation and Land Use; ES = Energy Supply.

Negative values represent net cost savings and positive values represent net costs associated with the policy recommendation.

Note: Results have been adjusted to remove overlaps between policies. AFW 3a and TLU 5 are not shown due to scale effects. AFW 3a costs \$835 per ton CO<sub>2</sub>e reduced, and TLU 5 costs \$1,479/ton.

## Summary of Current Scientific Literature on Causes and Impacts of Global Warming

All panels of scientists who have reviewed the science of climate change have concluded that there is a 90 to 95% probability that human activities have increased amounts of important GHGs (primarily CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O, and fluorocarbons) in the atmosphere to levels not seen in all of prior human experience, and likely not seen for 3 million years. *See, Fourth Report of the Intergovernmental Panel on Climate Change (IPCC) (2007)* and in at least three reports of the National Research Council of the National Academy of Sciences (NAS/NRC), *Climate Change Science: An Analysis of Some Key Questions* (2001) (“Climate Change Science”), NAS/NRC, *Surface Temperature Reconstructions for the Last 2,000 Years* (2006); NAS/NRC, *Abrupt Climate Change: Inevitable Surprises* (2002). These findings are also reflected in the summary of science prepared by the U.S. Environmental Protection Agency (U.S. EPA) in the Advance Notice of Proposed Rulemaking, *Regulating Greenhouse Gas Emissions Under the Clean Air Act*, 73 Fed. Reg. 44354 (July 30, 2008). Scientists have already observed increased temperatures

and a variety of related effects and, because GHGs have very long residence times in the atmosphere, if no action is taken to restrict emissions, impacts are likely to increase dramatically.

There are a variety of impacts that are expected to affect Arkansas. These include increases in severe weather events and drought, which, in turn, can be expected to adversely affect agriculture. Floods are expected to increase in frequency with related expansion of floodplains and flood damage. Sea level rise will inundate some nearby coastal areas, and related salt-water intrusion, coupled with increased drought stress may impact water supplies. In areas dependent on snow pack, such as the western United States, water supplies will be more severely affected. Ecosystems and sensitive species could be disrupted as climatic zones move north. Tropical diseases and insects will move north. Heat-related deaths will increase, although cold-related deaths will decrease. Climate change impacts in volatile regions of the world could destabilize these areas and pose a national security threat. There is also a possibility of sudden and dramatic climate change that cannot be predicted, but would have far greater and adverse impacts.

Although there are books and articles in the popular press that raise questions about climate change, none have been scientifically peer reviewed. The body of literature that has undergone peer review is virtually unanimous in concluding that human activities have affected climate and that the effects will increase if anthropogenic GHG emissions are not reduced. None of the skeptics will say to a reasonable degree of scientific certainty that emissions of GHGs will not have adverse impacts. The applicable legal standards require action if adverse impacts can be reasonably anticipated. See 42 U.S.C. §§ 7408(a)(1) (“air pollution which may reasonably be anticipated to endanger public health or welfare”), 7411(b)(1)(A) (same), 7521(a)(1) (same), 7547(a)(1)(same), 7571(a)(2)(A)(same); see also United Nations Framework Convention on Climate Change, art. 3, §3.

# Chapter 1

## Background and Overview

### Creation of the Governor's Commission on Global Warming

#### Arkansas Act 696

With the signing of Act 696 of the Arkansas 86th General Assembly (HB2460),<sup>1</sup> Governor Mike Beebe established the Governor's Commission on Global Warming (GCGW). By design, the Commission represents a wide diversity of views and perspectives, with members coming from business, industry, environmental groups, and academia. Seventeen of the 21 members of the Commission were appointed by the Governor, and two members each were appointed by the President Pro Tempore of the Arkansas State Senate and by the Speaker of the Arkansas House of Representatives.

As stated by Act 696, the purpose of the GCGW process is to place Arkansas in a position to help stabilize global climate, to allow Arkansas to lead the nation in attracting clean and renewable energy industries to the state, and to reduce consumer energy dependence on current carbon-generating technologies and expenditures. The primary duties outlined in Act 696 task the GCGW to:

1. "Conduct an in-depth examination and evaluation of the issues related to global warming and the potential impacts of global warming on the state, its citizens, its natural resources, and its economy, including without limitation, agriculture, travel and tourism, recreation, insurance, and economic growth and development."
2. "Based on the commission's evaluation of the current global warming data, the assessment of global warming mitigation strategies, and the available global warming pollutant reduction strategies, the commission shall set forth
  - a. A global warming pollutant reduction goal; and
  - b. A comprehensive strategic plan for implementation of the global warming pollutant reduction goal."

Act 696 includes an Emergency Clause, as follows: "It is found and determined by the General Assembly of the State of Arkansas that it is imperative that Arkansas study the scientific data, literature, and research on global warming to determine whether global warming is an immediate threat to the citizens in the State of Arkansas; that the potential impact of global warming on the state and its citizens, its natural resources, and the economy necessitates a thorough review by the state and a strategy to deal with the consequences of global warming; that economic opportunities might arise from an emerging carbon market tailored to reduce carbon emissions; that failure to take necessary steps to prevent, stabilize, or mitigate the effects of global warming will cause irreparable harm to the lives and livelihoods of

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<sup>1</sup> State of Arkansas, 86th General Assembly, Regular Session, 2007. "Act 696: An Act to Establish the Governor's Commission on Global Warming; to Direct the Commission to Study Issues Related to Global Warming and the Emerging Carbon Market; to Establish a Global Warming Pollutant Reduction Goal and Comprehensive Strategic Plan; and for Other Purposes." Available at: <http://www.arkleg.state.ar.us/ftp/root/acts/2007/public/act696.pdf>.

Arkansans; and that this act is immediately necessary to ensure the welfare and well-being of the citizens of this state. Therefore, an emergency is declared to exist and this act being immediately necessary for the preservation of the public peace, health, and safety...”

## **GCGW’s Response**

In fulfillment of the requirements of Act 696, the GCGW provides the following key recommendations and accomplishments:

- Recommendation of a comprehensive set of 54 specific policies to reduce GHG emissions and address climate-, energy-, and commerce-related issues in Arkansas. The GCGW members present and voting approved 28 policy actions unanimously, approved 23 by a super majority (five objections or fewer, including 19 that had only one objection), and approved 3 by a majority (fewer than half object). Explanations of objections are in Appendices F through J of this report, which contain detailed accounts of the GCGW’s recommendations.
- Recommendation that Arkansas adopt a statewide, economy-wide global warming pollutant reduction goal to reduce the state’s gross greenhouse gas (GHG) emissions below 2000 levels by 20% by 2020, 35% by 2025, and 50% by 2035.<sup>2</sup> The GCGW based its recommendations on its review of the potential overall emission reduction estimates (as compared to the GHG emissions inventory and forecast) for 31 of 54 policy recommendations for which emission reductions were quantified, and its review of goals and targets adopted by several other states. Of the 54 policy recommendations, 31 were analyzed quantitatively to have a cumulative effect of reducing emissions by about 35.5 million metric tons of carbon dioxide equivalent (MMtCO<sub>2</sub>e) in 2020 and 53.3 MMtCO<sub>2</sub>e in 2025. Together, if the 31 quantified policy recommendations and the recent federal actions (or their functional equivalent) are successfully implemented, the 2020 emission reduction goal would be achieved, and the 2025 GHG emission reduction goal would come very close to being achieved based on results of analysis of GCGW proposals conducted through the GCGW and Technical Work Group (TWG) process. In addition, the GCGW recommends that the state report to the Governor and the state legislature every 2 years on the state’s progress toward achieving the statewide GHG reduction goal, and identify future actions and resource needs.
- Evaluation of the direct costs and direct cost savings of the policy recommendations in Arkansas. The GCGW analyzed quantitatively the direct costs or cost savings of 29 of its 54 policy recommendations. Although the total net cost associated with the 29 policies analyzed is estimated at about \$3.7 billion between 2009 and 2025, the weighted-average cost-effectiveness of the 29 policies is estimated to be approximately \$8.8/tCO<sub>2</sub>e reduced. Many of the policies are estimated to yield significant cost-saving opportunities for Arkansans. Other policies will incur net costs.
- Review, update, and approval of a comprehensive inventory and forecast of GHG emissions in Arkansas for 1990 through 2025. This is the first comprehensive, statewide GHG inventory and forecast that has been developed for Arkansas. It has benefited from the

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<sup>2</sup> Year 2000 was selected as the base year for the goals because emissions inventory data are more complete for year 2000 than for previous years.

expertise of many GCGW, TWG, and Advisory Body members who provided state-specific data.

- A review of the physical science of climate change and potential implications for the southern United States and developments in U.S. law related to climate change issues. The GCGW held a special evening session at which a member of the Intergovernmental Panel on Climate Change presented the results of that panel's study and of the assessments of impacts on the southeastern United States, and an environmental attorney presented the current status of international, federal, and state law on the subject and the treatment of science under the law.

## **Recent Actions**

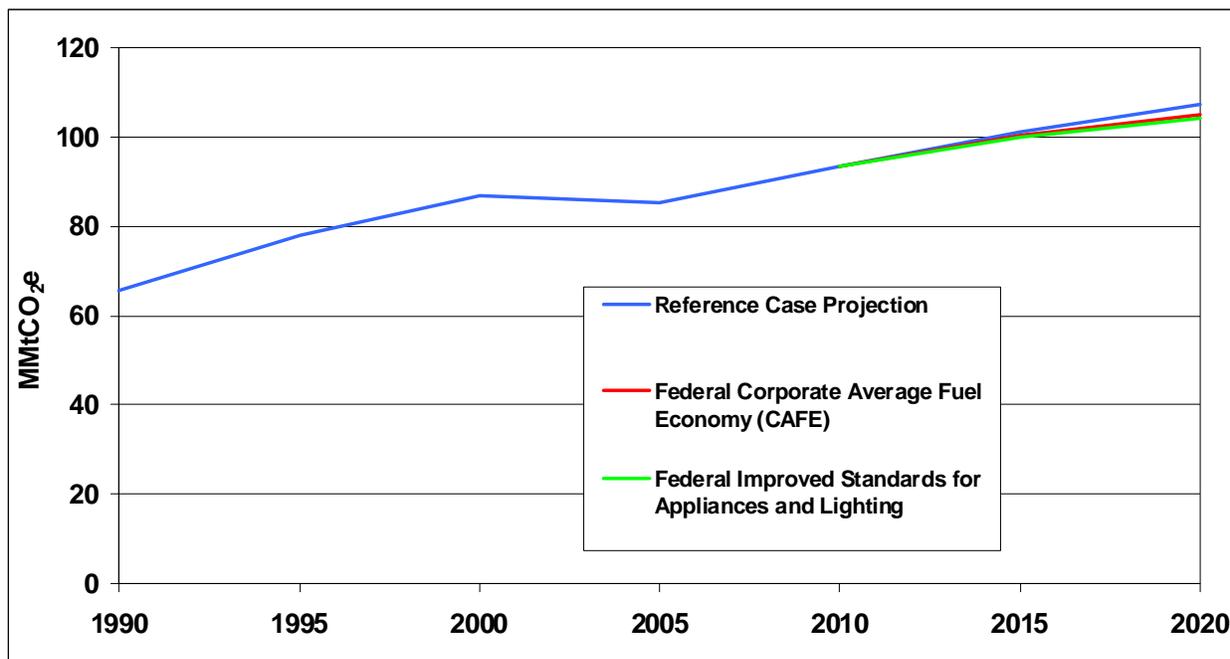
### **GHG Reductions Associated With Recent Federal Actions**

The federal Energy Independence and Security Act of 2007 (EISA) was signed into law in December 2007. This law contains several requirements that will reduce GHG emissions as they are implemented over the next few years. During the GCGW process, sufficient information was identified (e.g., implementation schedules) to estimate GHG emission reductions associated with implementing the Corporate Average Fuel Economy requirements and energy efficiency requirements for new appliances and lighting in Arkansas. The GHG emission reductions projected to be achieved by these actions are shown in Figure 1-1. Table 1-1 provides the numeric estimates underlying Figure 1-1. Together, these federal requirements are estimated to reduce gross GHG emissions for all sectors combined in Arkansas by about 3.1 MMtCO<sub>2</sub>e (a 2.9% reduction) from the business-as-usual emissions in 2020, and by about 4.1 MMtCO<sub>2</sub>e (a 3.6% reduction) from the business-as-usual emissions in 2025. Note, however, that GHG emission reductions associated with the EISA's Title IV (Energy Savings in Buildings and Industry) and Title V (Energy Savings in Government and Public Institutions) requirements have not been quantified because of the uncertainties in how they will be implemented. It is expected that these requirements will overlap with some of the residential, commercial, and industrial (RCI) sector policy recommendations, especially RCI-2b, RCI-3a, RCI-3b, RCI-4a, and RCI-4b.

### **Recent State Actions**

Arkansas has recently embarked on statewide energy efficiency programs in response to concerns about energy costs. Ark. Code Ann. §§23-3-401 *et seq.* authorizes the Arkansas Public Service Commission (APSC) to develop energy efficiency and conservation programs to address high energy costs. In January 2007, APSC issued its energy efficiency and conservation plan rules. The electric and gas utilities proposed a series of programs in July 2007, and the APSC approved several energy efficiency and conservation programs. The total cost of the initial quick-start programs is approximately \$18,530,924 for the initial 2-year period ending December 31, 2009. Municipal and cooperative electric utilities are also currently pursuing energy efficiency programs.

**Figure 1-1. Estimated emission reductions associated with the effect of recent federal actions in Arkansas (consumption-basis, gross emissions)**



**Table 1-1. Estimated emission reductions associated with the effect of recent federal actions in Arkansas (consumption-basis, gross emissions)**

Sector / Recent Action	GHG Reductions		GHG Emissions (MMtCO <sub>2</sub> e)	
	(MMtCO <sub>2</sub> e)		Business as Usual	With Recent Actions
	2012	2020	2020	2020
<b>Residential, Commercial and Industrial (RCI)</b>				
Energy Efficiency Requirements for New Appliances and Lighting	0.34	0.89	18.1	17.2
<b>Transportation and Land Use (TLU)</b>				
Corporate Average Fuel Economy (CAFE) Requirements	1.02	3.26	31.1	27.8
<b>Total (RCI + TLU Sectors)</b>	<b>1.35</b>	<b>4.14</b>	<b>49.2</b>	<b>45.0</b>
<b>Total (All Sectors)</b>	—	—	<b>114.2</b>	<b>110.1</b>

GHG = greenhouse gas; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent.

## The GCGW Process

The GCGW began its deliberative process at its third meeting on February 7, 2008, and met a total of nine times, with the final decisional meeting held on September 25, 2008, followed by a conference call for review of this report. In all, more than 75 meetings and teleconferences of the GCGW and the five supporting TWGs were held to identify and analyze various potential policy actions in advance of the GCGW's September 25, 2008, final decisional meeting.

The five TWGs considered information and potential recommendations in the following sectors:

- Residential, Commercial, and Industrial (RCI);
- Energy Supply (ES);
- Transportation and Land Use (TLU);
- Agriculture, Forestry, and Waste Management (AFW); and
- Cross-Cutting Issues (CC) (i.e., issues that cut across the above sectors).

The Center for Climate Strategies (CCS) provided facilitation and technical assistance to the GCGW and each of the TWGs, based on a detailed proposal approved by the GCGW. The TWGs consisted of only GCGW members; however, the Commission established and appointed an Advisory Body composed of the directors of the following state agencies: Agriculture Department, Department of Environmental Quality, Forestry Commission, Highway and Transportation Department, Natural Resources Commission, Public Service Commission, State Game and Fish Commission, Department of Economic Development, Department of Parks and Tourism, and Oil and Gas Commission. Advisory Body members were assigned to each TWG to assist in responding to questions and providing technical information as requested by the GCGW members (see Appendix C for a listing of the TWG and Advisory Body members of each TWG). Members of the public were invited to observe and provide input at all meetings of the GCGW and TWGs. The TWGs served as advisers to the GCGW and helped generate initial recommendations on Arkansas-specific policy options to be added to the catalog of existing states actions; priority policy recommendations for analysis; draft proposals on the design characteristics and quantification of the proposed policy recommendations; specifications and assistance for analysis of draft policy options (including best available data sources, methods and assumptions); and other key elements of policy option proposals, including related policies and programs, key uncertainties, co-benefits and costs, feasibility issues, and potential barriers to consensus. Where members of a TWG did not fully agree on recommendations to the GCGW, the summary of their efforts was reported to the GCGW as a part of its consideration and actions. The GCGW then made its decisions after reviewing the TWGs' proposals, including modifications as deemed appropriate in their judgment.

The GCGW process employed a model of informed self-determination through a facilitated, stepwise, fact-based, and consensus-building approach. With oversight by the Arkansas Governor's Office, the process was conducted by CCS, an independent, expert facilitation and technical analysis team. It was based on procedures that CCS has used in a number of other state climate change planning initiatives since 2000, but was adapted specifically for Arkansas. The GCGW process sought but did not mandate consensus, and it explicitly documented the level of GCGW support for policies and key findings through a voting process established in advance, including barriers to full consensus where they existed on final consideration of proposed actions.

The 54 policy recommendations (out of more than 300 potential options considered) adopted by the GCGW and presented in this report were developed through a stepwise approach that included: (1) expanding a list existing states actions to include additional Arkansas-specific actions; (2) developing a set of "priority for analysis" options for further development; (3) fleshing these proposals out for full analysis by development of "straw proposals" for level of

effort, timing and parties involved in implementation; (4) developing and applying a common framework of analysis for options, including sector specific guidance and detailed specifications for options that include data sources, methods and key assumptions; (5) reviewing results of analysis and modifying proposals as needed to address potential barriers to consensus; (6) finalizing design and analysis of options to remove barriers to final agreement; and (7) developing other key elements of policy proposals such as implementation mechanisms, co-benefits, and feasibility considerations. At the final three meetings of the process, policy recommendations with at least majority support (defined as less than half of those present objecting) from GCGW members present were adopted by the GCGW and included in this report. The TWGs' recommendations to the GCGW were documented and presented to the GCGW at each GCGW meeting. All of the GCGW and TWG meetings were open to the public, and all materials for and summaries of the GCGW and TWG meetings were posted on the GCGW Web site ([www.arclimatechange.us](http://www.arclimatechange.us)). A detailed description of the deliberative process is included in Appendix B.

## Analysis of Policy Recommendations

With CCS providing facilitation and technical analysis, the five TWGs submitted recommendations for policies for GCGW consideration using a “policy option template” conveying the following key information:

- Policy Description
- Policy Design (Goals, Timing, Parties Involved)
- Implementation Mechanisms
- Related Policies/Programs in Place
- Type(s) of GHG Reductions
- Estimated GHG Reductions and Net Costs or Cost Savings
- Key Uncertainties
- Additional Benefits and Costs
- Feasibility Issues
- Status of Group Approval
- Level of Group Support
- Barriers to Consensus

In its deliberations, the GCGW reviewed, modified, and reached group agreement on various policy recommendations. The final versions for each sector, conforming to the policy option templates, appear in Appendices F through J and constitute the most detailed record of decisions of the GCGW. Appendix E describes the methods used for quantification of the 31 policy recommendations that were analyzed quantitatively. The quantitative analysis produced estimates of the GHG emission reductions and direct net costs (or cost savings) of implementation of various policies, in terms of both a net present value from 2009 to 2025 and a dollars-per-ton cost (i.e., cost-effectiveness). The key methods are summarized below.

**Estimates of GHG Reductions:** Using the projection of future GHG emissions (see below) as a starting point, 31 policy recommendations were analyzed by CCS to estimate GHG reductions attributable to each policy in the individual years of 2015 and 2025 and cumulative reductions over the period 2009–2025. The estimates were prepared in accordance with guidance by the

appropriate TWG and the GCGW, which later reviewed the estimates and, in some cases, directed that they be revised with respect to such elements as goals, data sources, assumptions, sensitivity analysis, and methodology. Many policies were estimated to affect the quantity or type of fossil fuel combusted; others affected methane or CO<sub>2</sub> sequestered. Among the many assumptions involved in this task was selection of the appropriate GHG accounting framework—namely, the choice between taking a “production-based” approach versus a “consumption-based” approach to various sectors of the economy.<sup>3</sup>

**Estimates of Costs/Cost Savings:** The analyses of 29 policy recommendations included estimates of the direct cost of those policies, in terms of both net costs or cost savings during 2009–2025 and a dollars-per-ton cost (i.e., cost-effectiveness). (The other two policy recommendations that were analyzed with respect to their GHG reductions were such that their costs or cost savings could not be readily estimated.) Following is a brief summary of the approach used to estimate the costs or cost savings associated with the policy recommendations:

- *Discounted and annualized costs or cost savings*—Standard approaches were taken here. The net present value of costs or cost savings was calculated by applying a real discount rate of 5%. Dollars-per-ton estimates were derived as an annualized cost per ton, dividing the present value cost or savings by the cumulative GHG reduction measured in tons. As was the case with GHG reductions, the period 2009–2025 was analyzed.
- *Cost savings*— Total net costs or savings were estimated through comparison of monetized costs and savings of policy implementation over time, using discounting. These net costs could be positive or negative; negative costs indicated that the policy saved money or produced “cost savings.” Many policies were estimated to create net financial cost savings (typically through fuel savings and electricity savings associated with new policy actions).
- *Direct vs. indirect effects*—Estimates of costs and cost savings were based on “direct effects” (i.e., those borne by the entities implementing the policy).<sup>4</sup> Implementing entities could be individuals, companies, and/or government agencies. In contrast, conventional cost-benefit analysis takes the “societal perspective” and tallies every conceivable impact on every entity in society (and quantifies these wherever possible).

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<sup>3</sup> A production-based approach estimates GHG emissions associated with goods and services produced within the state, and a consumption-based approach estimates GHG emissions associated with goods and services consumed within the state. In some sectors of the economy, these two approaches may not result in significantly different numbers. However, the power sector is notable, in that it is responsible for large quantities of GHG emissions, and states often produce more or less electricity than they consume (with the remainder attributable to power exports or imports). From 1990 to 1999 and from 2001 to 2004, Arkansas was a net exporter of electricity, meaning that Arkansas power plants produced more electricity than it consumed. In 2000 and 2005, Arkansas was a net importer of electricity. Based on the approval of the GCGW, the final reference case forecast assumes that Arkansas is self-sufficient in electricity production, and that there will be no net imports over the revised forecast period (2006–2025). For the purpose of estimating emissions, natural gas-fired generation is assumed to fill any gaps in the supply of electricity to meet Arkansas demand during the forecast period. Thus, for the forecast, production- and consumption-based emissions are the same.

<sup>4</sup> “Additional benefits and costs” were defined as those borne by entities other than those implementing the policy recommendation. These indirect effects were quantified on a case-by-case basis, depending on magnitude, importance, need, and availability of data.

**Additional Costs and Benefits:** The GCGW recommendations were guided by four decision criteria that included GHG reductions and monetized costs and cost savings of various policies, as well as other potential co-benefits and costs (e.g., social, economic, and environmental) and feasibility considerations. The TWGs were asked to examine the latter two in qualitative terms where deemed important and quantify them on a case-by-case basis, as needed, depending on need and where data were readily available.

**Implementation Mechanisms:** The analysis for each recommendation (see Appendices F through J) of the GCGW includes guidance on the policy instruments or “mechanisms” that were prescribed or assumed for the policy action. This includes a range of potential mechanisms including, for instance, funding incentives, codes and standards, voluntary and negotiated agreements, market based instruments, information and education, reporting and disclosure, and other instruments. In some cases, the recommended instruments are precise. In other cases, they are more general and envision further work to develop concrete programs and steps to achieve the goals recommended by the GCGW.

## **Arkansas GHG Emissions Inventory and Reference Case Projections**

In May 2008, CCS completed a draft GHG emissions inventory and reference case projection to assist the GCGW and TWGs in understanding past, current, and possible future GHG emissions in Arkansas, and thereby inform the policy development process.<sup>5</sup> The GCGW and TWGs reviewed, discussed, and evaluated the draft inventory and projections methodologies, as well as alternative data and approaches for improving the draft inventory and projections. The inventory and reference case projections were revised to address the comments approved by the GCGW, and were subsequently approved by the GCGW at its 10th meeting on September 25, 2008.<sup>6</sup>

The inventory and reference case projections included detailed coverage of all economic sectors and GHGs in Arkansas, including future emission trends and assessment issues related to energy, the economy, and population growth. The assessment included estimates of total statewide “gross emissions” (leaving aside carbon sequestration<sup>7</sup>) on a production basis for all sources and on a consumption basis for the electricity sector. (See prior discussion under “Analysis of Policy Recommendations” in this chapter for an explanation of the production versus consumption approach.) Further discussion of the issues involved in developing the inventory and reference case projections is summarized in Chapter 2 (Inventory and Forecast of GHG Emissions) and discussed in detail in the final report for the inventory and reference case projections.

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<sup>5</sup> Center for Climate Strategies. *Draft Arkansas Greenhouse Gas Inventory and Reference Case Projections, 1990–2025*. Prepared for the Arkansas Governor’s Commission on Global Warming. May 2008. Available at: [http://www.arclimatechange.us/Inventory\\_Forecast\\_Report.cfm](http://www.arclimatechange.us/Inventory_Forecast_Report.cfm).

<sup>6</sup> Center for Climate Strategies. *Final Arkansas Greenhouse Gas Inventory and Reference Case Projections, 1990–2025*. Prepared for the Arkansas Governor’s Commission on Global Warming. October 2008. Available at: [http://www.arclimatechange.us/Inventory\\_Forecast\\_Report.cfm](http://www.arclimatechange.us/Inventory_Forecast_Report.cfm).

<sup>7</sup> Sequestration refers to the storing of carbon in mines, brine strata, oceans, plants, and soil. As trees and other plants grow, they remove CO<sub>2</sub> (the principal GHG) from the atmosphere, transforming the carbon through photosynthesis into cellulose, starch, and sugars, thus sequestering it in their structures and roots. The oxygen is released back into the atmosphere. Arkansas’ forests and agricultural lands are capable of sequestering much CO<sub>2</sub>, as described in Chapter 7 (Agriculture, Forestry, and Waste Management).

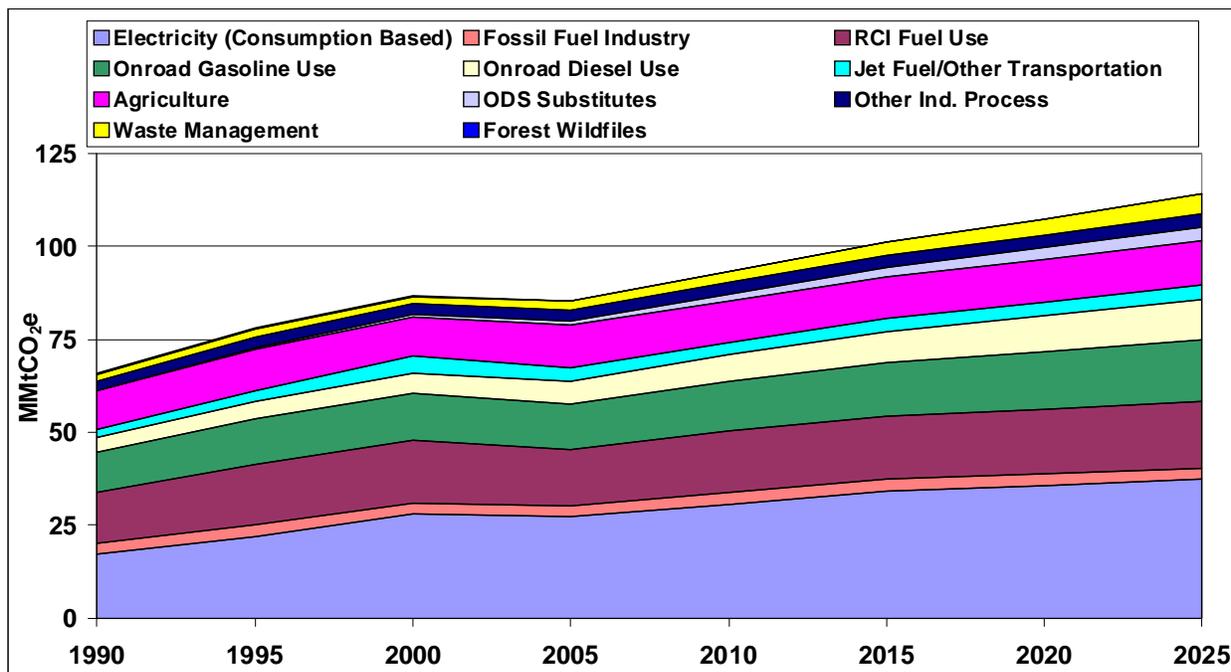
The inventory and reference case projections revealed substantial emission growth rates and related mitigation challenges. Figure 1-2 shows the reference case projections for Arkansas' gross GHG emissions as rising fairly steeply to 114 MMtCO<sub>2</sub>e by 2025, growing by 74% over 1990 levels. Figure 1-2 also provides the sectoral breakdown of projected GHG emissions.

The inventory and reference case projections of Arkansas' GHG emissions provided the following critical findings:

- As is common in many states, the electricity and transportation sectors have the largest emissions, and their emissions are expected to continue to grow faster than in other sectors.
- From 2005 to 2025, emissions associated with electricity generation to meet both in-state and out-of-state demand are projected to be the largest contributor to future emissions growth, followed by emissions associated with the transportation sector. Other sources of emissions growth include the RCI fuel use sectors, the transmission and distribution of natural gas, and the increasing use of hydrofluorocarbons and perfluorocarbons as substitutes for ozone-depleting substances in refrigeration, air conditioning, and other applications.

While Arkansas' estimated emissions growth rate presents challenges, it also provides major opportunities. Key choices regarding technologies and infrastructure can have a significant impact on emissions growth in Arkansas. The GCGW's recommendations document the opportunities for the state to reduce its GHG emissions, while continuing its strong economic growth by being more energy efficient, using more renewable energy sources, and increasing the use of cleaner transportation modes, technologies, and fuels.

**Figure 1-2. Gross GHG emissions by sector, 1990–2025: historical and projected (consumption-based approach) business-as-usual/base case**



MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; RCI = direct fuel use in residential, commercial, and industrial sectors; ODS = ozone-depleting substance; Ind. = industrial.

## **GCGW Policy Recommendations (Beyond Recent Actions)**

The GCGW recommended 54 policy actions. The GCGW members present and voting approved 28 policy actions unanimously, approved 23 by a super majority (five objections or fewer), and approved 3 by a majority (fewer than half object). Explanations of objections are in Appendices F through J of this report, which contain detailed accounts of the GCGW's recommendations.

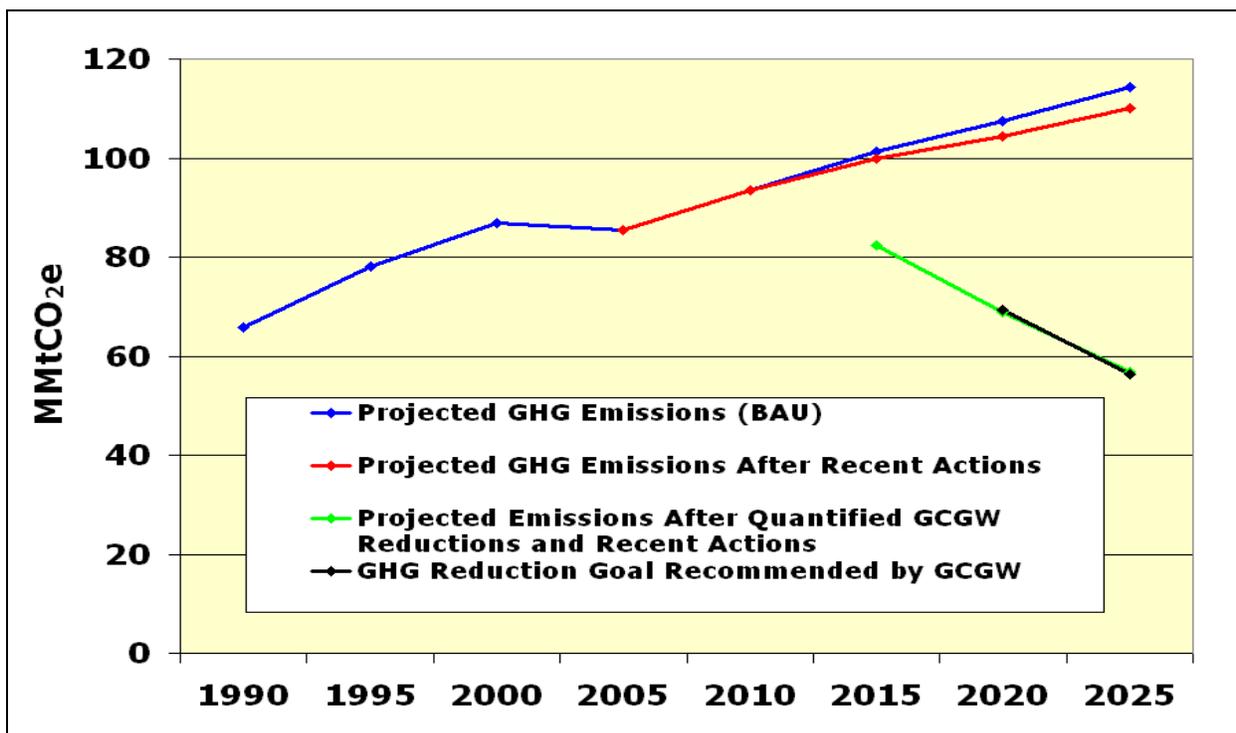
A total of 31 of the 54 policy recommendations were analyzed quantitatively to estimate their effects on emissions. Of these 31 analyzed for their emission reductions, 29 were analyzed quantitatively to estimate their costs or cost savings. The 31 recommendations for which emission reductions were quantified were estimated to have a cumulative effect of reducing emissions by about 17.6 MMtCO<sub>2e</sub> in 2015, 35.5 MMtCO<sub>2e</sub> in 2020, and 53.3 MMtCO<sub>2e</sub> in 2025.

Figure 1-3 presents a graphical summary of the potential cumulative emission reductions associated with the recent federal actions and the 31 policy recommendations relative to the business-as-usual reference case projections. Table 1-2 provides the numeric estimates underlying Figure 1-3. In Figure 1-3:

- The blue line shows actual (for 1990, 1995, 2000, and 2005) and projected (for 2010, 2015, 2020, and 2025) levels of Arkansas' gross GHG emissions on a consumption basis. (The consumption-based approach accounts for emissions associated with the generation of electricity in Arkansas to meet the state's demand for electricity)
- The red line shows projected emissions associated with recent federal actions that were analyzed quantitatively.
- The green line shows projected emissions if all of the GCGW's 31 recommendations that were analyzed quantitatively with respect to their GHG reduction potential are implemented successfully and the estimated reductions are fully achieved. (Note that other GCGW recommendations would have the effect of reducing emissions, but those reductions were not analyzed quantitatively, so are not reflected in the green line.)
- The black line shows the projected emission level associated with the GCGW's recommendation for Arkansas to adopt a statewide, economy-wide global warming pollutant reduction goal to reduce the state's gross GHG emissions below 2000 levels by 20% by 2020, 35% by 2025, and 50% by 2035. Together, if the 31 quantified policy recommendations and the recent federal actions (or their equivalent) are successfully implemented, the 2020 emission reduction goal would be achieved, and the 2025 GHG emission reduction goal would come very close to being achieved, based on results of analysis of GCGW proposals conducted through the GCGW and TWG process.

For the policies recommended by the GCGW to yield the levels of estimated emission reductions shown in Table 1-3, they must be implemented in a timely, aggressive, and thorough manner.

**Figure 1-3. Annual GHG emissions: reference case projections and GCGW recommendations (consumption-basis, gross emissions)**



MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; GHG = greenhouse gas; GCGW = Governor's Commission on Global Warming.

**Table 1-2. Annual emissions: reference case projections and impact of GCGW recommendations (consumption-basis, gross emissions)**

Annual Emissions (MMtCO <sub>2</sub> e)	1990	2000	2005	2010	2015	2020	2025
Projected GHG Emissions	65.8	86.8	85.4	93.5	101.3	107.5	114.2
Reductions From Recent Actions*			0.0	0.1	1.4	3.1	4.1
Projected GHG Emissions After Recent Actions			85.4	93.4	99.9	104.4	110.1
Total GHG Reductions From 31 Analyzed GCGW Recommendations					17.6	35.5	53.3
Projected Annual Emissions After Quantified GCGW Reductions <sup>†</sup>					82.3	68.9	56.8
2020 and 2025 GHG Reduction Goal Recommended by GCGW						69.4	56.4

MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; GHG = greenhouse gas; GCGW = Governor's Commission on Global Warming.

\* Reductions from recent actions include the Energy Independence and Security Act of 2007, Title III. GHG reductions from Titles IV and V of this Act have not been quantified because of the uncertainties in how they will be implemented. It is expected that Titles IV and V measures will overlap with RCI policies, especially RCI-2b, RCI-3a, RCI-3b, RCI-4a, and RCI-4b.

<sup>†</sup> Projected annual emissions also include reductions from recent actions.

**Table 1-3. Summary by sector of estimated impacts of implementing all of the GCGW recommendations (cumulative reductions and costs/savings)**

Sector	GHG Reductions (MMtCO <sub>2</sub> e)			Net Present Value 2009–2025 (Million \$)	Cost-Effectiveness (\$/tCO <sub>2</sub> e)
	2015	2025	Total 2009–2025		
Residential, Commercial, and Industrial	2.5	9.2	69.8	–\$1,313	–\$19
Energy Supply	6.0	22.6	179.5	\$ 6,228	\$35
Transportation and Land Use	1.3	3.2	28.9	–\$2,244	\$78
Agriculture, Forestry, and Waste Management	7.8	18.3	162.2	\$1,045	\$6.4
Cross-Cutting Issues	Non-quantified, enabling options				
<b>TOTAL (includes all adjustments for overlaps)</b>	<b>17.6</b>	<b>53.3</b>	<b>440.4</b>	<b>\$3,717</b>	<b>\$8.8</b>

GHG = greenhouse gas; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; \$/tCO<sub>2</sub>e = dollars per metric ton of carbon dioxide equivalent.

The values in this table do not include the effects of recent actions. Negative values in the Net Present Value and the Cost-Effectiveness columns represent net cost savings associated with the policy recommendations.

Within each sector, values have been adjusted to eliminate double counting for policies or elements of policies that overlap. In addition, values associated with policies or elements of policies within a sector that overlap with policies or elements of policies in another sector have been adjusted to eliminate double counting. Appendix G (for the RCI sectors), Appendix J (for the AFW sectors), and Appendix I (for the TLU sectors) of this report provide documentation of how sector-level emission reductions and costs (or cost savings) were adjusted to eliminate double counting associated with overlaps between policies.

**Table 1-4. Residential, Commercial, and Industrial Policy Recommendations**

No.	Policy Recommendation	GHG Reductions (MMtCO <sub>2</sub> e)			Net Present Value 2009–2025 (Million \$)	Cost-Effectiveness (\$/tCO <sub>2</sub> e)	Level of Support
		2015	2025	Total 2009–2025			
RCI-1*	Improved Building Codes	0.2	0.6	5.3	–\$118	–\$22	Super Majority (1 objection)
RCI-2a*	Utility and Non-Utility DSM for Peak Use Electricity	0.01	0.02	0.21	–\$11	–\$52	Super Majority (1 objection)
RCI-2b*	Utility and Non-Utility DSM and Energy Efficiency for Electricity	1.1	4.1	30.5	–\$1,450	–\$48	Majority (7 objections)
RCI-3a*	Reduced Energy Use in New and Retrofitted State-Owned Buildings	0.1	0.6	4.3	–\$42	–\$10	Super Majority (1 objection)
RCI-3b*	Reduced Energy Use in State-Owned Buildings	0.2	0.4	4.2	–\$46	–\$11	Super Majority (1 objection)
RCI-4a*	Promotion and Incentives for Improved New Building Design and Construction	0.2	1.1	7.0	–\$160	–\$23	Super Majority (1 objection)
RCI-4b*	Promotion and Incentives for Improved Existing Buildings	0.0	0.3	1.7	–\$39	–\$23	Super Majority (1 objection)
RCI-5*	Education for Consumers, Industry Trades, and Professions	<i>Not Quantified</i>					Unanimous
RCI-6 <sup>†</sup>	Incentives and Funds To Promote Renewable Energy and Energy Efficiency	0.2	0.8	5.1	–\$118	–\$23	Super Majority (1 objection)
RCI-7*	Green Power Purchasing for Consumers	0.2	0.6	4.7	\$61	\$13	Unanimous
RCI-8*	Nonresidential Energy Efficiency	0.4	1.0	8.6	\$583	\$68	Unanimous
RCI-9 <sup>†</sup>	Support for Energy-Efficient Communities, Including Smart Growth	<i>Not Quantified</i>					Unanimous
RCI-10 <sup>†</sup>	Energy-Savings Sales Tax	0.0	0.1	0.7	–\$33	–\$47	Super Majority (1 objection)
	<b>Sector Total After Adjusting for Overlaps</b>	<b>2.55</b>	<b>9.24</b>	<b>69.77</b>	<b>–\$1,313</b>	<b>–\$18.8</b>	
	<b>Reductions From Recent Actions (ESIA Title II requirements for new appliances and lighting)</b>	<b>0.34</b>	<b>0.89</b>	<b>8.02</b>	<b><i>Not Quantified</i></b>		
	<b>Sector Total Plus Recent Actions</b>	<b>2.89</b>	<b>10.13</b>	<b>77.79</b>	<b>–\$1,313</b>	<b>–\$18.8</b>	

DSM = demand-side management; EISA = Energy Independence and Security Act of 2007; GHG = greenhouse gas; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; \$/tCO<sub>2</sub>e = dollars per metric ton of carbon dioxide equivalent.

Negative values in the Net Present Value and the Cost-Effectiveness columns represent net cost savings.

The numbering used to denote the above policy recommendations is for reference purposes only; it does not reflect prioritization among these important policy recommendations.

\* The GCGW approved this option at Meeting #9 (September 9, 2008); 18 members present and voting (one by phone).

<sup>†</sup> The GCGW approved this option at Meeting #10 (September 25, 2008); 21 members present and voting (none by phone).

**Table 1-4 (continued). Energy Supply Policy Recommendations**

No.	Policy Recommendation	GHG Reductions (MMtCO <sub>2</sub> e)			Net Present Value (Million \$)	Cost- Effectiveness (\$/tCO <sub>2</sub> e)	Level of Support
		2015	2025	Total 2009– 2025			
ES-2*	Technology Research & Development	<i>Not Quantified</i>					Unanimous
ES-3 <sup>†</sup>	3a: Renewable Portfolio Standard (RPS)	0.3	3.6	21.9	\$548	\$25.0	Majority (10 objections)
	3b: Renewable Energy Feed-In Tariff (REFIT)	0.2	2.0	12.3	\$399	\$32.5	Super Majority (4 objections)
ES-4 <sup>†</sup>	Grid-Based Renewable Energy Incentives and/or Barrier Removal	<i>Not Quantified</i>					Unanimous
ES-5 <sup>†</sup>	Approaches Benefiting From Regional Application	<i>Not Quantified</i>					Unanimous
ES-6*	Combined Heat and Power	0.6	2.9	20.0	\$886	\$44.3	Unanimous
ES-7 <sup>†</sup>	Geological Underground Sequestration for New Plants	2.9	5.6	56.5	\$1,801	\$31.9	Majority (10 objections)
ES-8 <sup>†</sup>	Transmission System Upgrades	<i>Not Quantified</i>					Unanimous
ES-9*	Nuclear Power	0.0	9.8	58.9	\$1,574	\$26.7	Unanimous
ES-10 <sup>†</sup>	Carbon Tax	<i>Not Quantified</i>					Super Majority (4 objections)
ES-11*	Efficiency Improvements and Repowering of Existing Plants	2.3	2.3	31.8	\$1,568	\$49.3	Unanimous
	<b>Sector Total After Adjusting for Overlaps</b>	<b>6.0</b>	<b>22.6</b>	<b>179.5</b>	<b>\$6,228</b>	<b>\$34.7</b>	
	<b>Reductions From Recent Actions</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>\$0</b>	<b>\$0.0</b>	
	<b>Sector Total Plus Recent Actions</b>	<b>6.0</b>	<b>22.6</b>	<b>179.5</b>	<b>\$6,228</b>	<b>\$34.7</b>	

GHG = greenhouse gas; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; \$/tCO<sub>2</sub>e = dollars per metric ton of carbon dioxide equivalent.

Negative values in the Net Present Value and the Cost-Effectiveness columns represent net cost savings.

The numbering used to denote the above policy recommendations is for reference purposes only; it does not reflect prioritization among these important policy recommendations.

\* The GCGW approved this option at Meeting #9 (September 9, 2008); 18 members present and voting (one by phone).

<sup>†</sup> The GCGW approved this option at Meeting #10 (September 25, 2008); 21 members present and voting (none by phone).

**Table 1-4 (continued). Transportation and Land Use Policy Recommendations**

No.	Policy Recommendation	GHG Reductions (MMtCO <sub>2</sub> e)			Net Present Value 2009–2025 (Million \$)	Cost-Effectiveness (\$/tCO <sub>2</sub> e)	Level of Support
		2015	2025	Total 2009–2025			
TLU-1*	Study the Feasibility of Plug-In Vehicles	<i>Not Quantified—Qualitative Study Recommendation</i>					Unanimous
TLU-2 <sup>†</sup>	Research and Development of Renewable Transportation Fuels	<i>Incorporated Into Analysis for TLU-3</i>					Super Majority (1 objection)
TLU-3 <sup>†</sup>	Advanced Biofuels Development and Expansion	0.88	2.54	21.26	–\$2,293	–\$108	Super Majority (1 objection)
TLU-4*	Smart Growth, Pedestrian and Bicycle Infrastructure	0.06	0.17	1.39	≤0 (Net Savings)	≤0 (Net Savings)	Unanimous
TLU-5*	Improve and Expand Transit Service and Infrastructure	0.001	0.007	0.03	1.5	\$1,479	Unanimous
TLU-6 <sup>†</sup>	School and University Transportation Bundle	0.006	0.013	0.113	N/A	N/A	Unanimous
TLU-7*	Promote and Facilitate Freight Efficiency	0.33	0.47	6.1	\$48	\$104	Unanimous
TLU-8 <sup>†</sup>	Procurement of Efficient Fleet Vehicles (Passenger and Freight)	<i>State "Lead by Example" Qualitative Recommendation</i>					Unanimous
TLU-9 <sup>†</sup>	Fuel Efficiency: Clean Car Incentive	<i>Not Quantified—Qualitative Study Recommendation</i>					Super Majority (1 objection)
TLU-10*	Public Education	<i>Not Quantified</i>					Unanimous
	<b>Sector Total After Adjusting for Overlaps</b>	<b>1.28</b>	<b>3.2</b>	<b>28.89</b>	<b>–\$2,244</b>	<b>–\$78</b>	
	<b>Reductions From Recent Actions (Federal CAFE Requirements)</b>	<b>1.02</b>	<b>3.26</b>	<b>26.9</b>	<b><i>Not Quantified</i></b>		
	<b>Sector Total Plus Recent Actions</b>	<b>2.29</b>	<b>6.45</b>	<b>30.2</b>	<b>–\$2,244</b>	<b>–\$78</b>	

CAFE = corporate average fuel economy; GHG = greenhouse gas; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; \$/tCO<sub>2</sub>e = dollars per metric ton of carbon dioxide equivalent; N/A = not applicable.

Negative values in the Net Present Value and the Cost-Effectiveness columns represent net cost savings.

The numbering used to denote the above policy recommendations is for reference purposes only; it does not reflect prioritization among these important policy recommendations.

\* The GCGW approved this option at Meeting #9 (September 9, 2008); 18 members present and voting (one by phone).

<sup>†</sup> The GCGW approved this option at Meeting #10 (September 25, 2008); 21 members present and voting (none by phone).

**Table 1-4 (continued). Agriculture, Forestry, and Waste Management Policy Recommendations**

No.	Policy Recommendation		GHG Reductions (MMtCO <sub>2</sub> e)			Net Present Value 2009–2025 (Million \$)	Cost-Effectiveness (\$/tCO <sub>2</sub> e)	Level of Support
			2015	2025	Total 2009–2025			
AFW-1*	Manure Management		Not quantified					Unanimous
AFW-2†	Promotion of Farming Practices That Achieve GHG Benefits	Soil Carbon	0.5	1.3	11	–\$71	–\$6	Super Majority (1 objection)
		Nutrient Efficiency	0.1	0.3	2.4	–\$66	–\$27	
AFW-3†	Improved Water Management and Use	Increased Surface Water	0.005	0.01	0.10	\$86	\$835	Super Majority (1 objection)
		Improved Purification	0.001	0.001	0.01	–\$0.4	–\$39	
AFW-4†	Expanded Use of Agriculture and Forestry Biomass Feedstocks for Electricity, Heat, or Steam Production	Energy From Biomass	2.1	4.2	41	\$1,637	\$40	Super Majority (1 objection)
		Energy From Livestock Manure and Poultry Litter	0.01	0.02	0.2	\$0.8	\$4	
		Capture of Waste Heat	0.02	0.06	0.50	–\$70	–\$140	
AFW-5†	Expanded Use of Advanced Biofuels		1.4	2.2	20	\$114	\$6	Unanimous
AFW-6†	Expanded Use of Locally Produced Farm and Forest Products		0.03	0.06	0.6	\$2	\$4	Unanimous
AFW-7†	Forest Management and Establishment for Carbon Sequestration	Urban Forestry	0.02	0.1	0.4	\$17	\$41	Unanimous
		Sustainable Forest Management	4.1	10.4	91	\$1,139	\$21	
		Afforestation	0.7	1.8	16	\$201	\$12	
AFW-8†	Advanced Recovery and Recycling		1.5	4.4	36	–\$283	–\$8	Super Majority (1 objection)
AFW-9†	End-of-Use Waste Management Practices		0.02	0.02	0.4	–\$1	–\$3	Super Majority (1 objection)
	<b>Sector Total After Adjusting for Overlaps</b>		<b>7.8</b>	<b>18.3</b>	<b>162.2</b>	<b>\$1,045</b>	<b>\$6.4</b>	
	<b>Reductions From Recent Actions</b>		<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>\$0.0</b>	<b>\$0.0</b>	
	<b>Sector Total Plus Recent Actions</b>		<b>7.8</b>	<b>18.3</b>	<b>162.2</b>	<b>\$1,045</b>	<b>\$6.4</b>	

GHG = greenhouse gas; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; \$/tCO<sub>2</sub>e = dollars per metric ton of carbon dioxide equivalent.

Negative values in the Net Present Value and the Cost-Effectiveness columns represent net cost savings.

The numbering used to denote the above policy recommendations is for reference purposes only; it does not reflect prioritization among these important policy recommendations.

\* The GCGW approved this option at Meeting #8 (July 31, 2008); 19 members present and voting (two by phone).

† The GCGW approved this option at Meeting #9 (September 9, 2008); 18 members present and voting (one by phone).

**Table 1-4 (continued) Cross-Cutting Issues Policy Recommendations**

No.	Policy Recommendation	GHG Reductions (MMtCO <sub>2</sub> e)			Net Present Value 2009–2025 (Million \$)	Cost-Effectiveness (\$/tCO <sub>2</sub> e)	Level of Support
		2015	2025	Total 2009–2025			
CC-1 <sup>†</sup>	Greenhouse Gas Inventories and Forecasts	<i>Not Quantified</i>					Unanimous
CC-2 <sup>‡</sup>	State Greenhouse Gas Reporting and Registry	<i>Not Quantified</i>					Unanimous
CC-3 <sup>‡</sup>	Statewide Greenhouse Gas Reduction Goals or Targets	<i>Not Quantified</i>					Super Majority (3 objections)
CC-4*	The State’s Own Greenhouse Gas Emissions (Lead by Example)	<i>Not Quantified</i>					Unanimous
CC-5*	Comprehensive Local Government Climate Action Plans	<i>Not Quantified</i>					Super Majority (1 objection)
CC-6*	State Climate Public Education and Outreach	<i>Not Quantified</i>					Super Majority (1 objection)
CC-7 <sup>‡</sup>	Optimizing Best Scale of Reduction Policies	<i>Not Quantified</i>					Unanimous
CC-8 <sup>†</sup>	Creative Financial Mechanisms	<i>Not Quantified</i>					Super Majority (1 objection)
CC-9*	Adaptation and Vulnerability	<i>Not Quantified</i>					Super Majority (1 objection)
CC-10 <sup>†</sup>	Climate Change-Related Economic Development	<i>Not Quantified</i>					Unanimous
CC-11 <sup>†</sup>	Regulatory Realignment in Government To Encourage Constructive Climate Action	<i>Not Quantified</i>					Super Majority (2 objections)

GHG = greenhouse gas; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; \$/tCO<sub>2</sub>e = dollars per metric ton of carbon dioxide equivalent.

The numbering used to denote the above policy recommendations is for reference purposes only; it does not reflect prioritization among these important policy recommendations.

\* The GCGW approved this option at Meeting #8 (July 31, 2008); 19 members present and voting (two by phone).

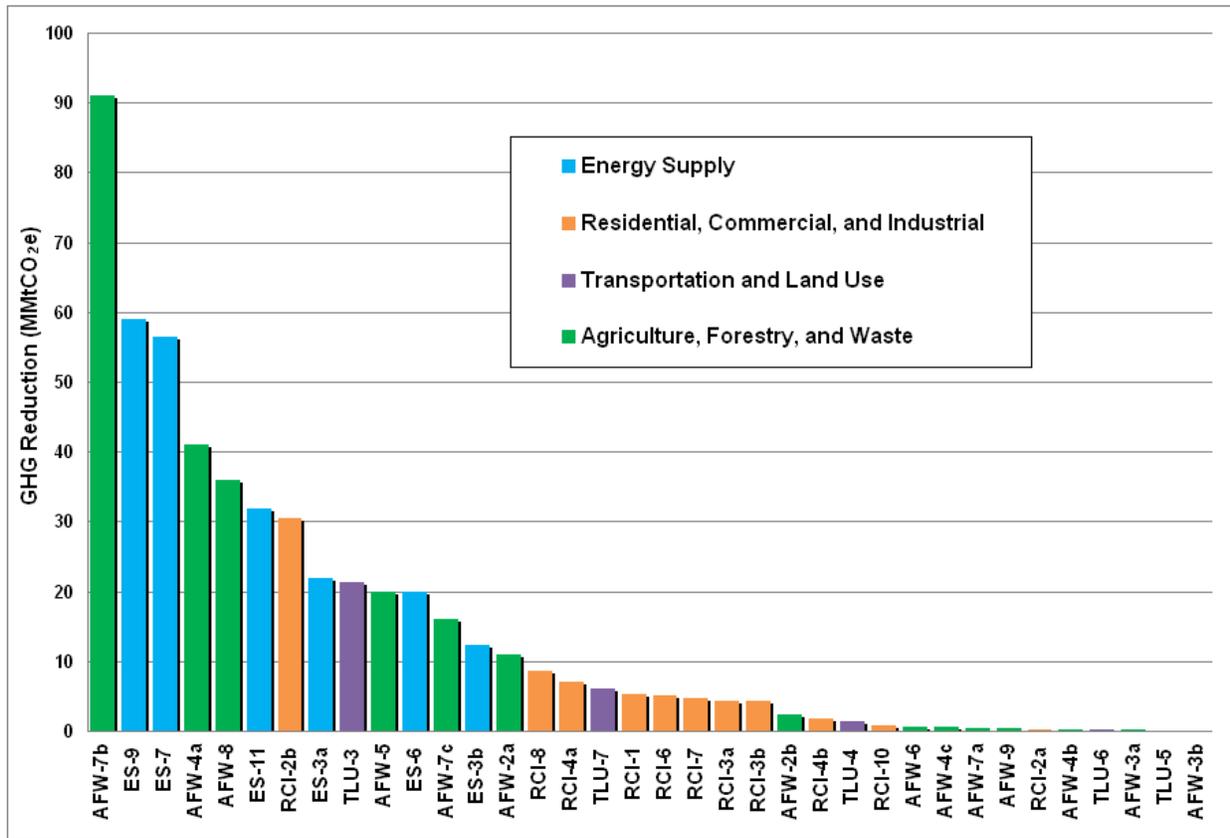
† The GCGW approved this option at Meeting #10 (September 25, 2008); 21 members present and voting (none by phone).

## Perspectives on Policy Recommendations

As explained above, the GCGW considered the estimates of the GHG reductions that could be achieved by 31 of its recommendations, and the costs (or cost savings) of 29 of those 31. Figure 1-4 presents the estimated tons of GHG emission reductions for each policy recommendation for which estimates were quantified, expressed as a cumulative figure for the period 2009–2025. In addition to the imprecision in GHG reductions achieved by each policy recommendation, there are uncertainties about the exact cost (or cost savings) per ton of reduction achieved. Figure 1-5 presents the estimated dollars-per-ton cost (or cost savings, depicted as a negative number) for each policy recommendation for which cost estimates were quantified, expressed as a cumulative figure for the period 2009–2025. This measure is calculated by dividing the net present value of the cost of the policy recommendation by the cumulative GHG reductions, all for the period 2009–2025.

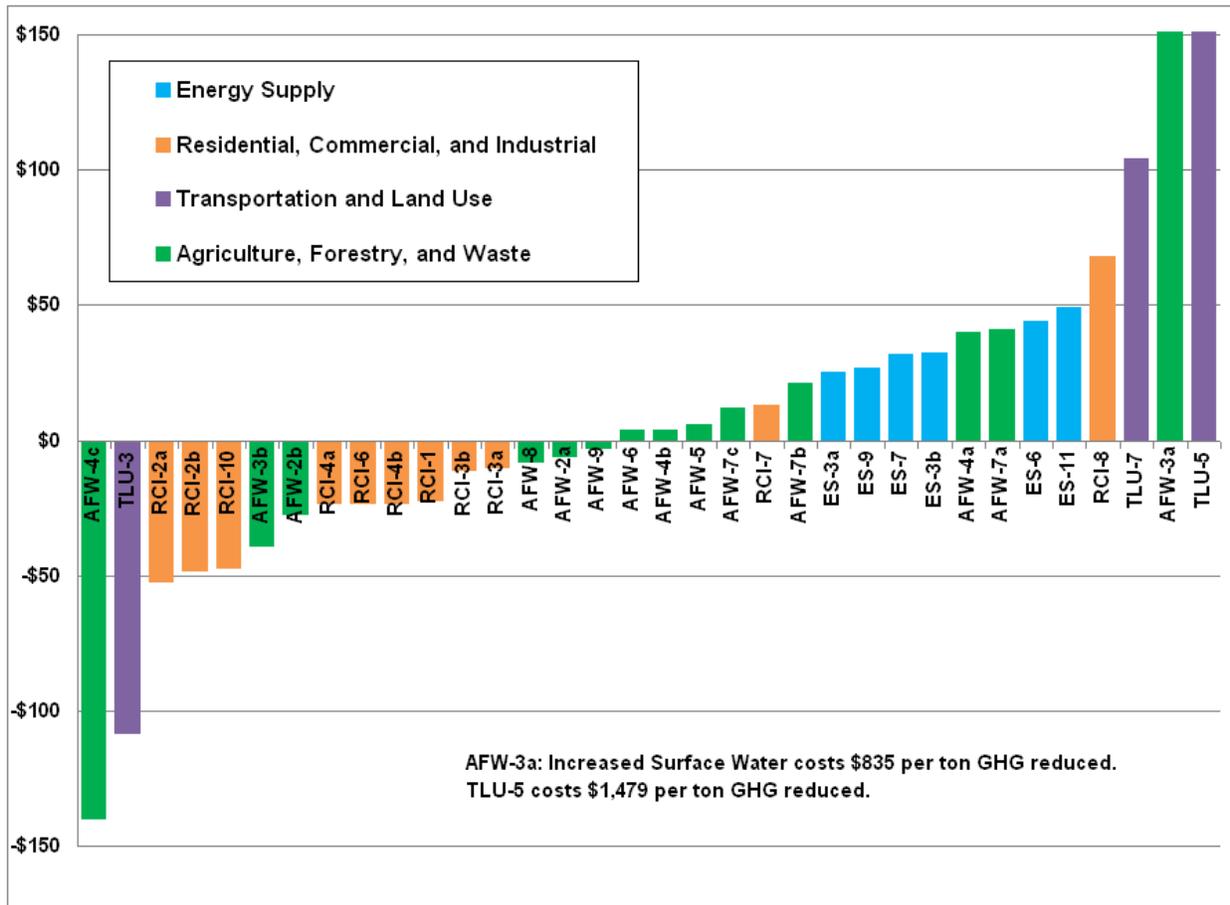
Figure 1-6 presents a stepwise marginal cost curve for Arkansas. The horizontal axis represents the percentage of GHG emissions reduction in 2025 for each option relative to the business as usual (BAU) forecast. The vertical axis represents the marginal cost of mitigation (expressed as the cost-effectiveness of each policy recommendation on a cumulative basis, 2009-2025). In the figure, each horizontal segment represents an individual policy. The width of the segment indicates the GHG emission reduction potential of the option in percentage terms. The height of the segment relative to the x-axis shows the average cost (saving) of reducing one MMtCO<sub>2</sub>e of GHG emissions with the application of the option.

**Figure 1-4. GCGW policy recommendations ranked by cumulative (2009–2025) GHG reduction potential**



GHG = greenhouse gas; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; AFW = Agriculture, Forestry, and Waste Management; RCI = Residential, Commercial, and Industrial; TLU = Transportation and Land Use; ES = Energy Supply.

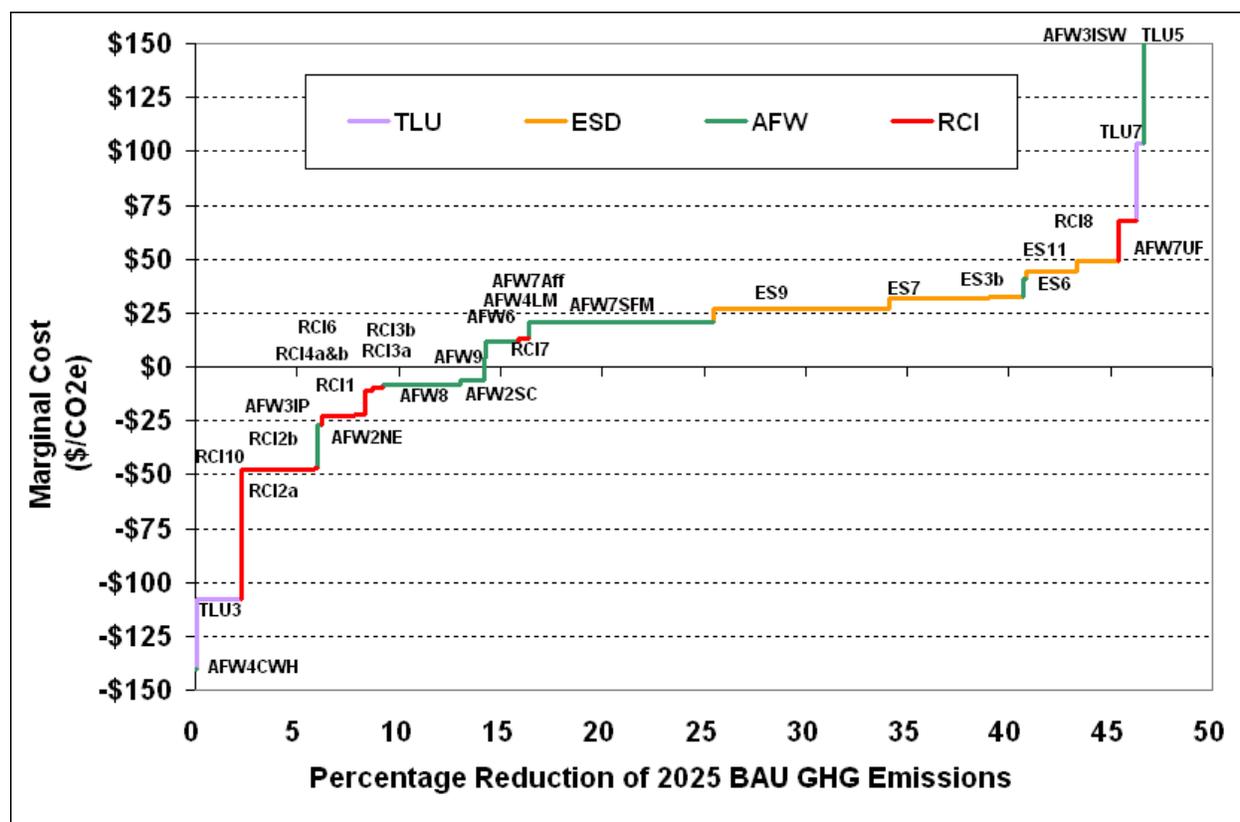
**Figure 1-5. GCGW policy recommendations ranked by cumulative (2009–2025) net cost/cost savings per ton of GHG removed**



GHG = greenhouse gas; RCI = Residential, Commercial, and Industrial; TLU = Transportation and Land Use; ES = Energy Supply; AFW = Agriculture, Forestry, and Waste Management.

Negative values represent net cost savings and positive values represent net costs associated with the policy recommendation.

Figure 1-6. Stepwise marginal cost curve for Arkansas, 2025



BAU = business as usual; GHG = greenhouse gas; tCO<sub>2</sub>e = metric tons of carbon dioxide equivalent; AFW = Agriculture, Forestry, and Waste Management; RCI = Residential, Commercial, and Industrial; TLU = Transportation and Land Use; ES = Energy Supply.

Negative values represent net cost savings and positive values represent net costs associated with the policy recommendation.

Note: Results have been adjusted to remove overlaps between policies. AFW 3a and TLU 5 are not shown due to scale effects. AFW 3a costs \$835 per ton CO<sub>2</sub>e reduced, and TLU 5 costs \$1,479/ton.

## Summary of Current Scientific Literature on Causes and Impacts of Global Warming

All panels of scientists that have reviewed the science of climate change have concluded that there is a 90 to 95% probability that human activities have increased amounts of important GHGs (primarily CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O, and fluorocarbons) in the atmosphere to levels not seen in all of prior human experience, and likely not seen for 3 million years. *See, Fourth Report of the Intergovernmental Panel on Climate Change (IPCC) (2007)* and in at least three reports of the National Research Council of the National Academy of Sciences (NAS/NRC), *Climate Change Science: An Analysis of Some Key Questions* (2001) (“Climate Change Science”), NAS/NRC, *Surface Temperature Reconstructions for the Last 2,000 Years* (2006); NAS/NRC, *Abrupt Climate Change: Inevitable Surprises* (2002). These findings are also reflected in the summary of science prepared by the U.S. Environmental Protection Agency (U.S. EPA) in the Advance Notice of Proposed Rulemaking, *Regulating Greenhouse Gas Emissions Under the Clean Air*

*Act*, 73 Fed. Reg. 44354 (July 30, 2008). Scientists have already observed increased temperatures and a variety of related effects and, because GHGs have very long residence times in the atmosphere, if no action is taken to restrict emissions, impacts are likely to increase dramatically.

There are a variety of impacts that are expected to affect Arkansas. These include increases in severe weather events and drought, which, in turn, can be expected to adversely affect agriculture. Floods are expected to increase in frequency with related expansion of floodplains and flood damage. Sea level rise will inundate some nearby coastal areas, and related salt-water intrusion, coupled with increased drought stress may impact water supplies. In areas dependent on snow pack, such as the western United States, water supplies will be more severely affected. Ecosystems and sensitive species could be disrupted as climatic zones move north. Tropical diseases and insects will move north. Heat-related deaths will increase, although cold-related deaths will decrease. Climate change impacts in volatile regions of the world could destabilize these areas and pose a national security threat. There is also a possibility of sudden and dramatic climate change that cannot be predicted, but would have far greater adverse impacts.

Although there are books and articles in the popular press that raise questions about climate change, none have been scientifically peer reviewed. The body of literature that has undergone peer review is virtually unanimous in concluding that human activities have affected climate and that the effects will increase if anthropogenic GHG emissions are not reduced. None of the skeptics will say to a reasonable degree of scientific certainty that emissions of GHGs will not have adverse impacts. The applicable legal standards require action if adverse impacts can be reasonably anticipated. See 42 U.S.C. §§ 7408(a)(1) (“air pollution which may reasonably be anticipated to endanger public health or welfare”), 7411(b)(1)(A) (same), 7521(a)(1) (same), 7547(a)(1)(same), 7571(a)(2)(A)(same); see also United Nations Framework Convention on Climate Change, art. 3, §3.

# Chapter 2

## Inventory and Projections of GHG Emissions

### Introduction

This chapter summarizes Arkansas' greenhouse gas (GHG) emissions and sinks (carbon storage) from 1990 to 2025. The Center for Climate Strategies (CCS) prepared a draft of Arkansas' GHG emissions inventory and reference case projections for the Arkansas Governor's Commission on Global Warming (GCGW). The draft inventory and reference case projections, completed in May 2008, provided the GCGW with an initial, comprehensive understanding of current and possible future GHG emissions. The draft report was provided to the GCGW and its Technical Work Groups (TWGs) to assist them in understanding past, current, and possible future GHG emissions in Arkansas, and thereby inform the policy recommendation development process. The GCGW and TWGs have reviewed, discussed, and evaluated the draft inventory and methodologies, as well as alternative data and approaches for improving the draft GHG inventory and forecast. The inventory and forecast have since been revised to address the comments provided by the GCGW. The information in this chapter reflects the information presented in the final *Arkansas Greenhouse Gas Inventory and Reference Case Projections* report (hereafter referred to as the Inventory and Projections report).<sup>1</sup>

Historical GHG emission estimates (1990 through 2005)<sup>2</sup> were developed using a set of generally accepted principles and guidelines for state GHG emission inventories, relying to the extent possible on Arkansas-specific data and inputs. The reference case projections (2006–2025) are based on a compilation of various existing projections of electricity generation, fuel use, and other GHG-emitting activities, along with a set of simple, transparent assumptions described in the final Inventory and Projections report.

The Inventory and Projections report covers the six types of gases included in the U.S. GHG inventory: carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF<sub>6</sub>). Emissions of these GHGs are presented using a common metric, CO<sub>2</sub> equivalence (CO<sub>2</sub>e), which indicates the relative contribution of each gas, per unit mass, to global average radiative forcing on a global warming potential-weighted basis.<sup>3</sup>

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<sup>1</sup> Center for Climate Strategies. *Final Arkansas Greenhouse Gas Inventory and Reference Case Projections: 1990–2025*. Prepared for the Arkansas Governor's Commission on Global Warming. October 2008.

<sup>2</sup> The last year of available historical data for each sector varies between 2000 and 2005.

<sup>3</sup> Changes in the atmospheric concentrations of GHGs can alter the balance of energy transfers between the atmosphere, space, land, and the oceans. A gauge of these changes is called radiative forcing, which is a simple measure of changes in the energy available to the Earth–atmosphere system. Holding everything else constant, increases in GHG concentrations in the atmosphere will produce positive radiative forcing (i.e., a net increase in the absorption of energy by the Earth). See: Boucher, O., et al. "Radiative Forcing of Climate Change." Chapter 6 in *Climate Change 2001: The Scientific Basis*. Contribution of Working Group 1 of the Intergovernmental Panel on Climate Change Cambridge University Press. Cambridge, United Kingdom. Available at:

[http://www.grida.no/climate/ipcc\\_tar/wg1/212.htm](http://www.grida.no/climate/ipcc_tar/wg1/212.htm).

It is important to note that the emission estimates reflect the GHG emissions associated with the electricity sources used to meet Arkansas' demands, corresponding to a consumption-based approach to emissions accounting. Another way to look at electricity emissions is to consider the GHG emissions produced by electricity generation facilities in the state—a production-based method. The study covers both methods of accounting for emissions, but for consistency, all total results are reported as consumption-based.

## Arkansas GHG Emissions: Sources and Trends

Table 2-1 provides a summary of GHG emissions estimated for Arkansas by sector for 1990, 2000, 2005, 2010, 2015, 2020, and 2025. As shown in this table, Arkansas is estimated to be a net source of GHG emissions (positive, or gross, emissions). Arkansas' forests serve as sinks of GHG emissions (removal of emissions, or negative emissions). Arkansas' net emissions subtract the equivalent GHG reduction from emission sinks from the gross GHG emission totals. The following sections discuss GHG emission sources and sinks, trends, projections, and uncertainties.

## Historical Emissions

### Overview

In 2005, on a gross emissions consumption basis (i.e., excluding carbon sinks), Arkansas accounted for approximately 85 million metric tons (MMt) of CO<sub>2</sub>e emissions, an amount equal to 1.2% of total U.S. gross GHG emissions. On a net emissions basis (i.e., including carbon sinks), Arkansas accounted for approximately 65 MMtCO<sub>2</sub>e of emissions in 2005, an amount equal to 1.0% of total U.S. net GHG emissions.<sup>4</sup> Arkansas' GHG emissions are rising faster than those of the nation as a whole. From 1990 to 2005, Arkansas' gross GHG emissions increased by 30%, while national gross emissions rose by 16%.<sup>5</sup>

On a per-capita basis, Arkansans emitted about 31 metric tons (t) of gross CO<sub>2</sub>e in 2005, higher than the national average of about 24 tCO<sub>2</sub>e. Figure 2-1 illustrates the state's emissions per capita and per unit of economic output. It also shows that while per-capita emissions have increased from 1990 to 2000 in Arkansas and then began to decrease from 2000 to 2005, per capita emissions for the nation as a whole remained fairly flat from 1990 to 2005. The higher per capita emission rates in Arkansas are driven by emissions growth in the electricity supply, transportation, and agricultural sectors (agricultural sector emissions are twice the national average). In both Arkansas and the nation as a whole, economic growth exceeded emissions growth throughout the 1990–2005 period. From 1990 to 2005, emissions per unit of gross product dropped by 26% nationally, and by 23% in Arkansas.<sup>6</sup>

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<sup>4</sup> The national emissions used for these comparisons are based on 2005 emissions from U.S. Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2006*, April 15, 2008, EPA430-R-08-005. Available at: <http://www.epa.gov/climatechange/emissions/usinventoryreport.html>.

<sup>5</sup> During this period, population grew by 18% in Arkansas and by 19% nationally. However, Arkansas' economy grew at a faster rate on a per capita basis (up 44% vs. 32% nationally).

<sup>6</sup> Based on real gross domestic product (millions of chained 2000 dollars) that excludes the effects of inflation. U.S. Department of Commerce, Bureau of Economic Analysis. "Gross Domestic Product by State." Available at: <http://www.bea.gov/regional/gsp/>.

The principal sources of Arkansas' GHG emissions in 2005 are electricity consumption and transportation, accounting for 32% and 26% of Arkansas' gross GHG emissions, respectively, as shown in Figure 2-2. The direct use of fuels—natural gas, oil products, coal, and wood—in the residential, commercial, and industrial (RCI) sectors accounts for another 18% of the state's emissions in 2005.

**Table 2-1. Arkansas historical and reference case GHG emissions, by sector\***

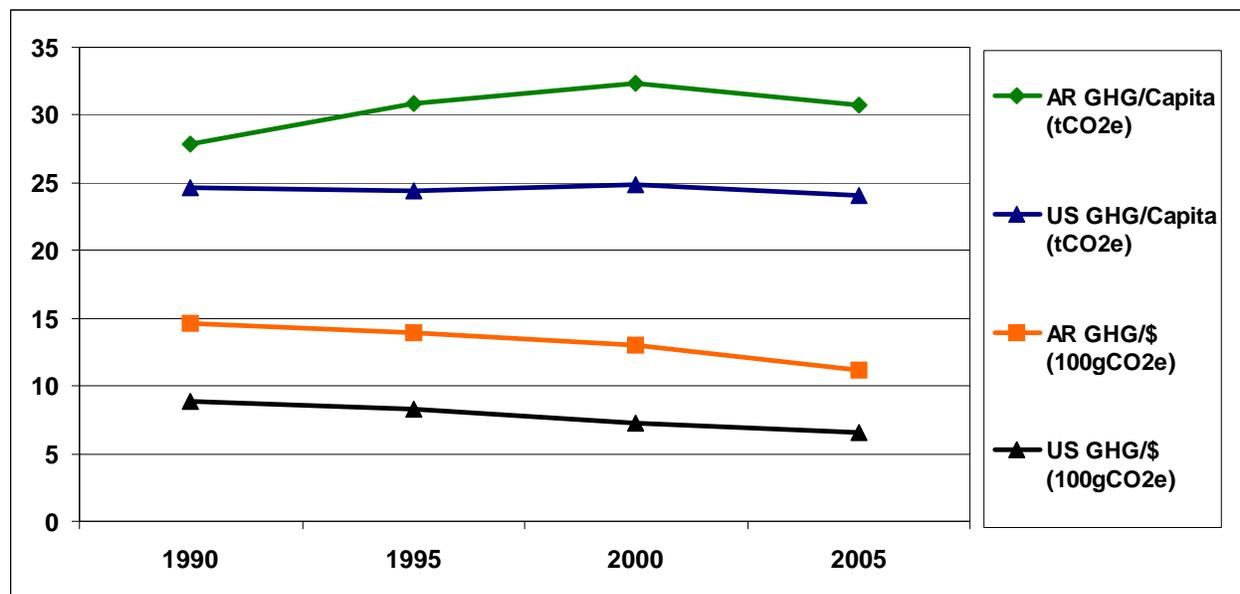
Million Metric Tons CO <sub>2</sub> e	1990	2000	2005	2010	2015	2020	2025
<b>Energy (Consumption Based)</b>	<b>50.7</b>	<b>70.4</b>	<b>67.2</b>	<b>74.3</b>	<b>80.5</b>	<b>85.0</b>	<b>89.6</b>
<b>Electricity Use (Consumption)</b>	<b>17.4</b>	<b>28.0</b>	<b>27.2</b>	<b>30.7</b>	<b>34.1</b>	<b>35.7</b>	<b>37.4</b>
Electricity Production (in-state)	22.5	27.4	27.2	30.7		35.7	37.4
<i>Coal</i>	19.7	24.8	23.1	27.1	30.5	30.5	30.5
<i>Natural Gas</i>	2.64	2.37	3.98	3.49	3.45	5.05	6.69
<i>Oil</i>	0.07	0.17	0.15	0.15	0.15	0.15	0.15
<i>MSW/Landfill Gas</i>	0.06	0.07	0.00	0.00	0.00	0.00	0.00
<i>Biomass</i>	0.008	0.010	0.009	0.009	0.009	0.009	0.009
<i>Other Wastes</i>	0.000	0.003	0.000	0.000	0.000	0.000	0.000
<i>Pumped Storage</i>	0.03	0.00	0.00	0.00	0.00	0.00	0.00
Imported/Exported Electricity	-5.03	0.56	0.00	0.00	0.00	0.00	0.00
<b>Residential/Commercial/Industrial (RCI) Fuel Use</b>	<b>13.7</b>	<b>17.1</b>	<b>15.1</b>	<b>16.7</b>	<b>17.0</b>	<b>17.5</b>	<b>18.1</b>
<i>Coal</i>	0.55	0.90	0.87	0.90	0.89	0.89	0.90
<i>Natural Gas</i>	10.1	11.0	8.2	9.6	9.7	10.0	10.3
<i>Petroleum</i>	2.90	5.03	5.92	6.08	6.3	6.40	6.66
<i>Wood (CH<sub>4</sub> and N<sub>2</sub>O)</i>	0.14	0.16	0.15	0.17	0.18	0.19	0.20
<b>Transportation</b>	<b>16.9</b>	<b>22.4</b>	<b>22.0</b>	<b>23.9</b>	<b>26.2</b>	<b>28.6</b>	<b>31.1</b>
<i>On-road Gasoline</i>	10.9	12.4	12.4	13.3	14.4	15.4	16.5
<i>On-road Diesel</i>	3.78	5.37	6.08	7.22	8.29	9.55	10.8
<i>Rail, Natural Gas, LPG, other</i>	0.57	0.87	1.10	1.11	1.12	1.13	1.14
<i>Marine Vessels</i>	0.93	1.79	1.84	1.73	1.86	1.98	2.11
<i>Jet Fuel and Aviation Gasoline</i>	0.72	2.01	0.53	0.50	0.51	0.52	0.53
<b>Fossil Fuel Industry</b>	<b>2.72</b>	<b>2.88</b>	<b>2.82</b>	<b>2.97</b>	<b>3.18</b>	<b>3.11</b>	<b>3.04</b>
Natural Gas Industry	2.58	2.79	2.73	2.89	3.10	3.04	2.98
Oil Industry	0.13	0.09	0.10	0.09	0.08	0.07	0.06
Coal Mining	0.003	0.001	0.000	0.000	0.000	0.000	0.000
<b>Industrial Processes</b>	<b>2.23</b>	<b>3.41</b>	<b>4.03</b>	<b>4.92</b>	<b>5.67</b>	<b>6.46</b>	<b>7.45</b>
Cement Manufacture (CO <sub>2</sub> )	0.31	0.65	0.68	0.74	0.79	0.86	0.92
Lime Manufacture (CO <sub>2</sub> )	0.05	0.07	0.28	0.48	0.48	0.48	0.48
Limestone and Dolomite Use (CO <sub>2</sub> )	0.07	0.06	0.07	0.07	0.07	0.08	0.08
Soda Ash (CO <sub>2</sub> )	0.03	0.03	0.02	0.02	0.02	0.02	0.02
Ammonia and Urea (CO <sub>2</sub> )	0.53	0.30	0.28	0.28	0.28	0.28	0.28
Iron & Steel (CO <sub>2</sub> )	0.09	0.36	0.38	0.42	0.48	0.55	0.62
Nitric Acid (N <sub>2</sub> O)	0.88	1.00	0.99	0.99	0.99	0.99	0.99
ODS Substitutes (HFC, PFC)	0.00	0.76	1.16	1.76	2.40	3.06	3.91
Electric Power T&D (SF <sub>6</sub> )	0.27	0.18	0.17	0.15	0.15	0.14	0.14

Million Metric Tons CO <sub>2</sub> e	1990	2000	2005	2010	2015	2020	2025
<b>Waste Management</b>	<b>2.01</b>	<b>2.05</b>	<b>2.40</b>	<b>2.89</b>	<b>3.49</b>	<b>4.24</b>	<b>5.17</b>
Landfills	1.45	1.49	1.81	2.26	2.82	3.53	4.41
Wastewater Management	0.48	0.56	0.59	0.63	0.67	0.72	0.77
Waste Combustion	0.07	0.00	0.00	0.00	0.00	0.00	0.00
<b>Agriculture</b>	<b>10.7</b>	<b>10.7</b>	<b>11.7</b>	<b>11.2</b>	<b>11.4</b>	<b>11.6</b>	<b>11.9</b>
Enteric Fermentation	2.02	2.05	2.08	2.10	2.17	2.24	2.30
Manure Management	1.68	1.45	1.31	1.37	1.43	1.49	1.55
Agricultural Soils	4.76	4.62	5.24	4.56	4.42	4.29	4.15
Rice Cultivation	2.14	2.52	2.92	3.06	3.27	3.49	3.70
Agricultural Burning	0.05	0.06	0.11	0.11	0.13	0.14	0.16
<b>Forest Wildfires and Prescribed Burning</b>	<b>0.17</b>	<b>0.18</b>	<b>0.18</b>	<b>0.18</b>	<b>0.18</b>	<b>0.18</b>	<b>0.18</b>
<b>Gross Emissions (Consumption Basis)</b>	<b>65.8</b>	<b>86.8</b>	<b>85.4</b>	<b>93.5</b>	<b>101.3</b>	<b>107.5</b>	<b>114.2</b>
<i>Increase relative to 1990</i>		32%	30%	42%	54%	63%	74%
<b>Emissions Sinks</b>	<b>-38.5</b>	<b>-20.8</b>	<b>-20.9</b>	<b>-20.9</b>	<b>-20.9</b>	<b>-20.9</b>	<b>-20.9</b>
<b>Forestry and Land Use</b>	<b>-36.7</b>	<b>-19.0</b>	<b>-19.1</b>	<b>-19.1</b>	<b>-19.1</b>	<b>-19.1</b>	<b>-19.1</b>
Forested Landscape	-34.2	-18.2	-18.2	-18.2	-18.2	-18.2	-18.2
Urban Forestry and Land Use	-2.43	-0.83	-0.91	-0.91	-0.91	-0.91	-0.91
<b>Agricultural Soils (Cultivation Practices)</b>	<b>-1.80</b>						
<b>Net Emissions (Consumption Basis) (including forestry and land use sinks)</b>	<b>27.3</b>	<b>66.0</b>	<b>64.6</b>	<b>72.6</b>	<b>80.4</b>	<b>86.6</b>	<b>93.4</b>

MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; CH<sub>4</sub> = methane; N<sub>2</sub>O = nitrous oxide; MSW = municipal solid waste; LPG = liquefied petroleum gas; ODS = ozone-depleting substance; HFC = hydrofluorocarbon; PFC = perfluorocarbon; SF<sub>6</sub> = sulfur hexafluoride; T&D = transmission and distribution.

\* Totals may not equal exact sum of subtotals shown in this table due to independent rounding.

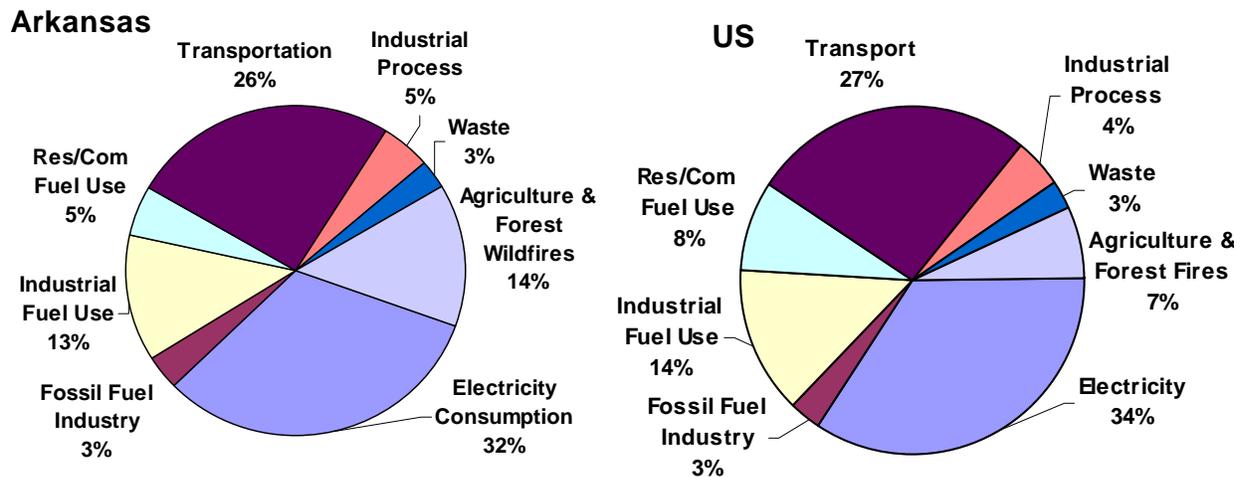
**Figure 2-1. Arkansas and U.S. gross GHG emissions, per-capita and per-unit gross product**



GHG = greenhouse gas; tCO<sub>2</sub>e = metric tons of carbon dioxide equivalent.; g = grams.

Figure 2-2 shows the agricultural and forest wildfire (including prescribed burning) sectors together accounted for 14% of the gross GHG emissions in Arkansas in 2005. These CH<sub>4</sub> and N<sub>2</sub>O emissions primarily come from agricultural soils, rice cultivation, enteric fermentation, and manure management. Industrial process emissions accounted for another 5% of the state's GHG emissions in 2005, and these emissions are rising due to the increasing use of HFCs and PFCs as substitutes for ozone-depleting chlorofluorocarbons.<sup>7</sup> Other industrial process emissions include CO<sub>2</sub> released by cement and lime manufacturing; CO<sub>2</sub> released during soda ash, limestone, and dolomite use; CO<sub>2</sub> released during ammonia, urea, and iron and steel production; N<sub>2</sub>O released during nitric acid production; and SF<sub>6</sub> released from transformers used in electricity transmission and distribution systems. Also, landfills and wastewater management facilities produce CH<sub>4</sub> and N<sub>2</sub>O emissions that accounted for 3% of total gross GHG emissions in Arkansas in 2005. Similarly, emissions associated with the production, processing, transmission, and distribution of fossil fuels accounted for 3% of the gross GHG emissions in 2005.

**Figure 2-2. Gross GHG emissions by sector, 2005: Arkansas and U.S.**



Forestry emissions refer to the net CO<sub>2</sub> flux<sup>8</sup> from forested lands in Arkansas, which account for about 56% of the state's land area.<sup>9</sup> Arkansas' forests are estimated to be net sinks of CO<sub>2</sub> emissions in the state, reducing net GHG emissions by 19 MMtCO<sub>2</sub>e in 2005. In addition, estimates of net carbon fluxes from agricultural soil cultivation practices are estimated to be net

<sup>7</sup> Chlorofluorocarbons are also potent GHGs; however, they are not included in GHG estimates because of concerns related to implementation of the Montreal Protocol on Substances That Affect the Ozone Layer. See Appendix I in the Final Inventory and Projections report for Arkansas ([http://www.arclimatechange.us/Inventory\\_Forecast\\_Report.cfm](http://www.arclimatechange.us/Inventory_Forecast_Report.cfm)).

<sup>8</sup> "Flux" refers to both emissions of CO<sub>2</sub> to the atmosphere and removal (sinks) of CO<sub>2</sub> from the atmosphere.

<sup>9</sup> Total forested acreage in Arkansas is 18.8 million acres. For acreage by forest type, see: Richard A. Birdsey and George M. Lewis. "Carbon in United States Forests and Wood Products, 1987–1997: State-by-State Estimates." Arkansas Estimate for 1987–1997. Available from the U.S. Department of Agriculture, Forest Service, Northern Global Change Research Program, at: <http://www.fs.fed.us/ne/global/pubs/books/epa/states/AR.htm>. The total land area in Arkansas is 33.3 million acres (<http://www.50states.com/arkansas.htm>).

sinks of CO<sub>2</sub> emissions in Arkansas. However, the Inventory and Projections report does not consider above-ground carbon sequestration in agriculture because it is not considered to be sequestered.<sup>10</sup>

## Reference Case Projections

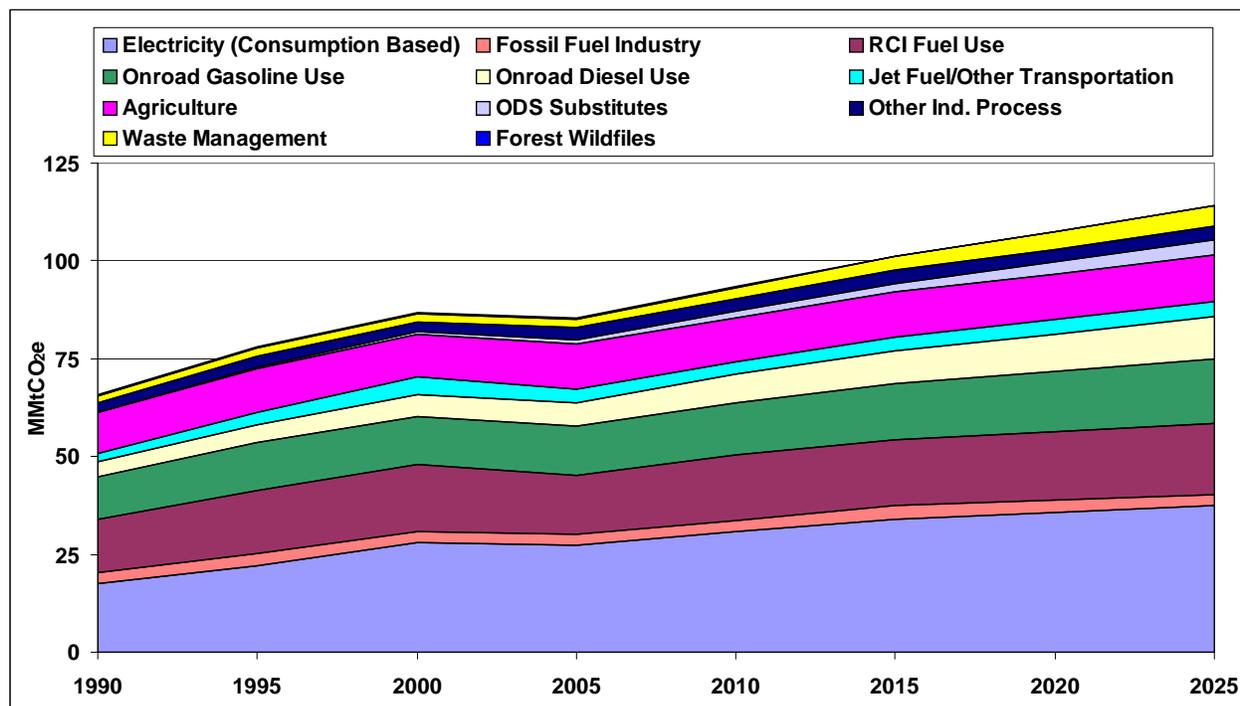
Relying on a variety of sources for projections, as noted in the Inventory and Projections report, a simple reference case projection of GHG emissions through 2025 was developed. As illustrated in Figure 2-3 and shown numerically in Table 2-1, under the reference case projections, Arkansas' gross GHG emissions continue to grow steadily, climbing to about 114 MMtCO<sub>2</sub>e by 2025, or 74% above 1990 levels. This equates to a 1.6% annual rate of growth from 1990 to 2025. By 2025, the share of emissions associated with electricity consumption and the transportation sector both increase slightly to 33% and 27%, respectively; emissions from the residential, commercial, and industrial (RCI) fuel use and agriculture sectors both decrease to 16% and 10%, respectively.

Emissions associated with electricity consumption are projected to be the largest contributor to future GHG emissions growth, followed by emissions associated with the transportation sector, as shown in Figure 2-4. Other sources of emissions growth include the increasing use of HFCs and PFCs as substitutes for ozone-depleting substances in refrigeration, air conditioning, and other applications, as well as the RCI fuel use sector. Table 2-2 summarizes the growth rates that drive the growth in the Arkansas reference case projections, as well as the sources of these data.

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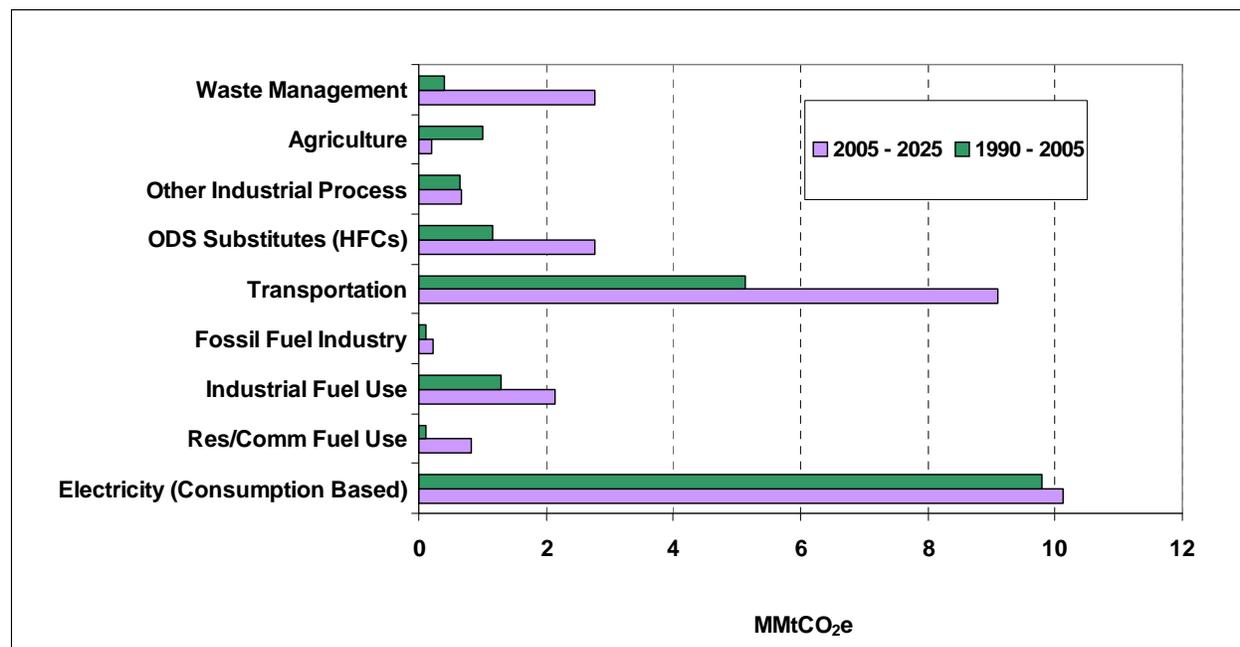
<sup>10</sup> Above-ground carbon re-enters the natural carbon cycle and is lost to the atmosphere through respiration or decomposition either directly or indirectly (e.g., used as energy as animal feed or by humans) over relatively short periods of time (months to years). Carbon sequestration in agriculture is below ground in the form of soil carbon (i.e., the result of the photosynthesis process), where carbon can be stored over long periods of time (potentially indefinitely). The U.S. Environmental Protection Agency (EPA) Web sites <http://www.epa.gov/sequestration/ccycle.html> and [http://www.epa.gov/sequestration/local\\_scale.html](http://www.epa.gov/sequestration/local_scale.html) have some useful information. For additional information on the potential for sequestration in agriculture, see EPA's *Greenhouse Gas Mitigation Potential in U.S. Forestry and Agriculture* (<http://www.epa.gov/sequestration/pdf/greenhousegas2005.pdf>).

**Figure 2-3. Arkansas gross GHG emissions by sector, 1990–2025: historical and projected**



MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; RCI = direct fuel use in residential, commercial, and industrial sectors; ODS = ozone-depleting substance; Ind. = industrial.

**Figure 2-4. Sector contributions to gross emissions growth in Arkansas, 1990–2025: reference case projections**



MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; ODS = ozone-depleting substance; HFCs = hydrofluorocarbons; Res/Comm = direct fuel use in the residential and commercial sectors.

**Table 2-2. Key annual growth rates for Arkansas, historical and projected**

	1990–2005	2005–2025	Sources
Population	1.10%	0.81%	1990–2004 from Historical Data from U.S. Census Bureau, Intercensal Population Estimates at: <a href="http://cber.uark.edu/data/population/Geographic_Regions.xls">http://cber.uark.edu/data/population/Geographic_Regions.xls</a> Arkansas County and State Population Projections: Time Series Extrapolations, 2005–2030 <a href="http://www.aiea.ualr.edu/research/demographic/population/default.html">http://www.aiea.ualr.edu/research/demographic/population/default.html</a>
Electricity Sales	3.55%	1.37%	For 1990–2005, annual growth rate in total electricity sales for all sectors combined in Arkansas calculated from EIA State Electricity Profiles (Table 8) and sales by Arkansas generators calculated from EIA State Electricity Profiles (Table 5) <a href="http://www.eia.doe.gov/cneaf/electricity/st_profiles/arkansas.html">http://www.eia.doe.gov/cneaf/electricity/st_profiles/arkansas.html</a> For 2005–2025, annual growth rates are based on average growth rates in the SERC and SPP regions in which Arkansas is located.
Vehicle Miles Traveled	2.7%	1.7%	Based on SIT default Federal Highway Administration VMT for 1990–1992; 1993–2005 VMT provided by Arkansas Highway and Transportation Department; VMT for 2006–2025 calculated by linear regression based on 1990–2005 VMT.

<sup>a</sup> Represents annual growth in total sales of electricity by generators in Arkansas to RCI sectors located within and outside of Arkansas.

<sup>b</sup> Represents annual growth in total sales of electricity by generators in Arkansas to RCI sectors located within Arkansas.

EIA = Energy Information Administration; SIT = State (GHG) Inventory Tool; VMT = vehicle miles traveled.

### **A Closer Look at the Two Major Sources: Electricity Supply and Transportation**

As shown in Figure 2-2, electricity use in 2005 accounted for 32% of Arkansas’ gross GHG emissions (about 27 MMtCO<sub>2</sub>e), which was very similar to the national share of emissions from electricity generation (34%). On a per-capita basis, Arkansas’ GHG emissions from electricity consumption are higher than the national average (in 2005, 9.8 tCO<sub>2</sub>e per capita in Arkansas, versus 8.1 tCO<sub>2</sub>e per capita nationally). Electricity generation in Arkansas is dominated by steam units, which are primarily powered by coal and nuclear fuel. In 2005, 45% of Arkansas’ electricity generation was provided by coal-fired units, with another 27% of generation provided by nuclear units. The remaining in-state generation came from a mix of natural gas, hydroelectric, biomass, oil, and refuse-derived fuel facilities.<sup>11</sup>

As noted above, these electricity emission estimates reflect the GHG emissions associated with the electricity sources used to meet Arkansas’ demand for electricity, corresponding to a consumption-based approach to emissions accounting. From 1990 to 1999 and from 2001 to 2004, Arkansas was a net exporter of electricity, meaning that Arkansas power plants have produced more electricity than is consumed in the state.<sup>12</sup> For 2000 and 2005, Arkansas was a

<sup>11</sup> Percentages are based on gross generation (including plant fuel use) associated with the electricity produced by facilities in Arkansas.

<sup>12</sup> Estimating the emissions associated with electricity use requires an understanding of the electricity sources (both in state and out of state) used by utilities to meet consumer demand. The current estimates reflect some very simple assumptions, as described in Appendix A of the Inventory and Projections report.

net importer of electricity. Based on the approval of the GCGW, the final reference case forecast assumes that Arkansas is self-sufficient in electricity production, and that there will be no net imports over the revised forecast period (2006–2025). For the purpose of estimating emissions, natural gas-fired generation is assumed to fill any gaps in the supply of electricity to meet Arkansas demand during the forecast period.

While estimates are provided for emissions from both electricity production and consumption, unless otherwise indicated, tables, figures, and totals in this report reflect electricity consumption emissions. The consumption-based approach can better reflect the emissions (and emission reductions) associated with activities occurring in the state, particularly with respect to electricity use (and efficiency improvements), and is particularly useful for decision making. Under this approach, emissions associated with electricity exported to other states would need to be covered in those states' inventories in order to avoid double counting or exclusions.

Like electricity emissions, GHG emissions from transportation fuel use have risen steadily from 1990 to 2005, at an average annual growth rate of 1.8%. In 2005, gasoline-powered on-road vehicles accounted for about 57% of transportation GHG emissions; on-road diesel vehicles for 28%; marine vessels for 8%; aviation fuels for 2%; and rail and other sources (natural gas- and liquefied petroleum gas-fueled vehicles used in transport applications) for the remaining 5%. As a result of Arkansas' population and economic growth and an increase in total vehicle miles traveled, emissions from on-road gasoline use grew at a rate of 0.91% annually between 1990 and 2005. Meanwhile, emissions from on-road diesel use rose by 3.2% per year from 1990 to 2005, suggesting an even more rapid growth in freight movement within or across the state. Emissions from on-road gasoline vehicles in 2025 are projected to increase by 1.4% annually from 2005 levels, and emissions from on-road diesel vehicles are projected to increase by 2.9% annually from 2005 to 2025, with total transportation emissions are expected to reach 31 MMtCO<sub>2e</sub> by 2025.

## **GCGW Revisions**

The GCGW made the following revisions to the inventory and reference case projections, which explain the differences between the final Inventory and Projections report and the draft initial assessment completed during May 2008:

- *Energy Supply:*
  - *Gross coal-fired generation:* The GCGW approved including both the Plum Point and Hempstead County (Turk) coal plants in the reference case projections (both of these plants were included in the May 2008 draft forecast). The GCGW revised the start year for the plants, changing the on-line start date for Plum Point from 2009 to 2010 and for Hempstead County from 2011 to 2012. The GCGW also approved a faster ramp-up of output from the Plum Point and Hempstead plants relative to the draft forecast.
  - *Net imports:* Assume no net imports (or exports) during the forecast period (2006–2025). The draft forecast assumed Arkansas would be a net importer of electricity from 2005 to 2010 and a net exporter of electricity from 2011 to 2025.
  - *Gross natural gas-fired generation and primary energy use:* Include natural gas combined-cycle capacity to satisfy the criteria (1) that Arkansas be self-sufficient in

electricity production, and (2) that there are no net imports over the revised forecast period (2006–2025) (the earlier forecast did not include this assumption).

- *Gross oil-fired generation and primary energy use:* About 20%–25% higher than the draft forecast for 2006–2025.
- *Gross nuclear generation and primary energy use:* 36% less than the draft forecast in the 2020–2025 period.
- *All other gross generation and primary energy use:* About 3% higher than the draft forecast for 2006–2025.
- *Agriculture:*
  - A preliminary estimate was made of the likely emissions coming from catfish farms in Arkansas. This emission estimate was relatively low and has been documented in Appendix F of the Inventory and Projections report. However, the GCGW determined that the uncertainty associated with this estimate was too great for these emissions to be included in the overall agricultural emission totals included in this section of the report.
  - Two additional tables have been added to Appendix F of the Inventory and Projections report that categorize manure management emissions by pollutant (N<sub>2</sub>O and CH<sub>4</sub>) and by animal (chicken, dairy, etc). This does not change the manure management emissions total.
- *Waste Management:*
  - Arkansas Department of Environmental Quality (ADEQ) provided 2002–2005 municipal solid waste (MSW) landfill disposal data, which were used in place of default EPA data.
  - ADEQ also provided a growth rate for MSW landfill disposal, which replaced the original growth rate that was based on historical data.

## Key Uncertainties

Some data gaps exist in this inventory, and particularly in the reference case projections. Key tasks for future refinement of this inventory and forecast include review and revision of key drivers, such as the transportation, electricity demand, and RCI fuel use growth rates that will be major determinants of Arkansas' future GHG emissions (see Table 2-2 and Figure 2-4). These growth rates are driven by uncertain economic, demographic, and land use trends (including growth patterns and transportation system impacts), all of which deserve closer review and discussion.

# Chapter 3

## Cross-Cutting Issues

### Overview of Cross-Cutting Issues

Some issues relating to climate policy cut across multiple, or even all, sectors. The Arkansas Governor's Commission on Global Warming (GCGW) addressed such issues explicitly in a separate Cross-Cutting Issues (CC) Technical Work Group (TWG). Cross-cutting recommendations typically encourage, enable, or otherwise support emission mitigation activities and/or other climate actions. The types of policies considered for this sector are not readily quantifiable in terms of greenhouse gas (GHG) reductions and costs or cost savings. Nonetheless, if successfully implemented, they would most likely contribute to GHG emission reductions and implementation of the GCGW's policy recommendations described in Chapters 4–7 of this report.

The CC TWG developed recommendations for 11 policies (see Table 3-1) that were then reviewed, revised, and ultimately adopted by the GCGW members present and voting. Ten of the recommendations are focused on enabling GHG emission reductions and mitigation activities, while one (CC-9 [Adaptation and Vulnerability]) addresses adaptation to the changes expected from the effects of GHGs that will remain in the atmosphere for decades.

### Key Challenges and Opportunities

In fulfilling one of its requirements under Arkansas Act 696, the GCGW recommends that by 2009 Arkansas adopt a statewide, economy-wide global warming pollutant reduction goal to reduce the state's gross GHG emissions below 2000 levels by 20% by 2020, 35% by 2025, and 50% by 2035. The GCGW based its recommendations on its review of the potential overall emission reduction estimates (as compared to the GHG emissions inventory and forecast) for 31 of 54 policy recommendations for which emission reductions were quantified, and its review of goals and targets adopted by several other states. While 23 other of the GCGW's policy recommendations were not readily quantifiable, some of them would most likely achieve additional reductions, including several of the CC policy recommendations. In addition, emerging technologies may hold the potential to reduce emissions even further.

An opportunity and a challenge is for Arkansas to establish the Arkansas Climate Change Center (CC-9) to (1) collect and analyze data to monitor the effects of climate change in the state, and (2) develop a plan to manage the projected impacts of climate change on the state and reduce the state's contribution to GHGs. In addition, the vision for the Center is to attract leading researchers, scientists, economists, and policy analysts to support implementation of six other CC policy recommendations (i.e., CC-3, CC-4, CC-7, CC-8, CC-10, and CC-11). The Center could provide a significant coordination role with state and local governments, nongovernmental organizations (NGOs), and the private sector to avoid duplication of effort, along with the research support needed to enable decision making on how best to implement policies to mitigate GHG emissions as Arkansas works to achieve the recommended global warming pollutant reduction goals. The GCGW recommends that the Governor's Office seek government and private funding to support establishment of the Center as soon as possible. Until the Center is

established, the GCGW recommends that the state decide on the appropriate lead agency or agencies for implementing the GCGW-recommended CC policies.

**Table 3-1. Cross-Cutting Issues Policy Recommendations**

No.	Policy Recommendation	GHG Reductions (MMtCO <sub>2</sub> e)			Net Present Value 2009–2025 (Million \$)	Cost-Effectiveness (\$/tCO <sub>2</sub> e)	Level of Support
		2015	2025	Total 2009–2025			
CC-1 <sup>†</sup>	Greenhouse Gas Inventories and Forecasts	<i>Not Quantified</i>					Unanimous
CC-2 <sup>‡</sup>	State Greenhouse Gas Reporting and Registry	<i>Not Quantified</i>					Unanimous
CC-3 <sup>‡</sup>	Statewide Greenhouse Gas Reduction Goals or Targets	<i>Not Quantified</i>					Super Majority (3 objections)
CC-4*	The State's Own Greenhouse Gas Emissions (Lead by Example)	<i>Not Quantified</i>					Unanimous
CC-5*	Comprehensive Local Government Climate Action Plans	<i>Not Quantified</i>					Super Majority (1 objection)
CC-6*	State Climate Public Education and Outreach	<i>Not Quantified</i>					Super Majority (1 objection)
CC-7 <sup>‡</sup>	Optimizing Best Scale-of-Reduction Policies	<i>Not Quantified</i>					Unanimous
CC-8 <sup>†</sup>	Creative Financial Mechanisms	<i>Not Quantified</i>					Super Majority (1 objection)
CC-9*	Adaptation and Vulnerability	<i>Not Quantified</i>					Super Majority (1 objection)
CC-10 <sup>†</sup>	Climate Change-Related Economic Development	<i>Not Quantified</i>					Unanimous
CC-11 <sup>†</sup>	Regulatory Realignment in Government To Encourage Constructive Climate Action	<i>Not Quantified</i>					Super Majority (2 objections)

GHG = greenhouse gas; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; \$/tCO<sub>2</sub>e = dollars per metric ton of carbon dioxide equivalent.

The numbering used to denote the above policy recommendations is for reference purposes only; it does not reflect prioritization among these important policy recommendations.

\* The GCGW approved this option at Meeting #8 (July 31, 2008); 19 members present and voting (two by phone).

† The GCGW approved this option at Meeting #10 (September 25, 2008); 21 members present and voting (none by phone).

Establishing a GHG inventory and forecast function within state government is an essential element of understanding where emission reduction opportunities lie, identifying what emission trends are developing, and tracking the effectiveness of policies that the state adopts and implements to reduce GHG emissions. The preparation of periodic inventories and forecasts will most likely require additional resources. These resources are minimized, but not eliminated by, adding implementation of this recommendation to the existing emissions inventory duties of the Arkansas Department of Environmental Quality (ADEQ).

Opportunities exist for sources of GHG emissions in Arkansas to participate in a GHG registry to identify emission reduction opportunities, reduce risks, and potentially develop revenue associated with possible future GHG mandates by developing the required infrastructure in advance for documenting GHG reduction credits. Tracking and reporting GHG emissions can also help in the implementation of periodic state GHG inventories. Thus, the GCGW includes a recommendation for all sources of GHG emissions in Arkansas (including state government agencies) to voluntarily participate in a GHG reduction registry.

To support this policy, the GCGW recommends that the state join a registry as a member organization to develop knowledge of the reporting mechanism, reporting costs, registry requirements, and resource demands to inform Arkansas' sources of GHG emissions. Should the state join The Climate Registry as a member organization, along with 39 other U.S. states, the Governor's Office [Should governor's office be initially capitalized?] and The Climate Registry will need to consult on the per-capita-based membership fee.

The GCGW acknowledges that implementation of some of its recommendations will require additional up-front investment of resources, as well as identifying mechanisms that will save energy and money, create "green" jobs, and consider regional approaches for Arkansas. To address these concerns, the GCGW has included recommendations to identify and implement creative financial mechanisms (CC-8), provide climate change-related economic development opportunities (CC-10), and optimize best scale-of-reduction policies (CC-7). For CC-8, the GCGW recommends that the state legislature establish a board to identify and procure funding from a broad range of sources to support implementation of this policy recommendation, with a goal to establish funding for this policy by mid-2009. For CC-10, the GCGW recommends that the state legislature allocate basic seed money by the end of the 2009 legislative session to facilitate implementation of this policy.

Ultimately, many strategies for reducing GHG emissions will need to be developed and implemented by local communities. Thus, the GCGW has included in its set of CC recommendations a policy to encourage and support local governments and communities to develop plans to address GHG emissions. In so doing, the GCGW recommends that the state (1) provide resources and materials to educate community planning and zoning officials about climate change, impacts, and opportunities; and (2) identify and work with local government leaders, model municipalities, and community-based organizations that have expertise or interest in climate-related issues to build local community capacity to mitigate GHG emissions.

Public education and outreach will be the foundation for the long-term success of many efforts to reduce GHGs. The GCGW recommends that the Governor form a climate literacy education and outreach committee (coordinated by ADEQ and supported by outreach coordinators from all state agencies) to educate the public and other audiences regarding the state's climate change action plan and associated policies, and to oversee outreach activities.

Finally, the GCGW has included recommendations for two policies providing the state the opportunity to "lead by example." One policy (CC-4) calls for state and local government operations and school districts (including universities) to establish GHG reduction targets consistent with the GHG emission reduction levels that the GCGW recommends for statewide GHG reduction goals or targets. Implementation of this policy will be helpful in setting an

example for NGOs, while identifying opportunities for reducing energy costs. The second policy (CC-11) calls for the Governor to conduct a review of state policies and regulations to identify opportunities for realigning them to remove impediments to climate-friendly options. It also recommends that state agencies identify opportunities to utilize incentives to minimize the carbon footprint of state government, as well as entities affected by state government regulations and policies (e.g., local governments and the private sector).

## **Overview of Policy Recommendations and Estimated Impacts**

Cross-cutting issues include policies that apply across the board to all sectors and activities. Cross-cutting recommendations typically encourage, enable, or otherwise support emission mitigation activities and/or other climate actions. The GCGW recommends that 11 such policies be adopted and implemented by Arkansas. All are enabling policies that are not quantified in terms of tons of GHG reduction or costs.

Detailed descriptions of the individual CC policy recommendations as presented to and approved by the GCGW can be found in Appendix F of this report.

## **Cross-Cutting Issues Policy Descriptions**

### **CC-1. Greenhouse Gas Inventories and Forecasts**

Greenhouse gas emission inventories and forecasts are essential to understanding the magnitude of all emission sources and sinks (both natural and those resulting from human endeavors), the relative contribution of various types of emission sources and sinks to total emissions, and the factors that affect trends over time. Inventories and forecasts help to inform state leaders and the public on statewide trends, opportunities for mitigating emissions or enhancing sinks, and verifying GHG reductions associated with implementation of the GCGW's policy recommendations.

The GCGW recommends that the state develop an inventory and forecast system that is aligned with national protocols and tailored to specific emissions/sinks found in Arkansas. In so doing, the state should coordinate with the U.S. Environmental Protection Agency (EPA) on the development of a mandatory federal GHG reporting rule. In addition, the GCGW recommends that the state refine the GHG inventory for previous and current time periods, as needed, to support implementation of the policy recommendations by the GCGW, until the EPA reporting requirements on GHG emission inventories and forecasts become clear. The state should develop a benchmark emissions estimate and associated gap analysis for all years, and identify missing data and/or additional information required. The inventory and forecast function should be integrated with existing related functions, such as those carried out by ADEQ, which develops inventories for the criteria air pollutants.

### **CC-2. State Greenhouse Gas Reporting and Registry**

Greenhouse gas reporting reflects the measurement and reporting of GHG emissions to support both goal development and tracking and management of emissions. GHG reporting can help sources identify emission reduction opportunities, reduce risks, and potentially develop revenue associated with possible future GHG mandates by developing the required infrastructure in advance. Tracking and reporting GHG emissions can also help in the implementation of periodic state GHG inventories.

GHG reporting is a precursor for sources of GHG emissions to participate in GHG reduction programs, opportunities for recognition, and a GHG emission reduction registry, as well as to secure "baseline protection" (i.e., credit for early reductions). A GHG registry enables recording of GHG emission reductions in a central repository with "transaction ledger" capacity to support tracking, management, and "ownership" of emission reductions; establish baseline protection; enable recognition of environmental leadership; and/or provide a mechanism for regional, multistate, and cross-border cooperation. Properly designed registry structures also provide a foundation for possible future trading programs.

The GCGW recommends that the state participate in a nationally recognized, voluntary reporting and registry program (e.g., The Climate Registry) to develop knowledge of the reporting mechanism, reporting costs, registry requirements, and resource demands. To the extent that Arkansas' needs may not be fully met by a national reporting and registry program for sources or sinks/offsets (e.g., the agricultural and forestry sectors) that are specific to Arkansas, the state should consider developing supplemental or ancillary registry capacity or opportunities to enable their participation in a registry.

The GCGW also recommends that state government entities join a registry as an emissions reporter to register its own emission reductions, and facilitate and encourage voluntary participation in a reporting and a registry program by other public and private entities (e.g., local governments, academic and nonprofit institutions, and businesses and regulated industries). The state should make every effort to avoid duplication of reporting requirements on owners or operators of emission sources or sinks by relying on the use of data that emission sources already report under existing state and federal programs, and should seek opportunities to participate with the EPA in developing federal requirements for reporting GHG emissions.

### **CC-3. Statewide Greenhouse Gas Reduction Goals or Targets**

Section 5 (Purpose and duties) of Arkansas Act 696 requires the GCGW to set forth a global warming pollutant reduction goal based on the GCGW's evaluation of the current global warming data, the assessment of global warming mitigation strategies, and the available global warming pollutant reduction strategies.<sup>1</sup> Consistent with this charge, the establishment of a statewide goal or target can provide vision and direction, a framework within which implementation of GCGW policy recommendations can proceed effectively, and a basis of comparison for periodic assessments of progress. Greenhouse gas reduction goals or targets recommended by the GCGW should be consistent with the parallel goal of an efficient, robust Arkansas economy.

The GCGW recommends that Arkansas establish a statewide, economy-wide goal to reduce the state's gross GHG emissions below 2000 levels by 20% by 2020, 35% by 2025, and 50% by 2035. These goals should be adopted by the state by 2009. The GCGW recommends that the Arkansas Climate Change Center prepare a report to the Governor and the state legislature once every 2 years on the state's progress toward achieving the statewide GHG reduction goal, in coordination with ADEQ and other state agencies, as appropriate. This report should address each sector's progress toward reducing GHG emissions; identify the contribution of each sector's emissions (as noted in the GHG inventory and forecast report) toward achieving the statewide goal; and specify future actions and resource needs.

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<sup>1</sup> State of Arkansas, 86th General Assembly, Regular Session, 2007. "Act 696: An Act to Establish the Governor's Commission on Global Warming; to Direct the Commission to Study Issues Related to Global Warming and the Emerging Carbon Market; to Establish a Global Warming Pollutant Reduction Goal and Comprehensive Strategic Plan; and for Other Purposes." Available at: <http://www.arkleg.state.ar.us/ftproot/acts/2007/public/act696.pdf>.

#### **CC-4. The State's Own Greenhouse Gas Emissions (Lead by Example)**

As a "lead by example" policy, the GCGW recommends that state and local government operations and school districts (including universities) begin immediately to establish GHG reduction targets consistent with the GHG emission reduction levels that the GCGW recommends for statewide GHG reduction goals or targets. Establishing these targets will be helpful in setting an example for NGOs, and will help agencies to focus on doing the necessary analysis.

Reductions should be reported at the agency level. Thus, state and local government agencies or departments would first need to develop agency- or department-specific GHG emissions inventory data, ideally building on existing energy use reporting data. This would become the baseline data for ongoing emission reduction activities and measurement, which could be included in annual reporting for all entities. Agency and/or department reports would be aggregated into a summary report reflecting state GHG emissions.

The Arkansas Climate Change Center should oversee the ongoing climate efforts of the state government's agencies or departments; review their performance; and provide direction, guidance, resources, shared approaches, and recognition to agencies or departments and their employees working to reduce the state government's GHG emissions.

#### **CC-5. Comprehensive Local Government Climate Action Plans**

"Think globally, act locally" is the refrain often heard to bring action to bear on environmental issues within the average individual's ability. Similarly, local government actions on climate change issues will be a keystone for achieving state and federal climate action goals. No single approach can be universally applied at the local level; however, local communities are often the incubators for new approaches that can be further developed and applied on a larger level. Local governments will report on progress on climate change issues and will provide innovative, multisector solutions that will be shared with others through a clearinghouse or other mechanisms. Arkansas will provide encouragement and assistance to local jurisdictions to sustain global warming objectives.

Beginning in 2009, the GCGW recommends that Arkansas provide resources and materials to educate community planning and zoning officials about climate change, impacts, and opportunities. Regional meetings will be conducted to train local officials, discuss the state's global warming program, and review other jurisdictions' approaches and lessons learned, to emphasize assistance and resources and to underscore the value of collaboration.

A key initial goal of this recommendation is for Arkansas to identify and work with local government leaders, model municipalities, and community-based organizations that have expertise or interest in climate-related issues to build local capacity for developing and implementing local efforts to mitigate GHG emissions. The state will host events periodically that focus on leading by example, sharing specifics on lessons learned and opportunities, and illustrating financial investments and payback, co-benefits, etc. Development and implementation of local plans will help Arkansas achieve its statewide GHG emission reduction

goals. If local governments include energy efficiency and renewable and clean energy actions in their plans, these actions have multiple benefits, including saving money, creating jobs, promoting sustainable growth, and reducing emissions of GHGs and other air pollutants.

#### **CC-6. State Climate Public Education and Outreach**

The key for long-term success of Arkansas' strategies for addressing climate change lies with increasing the awareness of the issue, as well as the societal costs of and benefits from adopting new policies and/or goals. Education of Arkansas' citizens, business leaders, and policymakers is integral to the successful implementation of changes to mitigate the effects of climate change on the state's environment, economy, and lifestyle. Outreach will extend Arkansans' personal and cooperative commitment to mitigate the effects of climate change to all sectors of endeavor, as well as to future generations.

Starting in 2009, the GCGW recommends that Arkansas develop climate change educational and outreach objectives for implementation in 2010 for the following target audiences:

- **State Executive Agencies**—The Governor should form a climate literacy education and outreach committee (coordinated by ADEQ) to educate the public and other audiences regarding the state's climate change action plan and associated policies, and to oversee outreach activities. The committee should consist of appointed members, and should be supported by outreach coordinators from relevant state agencies (energy supply, forestry, agriculture, etc.).
- **General Public**—Arkansas should increase the public's awareness of and engagement in climate change actions in their personal and professional lives.
- **Future Generations**—Arkansas should integrate climate change into educational curricula, post-secondary degree programs, and professional licensing to address the multidisciplinary approach to reduce adverse climate change effects.

Climate literacy education and outreach would utilize the same practices as existing ADEQ practices. ADEQ has an established network for education and outreach for issues similar to climate literacy (e.g., pollution prevention, clean air). The education and outreach program would include aspects of global warming actions developed from other sectors (i.e., forestry, energy supply, agriculture). Collaboration with NGOs will facilitate public education and outreach, and ensure that climate education is coordinated enough to be broadly effective.

#### **CC-7. Optimizing Best Scale-of-Reduction Policies**

This policy recommends that Arkansas, through the assistance of the Climate Change Center, investigate optimization of scale for each specific GHG reduction considered by the state, and report its findings annually. These investigations should include interstate and regional opportunities that optimize GHG reductions. For the purpose of this policy recommendation, "optimization" should be interpreted as opportunities that further increase the state's overall reduction goals by at least 1% per year, or accelerate the achievement of certain goals by at least one year.

#### **CC-8. Creative Financial Mechanisms**

Allocation of some resources under existing state programs and initiatives can be targeted to achieving state climate goals. However, it is likely that additional resources may be needed to implement the GCGW's recommendations. Therefore, the state and others will need to consider seeking and stimulating additional funding and investment in climate solutions. Initiatives could include (but are not limited to) establishing, promoting, and utilizing creative financing mechanisms for projects and products that reduce GHGs. Examples could include establishing a State Revolving Loan Fund to finance products and services with low-carbon intensity, promoting the use of "green products" procurement preferences, and establishing and promoting greener buying cooperatives.

The GCGW recommends that Arkansas establish a board to identify and procure funding from a broad range of sources to support implementation of this policy recommendation, with a goal to establish funding for this policy by mid-2009. The state should also survey options within existing state economic development plans appropriate to support GHG mitigation policies within Arkansas.

#### **CC-9. Adaptation and Vulnerability**

The GCGW recommends establishing the Arkansas Climate Change Center for collecting and analyzing data to monitor the effects of climate change on Arkansas, using the data to develop a plan to manage the projected impacts of climate change on Arkansas and reducing the Arkansas' contribution to GHGs. Along with existing local, state, and federal agencies, the Arkansas Climate Change Center will help to address the impact of climate change. The impact issues would include identifying the climate change risks to humans (e.g., factors that could contribute to disease); water resources (e.g., risk factors that could cause flooding, drought, pollution of waterways); temperature-sensitive populations (e.g., factors that could place immunocompromised individuals at even greater health risks); and ecosystems (e.g., animals and plants that may be affected by changes in their environment).

Along with these adverse changes in the natural environment, climate change could also harm Arkansas' energy, transportation, and communication systems; vital infrastructure (including public facilities); and entire economy. The analysis of these risks, along with occurring climate change data, can be used to create a model to project future problems and hopefully develop solutions to address these issues. The state should work with industries and research universities to create the Arkansas Climate Change Center. The establishment of the Center should attract more researchers and scientists to Arkansas to help stimulate industrial partners for new economic development and to create new "green" jobs for Arkansans. Once established, the Center could help to coordinate implementation of many of the GCGW's recommendations.

#### **CC-10. Climate Change-Related Economic Development**

Successful state GHG mitigation efforts are highly dependent on active participation of the business community, particularly in the energy, agriculture, transportation, development, and

manufacturing sectors. The intent of this policy is to encourage and facilitate the involvement of funding and investment sources, business interests, and entrepreneurs in pursuing business opportunities associated with GHG mitigation and global warming solutions as quickly and as significantly as possible.

Arkansas' ability to identify and secure early business opportunities associated with climate change may be enhanced, increasing its global competitive advantage and job creation within the state. This policy recommendation includes five specific goals aimed at identifying and leveraging economic development opportunities associated with GHG mitigation in Arkansas, and a performance-based strategic management system to monitor progress.

The GCGW recommends that the state legislature allocate basic seed money by the end of the 2009 legislative session to facilitate implementation of this policy.

#### **CC-11. Regulatory Realignment in Government To Encourage Constructive Climate Action**

This policy recommends that state government conduct a review of its policies and regulations to identify opportunities for realigning them to remove impediments to climate-friendly options. In addition, it recommends that state agencies identify opportunities to utilize incentives to minimize the carbon footprint of state government, as well as entities affected by state government regulations and policies (e.g., local governments and the private sector). Examples include (but are not limited to) coordination and alignment among state agencies' policies and programs; reduced costs and/or time frames for greener permits; "performance-based" regulations; and reducing or eliminating "throughput incentives," so that regulated utilities are compensated for demand-side reductions, not just supply-side activities.

This policy includes several specific recommendations, such as one for state agencies to conduct audits of energy use and GHG emissions associated with state facilities and activities to establish baseline levels needed to set achievable goals for reducing emissions. A second recommendation is for the legislature and Governor to coordinate with ADEQ in formulating an amendment to the definition of "air contaminant" in Chapter 2 of the Arkansas Air Pollution Control Code (Regulation 18) to remove any barriers that prevent Arkansas from controlling CO<sub>2</sub> emissions.<sup>2</sup> This policy will enable Arkansas to mitigate CO<sub>2</sub> emissions, as well as to effectively coordinate its GHG mitigation policies and programs with future regional and national policies and programs. A third recommendation is for the legislature and governor to coordinate to remove the 1999 exemption of Merchant Power Plants from the standard Arkansas Public Service Commission's process such that these plants would be required to substantiate that a public need exists for the electricity they propose to generate and sell in Arkansas.

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<sup>2</sup> See Arkansas Pollution Control and Ecology Commission. "Chapter 2: Definitions." In *Arkansas Air Pollution Control Code—Regulation 18* ([http://www.adeg.state.ar.us/regs/files/reg18\\_final\\_990215.pdf](http://www.adeg.state.ar.us/regs/files/reg18_final_990215.pdf)): "Air contaminant" means any solid, liquid, gas, or vapor or any combination thereof. The following shall not be considered air contaminants: water vapor, oxygen, carbon dioxide, nitrogen, hydrogen, and inert gases.

# Chapter 4

## Residential, Commercial, and Industrial Sectors

### Overview of Greenhouse Gas Emissions

Activities in the residential, commercial, and industrial (RCI) sectors produce GHG emissions when fuels are combusted to provide space heating, process heating, and other applications. In 2005, combustion of oil, natural gas, coal, and wood in the RCI sectors contributed about 18% (about 15 million metric tons of carbon dioxide equivalent [MMtCO<sub>2</sub>e]) of Arkansas' gross greenhouse gas (GHG) emissions. This sector is the third largest source of GHG emissions in the state.<sup>1</sup> Industrial Process emissions are rising primarily due to the increasing use of hydrofluorocarbons (HFCs) as substitutes for ozone-depleting chlorofluorocarbons (CFCs). The production of nitric acid results in nitrous oxide (N<sub>2</sub>O) emissions. In addition, sulfur hexafluoride (SF<sub>6</sub>) is released in the use of electric power transmission and distribution (T&D) equipment. Together, industrial process emissions, including cement production and chemical manufacturing, account for an additional 4.7% of Arkansas's gross GHG emissions (4.03 MMtCO<sub>2</sub>e).

Considering only the direct emissions that occur within buildings and industries, however, ignores the fact that nearly all electricity sold in the state is consumed as the result of RCI activities. If the emissions from all three subsectors of RCI are included (i.e., direct fuel use, emissions associated electricity consumption, and industrial processes), they total about 47% of the state's gross GHG emissions in 2005. Therefore, the state's future GHG emissions will depend heavily on future trends in the consumption of electricity and other fuels in these sectors.

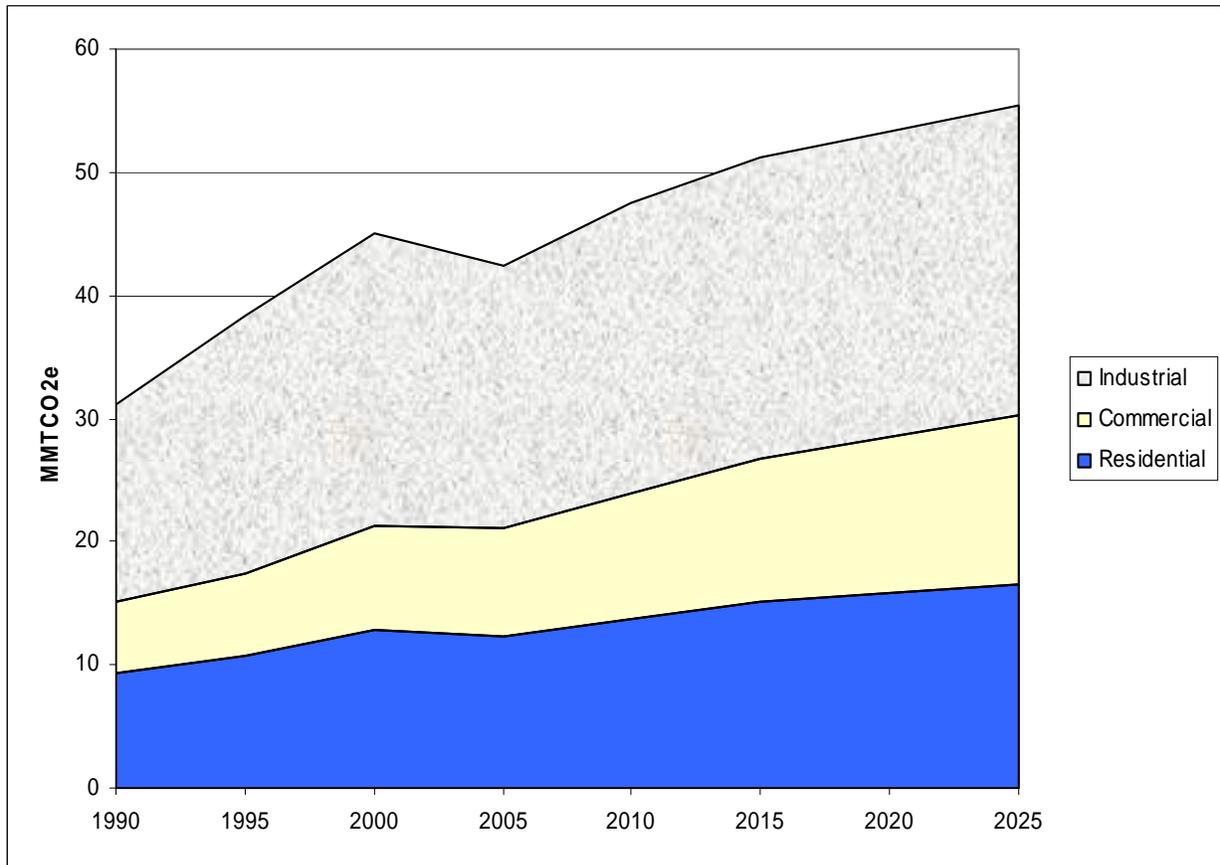
Figure 4-1 shows the growth in GHG emissions by sector through 2025, including electricity use. For the 20-year period, the fastest growth in GHG emissions is the commercial sector, which is forecasted to grow at a 2.7% annual rate. GHG emissions in the residential sector are expected to grow at 1.7%, and the industrial sector has the slowest growth in emissions, at slightly less than 1% a year. The net result of these differential growth rates is that industrial GHG emissions decline from about 50% of Arkansas' total emissions to about 45% by 2025, and emissions from the commercial sector grows by over 50%, from nearly 9 MMtCO<sub>2</sub>e to over 13 MMtCO<sub>2</sub>e by 2025.

Much of the growth in GHG emissions over the period can be attributed an average 1.4% annual growth in electricity demand over the 2005–2025 period for the RCI sectors. However, electricity-related GHG emissions grow by 1.8% per year due to the addition of fossil fuel-based generation resources. Residential GHG emissions from electricity grow by 2% per year, commercial emissions grow by 3% per year, and industrial emissions grow by 0.9% per year.

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<sup>1</sup> Emissions associated with the electricity supply sector (discussed in Chapter 5) have been allocated to each of the RCI sectors for comparison of those emissions to the emissions associated with direct fuel consumption. Note that this comparison is provided for information purposes, and that emissions estimated for the electricity supply sector are not double counted in the total emissions for the state.

**Figure 4-1. Historical and projected residential, commercial, and industrial greenhouse gas emissions by sector in Arkansas: 1990–2025\***

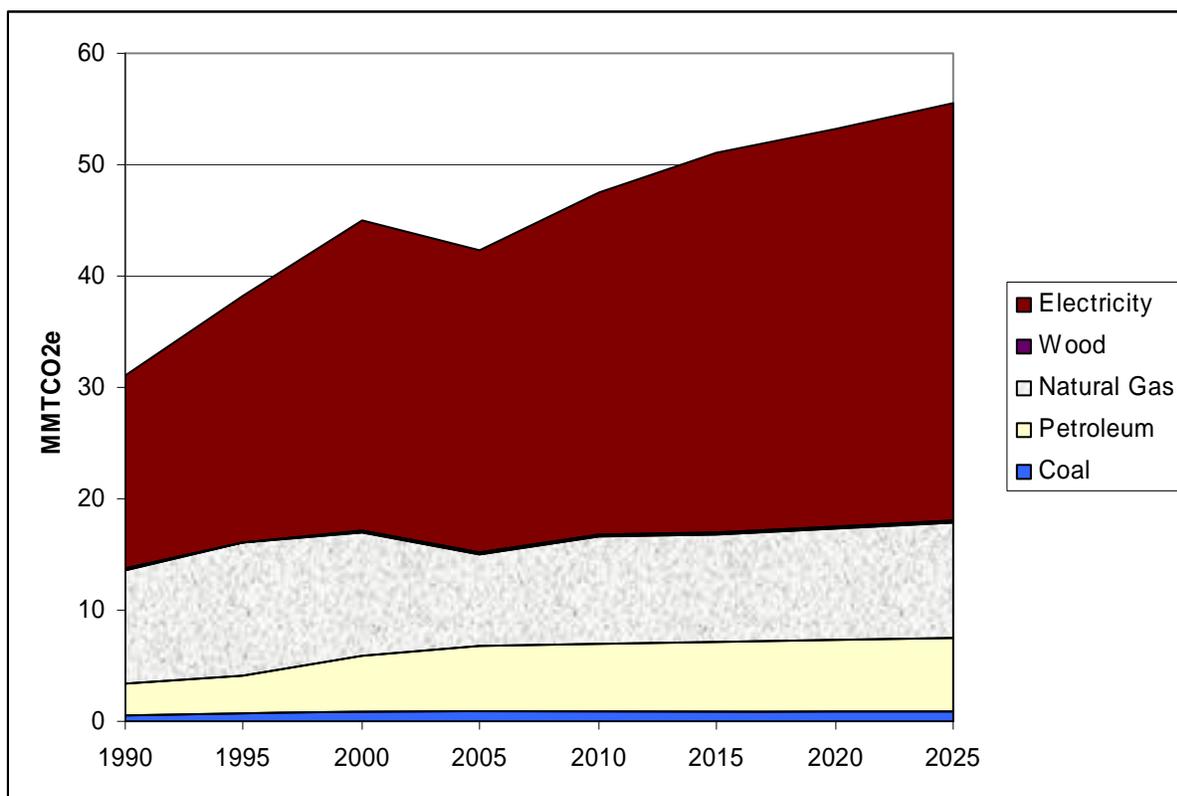


MMtCO<sub>2</sub>e - million metric tons of carbon dioxide equivalent

\* Emissions associated with the direct use of natural gas, petroleum, coal, and wood and the consumption of electricity. Source: Tables 3a, 4a, and 5a in the Consolidated Arkansas Inventory and Forecast.

Figure 4-2 shows the growth in GHG emissions by fuel type through 2025. For the 20-year period, emissions in the sector are dominated by electricity supply, and rise by 37% from 27 MMtCO<sub>2</sub>e in 2005 to 37 MMtCO<sub>2</sub>e in 2025. Direct emissions from coal are forecasted to be essentially unchanged (not including coal use for electricity generation), and emissions from natural gas and petroleum increase by 1.3% and 0.6% per year, respectively. The emissions data from natural gas mask large differences in the growth of the use of this fuel. Residential natural gas consumption is expected to stay constant from 2005 to 2025, while commercial and industrial gas use increases at 1.9% and 1.6% per year, respectively.

**Figure 4-2. Historical and projected residential, commercial, and industrial GHG emissions by type of fuel in Arkansas, 1990–2025\***



MMtCO<sub>2</sub>e - million metric tons of carbon dioxide equivalent

\* Emissions associated with the direct use of natural gas, petroleum, coal, and wood and the consumption of electricity. Wood-related GHG emissions are too small to be distinguished. Source: Tables 3a, 4a, and 5a in Consolidated Arkansas Inventory and Forecast.

## Key Challenges and Opportunities

The principal means to reduce RCI emissions include improving energy efficiency, substituting electricity and natural gas with lower-emission energy resources (such as biomass and wind), and various strategies to decrease the emissions associated with electricity production (see Chapter 5, Energy Supply). The state’s limited pursuit of energy efficiency until recent years offers abundant opportunities to reduce emissions through programs and initiatives to improve the efficiency of buildings, appliances, and industrial practices. The advantages of having “low hanging fruit” in the form of low cost energy efficiency opportunities in the RCI sectors are countered by an underdeveloped private sector that will likely be responsible for scoping, implementing, and evaluating energy efficiency projects. These green collar jobs require special training and equipment that take time for firms within the state to acquire.

Arkansas has recently embarked on statewide energy efficiency programs in response to concerns about energy costs. Ark. Code Ann. §§23-3-401 *et seq.* authorizes the Arkansas Public Service Commission (APSC) to develop energy efficiency and conservation programs to address high energy costs. In January 2007, APSC issued its energy efficiency and conservation plan

rules. The electric and gas utilities proposed a series of programs in July 2007, and the APSC approved several energy efficiency and conservation programs. The total cost of the initial quick-start programs is approximately \$18,530,924 for the initial 2-year period ending December 31, 2009. Municipal and cooperative electric utilities are also currently pursuing energy efficiency programs.

The Arkansas Governor's Commission on Global Warming (GCGW) has identified significant opportunities for reducing GHG emissions growth attributable to the RCI sectors in Arkansas. These include expanding or launching energy efficiency programs for electricity, natural gas, and other direct-use fuels; regularly updating building codes; requiring state and local governments to implement beyond-code building practices and green power purchase/generation; and actively promoting adoption of combined heat and power in the state. The GCGW has also identified significant opportunities to reduce GHG emissions through policies addressing electricity production, such as tapping into the state's biomass potential (detailed in Chapter 5).

## Overview of Policy Recommendations and Estimated Impacts

The GCGW recommends, with varying levels of support, a set of 13 policies for the RCI sectors that offer significant, cost-effective GHG emissions reductions within the state. These recommendations and results are summarized in Table 4.1. The GHG emission reductions and costs per ton of GHG reductions for 11 of these policies were quantified. The quantified policy recommendations could lead to emission savings from reference case projections of:

- 9.2 MMtCO<sub>2</sub>e per year by 2025, and a cumulative savings of 70 MMtCO<sub>2</sub>e from 2009 to 2025, and
- Net cost savings of over \$1.3 billion through 2025 on a net present value basis.<sup>2</sup> The weighted-average costs of these policies are a net savings of nearly \$19/MMtCO<sub>2</sub>e.

Because most energy use occurs in buildings, the recommended policies center on improving energy efficiency in buildings. There is overlap among the policies as to the types of activities and equipment they cover, but the text following Table 4-1 provides general guidance on how the policies complement each other. RCI-5 increases the human capital component of energy efficiency by providing education and training for energy users across the state. RCI-2b is the most general recommended policy that deploys electric energy efficiency across all types of energy use: space conditioning, windows, appliances, and water heating and other end uses and technologies. Efficiency improvements occur through improvements in building shells (RCI-1, RCI-3, RCI-4) and weatherization (RCI-6), or enhancing the efficiency of energy-consuming equipment within the buildings (RCI-2b, RCI-10). RCI-9 is unique because it targets both building- and transportation-related emissions. It decreases total GHG emissions by reducing sprawl, encouraging high-performance buildings, and promoting alternative work schedules, such as telecommuting and 4-day work weeks for government employees.

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<sup>2</sup> The net cost savings, shown in constant 2005 dollars, are based on fuel expenditures; operations, maintenance, and administrative costs; and amortized, incremental equipment costs. All net present value analyses here use a 5% real discount rate.

**Table 4-1. Summary List of Policy Recommendations**

No.	Policy Recommendation	GHG Reductions (MMtCO <sub>2</sub> e)			Net Present Value 2009–2025 (Million \$)	Cost-Effectiveness (\$/tCO <sub>2</sub> e)	Level of Support
		2015	2025	Total 2009–2025			
RCI-1*	Improved Building Codes	0.2	0.6	5.3	–\$118	–\$22	Super Majority (1 objection)
RCI-2a*	Utility and Non-Utility DSM for Peak Use Electricity	0.01	0.02	0.21	–\$11	–\$52	Super Majority (1 objection)
RCI-2b*	Utility and Non-Utility DSM and Energy Efficiency for Electricity	1.1	4.1	30.5	–\$1,450	–\$48	Majority (7 objections)
RCI-3a*	Reduced Energy Use in New and Retrofitted State-Owned Buildings	0.1	0.6	4.3	–\$42	–\$10	Super Majority (1 objection)
RCI-3b*	Reduced Energy Use in State-Owned Buildings	0.2	0.4	4.2	–\$46	–\$11	Super Majority (1 objection)
RCI-4a*	Promotion and Incentives for Improved New Building Design and Construction	0.2	1.1	7.0	–\$160	–\$23	Super Majority (1 objection)
RCI-4b*	Promotion and Incentives for Improved Existing Buildings	0.0	0.3	1.7	–\$39	–\$23	Super Majority (1 objection)
RCI-5*	Education for Consumers, Industry Trades, and Professions	<i>Not Quantified</i>					Unanimous
RCI-6 <sup>†</sup>	Incentives and Funds To Promote Renewable Energy and Energy Efficiency	0.2	0.8	5.1	–\$118	–\$23	Super Majority (1 objection)
RCI-7*	Green Power Purchasing for Consumers	0.2	0.6	4.7	\$61	\$13	Unanimous
RCI-8*	Nonresidential Energy Efficiency	0.4	1.0	8.6	\$583	\$68	Unanimous
RCI-9 <sup>†</sup>	Support for Energy-Efficient Communities, Including Smart Growth	<i>Not Quantified</i>					Unanimous
RCI-10 <sup>†</sup>	Energy-Savings Sales Tax	0.0	0.1	0.7	–\$33	–\$47	Super Majority (1 objection)
	<b>Sector Total After Adjusting for Overlaps</b>	<b>2.55</b>	<b>9.24</b>	<b>69.77</b>	<b>–\$1,313.37</b>	<b>–\$18.82</b>	
	<b>Reductions From Recent Actions (ESIA Title II requirements for new appliances and lighting)</b>	<b>0.34</b>	<b>0.89</b>	<b>8.02</b>	<b><i>Not Quantified</i></b>		
	<b>Sector Total Plus Recent Actions</b>	<b>2.89</b>	<b>10.13</b>	<b>77.79</b>	<b>–\$1,313.37</b>	<b>–\$18.82</b>	

DSM = demand-side management; EISA = Energy Independence and Security Act of 2007; GHG = greenhouse gas; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; \$/tCO<sub>2</sub>e = dollars per metric ton of carbon dioxide equivalent.

Negative values in the Net Present Value and the Cost-Effectiveness columns represent net cost savings.

The numbering used to denote the above policy recommendations is for reference purposes only; it does not reflect prioritization among these important policy recommendations.

\* The GCGW approved this option at Meeting #9 (September 9, 2008); 18 members present and voting (one by phone).

† The GCGW approved this option at Meeting #10 (September 25, 2008); 21 members present and voting (none by phone).

The policy recommendations also differ among the customer classes they target. RCI-3 requires government to lead the rest of the state by example by requiring that new construction and retrofits of existing building stock meet high-performance building requirements. RCI-6 targets low-income residential customers who tend to use energy inefficiently, but are typically hard to reach for utility energy efficiency programs. This policy recommendation also provides incentives for the purchase of new energy-efficient ENERGY STAR-manufactured homes through 2025.

Several of the policy recommendations address the characteristics of “upstream” generation that supplies electricity to the RCI sectors. RCI-8 pursues opportunities to capture waste heat from commercial and industrial processes to generate electricity using combined heat and power projects. RCI-7 incentivizes residential consumers to switch to renewable sources of power, such as hydropower and biomass for their electricity needs.

The policy recommendations developed by the GCGW were designed to minimize overlap between policy recommendations. Government high-performance building standards (RCI-3a and RCI-3b) have little overlap with utility efficiency programs. The private-sector building standards policy recommendations (RCI-4a and RCI-4b) go above and beyond what is required under the building code policy recommendation (RCI-1). The energy efficiency equipment deployed under RCI-10 is additional to utility-funded programs (RCI-2b), as it is being funded by a state tax holiday for certain equipment.

There is overlap in the expected emission reductions and costs among some of the policies within the RCI sectors, as well as between policies in the RCI and energy supply (ES) sectors. RCI-6 provides additional energy efficiency funding and implementation mechanisms for low-income residential customers. Well-designed utility and non-utility energy efficiency/demand-side management programs will target these populations, but not at the level identified under this policy recommendation so RCI-6 is assumed to overlap with RCI-2b.

There are two primary interactions between the RCI and ES sector policies, both concerning the clean energy portfolio components in policy recommendation ES-3a (Renewable Portfolio Standard). Most of the RCI policies (especially RCI-2b) decrease overall electricity demand. As the renewable energy portfolio requirements are based on meeting a percentage of load with specific renewable energy or nuclear resources, the costs of ES-3a would be reduced by reducing energy demand through these RCI policies. Finally, an additional feedback is that certain ES policies (including ES-3a) will have the effect of reducing the GHG emissions associated with energy production, so that RCI policies that target electricity use will have a reduced impact on overall emissions. However, this impact is small and has not been reflected in the analysis.

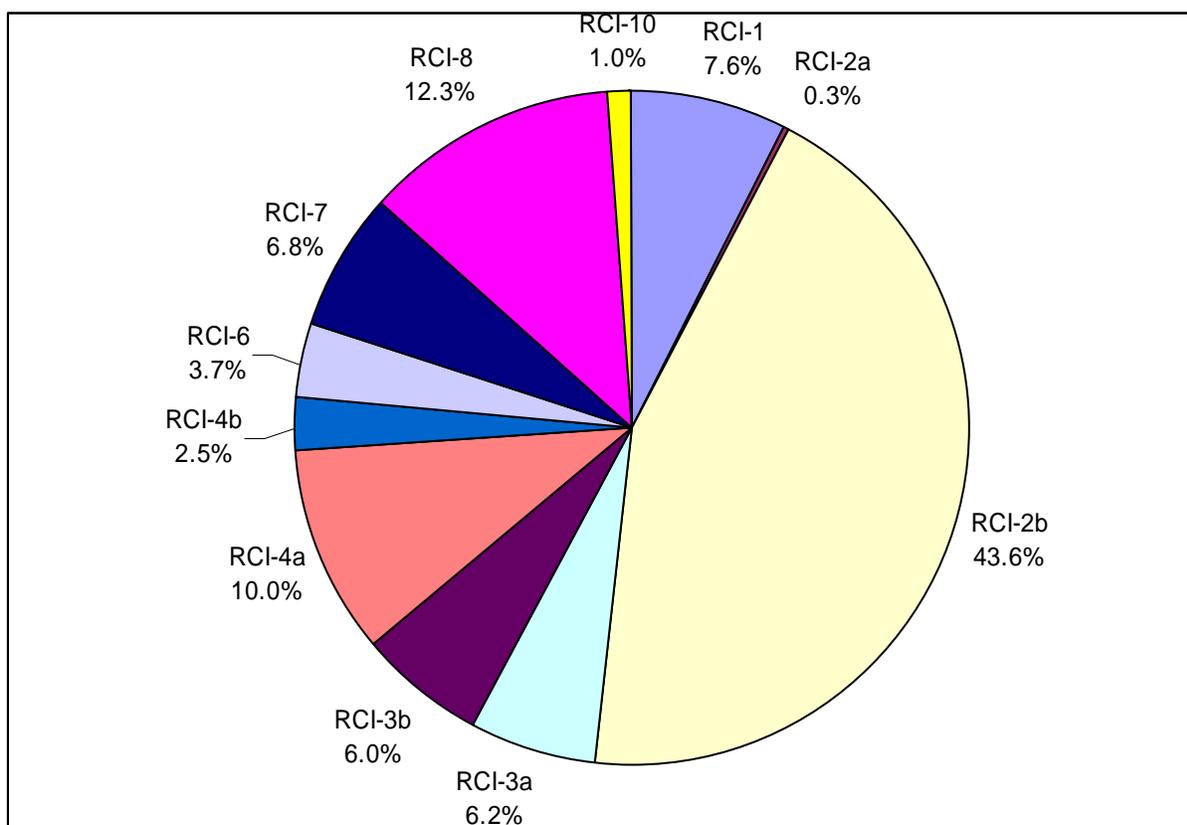
The policy recommendations for the RCI sectors are affected by both state and federal policies that incentivize or mandate more efficient use of energy. The federal Energy Independence and Security Act (EISA) of 2007 was signed into law in December 2007. This law contains several requirements that will reduce GHG emissions as they are implemented over the next few years. During the GCGW process, sufficient information was identified (e.g., implementation schedules) to estimate GHG emission reductions associated with implementing energy efficiency requirements for new appliances and lighting in Arkansas under Title III of the EISA.

The net effect of these reductions was estimated at 1,900 gigawatt-hours (GWh) of electricity and 1,200 billion British thermal units (BBtu) of natural gas savings in Arkansas by 2025. The associated GHG reductions for these savings are project to be 0.9 MMtCO<sub>2</sub>e for the year 2025 using the RCI TWG CO<sub>2</sub> methodology. Note, however, that GHG emission reductions associated with the Title IV (Energy Savings in Buildings and Industry) and Title V (Energy Savings in Government and Public Institutions) requirements of the federal Energy Independence and Security Act of 2007 have not been quantified because of the uncertainties in how they will be implemented. It is expected that the Title IV and Title V requirements will overlap with some of the RCI policy recommendations, especially RCI-2b, RCI-3a, RCI-3b, RCI-4a, and RCI-4b.

Arkansas has also started energy efficiency programs to reduction energy consumption within the state. The Arkansas Public Service Commission has authorized quick-start programs of approximately \$18,530,924 for the initial 2-year period ending December 31, 2009. Municipal and cooperative electric utilities are also currently pursuing energy efficiency programs. These actions are expected to reduce Arkansas GHG emissions by 0.20 MMtCO<sub>2</sub>e in 2009 using the RCI TWG CO<sub>2</sub> methodology. The Annex to the RCI Appendix details the assumptions and approach used to estimate reductions from existing actions in Arkansas and from EISA (2007).

Figure 4-3 shows the cumulative emission reductions from the eight policy recommendations that have been quantified for the entire planning period for 2009–2025. There is a great deal of variation in the emissions reductions from the policy recommendations. Public-sector operations in the state (including schools and local government buildings) are significant GHG emitters. Together, the aggressive government building policy recommendations (RCI-3a and RCI-3b) contribute about 12% of total GHG reductions. Combined, the private-sector high-performance building recommendations (RCI-4a and RCI-4b) provide only about 12.5% of the total reductions, because of assumptions about the new building construction rate and the rate of “down to the studs” building retrofits. RCI-2b will also contribute to building-related GHG reductions, as minor retrofits and equipment upgrades deploy energy-efficient equipment under this policy recommendation. The two energy supply policy recommendations (RCI-7 and RCI-8) contribute almost 20% of the total GHG reductions.

**Figure 4-3. Aggregate GHG emission reductions, 2009–2025\***



\* These are the reductions from the policy recommendations, net of overlaps between recommendations.

The policy recommendations described briefly below, and in more detail in Appendix G, not only result in significant emission reductions and costs savings, but offer a host of additional benefits as well. These benefits include savings to consumers and businesses on energy bills, which can have macroeconomic benefits; reduction in spending on energy by low-income households; reduced peak demand, electricity system capital and operating costs, risk of power shortages, energy price increases, and price volatility; improved public health as a result of reduced pollutant and particulate emissions by power plants; reduced dependence on imported fuel sources; and green collar employment expansion and economic development.

For the RCI policies recommended by the GCGW to yield the levels of savings described here, they must be implemented in a timely, aggressive, and thorough manner. This means, for example, not only putting the policies themselves in place, but also attending to the development of “supporting policies” that are needed to help make the recommended policies effective. While the adoption of the recommended policies can result in considerable benefits to Arkansas’ environment and consumers, careful, comprehensive, and detailed planning and implementation, as well as consistent support, of these policies will be required if these benefits are to be achieved.

## Residential, Commercial, and Industrial Sectors Policy Descriptions

### RCI-1 Improved Building Codes

By a super majority vote, the GCGW recommends that Arkansas take action to improve the state's building codes. Building energy codes specify minimum energy efficiency requirements for new buildings or for existing buildings undergoing a major renovation. Almost half of all U.S. GHG emissions annually are associated with the operation of RCI buildings, along with the embodied energy of building materials.<sup>3</sup> Given the long lifetime of most buildings, improving the energy efficiency of buildings in the state—for example, by strengthening building energy codes—will have a considerable immediate and ongoing impact on reducing building-sector GHG emissions. Although Arkansas law currently requires statewide use of relatively up-to-date building codes as defined by the International Energy Conservation Code, updates to the codes need to be made regularly, and code enforcement in the state needs to be strengthened. Also, the state can improve codes that are not limited to heating, ventilation, and air conditioning (HVAC) systems, including daylighting design to reduce lighting needs, electric lighting design, building envelope design, and integrated building design strategies.

The GCGW recommends that the state take the following actions to improve building codes: expand statewide adoption and enforcement of existing building codes, follow national codes without amendments in Arkansas, and update Arkansas codes in concert with the timing of the national codes. Also, the GCGW targets include a 10% improvement in energy efficiency through educational programs for builders, building inspectors, and other building industry professionals to ensure that the existing codes are implemented and enforced.

### RCI-2a Utility and Non-Utility DSM for Peak-Use Electricity

By a super majority vote, the GCGW recommends that Arkansas take action to reduce GHG emissions from peak-use electricity. Peak-use electricity serves consumers when demand is highest during the daytime on weekdays and weekends. Demand-side management (DSM) programs can mitigate the need to install new peak-use generation resources by reducing the amount of electricity sold during peak periods, and in turn reducing GHG emissions. These reductions can be achieved in two ways: (1) install energy-efficient equipment, such as high-efficiency air conditioners, lighting, and chillers (types of equipment deployed under RCI-2b); and (2) reduce GHG emissions by reducing absolute levels of energy use by consumers due to higher prices.

This policy recommendation deploys equipment, such as real-time pricing and smart metering, that gives consumers information about their energy use and enables them to better rationalize

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<sup>3</sup> U.S. Department of Energy, Energy Information Administration. "U.S. Energy Consumption by Sector." Available at: [http://www.architecture2030.org/building\\_sector/index.html](http://www.architecture2030.org/building_sector/index.html).

their use. These schemes reflect rational pricing that results in price increases during peak periods, leading consumer to make energy-saving choices. For example, instead of using an electric clothes dryer, higher prices give customers rewards for using line drying or other low-energy-consuming practices.

The goal of this policy is for Arkansas to implement energy efficiency programs and DSM to reduce growth in electricity peak demand by 5% per year by 2010 and by 10% per year by 2015. These activities are expected to be additional to load curtailment programs that already exist or are being planned by utilities throughout the state.

#### **RCI-2b Utility and Non-Utility DSM and Energy Efficiency for Electricity**

With a majority vote, the GCGW recommends that Arkansas increase the efficiency of electricity use in the state through a goal of meeting all new electric load growth in Arkansas through energy efficiency and DSM. This policy involves implementing new or expanding existing electric utility energy efficiency programs for all sectors, including the RCI and agricultural sectors. To encourage the utilities to offer and promote these programs, the APSC should adopt rate designs and cost recovery mechanisms that are necessary and in the public interest, to decouple the recovery of the utilities' revenues from the amount of electricity or natural gas sold. Further, the APSC should identify appropriate incentives that are necessary and in the public interest, to further encourage the utilities to offer energy efficiency, conservation, and DSM programs.

The efficiency with which electricity is used today can be improved in countless applications across all sectors and throughout the state. These efficiency improvements can lead to increased productivity for a fixed amount of electricity input, or can produce the same results using less electricity. Arkansas' efforts to date offer substantial room for improvement. As a result, the state has low-cost opportunities compared to states with well-established energy efficiency programs. National studies suggest that Arkansas has substantial potential to improve the efficiency of its energy use. To investigate the potential for energy efficiency specifically for Arkansas, this policy recommends undertaking a comprehensive study of supplies in the state.

The goal of this policy is for Arkansas to implement energy efficiency programs and DSM to eliminate electric utility demand growth over a realistic phase-in period. Statewide electricity demand growth is projected to be 1.4% through 2030. Therefore, energy efficiency and DSM programs that deliver demand reductions of 1.4% of total sales (based on a prior 3-year running average) would be phased in through 2015. Interim targets are to be linear reductions of projected load growth: 16% of new load growth will be met with efficiency and DSM in 2010, 32% in 2011, 48% in 2012, 64% in 2013, 80% in 2014, and 100% in 2015. Thereafter, energy efficiency and DSM programs delivering demand reductions equal to 1.4% of total electricity sales would be continued, unless a comprehensive assessment of potential efficiency gains in Arkansas and best practices nationwide indicates that greater gains are possible.

**RCI-3a Reduced Energy Use in New and Retrofitted State-Owned Buildings: Government “Lead by Example”**

With a super majority vote, the GCGW recommends government “lead by example” initiatives and requirements that both help state and local governments achieve substantial energy cost savings and promote the adoption of clean energy technologies for significant GHG emission reductions in new state and local government buildings. The policy would apply to state government agencies, local governments, schools, and universities.

This policy recommendation sets energy efficiency goals for new construction and major renovations, and provides energy efficiency targets that are much higher than code standards. It achieves GHG reductions by setting a goal to reduce fossil fuel consumption by state and local facilities, which are then certified by a third party for compliance. Other elements include developing life-cycle GHG accounting protocols and a minimum of ENERGY STAR-rated appliances for all government procurement. The policy recommends allowing state agencies to retain funds saved by improving energy efficiency for funding additional energy efficiency investments.

The goals of this policy require that by 2009 all new state buildings (buildings that utilize a minimum of 20% of state funds), developments, and major renovations be designed to meet a fossil fuel, GHG-emitting, energy consumption performance standard of 50% less energy use than the ASHRAE 90.1-2004 energy standard. This standard is increased to a 60% reduction in 2012, 70% in 2017, 80% in 2020, and 90% in 2025, with the goal of the buildings becoming carbon-neutral in 2030 (using no GHG-emitting energy to operate). The higher-level GHG reduction targets may be met through the purchase of renewable energy by governments. The policy also requires that all new or retrofitted buildings meet stringent green building third-party verification requirements.

**RCI-3b Reduced Energy Use in Existing State-Owned Buildings: Government “Lead by Example”**

With a super majority vote, the GCGW recommends government “lead by example” initiatives to help state and local governments achieve substantial energy cost savings, while promoting the adoption of clean energy technologies for significant GHG emission reductions in existing state and local government buildings. The proposed policy provides energy efficiency targets for existing buildings that are much higher than code standards.

The Arkansas state government is a significant consumer of energy. The state owns or leases approximately 29.45 million square feet of building space, and pre-K through 12 schools account for an additional 85 million square feet. Additional local government buildings, such as courthouses, city halls, and other facilities, are not included in this inventory. Arkansas’ public school buildings are in need of approximately \$1.6 trillion of repairs and improvements that

“Impact Functioning of School, i.e., Mechanical, Electrical, HVAC.” These needs are opportunities for installing more energy-efficient equipment.<sup>4</sup>

The goal of this policy requires a 30% reduction in electricity consumed by existing state and local facilities, schools, and universities by 2020. The program gets implemented so that in 2009 20% of government facilities receive the energy efficiency investments, rising to 40% of square footage in 2014, 60% in 2016, and 80% in 2018. By 2020, the entire state existing building stock will have received efficiency investments to reach the 30% improvement target. The policy also requires that a third-party-verified green building certification system for commercial buildings be used for compliance. Also included is a program to audit state activities and facilities, with a goal of at least 20% of all buildings being audited annually, and a requirement for state and local governments to submit annual energy plans to the state. Additionally the recommendation includes a statewide goal that by 2025, a minimum of 15% of energy consumed by state and local government buildings will come from renewable in-state energy sources.

#### **RCI-4a      Promotion and Incentives for Improved New Building Design and Construction**

With a super majority vote, the GCGW recommends this policy, which provides incentives and targets to induce the owners and developers of new buildings to improve the efficiency of those buildings' use of energy and other resources. It also contains provisions for raising targets periodically and providing resources to building industry professionals to help achieve the desired building performance.

This policy includes elements to encourage both the improvement and review of energy use goals over time, and flexibility in contracting arrangements to facilitate integrated energy- and resource-efficient design, construction, and renovation. Incentives could include low-cost loans for investments in energy efficiency, tax credits, and feebates.

The goal of this policy is beginning in 2011 to voluntarily increase new building performance by using tiered incentives for energy efficiency in new residential and commercial buildings that achieve at least a 20% reduction in energy use relative to existing codes. The incentives are scaled so that higher-efficiency buildings receive higher incentives. The minimum efficiency improvement that is eligible for the incentive increases to 25% in 2016, 30% in 2018, and 35% in 2020. Performance is measured through a stringent, third-party-verified green building certification system reduces the requirement for significant oversight and enforcement by state organizations.

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<sup>4</sup> Task Force to Joint Committee on Educational Facilities. *Arkansas Statewide Educational Facilities Assessment—2004. Final Report to the Joint Committee on Educational Facilities.* November 30, 2004, p. 20. Available at: <http://www.arkleg.state.ar.us/data/education/statereport.pdf>.

#### **RCI-4b Promotion and Incentives for Improved Existing Building Design and Construction**

With a super majority vote, the GCGW recommends this policy, which provides incentives and targets to induce the owners and developers of existing buildings to improve the efficiency of those buildings' use of energy and other resources. It also contains provisions for raising targets periodically and providing resources to building industry professionals to help achieve the desired building performance. Existing buildings can exhibit poor energy use indicators because of degraded equipment performance, nonintegrated design, or outdated (not the best available) equipment.

This policy recommendation includes elements to encourage both the improvement and review of energy use goals over time, and flexibility in contracting arrangements so as to facilitate integrated energy- and resource-efficient design, construction, and renovation. Incentives could include low-cost loans for investments in energy efficiency, tax credits, and feebates.

The goal of this policy is beginning in 2011 to voluntarily increase building performance by using tiered incentives for energy efficiency in new residential and commercial buildings that achieve at least a 15% reduction in energy use relative to regional average use for comparable buildings. The incentives are scaled so that higher-efficiency buildings receive higher incentives. The minimum efficiency improvement that is eligible for the incentive increases to 20% in 2014, 25% in 2016, 30% in 2018, and 35% in 2020. Performance is measured through a stringent, third-party-verified green building certification system, which reduces the requirement for significant oversight and enforcement by state organizations.

#### **RCI-5 Education for Consumers, Industry Trades, and Professions**

With a unanimous vote, the GCGW recommends a broad climate change and GHG reduction education program. The ultimate effectiveness of emission reduction activities in many cases depends on providing information and education to consumers regarding the energy and GHG emission implications of their choices. Public education and outreach is vital to fostering a broad awareness of climate change issues and effects (including co-benefits, such as clean air and public health) among the state's citizens. Such awareness is necessary to engage citizens in actions to reduce GHG emissions in their personal and professional lives.

This policy has two goals. The first is by 2010 to implement consumer awareness education on energy consumption and how consumers can reduce GHG emissions. Consumers typically consider energy issues "below the radar" when energy costs are a small part of disposable income and are not the subject of extensive media coverage. The education program can link energy consumption to the costs of climate change and the benefits from GHG reductions, such as green collar jobs and reduced energy expenditures for their household.

The second goal of this recommendation is technical education for builders and contractors on the specific methods they can incorporate to reduce GHG emissions at every stage of construction beginning in 2010. This policy recommendation also addresses education and outreach programs for building professionals to encourage incorporation of energy efficiency and GHG emission reduction considerations, such as programs to train builders and contractors.

Education and training should also be made available to builders and contractors and others for retrofitting existing buildings.

#### **RCI-6 Incentives and Funds To Promote Renewable Energy and Energy Efficiency**

By a super majority vote, the GCGW recommends RCI-6 to improve the energy efficiency of target markets. At least 33% of Arkansans have an income of less than \$30,000/year, of which they spend 20%–30% on utility bills. There are currently not enough weatherization or energy conservation programs in place to reduce the economic burden on this population or to have a scalable impact on mitigating the GHG emissions produced by these homes. Providing traditional financing options for low-income homeowners will not meet their needs or achieve any meaningful scale. The need exists for identifying these homeowners; educating them about the benefits of, and the opportunity for having, energy audits; and financing the implementation of energy-efficient measures.

In addition, manufactured (mobile) homes account for approximately 27% of residential structures in Arkansas. Yet, mobile homes are exempt from compliance with the Arkansas Energy Code and fall under U.S. Department of Housing and Urban Development regulation. These homes are factory-made and can more easily implement efficiency improvements.

The goal of this program is to increase the energy efficiency in low-income and manufactured residences. The low-income retrofit portion of this policy targets the weatherization of 10,000 homes annually by 2015 with energy efficiency improvements of 33% per upgraded residence. The long-term goal is retrofitting 90% of the total low-income homeowner population. This program also expands available funding per residence from the current level (approximately \$2,800) to be able to upgrade major appliances, such as furnaces.

For the manufactured housing portion of this policy, the goal is to provide incentives for the purchase of new ENERGY STAR-manufactured homes, so that by 2025, 75% of all new manufactured homes purchased are ENERGY STAR-certified.

#### **RCI-7 Green Power Purchasing for Consumers**

By unanimous vote the GCGW recommends this policy to promote the use of renewable electricity for Arkansas' residential customers. Arkansas is endowed with renewable resources that can be used for electricity generation or substituted for direct fossil fuel use. This recommendation leverages this potential through programs and policies that encourage consumers to switch from using fossil fuels to purchasing renewable electricity for their energy use.

Green power purchasing refers to a variety of consumer-driven strategies to increase the production and delivery of low-GHG power sources beyond levels achieved through renewable portfolio standard and other mandatory programs. These sources include solar, wind, geothermal, biogas, biomass, and low-impact hydroelectric energy. Green power purchasing programs provide consumers with information about alternative green sources of energy they can select, rather than the traditional, more carbon-intensive sources.

The goal of this policy is that by 2025, this voluntary program incentivizes one of four residential customers to participate in green power purchasing programs. Those who participate in the program will purchase up to 25% of their total electricity use from renewable resources. The program will require a mechanism that strongly encourages utilities purchasing power to develop green power in Arkansas.

#### **RCI-8 Nonresidential Energy Efficiency**

Combined heat and power (CHP) refers to any system that simultaneously or sequentially generates electric energy and utilizes the thermal energy that is normally wasted, significantly increasing efficiency over separate generation of electricity and thermal energy. Many CHP systems are capable of an overall efficiency of over 80%—double that of conventional systems. Another significant advantage is the reduced transmission and distribution losses associated with centralized power generation.

Existing data suggest the existence of a very large unrealized potential for CHP in Arkansas. However, energy recycling, including CHP, is challenged by several noneconomic factors, such as regulatory and environmental permitting complexity or uncertainty, utility resistance to CHP because of potential loss of expected revenue, and increased complexity of facility design and operations. Additional installations of new CHP systems by residential, commercial, institutional, and industrial energy consumers, and continued operation or expansion of existing systems, could be encouraged through a combination of regulatory changes (starting with a review of state and regional policies on permitting, net metering, standby rates, interconnection, and other issues affecting CHP); education and information transfer; and incentive programs.

The GCGW unanimously recommends increased effort toward tapping into the unrealized potential for CHP and waste heat recovery in Arkansas. The goal is to install additional CHP and waste heat recovery technical potential on 25% of new boiler installations of a minimum size rating consistent with a reasonable payout in the state.

This GCGW also recommends that Arkansas consider adopting incentives to encourage high-efficiency electrical transformers that can efficiently handle nonlinear (variable) loads from digital equipment and lighting.

#### **RCI-9 Support for Energy-Efficient Communities, Including Smart Growth**

By unanimous vote, the GCGW adopted this policy recommendation to promote smart growth. Smart growth dictates how the state will invest its money in community development, either by regulating local land-use decisions or by providing incentives to influence those decisions. Existing building, zoning codes, and business schedules often work against smart growth development. In the context of GHG emissions, smart growth policies can serve to revitalize and reuse commercial sites and will help preserve critical natural resources and farmland.

The goals of this program are multifaceted:

- By 2009, provide resources for local jurisdictions to examine and rewrite their outdated state and local codes to accommodate for smart growth initiatives in community planning and development. Implementing smart growth policies is expected to reduce (per-unit) energy consumption, GHG emissions, infrastructure costs, and new construction by 30% by 2030. Design all new buildings, developments, and major renovations to meet the targets in RCI-4a and RCI-4b.
- Create incentives to encourage smart growth by meeting Built Green Community certification or the LEED-ND (LEED for Neighborhood Development) gold level, with minimum energy and location criteria.
- Encourage compact and transit-oriented, mixed-use development within urban growth areas that results in reduced vehicle miles traveled and GHG emissions and encourages walking and biking.
- Encourage state and local governments and private firms to adopt telework policies to reduce building and transportation-related GHG emissions.
- Commission a study on the effects of alternative work schedules similar to West Virginia House Resolution #34 and others.
- Limit sprawl by enabling transfer of development rights, revitalizing communities through developed land and building reuse incentives, and institute a variety of conservation measures for woodlands and wetlands.
- Support locally owned shops, restaurants, and farmers' markets to help local businesses and family farms remain profitable, thus strengthening the local economy and protecting rural legacy and lands.

#### **RCI-10 Energy-Savings Sales Tax**

By a super majority vote, this policy recommendation refers to a sales tax exemption for energy-efficient products, such as compact fluorescent lights, geothermal heat pumps, highly efficient heat pump systems, and ENERGY STAR-certified water heaters, refrigerators and freezers, clothes washers and dryers, and dishwashers. Establishing a market signal that rewards lower-carbon purchase decision making provides consumers an incentive to improve their energy efficiency and reduce their adverse impacts on climate.

The list of energy efficiency measures that this policy recommendation applies to contains the same measures that utility energy efficiency programs typically pursue. Utility programs assume that some portion (usually ~25%) of the capital costs of the efficiency measure is paid for by the participant. Thus, this policy recommendation reduces the purchase price (capital cost) of energy-efficient goods by consumers by the amount of the sales tax. However, these costs are then paid for by the state, rather than consumers.

The goal of this policy is to implement a state sales tax exemption for all consumers on energy-efficient equipment. The program is to be implemented by 2010 and requires point-of-sale tax exemption at retailers for the tax policy to be implemented.

# Chapter 5

## Energy Supply

### Overview of GHG Emissions

Greenhouse gas (GHG) emissions from Arkansas's energy supply (ES) sector include emissions from electricity generation and represent a substantial portion of the state's overall GHG emissions (approximately 32% of gross emissions on a consumption basis in 2005). From 1990 to 1999 and from 2001 to 2004, Arkansas was a net exporter of electricity, meaning that Arkansas power plants have produced more electricity than is consumed in the state.<sup>1</sup> For 2000 and 2005, Arkansas was a net importer of electricity. Based on the approval of the Arkansas Governor's Commission on Global Warming (GCGW), the final reference case forecast assumes that Arkansas is self-sufficient in electricity production, and that there will be no net imports over the revised forecast period (2006–2025). For the purpose of estimating emissions, natural gas-fired generation is assumed to fill any gaps in the supply of electricity to meet Arkansas demand during the forecast period.

In the absence of any mitigation efforts, GHG emissions from Arkansas's ES sector are expected to increase from 2005 base year levels of 27.2 million metric tons (MMt) of carbon dioxide equivalent (CO<sub>2</sub>e) to about 37.4 MMtCO<sub>2</sub>e by 2025, or by approximately 37.2% over this 20-year period. The reference case forecast includes the following two coal plants: Plum Point to be brought on-line in 2010 and the Turk plant in Hempstead County to be brought on-line in 2012. The reference case projections reflect the planning assumption that sufficient high-efficiency natural gas-fired capacity is built within the state to satisfy future retail electricity demand growth in Arkansas. This trend is summarized in Figure 5-1. It is important to emphasize that these GHG reduction trends are evident prior to the implementation of any of the ES mitigation measures recommended by the GCGW.

### Key Challenges and Opportunities

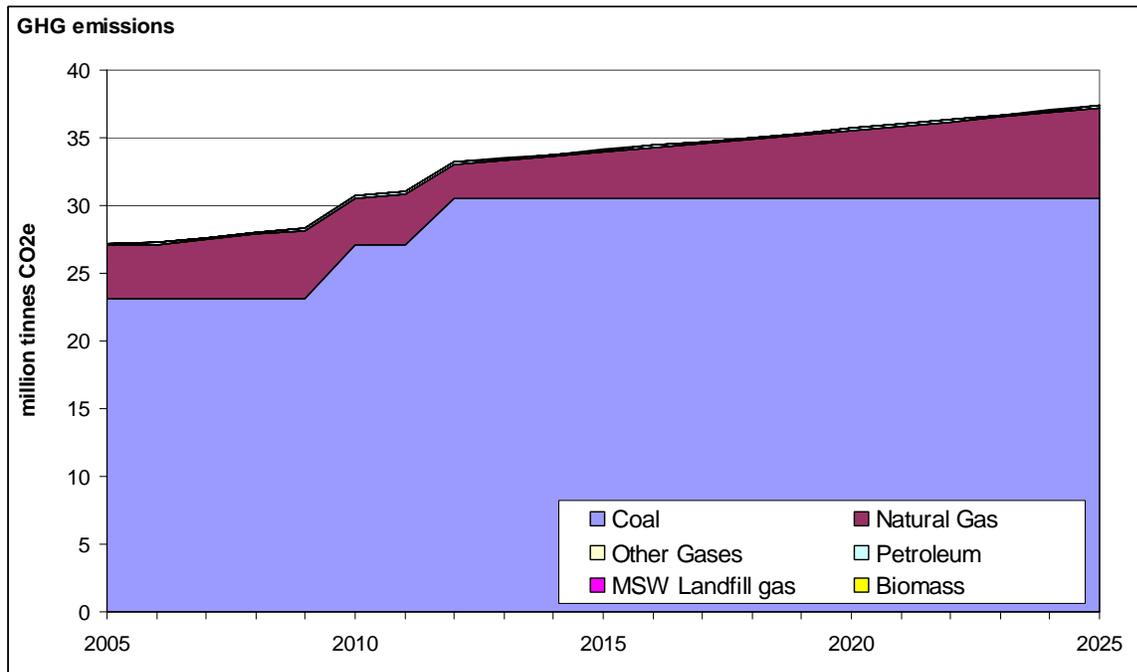
The key challenge in addressing GHG emissions from Arkansas's ES sector is the state's continued reliance on coal-fired generation inside the state. The share of GHG emissions from coal-fired generation was about 85% in 2005, and is projected to reach 92% in 2012 when both the new Plum Point and Hempstead plants are on line, and drop only slightly—to 82% in 2025—associated with the addition of high-efficiency natural gas generation.

Like many other states, the projected large growth in electricity sales is the primary driver for Arkansas' GHG emissions. The projected average annual growth rate of electricity sales in Arkansas between 2005 and 2025 is rather substantial—about 1.37% per year. This rate incorporates any current demand-side management programs in the state.

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<sup>1</sup> Estimating the emissions associated with electricity use requires an understanding of the electricity sources (both in state and out of state) used by utilities to meet consumer demand. The current estimates reflect some very simple assumptions, as described in Appendix A of the Inventory and Projections report.

**Figure 5-1. Recent and projected GHG emissions from the electricity sector, Arkansas, 2005–2025 (consumption basis)**



GHG = greenhouse gas; MMtCO<sub>2</sub>e = million metric tons carbon dioxide equivalent; MSW = municipal solid waste.

Arkansas has several opportunities for reducing the growth in GHG emissions attributable to energy production and supply. For example, the carbon intensity of in-state electricity generation could be decreased through the introduction of new renewable resources, such as wind and biomass, the addition of carbon capture and storage technologies for existing (through retrofits) coal-fired stations in the state once such technology is commercially available, and the penetration of combined heat and power systems. Significant opportunities to reduce GHG emissions through options to further reduce electricity consumption also exist, and can often provide net cost savings to Arkansas consumers and the state. Several demand-side management, energy efficiency, and conservation measures recommended in the residential, commercial, and industrial sector are detailed in Chapter 4 of this report.

## Overview of Policy Recommendations and Estimated Impacts

The GCGW analyzed and is recommending several policies for the ES sector that offer the potential for significant GHG emission reductions, as summarized in Table 5-1. All policy recommendation totals are relative to the underlying assumption that electricity expansion in Arkansas will proceed with the installation of the Plum Point pulverized coal station in 2010 and the installation of the Hempstead pulverized coal plant in 2012. In making this assumption, the GCGW is not recommending for or against the need for or merits of the addition of the Hempstead plant.

**Table 5-1. Summary results for energy supply policy recommendations and existing actions**

No.	Policy Recommendation	GHG Reductions (MMtCO <sub>2</sub> e)			Net Present Value (Million \$)	Cost-Effectiveness (\$/tCO <sub>2</sub> e)	Level of Support
		2015	2025	Total 2009–2025			
ES-1*	Green Power Purchases and Marketing	<i>Transferred to RCI TWG</i>					Unanimous
ES-2*	Technology Research & Development	<i>Not Quantified</i>					Unanimous
ES-3 <sup>†</sup>	3a: Renewable Portfolio Standard (RPS)	0.3	3.6	21.9	\$548	\$25.0	Majority (10 objections)
	3b: Renewable Energy Feed-In Tariff (REFIT)	0.2	2.0	12.3	\$399	\$32.5	Super Majority (4 objections)
ES-4 <sup>†</sup>	Grid-Based Renewable Energy Incentives and/or Barrier Removal	<i>Not Quantified</i>					Unanimous
ES-5 <sup>†</sup>	Approaches Benefiting From Regional Application	<i>Not Quantified</i>					Unanimous
ES-6*	Combined Heat and Power	0.6	2.9	20.0	\$886	\$44.3	Unanimous
ES-7 <sup>†</sup>	Geological Underground Sequestration for New Plants	2.9	5.6	56.5	\$1,801	\$31.9	Majority (10 objections)
ES-8 <sup>†</sup>	Transmission System Upgrades	<i>Not Quantified</i>					Unanimous
ES-9*	Nuclear Power	0.0	9.8	58.9	\$1,574	\$26.7	Unanimous
ES-10 <sup>†</sup>	Carbon Tax	<i>Not Quantified</i>					Super Majority (4 objections)
ES-11*	Efficiency Improvements and Repowering of Existing Plants	2.3	2.3	31.8	\$1,568	\$49.3	Unanimous
	<b>Sector Total After Adjusting for Overlaps<sup>‡</sup></b>	<b>6.0</b>	<b>22.6</b>	<b>179.4</b>	<b>\$6,228</b>	<b>\$34.7</b>	
	<b>Reductions From Recent Actions</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>\$0</b>	<b>\$0.0</b>	
	<b>Sector Total Plus Recent Actions<sup>‡</sup></b>	<b>6.0</b>	<b>22.6</b>	<b>179.4</b>	<b>\$6,228</b>	<b>\$34.7</b>	

GHG = greenhouse gas; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; \$/tCO<sub>2</sub>e = dollars per metric ton of carbon dioxide equivalent.

Negative values in the Net Present Value and the Cost-Effectiveness columns represent net cost savings.

The numbering used to denote the above policy recommendations is for reference purposes only; it does not reflect prioritization among these important policy recommendations.

All totals are relative to the underlying assumption that electricity expansion in Arkansas proceeds with the planned additions of the coal-fired Plum Point and Hempstead County power stations.

\* The GCGW approved this option at Meeting #9 (September 9, 2008); 18 members present and voting (one by phone).

<sup>†</sup> The GCGW approved this option at Meeting #10 (September 25, 2008); 21 members present and voting (none by phone).

<sup>‡</sup> The cumulative results are based on the sum of the following:

- ES-3b (Renewable Energy Feed-In Tariff [REFIT]);
- ES-6 (Combined Heat and Power);
- ES-7 (Geological Underground Sequestration for New Plants);
- ES-9 (Nuclear Power); and
- ES-11 (Efficiency Improvements and Repowering of Existing Plants).

ES-3b and ES-6 overlap with AFW-4 (Expanded Use of Agriculture and Forestry Biomass Feedstocks for Electricity, Heat, or Steam Production: Energy From Biomass and Capture of Waste Heat). These overlaps were addressed by excluding the emission reductions and costs/savings associated with the biomass and waste heat components for AFW-4 from the cumulative totals for all AFW policy recommendations combined.

These recommendations include efforts to support technology research and development (R&D) activities (ES-2), encourage the penetration of renewable energy (ES-3), provide incentives for renewable energy (ES-4), encourage regional approaches to GHG reductions (ES-5), promote combined heart and power (CHP) systems (ES-6), sequester GHG emissions from coal-fired stations (ES-7), encourage support for transmission and distribution (T&D) upgrades (ES-8), promote nuclear power (ES-9), support a carbon tax (ES-10), and promote efficiency improvements at existing power plants. These policy recommendations contribute to GHG emission reductions during 2009–2025, as outlined in Table 5-1.

Overall, the ES mitigation recommendations yield annual GHG emission reductions from reference case projections of about 22.6 MMtCO<sub>2</sub>e in 2025 and cumulative reductions of 179.5 MMtCO<sub>2</sub>e from 2009 through 2025, at a net cost of approximately \$6.228 billion through 2025 on a net present value basis. The weighted-average cost of saved carbon for the ES measures is about \$35/tCO<sub>2</sub>e avoided. An overview of each policy recommendation is provided in this chapter. Additional details regarding the application of these recommendations to Arkansas (targets, implementation mechanisms, parties involved, modeling approach, etc.) are provided in Appendix H.

## Energy Supply Sector Policy Descriptions

The ES sector has several opportunities for mitigating GHG emissions from electricity generation, including mitigation activities associated with the generation, transmission, and distribution of electricity—whether generated through the combustion of fossil fuels, renewable energy sources in a centralized power station supplying the grid, distributed generation facilities, or imported into the state.

### **ES-2. Technology Research & Development**

This recommendation involves support for R&D that targets a particular GHG-mitigating technology as part of a state initiative to build an industry around that technology in the state, and sets the stage for future adoption of the technology for use in the state. This recommendation also includes funding for demonstration projects to help commercialize technologies that have already been developed, but are not yet in widespread use. Finally, funding is also intended to support increased collaboration among existing institutions in the state for R&D.

### **ES-3a. Renewable Portfolio Standard (RPS)**

A renewable portfolio standard (RPS) is a requirement that utilities must supply a certain, generally fixed, percentage of electricity from an eligible renewable energy source(s). An environmental portfolio standard expands that notion to include energy efficiency or other GHG emission-reducing technologies as an eligible resource. About 20 states currently have an RPS in place. In some cases, utilities can also meet their portfolio requirements by purchasing Renewable Energy Certificates from eligible renewable energy projects. The application of an RPS in Arkansas is provisional. That is the primary recommendation for achieving greater penetration of renewable energy in the recommendation described in ES-3b (Renewable Energy Feed-In Tariff [REFIT]). However, if certain goals of the REFIT recommendation are not achieved, the RPS would go into effect. If regional and national bulk electric transmission lines (the equivalent of the interstate highway system) are not built, access to significant and cost-effective renewable generation will be obstructed, and goals for such must be scaled back to levels reliably and economically achievable.

### **ES-3b. Renewable Energy Feed-In Tariff (REFIT)**

A Renewable Energy Feed-In Tariff (REFIT) provides guaranteed above-market rates for a given period to entities that install qualifying sources of renewable energy and sell energy back to the grid. The higher rate helps overcome the cost disadvantages of renewable energy sources and may be set at different levels for the various forms of renewable power generation. Utilities would be able to recover the cost of the program, plus a reasonable profit, from their ratepayer base. In cases where the entity does not have the capital available to finance the renewable

energy installation, it can display this utility guarantee to a financial institution to aid in obtaining a loan for the purchase price of the installation.

#### **ES-4. Grid-Based Renewable Energy Incentives and/or Barrier Removal**

This policy recommendation involves tax incentives and innovative financing programs for residential and commercial utility users who develop or apply successful renewable energy systems. The tax and loan incentives would be proportional to the amount of renewable energy they are using, with the greatest incentives for those who use net metering and return energy to the grid for use by other utility customers. Legislative Council, the Arkansas Department of Finance and Revenue, the Arkansas Development Finance Authority, the Arkansas Department of Environmental Quality, and the Arkansas Science and Technology Authority, in coordination with the GCGW and the appropriate legislative leaders, should research model programs in other states and countries and make recommendations on specific policies in time for the next legislative session. In addition, pilot and demonstration programs should be established to demonstrate the effectiveness of these policies as they are implemented. Alternative sources of funding, including foundations, utility companies, and others, should be sought to supplement state revenue for these policies.

#### **ES-5. Approaches Benefiting From Regional Application**

The primary goal of this policy recommendation is to establish a program that will allow Arkansas to adapt to and be prepared for a federally implemented cap-and-trade system. A cap-and-trade system is a market mechanism by which GHG emissions are limited or capped at a specified level, and those participating in the system are required to hold permits for each unit of emissions. Through trading, participants with lower costs of compliance can choose to overcomply and sell their additional reductions to participants for whom compliance costs are higher. In this fashion, the overall costs of compliance are lower than they would otherwise be.

#### **ES-6. Combined Heat and Power**

CHP refers to any system that simultaneously or sequentially generates electric energy and utilizes the thermal energy that is normally wasted. The recovered thermal energy can be used for industrial process steam, space heating, hot water, air conditioning, water cooling, product drying, or nearly any other thermal energy need in the commercial and industrial sectors. The end result is significantly increased efficiency over generating electric and thermal energy separately. In fact, many CHP systems are capable of an overall efficiency of over 80%—double that of conventional systems. Another significant advantage is the reduced T&D losses associated with centralized power generation.

#### **ES-7. Geological Underground Sequestration for New Plants**

This policy recommendation refers to the capture of CO<sub>2</sub> from fossil fuel-fired power plant emissions and its sequestration in geologic formations, including oil and gas reservoirs,

unminable coal seams, and deep saline reservoirs. Broadly, three different types of technologies exist: post-combustion, pre-combustion, and oxyfuel combustion. After capture, the CO<sub>2</sub> must be transported to suitable storage sites, which this is often accomplished via pipeline.

This policy affects all new coal-fired power plants, both those that are currently under construction and those that have not yet received full approval for construction in Arkansas. Plants currently under construction (including the Plum Point plant) should install and employ post-combustion carbon capture and storage (CCS) as soon after the plant's opening as the technology becomes available. Plants that have not yet received full approval for construction (including the Hempstead plant) should employ CCS as soon as they begin operations. All other new coal-fired generating plants should employ state-of-the-art pre-combustion CCS as soon as they begin operations.

This policy implies that, except for the already-permitted Plum Point plant, there will be no new coal-fired generating plants in Arkansas until sequestration is ready. Until that time, the electricity that would have been generated by new plants should be replaced with expanded energy efficiency, renewable energy, and, as a last resort, natural gas combined-cycle technology.

#### **ES-8. Transmission System Upgrades**

This recommendation involves measures to improve transmission systems to reduce bottlenecks and enhance throughput while satisfying long-term electricity demands, improving the efficiency of operations, and allowing for delivery of diverse and renewable energy sources located outside of the state. Opportunities exist to substantially increase transmission line carrying capacity through the implementation of new construction and retrofit activities on the transmission grid, including incorporating advanced composite conductor technologies, capacitance technologies, and grid management software. This recommendation is important, as siting new transmission lines can be a difficult process, given their cost and their local impact on the environment and on the use, enjoyment, and value of property.

#### **ES-9. Nuclear Power**

Nuclear power has historically been a low-GHG source of electric power. However, no new nuclear power plants have come on line in the United States since 1996 due to high capital costs. Long-term disposal of nuclear waste and public safety are public policy concerns with nuclear power. With the national pricing of the GHG cost of fossil fuel generation, with either a cap-and-trade system or a carbon tax, nuclear power may be more cost-competitive.

The Energy Policy Act of 2005 included provisions encouraging the construction of new nuclear units. There are currently nine applications for a new plant on file with the Nuclear Regulatory Commission (NRC). The one nearest to Arkansas is adjacent to the existing Grand Gulf unit in Port Gibson, Mississippi; it has been accepted for docketing by the NRC. As new nuclear power plants come on line in the future in the Arkansas region, they will offer Arkansas electric utilities an alternative to the construction of fossil fuel generation units.

## **ES-10. Carbon Tax**

The primary goal of this policy recommendation is to establish a mechanism that will allow Arkansas to adapt to and be prepared for a federally implemented carbon tax and other federal climate policies. A carbon tax sets a fee, or tax, for the release of carbon to the atmosphere. It does not set a limit, reduce, or otherwise control the tons of carbon released. The tax raises the cost of carbon-based emissions and, therefore, encourages investment in low-carbon or no-carbon alternatives. It also generates revenue for the government, which could be directed toward energy efficiency, the development and use of renewable energy, climate change adaptation investments, and other measures to mitigate or address the impacts of climate change. Many proposals also have options to rebate the tax back to the ratepayer, particularly low-income ratepayers. A carbon tax could be implemented as a tax on fossil fuels according to the amount of CO<sub>2</sub> emitted by their combustion. One of the benefits is that the tax can be more easily applied across all sectors. To achieve the stated goal, the amount of the tax must be high enough to trigger financial and behavioral decisions toward conservation or a shift to lower-emitting fuels.

The design elements of this policy include the following:

- Arkansas should only consider carbon tax programs that are national in scope, and in conjunction with other carbon tax and “cap-and-trade” programs that are proposed. The state should opt for national programs that use revenue sharing back to state government for purposes of implementing state initiatives on global warming. The state should promote a national carbon tax that does not put Arkansas at a competitive disadvantage with other states.
- Arkansas should make the cost of inefficient or higher CO<sub>2</sub>-emitting activities more expensive than alternatives, thereby creating a financial incentive to discourage activities that result in CO<sub>2</sub> emissions. The amount of revenue that the carbon tax generates annually should depend on the facilities subject to the tax. The amount of the tax should be high enough to contribute to the reduction targets specified in a statute. From a competitive perspective, one advantage of a carbon tax is that it is constant and predictable, making a business case more stable than some alternatives.

A carbon tax should include options to rebate the tax back to the ratepayer, thus creating a true cost of carbon but keeping ratepayers from paying more on their utility bills. This should include rebates on income and payroll taxes, particularly for low-income ratepayers.

- Voluntary carbon offset programs should be established in Arkansas through utility bills and other mechanisms.

## **ES-11. Efficiency Improvements and Repowering of Existing Plants**

This recommendation involves improving efficiency at existing plants through such improvements as more efficient boilers and turbines, improved control systems, or combined-cycle technology. This could also include switching to lower- or zero-emitting fuels at existing plants, or new capacity additions. Policies to encourage efficiency improvements and repowering

of existing plants could include incentives and/or regulations. Although most economic improvements have already been made, existing power plants should be encouraged to reach specific energy efficiency goals before new plants are constructed.

# Chapter 6

## Transportation and Land Use Sectors

### Overview of Greenhouse Gas Emissions

The transportation sector, which includes light- and heavy-duty (on-road) vehicles, aircraft, rail engines, and marine engines, is one of the largest contributors of gross greenhouse gas (GHG) emissions in Arkansas. This sector accounted for 26% of Arkansas's gross GHG emissions in 2005, which was slightly under the national average of 27%. However, by 2025, the share of emissions associated with the transportation sector is anticipated to increase slightly to 27%.

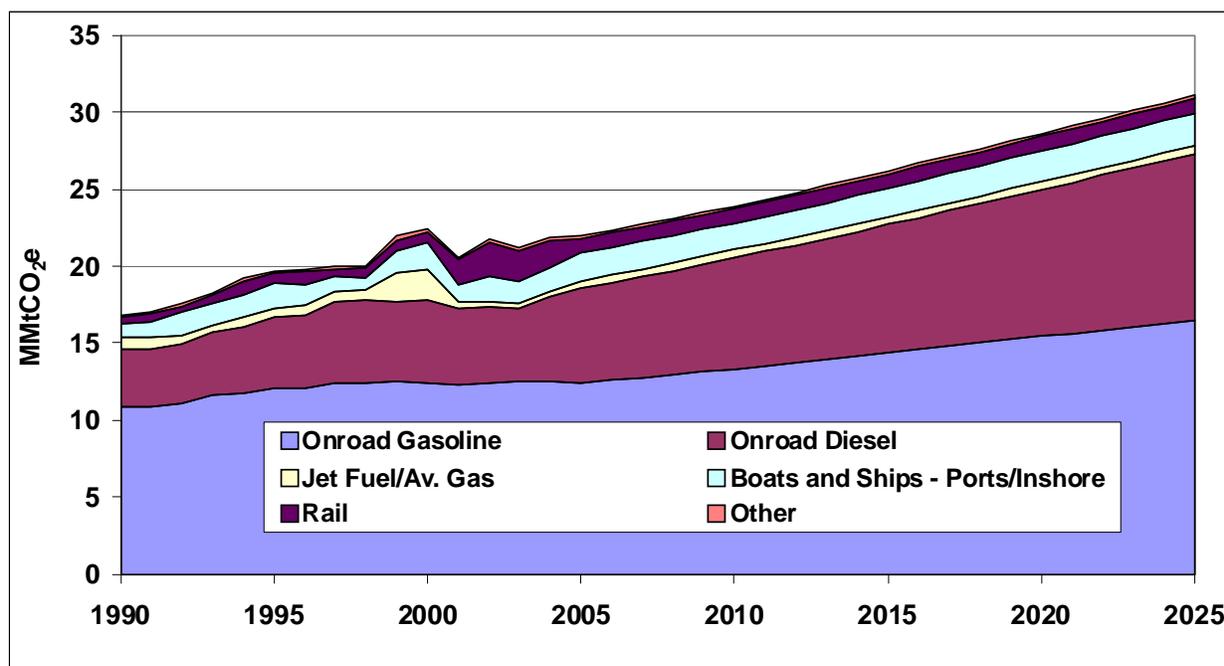
From 1990 to 2005, Arkansas' GHG emissions from transportation fuel use have risen steadily at an average rate of about 1.8% annually. The GHG emissions associated with Arkansas' transportation sector also rose accordingly, increasing by 5 million metric tons of carbon dioxide equivalent (MMtCO<sub>2</sub>e) emissions during the same time period from about 17 MMtCO<sub>2</sub>e to 22 MMtCO<sub>2</sub>e. If left unabated, this number is expected to increase by 29%, to 31 MMtCO<sub>2</sub>e by 2025.

Carbon dioxide (CO<sub>2</sub>) accounts for about 98% of transportation GHG emissions, with most of the remaining GHG emissions coming from nitrous oxide (N<sub>2</sub>O) emissions from gasoline engines. Emissions released from on-road gasoline consumption account for approximately 57% of the transportation sector's GHG emissions. This has historically been the largest share of transportation GHG emissions, and this trend is forecast to continue.

Figure 6-1 shows historic and projected transportation GHG emissions by fuel and source. As a result of Arkansas' population and economic growth and an increase in total vehicle miles traveled (VMT), on-road gasoline consumption increased by about 15% between 1990 and 2005 and accounted for 57% of the total transportation emissions in 2005. Meanwhile, on-road diesel fuel consumption rose by 61% during that period, accounting for 28% of GHG emissions from the transportation sector in 2005, suggesting an even more rapid growth in freight movement within or across the state.

In the absence of significant increases in vehicle fuel economy, on-road gasoline and diesel emissions are expected to continue to grow. GHG emissions from on-road gasoline consumption are projected to increase by about 32%, and GHG emissions from on-road diesel consumption are expected to increase by 78% between 2005 and 2025. The consumption of these fuels will significantly contribute to the projected 41% increase in overall emission levels for the entire state of Arkansas over 2005 levels by 2025.

Figure 6-1. Transportation GHG emissions by fuel source, 1990–2020



MMtCO<sub>2</sub>e - million metric tons of carbon dioxide equivalent; av. gas = aviation gas.

## Key Challenges and Opportunities

Arkansas has substantial opportunities to reduce transportation emissions. The principal means to reduce emissions from transportation and land use (TLU) are:

- Improving vehicle fuel efficiency,
- Substituting gasoline and diesel with lower-emission fuels, and
- Reducing total VMT.

In Arkansas and in the nation as a whole, vehicle fuel efficiency has improved little since the late 1980s, yet many studies have documented the potential for substantial increases in efficiency, while maintaining vehicle size and performance. Automobile manufacturers typically oppose dramatic increases in fuel economy. Key points of contention include the cost to manufacturers and cost to consumers. Even with the adoption of the new federal corporate average fuel economy (CAFE) requirements, there may still be opportunities for further increases in fuel efficiency while maintaining vehicle size and performance.

The use of fuels with lower per-mile GHG emissions is growing in Arkansas, and larger market penetration is possible. Conventional gasoline- and diesel-fired vehicles can use low-level blends of biofuels. Alternative-technology vehicles can also use higher-level blends of biofuels, as well as other types of alternative fuels, such as natural gas and hydrogen. The type of fuel used is a crucial determinant of impact on emissions, as some alternative fuels have relatively little GHG benefit. Currently, the most prevalent biofuel in Arkansas is corn-based ethanol, which has

minimal GHG benefit from a life-cycle perspective.<sup>1</sup> Key determinants of impact will be the development and deployment of fuel types. At present, fuel distribution infrastructure is a constraining factor.

Reducing VMT is crucial to mitigating GHG emissions from transportation. Developing smarter land-use and transportation development patterns that reduce trip length and support transit, ride sharing, biking, and walking can contribute substantially to this goal. A variety of pricing policies and incentive packages can also help to reduce VMT. Developing better planning methods and regulations, and increasing funding of multiple modes of transportation will be key components in achieving these goals.

## **Overview of Policy Recommendations and Estimated Impacts**

The Arkansas Governor's Commission on Global Warming (GCGW) recommends a set of 10 policies for the TLU sector that offer the potential for major economic benefits and emission savings. Implementing these policy recommendations could lead to emission reductions of:

- 3.2 MMtCO<sub>2</sub>e per year by 2025, and
- 28.89 MMtCO<sub>2</sub>e cumulative from 2009 through 2025.

The weighted-average cost effectiveness of the recommended policies is about  $-\$78/\text{tCO}_2\text{e}$ , representing a cost savings. This average value includes policies that have both much lower and much higher likely costs per ton.

The estimated impacts of the individual policies are shown in Table 6-1. The GCGW policy recommendations are described briefly here and in more detail in Appendix I of this report. The recommendations not only result in significant emission reductions, but offer a host of additional benefits as well. These benefits include reduced local air pollution; more livable, healthier communities; and economic development and job growth from in-state biofuel production. To yield the levels of savings described here, the recommended policies need to be implemented in a timely, aggressive, and thorough manner.

Some policies focus on reducing VMT by further developing other modes of transportation, such as transit (TLU-5), freight rail (TLU-7), and pedestrian and bicycling infrastructure (TLU-4 and TLU-6). These policies help to reduce GHG emissions by moving people and freight more efficiently and providing other options for people and freight to reach their destinations.

Qualitative policies (policy recommendations that are nonquantifiable) are also an important component of the recommended policies, but are not reflected in the GHG emission reductions or costs. These recommendations focus on studying the feasibility of plug-in hybrid electric vehicles (PHEVs) (TLU-1), research and development of renewable transportation fuels (TLU-2), fuel efficiency incentives (TLU-9), public education (TLU-10), and procuring efficient fleet vehicles for the state (TLU-8). While the implementation of these recommendations may

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<sup>1</sup> Biofuels analysis was based on information from the Argonne National Laboratory's GREET model, version 1.8, which indicates a life-cycle emission reduction of 15.9% for E85 corn ethanol. See Appendix I for more details on assumed reduction factors for various types of biofuels.

contribute to significant GHG emission reductions, the immediate impact of these policies individually is not quantifiable.

Further developing biofuels and expanding the biofuels market can significantly reduce GHG emissions, while boosting the state's economy. TLU-3 focuses on this area, while working in conjunction with the research and development of renewable transportation fuels afforded by TLU-2.

**Table 6-1. Summary list of TLU policy recommendations**

No.	Policy Recommendation	GHG Reductions (MMtCO <sub>2</sub> e)			Net Present Value 2009–2025 (Million \$)	Cost-Effectiveness (\$/tCO <sub>2</sub> e)	Level of Support
		2015	2025	Total 2009–2025			
TLU-1*	Study the Feasibility of Plug-In Vehicles	<i>Not Quantified—Qualitative Study Recommendation</i>					Unanimous
TLU-2†	Research and Development of Renewable Transportation Fuels	<i>Incorporated Into Analysis for TLU-3</i>					Super Majority (1 objection)
TLU-3†	Advanced Biofuels Development and Expansion	0.88	2.54	21.26	–\$2,293	–\$108	Super Majority (1 objection)
TLU-4*	Smart Growth, Pedestrian and Bicycle Infrastructure	0.06	0.17	1.39	≤0 (Net Savings)	≤0 (Net Savings)	Unanimous
TLU-5*	Improve and Expand Transit Service and Infrastructure	0.001	0.007	0.03	1.5	\$1,479	Unanimous
TLU-6†	School and University Transportation Bundle	0.006	0.013	0.113	N/A	N/A	Unanimous
TLU-7*	Promote and Facilitate Freight Efficiency	0.33	0.47	6.1	\$48	\$104	Unanimous
TLU-8†	Procurement of Efficient Fleet Vehicles (Passenger and Freight)	<i>State "Lead by Example" Qualitative Recommendation</i>					Unanimous
TLU-9†	Fuel Efficiency: Clean Car Incentive	<i>Not Quantified—Qualitative Study Recommendation</i>					Super Majority (1 objection)
TLU-10*	Public Education	<i>Not Quantified</i>					Unanimous
	<b>Sector Total After Adjusting for Overlaps</b>	<b>1.28</b>	<b>3.2</b>	<b>28.89</b>	<b>–\$2,244</b>	<b>–\$78</b>	
	<b>Reductions From Recent Actions (Federal CAFE Requirements)</b>	<b>1.02</b>	<b>3.26</b>	<b>26.9</b>	<b><i>Not Quantified</i></b>		
	<b>Sector Total Plus Recent Actions</b>	<b>4.28</b>	<b>8.36</b>	<b>86.0</b>	<b>–\$2,244</b>	<b>–\$78</b>	

CAFE = corporate average fuel economy; GHG = greenhouse gas; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; \$/tCO<sub>2</sub>e = dollars per metric ton of carbon dioxide equivalent; N/A = not applicable

Negative values in the Net Present Value and the Cost-Effectiveness columns represent net cost savings.

The numbering used to denote the above policy recommendations is for reference purposes only; it does not reflect prioritization among these important policy recommendations.

\* The GCGW approved this option at Meeting #9 (September 9, 2008); 18 members present and voting (one by phone).

† The GCGW approved this option at Meeting #10 (September 25, 2008); 21 members present and voting (none by phone).

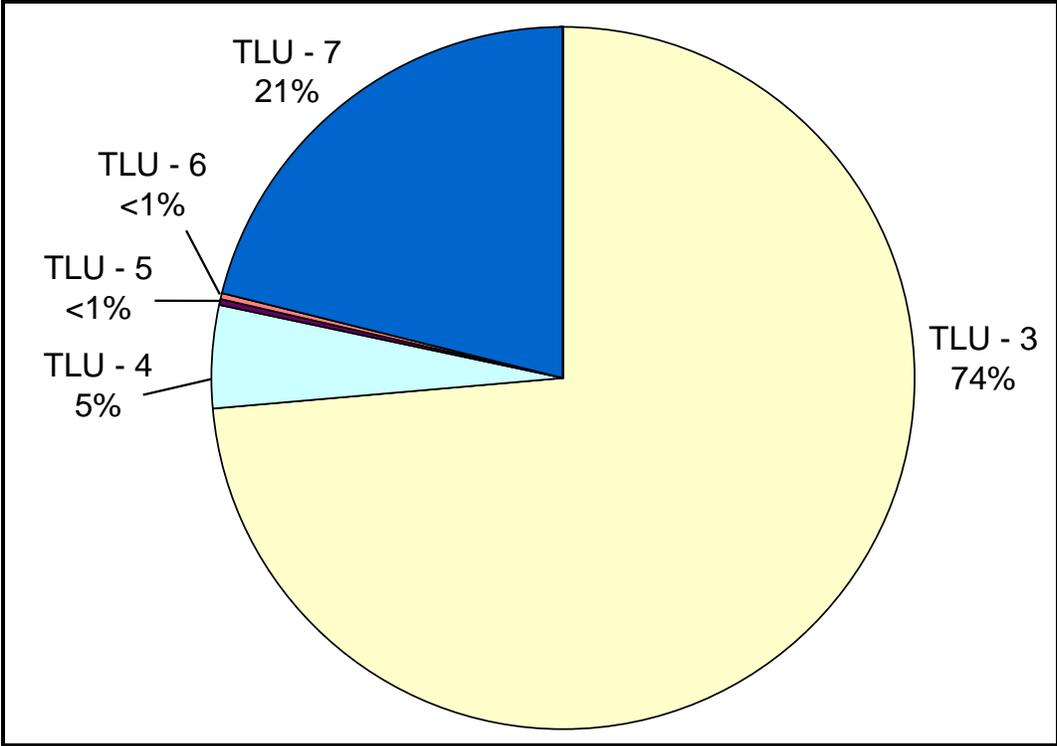
Arkansas can achieve greater alternative fuel use through a combination of research and development, as well as through implementing voluntary and mandatory measures. Research and Development of Renewable Transportation Fuels (TLU-2) can work in conjunction with Advanced Biofuels Development and Expansion (TLU-3) to help make biofuels more efficient and more available, while at the same time providing an economic benefit to the Arkansas economy by promoting in-state development and production of these fuels.

A number of policies would work together to reduce VMT by increasing the viability of other modes of travel. These policies will require increased coordination among state and local governments and businesses in many cases. TLU-4 (Smart Growth, Pedestrian and Bicycle Infrastructure) promotes protecting open space, while revitalizing downtown areas focusing on infill development, transit-oriented development, and the development of pedestrian and bicycle infrastructure. Related to TLU-4 is TLU-5 (Improve and Expand Transit Service and Infrastructure), which promotes both increasing transit service and developing a high-speed intra-city passenger rail system. Such a rail system would be most efficient traveling from city center to city center, where there is sufficient population density to support the system. The density necessary to support this rail system could be developed through the policies set forth in TLU-4. Similarly, TLU-6, which promotes walking, bicycling, and utilizing carpools and transit systems to access schools, colleges, and universities, and promotes the siting of new schools in walkable communities, works very well in cooperation with TLU-4 and TLU-5. All three of these policies will require cooperation among planning agencies, state and local governments, developers, and communities as a whole.

Public education, listed as a separate policy recommendation under TLU-10 (Public Education), works in conjunction with numerous other recommended policies. Educating citizens on how they can minimize their impact, operate their vehicle more efficiently, reduce their VMT, and cut their GHG emissions can be a key to the success of many of these policies. Additionally public education can help to generate the support necessary for the success of other policies, such as smart growth communities (TLU-4), safe routes to school (TLU-6), the procurement of efficient fleet vehicles (TLU-8), and the incentivizing of clean cars (TLU-9).

Figure 6-2 shows the breakdown of the projected impacts of the recommended TLU policies, taken together, in terms of avoided GHG emissions. For the TLU policies recommended by the GCGW to yield the levels of savings described here, the policies must be implemented in a timely, aggressive, and thorough manner. This means, for example, not only putting the policies themselves in place, but also attending to the development of supporting policies that are needed to help make the recommended policies effective. While the adoption of the recommended policies can result in considerable benefits to Arkansas' environment and consumers, careful, comprehensive, and detailed planning and implementation, as well as consistent support of these policies will be required if these benefits are to be achieved.

Figure 6-2. Aggregate GHG Emission Reductions, 2009–2025



## Transportation and Land Use Sectors Policy Descriptions

The policy recommendations described briefly here not only result in significant emission reductions and cost savings but also offer a host of additional benefits, such as reduced local air pollution; more livable, healthier communities; and increased transportation choices.

### **TLU-1. Study the Feasibility of Plug-In Vehicles**

This policy recommendation will implement a study that will review relevant, completed, ongoing, and forthcoming studies, including the 3-year national study (begun in 2007 and expected to be completed by 2010) by the Electric Power Research Institute, Ford Motor Company, and Southern California Edison, which will develop and evaluate technical approaches for integrating plug-in hybrid electric vehicles (PHEVs) into the nation's electric grid system.<sup>2</sup> Following the review of the relevant studies, this policy will assess the potential effectiveness of implementing some or all of the following options: converting state and local government fleets to PHEVs, providing funding for school districts to acquire plug-in electric hybrid school buses, providing rate recovery for utility research and development investments in pilot tests of vehicle-to-grid systems, assessing the need of electric vehicle charging in state parking facilities, developing and funding at least one vehicle-to-grid pilot involving a fleet of public plug-ins parked in a state garage, identifying Arkansas companies and economic sectors with potential vehicle electrification markets, and developing a strategy to help Arkansas companies position themselves for success in those markets.

### **TLU-2. Research and Development of Renewable Transportation Fuels**

This policy recommendation provides support and assistance for the development of low-carbon fuels that are not yet commercially available in Arkansas, such as cellulosic ethanol. Support and assistance will surround the funding of the research and development related to biofuel/biodiesel production, such as investigating the production of biofuels from Arkansas-based biomass feedstocks from agricultural production, agricultural processing, forest or wood resources or production processes, or other cellulosic crops. This will be done in order to increase the capacity of the state university system to develop and produce such fuels cost-effectively. Additionally this policy will attempt to identify funding sources to conduct analyses and identify which renewable fuels will provide the best options for Arkansas and its constituent regions and cities.

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<sup>2</sup> Ford Motor Company. "EPRI Joins Ford-SCE Analysis of Plug-In Hybrids on Grid." March 27, 2008. Available at <http://www.ford.com/about-ford/news-announcements/press-releases/press-releases-detail/pr-epri-joins-fordsce-analysis-of-27955>.

### **TLU-3. Advanced Biofuels Development and Expansion**

This policy recommends that Arkansas encourage state and national industries to reach for specific goals, as measured by specific volume amounts or percentages of advanced biofuels that would produce fewer GHG emissions when considered on a per-volume and/or per-energy-unit basis. The state could incentivize the development of in-state industries and businesses that produce and distribute alternative fuels with the goal of this policy recommendation being to increase the use of alternative fuels that emit less GHG emissions in automobile and other gasoline-powered vehicles to the level of at least 10% of the total consumed by 2015, with particular emphasis on biofuels.

This policy also recommends that the state encourage industry and research universities to work together to create an Arkansas Alternative Energy Institute.

### **TLU-4. Smart Growth, Pedestrian and Bicycle Infrastructure**

This policy recommendation calls for incentives and programs to encourage smart growth, including enhancing the pedestrian and bicycle infrastructure. Current land-use development practices increase vehicle travel by dispersing destinations, which separates activities and favors automobile travel over alternative modes. "Smart growth" planning by local, regional, and state governments refers to development that reduces sprawl and maximizes environmental, fiscal, and economic resources. Under this policy recommendation, Arkansas would encourage, facilitate, and undertake a set of smart growth activities related to the following initiatives: mixed use, open-space protections, downtown revitalization, "greyfield" redevelopment,<sup>3</sup> infill development, transit-oriented development, and pedestrian and bicycle infrastructure. This policy recommendation seeks to preserve open, recreational, and agricultural spaces and to prevent sprawl, especially on the periphery of urban areas where sprawling development may otherwise occur.

### **TLU-5. Improve and Expand Transit Service and Infrastructure**

The goal of this policy recommendation is to reduce light-duty vehicle VMT in urban areas from the 2008 baseline growth by 1% per year starting in 2010 until 2025. This will be achieved by making improvements to existing transit service, such as increasing service frequency, improving the quality of service, and reducing travel times on selected transit routes. This policy recommendation will also include expanding transit routes to reach more people. It will shift passenger transportation from single-occupant vehicles to public transit, thereby reducing GHG emissions.

This policy recommends that incentives be offered to potential passengers and that loans and/or subsidies be made to operators (public or private) to provide improved and less expensive intercity bus service. Also, financing will be provided in addition to regulatory relief, and eminent domain will be used to develop, either publicly or privately, a high-speed intercity

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<sup>3</sup> Greyfields are underutilized land in the form of parking lots, declining strip malls, and vacant parcels.

passenger rail system to serve major urban areas, or financial assistance will be made available to improve services already provided by Amtrak on other routes.

#### **TLU-6. School and University Bundle**

This policy recommendation focuses on encouraging the reduction of transportation GHG emissions when transporting students to K-12 schools, colleges, and universities. This is accomplished by utilizing the federal Safe Routes To School program, which promotes students at the K-12 level walking and riding their bikes to school. Additionally, this policy recommends that school districts study the most efficient bus routes to limit the VMT by school buses. At high schools, colleges, and universities, will promote car and van pooling and policies that limit the availability of student parking. Goals for this policy recommendation include a 5% reduction in total VMT for transporting students to school by 2012, which increases to a goal of a 10% reduction by 2025.

#### **TLU-7. Promote and Facilitate Freight Efficiency**

This policy recommendation focuses on promoting and facilitating freight efficiency by improving railroad infrastructure and rail yards, increasing rail and river shipping capacity, providing economic assistance and regulatory streamlining for the improvement of intermodal rail yards and the relief of freight bottlenecks, providing electrification at truck stops to reduce idling, supporting and promoting policies and legislation that improve regulatory oversight of the railroad industry, providing plug-in power at port sites to enable vessels to turn off engines and reduce idling, and providing incentives for purchasing and/or upgrading to more efficient trucks.

The goals of this policy recommendation are to reduce truck idling by Class 8 (tractor-trailer) trucks by 80% by 2010 and 100% by 2020 by reforming the state transportation board, investing in rail infrastructure, establishing standards for truck stop electrification, assessing port facilities and rail-switching yards, and providing incentives to trucking companies that invest in the purchase of low-emission engines and lightweight tractor/trailer combinations.

#### **TLU-8. Procurement of Efficient Fleet Vehicles (Passenger and Freight)**

This policy recommends that state and local government agencies “lead by example” by enacting procurement policies and or joining the U.S. Environmental Protection Agency’s SmartWay program and utilizing SmartWay Upgrade Kits that result in the adoption of lower-emitting vehicle fleets. In leading by example, state and local governments will ensure that their vehicle fleets meet or exceed the targets set for the state as whole, while ensuring that the means are available for all public and private vehicles to also exceed these standards voluntarily.

#### **TLU-9. Fuel Efficiency: Clean Car Incentive**

This policy recommendation promotes the use of a market-based incentives program to provide rebates to Arkansans who purchase new vehicles that reduce oil consumption and have lower GHG emissions by being more fuel efficient. This program would be self-financed, being paid

for with disincentives (fees) to those who purchase new vehicles that are less fuel-efficient. The rebates or fees would be subtracted or added to the purchase price of the vehicle at the point of sale. Incentives and disincentives should equal out to zero, as the point at which incentives are provided or disincentives are included—the “pivot point”—would rise in proportion to each vehicle’s gasoline savings or consumption. The pivot point is essentially the average mileage standard that divides the incentives from disincentives. The goals of this policy recommendation include increasing the sales of fuel-efficient vehicles, reducing the sales of inefficient vehicles, and raising the average mile-per-gallon (mpg) rate within the state.

#### **TLU-10. Public Education**

This policy recommendation focuses on better informing the public of the measures they as individuals can take to reduce their transportation-related GHG emissions. It encourages drivers to voluntarily reduce their fuel consumption as well as their VMT. This policy would educate the public about transportation options and consequences, proper vehicle operation and maintenance aimed at increased mpg reducing GHG emissions, and city planning choices. This curriculum would be a requirement for all driver training programs and would be distributed through other possible venues as deemed appropriate by the agency(ies) developing the program.

# Chapter 7

## Agriculture, Forestry, and Waste Management

### Overview of GHG Emissions

The agriculture, forestry, and waste management (AFW) sectors are directly responsible for moderate amounts of Arkansas's current greenhouse gas (GHG) emissions. The total AFW contribution to carbon dioxide equivalent (CO<sub>2</sub>e) gross emissions in 2005 was 14 million metric tons (MMt), or about 17% of the state's total. The AFW contribution to net emissions in 2005 was -7 MMtCO<sub>2</sub>e due to the net sequestration of carbon in the forestry and agriculture sectors. As described in the Inventory and Forecast (I&F) report, it is important to recognize that emissions from fossil fuel consumption within the AFW sectors are included within the residential, commercial, and industrial (RCI) sectors (particularly the industrial sector).

Agricultural emissions include methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O) emissions from enteric fermentation, manure management, agricultural soils management, rice cultivation, and agriculture residue burning. These emissions were estimated to be about 12 MMtCO<sub>2</sub>e in 2005. As shown in Figure 7-1, emissions from soil carbon losses from tilling, commercial fertilizer and livestock manure application to soils, rice cultivation, manure management, enteric fermentation, and fertilizer application all make significant contributions to the sector totals. Sector emissions include CO<sub>2</sub> emissions from oxidized soil carbon and application of urea and lime; N<sub>2</sub>O emissions from activities that increase nitrogen in the soil, including fertilizer (synthetic, organic, and livestock) application and production of nitrogen-fixing crops (legumes); and CH<sub>4</sub> emissions from rice cultivation.

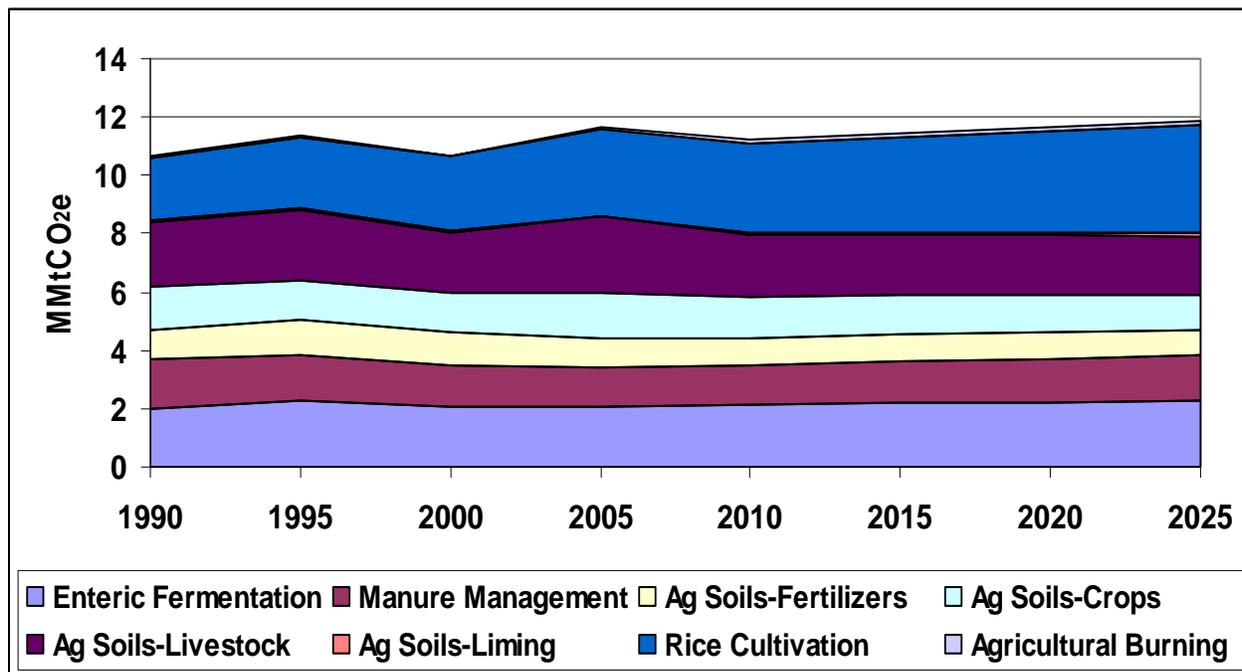
Rice cultivation is a significant contributor of GHG emissions in Arkansas. Emissions from rice cultivation comprised 20% (2.1 MMtCO<sub>2</sub>e) of gross agricultural emissions in 1990. This number is projected to increase to 31% (3.70 MMtCO<sub>2</sub>e) of agricultural emissions by 2025. Agricultural soils emissions are projected to decrease from 1990 to 2025, with 1990 emissions accounting for 45% (4.8 MMtCO<sub>2</sub>e) of gross agricultural emissions and 2025 emissions estimated to be about 35% (4.2 MMtCO<sub>2</sub>e) of gross agricultural emissions. Emissions from other agricultural sources are projected to stay relatively constant through 2025.

Forestland emissions refer to the net carbon dioxide flux<sup>1</sup> from forested lands in Arkansas, which account for about 57% of the state's land area. As shown in Table 7-1, U.S. Forest Service (USFS) data suggest that the total flux estimate for Arkansas forests, including all forest pools, fluctuates between -43 MMtCO<sub>2</sub>e/year (between 1988 and 1995) and -18 MMtCO<sub>2</sub>e/year (between 1995 and 2005). For the reference case projections (2005-2025), the forest area and carbon densities of forestlands were assumed to remain at the same levels as in 2005. Table 7-2 provides a summary of the estimated flux for the entire forestry and land use sector.

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<sup>1</sup> "Flux" refers to both emissions of CO<sub>2</sub> to the atmosphere and removal (sinks) of CO<sub>2</sub> from the atmosphere.

**Figure 7-1. Historical and projected gross GHG emissions from the agriculture sector, Arkansas, 1990–2025**



MMtCO<sub>2e</sub> = million metric tons of carbon dioxide equivalent

**Table 7-1. Annual forest carbon fluxes for Arkansas**

Forest Pool	1988–1995 Flux (MMtCO <sub>2</sub> )	1995–2005 Flux (MMtCO <sub>2</sub> )
Forest carbon pools (nonsoil)	-29.5	-13.5
Soil organic carbon	-8.92	0.36
Harvested wood products	-4.69	-4.69
<b>Totals</b>	<b>-43.2</b>	<b>-17.8</b>
<b>Totals (excluding soil carbon)</b>	<b>-34.2</b>	<b>-18.2</b>

Note: Positive number indicates net emission. Based on U.S. Forest Service input, emissions from soil organic carbon are excluded from the forestry sector summary due to a high level of uncertainty.

MMtCO<sub>2e</sub> = million metric tons of carbon dioxide equivalent.

**Table 7-2. Forestry and land use flux and reference case projections (MMtCO<sub>2e</sub>)**

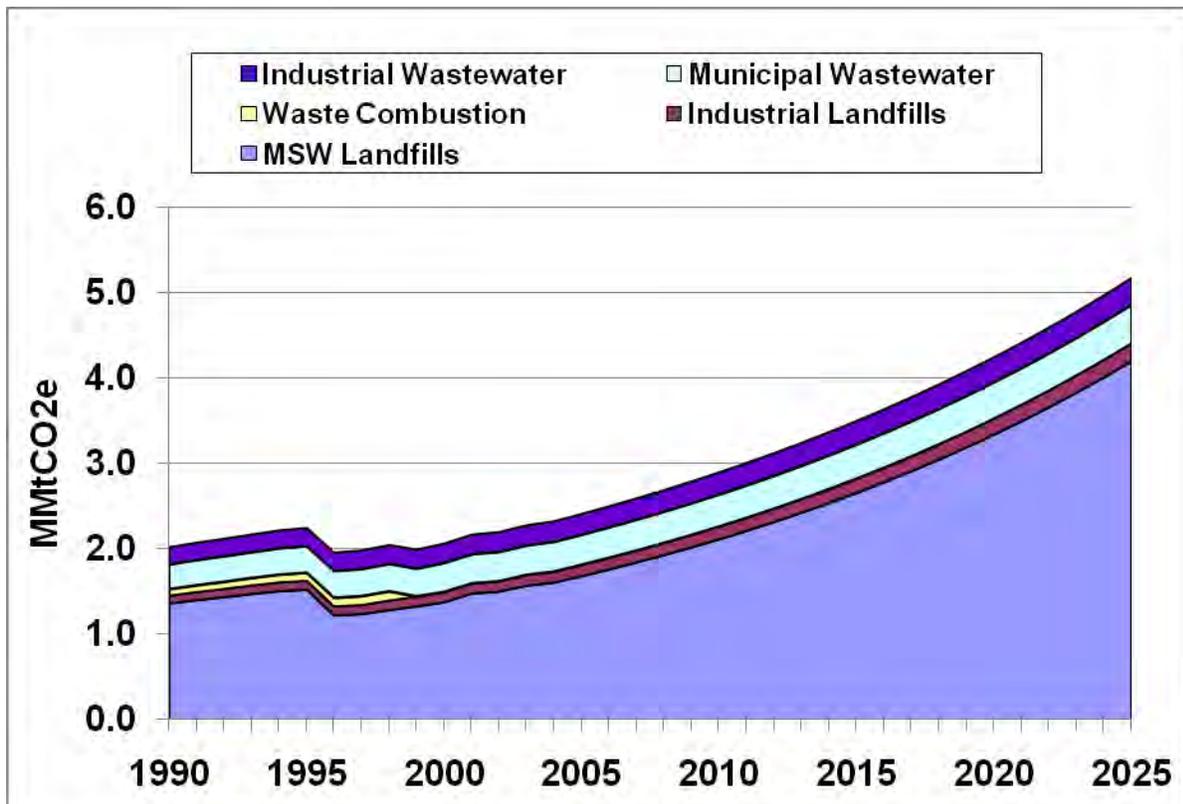
Subsector	1990	2000	2005	2010	2020	2025
Forested landscape (excluding soil carbon)	-34.2	-18.2	-18.2	-18.2	-18.2	-18.2
Forest fires and prescribed burns	0.17	0.18	0.18	0.18	0.18	0.18
Urban forestry and land use	-2.43	-0.83	-0.91	-0.91	-0.91	-0.91
<b>Sector Total</b>	<b>-36.5</b>	<b>-18.8</b>	<b>-18.9</b>	<b>-18.9</b>	<b>-18.9</b>	<b>-18.9</b>

MMtCO<sub>2e</sub> = million metric tons of carbon dioxide equivalent

Note: Positive numbers indicate net emission.

Figure 7-2 shows estimated historical and projected emissions from the management and treatment of solid waste and wastewater. Emissions from waste management consist largely of CH<sub>4</sub> emitted from landfills, while emissions from wastewater treatment include both CH<sub>4</sub> and N<sub>2</sub>O. Emissions are also included for municipal solid waste (MSW) combustion. Figure 7-2 illustrates that emissions from MSW landfills are projected to increase significantly through 2025. Overall, the waste management sector accounts for less than 5% of Arkansas’s total gross emissions per year from 1990 through 2025.

**Figure 7-2. Estimated historical and projected emissions from waste and wastewater management in Arkansas**



MMtCO<sub>2</sub>e = million metric tons carbon dioxide equivalent; MSW = municipal solid waste.

Opportunities for GHG mitigation in the AFW sector involve measures that can reduce emissions within the sector or in other sectors. Examples of reductions that can occur within the sector include changes in crop management practices that reduce GHG emissions by building soil carbon (indirectly sequestering carbon from the atmosphere); more efficient nutrient application (reducing N<sub>2</sub>O emissions—note that emissions outside of the AFW sectors are also reduced here due to the embedded energy in nutrients and the potential for lower energy consumption during their application); reforestation projects that achieve GHG reductions by increasing the carbon sequestration capacity of the state’s forests; and landfill gas collection and control, which reduces methane emissions from landfills.

For GHG reductions outside of the AFW sector, actions taken within the sector, such as production of liquid biofuels, can offset emissions in the transportation sector, while biomass

energy can reduce emissions in the energy supply (ES) and RCI sectors. Similarly, actions that promote solid waste reduction or recycling can reduce emissions within the AFW sectors (future landfill CH<sub>4</sub>), as well as emissions associated with the production of recycled products (recycled products often require less energy to produce than similar products from raw materials). Finally, urban forestry projects can reduce energy consumption within buildings through shading and wind protection.

Following are primary opportunities for GHG mitigation identified by the Governor's Commission on Global Warming (GCGW).

- **Manure management:** Implementing improved manure handling and storage programs, practices, and technologies can reduce CH<sub>4</sub> and N<sub>2</sub>O emissions from dairy, hog, and poultry operations. A variety of sources were considered in attempting to quantify the best manure management practices to reduce GHG emissions. While it is very likely that manure management can reduce emissions, the maximum achievable level of emissions reduction is uncertain.
- **Farming practices that achieve GHG benefits:** Implementing programs that incentivize growers to utilize cultivation practices that build soil carbon and reduce nutrient consumption can indirectly sequester CO<sub>2</sub> from the atmosphere. New technologies in the area of precision agriculture offer opportunities to reduce nutrient application and fossil fuel consumption.
- **Improving management of water resources:** Enhancing current capabilities/capacities of storing surface water, can make it is available at appropriate times and in the necessary quantities to reduce pumping and energy consumption, in addition to other ancillary benefits.
- **Expanded use of forest and agricultural biomass:** Expanding use of biomass energy from residue removed from forested areas during treatments to reduce fire risk, crop residues, and purpose-grown crops, and from livestock manure/poultry litter can achieve GHG benefits by offsetting fossil fuel consumption (to produce either electricity or heat/steam). Programs to expand sustainably procured biomass fuel production will most likely be needed to supply a portion of the fuel mix for the renewable energy goals under ES and RCI.
- **Production of advanced liquid biofuels:** Producing renewable fuels, such as ethanol from energy crops, crop residue, forestry residue, or municipal solid waste and biodiesel from crop seed oils, can produce significant reductions when they are used to offset consumption of fossil fuels (e.g., gasoline and diesel in the Transportation and Land Use [TLU] and RCI sectors). This is particularly true when these fuels are produced using processes and/or feedstocks that emit much lower GHG emissions than those from conventional sources (e.g., corn-based ethanol or soy-based biodiesel).
- **Expanded use of locally produced farm and forest products:** Continually promoting farmers' markets in the state, along with using locally sourced wood products with lower embodied energy than other potentially imported building materials, provides benefits through lower associated transportation emissions and lower embodied GHGs.
- **Enhancement/protection of forest carbon sinks:** Through a variety of programs, enhanced levels of CO<sub>2</sub> sequestration can be achieved and carbon can be stored in the state's forest biomass. These programs include reforestation programs, restocking of poorly stocked forests, urban tree programs, wildfire risk reduction, and other forest health programs.

Programs aimed at reducing the conversion of forested lands to nonforest cover will also be important to increase levels of carbon sequestration and to protect the stored carbon in the state's forest biomass.

- **Changes in municipal solid waste management practices:** Concentrating on enhancing the source reduction, recycling, and organics management (e.g., composting practices) in the state can result in significant GHG emission reductions. Also, for waste remaining after full implementation of these “front-end” practices, appropriate GHG-beneficial “end-of-life” practices should be implemented, including enhanced landfill gas collection and utilization.

## Key Challenges and Opportunities

Within the forestry sector, Forest Management and Establishment for Carbon Sequestration programs (AFW-7) have the potential to deliver over 12 MMtCO<sub>2</sub>e/year of GHG reductions in 2025 (see Table 7-2). These programs include forestation, urban forestry, and sustainable forest management (e.g., wildfire reduction, restocking, and forest health approaches) to minimize terrestrial carbon losses, while enhancing carbon sequestration. The overall goal for the forestation recommendation calls for establishing new forest on 500,000 acres by 2025. For the sustainable forest management element, the goals are to achieve carbon benefits on 25% of privately owned land and 17% of publicly owned resource lands by 2025. Appropriate species selection and placement of trees can provide additional benefits through continuity of wildlife habitat, wetland buffers and protection, and adaptation to climate change.

For urban forestry, the goals are to increase urban canopy cover in Arkansas. A strong relationship between all of the related parties is needed (e.g., Arkansas Forestry Commission, utilities, communities, and nongovernmental organizations) to achieve the full goal of 1.7 million new trees in urban areas statewide (or a 4% increase in the number of urban trees).

GCGW recommendation AFW-4 promotes the expanded use of biomass as an energy source for producing electricity, heat, or steam. Use of biomass to supplant fossil fuels was estimated to reduce over 4 MMtCO<sub>2</sub>e by 2025. The GCGW conducted a limited assessment of the available biomass resources in the state, which indicated that sufficient resources were available through 2025 to achieve the goals for both the advanced biofuels recommendation (below) and this biomass for energy recommendation. The GCGW noted that the expansion of crops as an energy feedstock needs to ensure that the energy crops are grown on appropriate land and in ways that do not damage terrestrial or aquatic resources or displace food and fiber production. A key challenge to the implementation of this recommendation is the proximity of the feedstock to the end user.

The GCGW found significant opportunity in promoting advanced biofuels production using feedstocks and production methods with superior GHG benefits (e.g., superior to conventional starch-based ethanol). The GCGW adopted the definition of “advanced biofuels” provided by the U.S. Energy Independence and Security Act of 2007: Advanced biofuel “means renewable fuel, other than ethanol derived from corn starch, that has lifecycle GHG emissions, as determined by

the Administrator, after notice and opportunity for comment, that are at least 50 percent less than baseline lifecycle GHG emissions.”<sup>2</sup>

It should be noted that there is significant overlap in benefits with the TLU-3 (Advanced Biofuels Development and Expansion) recommendation. However, the GCGW recognizes in-state production and consumption result in the highest benefits. An example of biofuels that could be produced with much better GHG impacts is ethanol from cellulosic hydrolysis of biomass fiber. Feedstocks for the fiber needed for this recommendation could come from crop residue, energy crops, forestry residue, or MSW. A major challenge for the success of AFW-5 is the establishment of a viable commercial-scale cellulosic ethanol or other biofuels industry within the next 5 to 10 years.

Within the agriculture sector, the GCGW recommends programs to promote farming practices that achieve GHG benefits, such as soil management programs that increase soil carbon levels, thereby indirectly sequestering carbon from the atmosphere. These programs, combined with additional measures to promote nutrient efficiency, were estimated to achieve reductions of over 1.5 MMtCO<sub>2</sub>e per year by 2025. Programs that would assist farmers in reaching the goals of these recommendations include the encouragement of research and development of farming practices and cropping systems that increase carbon input (e.g., reversion to native vegetation, setting aside agricultural land as grassland, improved crop rotations, yield enhancement measures, organic amendments, cover crops, improved irrigation practices), or decrease carbon output (e.g., proper tillage methods), while maintaining crop yield, so that GHG emissions are reduced.

AFW-8 and AFW-9 provide an integrated set of recommendations for future management of municipal solid waste in Arkansas. AFW-8 focuses on “front-end” waste management technologies: source reduction, recycling, and composting, while AFW-9 focuses on “end-of-use” waste management approaches. The recommendations for AFW-8 represent a continuation of the recycling policy currently in place in Arkansas; increasing the MSW recycling rate for GHG-significant solid waste streams by 2% every 5 years where this is geographically cost-effective. The combined front-end waste management elements produce substantial GHG savings of 4.4 MMtCO<sub>2</sub>e in 2025. Source reduction and recycling will result in avoided landfill GHG emissions, as well as avoided product/packaging life-cycle GHG emissions.

Although AFW-8 is estimated to deliver net societal cost savings, successful implementation will require the strengthening of existing (or the introduction of new) recycling legislation, the provision of incentives/subsidies to the municipalities to have more aggressive recycling efforts (currently, it is more expensive to recycle than to landfill), and/or the encouragement of procuring products produced from recycled material. Initial up-front waste management infrastructure investment by communities in the form of material recovery facilities and composting operations may also be required. Cost savings result from avoided landfill fees and the addition of the value of recycled or composted materials. The recommendations provided in AFW-9 are expected to deliver an additional 0.4 MMtCO<sub>2</sub>e by 2025.

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<sup>2</sup> Library of Congress—Thomas. "Energy Independence and Security Act of 2007." Section 201—Definitions. Available at: <http://thomas.loc.gov/home/c110query.html>.

In addition to the opportunities and challenges indicated above, it is also important for Arkansas to address the impacts of climate change, including the potential impacts on water resources, ecosystems, habitat, wildlife, and fisheries. These issues are closely linked to many of the mitigation recommendations under the AFW sector, but are specifically considered under the Cross-Cutting Issues recommendations (CC-9: Adaptation and Vulnerability).

## **Overview of Policy Recommendations and Estimated Impacts**

As noted above, the nine policy recommendations for the AFW sector address a diverse array of activities. Taken as a whole, they offer significant cost-effective emission reductions, as shown in Table 7-3.

Figure 7-3 shows the breakdown of the cumulative emission reductions (2009–2025) anticipated from the recommended actions in the AFW sector. The greatest emission reductions achieved (67%) come from implementation of forest management and establishment for carbon sequestration. This policy incorporates programs to improve urban forestry, encourage afforestation/reforestation, and implement sustainable forestry management practices. Advanced recovery and recycling (AFW-8), also provides significant GHG benefits (22%) through source reduction, recycling, and composting. It is important to note that these emission reductions are life-cycle GHG reductions that occur both within and outside of Arkansas (resulting from lower energy use and GHG emissions to create, transport, and dispose of new products and packaging that are avoided through source reduction and recycling). Expanded use of agriculture and forestry biomass feedstocks for electricity, heat, or steam production (AFW-4) and expanded use of advanced biofuels (AFW-5) both offer significant GHG reductions. However, AFW-4 and AFW-5 overlap with recommendations under the ES and TLU Technical Work Groups, respectively. After accounting for overlap, these policies contribute a significantly smaller proportion to the AFW sector total.

**Table 7-3. Summary List of Policy Recommendations**

No.	Policy Recommendation		GHG Reductions (MMtCO <sub>2</sub> e)			Net Present Value 2009–2025 (Million \$)	Cost-Effectiveness (\$/tCO <sub>2</sub> e)	Level of Support
			2015	2025	Total 2009–2025			
AFW-1*	Manure Management		<i>Not Quantified</i>					Unanimous
AFW-2†	Promotion of Farming Practices That Achieve GHG Benefits	Soil Carbon	0.5	1.3	11	–\$71	–\$6	Super Majority (1 objection)
		Nutrient Efficiency	0.1	0.3	2.4	–\$66	–\$27	
AFW-3†	Improved Water Management and Use	Increased Surface Water	0.005	0.01	0.10	\$86	\$835	Super Majority (1 objection)
		Improved Purification	0.001	0.001	0.01	–\$0.4	–\$39	
AFW-4†	Expanded Use of Agriculture and Forestry Biomass Feedstocks for Electricity, Heat, or Steam Production	Energy From Biomass	2.1	4.2	41	\$1,637	\$40	Super Majority (1 objection)
		Energy From Livestock Manure and Poultry Litter	0.01	0.02	0.2	\$0.8	\$4	
		Capture of Waste Heat	0.02	0.06	0.50	–\$70	–\$140	
AFW-5†	Expanded Use of Advanced Biofuels		1.4	2.2	20	\$114	\$6	Unanimous
AFW-6†	Expanded Use of Locally Produced Farm and Forest Products		0.03	0.06	0.6	\$2	\$4	Unanimous
AFW-7†	Forest Management and Establishment for Carbon Sequestration	Urban Forestry	0.02	0.1	0.4	\$17	\$41	Unanimous
		Sustainable Forest Management	4.1	10.4	91	\$1,139	\$21	
		Afforestation	0.7	1.8	16	\$201	\$12	
AFW-8†	Advanced Recovery and Recycling		1.5	4.4	36	–\$283	–\$8	Super Majority (1 objection)
AFW-9†	End-of-Use Waste Management Practices		0.02	0.02	0.4	–\$1	–\$3	Super Majority (1 objection)
	<b>Sector Total After Adjusting for Overlaps<sup>‡</sup></b>		<b>7.8</b>	<b>18.3</b>	<b>162.2</b>	<b>\$1,045</b>	<b>\$6.4</b>	
	<b>Reductions From Recent Actions</b>		<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>\$0.0</b>	<b>\$0.0</b>	
	<b>Sector Total Plus Recent Actions</b>		<b>7.8</b>	<b>18.3</b>	<b>162.2</b>	<b>\$1,045</b>	<b>\$6.4</b>	

GHG = greenhouse gas; MMtCO<sub>2</sub>e = million metric tons carbon dioxide equivalent; \$/tCO<sub>2</sub>e = dollars per ton of carbon dioxide equivalent.

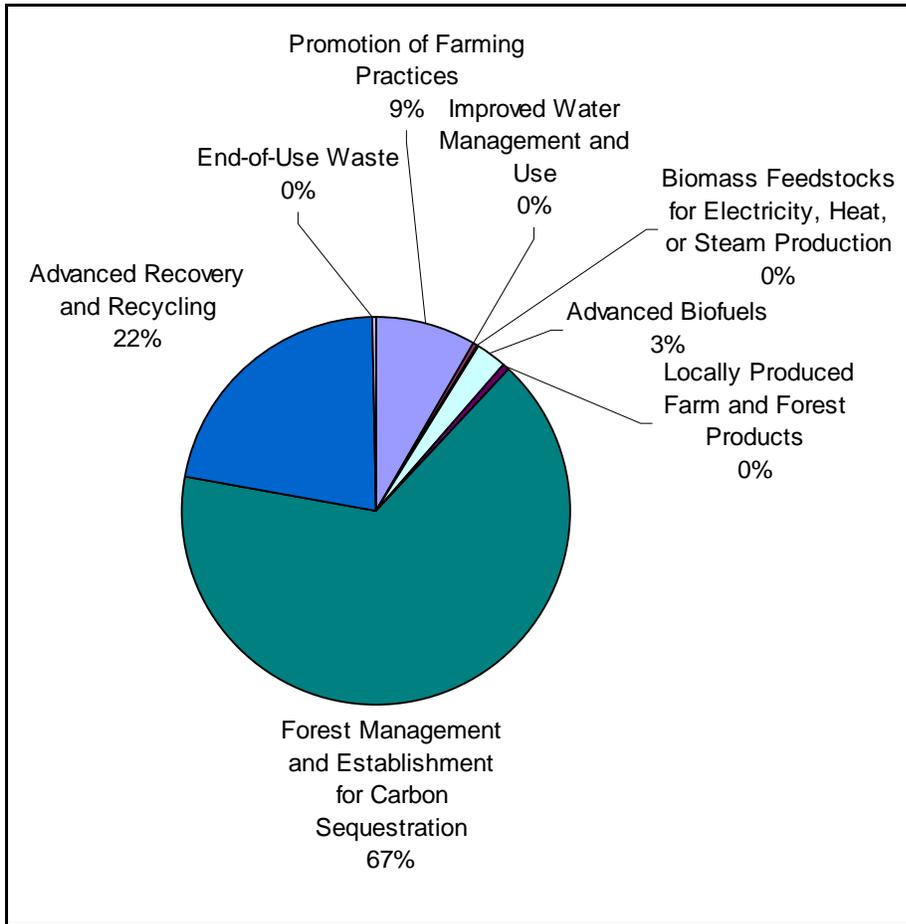
Negative values in the Net Present Value and the Cost-Effectiveness columns represent net cost savings associated with the recommendations. Totals in some columns may not add to the totals shown due to rounding.

\* The GCGW approved this option at Meeting #8 (July 31, 2008); 19 members present and voting (two by phone).

† The GCGW approved this option at Meeting #9 (September 9, 2008); 18 members present and voting (one by phone).

<sup>‡</sup>Overlaps include an assumed overlap of AFW-5 with TLU-3 (reductions excluded from AFW totals); an assumed 100% overlap of AFW-4 with ES-3 (reductions and costs excluded from AFW totals).

**Figure 7-3. Percentage of avoided GHG emissions by policy**



## **Agriculture, Forestry, and Waste Management Sectors Policy Descriptions**

The AFW sectors include emission mitigation opportunities related to the use of biomass energy, protection and enhancement of forest and agricultural carbon sinks, control of agricultural CH<sub>4</sub> and N<sub>2</sub>O emissions, production of renewable liquid fuels, production of additional biomass energy, forestation on nonforested lands, and an increase in municipal solid waste source reduction, recycling, composting, and landfill gas collection.

### **AFW-1 Manure Management**

This policy recommendation promotes the use of improved manure management practices that reduce GHG emissions associated with manure handling and storage, including manure composting to reduce CH<sub>4</sub> emissions, movement of manure from nutrient-rich to nutrient-deficient areas, and improved methods for application to fields (for reduced N<sub>2</sub>O emissions). Application improvements include incorporating manure into soil instead of surface spraying or spreading.

### **AFW-2 Promotion of Farming Practices That Achieve GHG Benefits**

This policy recommendation addresses both agricultural soil carbon management and nutrient management to achieve GHG benefits. For soil carbon management, conservation-oriented management of agricultural lands, cropping systems, crop management, and agricultural practices may regulate the net flux of CO<sub>2</sub> from soil. Each farm operation and each field management unit has unique traits that may allow management practices to influence nutrient, water, and carbon cycling and sequestration.

The efficient use of agricultural fertilizer, both commercial and animal-based, can be improved through certain management practices and systems. An example is overapplication of nitrogen, which can result in plants not fully metabolizing the nitrogen, allowing the nitrogen to leach into groundwater and/or be emitted to the atmosphere as N<sub>2</sub>O. Better nutrient utilization can lead to lower N<sub>2</sub>O emissions from runoff. An example is tile drainage systems that use the latest technology and design models to reduce nitrates leaching into surface water and groundwater.

### **AFW-3 Improved Water Management and Use**

The focus of this policy is on improving water management and use. Using surface water versus groundwater and decreasing water consumption both reduce pumping and energy consumption. Additionally, excess surface water can lead to runoff of nitrogen, with subsequent emission of N<sub>2</sub>O to the atmosphere. Managing and improving water consumption and nutrients spread on crops will result in a minimal loss of carbon from the soil. Reusing water can create nutrient management problems, and must be considered when implementing this policy.

#### **AFW-4 Expanded Use of Agriculture and Forestry Biomass Feedstocks for Electricity, Heat, or Steam Production**

This policy dedicates a sustainable quantity of biomass from agricultural industry residues, agricultural lands, wood industry process residues, unused forestry residues, agroforestry resources, dedicated energy crops, MSW, and livestock manure and poultry litter to efficient conversion to heat, steam, or electricity. This biomass should be collected and used in an environmentally acceptable manner, considering proper facility siting and feedstock use (e.g., proximity of users to biomass, impacts on water supply and quality, control of air emissions, solid waste management, cropping management, nutrient management, soil and nonsoil carbon management, and impacts on biodiversity and wildlife habitat). The objective is to create concurrent reduction of GHG emissions due to displacement of fossil fuel, considering life-cycle emissions associated with viable collection, hauling, and energy conversion and distribution systems. An additional GHG benefit is obtained through reduced methane emissions resulting from the capture of emissions from manure and poultry litter. Additional benefits can be achieved through the capture and use of waste heat from biomass facilities, where the waste heat could be used for cogeneration to displace heating costs and fossil fuel use. Local electricity or steam production yields the greatest net energy payoff.

*Note: This recommendation is linked with some Energy Supply and Residential, Commercial and Industrial renewable energy recommendations (i.e., ES-3a, ES-6, RCI-7, and RCI-8). AFW-4 focuses on the supply elements of the implementation of a biomass-to-energy program (e.g., availability, collection, and distribution), while the ES/RCI recommendations focus on the demand side (e.g., generation infrastructure and purchasing for consumers).*

#### **AFW-5 Expanded Use of Advanced Biofuels**

This policy promotes sustainable in-state production of advanced biofuels from agriculture, forestry and MSW feedstocks (raw materials) to displace the use of conventional petroleum-based fuels. It also promotes advanced biofuel production systems that improve the embedded energy content and carbon profile of biofuels. It focuses on feedstocks that produce advanced biofuels with significantly lower embedded GHG emissions compared to conventional fuel products (from a life-cycle perspective).

This policy also promotes the in-state development of feedstocks, such as cellulosic material and perennials that are able to be utilized. Recognizing that conversion technologies, such as thermochemical Fischer-Tropsch processes and enzymatic conversion, are developing fast in this sector, the policy recommends facilitating, but not requiring, their development and establishment in Arkansas.

*Note: This recommendation is linked with the Transportation and Land Use recommendation TLU-3 (Advanced Biofuels Development and Expansion). AFW-5 focuses on the supply elements of the implementation of a biofuels program, while TLU-3 focuses on the demand side (e.g., vehicle technology requirements, E10, E85).*

## **AFW-6 Expanded Use of Locally Produced Farm and Forest Products**

AFW-6 focuses on the production and consumption of locally produced agricultural and forest products to displace the consumption of goods transported from other states or countries, and thus reduce transportation-related GHG emissions. Additionally, increasing the amount of renewable wood products used for residential and commercial buildings can increase carbon sequestration in wood products and displace GHG emissions associated with processing high-energy input materials, such as steel, plastic, and concrete.

## **AFW-7 Forest Management and Establishment for Carbon Sequestration**

Arkansas' forests and forest management have a significant role to play in the state's strategies to reduce or offset GHGs and adapt to future climate effects. This policy establishes or re-establishes forests on land not currently forested, such as fallow or marginal agricultural land ("afforestation"); promotes retaining forest cover and associated carbon stocks by regenerating forests ("reforestation" or "restoration"); helps maintain and improve the health and longevity of trees in urban and residential areas (urban forestry); and implements, in a carbon-sensitive manner, such practices as site preparation, erosion control, and stand stocking to ensure conditions that support forest growth.

Forest management activities promote forest productivity and increase the rate of CO<sub>2</sub> sequestration in forest biomass and soils and in harvested wood products. The urban forestry component also has the potential to reduce fossil fuel consumption through shading and wind protection of homes and commercial buildings. Reducing the severity of wildfires can reduce GHG emissions by lowering the forest carbon lost during a fire and maintaining carbon sequestration potential. Similarly, reducing damage from insects, disease, and invasive plants decreases GHG emissions by maintaining the carbon sequestration potential of healthy forests.

The implementation of this recommendation also needs to consider non-GHG benefits, such as the provision of wildlife habitat, biodiversity, and stream buffers and improvement of water quality.

## **AFW-8 Advanced Recovery and Recycling**

Advanced recovery and recycling promotes the reduction of the volume of waste produced, as well as reduction in consumption through incentives, awareness, and increased efficiency. Three major areas of focus in Arkansas are source reduction, organic waste management, and advanced recycling. This policy builds on the statutory recycling goal of 45% by 2010 and provides GHG benefits not only from avoided disposal emissions, but also from product life-cycle emission reductions (associated with the manufacture and transport of new packaging and products). Redirecting organic wastes (such as food, yard, and paper) from landfills into composting programs is very effective at reducing GHG emissions. To be successful, this policy recommendation needs to promote reuse and recycling through best management practices for corporations, businesses, and government organizations.

## **AFW-9 End-of-Use Waste Management Practices**

This policy promotes activities that further reduce GHG production by encouraging the use of energy recovery technologies. The focus is on the utilization of methane at landfills through the enabling of anaerobic digesters to capture and utilize that energy through electric power, heating, or liquefied natural gas. These technologies will help reduce GHG emissions from waste management, while producing cleaner energy. They make a two-fold contribution to climate protection, by reducing emissions of methane and other GHGs into the atmosphere (via collection and control), and offsetting energy that would have otherwise come from fossil fuels. For example, the emissions created by landfills (methane) can be used to make electricity that would have otherwise been produced from fossil-based feedstocks, such as natural gas or coal.

# Chapter 8

## Review of Current Scientific Literature on Causes and Impacts of Global Warming

The Supreme Court in *Massachusetts v. Environmental Protection Agency*, 127 S.Ct. 1438 (2007), stated:

A well-documented rise in global temperatures has coincided with a significant increase in the concentration of carbon dioxide in the atmosphere. Respected scientists believe the two trends are related. For when carbon dioxide is released into the atmosphere, it acts like the ceiling of a greenhouse, trapping solar energy and retarding the escape of reflected heat. It is therefore a species—the most important species—of a "greenhouse gas."

Consistent with the findings of the Supreme Court, there is a broad scientific consensus that, over the last two centuries, there is a 90%–95% probability that human activities have increased amounts of important greenhouse gases (GHGs, primarily carbon dioxide, methane, nitrous oxide, and fluorocarbons)<sup>1</sup> in the atmosphere to levels not seen in all of prior human experience, and likely not seen for 3 million years. This consensus has been reflected in *Climate Change 2007: The Physical Science Basis. Fourth Assessment Report of the Intergovernmental Panel on Climate Change* (IPCC 2007), and in at least three reports of the National Research Council of the National Academy of Sciences (NAS/NRC): *Climate Change Science: An Analysis of Some Key Questions* (2001), *Abrupt Climate Change: Inevitable Surprises* (2002), and *Surface Temperature Reconstructions for the Last 2,000 Years* (2006). These findings are also reflected in the summary of science prepared by the U.S. Environmental Protection Agency in the Advance Notice of Proposed Rulemaking: *Regulating Greenhouse Gas Emissions Under the Clean Air Act* (July 30, 2008).

As reflected in these reports, it is likely or very likely that human-induced increases in these GHGs are already causing global climate to warm. Human activities likely caused most of the approximately 0.6 °C (1.1 °F) rise over the 20th century.<sup>2</sup> The mean ocean temperature has risen by 0.05 °C (0.09 °F), global average sea level has risen by 0.1–0.2 meters (1/3–2/3 feet) over the 20th century, and snow cover and Arctic ice have decreased by about 10% and 10%–15%, respectively, since the late 1960s (when data first became available for this measurement).<sup>3</sup> Various other climate factors are changing consistent with warming induced by GHGs. By contrast, we know of no measures of climate on the global scale that indicate cooling. It is virtually certain that what has been observed so far is only the beginning, and that continued

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<sup>1</sup> Water vapor is a GHG and is an important amplifier of climate change because its atmospheric concentrations tend to increase when the atmosphere and surface waters warm up. Anthropogenic emissions of water vapor to the atmosphere by automobiles and other combustion sources do not significantly affect global atmospheric concentrations of water vapor relative to the natural evaporation and condensation processes.

<sup>2</sup> NAS/NRC, *Climate Change Science*, p. 1.

<sup>3</sup> *Id.*, p. 16.

GHG emissions along current trajectories will cause additional warming of the Earth system as a whole. The average time for removal from the atmosphere of added carbon dioxide is measured in centuries. It is very likely that such perturbation would cause the rate of surface warming and sea level rise in the 21st century to be substantially larger and faster than that experienced in the 20th century, without precedent in the past 10,000 years.

The evidence that anthropogenic emissions of GHGs have already affected the climate includes the following observations:

- Ocean temperature has increased to depths of at least 3,000 meters.
- Global sea levels rose by 1.7 millimeters per year (mm/yr) during the 20th century and by 3.1 mm/yr during 1993–2003. There is high scientific confidence that the rate of rise increased during the 20th century.
- The average Arctic temperature has increased at twice the global average.
- Summer Arctic sea ice has shrunk at 7.4% per decade since 1978.
- Mountain glaciers have declined in both hemispheres.
- There is a trend toward less snow at low altitudes.
- Atmospheric water vapor content has increased (consistent with the effect of increased air temperature).
- There has been an increase in precipitation over many large regions (the Northern Hemisphere, in general, and eastern North America).
- There have been more intense, longer droughts in many regions.
- There has been less rainfall in African Sahel, southern Africa, and southern Asia.
- The frequency of heavy rainfall events has increased over most land areas.
- There have been widespread increases in hot days and nights, and heat waves.
- Various ecological changes have been observed, including impacts on nesting behavior, insect and disease outbreaks, and species distribution.

On the other hand, to date, there have been no observed effects upon:

- Global average diurnal temperature range.
- Antarctic sea ice extent.
- Tornadoes, hail, lightning, and dust storms.
- Meridional overturning circulation in the global ocean, which would lead to cooling of Europe.

A variety of impacts will affect Arkansas and the southeastern United States, particularly if emissions of GHGs are not limited. These impacts include the following:

- There will be increased storminess, with increases in floods, windstorms, and, in some places, ice storms.
- Floodplains will likely increase in extent as larger floods increase in frequency. Ground-level ozone pollution will be exacerbated. Tropical and insect-borne diseases will move north.
- There will be increased heat-related deaths and decreased cold-related deaths.
- Although less likely to impact Arkansas directly, there will be adverse impacts on winter sports that will reduce the snow season in resorts.
- There will be strains on water supplies, particularly in western states, which will witness a decreased snowpack.
- There will be increased drought stress, because there will be less precipitation during summer months and more during winter months, putting further stress on water supplies.
- The increases in drought stress and storminess are likely to have an adverse impact upon agriculture and forestry.
- Sea levels will rise, putting stress on coastal areas and causing salt-water intrusion into coastal aquifers. Sea levels are expected to rise by 1–2 feet by 2100 due to thermal expansion, alone. However, the sea level rise could be much greater due to melting of the Greenland or Antarctic glaciers.
- Rising sea levels, increased drought stress, and impacts on agriculture will also become “a [national security] threat multiplier for instability in some of the most volatile regions of the world.”<sup>4</sup> This insecurity may affect Arkansas.
- Cold-water fisheries will decline.
- Coral reefs and related fisheries will be adversely affected by ocean acidification caused by increased carbon dioxide levels.
- Climatic hardiness zones will move north and the distribution of vegetation and wildlife will change. This will likely put stress upon vulnerable species.

There is also a danger of severe and sudden impacts whose likelihood cannot be assessed, as reflected in the NAS/NRC report *Abrupt Climate Change: Inevitable Surprises* (2002). The glaciers in the Antarctic and Greenland provide a 100,000-year history that show that climate was far more variable before the beginning of human civilization. This history raises the concern that there may be more extreme results as a result of increasing atmospheric GHG levels. Over the last 5,000 years, climate has been very stable, but the norm is rapid and wild fluctuation. If a forcing element, such as levels of GHGs in the atmosphere, changes considerably, it is possible that we could pass a threshold and flip a switch that would cause the climate to undergo rapid change that could include dramatically warmer or colder temperatures or rapid changes in sea level. We cannot predict when continental glaciers will collapse and how fast this will occur. The fossil record shows that there have been 5-meter rises in sea level in the shortest interval that can

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<sup>4</sup> CNA. *National Security and the Threat of Climate Change*. Available at: <http://securityandclimate.cna.org/>.

be read (10 years). A recent study has found that melting of continental glaciers could cause a rise of as much as 3–6 feet by 2100, in addition to the 1–2-foot rise predicted as a result of thermal expansion. In light of recent evidence, James Hansen has expressed the following concern:

Crystallizing scientific data and analysis reveal that the Earth is close to dangerous climate change, to tipping points of the system with the potential for irreversible deleterious effects.<sup>5</sup>

Several individuals have pointed to publications and speeches by “climate skeptics” that appear to present contrary views. However, these publications have not been peer reviewed. Peer-reviewed scientific literature has unanimously endorsed the views in the IPCC and NAC/NRC reports described above.<sup>6</sup> In fact, the individuals who raise “questions” about the consensus view are not disagreeing about the science, but are confusing science and policy, disagreeing with the default position dictated by applicable law for addressing residual face of uncertainty, and quite frequently basing their view on largely unsupported and sometimes unstated assumptions regarding the relative environmental and economic risks of error.

Moreover, there is no disagreement that there are some uncertainties regarding the degree of risk from GHG atmospheric increases, the timing of impacts and, in some cases, even the nature of some risks. The critics suggest that economic concerns regarding response suggest that we should not take action unless it is virtually certain that very bad things will happen. However, applicable law, including the United Nations Framework Convention on Climate Change and the federal Clean Air Act, require that actions be taken to limit emissions if there is a risk of serious harm, rather than a certainty. Thus, the United Nations Framework Convention on Climate Change, which has been ratified by the United States, provides:

The Parties should take precautionary measures to anticipate, prevent or minimize the causes of climate change and mitigate its adverse effects. Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing such measures, taking into account that policies and measures to deal with climate change should be cost-effective so as to ensure global benefits at the lowest possible cost.<sup>7</sup>

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<sup>5</sup> James E. Hansen. "Dangerous Human-Made Interference with Climate." Testimony to Select Committee on Energy Independence and Global Warming, United States House of Representatives. April 26, 2007. Available at: [http://www.columbia.edu/~jeh1/2007/Testimony\\_20070426.pdf](http://www.columbia.edu/~jeh1/2007/Testimony_20070426.pdf).

<sup>6</sup> Naomi Oreskes. "Beyond the Ivory Tower: The Scientific Consensus on Climate Change." *Science* December 3, 2004;306(5702):1686. Available at: <http://www.sciencemag.org/cgi/content/full/306/5702/1686>. Some publications are miscited. For example, some cite the work of Bjørn Lomborg, *Cool It: The Skeptical Environmentalist's Guide to Global Warming* (September 2007), as evidence against taking action. In *Cool It*, he writes: "Global warming is real and man-made. It will have a serious impact on humans and the environment toward the end of this century." *Id.* at 8. He also agrees that action should be taken to address climate change. (See <http://www.lomborg.com/faq/>.) Dr. Lomborg is an economist, not a climate scientist, and his work expresses his opinion on solutions.

<sup>7</sup> United Nations Framework Convention on Climate Change. Article 3, section 3. Available at: <http://unfccc.int/2860.php>.

A similar or identical precautionary standard appears in many sections of the federal Clean Air Act. Thus, section 202(a)(1), which was construed by the United States Supreme Court in *Massachusetts v. Environmental Protection Agency* provides as follows:

The Administrator shall by regulation prescribe . . . standards applicable to the emission of any air pollutant from any class or classes of new motor vehicles or new motor vehicle engines, which in his judgment cause, or contribute to, air pollution which may reasonably be anticipated to endanger public health or welfare.

The applicable science meets this standard, and no skeptic says that there is a reasonable scientific certainty that there will not be adverse impacts from rising GHG levels.

## **Appendix A**

### **Act 696**

**An Act to Establish the Governor's Commission on Global Warming; to Direct the Commission to Study Issues Related to Global Warming and the Emerging Carbon Market; to Establish a Global Warming Pollutant Reduction Goal and Comprehensive Strategic Plan; and for Other Purposes**

*[This page intentionally left blank]*

Stricken language would be deleted from and underlined language would be added to the law as it existed prior to this session of the General Assembly.

Act 696 of the Regular Session

As Engrossed: H3/7/07 H3/13/07

A Bill

1 State of Arkansas  
2 86th General Assembly  
3 Regular Session, 2007

HOUSE BILL 2460

4  
5 By: Representatives Webb, Adcock, T. Baker, Blount, Bond, T. Bradford, Breedlove, E. Brown, J.  
6 Brown, Burris, Cash, Cheatham, Chesterfield, Cook, D. Creekmore, Dickinson, S. Dobbins, Dunn,  
7 Edwards, Garner, Hall, Harrelson, House, Hoyt, D. Hutchinson, Hyde, D. Johnson, J. Johnson, W.  
8 Lewellen, Lovell, Maloch, Moore, Pate, Pennartz, Petrus, Pickett, Pierce, Powers, S. Prater, Rainey,  
9 Reep, Reynolds, J. Roebuck, Saunders, Schulte, Shelby, L. Smith, Stewart, Sullivan, Sumpter, Wagner,  
10 Walters, Wills, Woods, *Rosenbaum, Maxwell*  
11 By: Senators Argue, Broadway, Brown, Bryles, Faris, J. Jeffress, Madison, Malone, Salmon, R.  
12 Thompson, *Crumbly*  
13  
14

15 **For An Act To Be Entitled**

16 AN ACT TO ESTABLISH THE GOVERNOR'S COMMISSION ON  
17 GLOBAL WARMING; TO DIRECT THE COMMISSION TO STUDY  
18 ISSUES RELATED TO GLOBAL WARMING AND THE EMERGING  
19 CARBON MARKET; TO ESTABLISH A GLOBAL WARMING  
20 POLLUTANT REDUCTION GOAL AND COMPREHENSIVE  
21 STRATEGIC PLAN; AND FOR OTHER PURPOSES.

22  
23 **Subtitle**

24 TO ESTABLISH THE GOVERNOR'S COMMISSION  
25 ON GLOBAL WARMING; TO DIRECT THE  
26 COMMISSION TO STUDY ISSUES RELATED TO  
27 GLOBAL WARMING; AND TO ESTABLISH A  
28 GLOBAL WARMING POLLUTANT REDUCTION GOAL  
29 AND COMPREHENSIVE STRATEGIC PLAN.  
30

31  
32 BE IT ENACTED BY THE GENERAL ASSEMBLY OF THE STATE OF ARKANSAS:

33  
34 SECTION 1. Commission established – Membership.

35 (a) The Governor's Commission on Global Warming is hereby created and



1 established, referred to hereafter as the "commission".

2 (b) The commission shall be composed of twenty-one (21) members  
3 appointed as follows:

4 (1) Two (2) members appointed by the President Pro Tempore of  
5 the Senate;

6 (2) Two (2) members appointed by the Speaker of the House of  
7 Representatives; and

8 (3) Seventeen (17) members appointed by the Governor as follows:

9 (A) One (1) member from the public energy sector;

10 (B) One (1) member from a rural electric cooperative;

11 (C) One (1) member from the municipal energy sector;

12 (D) Two (2) members from the agriculture sector;

13 (E) One (1) member from the forestry sector;

14 (F) Two (2) members from separate nonprofit environmental  
15 organizations;

16 (G)(i) Three (3) members who are scientists from an  
17 accredited state institution of higher education;

18 (ii) One (1) of the three (3) scientists shall be a  
19 climatologist;

20 (H) One (1) member from the state Chamber of  
21 Commerce/Associated Industries of Arkansas;

22 (I) One (1) member of the AFL-CIO;

23 (J) One (1) member who is an economist from an accredited  
24 state institution of higher education;

25 (K) One (1) member from the construction industry with  
26 experience in sustainable energy construction or design; and

27 (L) Two (2) members who are citizens at large.

28 (c) The commission shall establish and appoint an advisory body  
29 composed of the directors of the following state agencies or his or her  
30 designee:

31 (1) Arkansas Agriculture Department;

32 (2) Arkansas Department of Environmental Quality;

33 (3) Arkansas Forestry Commission;

34 (4) Arkansas Highway and Transportation Department;

35 (5) Arkansas Natural Resources Commission;

36 (6) Arkansas Public Service Commission;

1           (7) Arkansas State Game and Fish Commission;

2           (8) Department of Economic Development;

3           (9) Department of Parks and Tourism; and

4           (10) Oil and Gas Commission.

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6           SECTION 2. Co-chairs.

7           The commission shall have two (2) co-chairs to be elected from among  
8 the members of the commission.

9  
10          SECTION 3. Quorum.

11          A quorum of the commission shall consist of a majority of the members.

12  
13          SECTION 4. Vacancies.

14          A vacancy on the commission shall be filled as soon as possible by the  
15 appointing authority.

16  
17          SECTION 5. Purpose and duties.

18          (a) The commission shall conduct an in-depth examination and  
19 evaluation of the issues related to global warming and the potential impacts  
20 of global warming on the state, its citizens, its natural resources, and its  
21 economy, including without limitation, agriculture, travel and tourism,  
22 recreation, insurance, and economic growth and development.

23          (b) Based on the commission's evaluation of the current global warming  
24 data, the assessment of global warming mitigation strategies, and the  
25 available global warming pollutant reduction strategies, the commission shall  
26 set forth:

27                 (1) A global warming pollutant reduction goal; and

28                 (2) A comprehensive strategic plan for implementation of the  
29 global warming pollutant reduction goal.

30          (c) The commission shall present its global warming pollutant  
31 reduction goal and comprehensive strategic plan for consideration to the  
32 Eighty-Seventh General Assembly and develop findings and recommendations as  
33 may be directed thereafter by the Eighty-Seventh General Assembly.

34          (d) The purpose of the global warming pollutant reduction goal and  
35 comprehensive strategic plan is to place Arkansas in a position to help  
36 stabilize the global climate, to allow Arkansas to lead the nation in

1 attracting clean and renewable energy industries to our state, and to reduce  
2 consumer energy dependence on current carbon-generating technologies and  
3 expenditures.

4 (e) In fulfilling its purpose under this act, the commission shall:

5 (1) Review current scientific literature on the causes of global  
6 warming;

7 (2) Review actions taken by the federal government and by other  
8 states to address global warming;

9 (3) Evaluate the available data regarding emissions of  
10 greenhouse gases from within the state and evaluate the extent to which  
11 reductions in the emissions of greenhouse gases in the state may affect  
12 global warming;

13 (4) Evaluate the economic opportunities for the state from the  
14 emerging carbon market that may result from international, national, and  
15 local efforts to address the effect of global warming;

16 (5) Conduct a cost-effectiveness analysis based on the projected  
17 expenses of taking immediate action versus delayed action to address the  
18 effect of global warming on individuals, households, local and state  
19 governments, businesses, educational institutions, medical institutions,  
20 agricultural operations, and other sectors identified by the commission; and

21 (6) Evaluate the benefit of any action taken at the state level,  
22 either by or within this state or by other states, at the national level, or  
23 at the international level to address the effect of global warming on  
24 individuals, households, local and state governments, businesses, educational  
25 institutions, agricultural operations, medical institutions, and other  
26 sectors identified by the commission.

27 (7) The Governor's Commission on Global Warming is authorized to  
28 accept gifts, grants, and donations for use in carrying out its purpose and  
29 duties.

30  
31 SECTION 6. Additional duties.

32 The commission may work cooperatively with other states and federal  
33 governmental agencies to organize a Governor's forum on global warming,  
34 including its causes, impacts, challenges, and opportunities in the region.

35  
36 SECTION 7. Staffing.

1           Upon the prior approval of the Legislative Council of the General  
2 Assembly, the Director of the Bureau of Legislative Research shall assign  
3 professional staff to the commission to aid in its work.

4  
5           SECTION 8. Meetings.

6           The Governor shall convene the first meeting of the commission, which  
7 shall be at the State Capitol. Further meetings shall be at the call of the  
8 co-chairs.

9  
10          SECTION 9. Report.

11          The commission shall report its findings and recommendations to the  
12 Governor on or before November 1, 2008, in order to report its findings and  
13 recommendations to the Eighty-Seventh General Assembly.

14  
15          SECTION 10. Life of commission.

16          The commission shall be abolished on or before December 31, 2009, at  
17 the discretion of the Governor.

18  
19          SECTION 11. EMERGENCY CLAUSE. It is found and determined by the  
20 General Assembly of the State of Arkansas that it is imperative that Arkansas  
21 study the scientific data, literature, and research on global warming to  
22 determine whether global warming is an immediate threat to the citizens in  
23 the State of Arkansas; that the potential impact of global warming on the  
24 state and its citizens, its natural resources, and the economy necessitates a  
25 thorough review by the state and a strategy to deal with the consequences of  
26 global warming; that economic opportunities might arise from an emerging  
27 carbon market tailored to reduce carbon emissions; that failure to take  
28 necessary steps to prevent, stabilize, or mitigate the effects of global  
29 warming will cause irreparable harm to the lives and livelihoods of  
30 Arkansans; and that this act is immediately necessary to ensure the welfare  
31 and well-being of the citizens of this state. Therefore, an emergency is  
32 declared to exist and this act being immediately necessary for the  
33 preservation of the public peace, health, and safety shall become effective  
34 on:

35           (1) The date of its approval by the Governor;

36           (2) If the bill is neither approved nor vetoed by the Governor,

1 the expiration of the period of time during which the Governor may veto the  
2 bill; or

3 (3) If the bill is vetoed by the Governor and the veto is  
4 overridden, the date the last house overrides the veto.

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*/s/ Webb, et al*

*APPROVED: 3/30/2007*

# **Appendix B**

## **Description of the Arkansas Governor's Commission on Global Warming Process**

### **Memorandum**

To: Arkansas Governor's Commission on Global Warming

From: The Center for Climate Strategies

Re: Work Plan for Launch of the Arkansas Governor's Commission on Global Warming Process

Date: February 7, 2008

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This memorandum outlines the proposed work plan for the Arkansas Governor's Commission on Global Warming (Commission). Initially the purpose and goals of the process are described, including the proposed general outline of the final report and the overall timing and milestones. Also described are the design of the process, including key principles and guidelines. A set of general Commission meeting agendas follows, showing the progression of the process over time. Lastly, an outline of the budget and funding plan is presented, along with a description of the project team.

### **Purpose and Goals of the Arkansas Governor's Commission on Global Warming**

With the signing of Act 696 of the Arkansas 86<sup>th</sup> General Assembly (HB2460), Governor Mike Beebe established the Governor's Commission on Global Warming. Seventeen of the twenty-one members of the Commission are appointed by the Governor, and two members each are appointed by the President Pro Tempore of the Arkansas State Senate and by the Speaker of the Arkansas House of Representatives. The Commission is charged with setting a "global warming pollution reduction goal" and a "comprehensive strategic plan for implementation of the global warming pollution reduction goal." The Act contains several study and evaluation requirements related to both action and inaction scenarios, and requires a final report to be provided to the Governor by November 1, 2008, in order to provide findings to the Eighty-Seventh General Assembly. In addition, the Commission is charged with establishing and appointing an Advisory Body composed of the directors of the following state agencies: Agriculture Department, Department of Environmental Quality, Forestry Commission, Highway and Transportation Department, Natural Resources Commission, Public Service Commission, State Game and Fish Commission, Department of Economic Development, Department of Parks and Tourism, and Oil and Gas Commission.

The Center for Climate Strategies (CCS) will aid the Arkansas Governor's Commission on Global Warming in its examination and evaluation of the "...issues related to global warming on the state, its citizens, its natural resources, and its economy." By following a detailed work plan and policy development process, CCS will provide administrative, technical, facilitative, informational, and document development support toward the development of an Arkansas

Climate Action Plan to Governor Beebe by November 1, 2008. The development of an Arkansas Climate Action Plan will address the directives of the Act with respect to establishing a global warming (greenhouse gas (GHG)) reduction goal for Arkansas and a comprehensive strategic plan and final report for its implementation.

To support these needs, CCS will provide critical startup planning and technical support activities, followed by the launch and management of a Climate Action Plan process in 2008. CCS will work in partnership with and under the direction of the Commission and Governor's Office as an impartial and expert party throughout the startup and management of the Climate Action Plan process.

The following presents a proposed work plan for startup, management, and completion of an Arkansas Climate Action Plan process to support the mission of the Commission under Act 696 of the Arkansas 86<sup>th</sup> General Assembly. CCS will provide administrative, informational and educational, facilitative, and advanced technical support to serve the needs of the Commission.

As stated by Act 696, the purpose of the Commission process is to place Arkansas in a position to help stabilize the global climate, to allow Arkansas to lead the nation in attracting clean and renewable energy industries to the state, and to reduce consumer energy dependence on current carbon-generating technologies and expenditures. The primary duties outlined in Act 696 task the Commission to:

- (1) Conduct an in-depth examination of the potential causes and impacts of global warming on the state, its citizens, its natural resources, and its economy; and
- (2) Assess global warming mitigation strategies by :
  - a. Establishing a global warming pollutant reduction goal, and
  - b. Developing a comprehensive strategic plan for implementation of the global warming pollution reduction goal, to be presented in a final report to the 87<sup>th</sup> General Assembly for consideration.

The Commission process will follow the format of CCS policy development processes used successfully in a number current and completed state-level climate action planning initiatives. This consensus-building model supports informed and collaborative self-determination by a broadly representative group of designated stakeholders and technical experts. The supported process of the Commission will be transparent, inclusive, stepwise, fact-based, and consensus driven. The process will seek but not mandate consensus and will use formal voting to determine the level of support for individual policy options. (See **key principles and guidelines** section for additional detail.) CCS conducts all of its stakeholder processes in compliance with the "*Model Standards of Conduct for Mediators*," published in August 2005 by the American Arbitration Association, American Bar Association, and Association for Conflict Resolution.

As an impartial party, CCS does not take positions on climate policy issues or legislation. CCS supports the purpose and goals of the Executive Orders or other directives that establish its processes (such as Act 696 of the Arkansas 86<sup>th</sup> General Assembly), and does not dispute the findings of the Intergovernmental Panel on Climate Change or the National Academies of Science (NAS) on the science of climate change often-cited in Executive Orders establishing planning processes.

**The deliverables will be implemented by CCS in three integrated tasks:**

**I. Preliminary Evaluations.**

**II. GHG Inventory and Forecast Assessment.**

**III. Climate Action Plan Process.**

**Task I – Preliminary Evaluations** – will include an extensive review of the science and current state and federal actions that could affect decisions of the State of Arkansas and further baseline assessments to educate and inform the Commission as it designs and develops a global warming pollutant reduction goal. During this initial task, CCS will:

- (1) Review, summarize, and evaluate the scientific and technical literature available on both the causes of global warming and the potential impacts on Arkansas, its citizens, its natural resources, and its economy, including agriculture, travel, tourism, recreation, insurance, and economic growth and development. By assessing climate change impacts in Arkansas, CCS will help the Commission determine whether the development of a state climate adaptation strategy is necessary. This review will include, among other scientific literature, the Fourth Assessment of the Intergovernmental Panel on Climate Change and a summary of potential state impacts and vulnerabilities by a state climate science panel assembled for this purpose. CCS will also identify other key studies and assessments related to climate change mitigation options in Arkansas. This in-depth examination will serve to educate and advise Commission members on the technical and scientific aspects of climate change. CCS has demonstrated experience in successfully forming science advisory panels. For example, in Arizona, it assisted the state in forming a science panel to serve as a resource for the Arizona Climate Change Advisory Group; to conduct an assessment of the effects of climate change on water resources; and, to assist the state with public education programs. Members of the CCS team have extensive experience in developing scientific assessments, reviews and briefings, including court proceedings, legislative commissions and hearings, peer reviewed academic literature, and graduate school curricula.
- (2) Identify and assess multi-state and federal climate policy issues and options that could affect decisions of the State of Arkansas. CCS will review for the Commission its comprehensive compendium of state and federal actions, including over 300 actions taken and/or considered by U.S. states, regions and/or the federal government to reduce GHG emissions in tandem with other economic benefits and cost savings.
- (3) Identify existing state actions in Arkansas that reduce GHG emissions, and assess the GHG reduction potential of key actions recently implemented and/or formally planned by the state.
- (4) Assist in the identification of potential early actions by the State to address climate change policy needs.
- (5) Evaluate the economic opportunities for the State of Arkansas from the carbon market now emerging as a result of existing international, national, and local efforts to address global warming.
- (6) Assist in the identification of technical experts in Arkansas for possible membership in Technical Work Groups (TWGs) during the climate action planning process.

- (7) Assist in the development of communications tools to support the climate action planning process, including a project website, document templates, and other tools.
- (8) Provide visible and written aids to assist the Commission in understanding the climate science, opportunity, and policy environment throughout the duration of the Commission's charge.

**Task II – GHG Inventory and Forecast Assessment** – will include the following task and subtasks by CCS:

- (1) Develop a draft inventory and forecast of Arkansas greenhouse gas (GHG) emissions from 1990 to 2025. This assessment will document a reference case for emissions that includes evaluation of existing and planned actions, as well as reference case forecasts at the sector and sub-sector level for all GHGs recognized by the United Nations Framework Convention on Climate Change (UNFCCC). The GHG inventory and forecast report will be reviewed by the Commission as the backdrop for its discussion regarding the establishment of a global warming pollutant (or GHG) reduction goal. CCS has produced numerous state of the art assessments of state level GHG emissions inventories and forecasts.

**Task III – Climate Action Plan Process** – will include the following management, facilitation, and technical support tasks related to the Climate Action Plan process; the final report reflecting the comprehensive strategic plan and strategies and the statewide global warming pollutant reduction goal developed by the Commission; and implementation support to the Commission in its work with the Governor and the 87<sup>th</sup> General Assembly. CCS has assisted several states in the development of consensus based comprehensive GHG reduction plans and statewide goals.

- (1) Facilitation of six or more structured climate action planning meetings of the Commission and a series of interim meetings of five TWGs to identify, prioritize, develop, and quantify final recommendations to be brought forward in the Commission's comprehensive Climate Action Plan.
- (2) Development of a comprehensive set of specific policy recommendations by the Commission in the form of a strategic implementation plan to reduce GHG emissions and enhance energy and economic opportunity in Arkansas by 2025 and beyond. This will include detailed analyses of GHG reduction potential and cost or cost savings (i.e., cost effectiveness) for each recommended policy option as appropriate (some measures may not require quantification, such as reporting or education) as well as the aggregate impacts of the implementation plan. Consistent with Act 696, the projected costs of delayed actions will also be considered, as will the potential benefits of recommended actions on individuals, households, local and state governments, businesses, educational institutions, agriculture operations, medical institutions, and other sectors the Commission may identify. CCS has conducted numerous state of the art cost-effectiveness evaluations and other economic assessments of GHG reduction strategies at the state, regional and national level through advisory group processes.
- (3) Facilitate and provide technical support to the Commission's process to establish a recommended statewide global warming pollutant (or GHG) reduction goal to be met by implementation of the comprehensive climate action plan developed by the Commission.

CCS has facilitated the establishment of statewide GHG reduction goals in several states as well as the western region.

- (4) Issuance by November 1, 2008 of recommendations in the form of a final report from the Commission to the Governor and for consideration by the 87<sup>th</sup> General Assembly. At the end of the detailed technical and planning process, CCS will prepare a comprehensive report addressing the most appropriate actions for Arkansas to pursue through legislation, rules, regulations, and voluntary actions to achieve its global warming pollutant (GHG) reduction goal. CCS will ensure – through its consensus-based policy development process model – that all recommendations reflect the highest levels of consensus building possible among the members of the Commission while also addressing the full set of charges to the Commission. The final report to the Governor and the 87<sup>th</sup> General Assembly that compiles and summarizes final Climate Action Plan recommendations of the Commission will include:
  - a. Executive Summary
  - b. Status and Summary of Climate Change Science and Potential Impacts of Climate Change on Arkansas
  - c. History and Status of State Actions Related to GHG Emissions
  - d. Inventory and Forecast of Arkansas GHG Emissions
  - e. Recommended Policy Actions by Sector:
    - i. Energy Supply
    - ii. Residential, Commercial, and Industrial
    - iii. Transportation and Land Use
    - iv. Agriculture, Forestry and Waste Management
    - v. Cross-Cutting Issues, including Emissions Reporting, Registries, Goals Public Education, and other issues
    - vi. Technical Appendices
- (5) Assistance to the Commission in dialogue with the Governor of Arkansas and in briefings and testimony before the 87<sup>th</sup> General Assembly through April 2009 (or the end of the legislative session) to ensure effective implementation of the legislative initiatives recommended in the comprehensive Climate Action Plan developed by the Commission.
- (6) In addition, CCS provides advanced economic analysis and modeling capabilities for potential policy recommendations, including cost-effectiveness evaluations of individual strategies to reduce GHG emissions as well as the cumulative impacts of a comprehensive GHG reduction plan to achieve global warming pollutant reduction goals set by the Commission. The expertise of the CCS team includes the ability to perform a comprehensive array of advanced economic analyses that are customized to the preferences and needs of the Commission and its TWGs. These include: development of Mitigation Abatement Cost (MAC) estimates and curves for individual and aggregate policy options (i.e., cost effectiveness); Differential Labor Impact Analysis; Value Added Impacts; Income Impacts (including distributional effects on different income classes); Emissions Trading Design and Impacts including GHG Allowance (Permit) Prices; Energy Price Impact Analysis; Transportation System Modeling; Forestry and Agriculture System Modeling; and Macroeconomic Modeling through Dynamic Equilibrium Modeling or other methods. Economic modeling to be performed by CCS

for recommended policy options will be determined by the Commission, with assistance by CCS and TWGs, on a case-by-case basis based on facilitated discussions and available resources.

**Project Schedule.** Task I of the CCS work plan will begin in January 2008, focusing on the preparation of an in-depth review and evaluation of literature on climate change science (causes and impacts), existing state and federal policy actions, and analysis on how Arkansas can contribute to and benefit from concerted action to address climate change. The first full meeting of the Commission’s climate action planning process will be held in February 7, 2008, with five additional meetings and a final report to be completed by November 1, 2008. Should the Commission desire to extend the length of the process, CCS can provide assistance as needed. Two or more TWG teleconference meetings for each of the five TWGs will be held between each of the Commission meetings. The Commission’s climate action planning process is expected to proceed according to the following draft schedule:

Date	Action
January 2008	Task I: Preliminary Evaluation commences
January 2008	Task II: GHG Inventory and Forecast commences
February 7 and 28, 2008	Task III: 3 <sup>rd</sup> and 4 <sup>th</sup> Commission meetings
April 9, 2008	5 <sup>th</sup> Commission meeting
May 19, 2008	6 <sup>th</sup> Commission meeting
July 31, 2008	7 <sup>th</sup> Commission meeting
September 25, 2008	8 <sup>th</sup> Commission meeting
November 1, 2008	Final Report Due
Between Commission Meetings	TWG conference calls and meetings
December 2008 through April 2009	Support to the Commission in dialogue with and testimony for the 87 <sup>th</sup> General Assembly

## **Final Report**

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The Commission final report is expected no later than November 1, 2008. It will compile and summarize the final recommendations of the Commission and cover the following areas:

1. Executive Summary
2. History and Status of State Actions

3. Inventory and Forecast of Arkansas GHG Emissions
4. Proposed Goals for Reducing Greenhouse Gas Emissions in Arkansas
5. Recommended Policy Actions by Sector:
  - a. Energy Supply
  - b. Residential, Commercial, and Industrial
  - c. Transportation and Land Use
  - d. Agriculture, Forestry, and Waste Management
  - e. Cross Cutting Issues (Emissions Reporting, Registries, and Education)
6. Technical Appendices

### **Design of the Process**

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The Commission’s climate action planning process will echo the format of several successful state climate action processes conducted by CCS (available through [www.climatestrategies.us](http://www.climatestrategies.us)). This consensus building model combines techniques of alternative dispute resolution, community collaborative decision-making, and corporate strategic planning in a combined form of facilitation and technical analysis known as “evaluative facilitation.” The process will conform directly to the purpose, duties, staffing, meeting, and reporting requirements as outlined in SECTIONS 5 through 10 of Act 696.

The process fully integrates group decisions and technical analysis through open, informed, and collaborative decision-making and self-determination by a broadly representative group of stakeholders (the Commission), with the support of TWGs that are comprised of Commission members and others. Activities of the Commission will be transparent, inclusive, stepwise, fact-based, and consensus driven (see key principles and guidelines of the process listed below). The process will *seek but not mandate consensus* on individual policy option recommendations and will use formal voting to identify potential objections and alternatives.

The climate action planning process relies on intensive use of information and interaction between facilitators, participants, and technical analysts. The CCS team provides close coordination and support for the activities of the Commission and its TWGs, including facilitation and technical support. To facilitate learning, collaboration, and task completion by the Commission and TWGs, CCS will provide a series of discussion and decision templates for each step in the structured planning process, including:

- A public website for all information and proceedings of the process at [www.arclimatechange.us](http://www.arclimatechange.us);
- Standard meeting documents, including: agenda and notice, discussion PowerPoint, meeting summary, and reference documents formatted for each of the Commission and TWG meetings;
- A draft final report, PowerPoint presentation, and series of worksheets for review and approval of the GHG emissions inventory and forecasts for the State;
- An initial master catalog of state and multi-state GHG reduction policy options with brief descriptions for each option, suggested ranking criteria, draft rank of potential for GHG

reductions and costs or cost savings for each action;

- An assessment of the emissions savings and other impacts of actions recently adopted in Arkansas;
- A balloting form for identification of initial priorities for analysis for each of the sector-based TWGs;
- Templates for the development and analysis of individual policy option recommendations;
- A document describing the techniques and methods used for quantifying GHG reductions and costs or cost savings associated with each of the policy options being considered;
- Analysis materials, including documentation of key data sources, assumptions, models, methods, and printouts of worksheets as needed;
- A final report format with summary chapters and technical appendices; and
- Other documents will be developed by CCS as needed to support the Commission.

The Commission and TWG process will reflect the following **key principles and guidelines**:

The process is fully transparent. All materials considered by the Commission and TWGs are posted to the project website, and all meetings are open to the public. CCS will follow state meeting law requirements in the notice and conduct of meetings and votes, as needed. For TWG teleconference meetings (some in-person meetings are possible), the State will arrange for physical locations with a telephone and a telephone monitor so that the public can listen. The quantification of potential policy options is transparent with respect to data sources, methods, key assumptions, and uncertainties. In addition, policy design parameters and implementation methods for recommended actions are explicit and transparent, including goal levels, timing, coverage of parties, and implementation mechanisms. The transparency of technical analysis, policy design, and participant viewpoints is critical to the identification and resolution of potential conflicts.

The process is inclusive. A diverse group of Commission and TWG members are chosen by the State to represent a broad spectrum of interests and expertise in Arkansas. The public is afforded the opportunity to provide meaningful review of and comment upon pending Commission decisions.

The process is stepwise. Each step of the sequential process builds incrementally on the former toward a final solution. Sufficient time, information, and interaction are provided between steps to ensure comfort with decisions and quality of results. Participants are responsible for staying current with information developed by and decisions of the process, and decisions are not reconsidered once voted upon.

The process will seek but not mandate consensus. CCS will facilitate votes of the Commission at each of the major milestones in the process in order to advance to next steps, consistent with state procedural requirements. Voting is conducted by simple request for objection at the point of decision (by hand), followed by resolution of conflicts through discussion and development of alternatives, as needed, in order to proceed. Final votes by the Commission on specific individual recommendations include support at three levels, including: Unanimous consent (no objection), Super-majority (typically five objections or fewer), and Majority (fewer than half object).

Typically, the early stages of the process proceed with unanimous consent or super-majority. Final recommendations may include recommendations at all three levels, depending on the Arkansas-specific process developed for the Commission. The final report will document the level of Commission support for individual recommended options, including barriers to consensus and suggested alternatives for those recommendations with less than unanimous support.

The process is comprehensive. The Commission will explore solutions in all sectors and across all potential implementation methods. Recommendations may include state-level and multi-state actions (regional and national) as well as potential effects of international actions. Mitigation of all GHGs will be examined. Units will be expressed in million metric tons of carbon dioxide equivalent (MMTCO<sub>2</sub>e). Significant actions taken by the executive or legislative branches during the process will be included as updates to the reference case forecast of emissions.

The process is guided by clear decision criteria for the selection and design of recommended actions. These include consideration of: (1) GHG reduction potential; (2) cost or cost savings per ton of GHG emissions removed (i.e., cost effectiveness); (3) potential co-benefits, including economic and energy policy improvements; and (4) potential feasibility issues (technical, economic, political, institutional). Consistent with Act 696, the projected costs of delayed actions will also be considered, as will the potential benefits of recommended actions on individuals, households, local and state governments, businesses, educational institutions, agriculture operations, medical institutions, and other sectors the Commission may identify.

The process is quantitative. Results of Commission decisions will include explicit descriptions of policy design parameters and results of economic analysis (referred to as cost-effectiveness analysis in the Act). Recommendations can include both quantified and non-quantified actions, depending on preferences of the Commission, with emphasis on quantification of GHG reduction potential and cost or cost savings for as many recommendations as possible. Additional quantification needs related to co-benefits, externalities, or feasibility issues will be evaluated on a case-by-case basis pending Commission input and available resources.

The process covers short-, medium-, and long-term periods of action. The period of analysis for emissions inventories and reference case projections will be 1990-2025, with assessment of later periods being optional and consistent with available resources. Emission reduction options and related energy and economic analyses are expected to cover the period from the present to 2025, with supplemental analysis also possible for longer periods if resources permit.

The process is implementation oriented. The goal of the process is the ultimate adoption of specific policies by the State of Arkansas based on the recommendations of the Commission and subsequent, more detailed analyses as needed. Accordingly, recommendations of the Commission are intended to support policy adoption, but may not necessarily comprise the level of detail necessary for final programmatic implementation, e.g., rulemaking, institutional design, funding, etc. This predisposition toward implementation is consistent with Act 696 in its specific intent to help stabilize the climate, allow Arkansas to lead the nation in attracting clean and renewable energy industries to the State, and reduce consumer dependence on current, carbon-generating technologies and expenditures.

The TWG process is fully integrated with the Commission and facilitated by the CCS team under the coordination of the Commission. Under this approach, TWGs are comprised of members of the Commission and/or their staff, may have additional technical members appointed by the

Governor, and serve in an advisory role to the Commission. The TWGs are structured around the following sectors: Transportation; Energy Supply; Residential, Commercial and Industrial; Agriculture, Forestry and Waste; and Cross-Cutting Issues. The TWGs will also consider global warming science and impacts issues, as called for in Act 696.

### **Commission Meeting Objectives and Agendas**

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The objectives and agendas for each of the Commission and TWG meetings are listed below, with notes regarding each of the decisions of the Commission. Note that the Commission has held two meetings; thus, the process outlined in this work plan will begin with the third meeting of the Commission.

#### **MEETING THREE**

- Objectives:
  - Introduction to the process, presentation of preliminary fact-finding (inventory and forecast of emissions, Catalog of state actions, review of climate science and impacts), formation of TWGs (no votes, but Commission members should be prepared to specify one or more TWGs in which they would like to participate), next steps.
- Agenda:
  - Welcome and Introductions
  - Review of Purpose & Goals
  - Open Government Briefing
  - Review of Inventory and Forecast of Arkansas GHG Emissions, Recent Actions
  - Review of State and National Climate Actions
  - Review of Climate Commission Process
  - Review of State Climate Action Catalogs
  - Next Steps for Commission and Technical Work Groups
  - Agenda, Time and Date for Next Meeting
  - Public Input and Announcements

Interim TWG calls will cover: (1) suggested revisions to the draft inventory and reference case projections, and (2) review and suggested modifications to the Catalog of policy options.

#### **MEETING FOUR**

- Objectives:
  - Addition of potential actions to the draft Catalog of state actions (by vote); identification of potential revisions to the draft emissions inventory and forecast (by vote if/as needed)
- Agenda:
  - Review and recommended updates to the draft emissions inventory and forecast
  - Review and approval of additional actions to the Catalog of possible Arkansas actions

- Discussion of the process for identifying initial policy option priorities for TWG analysis
- Next meeting agenda, time, location, date
- Public input and announcements

Interim TWG calls will cover: (1) suggested revisions to the emissions inventory and reference case projections, as needed; and (2) early ranking of options in the Catalog and balloting for initial “priority for analysis” options.

## **MEETING FIVE**

- Objectives:
  - Review and approval of initial priorities for analysis of TWG identified policy options (by vote); review and approval of revisions to the emissions inventory and forecast (by vote if/as needed)
- Agenda:
  - Agreement on inventory and forecast revisions, with modifications as needed
  - Review and approval of TWG-suggested lists of initial policy priorities for analysis, with modifications as needed
  - Discussion of process for developing straw policy design proposals for analysis of priority policy options
  - Briefing on quantification methods for draft policy options
  - Next meeting agenda, time, location, date
  - Public input and announcements

Interim TWG calls will cover: (1) development of straw proposals of design parameters for individual options, and (2) next steps for analysis of options.

## **MEETING SIX**

- Objectives:
  - Review and approval of TWG suggested straw proposals for policy design (goals, timing, coverage of parties) (by vote); review and approval of any additions to the list of priority policy options for analysis, if/as needed (by vote); preparation for quantification phase of the process (briefing and discussion)
- Agenda:
  - Review and approval of straw proposals for policy design, with modifications as needed
  - Discussion and approval of additional priority policy options for analysis, if/as needed
  - Discussion of quantification principles and guidelines, key assumptions for TWG analysis of priority policy options
  - Next meeting agenda, time, location, date
  - Public input and announcements

Interim TWG calls will cover: (1) review of proposed quantification procedures for individual options, including proposed data sources, methods, assumptions; (2) review of first round of quantification results, identification of needs for revision as needed; and (3) identification of potential early consensus options to recommend for Commission approval.

## **MEETING SEVEN**

- Objectives:
  - Review and approval of consensus policy recommendations (by vote); identification of specific barriers to consensus, and potential alternatives for non-consensus policy options (discussion).
- Agenda:
  - Review of the draft pending policy options list, with results of analysis and cumulative emissions reductions potential
  - Identification of early consensus policy options
  - Identification of barriers and alternatives for remaining options, with guidance for additional work on options to TWGs
  - Review of final report progress and plans
  - Next meeting agenda, time, location, date
  - Public input and announcements

Interim TWG calls will cover: (1) final revisions to alternative policy design and implementation mechanisms as needed, (2) final analysis of options and alternatives, and (3) final steps on formulation of cross cutting policy options and mechanisms.

## **MEETING EIGHT**

- Objectives:
  - Review and approval of final policy option recommendations (by vote); review of final report procedures.
- Agenda:
  - Review of the draft pending policy options list, with results of analysis and cumulative emission reduction potential
  - Review and final approval of draft pending policy options, with revisions as needed
  - Summary of the process, review of next steps for completion and transmittal of the final report
- Public input and announcements

## **FINAL REPORT**

- Draft report language by CCS to the Commission and public
- First round of review and inputs to CCS

- Updated draft report language to the Commission and public
- Final Commission call to discuss suggested changes to the final report
- Final report transmitted to the Commission by CCS

## **Participant Roles and Responsibilities**

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The Commission process involves a number of parties with specific roles and responsibilities, as follows:

### **Governor**

The Governor convenes the climate action plan process at the first meeting of the Commission at the State Capitol, with further meetings held at the call of the co-chairs of the Commission. The Commission must report its findings and recommendations to the Governor on or before November 1, 2008, in order to report its findings and recommendations to the 87<sup>th</sup> General Assembly.

### **Center for Climate Strategies**

The Governor and the Commission have asked CCS to partner in forming and conducting a participatory statewide climate action planning process to meet the goals of the Commission. CCS will work in partnership with the Commission to achieve the overall goals of the process. In this role, CCS will design the Commission process and provide facilitation and technical support to the Commission and its TWGs through a team of project managers, facilitators, and technical analysts to support Commission needs.

CCS serves as an impartial and expert party and does not take positions on issues or direct the parties toward particular solutions. As such, CCS serves as a group mediator, but not as an arbitrator. CCS will manage and facilitate meetings and votes during meetings, schedule meetings in coordination with the Chair, develop meeting agendas, produce documents for the Commission and TWG consideration, and perform and present technical analysis.

CCS abides by the Model Standards of Conduct for Mediators approved by the American Arbitration Association, the Litigation Section and the Dispute Resolution Section of the American Bar Association, and the Society of Professionals in Dispute Resolution. CCS also ensures that adequate funding exists to successfully complete the process through private sources, as needed.

### **The Commission**

Seventeen of the twenty-one members of the Commission are appointed by the Governor, and two members each are appointed by the President Pro Tempore of the Arkansas State Senate and by the Speaker of the Arkansas House of Representatives. The Commission makes final recommendations for specific climate policy actions and approves a final Arkansas GHG emissions inventory and forecast. Commission members are appointed to respond to the goals and timelines of the process. CCS will facilitate Commission activities, provide supporting analysis of options under consideration, and deliberate and cast votes in an open-group format.

## **Technical Work Groups**

TWG members will be comprised of Commission members assigned to specific sector-based TWGs. In addition, two members of the Commission's Advisory Body will be assigned to each TWG to provide non-Commission individuals with technical expertise and interest of importance to the process. The TWGs will provide guidance to Commission members on decisions related to milestones in the stepwise process. TWGs will also provide assistance to CCS in the identification, design, and quantification of policy recommendations. Sector based TWGs include:

- Energy Supply (heat and power);
- Residential, Commercial, Industrial (energy efficiency and conservation, and industrial process);
- Transportation and Land Use;
- Agriculture, Forestry and Waste Management; and
- Cross Cutting Issues (reporting, registries, public education, goals, etc.).

### **The TWGs will perform the following tasks in assistance to the Commission:**

- Review the catalog of existing, planned, and potential state actions and suggest additional state-level actions for Commission consideration;
- Suggest a list of initial priorities for analysis of policy actions for Commission consideration through a balloting process;
- Develop and suggest initial "straw proposals" for the design of individual policy actions (with CCS assistance), including goals, timing, and coverage of parties for Commission consideration;
- Assist with the identification and development of data and assumptions to assist CCS with analysis and quantification of individual policy actions for Commission consideration, as needed;
- Review proposals for the analysis and quantification of individual policy actions, including data sources, methods and key assumptions for Commission consideration;
- Respond to requests by the Commission for the development of alternative design scenarios or analyses to address potential barriers to consensus;
- Review draft final text for policy actions and final report language with suggested changes, as needed, for consideration by the Commission; and
- Assistance, as needed, with climate change science and impacts assessments and reviews as they relate to the charge of the Commission.

CCS will provide a facilitation and technical analysis team to assist the TWGs and coordinate Commission and TWG activities. CCS will also be responsible for drafting technical materials on behalf of the TWGs and Commission.

## **Government Agencies**

Ten state agencies will designate representatives to an advisory body established by the Commission. Selected agencies may also provide staff to support TWG meetings and related activities in support of the Commission and CCS team. This includes technical review and input to TWG meetings. The Commission may also appoint agency representatives as TWG members.

## **The Public**

The public is invited to attend Commission meetings and provide review and input to the Commission and TWG members. Other public input mechanisms may be developed as needed based on guidance from the Commission.

## **Participant Guidelines**

Commission and TWG members are expected to follow certain codes of conduct during the process, including:

- Participants are expected to support the process and its concept fully and, through the group process, in good faith directly collaborate toward the goals of the Commission and TWGs.
- Participants are expected to act as equals during the process to ensure that all members have equal footing during deliberations and decisions.
- Participants must attend meetings and stay current with information provided to the group and the decisions of the group.
- Participants are asked not to reconsider decisions already made in the stepwise process. Once the Commission reaches a milestone by vote, it moves to the next step.
- Participants represent only themselves when making Commission decisions and/or speaking about the process with the media or in other public settings.
- Participants should refrain from personal criticisms and provide objective, fact-based comments and alternatives during Commission and TWG discussions.

## **Project Budget**

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CCS and the Commission have agreed upon a projected budget for the project. The estimated CCS budget for completion of startup and completion of the Commission process covers the core facilitation process and quantification of approximately 50 policy recommendations. Changes in the number of meetings, number of policy options, or type of analysis may require additional budget support.

## **Project Funding**

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CCS works with a group of private foundation donors to provide cost share to its state partners to ensure a timely and successful launch and completion of the planning processes and other phases of the project. Key donors have pledged support for the Commission, and the State of Arkansas will also provide financial support to the project.

## **Project Team**

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The CCS project team consists of the following members (CCS may alter the team configuration based on need during the process):

### **Facilitation Team**

- Tom Peterson, Ken Colburn

### **Project Management Team**

- Tom Peterson, Randy Strait, Ken Colburn, Tom Looby, Gloria Flora, Joan O'Callaghan

### **Climate Change Science Lead Consultant**

- Bobby McKinstry, Bill Dougherty

### **Inventory and Forecast Team**

- Randy Strait, Maureen Mullen, Bill Dougherty, Holly Lindquist, Steven Roe

### **Technical Work Group Facilitators and Consultants**

#### **Energy Supply**

- Tom Peterson, Donna Boysen, Bill Dougherty, Michael Lazarus, Sivan Kartha

#### **Residential, Commercial, and Industrial**

- Tom Peterson, Donna Boysen, Michael Lazarus, David Von Hippel

#### **Agriculture, Forestry, and Waste Management**

- Steve Roe, Gloria Flora, Katie Bickel, Jennifer Jenkins, Brad Strode, Peter Kuch, Joe Pryor

#### **Transportation and Land Use**

- Lewison Lem, Kathy Leotta, Bill Cowart, Will Schroeer

#### **Cross Cutting Issues**

- Tom Looby, Ken Colburn, Randy Strait, Katie Pasko

#### **Economic Modelers**

- Adam Rose, Dan Wei, Brandt Stevens

# Appendix C

## Members of Technical Work Groups

### Cross-Cutting Issues (CC)

**Nick Brown**, President and Chief Executive Officer, Southwest Power Pool, Inc.

**Joan Cash**, Legislator, State of Arkansas / Vice President and Owner, Farm Equipment Sales and Services

**Jerry Farris, PhD**, Associate Dean, College of Sciences and Mathematics, Arkansas State University

**Rob Fisher**, Executive Director, The Ecological Conservation Organization

**Christopher Ladner**, President and Chief Executive Officer, ecoIntegration

**Elizabeth Martin, PhD**, Instructor and Research Specialist, University of Arkansas

**Jeffrey Short**, General Engineer, United States Department of Energy (retired)

### Advisory Body Members

**Nancy Ledbetter**, Arkansas Game and Fish Commission

**Teresa Marks**, Arkansas Department of Environmental Quality

### Center for Climate Strategies

**Ken Colburn**, Co-Facilitator

**Randy Strait**, Co-Facilitator

**Katie Pasko**, Coordination Support

### Residential, Commercial, and Industrial (RCI)

**Steve Cousins**, Vice President of Refining, Lion Oil Company

**Kevan Inboden**, Special Projects Administrator, City Water and Light

**Christopher Ladner**, President and Chief Executive Officer, ecoIntegration

**Robert McAfee, PhD**, Climate Change Messenger (Volunteer), The Climate Project

**Hugh McDonald**, President, Entergy Arkansas, Inc.

**Annette Pagan**,<sup>1</sup> Managing Director of U.S. Programs, Winrock International

**Pearlie Reed**,<sup>1</sup> Consultant and Conservationist, Retired, Self-Employed / Co-Chair

**Cindy Sagers, PhD**, Professor, University of Arkansas

**Jeffrey Short**, General Engineer, United States Department of Energy (retired)

**Kathy Webb**, Legislator, State of Arkansas / GCGW Co-Chair

### Advisory Body Members

**Richard Davies**, Arkansas Department of Parks and Tourism

**Maria Haley**, Arkansas Economic Development Commission

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<sup>1</sup> Pearlie Reed served as co-chair of the Governor's Commission on Global Warming (GCGW) and on the RCI and AFW Technical Work Groups (TWGs) until June 17, 2008, when Mr. Reed resigned from the GCGW. The Governor appointed Annette Pagan as Mr. Reed's replacement in the RCI and AFW TWGs for the duration of the GCGW process.

## **Center for Climate Strategies**

**Tom Peterson**, Facilitator

**Hal Nelson, PhD**, Senior Analyst

## **Energy Supply (ES)**

**Nick Brown**, President and Chief Executive Officer, Southwest Power Pool, Inc.

**Joan Cash**, Legislator, State of Arkansas / Vice President and Owner, Farm Equipment Sales and Services

**Rob Fisher**, Executive Director, The Ecological Conservation Organization

**Art Hobson, PhD**, Professor Emeritus of Physics, University of Arkansas

**Kevan Inboden**, Special Projects Administrator, City Water and Light

**Robert McAfee, PhD**, Climate Change Messenger (Volunteer), The Climate Project

**Hugh McDonald**, President, Entergy Arkansas, Inc.

**Kevin Smith**, Insurance and Financial Services, Farmers Insurance / GCGW Co-Chair

**Gary Voigt**, Chief Executive Officer, Arkansas Electric Cooperative Corporation

**Kathy Webb**, Legislator, State of Arkansas / GCGW Co-Chair

## **Advisory Body Members**

**Lawrence Bengal**, Arkansas Oil and Gas Commission

**John Bethel**, Arkansas Public Service Commission

## **Center for Climate Strategies**

**Tom Peterson**, Facilitator

**Bill Dougherty, PhD**, Senior Analyst

**Joan O'Callaghan**, Coordination Support

## **Transportation and Land Use (TLU)**

**Aubra Anthony, Jr.**, President and Chief Executive Officer, Anthony Forest Products Company

**Richard Ford, PhD**, Professor, University of Arkansas, Little Rock

**Miles Goggans**, President, Goggans, Inc.

**Art Hobson, PhD**, Professor Emeritus of Physics, University of Arkansas

**Elizabeth Martin, PhD**, Instructor and Research Specialist, University of Arkansas

**Bill Reed**, Vice President, Public Affairs, Riceland Foods, Inc.

**Cindy Sagers, PhD**, Professor, University of Arkansas

**Gary Voigt**, Chief Executive Officer, Arkansas Electric Cooperative Corporation

## **Advisory Body Members**

**Lynn Malbrough**, Arkansas Highway and Transportation

**Randy Young**, Arkansas Natural Resources Commission

## **Center for Climate Strategies**

**Lewis Lem, PhD**, Facilitator

**Kathy Leotta**, Coordination Support

**Jason Miles**, Coordination Support

## **Agriculture, Forestry, and Waste Management (AFW)**

**Aubra Anthony, Jr.**, President and Chief Executive Officer, Anthony Forest Products Company

**Steve Cousins**, Vice President of Refining, Lion Oil Company

**Jerry Farris, PhD**, Associate Dean, College of Sciences and Mathematics, Arkansas State University

**Richard Ford, PhD**, Professor, University of Arkansas, Little Rock

**Miles Goggans**, President, Goggans, Inc.

**Annette Pagan**, Managing Director of U.S. Programs, Winrock International

**Bill Reed**, Vice President, Public Affairs, Riceland Foods, Inc.

**Pearlie Reed**, Consultant and Conservationist, Retired, Self-Employed / Co-Chair

**Kevin Smith**, Insurance and Financial Services, Farmers Insurance / GCGW Co-Chair

### **Advisory Body Members**

**Richard Bell**, Arkansas Agriculture Department

**John Shannon**, Arkansas Forestry Commission

### **Center for Climate Strategies**

**Joe Pryor**, Co-Facilitator

**Steve Roe**, Co-Facilitator

# **Appendix D**

## **Greenhouse Gas Emissions Inventory and Reference Case Projections**

A separate report titled “Final Arkansas Greenhouse Gas Inventory and Reference Case Projections, 1990–2025,” dated October 2008, was used throughout the Governor’s Commission on Global Warming (GCGW) process to provide detailed documentation on emissions. The final report, incorporating comments provided by the Technical Work Groups and approved by the GCGW, is available at: [http://www.arclimatechange.us/Inventory\\_Forecast\\_Report.cfm](http://www.arclimatechange.us/Inventory_Forecast_Report.cfm).

# Appendix E

## Methods for Quantification

This appendix describes in brief the methods used in quantifying the greenhouse gas (GHG) emission reductions and direct costs/cost savings associated with the policy recommendations, and provides examples of the distinction between “direct” and “indirect” costs. In addition, the combined impacts of all of the policy recommendations within and between each sector were estimated as if all of the recommendations were implemented together. This involved eliminating any overlaps in coverage of affected entities that would occur to avoid double counting of impacts. These quantification methods are based on those widely accepted among climate change mitigation policy analysts. The following general methods were used as the starting point, but were customized as needed to address the policy design features and specifications for analysis of each policy, as approved by the Arkansas Governor’s Commission on Global Warming (GCGW):

### Methods for Quantifying the Impacts of Policy Recommendations

- **Focus of Analysis: Net GHG reduction potential** in physical units of million metric tons (MMt) of carbon dioxide equivalent (CO<sub>2</sub>e) and **net cost per metric ton reduced** in units of dollars per metric ton of carbon dioxide equivalent (\$/tCO<sub>2</sub>e). Where possible, full life cycle analysis is used to evaluate the net energy (and emissions) performance of actions (taking into account all energy inputs and outputs to production). Net analysis of the effects of carbon sequestration is conducted where applicable.
- **Cost-Effectiveness:** Because monetized dollar value of GHG reduction benefits are not available, physical benefits are used instead, measured as dollars per MMtCO<sub>2</sub>e (cost or savings per ton) or “cost effectiveness” evaluation. Both positive costs and cost savings (negative costs) are estimated as a part of compliance cost.
- **Geographic Inclusion:** Measure GHG impacts of activities that occur within the state, regardless of the actual location of emissions reductions. For instance, a major benefit of recycling is the reduction in material extraction and processing (e.g., aluminum production). While a policy option may increase recycling in Arkansas, the reduction in emissions may occur where this material is produced. Where significant emissions impacts are likely to occur outside the state, this will be clearly indicated. These emissions reductions are counted towards the achievement of the state’s emission goal, since they result from actions taken by the state.
- **Direct vs. Indirect Effects:** “Direct effects” are those borne by the entities implementing the policy recommendation. For example, direct costs are net of any financial benefits or savings to the entity. “Indirect effects” are defined as those borne by the entities other than those implementing the policy recommendation. Indirect effects will be quantified on a case-by-case basis depending on magnitude, importance, time available, need and availability of data. (See additional discussion and list of examples below.)
- **Non-GHG (External) Impacts and Costs:** Include in qualitative terms where deemed important. Quantify on a case-by-case basis as needed depending on need and where data are readily available.

- **Discounting and Annualizing:** Discount a multi-year stream of net costs (or savings) to arrive at the “net present value cost” of the cost of implementing a policy option. Discount costs in constant 2005 dollars using a 5% annual real discount rate for the project period of 2009 through 2025 (unless otherwise specified for the particular policy option). Capital investments are represented in terms of annualized or amortized costs through 2025. Create an annualized cost per ton by dividing the present value cost or cost savings by the cumulative reduction in tons of GHG emissions.
- **Time Period of Analysis:** Count the impacts of actions that occur during the project time period and, using annualized emissions reduction and cost analysis, report emissions reductions and costs for specific target years of 2015 and 2025. Where additional GHG reductions or costs occur beyond the project period as a direct result of actions taken during the project period, show these for comparison and potential inclusion.
- **Aggregation of Cumulative Impacts of Policy Recommendations:** In addition to “stand alone” results for individual options, estimate cumulative impacts of all options combined. In this process we avoid simple double counting of GHG reduction potential and cost when adding emission reductions and costs associated with all of the policy recommendations. To do so we note and or estimate interactive effects between policy recommendations using analytical methods where significant overlap or equilibrium effects are likely. Documentation of how these overlaps were addressed is provided at the beginning of Appendix G for the RCI sectors, Appendix I for the TLU sectors, and Appendix J for the AFW sectors.
- **Policy Design Specifications and Other Key Assumptions:** Include explicit notation of timing, goal levels, implementing parties, the type of implementation mechanism, and other key assumptions as determined by the GCGW.
- **Transparency:** Include policy design choices (above) as well as data sources, methods, key assumptions, and key uncertainties. Use data and comments provided by GCGW to ensure best available data sources, methods, and key assumptions using their expertise and knowledge to address specific issues in Arkansas. Modifications will be made through facilitated decisions.

For additional reference see the economic analysis guidelines developed by the Science Advisory Board of the US EPA available at:

<http://yosemite.epa.gov/ee/epa/eed.nsf/webpages/Guidelines.html>.

## **Examples of Direct/Indirect Net Costs and Savings**

Note: These examples are meant to be illustrative.

### **Residential, Commercial, and Industrial (RCI) Sectors**

#### **Direct Costs and/or Savings**

- Net capital costs (or incremental costs relative to standard practice) of improved buildings, appliances, equipment (cost of higher-efficiency refrigerator versus refrigerator of similar features that meets standards)
- Net operation and maintenance (O&M) costs (relative to standard practice) of improved buildings, appliances, equipment, including avoided/extra labor costs for maintenance (less changing of compact fluorescent light (CFL) or light-emitting diode (LED) bulbs in lamps relative to incandescent)
- Net fuel (gas, electricity, biomass, etc.) costs (typically as avoided costs from a societal perspective)
- Cost/value of net water use/savings
- Cost/value of net materials use/savings (for example, raw materials savings via recycling, or lower/higher cost of low-global warming potential (GWP) refrigerants)
- Direct improved productivity as a result of industrial measures (measured as change in cost per unit output, for example, for an energy/GHG-saving improvement that also speeds up a production line or results in higher product yield)

#### **Indirect Costs and/or Savings**

- Re-spending effect on economy
- Net value of employment impacts
- Net value of health benefits/impacts
- Value of net environmental benefits/impacts (value of damage by air pollutants on structures, crops, etc.)
- Net embodied energy of materials used in buildings, appliances, equipment, relative to standard practice
- Improved productivity as a result of an improved working environment, such as improved office productivity through improved lighting (though the inclusion of this as indirect might be argued in some cases)

### **Energy Supply (ES) Sector**

#### **Direct Costs and/or Savings**

- Net capital costs (or incremental costs relative to reference case technologies) of renewables or other advanced technologies resulting from policies
- Net O&M costs (relative to reference case technologies) renewables or other advanced technologies resulting from policies

- Avoided or net fuel savings (gas, coal, biomass, etc.) of renewables or other advanced technologies relative to reference case technologies resulting from policies
- Total system costs (net capital + net O&M + avoided/net fuel savings + net imports/exports + net transmission and distribution (T&D) costs) relative to reference case total system costs

### **Indirect Costs and/or Savings**

- Re-spending effect on economy
- Higher cost of electricity reverberating through economy
- Energy security
- Net value of employment impacts
- Net value of health benefits/impacts
- Value of net environmental benefits/impacts (value of damage by air pollutants on structures, crops, etc.)

## **Agriculture, Forestry, and Waste Management (AFW) Sectors**

### **Direct Costs and/or Savings**

- Net capital costs (or incremental costs relative to standard practice) of facilities or equipment (e.g., manure digesters and associated infrastructure, generator; ethanol production facility)
- Net O&M costs (relative to standard practice) of equipment or facilities
- Net fuel (gas, electricity, biomass, etc.) costs or avoided costs
- Cost/value of net water use/savings

### **Indirect Costs and/or Savings**

- Net value of employment impacts
- Net value of human health benefits/impacts
- Net value of ecosystem health benefits/impacts (wildlife habitat; reduction in wildfire potential; etc.)
- Value of net environmental benefits/impacts (value of damage by air or water pollutants on structures, crops, etc.)
- Net embodied energy of water use in equipment or facilities relative to standard practice
- Reduced vehicle miles traveled (VMT) and fuel consumption associated with land use conversions (e.g., as a result of forest/rangeland/cropland protection policies)

## **Transportation and Land Use (TLU) Sector**

### **Direct Costs and/or Savings**

- Incremental cost of more efficient vehicles net of fuel savings.

- Incremental cost of implementing Smart Growth programs, net of saved infrastructure costs.
- Incremental cost of mass transit investment and operating expenses, net of any saved infrastructure costs (e.g., roads)
- Incremental cost of alternative fuel, net of any change in maintenance costs

**Indirect Costs and/or Savings**

- Health benefits of reduced air and water pollution.
- Ecosystem benefits of reduced air and water pollution.
- Value of quality-of-life improvements.
- Value of improved road safety.
- Energy security
- Net value of employment impacts

# Appendix F

## Cross-Cutting Issues

### Policy Recommendations

#### Summary List of Policy Recommendations

No.	Policy Recommendation	GHG Reductions (MMtCO <sub>2</sub> e)			Net Present Value 2009–2025 (Million \$)	Cost-Effectiveness (\$/tCO <sub>2</sub> e)	Level of Support
		2015	2025	Total 2009–2025			
CC-1 <sup>†</sup>	Greenhouse Gas Inventories and Forecasts	<i>Not Quantified</i>					Unanimous
CC-2 <sup>‡</sup>	State Greenhouse Gas Reporting and Registry	<i>Not Quantified</i>					Unanimous
CC-3 <sup>‡</sup>	Statewide Greenhouse Gas Reduction Goals or Targets	<i>Not Quantified</i>					Super Majority (3 objections)
CC-4*	The State's Own Greenhouse Gas Emissions (Lead by Example)	<i>Not Quantified</i>					Unanimous
CC-5*	Comprehensive Local Government Climate Action Plans	<i>Not Quantified</i>					Super Majority (1 objection)
CC-6*	State Climate Public Education and Outreach	<i>Not Quantified</i>					Super Majority (1 objection)
CC-7 <sup>‡</sup>	Optimizing Best Scale of Reduction Policies	<i>Not Quantified</i>					Unanimous
CC-8 <sup>†</sup>	Creative Financial Mechanisms	<i>Not Quantified</i>					Super Majority (1 objection)
CC-9*	Adaptation and Vulnerability	<i>Not Quantified</i>					Super Majority (1 objection)
CC-10 <sup>†</sup>	Climate Change-Related Economic Development	<i>Not Quantified</i>					Unanimous
CC-11 <sup>†</sup>	Regulatory Realignment in Government To Encourage Constructive Climate Action	<i>Not Quantified</i>					Super Majority (2 objections)

GHG = greenhouse gas; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; \$/tCO<sub>2</sub>e = dollars per metric ton of carbon dioxide equivalent.

The numbering used to denote the above policy recommendations is for reference purposes only; it does not reflect prioritization among these important policy recommendations.

\* The GCGW approved this option at Meeting #8 (July 31, 2008); 19 members present and voting (two by phone).

† The GCGW approved this option at Meeting #10 (September 25, 2008); 21 members present and voting (none by phone).

## CC-1. Greenhouse Gas Inventories and Forecasts

### Policy Description

Greenhouse gas (GHG) emission inventories and forecasts are essential for understanding the magnitude of all emission sources and sinks (both man-made and natural), the relative contribution of various types of emission sources and sinks to total emissions, and the factors that affect trends over time. Inventories and forecasts help to inform state leaders and the public on statewide trends, opportunities for mitigating emissions or enhancing sinks, and verifying GHG reductions associated with implementation of the Governor's Commission on Global Warming's (GCGW's) recommendations to the Governor.

### Policy Design

Develop an inventory and forecast system that is aligned with national protocols and tailored to specific emissions/sinks found in Arkansas.

#### Goals:

1. Coordinate with the U.S. Environmental Protection Agency (EPA) on the development of a mandatory federal GHG reporting rule (see Fiscal Year [FY] 2008 Consolidated Appropriations Amendment).<sup>1</sup>
  - a. This GHG rule will define sources, thresholds for reporting, and frequency of reporting, and can be used to define reporting standards for the previous year's emissions.
  - b. The rule will apply to the following gases: carbon dioxide (CO<sub>2</sub>), methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride.
  - c. Forecasting of GHG emissions will be included as part of the state's responsibilities. In forecasting future GHG emissions, treatment of uncertainties should be transparent, be as consistent as possible across sectors and time, and to the extent possible, reflect multiple scenarios.
2. Gather all inventory-related information for all historical years through 1990. Develop a benchmark emissions estimate and associated gap analysis for all years, and identify missing data and/or additional information required.

#### Timing:

Implement refinement of the GHG inventory for previous and current time periods, as needed, to support implementation of the policy recommendations by the GCGW until the requirements of the U.S. EPA reporting rule on GHG emission inventories and forecasts become clear.

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<sup>1</sup> 110<sup>th</sup> U.S. Congress, First Session, H.R. 2764: Consolidated Appropriations Act, 2008, <http://www.govtrack.us/congress/billtext.xpd?bill=h110-2764>, see Title II, Administrative Provisions, U.S. Environmental Protection Agency (EPA) (Including Rescission of Funds), pages 284 and 285.

**Parties Involved:**

- Arkansas Department of Environmental Quality (ADEQ).
- Forecast assistance provided by various other state agencies.

**Other:***General Emissions Breakdown*

Anecdotally, it could be assumed that 1/3 of GHG emissions are from energy production sources, 1/3 are from mobile (transportation) sources, and 1/3 are from “other” (residential, commercial, industrial, agricultural, forestry, etc).

**Implementation Mechanisms**

ADEQ already gathers information for many sectors included in the GHG inventory. The larger Title V facilities submit data annually and should include the GHG pollutants as part of that submittal. ADEQ develops data for smaller facilities and for other sectors, such as mobile sources, every 3 years. The additional pollutants can be incorporated into this process. Eventually, it may be appropriate to require certain sources to report their GHG emissions.

**Related Policies/Programs in Place***Federal Clean Air Act (CAA)*

Per the CAA, for several years ADEQ has been developing emission inventories for pollutants caused by stationary and mobile sources that contribute to the formation of the criteria air pollutants (i.e., ozone, carbon monoxide (CO), nitrogen dioxide, sulfur dioxide, fine particulate matter, and lead) and regional haze. The pollutants that contribute to the formation of the criteria air pollutants include CO, volatile organic compounds (VOCs), oxides of nitrogen (NO<sub>x</sub>), oxides of sulfur (SO<sub>x</sub>), lead metal and lead oxides, and fine particulate matter. The pollutants that contribute to the formation of regional haze include NO<sub>x</sub>, SO<sub>x</sub>, ammonia, VOC, fine particulate matter, and elemental carbon. Certain sources are reported every year; other sources are reported every 3 years. Currently, no GHGs are directly tracked or inventoried by ADEQ.

**Type(s) of GHG Reductions**

This recommendation is an enabling policy to encourage management, tracking, and ultimately reduction of GHG emissions. This recommendation does not directly reduce GHG emissions by itself.

**Estimated GHG Reductions and Costs or Cost Savings**

This recommendation could be considered an administrative and enabling function and may incur overhead costs. It will not directly reduce emissions per se, except where these data motivate individual companies or sources to reduce emissions for public relations purposes.

**Data Sources:** Many.

**Quantification Methods:** Several.

**Key Assumptions:** Development of inventories and forecasts on an ongoing basis will establish a baseline for GHG emissions and provide a monitoring tool for assessing the efficacy of the GCGW’s recommendations. Effective emission sinks can be identified and augmented. Public education and outreach will inform and involve citizens in the overall goal of GHG emission reductions. Forecasting will allow state officials to plan for, implement, and monitor necessary additions of emission sources or sinks to the emission cycle.

### **Key Uncertainties**

- The adequacy of ongoing funding for a statewide GHG inventory and forecasting function.
- Appropriate resources to effectively integrate existing data into a central reporting system.
- The most effective frequency of reporting.

### **Additional Benefits and Costs**

The preparation of periodic inventories and forecasts would most likely require additional resources. These resources are minimized but not eliminated by adding implementation of this recommendation to the existing emission inventory duties currently assigned to ADEQ.

Experience with GHG reduction efforts indicates that reporting entities are likely to realize cost savings as they begin to focus on ways to reduce energy use and emissions. Periodic public disclosure of GHG emission source and sink data in Arkansas may help to educate the public on opportunities for reducing GHG emissions and increasing carbon sequestration.

### **Feasibility Issues**

- Incorporating the reporting and forecasting efforts into existing workload demands.
- Gathering the required data in a timely and consistent manner.
- Maintaining the skills and expertise to accurately forecast based on trends.

### **Status of Group Approval**

Complete.

### **Level of Group Support**

Unanimous.

### **Barriers to Consensus**

Not applicable.

## CC-2. State Greenhouse Gas Reporting and Registry

### Policy Description

Greenhouse gas reporting reflects the measurement and reporting of GHG emissions to support both goal development and tracking and management of emissions. GHG reporting can help sources identify emission reduction opportunities, reduce risks, and potentially develop revenue associated with possible future GHG mandates by developing the required infrastructure in advance. Tracking and reporting of GHG emissions can also help in the implementation of periodic state GHG inventories. GHG reporting is a precursor for sources to participate in GHG reduction programs, opportunities for recognition, and a GHG emission reduction registry, as well as to secure “baseline protection” (i.e., credit for early reductions).

A GHG registry enables recording of GHG emission reductions in a central repository with “transaction ledger” capacity to support tracking, management, and “ownership” of emission reductions; establish baseline protection; enable recognition of environmental leadership; and/or provide a mechanism for regional, multistate, and cross-border cooperation. Properly designed registry structures also provide a foundation for possible future trading programs.

### Policy Design

The reporting and registry functions go hand-in-hand. The reporting protocol and format must be aligned with the requirements of the registry provider. To be effective, the registry must be applied on a national level, with an international registry being preferred.

**Goals:** Encourage participation in a nationally recognized, voluntary reporting and registry program. Pay supplemental attention to protocol development for any particular sources or sinks/offsets that are specific to Arkansas. Strive to avoid duplication of reporting requirements on emission sources. Rely on the use of data that emission sources already report under existing and future state and federal programs to avoid duplication of reporting burden on the sources.

#### *State of Arkansas*

Participate in a reporting and registry program to develop knowledge on the reporting mechanism, reporting costs, registry requirements, and resource demands. Educate other private and public organizations on the requirements of participation.

#### *Other Organizations*

Facilitate and encourage voluntary participation in a reporting and a registry program. Acknowledge or provide incentives for local governments, academic and nonprofit institutions, and businesses and regulated industries.

### Timing:

- Address state participation as quickly as possible.
- Develop a plan for encouraging organizations to participate in a reporting and registry program concurrent to the state’s participation in a program.

**Parties Involved:**

- Arkansas state agencies (lead by example).
- Local governments, academic and nonprofit institutions, and businesses and regulated industries.
- All GHG emission sources and sinks (both man-made and natural) should be included.

**Implementation Mechanisms**

The Climate Registry is a nonprofit partnership of states developing consistent, accurate, and transparent GHG emissions measurement protocols capable of supporting voluntary and mandatory GHG emission reporting policies for its members and reporting entities. Currently 39 U.S. states are members ([www.theclimateregistry.org](http://www.theclimateregistry.org)). The State of Arkansas should (1) join The Climate Registry as a board member for the benefit of sources in the state, and (2) itself become a reporter to The Climate Registry by requiring all state agencies to report GHG emissions through The Climate Registry. All “direct” emissions (Scope 1 emissions as defined by the GHG Protocol) and emissions associated with purchased power and heat (Scope 2 emissions) should be reported. Other indirect emissions (Scope 3 emissions) should be phased in over a period of 2 years after the start of the initial reporting effort. Direct and indirect reporting costs as well as results by agency should be presented in a public report. The reports associated with following years should include reference to previous year’s performance for tracking of performance.

The state should also provide reporting education and assistance for private entities to encourage their participation in The Climate Registry.

If and when a federal registry and reporting program is implemented, Arkansas will adjust its program as appropriate to align itself with the approved federal program.

**Related Policies/Programs in Place***Existing Reporting and Registry Organizations*

- The Climate Registry, a nonprofit organization that supports a voluntary GHG emissions registry.
- The Canadian Standards Association, GHG CleanProjects™ Registry provides a portal to report and showcase a project’s GHG emission reductions or removals.
- The California Climate Action Registry is a private, nonprofit organization originally formed by the state of California. The registry serves as a voluntary GHG registry to protect and promote early actions to reduce GHG emissions by organizations.

*Existing GHG Trading Organizations*

- Launched in 2003, the Chicago Climate Exchange (CCX), is the world’s first and North America’s only active voluntary, legally binding integrated trading system to reduce emissions of all six major GHGs, with offset projects worldwide.
- The International Emissions Trading Association is working for the development of an active, global GHG market, consistent across national boundaries and involving all flexibility

mechanisms: the Clean Development Mechanism, joint implementation, and emissions trading.

### **Type(s) of GHG Reductions**

This recommendation is an enabling policy to encourage adaptive management, tracking, and ultimately reduction of GHG emissions. This recommendation does not directly reduce GHG emissions by itself.

### **Estimated GHG Reductions and Costs or Cost Savings**

The reporting and registry components of this policy recommendation would help position Arkansas entities for participation in an emission trading program should one develop in the future, leading to cost savings. Although establishment of a credible reporting program is essential for participating in a trading program, these elements do not reduce GHG emissions themselves. This recommendation could be considered an administrative and enabling function; it does not directly reduce GHG emissions by itself.

**Data Sources:** Many.

**Quantification Methods:** Quantification methods will be designed to follow standard, comparative, and accepted reporting protocols to support the exchange and sale of emission reduction credits, should this become a need in Arkansas.

**Key Assumptions:** None cited.

### **Key Uncertainties**

None cited.

### **Additional Benefits and Costs**

None cited.

### **Feasibility Issues**

None cited.

### **Status of Group Approval**

Complete.

### **Level of Group Support**

Unanimous.

### **Barriers to Consensus**

Not applicable.

## CC-3. Statewide Greenhouse Gas Reduction Goals or Targets

### Policy Description

Section 5 (Purpose and duties) of Arkansas Act 696 requires the GCGW to set forth a global warming pollutant reduction goal based on the commission's evaluation of the current global warming data, the assessment of global warming mitigation strategies, and the available global warming pollutant reduction strategies.<sup>2</sup> Consistent with this charge, the establishment of a statewide goal or target can provide vision and direction, a framework within which implementation of GCGW policy recommendations can proceed effectively, and a basis of comparison for periodic assessments of progress. Greenhouse gas reduction goals or targets recommended by the GCGW should be consistent with the parallel goal of an efficient, robust Arkansas economy. In pursuit of similar climate progress, at least 18 other states have established GHG reduction goals or targets.

### Policy Design

**Goals:** The GCGW recommends that Arkansas establish a statewide, economy-wide goal to reduce the state's gross GHG emissions below 2000 levels by 20% by 2020, 35% by 2025, and 50% by 2035.

**Timing:** These goals should be adopted by the state by 2009.

**Parties Involved:** All parties statewide.

### Implementation Mechanisms

The Arkansas Climate Change Center should prepare a report to the Governor and the State Legislature once every 2 years on the state's progress toward achieving the statewide GHG reduction goal in coordination with ADEQ and other state agencies as appropriate. This report should address each sector's progress toward reducing GHG emissions, identify the contribution of each sector's emissions (identified in the GHG inventory and forecast report) toward achieving the statewide goal, and identify future actions and resource needs.

Until the Climate Change Center is established, the state will decide on the appropriate lead agency or agencies for implementing this policy.

### Related Policies/Programs in Place

Not applicable.

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<sup>2</sup> State of Arkansas, 86th General Assembly, Regular Session, 2007. "Act 696: An Act to Establish the Governor's Commission on Global Warming; to Direct the Commission to Study Issues Related to Global Warming and the Emerging Carbon Market; to Establish a Global Warming Pollutant Reduction Goal and Comprehensive Strategic Plan; and for Other Purposes." Available at: <http://www.arkleg.state.ar.us/ftp/root/acts/2007/public/act696.pdf>.

**Type(s) of GHG Reductions**

Not applicable.

**Estimated GHG Reductions and Costs or Cost Savings**

Not applicable.

**Key Uncertainties**

Uncertainty surrounds future growth rates in GHG emissions, as well as the timing and scope of implementation of the GCGW's policy recommendations.

**Additional Benefits and Costs**

Not cited.

**Feasibility Issues**

Not cited.

**Status of Group Approval**

Complete.

**Level of Group Support**

Super Majority (3 objections).

**Barriers to Consensus**

One member objected with concerns about the ability and high cost associated with reaching the 2020 goal since key technologies will not be available until 2020 or later. Two members objected to the 2025 and 2035 targets because they do not believe these targets are achievable.

## CC-4. The State's Own Greenhouse Gas Emissions (Lead by Example)

### Policy Description

State and local government entities are responsible for providing a multitude of public services that are delivered through very diverse operations and result in wide-ranging GHG emission production activities. Because of this role, they have the opportunity to model a diverse array of GHG emission reduction activities for a wide variety of clients. State and local government entities should take the lead in demonstrating that reductions in GHG emissions can be achieved by analyzing current operations, identifying significant GHG sources, and implementing changes in technology, procedures, behavior, operations, and services provided.

State government can also encourage and/or provide incentives to reduce GHG emissions by others in a variety of ways. One of the most important is to link GHG reductions to energy expenditures, and demonstrate that reduction in one leads to reduction in the other.

### Policy Design

The GCGW recommends that Arkansas establish GHG reduction targets for state and local government operations and school districts, with an emphasis on energy efficiency for both transportation and nontransportation uses. The establishment of these targets will be helpful in setting an example for nongovernmental entities and will help agencies to focus on doing the necessary analysis. Reductions should be reported at the agency level. Thus, state and local government agencies or departments would first need to develop agency- or department-specific GHG emissions inventory data, ideally building on existing energy use reporting data. This would become the baseline data for ongoing emission reduction activities and measurement, which could be included in annual reporting for all entities. Agency and/or department reports would be aggregated into a summary report reflecting state GHG emissions. The Arkansas Climate Change Center should oversee the ongoing climate efforts of the government's agencies or departments, review their performance, and provide direction, guidance, resources, shared approaches, and recognition to agencies or departments and their employees that are working to reduce the government's GHG emissions.

### Goals:

- Reduce GHG emissions from Arkansas state and local operations (including universities) consistent with the GHG emission reduction levels that the GCGW recommends for statewide GHG reduction goals or targets.
- Require all state and local agencies and school districts to make continual progress toward the goal, regardless of their starting point.

**Timing:** The state's efforts to "lead by example" in reducing its own GHG emissions should start immediately. The first annual report by agencies should be due by June 2010 or sooner. The second annual report should reflect initial progress in reducing GHG emissions as agencies begin to plan and implement operational changes.

**Parties Involved:** Coverage should include all operations of all state agencies including universities, authorities, quasi-state entities, local governments, and school districts.

### **Implementation Mechanisms**

- The Arkansas Climate Change Center is charged with collecting energy use and cost data from state and local agencies (including state-supported institutions of higher education) and public school systems. Until the Climate Change Center is established, the state will decide on the appropriate lead agency or agencies for implementing this policy.
- To allow for sharing of information and success stories, the Arkansas Climate Change Center will convene a meeting of agency representatives annually or biennially. This meeting will facilitate education and outreach to agencies and employees, and will allow for recognition of agency progress.
- The state will evaluate development of state contracts for the procurement of low-GHG products.
- All state agencies should consider GHG emissions in their evaluations of environmental assessments and environmental impact statements and similar environmental studies. State agencies should consider life-cycle GHG emissions as they design and perform their day-to-day functions and services—for example, ADEQ in considering environmental assessments and environmental impact statements, the Arkansas Public Service Commission (APSC) in considering energy projects, the Arkansas Department of Transportation in considering transportation projects, etc. Even without authority to control or reduce GHG emissions, raising them for examination will help increase awareness and perhaps consideration of lower-GHG alternatives.
- In the future, the state should consider climate-neutral bonding (i.e., no net increase in GHG emissions within the bond-issuing agency’s geographical jurisdiction after the project becomes operational).

### **Related Policies/Programs in Place**

None cited.

### **Type(s) of GHG Reductions**

This recommendation is an enabling policy to encourage all state and local government operations and school districts in Arkansas to reduce GHG emissions. It does not directly reduce GHG emissions by itself.

### **Estimated GHG Reductions and Costs or Cost Savings**

Not applicable.

### **Key Uncertainties**

Uncertainty surrounds future growth rates in GHG emissions, as well as the timing and scope of implementation of the GCGW's recommended policies and funding mechanisms, including those associated with the state’s own GHG emissions.

### **Additional Benefits and Costs**

Reductions in energy consumption can save money, and reductions in emissions can improve health.

### **Feasibility Issues**

Implementation of this policy recommendation may incur costs associated with conducting energy audits (which are addressed under RCI-3b) and collection and management of the data needed to identify baseline levels and methods for reducing fuel consumption and associated GHG emissions. Reducing fuel consumption will reduce emissions and may result in an overall net savings associated with avoided fuel costs.

### **Status of Group Approval**

Complete.

### **Level of Group Support**

Unanimous.

### **Barriers to Consensus**

Not applicable.

## CC-5. Comprehensive Local Government Climate Action Plans

### Policy Description

“Think globally, act locally” is the refrain often heard to bring action to bear on environmental issues within the average individual’s ability. Similarly, local government actions on climate change issues will be a keystone for achieving state and federal climate action goals. There is no single approach that can be universally applied at the local level; however, local communities are often the incubator for new approaches that can be further developed and applied on a larger level. Local governments will report on progress on climate change issues and will provide innovative, multi-sector solutions that will be shared with others through a clearinghouse or other mechanisms. The state will provide encouragement and assistance to local jurisdictions to sustain global warming objectives.

### Policy Design

Local climate planning initiatives will address local mitigation opportunities, which may change over time. Existing, regional planning data will be used to develop climate change baselines for various, high-value-GHG sectors (transportation, energy use, waste generation, etc.) and to forecast changes or reversals in future growth. The local jurisdictions periodically will report their progress to the state on reducing global warming impacts, so a comprehensive baseline is important when setting GHG targets, developing long-term sustainability plans and local adaptation measures, and requesting resources.

Local governments have many approaches and motives for reducing GHG emissions. Jurisdictions participating in reducing global warming pollution more often than not are motivated by the desire to simply cut traffic, save tax money, clean the air, and improve the quality of life in their communities. Local governments may develop collaborative agreements with organizations that advocate for a specific approach in order to simplify access to mechanisms for achieving results.

### Goals:

Beginning in 2009, the state will provide resources and materials to educate community planning and zoning officials about climate change, impacts, and opportunities. Regional meetings will be conducted to train local officials, discuss the state’s global warming program, and review other jurisdictions’ approaches and lessons learned, to emphasize assistance and resources and to underscore the value of collaboration. These meetings will be repeated periodically to:

- Identify individual community leaders who are acting effectively on climate change, and showcase and share their successes. Likewise, individual community leaders who are not yet acting on climate change should be encouraged to apply lessons learned. The state will host events periodically that focus on leading by example, sharing specifics on lessons learned and opportunities, and illustrating financial investments and payback, co-benefits, etc.

- Identify, assist, and leverage community-based organizations that have expertise or interest in climate-related issues. Work with community-based organizations to identify and build upon climate issues related to their core mission.
- Support and facilitate outreach and education within community-based organizations regarding climate change issues and actions. Establish a network of community-based organizations acting on climate change so they can collaborate, organize joint events, etc.
- Engage communities and students around university campuses to lead periodic meetings to reach out on climate change and discuss impacts, sector-specific mitigation actions, and adaptation opportunities.
- Sponsor university research on local government climate change initiatives, and periodically provide detailed information to the media about the outcome, benefits, etc.
- Encourage local communities to consider including the GCGW recommendations in their local action plans.

**Timing:** In FY 2009, identify local government leaders and model municipalities.

**Parties Involved:** Institutions, municipalities, service clubs, social and affinity groups, nongovernmental organizations (NGOs,) etc. Recognize leadership, share success stories and role models, and expand involvement and participation within civic society.

### Implementation Mechanisms

Local governments across the United States are implementing energy efficiency and renewable energy actions that can have multiple benefits, including saving money, creating jobs, promoting sustainable growth, and reducing emissions of GHGs and other air pollutants. Organizations are focusing on global warming issues and local municipality action.

Local jurisdictions should be encouraged to collaborate with global warming projects with other municipalities in their region (including those out-of-state). Regional climate change initiatives may be more efficient than state-level programs, as they often eliminate duplication of work and benefit from economies of scale. For example, regional initiatives have begun developing systems that reduce CO<sub>2</sub> emissions from power plants, increase renewable energy generation, track renewable energy credits, and research and establish baselines for carbon sequestration.

Local Arkansas jurisdictions will choose specific climate change actions that bring the quickest return on investment and serve their populations the most. Local jurisdictions can use specific best practice actions for stand-alone programs or as part of a regional climate action plan to reduce GHG emissions. Best practices (such as the California Best Practices Framework<sup>3</sup>) offer a variety of options ranging from simple steps to more complex undertakings for city and county agencies. Best practices are available for a broad range of climate change actions relating to energy conservation, community design and land use, transportation, renewable energy, waste reductions, purchasing, etc.

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<sup>3</sup> Institute for Local Government, California Climate Action Network. "Best Practices Framework." Version 5.0. May 9, 2008. Available at: [http://www.cacities.org/resource\\_files/26286.BestPracticesFramework%20v5.0.pdf](http://www.cacities.org/resource_files/26286.BestPracticesFramework%20v5.0.pdf).

Locally designed initiatives can provide an effective and cost-efficient way to achieve local, national, and global sustainability objectives. Local Governments for Sustainability (formerly the International Council for Local Environmental Initiatives [ICLEI]) provides technical consulting, training, and information services to build capacity, share knowledge, and support local governments in their implementation of programs to reduce pollution that causes global warming and in turn, reduce traffic, save money, and improve their communities' quality of life. Municipal leaders should be encouraged to join ICLEI's Cities for Climate Protection program and/or the U.S. Mayors Climate Protection Agreement.

### **Related Policies/Programs in Place**

Eureka Springs, Fayetteville, Little Rock, and North Little Rock have signed the U.S. Mayors Climate Protection Agreement, and Fayetteville, Little Rock, and North Little Rock have joined the Cool Cities program.<sup>4,5</sup> These jurisdictions may already be taking action to reduce GHG emissions, and may have already embarked on their own reporting plans.

### **Type(s) of GHG Reductions**

This recommendation is an enabling policy to encourage local governments to develop and implement climate action plans to reduce GHG emissions. It does not directly reduce GHG emissions by itself.

### **Estimated GHG Reductions and Costs or Cost Savings**

Not applicable.

### **Key Uncertainties**

- The adequacy of ongoing funding for the state to assist local governments in developing plans.
- The availability of resources and expertise to local governments to develop and implement their plans.

### **Additional Benefits and Costs**

Development and implementation of local plans will help the state to achieve its statewide GHG emission reduction goals. If local governments include energy efficiency and renewable and clean energy actions in their plans, these actions have multiple benefits, including saving money, creating jobs, promoting sustainable growth, and reducing emissions of GHGs and other air pollutants.

### **Feasibility Issues**

None cited.

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<sup>4</sup> U.S. Conference of Mayors Climate Protection Summit. *U.S. Mayors Climate Protection Agreement*. November 1–2, 2007. Available at: <http://www.seattle.gov/mayor/climate/>.

<sup>5</sup> See <http://www.coolcities.us/> and <http://www.acgov.org/coolcounties/>.

### **Status of Group Approval**

Complete.

### **Level of Group Support**

Super Majority (one objection).

### **Barriers to Consensus**

One member objected on the grounds that this policy recommendation does not identify the basis and content of the educational resources and materials that will be developed.

## CC-6. State Climate Public Education and Outreach

### Policy Description

The key for long-term success of Arkansas' strategies for addressing climate change lies with increasing the awareness of the issue, as well as the societal costs of and benefits from adopting new policies and/or goals. Education of Arkansas' citizens, business leaders, and policymakers is integral to the successful implementation of changes to mitigate the effects of climate change on the state's environment, economy, and lifestyle. Outreach will extend Arkansans' personal and cooperative commitment to mitigate the effects of climate change to all sectors of endeavor as well as to future generations.

### Policy Design

Climate literacy education and outreach would utilize the same practices as existing ADEQ practices. ADEQ has an established network for education and outreach for issues similar to climate literacy (e.g., pollution prevention, clean air). The education and outreach program would include aspects of global warming actions developed from other sectors (i.e., forestry, energy supply, agriculture). Collaboration with NGOs will facilitate public education and outreach and ensure that climate education is coordinated enough to be broadly effective.

The state will provide education and outreach funding for public information messages in the various media regarding Arkansas' climate literacy. Other incentives may include educational materials developed for K-12, university-level syllabi, and preferences in contracting for businesses that employ global warming mitigation practices and/or products. The target audiences will be evaluated periodically to determine the extent of knowledge and the efficacy of global warming outreach efforts.

### Goals:

The GCGW recommends that this policy address, at a minimum, the following target audiences:

#### *Target Audience: State Executive Agencies*

The Governor should form a climate literacy education and outreach committee (coordinated by ADEQ) to educate the public and other audiences regarding the state's climate change action plan and associated policies, and to oversee outreach activities. The committee should consist of appointed members and should be supported by outreach coordinators from relevant state agencies (energy supply, forestry, agriculture, etc.). The committee should:

- Work with the Governor's Office and state agencies to ensure a coordinated effort to implement an effective program that is consistent with the review of climate literacy programs, curricula, and courses.
- Create and maintain one or more "outreach coordinator" positions in relevant executive agencies, specifically tasked with climate change issues.
- Assess the level (establish a baseline) of public understanding of the impacts of climate change and variability of (proposed) state-specific actions to deal with global warming.

- Establish a recurring awards program to recognize leadership and attainment of the goals and objectives of the Arkansas global warming action plan.

*Target Audience: General Public*

Increase awareness and engage in climate change actions in personal and professional lives.

- Educate broadcasters, reporters, editorial boards, etc., about climate change and the risks it imposes, and provide a subset of solutions. Work with state broadcasters and print media associations to develop and run climate change public service announcements.
- Develop and maintain a state climate change Web site for the public, including a clearinghouse of Arkansas-specific climate change information and resources.
- Work with existing business outreach efforts to customers to enhance awareness of climate change issues and opportunities.
- Provide—and advertise—marketplace incentives to adopt and purchase goods with the minimum carbon “footprint.”

*Target Audience: Future Generations*

Integrate climate change into educational curricula, post-secondary degree programs, and professional licensing to address the multidisciplinary approach to reduce adverse climate change effects.

- Ensure climate change public education (K-12) performance standards for science and social studies; identify gaps in climate change education and develop specific curricula to fill any gaps.<sup>6,7,8,9</sup>
- Integrate “best practices” into public school design and construction, and use this as a means to educate the public about to educate students (and parents) firsthand in their communities and colleges.
- Organize groups of educators to identify, assemble, and employ climate change curricula appropriate to age groups. Make curricula and associated materials available to nonpublic-funded educational courses.
- Integrate climate change into core college curricula, and promote research into climate change and solutions at state universities; develop university “Centers of Excellence” on climate issues, new approaches, and technologies.
- Develop assessment tools to determine the impact of climate change curricula.

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<sup>6</sup> National Oceanic and Atmospheric Administration. Climate Program Office Web site. "Education Plan "and "NOAA's Requirements for Climate Literacy." Available at: <http://www.climate.noaa.gov/education/>.

<sup>7</sup> National Aeronautics and Space Administration. Earth Observatory Web site. Available at: <http://www.earthobservatory.nasa.gov>.

<sup>8</sup> U.S. Environmental Protection Agency. Climate Change Web site. Available at: <http://www.epa.gov/climatechange>.

<sup>9</sup> National Science Digital Library Web site. Available at: <http://www.nsdlib.org>.

- Include climate change discussions at state-funded venues, such as science centers, zoos, and museums.

**Timing:**

FY 2009:

- Develop climate change educational objectives.

Fiscal Year 2010:

- Identify potential projects and resource needs.
- Develop appropriate educational materials and outreach programs, with the expectation of yearly increases for several years to reach additional audiences.

**Parties Involved:** Prospective target audiences are the general public, governmental leaders and staff (federal, state, and community), business and development, and higher education.

**Implementation Mechanisms**

- Recruit coordinators.
- Identify key individuals and groups within target audiences.
- Refine the message in collaboration with these individuals and groups.
- Facilitate the “spread” of the message.
- Develop an integrated climate-oriented approach to teaching science standards.

**Related Policies/Programs in Place**

ADEQ has an established network for education and outreach for issues similar to global warming (e.g., pollution prevention, clean air). The Arkansas Energy Office promotes energy efficiency and emerging technologies through energy education and information programs. The APSC also supports energy efficiency programs in the state. The Arkansas Game and Fish Commission also has an established network for education and outreach, including four conservation education centers located throughout the state. The Arkansas Agriculture Department and Forestry Commission also have well-established education and outreach programs, including administration of Arkansas’ Alternative Fuels Development Program.

**Type(s) of GHG Reductions**

This recommendation is an enabling policy to establish an effective climate change education and outreach program throughout Arkansas. It does not directly reduce GHG emissions by itself.

**Estimated GHG Reductions and Costs or Cost Savings**

Not applicable.

### **Key Uncertainties**

Education and outreach on this scale are dependent upon recruitment of effective coordinators and key individuals within organizations. Managing the relationships with a variety of organizations and audiences may present a challenge.

### **Additional Benefits and Costs**

Commitment to global warming education and outreach will most likely require additional resources. Additional funding may be required to support ADEQ coordination efforts and the education and outreach committee.

### **Feasibility Issues**

Success will depend upon the attention and the energy input from the leadership throughout Arkansas.

### **Status of Group Approval**

Complete.

### **Level of Group Support**

Super Majority (one objection).

### **Barriers to Consensus**

One member objected on the grounds that this policy recommendation does not identify the basis and content of the educational resources and materials that will be developed.

## CC-7. Optimizing Best Scale of Reduction Policies

### Policy Description

The Arkansas Climate Change Center should investigate optimization of scale for each specific GHG reduction considered by the state and report its findings in its annual reports. These investigations should include interstate and regional opportunities that optimize GHG reductions.

### Policy Design

**Goals:** To guide the Arkansas Climate Change Center investigations, “optimization” should be interpreted as opportunities that further increase the state’s overall reduction goals by at least 1% per year, or accelerate the achievement of certain goals by at least one year.

**Timing:** As noted above.

**Parties Involved:** As noted above.

### Implementation Mechanisms

Until the Arkansas Climate Change Center is established, the state will decide on the appropriate lead agency or agencies for implementing this policy.

### Related Policies/Programs in Place

None cited.

### Type(s) of GHG Reductions

This recommendation is an enabling policy to encourage the state to evaluate inter-state and regional opportunities that optimize GHG reductions. This policy recommendation does not directly reduce GHG emissions by itself.

### Estimated GHG Reductions and Costs or Cost Savings

Not applicable.

### Key Uncertainties

None cited.

### Additional Benefits and Costs

None cited.

### Feasibility Issues

None cited.

**Status of Group Approval**

Complete.

**Level of Group Support**

Unanimous.

**Barriers to Consensus**

Not applicable.

## CC-8. Creative Financial Mechanisms

### Policy Description

Allocation of some resources under existing state programs and initiatives can be targeted to achieving state climate goals. However, it is likely that additional resources may also be needed to implement the recommendations in the state plan. Therefore, the state and others will need to consider seeking and stimulating additional funding and investment in climate solutions identified in the state plan. Initiatives could include (but not limited to) establishing, promoting, and utilizing creative financing mechanisms for projects and products that reduce GHGs. Examples could include establishment of a State Revolving Loan Fund to finance products and services with low-carbon intensity, promotion of the use of “green products” procurement preferences, and establishment and promotion of greener buying cooperatives.

### Policy Design

**Goals:** The state should establish a board to identify and procure funding from a broad range of sources to support implementation of this policy recommendation. The state should survey options within existing state economic development plans appropriate to support GHG mitigation policies within Arkansas. Until the Arkansas Climate Change Center is established, the state will decide on the appropriate lead agency or agencies for implementing this policy.

**Timing:** Establish funding by mid-2009.

**Parties Involved:** Arkansas Climate Change Center, state agencies, EPA, foundations, trusts, NGOs, companies, Arkansas Development Finance Authority.

### Implementation Mechanisms

A State Revolving Loan Fund could be established to help offset costs to individuals, companies, etc., for projects that aim to reduce GHG levels through developing new technologies or implementing efficiency strategies/programs. A number of these types of programs already exist in the state, but are focused in particular areas or programs like water allocation, for example. Additional options should include the compiling of funding programs that could have the potential for financial assistance, such as foundations, nonprofits, trusts, etc. An examination of other potential revenue sources from some tax base should also be considered. The idea of “creative” funding sources should be diverse and not limited to just one potential source in an effort to put as many options as possible on the table. It is foreseeable that these programs could be managed in coordination with the Arkansas Climate Change Center and state agencies. Examples of possible funding instruments and activities include the following:

- Establish a State Revolving Loan Program by mid-2009 focused on reducing GHGs in Arkansas.
- Pursue potential tax options that would help fund the GCGW's recommendations.
- Establish a database of potential funders interested in or having a record of funding environmental projects, like foundations or organizations.

- Pursue the potential for ballot initiatives, such as impact fees.
- Examine state incentive opportunities that might include tax credits.
- Establish innovative financing programs for residential and commercial ratepayers to more reasonably finance the up-front capital costs of adding efficiency improvements and renewable energy systems to their homes and small- and medium-size businesses and companies (refer to the U.S. Business Small Administration guidance for defining the size of businesses and companies).

### **Related Policies/Programs in Place**

None cited.

### **Type(s) of GHG Reductions**

This recommendation is an enabling policy to encourage the state to develop creative financial mechanisms that facilitate mitigation of GHG emissions. It does not directly reduce GHG emissions by itself.

### **Estimated GHG Reductions and Costs or Cost Savings**

Not applicable.

### **Key Uncertainties**

None cited.

### **Additional Benefits and Costs**

None cited.

### **Feasibility Issues**

The availability of resources for establishing a revolving loan fund.

### **Status of Group Approval**

Complete.

### **Level of Group Support**

Super Majority (1 objection).

### **Barriers to Consensus**

One member objected to including reference to a tax in this policy without indicating who would be taxed.

## CC-9. Adaptation and Vulnerability

### Policy Description

The Governor's Office should seek government and private funding to help secure efforts for long time monitoring of climate change in the state. A climate change analysis center (i.e., Arkansas Climate Change Center) for the collection and analysis of this data should be established using these funds.

Along with tracking the climate change data, Arkansas should encourage the development of a plan to manage the projected impacts of climate change on the state and to reduce the state's contribution to GHGs. The state should work with industries and research universities to create an Arkansas Climate Change Center. The establishment of the Center should attract more researchers and scientists to the state to help stimulate industrial partners for new economic development and to create new "green" jobs for the state's citizens.

Along with existing local, state, and federal agencies, the Arkansas Climate Change Center may help to address the impact of climate change. The impact issues would include identifying the climate change risks to: humans (e.g., factors that could contribute to disease); water resources (e.g., risk factors that could cause flooding, drought, pollution of waterways); temperature-sensitive populations (e.g., factors that could place immunocompromised individuals at even greater health risks); and ecosystems (e.g., animals and plants that may be affected by changes in their environment). Along with these adverse changes in the natural environment, climate change could also harm Arkansas' energy, transportation, and communication systems; vital infrastructure (including public facilities); and entire economy. The analysis of these risks along with occurring climate change data can be used to create a model to project future problems and hopefully develop solutions to address these issues.

Coordinated responses to climate change issues should be put into effect through the appropriate local, state, and federal agencies to address encountered problems.

### Policy Design

#### Goals and Timing:

As soon as possible, the Governor's Office will:

- Encourage grant writing with goals to acquire funds to establish an Arkansas Climate Change Center.
- Develop an Arkansas Climate Change Center, joining industry and research universities, which will continually work toward solutions for climate impact issues.
- Have established agencies in place to address climate change impact issues that will be constantly occurring.

- Have the Climate Change Center in place to record and analyze climate data that can be shared with other states and regions and used to create models to project detrimental climate change issues and to broadcast these projections in advance.
- The Arkansas Climate Change Center should work with the Parties Involved, listed below, to monitor data and analyses and address arising climate change issues.

**Parties Involved:** Arkansas Department of Natural Resources, National/State Weather Forecasters, Arkansas Department of Forestry, Arkansas Department of Energy, Arkansas Department of Transportation, Arkansas Department of Agriculture, Arkansas Department of Economic Development, Ducks Unlimited, Audubon Society, U.S. Army Corps of Engineers, Centers for Disease Control, the State University Systems, National Institutes of Health, National Science Foundation, NGOs,, National Oceanic and Atmospheric Administration, and U.S. EPA.

### Implementation Mechanisms

To be addressed by the Governor’s Office.

### Related Policies/Programs in Place

Federal and state agencies, such as U.S. EPA, national and state weather forecasting agencies, the U.S. Army Corps of Engineers, the Federal Emergency Management Agency, etc., have been in place to address various environmental issues and emergencies that may arise that may or may not be covered by this policy recommendation.

### Type(s) of GHG Reductions

Not applicable.

### Estimated GHG Reductions and Costs or Cost Savings

Not applicable.

**Data Sources:** Reports from various “parties involved,” such as reports from national weather forecasters, the Centers for Disease Control, U.S. EPA, etc.

**Quantification Methods:** The Arkansas Climate Change Center will acquire quantitative reports from the federal and state agencies mentioned and organize these into a complete report that would present a broad, overall analysis of the environmental impacts.

**Key Assumptions:** National and regional agencies will be in place to share data and be involved in national and regional analyses and modeling of future impacts.

### Key Uncertainties

- The acceptance of the federal government to approve CO<sub>2</sub> and other GHGs as pollutants, and to set regulations for controlling these pollutants.
- The uncertainty of the ultimate impact of GHGs on the state/national/global environment.
- The willingness of regional acceptance and participation in joint programs to help address the issues.

## **Additional Benefits and Costs**

- Benefits would include:
  - Produce more “green” jobs for the state;
  - Raise public awareness so that citizens can understand the environmental, economic, and social impacts of GHG emissions and to reduce these levels on an individual level;
  - Create a healthier environment by reducing GHGs; and
  - Have emergency plans in place to address issues that may arise from drastic environmental changes.
- An additional cost may be if the Arkansas Climate Change Center fails from lack of funding, and the impact of this loss falls back onto the previously existing state/federal agencies.

## **Feasibility Issues**

The success of this policy will depend upon the federal acceptance of GHGs as pollutants and the funding from the various proposed granting institutes.

## **Status of Group Approval**

Complete.

## **Level of Group Support**

Super Majority (one objection).

## **Barriers to Consensus**

A member objected on the grounds that the size, scope, and funding for the Arkansas Climate Change Center have not been determined.

## CC-10. Climate Change-Related Economic Development

### Policy Description

Successful state GHG mitigation efforts are highly dependent on active participation of the business community, particularly in the energy, agriculture, transportation, development, and manufacturing sectors. The intent of this policy is to encourage and facilitate the involvement of funding and investment sources, business interests, and entrepreneurs in pursuing business opportunities associated with GHG mitigation and global warming solutions as quickly and as significantly as possible. The creation of a clearinghouse-like entity may make it possible to match technology developers and other climate solution entrepreneurs with necessary financing more effectively and expeditiously. As a result, a state's ability to identify and secure early business opportunities associated with climate change may be enhanced, increasing its global competitive advantage and job creation within the state.

Potential funding sources include philanthropic organizations, high-net-worth individuals, or others interested in supporting innovative, environmentally effective market solutions. Recognizing that fortunes are likely to be made in the "new energy economy," for-profit investors, pension funds, mutual funds, and/or venture capitalists may be looking to fund similar business opportunities. Although technology entrepreneurs are often cited as offering potential global warming solutions, equally progressive solutions may lie in the fields of law, accounting, marketing, production, and government relations and lobbying. The objective of this policy recommendation is to leverage a state's specific talents for global warming solutions into securing the business opportunities and market advantages that well-supported "early-bird" efforts are likely to reap in a carbon-constrained world.

### Policy Design

In a continuing effort to reshape economic development in Arkansas, the recognized weaknesses in 20<sup>th</sup>-century models challenge new directions to incorporate broadened and dynamic global opportunities into the way state economies welcome sustainable and efficient production and creative activities that include reduced GHG levels. Accelerate Arkansas (<http://www.acceleratearkansas.com/>) has recently cited the importance of educational and community development to ensure effective economic development that grows beyond the dominance of conventional manufacturing recruitment.

#### Goals:

- Design a mechanism to evaluate and monitor programs, missions, and agencies responding to changing trends in economic development as linked with GHG mitigation, whenever possible.
- Conduct an in-depth analysis of the structure and organization of development activities by state government agencies, commissions, and other organizations, to encourage and transition the variety of state and local public, private, and nonprofit organizations into a structure that is in lock-step with necessary review processes and renewal cycles, enabling GHG mitigation and development renovations wherever possible.

- Consider economic development with greater emphasis on what works “sustainably” for Arkansas and regional communities to establish GHG mitigation as a means toward entrepreneurship and building a culture of continuous innovation and reconsideration.
- Leverage the state’s job creation and investment incentives into securing business and education opportunities that focus on improving economic development with GHG mitigation.
- Identify likely funding mechanisms and policy tools that not only provide economic development and recruitment stimulus for new industries and businesses that feature GHG mitigation actions, but also highlight benefiting infrastructure as it exists or is planned for Arkansas through implementing parties in support of renewable energy production.

**Timing:** Basic seed money should be allocated by the end of the 2009 legislative session.

**Parties Involved:** Arkansas Economic Developers, Arkansas Economic Development Commission,<sup>10</sup> Arkansas State Chamber of Commerce/Associated Industries of Arkansas, Accelerate Arkansas, Arkansas Development Finance Authority, Arkansas Science and Technology Authority, Arkansas Department of Workforce Education, the state’s University Centers for Business and Economic Research (e.g., University of Arkansas at Little Rock Small Business Development Center and Institute of Economic Advancement, University of Arkansas Fayetteville Center for Business and Economic Research, Arkansas State University Delta Center for Economic Development), Arkansas Assistance Procurement Center, University of Arkansas Cooperative Extension Service, Capital Access Arkansas, and the Office of State Procurement.

## Implementation Mechanisms

- Design and adapt a performance-based strategic management system such as a balanced scorecard.
- Incorporate metrics associated with predictions of GHG mitigation relationships that exist between ongoing actions and potential or targeted results.
  - Both design of those metrics and adaptation should be appropriately deduced or adjusted to improve accuracy, provide utility in decision making, and facilitate communication
    - Tracking could be charged to the Arkansas Climate Change Center
    - Standardized or benchmarked against performance across agencies, businesses, and communities
- Promote Arkansas’ use of a strategic management system in economic development through existing public relation efforts that promotes the state’s natural resources, such that value is publicized linking GHG mitigation (i.e., tourism, transportation, quality of life)
- Implement education and communication between policy makers and stakeholders as to importance to achieving economic indicators as they apply to:
  - Per capita income

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<sup>10</sup> See Arkansas Economic Development Commission Web site. Available at: <http://arkansasedc.com/>.

- Progress in Science, Technology, Engineering, and Mathematics (STEM) education
- Research and development funding levels
- Entrepreneurship
- Risk capital availability
- Total employment by industry sector and change in income
- Identify aspirant states or regional collaborations to survey and link with their strategic economic development whenever and wherever possible.
- Identify the champion for representation of GHG mitigation to the public
- Support a campaign of economic development linked to GHG mitigation at appropriate venues (trade shows, conferences, county fairs)
- To support economic development, Arkansas educational institutions should establish training programs to help provide a source of qualified persons to conduct energy audits and install efficiency recommendations and renewable energy systems for residential and commercial ratepayers.

### **Related Policies/Programs in Place**

Equity Investment Incentive Act of 2007, Advantage Arkansas (income tax credit), TrustArk (sales and use tax credit), Tax Back (sales and use tax refund), Create Rebate Program, ArkPlus (income tax credit).

### **Type(s) of GHG Reductions**

This recommendation is an enabling policy; it does not directly reduce GHG emissions by itself.

### **Estimated GHG Reductions and Costs or Cost Savings**

Not applicable.

### **Key Uncertainties**

Economic development related to climate change appears promising, that there will be "green" jobs that can not be readily exported, but there is uncertainty as to timing, location, and degree of those developing opportunities.

### **Additional Benefits and Costs**

New and emerging technologies in Arkansas, such as biotech crop research, is leading to climate-beneficial economic opportunities. Climate benefits of agricultural economies have been the subject of various research studies.<sup>11,12,13</sup>

<sup>11</sup> See Beach, R.H., B.J. DeAnjelo, S. Rose, C. Li, W. Salas, and S.J. DelGrosso. "Mitigation Potential and Costs for Global Agricultural Greenhouse Gas Emissions." *Agricultural Economics* 2008;38(2):109–115. Available at: [http://econpapers.repec.org/article/blaagecon/v\\_3A38\\_3Ay\\_3A2008\\_3Ai\\_3A2\\_3Ap\\_3A109-115.htm](http://econpapers.repec.org/article/blaagecon/v_3A38_3Ay_3A2008_3Ai_3A2_3Ap_3A109-115.htm).

<sup>12</sup> See G. Brookes and P. Barfoot. "Global Impact of Biotech Crops: Socio-Economic and Environmental Effects, 1996–2006." *AgBioForum* 2008;11(1):21-38. Available at: <http://www.agbioforum.org/v11n1/v11n1a03-brookes.pdf>.

### **Feasibility Issues**

Not applicable.

### **Status of Group Approval**

Complete.

### **Level of Group Support**

Unanimous.

### **Barriers to Consensus**

Not applicable.

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<sup>13</sup> See R. Pollin, H. Garrett-Peltier, J. Heintz, and H. Scharber. *Green Recovery: A Program to Create Jobs and Start Building a Low-Carbon Economy*. Center for American Progress. September 2008. Available from the Center for American Progress ([http://www.americanprogress.org/issues/2008/09/green\\_recovery.html](http://www.americanprogress.org/issues/2008/09/green_recovery.html)) and the University of Massachusetts Amherst Political Economy Research Institute (<http://www.peri.umass.edu/>).

## CC-11. Regulatory Realignment in Government To Encourage Constructive Climate Action

### Policy Description

State government agencies can lead by example in efforts to control GHG emissions by ensuring that their policies and regulations are climate-friendly. Each state agency should conduct a review of its policies and regulations to identify opportunities for realigning them to remove impediments to climate-friendly options. In addition, agencies should identify opportunities to utilize incentives to minimize the carbon footprint of state government as well as entities affected by state government regulations and policies (e.g., local governments and the private sector). Examples may include (but are not limited to) coordination and alignment between state agencies' policies and programs, reduced costs and/or time frames for greener permits, "performance-based" regulations, and reducing or eliminating "throughput incentives" so that regulated utilities are compensated for demand-side reductions, not just supply-side activities.

### Policy Design

Lead by example is one way to help spur activities that will ultimately decrease state agencies' GHG emissions. A multisector energy audit will help the state gain an understanding of where agencies currently stand on energy use, GHG emissions, and consumption. Once baseline data are collected, recommended goals should be set for reducing GHG emissions and increasing efficiency in state government. In addition, the Arkansas Climate Change Center should examine policies that block opportunities for reducing GHG emissions in Arkansas. In coordination with other programs being recommended by the GCGW, establishing a demand-side reduction credit could be initiated to encourage energy consumption reductions.

### Goals:

The state should amend the definition of "air contaminant" in Chapter 2 of the Arkansas Air Pollution Control Code (Regulation 18) to remove any barriers that prevent it from controlling CO<sub>2</sub> emissions.<sup>14</sup> This will enable Arkansas to mitigate CO<sub>2</sub>, as well as to effectively coordinate its GHG mitigation policies and programs with future regional and national policies and programs. The legislature and governor should coordinate with ADEQ in formulating an amendment to the definition of "air contaminant" to avoid regulating small sources of CO<sub>2</sub>.

The state should lead by example by implementing the following actions to mitigate its own GHG emissions:

- Examine state facilities and practices concerning GHG emissions.
- Conduct multisector energy audits of all state facilities.
- Set GHG reduction targets and standards for state government.

<sup>14</sup> See Arkansas Pollution Control and Ecology Commission. "Chapter 2: Definitions." In *Arkansas Air Pollution Control Code—Regulation 18* ([http://www.adeg.state.ar.us/regs/files/reg18\\_final\\_990215.pdf](http://www.adeg.state.ar.us/regs/files/reg18_final_990215.pdf)): "Air contaminant" means any solid, liquid, gas, or vapor or any combination thereof. The following shall not be considered air contaminants: water vapor, oxygen, carbon dioxide, nitrogen, hydrogen, and inert gases.

- Examine any policy barriers that are currently in place.
- Develop a process for tracking and reporting on annual progress.
- Establish demand-side reduction credits for regulated utilities.

**Timing:** Statewide program in place within 15 months of adoption.

**Parties Involved:** State agencies, research entities, Arkansas Climate Change Center, universities, NGOs.

## Implementation Mechanisms

### State Audits

*[Note: The following language is also included in RCI-3a (Reduced Energy Use in New and Retrofitted State-Owned Buildings) and RCI-3b (Reduced Energy Use in State-Owned Buildings).]*

Audits of energy use and associated GHG emissions by state agencies are vital for establishing baseline levels needed to set achievable goals for reducing emissions. It will be important to audit both state agency facilities and activities in order to fully assess and mitigate each agency's carbon footprint. It will also be important for state agencies to audit energy use and GHG emissions annually for tracking progress toward meeting GHG reduction goals. In so doing, the GCGW recommends that state agencies consider a phased approach by assessing energy use and associated emissions for state facilities and then for state activities.

- *State Facilities*—Since facilities are stable and stationary entities, protocols for auditing energy use and emissions should be fairly routine to implement annually, and would assist the agencies in developing experience that can be applied to assess energy use associated with their activities.
- *State Activities*—Development and implementation of protocols to assess energy use and emissions associated with state agency activities may be more difficult, because activities vary, depending on the mission of each agency, and are likely to change frequently, even within an agency. Nevertheless, an analysis of energy use and emissions associated with agency activities is necessary to develop plans to mitigate GHG emissions and demonstrate progress toward meeting GHG emission reduction goals.

In addition, the state should consider a phased approach, starting with the larger state government agencies first, to develop protocols and experience that can then be used to assist smaller agencies and the university system. Such an approach should be designed to leverage experience and assessment tools that can be used by other entities (e.g., school districts) to foster consistency in developing and implementing audit protocols on a routine basis.

The Arkansas Climate Change Center is charged with implementing this policy recommendation. Until the Climate Change Center is established, the state will decide on the appropriate lead agency or agencies for implementing this policy.

## Merchant Plants

In order for Arkansas to have more control over its GHG reduction, this policy recommends the removal of the 1999 exemption of Merchant Power Plants from the standard APSC process. Currently, Merchant Plants (Exempt Wholesale Generators (EWGs)) can build where ever they want as long as they meet the requirements of the ADEQ, U.S. Corps of Engineers (Wetlands), and EPA (Clean Air Act), which at present do nothing to address GHG emissions in the State. Unlike "rate-based" plants -- which put ratepayers at risk -- there is no requirement for merchant plants to substantiate that a public need exists for the electricity that they propose to generate and sell. This is because they are built with investors' money rather than ratepayers' money. This exemption from APSC oversight allows merchant plants to sell their power to anyone, anywhere. They can sell any or all their output to out-of-state entities, which means Arkansas experiences the brunt of any emissions consequences -- both of GHGs and unhealthy air pollutants -- but little to none of the energy benefit. Additionally, merchant plants tie up existing grid capacity that could otherwise be used to benefit Arkansas consumers, including development of renewable energy sources. This recommendation would remove the 1999 exemption. In addition, the legislature and governor should review and enact clarifying statutes governing environmental considerations for all power plants in Arkansas including ADEQ, APSC, and other state agencies. The legislature and governor should also review and consider removing incentives for merchant plants to locate in the state (e.g., Act 9 Bonds).<sup>15</sup>

### Related Policies/Programs in Place

None cited.

### Type(s) of GHG Reductions

This recommendation is an enabling policy; it does not directly reduce GHG emissions by itself.

### Estimated GHG Reductions and Costs or Cost Savings

Not applicable.

### Key Uncertainties

None cited.

### Additional Benefits and Costs

None cited.

### Feasibility Issues

Not applicable.

### Status of Group Approval

Complete.

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<sup>15</sup> Under Arkansas Act 9 of 1960, cities and counties are authorized to issue industrial revenue bonds (IRBs), commonly known as "Act 9 Bonds," to provide manufacturers with competitive financing. See the Arkansas Economic Development Commission's website for additional information, <http://arkansasedc.com/business-development/financing/industrial-revenue-bonds.aspx>.

## **Level of Group Support**

Super Majority (2 objections).

## **Barriers to Consensus**

One member objected because the Arkansas Pollution Control and Ecology Commission that has oversight over ADEQ had in fact already considered and unanimously rejected the suggestion that the state should amend the definition of “air contaminant” in Chapter 2 of the Arkansas Air Pollution Control Code (Regulation 18), and that the GCGW was overreaching in attempting to instruct that more narrowly focused Commission in how to perform their duties.

# Appendix G

## Residential, Commercial, and Industrial Sectors Policy Recommendations

### Summary List of Policy Recommendations

No.	Policy Recommendation	GHG Reductions (MMtCO <sub>2</sub> e)			Net Present Value 2009–2025 (Million \$)	Cost-Effectiveness (\$/tCO <sub>2</sub> e)	Level of Support
		2015	2025	Total 2009–2025			
RCI-1*	Improved Building Codes	0.2	0.6	5.3	–\$118	–\$22	Super Majority (1 objection)
RCI-2a*	Utility and Non-Utility DSM for Peak Use Electricity	0.01	0.02	0.21	–\$11	–\$52	Super Majority (1 objection)
RCI-2b*	Utility and Non-Utility DSM and Energy Efficiency for Electricity	1.1	4.1	30.5	–\$1,450	–\$48	Majority (7 objections)
RCI-3a*	Reduced Energy Use in New and Retrofitted State-Owned Buildings	0.1	0.6	4.3	–\$42	–\$10	Super Majority (1 objection)
RCI-3b*	Reduced Energy Use in State-Owned Buildings	0.2	0.4	4.2	–\$46	–\$11	Super Majority (1 objection)
RCI-4a*	Promotion and Incentives for Improved New Building Design and Construction	0.2	1.1	7.0	–\$160	–\$23	Super Majority (1 objection)
RCI-4b*	Promotion and Incentives for Improved Existing Buildings	0.0	0.3	1.7	–\$39	–\$23	Super Majority (1 objection)
RCI-5*	Education for Consumers, Industry Trades, and Professions	<i>Not Quantified</i>					Unanimous
RCI-6 <sup>†</sup>	Incentives and Funds To Promote Renewable Energy and Energy Efficiency	0.2	0.8	5.1	–\$118	–\$23	Super Majority (1 objection)
RCI-7*	Green Power Purchasing for Consumers	0.2	0.6	4.7	\$61	\$13	Unanimous
RCI-8*	Nonresidential Energy Efficiency	0.4	1.0	8.6	\$583	\$68	Unanimous
RCI-9 <sup>†</sup>	Support for Energy-Efficient Communities, Including Smart Growth	<i>Not Quantified</i>					Unanimous
RCI-10 <sup>†</sup>	Energy-Savings Sales Tax	0.0	0.1	0.7	–\$33	–\$47	Super Majority (1 objection)
	<b>Sector Total After Adjusting for Overlaps</b>	<b>2.55</b>	<b>9.24</b>	<b>69.77</b>	<b>–\$1,313.37</b>	<b>–\$18.82</b>	
	<b>Reductions From Recent Actions (ESIA Title II requirements for new appliances and lighting)</b>	<b>0.34</b>	<b>0.89</b>	<b>8.02</b>	<i>Not Quantified</i>		
	<b>Sector Total Plus Recent Actions</b>	<b>2.89</b>	<b>10.13</b>	<b>77.79</b>	<b>–\$1,313.37</b>	<b>–\$18.82</b>	

DSM = demand-side management; EISA = Energy Independence and Security Act of 2007; GHG = greenhouse gas; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; \$/tCO<sub>2</sub>e = dollars per metric ton of carbon dioxide equivalent.

Negative values in the Net Present Value and the Cost-Effectiveness columns represent net cost savings.

The numbering used to denote the above policy recommendations is for reference purposes only; it does not reflect prioritization among these important policy recommendations.

\* The GCGW approved this option at Meeting #9 (September 9, 2008); 18 members present and voting (one by phone).

<sup>†</sup> The GCGW approved this option at Meeting #10 (September 25, 2008); 21 members present and voting (none by phone).

## Overlap Discussion

The Governor's Commission on Global Warming (GCGW) and the Residential, Commercial, and Industrial (RCI) Technical Work Group (TWG) have developed 10 policy recommendations to reduce the emissions of greenhouse gases (GHGs) in the RCI sector. In addition to estimating the impacts of each individual policy recommendation, the combined impacts of the policy recommendations in each sector were estimated, assuming that all were implemented together. This involved eliminating any overlaps in coverage that would occur to avoid double counting of impacts. Also, some of the policy recommendations in one sector overlapped with those in another sector; therefore, these overlaps were identified, and the impact analysis was adjusted to eliminate double counting of impacts associated with these intersectoral overlaps. The following section identifies where these overlaps occurred and explains the methods used to adjust the impacts analysis to avoid double counting of impacts.

### Method for Analyzing RCI Cumulative Impacts

To assess the cumulative emission reductions for the policies in the RCI sector, it is necessary to consider any overlaps among the policies that affect similar types of energy use. Specifically, some policies (such as RCI-3) are defined by their goals for reducing energy use, while others (such as RCI-1 and RCI-2) are defined by addressing a specific type of energy use. In these cases, it is important to consider whether addressing the specific energy use would add to the overall reductions, or would just be subsumed into the more general reduction goal. To address this issue, policies were compared in terms of the type of energy use they target and the energy reduction strategies they implement. Overlaps were identified and quantified by sector (RCI or government/institutional), type of energy use targeted (water heating, space heating, etc.), and measure (e.g., solar hot water). If a policy's impact by sector and type of energy use was less than the impact from an overlapping policy for that same sector and type of energy use, it was excluded from the cumulative analysis.

*RCI-1 (Improved Building Codes)* doesn't overlap with RCI-2b, at least in theory, because RCI-2b either should be applied to existing demand or would be for energy efficiency improvements beyond new codes. There are no overlaps for this policy recommendation.

*RCI-2a (Utility and Non-Utility DSM for Peak Use Electricity)* quantifies the reduced use of electricity due to more rational pricing mechanisms, such as real-time pricing. Higher prices result in lower energy use overall. The quantification of this policy recommendation explicitly excludes conservation measures, such as high-efficiency air conditioners and chillers, which are included in RCI-1. This policy recommendation does not overlap with any other policy recommendations and is assumed to be additional to existing utility demand response measures.

*RCI-2b (Utility and Non-Utility DSM and Energy Efficiency for Electricity)* is the "headline" energy efficiency policy recommendation that potentially subsumes other policy recommendations.

*RCI-3a and RCI-3b (Reduced Energy Use in New and Retrofitted [3a] and Existing [3b] State-Owned Buildings)* typically show little overlap with utility programmatic investments and are additional to code improvements. These policy recommendations do not overlap with any other policy recommendations.

*RCI-4a and RCI-4b (Promotion and Incentives for Improved New [4a] and Existing [4b] Building Design and Construction)* are improvements “beyond code” only for new buildings and for major retrofits. These policy recommendations were quantified so that the energy efficiency measures deployed were additional to the more generation energy efficiency measures under RCI-2b. There are no overlaps for these policy recommendations.

*RCI-6 (Incentives and Funds To Promote Renewable Energy and Energy Efficiency)* provides additional energy efficiency funding and implementation mechanisms for low-income residential customers. Well-designed utility and non-utility energy efficiency/demand-side management programs will target these populations, but not at the level identified under this policy recommendation. RCI-6 is assumed to overlap 50% with RCI-2b.

*RCI-7 (Green Power Purchasing for Consumers)* voluntary purchasing programs in the residential sector do not overlap with other RCI policy recommendations, nor with Energy Supply (ES) policy recommendations, because green power purchasing is a voluntary, demand-side measure, in contrast to the regulatory, supply-side renewable portfolio standard promulgated under ES-3a and/or 3b. This policy recommendation is assumed to not overlap with any other ES policy recommendations. However, the biomass generation resulting from this recommendation partly overlaps with Agriculture, Forestry, and Waste management (AFW) policy recommendation AFW-4 (Expanded Use of Agriculture and Forestry Biomass Feedstocks for Electricity, Heat, or Steam Production), and is adjusted for this overlap in the AFW totals.

*RCI-8 (Nonresidential Energy Efficiency)* is a combined heat and power policy recommendation that is unique to the RCI sector and is not analyzed in the ES TWG. This recommendation is assumed not to overlap with any other ES policy recommendations. However, the biomass generation resulting from this policy recommendation partly overlaps with AFW-4 (Expanded Use of Agriculture and Forestry Biomass Feedstocks for Electricity, Heat, or Steam Production), and is adjusted for this overlap in the AFW totals.

*RCI-10 (Energy-Savings Sales Tax)* reduces prices for energy-efficient goods and increases the demand for these items that would have not occurred otherwise. There are no overlaps for this policy recommendation.

*Overlaps Between Sectors.* The electricity energy efficiency investments from the suite of RCI policy recommendations reduce electricity demand and thus make it possible to meet renewable energy mandates more cost-effectively. For example, under RCI-2b, electricity demand in 2025 is reduced by almost 9,600 gigawatt-hours (GWh) versus the reference case. ES-3a assumes a 15% renewable portfolio standard (RPS) by 2025, and with the implementation of RCI-2b would require 1440 GWh fewer of renewable resources to meet the target. Using the renewable energy cost assumptions for RCI-7, the reduced spending on higher-cost renewables in 2025 would result in savings of \$13 million in that year alone, and a net present value (NPV) of \$54 million from 2009 to 2025.

## RCI-1. Improved Building Codes

### Policy Description

This policy recommendation enforces existing building codes by strengthening and streamlining the building codes adoption and enforcement processes to increase energy efficiency (reduce energy consumption) for residential, commercial, and industrial buildings.

According to the U.S. Department of Energy (DOE), almost half of U.S. GHG emissions are associated with the construction and operation of buildings. Building energy codes specify minimum energy efficiency requirements for new buildings or for existing buildings undergoing a major renovation. Given the long lifetime of most buildings, enforcing existing state building codes will provide long-term GHG savings.

Also, the state can improve codes that are not limited to heating, ventilation, and air conditioning (HVAC) systems, including daylighting design to reduce lighting needs, electric lighting design, building envelope design, and integrated building design strategies.

In Arkansas, residential structures account for 60% of building energy use, with commercial structures accounting for the remaining 40%. In 2004, the residential sector accounted for 19% of Arkansas' total energy consumption, and the commercial sector accounted for 14%. Emphasis on enforcing residential codes holds a large potential for reducing GHG emissions.

### Policy Design

#### Goals:

- Expand statewide adoption and enforcement of existing building codes (nonquantifiable).
- Follow national codes without amendments in Arkansas, and update Arkansas codes in concert with the timing of the national codes.
- Achieve a 10% improvement in energy efficiency through educational programs for builders, building inspectors, and other building industry professionals to ensure that the existing codes are implemented and enforced.

#### Timing:

- Expand adoption and enforcement efforts of existing code requirements immediately.
- Coordinate adoption and enforcement initiatives with new code review cycles.

**Implementing Parties:** Building code officials, homeowners, building owners, builders, contractors, developers (new construction and existing buildings).

### Implementation Mechanisms

Consider updating Arkansas building energy codes through an administrative rulemaking process, rather than through legislative amendments.

## Related Policies/Programs in Place

- Arkansas Energy Code:
  - Residential—2003 International Energy Conservation Code (IECC), with Arkansas supplements and amendments to the 2003 IECC.
  - Commercial—2003 IECC (including ASHRAE/IESNA [American Society of Heating, Refrigerating and Air-Conditioning Engineers/Illuminating Engineering Society of North America] 90.1-2001), with Arkansas supplements and amendments to the 2003 IECC.
  - No set code review cycle.
  - Last effective date, October 1, 2004.
- National Energy Code:
  - Residential—2006 IECC.
  - Commercial—2006 IECC (including ASHRAE/IESNA 90.1-2001), with Arkansas supplements and amendments to the 2003 IECC.
  - 3-year code review cycle with yearly supplements.

Based on Arkansas Public Service Commission (APSC) data, statewide annual natural gas energy efficiency expenditures in 2008 are extrapolated to be \$4.6 million. Using the levelized cost assumptions in RCI-2b, gas existing actions are estimated to produce 1,200 billion British thermal units (BBtu) of reductions, which are subtracted from the total GWh reductions under RCI-1 and RCI-4a and RCI-4b equally each year through 2025.

## Type(s) of GHG Reductions

Carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), and nitrous oxide (N<sub>2</sub>O) emissions are reduced by avoided electricity generation from fossil fuel sources.

## Estimated GHG Reductions and Costs or Cost Savings

**Table G-1. Estimated GHG reductions and costs of or cost savings from RCI-1**

Quantification Factors	2015	2025	Units
GHG emission reductions	0.22	0.63	MMtCO <sub>2</sub> e
Net present value	-\$27.3	-\$117.6	\$ Million
Cumulative GHG reductions	0.89	5.30	MMtCO <sub>2</sub> e
Cost-effectiveness	-\$30.64	-\$22.18	\$/tCO <sub>2</sub> e

GHG = greenhouse gas; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; \$/tCO<sub>2</sub>e = dollars per metric ton of carbon dioxide equivalent.

Negative values in the Net Present Value and the Cost-Effectiveness rows represent net cost savings.

## Data Sources:

### A. Energy Consumption by Sector (Billions of British thermal units [BBtu])

Historical energy consumption in the state, by sector, is taken from the DOE Energy Information Administration (EIA) State Energy Data System, available at:

<http://www.eia.doe.gov/emeu/states/seds.html>. To calculate future projected energy consumption through 2030, growth factors were applied to the historical 2005 data. The growth factors are based on a combination of two parameters:

- *Growth Within the RCI Sectors*—Growth factors for the residential sector are based on projected population growth. Population figures are from the University of Arkansas Center for Business and Economic Research Population Projections for 2001 to 2004 (<http://cber.uark.edu/default.asp?show=population>), and the Time Series Extrapolations for 2005 to 2030 (<http://www.aiea.ualr.edu/research/demographic/population/default.html>). Growth in the commercial sector is based on nonmanufacturing employment growth projections, and industrial growth is based on manufacturing employment. Employment projections were taken from the Arkansas Department of Workforce Service's long-term industry employment projections (<http://www.discoverarkansas.net/?PageID=156>), with estimated 2004 employment and 2014 projected employment figures for the manufacturing and nonmanufacturing sectors.
- *Growth in Electricity Sales*—This factor was calculated based on historical retail sales from 1990 to 2005, obtained from the EIA Arkansas Electricity Profile, in gigawatt-hours (GWh), available from Table 8 at: [http://www.eia.doe.gov/cneaf/electricity/st\\_profiles/arkansas.html](http://www.eia.doe.gov/cneaf/electricity/st_profiles/arkansas.html).

### B. Baseline Power Station Electricity Generation (GWh) and Fuel Use (BBtu)

Gross generation for 2005 was obtained from the EIA databases (EIA-906 and EIA-920) on fuel stocks at all electric power sector generating facilities, broken down by fuel type ([http://www.eia.doe.gov/cneaf/electricity/page/eia906\\_920.html](http://www.eia.doe.gov/cneaf/electricity/page/eia906_920.html)). Data for later years were projected from the 2005 figure, based on projections of growth in generation for the Southwest Power Pool (SPP) region and the Southeastern Reliability Council (SERC) region. EIA assumes that Arkansas is located partly (85%) in the SERC region and partly (15%) in the SPP region. The projected regional consumption and generation data are from the EIA *Annual Energy Outlook 2008* (AEO2008) and can be accessed by downloading the “Electric Generation & Renewable Resource” file at <http://www.eia.doe.gov/oiaf/aeo/supplement/index.html>. On-site use was subtracted from all generation figures. The analysis is based on *consumption-based* generation, meaning it is based on the electricity sources that deliver electricity to consumers *in state*; therefore, the generation of electricity that is exported is not considered.

### C. Costs Associated With Electricity Generation

The costs in the United States to produce electricity using different types of technologies are from the EIA *Annual Energy Outlook 2007* (AEO2007), which used the EIA National Energy Modeling System. Capital costs and fixed and variable operations and maintenance costs are from Table 39 in the Electricity Market Module, available at: <http://www.eia.doe.gov/oiaf/archive/aeo07/assumption/index.html>. Prices for delivered fuel (in 2005\$/million [MM] Btu) are provided in the EIA Supplemental Tables to the AEO2007 by region, with projections through 2030. (Download “Consumption & Prices by Sector & Census

Division” at: <http://www.eia.doe.gov/oiaf/aeo/supplement/>; fuel prices by region begin with Table 11.) Transmission costs are added to the total as a constant \$80/kilowatt (kW).

## Quantification Methods

### *A. Heat Rates (Btu/kilowatt-hour [kWh])*

Heat rates indicate how much fuel is used (Btu) to generate a given amount of electricity (kWh). They vary greatly, depending on the type of power stations and the fuel used. Heat rates are used to convert figures for electricity into figures for fuel use, so the amount of fuel used can then be converted into GHG emissions using the appropriate GHG emission factors. Heat rates for 2005 for each type of generation and fuel were calculated from 2005 fuel use (in Btu) divided by 2005 generation (GWh). Projections for 2006 and beyond are based on annual combustion efficiency growth rates for the Mid-Atlantic Area Power Pool region. Combustion efficiency for a given year is calculated for each fuel type as the fuel use (in quadrillion Btu) divided by the electricity generated (in billion kWh), and the combustion efficiency growth rate applied to this value is based on the change in combustion efficiency from the previous year.

### *B. GHG Emissions Associated With End-Use Consumption (by Sector)*

Historical CO<sub>2</sub> data by sector (and further broken down by fuel type) were calculated by two U.S. Environmental Protection Agency (EPA) State Greenhouse Gas Inventory Tool (SIT) software modules: the Fossil Fuel Combustion Module and—for emissions from industrial sources—the SIT module for industry. CH<sub>4</sub> and N<sub>2</sub>O emissions were calculated by the Stationary Combustion Module and—for emissions from industrial sources—the SIT module for industry.

Projected emissions through 2030 were based on the 2005 data, with growth factors compounded from year to year, as discussed above in section A of the Data Sources section for energy consumption.

### *C. GHG Emissions Associated With Electricity Generation From Different Technologies and Fuels*

The projected data for each GHG were calculated for each fuel and generation type (e.g., non-lignite coal in a steam plant) as a direct product of the projected generation data (in GWh) described above in section B. Metric tons (t) of CO<sub>2</sub> are calculated from generation as:

$$\text{tCO}_2 = \text{GWh} * (\text{Btu/kWh}) * (\text{tCO}_2/\text{MMBtu}) * (\% \text{ of that fuel in the fuel mix})$$

where (Btu/kWh) is the heat rate and (tCO<sub>2</sub>/MMBtu) is the CO<sub>2</sub> emission factor. The calculation is similar for CH<sub>4</sub> and N<sub>2</sub>O, which are then converted to CO<sub>2</sub> equivalents (CO<sub>2</sub>e) using global warming potentials of 21 for CH<sub>4</sub> and 310 for N<sub>2</sub>O. The emission factors used for each GHG were the same as those used in the EPA SIT software modules.

## Key Assumptions:

- The rate at which cash flows are discounted is 5%.
- NPV is calculated in 2005 dollars.
- The NPV base year is 2009.

- Transmission and distribution (T&D) losses are 8.1%.<sup>1</sup>
- Manufactured housing is not included in the building code improvement quantification.
- Renovated commercial space is 30% of new building construction. Renovated residential space does not fall under code improvements.
- The new building construction rate is 1.3%/year for the residential sector,<sup>2</sup> and 2.0%/year for the commercial sector.<sup>3</sup>
- The 2008 avoided delivered electricity cost (\$2005) is \$58.28/megawatt-hour (MWh) The 2008 avoided peak delivered electricity cost is estimated at \$74.02/MWh.<sup>4</sup> The 2008 avoided natural gas cost (\$2005) is \$7.28/MMBtu.<sup>5</sup>
- The levelized capital cost of electricity energy efficiency (\$2005) is \$34.10/MWh.<sup>6</sup> This includes utility fixed costs of marketing, evaluation, and administration, which add an estimated 24% to the capital costs listed in Quantec et al. (2008).<sup>7</sup> This figure represents the total utility and participant costs that are typically figured into a total resource cost measure.
- The levelized cost of natural gas efficiency (\$2005) is \$5.10/MMBtu.<sup>8</sup> This includes utility fixed costs of marketing, evaluation, and administration, which add 24% to capital costs. This figure represents the total utility and participant costs that are typically figured into a total resource cost measure.
- T&D electricity losses are estimated at 8.1%, which is an average of 2005 and 2006 estimated losses/retail sales.<sup>9</sup>
- To estimate emission reductions from policy recommendations that are expected to displace conventional grid-supplied electricity (i.e., energy efficiency), a simple, straightforward approach is proposed. Through 2012, we assume that these policy recommendations would

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<sup>1</sup> U.S. Department of Energy, Energy Information Administration. State Electricity Profiles 2006. Data for Arkansas. Available at: [http://www.eia.doe.gov/cneaf/electricity/st\\_profiles/arkansas.html](http://www.eia.doe.gov/cneaf/electricity/st_profiles/arkansas.html).

<sup>2</sup> Based on U.S. Census Bureau data for new housing starts in Arkansas in 2005. Available at: <http://www.census.gov/const/C40/Table2/t2yu200512.txt>.

<sup>3</sup> Forecasted annual change in commercial floor space of 2.0% in West South Central, from AEO2005 output files. (Not available online.)

<sup>4</sup> Entergy Arkansas, Inc. Docket No. 81-071-F. Public Utility Regulatory Policies Act - Section 210. Filed on June 30, 2008. Available at: [http://www.apscservices.info/pdf/81/81-071-f\\_319\\_1.pdf](http://www.apscservices.info/pdf/81/81-071-f_319_1.pdf). The avoided cost is the average of all periods. The avoided peak cost is the average of summer and winter peaks.

<sup>5</sup> U.S. Department of Energy, Energy Information Administration. "Natural Gas Prices." January 2008 Arkansas City Gate Price. Available at: [http://tonto.eia.doe.gov/dnav/ng/ng\\_pri\\_sum\\_dcu\\_SAR\\_m.htm](http://tonto.eia.doe.gov/dnav/ng/ng_pri_sum_dcu_SAR_m.htm).

<sup>6</sup> Quantec LLC, Summit Blue Consulting, Nextant, Inc., A-TEC Energy Corporation, and Britt/Makela Group. *Assessment of Energy and Capacity Savings Potential in Iowa: Final Report*, vol. I. Prepared for the Iowa Utility Association. February 2008. (Not available online.)

<sup>7</sup> Ibid.

<sup>8</sup> Ibid.

<sup>9</sup> U.S. Department of Energy, Energy Information Administration. "Arkansas Electricity Profile." DOE/EIA-0348. 2006. Available at: [http://www.eia.doe.gov/cneaf/electricity/st\\_profiles/arkansas.html](http://www.eia.doe.gov/cneaf/electricity/st_profiles/arkansas.html).

displace generation from a “marginal” mix of fuel-based electricity sources comprised of 50% coal and 50% gas. This would equate to an emissions intensity of approximately 0.70 MMtCO<sub>2</sub>e/MWh through 2012. (We assume that sources without significant fuel costs would not be displaced, e.g., generation of nuclear, hydro, or other renewable resources). The Hempstead coal plant is expected to come on line during this period. However, beginning in 2013, the policy recommendations are assumed to avoid a mix of new fossil fuel-based capacity additions for the balance of the planning period. The thermal new-build mix following 2012 is estimated to be 100% natural gas combined-cycle plants. This would equate to an emissions intensity of approximately 0.43 MMtCO<sub>2</sub>e/MWh from 2013 to 2025.

### **Key Uncertainties**

None identified.

### **Additional Benefits and Costs**

The quantification of costs and benefits of energy efficiency only includes technologies that are currently commercialized. New technologies, such as building-integrated solar photovoltaic (PV) panels, LED (light-emitting diode) lighting, etc., that might lead to additional CO<sub>2</sub> reductions at a reduced cost, are not included in the cost analysis.

### **Feasibility Issues**

None identified.

### **Status of Group Approval**

Complete.

### **Level of Group Support**

Super Majority (1 objection).

### **Barriers to Consensus**

One member does not believe this policy recommendation will result in net cost savings.

## RCI-2a. Utility and Non-Utility DSM for Peak-Use Electricity

### Policy Description

Demand-side management (DSM) is a policy approach that requires actions that influence both the quantity and the patterns of energy consumed by end users. This policy recommendation focuses on increasing investment in electricity DSM programs. The goals may be accomplished through programs run by utilities or others, energy efficiency funds, and/or energy efficiency measures. These strategies are typically termed DSM activities, and may be designed to work in tandem with other strategies that can also encourage efficiency gains.

Natural gas utilities have experienced declines in sales to consumers over the last 10 years. As a result, the RCI TWG has decided that it is not necessary to impose a state goal for utilizing DSM programs to reduce consumption of natural gas. However, the APSC envisions increased direct natural gas use, and carbon pricing and other national market factors may also increase gas use in the future. While promoting direct natural gas use where it accomplishes energy efficiency and climate change goals, Arkansas should take advantage of any additional opportunities to promote increased efficiency in the use of natural gas.

GHGs from peak electricity DSM can be reduced from two sources. The first is the reduction of absolute levels of energy use by consumers due to higher prices. Real-time pricing and smart metering give consumers information about their energy use that enables them to better rationalize their use. Time-of-use pricing or other schemes to reflect rational pricing that result in price increases during peak periods potentially reduce demand by the estimated price elasticity of demand, typically by  $-0.20\%$  to  $-0.50\%$  (U.S. EIA, 2003), so that a 10% increase in prices would lead to a 2%–5% reduction in demand. In a survey of experience with smart metering, Owen and Ward (2006) find energy savings of 0%–10%. Peak avoided costs in 2008 are an average of 74% higher than nonpeak avoided costs, so the demand reductions could be larger, but this price differential would limit voluntary adoption of the program without regulatory encouragement.

In Arkansas, the avoided cost of peak electricity is 74% higher than nonpeak electricity. Using a  $-0.20\%$  elasticity, this would result in a 15% reduction in demand if the full price were passed on to customers. However, given uncertainty about the percentage price increase passed along to the customer (that it will not reflect the full peak cost), and issues about voluntary adoption, the program is phased in over time, and demand reductions are statically estimated at 5% for the customers who receive the peak demand measures. For this reason, the statewide reductions from the program are modest. The costs savings from the program result from assuming that the cost of the demand reduction measures is less than the avoided cost of electricity.

The other source of GHG reductions from policies to reduce peak demand is energy efficiency measures that reduce demand during peak periods, such as high-efficiency air conditioners and chillers. Included in the existing DSM measures in RCI-2b, these measures also reduce new generation capacity investments, a factor that is not quantified for GHG reductions. The GHG impacts of other types of rate structures are more difficult to quantify. Curtailment programs that

allow loads to be shifted during peak periods might result in different emission profiles as these loads move from peak to shoulder or baseload periods. Overall CO<sub>2</sub> savings from these programs are also difficult to quantify. (This element of this policy recommendation is not quantified.)

## Policy Design

**Goals:** Implement energy efficiency programs and DSM to reduce growth in electric peak demand by 5% per year by 2010 and by 10% per year by 2015. Energy efficiency gains remain constant from 2015 through 2025.

**Timing:** See above.

**Implementing Parties:** All electric utilities (public and private), municipal electric systems, electric cooperatives, regulators, and customers (all sectors).

## Implementation Mechanisms

Statewide expansion of energy efficiency programs.

## Related Policies/Programs in Place

There are currently no regulatory requirements for municipally owned electric systems and electric cooperatives to offer energy efficiency programs to their customers, although this could change in the next several years.

The current rate design for electric and gas utilities links a significant amount of the utilities' revenues to the amount of electricity or natural gas sold. Consequently, the utilities' revenues may be reduced with the introduction of energy efficiency programs, conservation programs, and DSM programs that reduce the amount of electricity or natural gas sold. To encourage the utilities to offer and promote these programs, the APSC should adopt rate designs and cost recovery mechanisms that are necessary and in the public interest, to decouple the recovery of the utilities' revenues from the amount of electricity or natural gas sold. Further, the APSC should identify appropriate incentives that are necessary and in the public interest, to further encourage the utilities to offer energy efficiency, conservation, and DSM programs.

**Energy Efficiency and Conservation Programs in Arkansas**—Ark. Code Ann. §§23-3-401 *et seq.* authorizes the APSC to develop energy efficiency and conservation programs to address high energy costs. The statute was passed in 1977 during the previous energy crisis. During the 2005 session, the Arkansas General Assembly passed Act 1939, which asked the Commission to report on any actions taken or planned pursuant to Ark. Code Ann. §§23-3-401 *et seq.*

The initial programs are “quick-start” programs offered by the utilities during the initial period of the APSC’s rules. The total cost of the initial quick-start programs is approximately \$18,530,924 for the initial 2-year period ending December 31, 2009. The total cost of all of the energy efficiency and conservation programs is approximately \$0.08–\$0.46 per month for an average residential electric or gas customer. (See

[http://www.apscservices.info/rules/energy\\_conservation\\_rules\\_06-004-R.pdf](http://www.apscservices.info/rules/energy_conservation_rules_06-004-R.pdf).)

**Net Metering Service**—Another service offering is net metering service. Pursuant to Ark. Code Ann. 23-18-601 *et seq.*, the APSC adopted net metering rules. (See [http://www.apscservices.info/rules/net\\_metering\\_rules.pdf](http://www.apscservices.info/rules/net_metering_rules.pdf).) Net metering permits customers to provide all or part of their monthly electricity needs through generating facilities powered by renewable resources. The maximum size is 25 kW for residential customers and 300 kW for other customers. Customers are able to offset their usage and receive a credit for any excess generation delivered to the electric utility during a 12-month period.

### Type(s) of GHG Reductions

CO<sub>2</sub>, CH<sub>4</sub>, and N<sub>2</sub>O emissions are reduced by avoided electricity generation from fossil fuel sources.

### Estimated GHG Reductions and Costs or Cost Savings

**Table G-2. Estimated GHG reductions and costs of or cost savings from RCI-2a**

Quantification Factors	2015	2025	Units
GHG emission reductions	0.01	0.02	MMtCO <sub>2</sub> e
Net present value	-\$3.9	-\$11.1	\$ Million
Cumulative GHG reductions	0.06	0.21	MMtCO <sub>2</sub> e
Cost-effectiveness	-\$69.71	-\$52.20	\$/tCO <sub>2</sub> e

GHG = greenhouse gas; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; \$/tCO<sub>2</sub>e = dollars per metric ton of carbon dioxide equivalent.

Negative values in the Net Present Value and the Cost-Effectiveness rows represent net cost savings.

**Data Sources:** See RCI-1.

- Gill Owen and Judith Ward. *Smart Meters: Commercial, Regulatory and Policy Drivers*. Appendix 2. Sustainability First. March 2006. Available at: <http://www.sustainabilityfirst.org.uk/docs/smartmeterspdfappendices.pdf>.
- U.S. Department of Energy, Energy Information Administration. "Price Responsiveness in the AEO2003 NEMS Residential and Commercial Buildings Sector Models." 2003. Available at: <http://www.eia.doe.gov/oiaf/analysispaper/elasticity/>.

**Quantification Methods:** See RCI-1.

### Key Assumptions:

- Demand response measures reduce the growth in peak electricity demand by the program targets 5% in 2010 and 10% in 2015. This number is consistent with the survey in Owen and Ward (2006), which finds that energy savings from smart meters vary from 0% to 10%. This is similar to what price elasticity of demand would predict. If peak price tariffs are 10%–20% higher than nonpeak tariffs, then demand reductions would range from 2.5% to 10% using price elasticities of –0.20% to –0.5% (EIA, 2003).

- Incremental (new) demand response for new peak electricity savings end in 2015 at 10% (plus avoided T&D), but the program delivers this savings level through 2025.
- Residential, commercial, and industrial customers all implement the program at the same rate.
- For levelized costs of energy efficiency measures and avoided costs of energy, see RCI-1.
- Peak load hours are 44% of total hours.
- T&D losses are estimated at 8.1%.
- Peak DSM displaces 100% natural gas generation (TWG assumption).
- CO<sub>2</sub> reductions and electricity savings from investments in measures to reduce peak demand, such as high-efficiency air conditioners and chillers, are not quantified under this policy recommendation, as they are included in RCI-2b.

### **Key Uncertainties**

None identified.

### **Additional Benefits and Costs**

T&D losses are typically greater during peak hours than during nonpeak hours. This analysis uses average T&D losses, so emission reductions might be modestly understated.

The quantification of costs and benefits of energy efficiency only includes technologies that are currently commercialized. New technologies, such as building-integrated solar PV panels, LED lighting, etc., that might lead to additional CO<sub>2</sub> reductions at a reduced cost, are not included in the cost analysis.

### **Feasibility Issues**

None identified.

### **Status of Group Approval**

Complete.

### **Level of Group Support**

Super Majority (1 objection).

### **Barriers to Consensus**

One member does not believe this policy recommendation will result in net cost savings.

## RCI-2b. Utility and Non-Utility DSM and Energy Efficiency for Electricity

### Policy Description

DSM is a policy approach that requires actions that influence both the quantity and the patterns of energy consumed by end users. This policy recommendation focuses on increasing investment in electricity DSM programs. The goals may be accomplished through programs run by utilities or others, energy efficiency funds, and/or energy efficiency goals. These strategies are typically termed DSM activities, and may be designed to work in tandem with other strategies that can also encourage efficiency gains.

Natural gas utilities have experienced declines in sales to consumers over the last 10 years. For this reason, the TWG has decided that it is not necessary to impose a state goal for utilizing DSM programs to reduce consumption of natural gas. However, the APSC envisions increased direct natural gas use, and carbon pricing and other national market factors may increase gas use in the future as well. While promoting direct natural gas use where it accomplishes energy efficiency and climate change goals, Arkansas should take advantage of any additional opportunities to promote increased efficiency in the use of natural gas.

### Policy Design

#### Goals:

- Implement an aggressive goal for energy efficiency and other DSM programs that eliminates electric utility demand growth over a realistic phase-in period. At this time and for the GCGW's purposes, average electricity demand growth is projected to be 1.4% through 2030. Therefore, energy efficiency and DSM programs that deliver demand reductions of 1.4% of total sales (based on a prior 3-year running average) would be phased in through 2015. Thereafter, energy efficiency and DSM programs delivering demand reductions equal to 1.4% of total electricity sales would be continued, unless a comprehensive assessment of potential efficiency gains in Arkansas and best practices nationwide indicates that greater gains are possible.
- Implement energy efficiency programs and DSM to reduce growth in total electricity demand so that annual electricity load growth is equal to 0% by 2015, when all new electricity use is met with DSM and energy efficiency investments.

**Timing:** Interim targets are to be linear reductions of projected load growth beginning in 2010. Approximately 16% of load growth will be met in each year with new energy efficiency investments during 2010–2015: 16% in 2010, 32% in 2011, 48% in 2012, 64% in 2013, 80% in 2014, and 100% by 2015.

**Implementing Parties:** All electric utilities (public and private), municipal electric systems, electric cooperatives, regulators, and customers (all sectors).

## Implementation Mechanisms

In 2009, Arkansas should engage expert assistance in providing an in-depth, comprehensive, state-specific energy efficiency analysis that outlines the potential to cost-effectively meet future energy utility demand through efficiency, DSM, and renewable energy (Maryland and Florida recently made such analyses the basis for energy policy planning). That in-depth study should quantify, among other things, the climate change emission reductions below baseline that would result from achieving that potential, and should become a basis for DSM program implementation.

For utilities subject to the authority of the APSC, the APSC should review any allocations that are subsidies coming from ratepayers and ensure that there is not inappropriate cross-subsidization between classes of consumers. For utilities (e.g., municipal utilities) that are not subject to the authority of the APSC, the governing body for the utility should review any allocations that are subsidies coming from ratepayers and ensure that there is not inappropriate cross-subsidization between classes of consumers.

## Related Policies/Programs in Place

The current rate design for electric and gas utilities links a significant amount of the utilities' revenues to the amount of electricity or natural gas sold. Consequently, the utilities' revenues may be reduced with the introduction of energy efficiency, conservation, and DSM programs that reduce the amount of electricity or natural gas sold. To encourage the utilities to offer and promote these programs, the APSC should adopt rate designs and cost recovery mechanisms that are necessary and in the public interest, to decouple the recovery of the utilities' revenues from the amount of electricity or natural gas sold. Further, the APSC should identify appropriate incentives that are necessary and in the public interest, to further encourage the utilities to offer energy efficiency, conservation, and DSM programs.

There are currently no regulatory requirements for municipally owned electric systems and electric cooperatives to offer energy efficiency programs to their customers, although this could change in the next several years.

### **Off-Peak and Interruptible Electric Service Rate Schedules and Demand Response**

**Programs**—In addition to the specific programs listed above, all of the electric utilities offer a variety of rate schedules to encourage commercial and industrial customers to avoid or reduce electricity usage at peak periods. The rate schedules offer discounts for the use of electricity at off-peak periods and penalties for use at peak periods. Additionally, customers can choose to take interruptible service, which permits the utility to interrupt those customers at peak periods and provides those customers with discounted rates for the electricity consumed. The electric utilities also offer time-of-use rates for commercial and industrial customers.

### **Electric Cooperative Energy Efficiency and Conservation Programs and Demand Response**

**Programs**—In addition to the energy efficiency and conservation programs introduced in response to the APSC's rules, the electric cooperatives of Arkansas offer a number of programs, including customer education efforts through the *Rural Arkansas* magazine, Web page information, the Doug Rye radio program, articles by Doug Rye, and educational materials for schools in the cooperatives' service territory. The cooperatives offer some home weatherization services for customers in their territory; various appliance programs, including heating and air

conditioning equipment and water heaters; direct load control of irrigation equipment and air conditioning equipment; and extensive interruptible service offerings, off-peak service offerings, and other rate schedules.

**Oklahoma Gas and Electric Company Energy Audit Program**—This program has a cost of approximately \$119,250. It provides residential energy audits that identify potential energy savings associated with installing weatherization improvements and replacing or upgrading heating and air conditioning equipment with more energy-efficient equipment. Customers will be provided a report and recommendations based upon the audit to improve the efficiency of their electricity use.

**Entergy Arkansas, Inc., Home Energy Solutions Program**—This program has a cost of approximately \$1,415,000 over the 2-year period ending December 31, 2009. It provides a variety of offerings to residential customers to promote the use of energy-efficient appliances and heating and air conditioning equipment. The program provides coupons of up to \$250 per customer for the purchase of ENERGY STAR appliances, heating and air equipment, and windows, and up to \$200 per customer to pay for tune-ups of heating and air conditioning systems to improve their operating efficiency.

**Decoupling Mechanisms**—In the recent rate cases for Arkansas Western Gas Company, Arkansas Oklahoma Gas Corporation, and CenterPoint Energy Arkla, the APSC approved mechanisms to ensure that the utilities do not suffer a loss in revenues due to declines in usage. These mechanisms address the declining usage per customer that the gas utilities have confronted. An additional benefit is that the mechanisms should enable the gas utilities to implement energy efficiency and conservation programs without negatively affecting revenues. The mechanisms were approved by the APSC as experimental or pilot programs for a number of years.

**Oklahoma Gas and Electric Company Commercial Lighting Replacement Program**—This program has a cost of approximately \$122,362. It provides coupons to assist commercial customers in replacing inefficient lighting systems with more energy-efficient lighting systems.

**Oklahoma Gas and Electric Company Electric Motor Replacement Program**—This program has a cost of approximately \$145,350. It provides education to commercial and industrial customers about the benefits of more efficient electric motors, and up to \$170 toward the replacement of each 25-horsepower motor.

**Compact Fluorescent Light Bulb Replacement Program**—This program is offered by Entergy Arkansas, Inc., Oklahoma Gas and Electric Company, and Southwestern Electric Power Company. Intended to promote the use of compact fluorescent light bulbs (CFLs), the program provides coupons of \$1–\$4 to apply toward the purchase of CFLs. The energy savings from a single CFL will most likely outweigh the cost of the entire energy efficiency and conservation program for an average residential customer. The cost of the program is approximately \$820,000.

Based on APSC data, statewide annual electricity energy efficiency expenditures in 2008 are extrapolated to be \$4.6 million. Using the levelized costs assumptions in RCI-2b, electricity existing actions are estimated to produce 181 GWh of reductions, which are subtracted from the

total GWh reductions under RCI-2b each year through 2025. CO<sub>2</sub> reductions are estimated using TWG assumptions in RCI-1.

### Type(s) of GHG Reductions

CO<sub>2</sub>, CH<sub>4</sub>, and N<sub>2</sub>O emissions are reduced by avoided electricity generation from fossil fuel sources.

### Estimated GHG Reductions and Costs or Cost Savings

**Table G-3. Estimated GHG reductions and costs of or cost savings from RCI-2b**

Quantification Factors	2015	2025	Units
GHG emission reductions	1.06	4.15	MMtCO <sub>2</sub> e
Net present value	-\$140.4	-\$1,450.1	\$ Million
Cumulative GHG reductions	1.06	30.45	MMtCO <sub>2</sub> e
Cost-effectiveness	-\$47.99	-\$47.62	\$/tCO <sub>2</sub> e

GHG = greenhouse gas; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; \$/tCO<sub>2</sub>e = dollars per metric ton of carbon dioxide equivalent.

Negative values in the Net Present Value and the Cost-Effectiveness rows represent net cost savings.

**Data Sources:** See RCI-1.

**Quantification Methods:** See RCI-1.

#### Key Assumptions:

- For levelized costs of energy efficiency measures and avoided costs of energy, see RCI-1.
- T&D losses are estimated at 8.1%.

### Key Uncertainties

The quantification of costs and benefits of energy efficiency only includes technologies that are currently commercialized. New technologies, such as building-integrated solar PV panels, LED lighting, etc., which might lead to additional CO<sub>2</sub> reductions at a reduced cost, are not included in the cost analysis.

### Additional Benefits and Costs

Maintenance and operating costs should be considered in the life-cycle cost accounting of high efficiency buildings.

### Feasibility Issues

None identified.

### Status of Group Approval

Complete.

### **Level of Group Support**

Majority (7 objections).

### **Barriers to Consensus**

One member does not believe this policy recommendation will result in net cost savings. Other members were concerned about the long-term feasibility of the energy efficiency goals.

## RCI-3a. Reduced Energy Use in New and Retrofitted State-Owned Buildings: Government “Lead by Example”

### Policy Description

Government-led, or “lead by example,” initiatives help state and local governments achieve substantial energy cost savings, while promoting the adoption of clean energy technologies for significant GHG emission reductions in new and existing state and local government buildings. The proposed policy provides energy efficiency targets that are much higher than code standards. This policy recommendation sets energy efficiency goals for new construction and major renovations.

### Policy Design

#### Goals:

- Require that all new state buildings (buildings that utilize a minimum of 20% of state funds), developments, and major renovations be designed to meet a fossil fuel, GHG-emitting, energy consumption performance standard of 50% less energy use than the ASHRAE 90.1-2004 energy standard. Special-use facilities, such as state laboratories, can receive an exemption from this rule, as determined by the Arkansas Energy Office (AEO).
- Increase the fossil fuel reduction standard for all new buildings to:
  - 60% reduction in 2012,
  - 70% in 2017,
  - 80% in 2020,
  - 90% in 2025, and
  - Carbon-neutral in 2030 (using no GHG-emitting energy to operate).
- For verification of energy efficiency performance, require state-funded buildings to be certified by the Leadership in Energy and Environmental Design™ (LEED) certification standards.
  - Buildings can also be verified through Green Globes for New Construction (with independent third-party verification), or other similarly stringent, national, third-party-verified green building certification system.

**Timing:** Beginning in 2009.

**Implementing Parties:** State government agencies, local governments, schools, and universities.

### Implementation Mechanisms

The state should include full life-cycle cost accounting for all its procurement. ENERGY STAR-rated appliances are to be a minimum acceptable level of energy efficiency for procurement where applicable.

*New Buildings:*

- State building procurement regulations that include energy requirements for the respective year.
- Database of new building performance that includes pertinent building metrics (energy savings, GHG emission reductions, operational savings, return on investment).

*Major Renovations:*

- Implementation of energy conservation measures to reduce energy use within state-funded buildings.
- A retained savings policy, whereby agencies can retain funds saved by improving energy efficiency to additional energy efficiency investments.

*Certification System:*

- AEO can determine which certification systems would be appropriate for energy efficiency validation.

**Related Policies/Programs in Place**

**Natural Gas Commercial and Industrial Energy Audits**—The Natural Gas Commercial and Industrial Energy Audits program provides energy audits conducted by a qualified third-party vendor to commercial and industrial customers of the natural gas distribution utilities in Arkansas. The program has a total cost of approximately \$351,000. It includes an audit of the building envelope and of all end-use natural gas equipment, which identifies potential energy savings associated with installing weatherization improvements and replacing or upgrading equipment with more energy-efficient equipment. Customers are provided a report and recommendations based upon the audit to improve the efficiency of their natural gas energy use.

**Type(s) of GHG Reductions**

CO<sub>2</sub>, CH<sub>4</sub>, and N<sub>2</sub>O emissions are reduced by avoided electricity generation from fossil fuel sources.

**Estimated GHG Reductions and Costs or Cost Savings**

**Table G-4. Estimated GHG reductions and costs of or cost savings from RCI-3a**

Quantification Factors	2015	2025	Units
GHG emission reductions	0.10	0.63	MMtCO <sub>2</sub> e
Net present value	-\$12.5	-\$41.6	\$ Million
Cumulative GHG reductions	0.37	4.31	MMtCO <sub>2</sub> e
Cost-effectiveness	-\$33.55	-\$9.65	\$/tCO <sub>2</sub> e

GHG = greenhouse gas; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; \$/tCO<sub>2</sub>e = dollars per metric ton of carbon dioxide equivalent.

Negative values in the Net Present Value and the Cost-Effectiveness rows represent net cost savings.

**Data Sources:** See RCI-1.

**Key Assumptions:**

- For levelized costs of energy efficiency measures and avoided costs of energy, see RCI-1.
- 90% of new and retrofitted buildings comply with the policy; the remaining 10% that don't comply are 20% less energy efficient than the policy calls for.
- The state begins to purchase renewable energy for the fossil fuel reduction targets when all energy efficiency gains are assumed to be made, which is estimated at a 70% reduction from current efficiency levels.
- The growth rate for new government buildings is 2% per year, which is the growth rate in new commercial buildings.
- For every square foot of new government buildings, 30% of equivalent square footage is retrofitted each year.

**Quantification Methods:** See RCI-1.

**Key Uncertainties**

None identified.

**Additional Benefits and Costs**

Maintenance and operation costs should be considered in life-cycle cost accounting for high-efficiency buildings.

The quantification of costs and benefits of energy efficiency only includes technologies that are currently commercialized. New technologies, such as building-integrated solar PV panels, LED lighting, etc., that might lead to additional CO<sub>2</sub> reductions at a reduced cost, are not included in the cost analysis.

**Feasibility Issues**

None identified.

**Status of Group Approval**

Complete.

**Level of Group Support**

Super Majority (1 objection).

**Barriers to Consensus**

One member does not believe this policy recommendation will result in net cost savings.

## RCI-3b. Reduced Energy Use in Existing State-Owned Buildings: Government “Lead by Example”

### Policy Description

Government-led, or “lead by example,” initiatives help state and local governments achieve substantial energy cost savings, while promoting the adoption of clean energy technologies for significant GHG emission reductions in existing state and local government buildings. The proposed policy provides energy efficiency targets for existing buildings that are much higher than code standards.

The Arkansas state government is a significant consumer of energy. The state owns or leases approximately 29.45 million square feet of building space, and pre-K through 12 schools account for an additional 85 million square feet. Additional local government buildings are not in this inventory, such as courthouses, city halls, and other facilities.

Arkansas’ public school buildings are in need of approximately \$1.6 trillion of repairs and improvements that “Impact Functioning of School, i.e., Mechanical, Electrical, HVAC.” These needs are opportunities for installing more energy-efficient equipment.<sup>10</sup>

### Policy Design

- **Goals:** Set a state goal to reduce by 2030, from a 2009 baseline, a minimum of 30% of electricity consumed by existing state and local facilities, schools, and universities. Require that 20% of the square footage of the existing state building stock (buildings that utilize a minimum of 20% of state funds) achieve 7 points (approximately 30% energy savings) per the full requirements of the LEED for Existing Buildings, Energy and Atmosphere Credit 1 by 2012. A similarly stringent, third-party-verified green building certification system for commercial buildings may also be used.
- Require the total square footage of buildings that meet the efficiency standard for existing buildings to be increased as follows:
  - 40% in 2014,
  - 60% in 2016,
  - 80% in 2018, and
  - 100% in 2020. By this date, the entire state existing building stock will have received efficiency investments to reach the 30% improvement target.
- Adjust the improvement targets and execute programs to achieve additional savings in 2020–2030.

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<sup>10</sup> Task Force to Joint Committee on Educational Facilities. *Arkansas Statewide Educational Facilities Assessment—2004. Final Report to the Joint Committee on Educational Facilities.* November 30, 2004, p. 20. Available at: <http://www.arkleg.state.ar.us/data/education/statereport.pdf>.

- Create a program to audit energy use, with a goal of at least 20% of all buildings being audited annually, and require state and local governments to submit annual energy plans to the state.
- Set a statewide goal that by 2025, a minimum of 15% of energy consumed by state and local government buildings will come from renewable in-state energy sources. This policy will allow the state to “lead by design,” and will create an established market for green power generators.

**Timing:** Beginning in 2010.

**Implementing Parties:** State government agencies, local governments, schools, and universities.

### Implementation Mechanisms

- Establish a Sustainability Coordinator function that will define the current performance of existing building stock, set priorities, and define energy efficiency programs. Utilize LEED or a similarly stringent rating system to verify and certify performance.
- Implement a retained savings policy, whereby agencies can retain a portion of funds saved by improving energy efficiency and apply them to additional energy efficiency investments.

#### *State Audits*

Audits of energy use and associated GHG emissions by state agencies are vital for establishing baseline levels needed to set achievable goals for reducing emissions. It will be important to audit both state agency facilities and activities in order to fully assess and mitigate each agency’s carbon footprint. It will also be important for state agencies to audit energy use and GHG emissions annually for tracking progress toward meeting GHG reduction goals. In so doing, the GCGW recommends that state agencies consider a phased approach by assessing energy use and associated emissions first for state facilities and then for state activities.

- *State Facilities*—Since facilities are stable and stationary entities, protocols for auditing energy use and emissions should be fairly routine to implement annually and would assist the agencies in developing experience that can be applied to assess energy use associated with their activities.
- *State Activities*—Development and implementation of protocols to assess energy and interior and exterior water use and emissions associated with state agency activities may be more difficult, because activities vary depending on the mission of each agency, and are likely to change frequently, even within an agency. Nevertheless, an analysis of energy use and emissions associated with agency activities is necessary to develop plans to mitigate GHG emissions and demonstrate progress toward meeting GHG emission reduction goals.

In addition, the state should consider a phased approach, starting with the larger state government agencies first, to develop protocols and experience that can then be used to assist smaller agencies and the university system. Such an approach should be designed to leverage experience and assessment tools that can be used by other entities (e.g., school districts) to foster consistency in developing and implementing audit protocols on a routine basis.

## Related Policies/Programs in Place

The existing Sustainable Building Design Practices Legislative Task Force is addressing issues associated with high-performance buildings.

## Type(s) of GHG Reductions

CO<sub>2</sub>, CH<sub>4</sub>, and N<sub>2</sub>O emissions are reduced by avoided electricity generation from fossil fuel sources.

## Estimated GHG Reductions and Costs or Cost Savings

**Table G-5. Estimated GHG reductions and costs of or cost savings from RCI-3b**

Quantification Factors	2015	2025	Units
GHG emission reductions	0.19	0.44	MMtCO <sub>2</sub> e
Net present value	-\$11.0	-\$46.3	\$ Million
Cumulative GHG reductions	0.70	4.21	MMtCO <sub>2</sub> e
Cost-effectiveness	-\$15.61	-\$11.00	\$/tCO <sub>2</sub> e

GHG = greenhouse gas; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; \$/tCO<sub>2</sub>e = dollars per metric ton of carbon dioxide equivalent.

Negative values in the Net Present Value and the Cost-Effectiveness rows represent net cost savings.

**Data Sources:** See RCI-1.

**Quantification Methods:** See RCI-1.

### Key Assumptions:

- For levelized costs of energy efficiency measures and avoided costs of energy, see RCI-1
- Arkansas state and local governments occupy 15.6% of commercial floor space in the state.
- All government buildings are commercial buildings.
- Renewable energy consisting of 80% wind and 20% biomass meets 25% of government electricity consumption in 2025.
- The state begins to purchase renewable energy for the fossil fuel reduction targets when all energy efficiency gains are assumed to be made, which is estimated at a 70% reduction from current efficiency levels.
- 90% of retrofitted buildings comply with the policy; the remaining 10% that don't comply are 20% less energy efficient than the policy calls for.

## Key Uncertainties

None identified.

### **Additional Benefits and Costs**

The quantification of costs and benefits of energy efficiency only includes technologies that are currently commercialized. New technologies, such as building-integrated solar PV panels, LED lighting, etc., that might lead to additional CO<sub>2</sub> reductions at a reduced cost, are not included in the cost analysis.

### **Feasibility Issues**

None identified.

### **Status of Group Approval**

Complete.

### **Level of Group Support**

Super Majority (1 objection).

### **Barriers to Consensus**

One member does not believe this policy recommendation will result in net cost savings.

## RCI-4a. Promotion and Incentives for Improved New Building Design and Construction

### Policy Description

Almost half of all GHG emissions in the United States are associated with residential, commercial, and industrial buildings and the energy associated with building materials. Improving the energy efficiency design and construction of buildings will have an immediate and ongoing impact on GHG reduction.

This policy provides incentives and targets to induce the owners and developers of new buildings to improve the efficiency with which energy and other resources are used in those buildings, along with provisions for raising targets periodically and providing resources to building industry professionals to help achieve the desired building performance. This policy can include elements to encourage the improvement and review of energy use goals over time, and to encourage flexibility in contracting arrangements to encourage integrated energy- and resource-efficient design, construction, and renovation. Incentives could include low-cost loans for investments in energy efficiency, tax credits, and feebates. The use of third-party rating systems will reduce the requirement for significant oversight and enforcement by state organizations.

### Policy Design

#### Goals:

- Provide tiered incentives for energy efficiency in new buildings that achieve at least a 20% reduction in energy use relative to the ASHRAE 90.1-2004 energy standard for commercial buildings, and the 2004 Arkansas Energy Code for residential buildings through certification in one of the following rating systems:
  - LEED (New Construction, Core & Shell, Commercial Interiors, Homes, or other appropriate version),
  - Green Globes New Construction, or
  - Similarly stringent, third-party-verified green building certification system for commercial or residential buildings.
- Make the incentives for this program commensurate with the energy efficiency threshold achieved. Tier the thresholds as follows:
  - 20%
  - 25%
  - 30%
  - 30% and above
- Increase the benchmark minimum efficiency standard for existing buildings as follows:
  - 20% in 2014
  - 25% in 2016
  - 30% in 2018

- 35% in 2020
- Require participating organizations or individuals to provide feedback on the costs and actual performance of energy efficiency improvements, and annual GHG reduction levels in new construction as compared to the Arkansas Energy Code.

**Timing:** Develop legislation in 2009; make incentives available in 2010; begin compliance in 2011.

**Implementing Parties:** All builders, building material suppliers, recycled building material sellers, and home improvement stores.

### Implementation Mechanisms

- A reference guide for defining the appropriate rating systems and verification requirements;
- Initial building audits of energy performance and operations of state buildings to define initial priorities;
- Low-cost loans for improving energy efficiency in residential buildings, including a weatherization program;
- A retained savings policy, whereby agencies can retain funds saved by improving energy efficiency and apply them to additional energy efficiency investments;
- Low-interest loans to fund energy efficiency retrofits for commercial and industrial buildings;
- Tax credits for energy-efficient residential, commercial, and industrial buildings; and
- A feebate program that allows for a self-funded financial mechanism.

### Related Policies/Programs in Place

Based on APSC data, statewide annual natural gas energy efficiency expenditures in 2008 are extrapolated to be \$4.6 million. Using the levelized cost assumptions in RCI-2b, gas existing actions are estimated to produce 1200 BBtu of reductions, which are subtracted from the total GWh reductions under RCI-1 and RCI-4a and RCI-4b equally each year through 2025.

### Type(s) of GHG Reductions

CO<sub>2</sub>, CH<sub>4</sub>, and N<sub>2</sub>O emissions are reduced by avoided electricity generation from fossil fuel sources.

## Estimated GHG Reductions and Costs or Cost Savings

**Table G-6. Estimated GHG reductions and costs of or cost savings from RCI-4a**

Quantification Factors	2015	2025	Units
GHG Emission reductions	0.21	1.06	MMtCO <sub>2</sub> e
Net present value	-\$21.8	-\$160.1	\$ Million
Cumulative GHG reductions	0.64	7.00	MMtCO <sub>2</sub> e
Cost-effectiveness	-\$33.88	-\$22.87	\$/tCO <sub>2</sub> e

GHG = greenhouse gas; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; \$/tCO<sub>2</sub>e = dollars per metric ton of carbon dioxide equivalent.

Negative values in the Net Present Value and the Cost-Effectiveness rows represent net cost savings.

**Data Sources:** See RCI-1.

**Quantification Methods:** See RCI-1.

### Key Assumptions:

- Baseline electricity use by sector that falls under RCI-4a (GWh):
  - Residential sector—51% (all end uses except refrigerators and 50% of appliances and lighting);<sup>11</sup>
  - Commercial sector—74% (all end uses except office equipment); and<sup>12</sup>
  - Industrial sector—14% (used for HVAC, lighting, and "other facility support," including natural gas used in the South Census region).<sup>13</sup>
- New building construction rate/year:
  - Residential sector—1.3%;<sup>14</sup>
  - Commercial sector—2.0%; and<sup>15</sup>
  - Industrial sector—0.4%.<sup>16</sup>

<sup>11</sup> U.S. Department of Energy, Energy Information Administration. "Residential Energy Consumption Survey 2001 Consumption and Expenditure Data Tables." Available at: <http://www.eia.doe.gov/emeu/recs/recs2001/detailcetbls.html> - space.

<sup>12</sup> U.S. Department of Energy, Energy Information Administration. "2003 Commercial Buildings Energy Consumption Survey Detailed Tables." Table C1: Total Energy Consumption by Major Fuel for Non-Mall Buildings. December 2006. Available at: [http://www.eia.doe.gov/emeu/cbecs/cbecs2003/detailed\\_tables\\_2003/detailed\\_tables\\_2003.html](http://www.eia.doe.gov/emeu/cbecs/cbecs2003/detailed_tables_2003/detailed_tables_2003.html) - consumexpen03.

<sup>13</sup> U.S. Department of Energy, Energy Information Administration. (2001). "2002 Manufacturing Energy Consumption Survey." Table 5.8: End Uses of Fuel Consumption, 2002. Form EIA-846. Available at: [http://www.eia.doe.gov/emeu/mecs/mecs2002/data02/pdf/table5.8\\_02.pdf](http://www.eia.doe.gov/emeu/mecs/mecs2002/data02/pdf/table5.8_02.pdf).

<sup>14</sup> U.S. Census Bureau. Table 2u: New Privately Owned Housing Units Authorized Unadjusted Units for Regions, Divisions, and States. December 2005. Available at: <http://www.census.gov/const/C40/Table2/t2yu200512.txt>.

<sup>15</sup> Forecasted annual change in commercial floor space of 2.0% in West South Central from AEO2005 output files.

- Estimated based on relative use of electricity and gas by sector (ratio of electricity savings to gas savings: BBtu/GWh):
  - Residential sector—101.4%;<sup>17</sup>
  - Commercial sector—63.5%; and<sup>18</sup>
  - Industrial sector—82.0%.<sup>19</sup>
- For levelized costs of energy efficiency measures and avoided costs of energy, see RCI-1.
- 90% of new buildings comply with the policy; the remaining 10% that don't comply are 20% less energy efficient than the policy calls for.

## Key Uncertainties

None identified.

## Additional Benefits and Costs

Wood products contain much less embodied energy than other building materials and, unlike other building materials, function as long-term sequesters of carbon. Additionally, wood products sourced locally have more energy and carbon advantages compared to products transported from distant sources. For example, a lumber-framed wall or floor system requires just 40% of the fossil fuel energy needed to manufacture a concrete wall or floor system and only 20% of the fossil fuel energy need to manufacture a steel wall or floor.<sup>20</sup>

The quantification of costs and benefits of energy efficiency only includes technologies that are currently commercialized. New technologies, such as building-integrated solar PV panels, LED lighting, etc., that might lead to additional CO<sub>2</sub> reductions at a reduced cost, are not included in the cost analysis.

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<sup>16</sup> Forecasted annual change in industrial electricity consumption from the Arkansas inventory and forecast, reduced by 25% for improvements in energy intensity per square foot (estimate).

<sup>17</sup> Based on the ratio of natural gas fuel use to site electricity use for residential buildings in Arkansas' climate zone. Source: U.S. Department of Energy, Energy Information Administration. "2001 Residential Energy Consumption Survey: Household Energy Consumption and Expenditures Tables." Table CE1-1c: Total Energy Consumption in U.S. Households by Climate Zone. Available at: [http://www.eia.doe.gov/emeu/recs/recs2001/ce\\_pdf/enduse/ce1-1c\\_climate2001.pdf](http://www.eia.doe.gov/emeu/recs/recs2001/ce_pdf/enduse/ce1-1c_climate2001.pdf).

<sup>18</sup> Based on the ratio of natural gas fuel use to site electricity use for commercial buildings nationwide. Source: U.S. Department of Energy, Energy Information Administration. "2003 Commercial Buildings Energy Consumption Survey Detailed Tables." Available at: [http://www.eia.doe.gov/emeu/cbecs/cbecs2003/detailed\\_tables\\_2003/detailed\\_tables\\_2003.html - consumexpen03](http://www.eia.doe.gov/emeu/cbecs/cbecs2003/detailed_tables_2003/detailed_tables_2003.html - consumexpen03).

<sup>19</sup> Gas facility support divided by electricity facility support (in BBtu) in the South Census region. Source: U.S. Department of Energy, Energy Information Administration. "2002 Energy Consumption by Manufacturers—Data Tables." Table 5.7: Energy Consumed as a Fuel by End Use—By Region With Total Consumption of Electricity. March 8, 2005. Available at: <http://www.eia.doe.gov/emeu/mecs/mecs2002/data02/shelltables.html>.

<sup>20</sup> J. Boyer, S. Bratkovich, A. Lindburg, and K. Fernholz. *Wood Products and Carbon Protocols: Carbon Storage and Low Energy Intensity Should Be Considered*. Dovetail Partners, Inc. April 28, 2008. Available at: <http://www.dovetailinc.org/reportView.php?action=displayReport&reportID=92>.

Operation and maintenance costs should be considered in life-cycle cost accounting for high-efficiency buildings.

### **Feasibility Issues**

None identified.

### **Status of Group Approval**

Complete.

### **Level of Group Support**

Super Majority (1 objection).

### **Barriers to Consensus**

One member does not believe this policy recommendation will result in net cost savings.

## RCI-4b. Promotion and Incentives for Improved Existing Building Design and Construction

### Policy Description

Almost half of all GHG emissions in the United States are associated with residential, commercial, and industrial buildings and the energy associated with building materials. Improving the energy efficiency design of buildings will have an immediate and ongoing impact on GHG reduction.

This policy provides incentives and targets to induce the owners and developers of existing buildings to improve the efficiency with which energy and other resources are used in those buildings, along with provisions for raising targets periodically and providing resources to building industry professionals to help achieve the desired building performance. This policy can include elements to encourage the improvement and review of energy use goals over time, and to encourage flexibility in contracting arrangements to promote integrated energy- and resource-efficient design, energy demand reduction, and practices that maintain optimal energy use. Incentives could include low-cost loans for investments in energy efficiency, tax credits, and feebates.

### Policy Design

#### Goals:

- Measure the performance of energy efficiency improvements in existing buildings against a regional average of similar building types.
- Provide tiered incentives for energy efficiency in existing buildings that achieve at least a 15% reduction in energy use versus the regional average for similar buildings through certification in one of the following rating systems:
  - LEED for Existing Buildings or
  - Similarly stringent, third-party-verified green building certification system for commercial or residential buildings.
- Make the incentives for this program commensurate with the energy efficiency threshold achieved. Tier the thresholds as follows:
  - 15%
  - 20%
  - 25%
  - 30% and above
- Increase the benchmark minimum efficiency standard for existing buildings as follows:
  - 20% in 2014
  - 25% in 2016
  - 30% in 2018
  - 35% in 2020

- Require participating organizations or individuals to provide feedback on the costs and actual performance of energy efficiency improvements, and annual GHG reduction levels in new construction against the benchmark.
- Offer low-cost loans or incentives to consumers for weatherization programs, including weatherstripping and insulation improvements.

**Timing:** Develop legislation in 2009; make incentive measures available in 2010; begin program in 2011.

**Implementing Parties:** All builders, building material suppliers, recycled building material sellers, and home improvement stores. The aforementioned should be considered for both private and public construction projects.

### Implementation Mechanisms

LEED, or equivalent rating system, will be used to define the benchmark and actual energy savings achieved. Relevant implementation mechanisms may include:

- Retro-commissioning of existing buildings;
- Audits of energy performance and operations by state and other government buildings;
- Implementation of design features to reduce energy use within state-funded buildings, through incorporation of proven planning guides and regulations;
- Financial and technical assistance for implementation of energy-saving programs in existing buildings, and a requirement that all state-owned buildings implement an energy management program;
- Low-interest loans to fund energy efficiency retrofits for commercial and industrial buildings; and
- Tax credits for energy-efficient RCI buildings. Funding for education programs could come from a variety of sources, including professional associations, matching grants from federal agencies, regional market energy efficiency organizations, and energy efficiency from utilities and non-utilities, among others.

### Related Policies/Programs in Place

**Oklahoma Gas and Electric Company Energy Audit Program**—This program has a cost of approximately \$119,250. It provides residential energy audits that identify potential energy savings associated with installing weatherization improvements and replacing or upgrading heating and air conditioning equipment with more energy-efficient equipment. Customers are provided a report and recommendations based upon the audit to improve the efficiency of their electricity use.

Based on APSC data, statewide annual natural gas energy efficiency expenditures in 2008 are extrapolated to be \$4.6 million. Using the levelized cost assumptions in RCI-2b, gas existing actions are estimated to produce 1200 BBtu of reductions, which are subtracted from the total GWh reductions under RCI-1 and RCI-4a and RCI-4b equally each year through 2025.

## Type(s) of GHG Reductions

CO<sub>2</sub>, CH<sub>4</sub>, and N<sub>2</sub>O emissions are reduced by avoided electricity generation from fossil fuel sources.

## Estimated GHG Reductions and Costs or Cost Savings

**Table G-7. Estimated GHG reductions and costs of or cost savings from RCI-4b**

Quantification Factors	2015	2025	Units
GHG emission reductions	0.05	0.27	MMtCO <sub>2</sub> e
Net present value	-\$5.3	-\$39.0	\$ Million
Cumulative GHG reductions	0.16	1.72	MMtCO <sub>2</sub> e
Cost-effectiveness	-\$34.06	-\$22.66	\$/tCO <sub>2</sub> e

GHG = greenhouse gas; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; \$/tCO<sub>2</sub>e = dollars per metric ton of carbon dioxide equivalent.

Negative values in the Net Present Value and the Cost-Effectiveness rows represent net cost savings.

**Data Sources:** See RCI-1.

**Quantification Methods:** See RCI-1.

### Key Assumptions:

- For levelized costs of energy efficiency measures and avoided costs of energy, see RCI-1.
- 90% of retrofitted buildings comply with the policy; the remaining 10% that don't comply are 20% less energy efficient than the policy calls for.
- This policy only applies to major retrofits (major renovations, i.e., "down to the studs") of existing buildings.
- The rate of major retrofits is assumed to be 30% of the following new building construction rates/year:
  - Residential sector—1.3%;
  - Commercial sector—2.0%; and
  - Industrial sector—0.4%.
- Baseline electricity use by sector that falls under RCI-4b (GWh):
  - Residential sector—51% (all end uses, except refrigerators, and 50% of appliances and lighting);
  - Commercial sector—74% (all end uses, except office equipment); and
  - Industrial sector—14% (used for HVAC, lighting, and "other facility support," including natural gas used for the South Census region).
- Estimated based on relative usage of electricity and gas by sector. Ratio of electricity savings to gas savings (BBtu/GWh):

- Residential sector—101.4%;
- Commercial sector—63.5%; and
- Industrial sector—82.0%.

### **Key Uncertainties**

None identified.

### **Additional Benefits and Costs**

Wood products contain much less embodied energy than other building materials and, unlike other building materials, function as long-term sequesters of carbon. Additionally, wood products sourced locally have more energy and carbon advantages compared to products transported from distant sources. For example, a lumber-framed wall or floor system requires just 40% of the fossil fuel energy needed to manufacture a concrete wall or floor system and only 20% of the fossil fuel energy need to manufacture a steel wall or floor.<sup>21</sup>

The quantification of costs and benefits of energy efficiency only includes technologies that are currently commercialized. New technologies, such as building-integrated solar PV panels, LED lighting, etc., that might lead to additional CO<sub>2</sub> reductions at a reduced cost, are not included in the cost analysis. Operation and maintenance costs should be considered in life-cycle cost accounting for high-efficiency buildings.

### **Feasibility Issues**

None identified.

### **Status of Group Approval**

Complete.

### **Level of Group Support**

Super Majority (1 objection).

### **Barriers to Consensus**

One member does not believe this policy recommendation will result in net cost savings.

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<sup>21</sup> J. Boyer, S. Bratkovich, A. Lindburg, and K. Fernholz. *Wood Products and Carbon Protocols: Carbon Storage and Low Energy Intensity Should Be Considered*. Dovetail Partners, Inc. April 28, 2008. Available at: <http://www.dovetailinc.org/reportView.php?action=displayReport&reportID=92>.

## RCI-5. Education for Consumers, Industry Trades, and Professions

### Policy Description

Education under this policy recommendation falls under two broad categories:

- Consumer awareness education on how consumers can reduce GHG emissions, and
- Technical education for builders and contractors on the specific methods they can incorporate to reduce GHG emissions at every stage of construction.

The ultimate effectiveness of emission reduction activities in many cases depends on providing information and education to consumers regarding the energy and GHG emission implications of their choices. Public education and outreach is vital to fostering a broad awareness of climate change issues and effects (including co-benefits, such as clean air and public health) among the state's citizens. Such awareness is necessary to engage citizens in actions to reduce GHG emissions in their personal and professional lives.

This policy recommendation also addresses education and outreach programs for building professionals to encourage incorporation of energy efficiency and GHG emission reduction considerations, such as programs to train builders and contractors.

Education and training should also be made available to builders and contractors and others for retrofitting existing buildings.

### Policy Design

**Goals:** Develop consumer and technical/professional education courses and outreach programs for GHG emission reductions to increase the number of professionals trained in energy efficiency.

**Timing:** By 2010, put the education/training recommendation in place and begin outreach programs.

**Implementing Parties:** Consumers, retailers, manufacturers, technicians, and professionals in building and related trades, code enforcement agencies, trade schools, community colleges, universities, Arkansas Department of Higher Education.

Issues related to Arkansas K-12 public schools are addressed in Cross-Cutting Issues policy recommendation CC-6 (State Climate Public Education and Outreach).

### Implementation Mechanisms

Funding for education programs could come from a variety of sources, including professional associations, matching grants from federal agencies, regional market energy efficiency organizations, and energy efficiency surcharges paid by energy customers or from utilities and non-utilities, among others.

## Related Policies/Programs in Place

**Energy Efficiency Arkansas Education Program**—This program is a component of a larger group of energy efficiency and conservation programs offered by the electric and gas utilities in Arkansas. It is intended to help Arkansas utility customers identify opportunities to engage in energy efficiency and conservation practices. The program has an overall cost of \$2.4 million, or approximately \$0.01–\$0.04 per month for an average residential electric or gas customer.

**Natural Gas Customer Education Programs**—CenterPoint Energy Arkla, Arkansas Western Gas Company, and Arkansas Oklahoma Gas Corporation will each provide additional company-specific customer education messages. The cost of the program is approximately \$409,636. The messages will be designed to support the statewide education program and direct customers to energy efficiency and conservation opportunities specific to each company.

## Type(s) of GHG Reductions

CO<sub>2</sub>, CH<sub>4</sub>, and N<sub>2</sub>O emissions are reduced by avoided electricity generation from fossil fuel sources.

## Estimated GHG Reductions and Costs or Cost Savings

Not quantifiable.

**Data Sources:** Not applicable.

**Quantification Methods:** Not quantifiable.

**Key Assumptions:** Not applicable.

## Key Uncertainties

None identified.

## Additional Benefits and Costs

None identified.

## Feasibility Issues

None identified.

## Status of Group Approval

Complete.

## Level of Group Support

Unanimous.

## Barriers to Consensus

Not applicable.

## RCI-6. Incentives and Funds To Promote Renewable Energy and Energy Efficiency

### Policy Description

This policy recommendation refers to financial mechanisms for energy efficiency that could increase program participation and investment by providing incentives to a variety of customer classes to improve the energy performance of buildings, equipment, and residences. These incentives could be targeted to residential customers, small businesses, and low-income consumers, as well as to other customer classes, including larger businesses and the industrial sector.

A public benefits charge (sometimes called a systems benefits charge) is a fee attributed to utility customers based on their use of energy in a given time period. With deregulation in many states, the public utility commissions often lost the ability to require electric utilities to implement efficiency programs. The result in many states was the development of the public benefits charge, which is a non-bypassable charge on electric bills. The funds collected are then provided to a third party to provide energy efficiency programming, or can support implementation of a revolving-loan payment, establishment of a micro-loan program, and tax incentives. Energy audits should be included to aid in assessing needs and tracking progress toward improvement.

At least 33% of Arkansas' population has an income of less than \$30,000/year, of which 20%–30% is spent on utility bills. There are currently not enough weatherization or energy conservation programs in place to reduce the economic burden on this population or to have a scalable impact on mitigating the GHG emissions produced by these homes. Providing traditional financing options for low-income homeowners will not meet their needs or achieve any meaningful scale.

The need exists for identifying these homeowners; educating them about, and the opportunity for, energy audits; and financing the implementation of energy-efficient measures with a shared savings approach.

There would be multiple benefits to develop an employer-driven, local economic impact initiative that reaches out to employees (scalable), connecting them to trained energy auditors (provided by public benefit funds), and to create a Program-Related Investment (PRI) fund (revolving energy fund) to finance moderate energy efficiency measures for employees (builds employee retention and adds benefits). The resulting energy savings would be split between the employee's monthly payroll deduction (paid into the PRI) and the employee, manifested in the lower utility bill. Employers would be provided the incentive to create the PRI with either a state tax credit or the right to "bank" or capture the aggregated annual CO<sub>2</sub> savings from their employees.

Manufactured (mobile) homes account for approximately 27% of residential structures in Arkansas. Mobile homes and temporary dwellings (hunting camps, boat houses) are exempt from compliance with the Arkansas Energy Code and fall under U.S. Department of Housing and

Urban Development (HUD) regulation. These homes are factory-made and can more easily implement efficiency improvements. ENERGY STAR has a program for energy-efficient manufactured homes.

In Schweitzer et al.'s (2003) review of 20 major energy audits, the audits accounted for less than 4% of program spending on conservation, yet resulted in an estimated 18% of cost and energy savings. Audits are one of the lowest-cost conservation measures available to utilities and non-utility programs and form a core element of DSM programs.

## Policy Design

### Goals:

#### *Low-Income Pilot Program*

- Fund a Low-Income Pilot Program in rural Arkansas counties that targets weatherization of the counties' low-income population, working with the local economic development office, Arkansas community action agencies, industries, and manufacturers.
- Beginning year one of the program, double the estimated 1,200 homes a year that are currently receiving weatherization assistance to 2,400 homes. Each year for the next 5 years, increase the number of homes receiving weatherization, until by 2015 10,000 homes are being retrofitted annually. At the 10,000 homes per year weatherization rate in 2015, by 2025 138,000 homes would be weatherized, which is 78% of 2008 eligible units (assumes no new, eligible, low-income residences over the 2010–2025 period).
- Ultimately, target 90% of the low-income homeowner population (approximately 178,000 residences in 2008) who are eligible for federal weatherization assistance.
- Expand available funding per residence from the current level (approximately \$2,800) to be able to upgrade major appliances, such as furnaces.
- Target energy efficiency improvements of 33% per upgraded residence.
- Increase these targets annually until the low-income target is achieved, and then target weatherization in homes that are above the federal weatherization eligibility level.

#### *New Manufactured Housing*

- Require that the incentive program for manufactured housing purchased in or shipped to Arkansas be ENERGY STAR-qualified or have other equivalent energy-efficient, third-party certification.
- Ensure that these units are at least 30% more energy efficient than comparable available manufactured housing.
- Through the incentives, increase the penetration of energy-efficient manufactured housing to 75% of new manufactured housing sales by 2025.

#### *Other*

- Add a minimum of 75–100 new certified auditors, which are green collar jobs.

- Expand energy audit programs for all sectors, and increase them annually until 100% saturation is achieved.

### **Timing:**

#### *Low-Income Pilot Program*

- 2009–10—Launch a Low-Income Pilot Program in select rural counties through public-private partnerships.
- 2009–10—Build the state's capacity of certified energy auditors/raters; identify and prequalify subcontractors statewide.
- July 2010—Fund a program manager and adequate staff to begin statewide implementation of the goal 2,400 homes.
- 2010 and beyond—Increase funding to meet annual targets.

#### *Manufactured Homes*

- Begin in 2010 an incentive program for ENERGY STAR-Qualified Manufactured Housing or other equivalent efficient third-party certification.

#### *Other*

- Expand energy audit programs by 2010. Make the annual increase 10% of the audited stock.

**Implementing Parties:** Commercial and industrial energy users in the private and public sectors (including those responsible for mixed-use projects), nongovernmental organizations, public agencies, utilities, building design and construction professionals, lenders, the Arkansas Chapter of the U.S. Green Building Council.

### **Implementation Mechanisms**

Offer low-cost loans or incentives to consumers for weatherization programs, including weatherstripping and insulation improvements. These could include “weatherization kits” like those being offered to low-income residents in Chicago to improve their building energy efficiency and reduce energy expenditures.

### **Related Policies/Programs in Place**

**Energy Efficiency, Conservation, and DSM Programs**—The current rate design for electric and gas utilities links a significant amount of the utilities' revenues to the amount of electricity or natural gas sold. Consequently, the utilities' revenues may be reduced with the introduction of energy efficiency, conservation, and DSM programs that reduce the amount of electricity or natural gas sold. To encourage the utilities to offer and promote these programs, the APSC should adopt rate designs and cost recovery mechanisms that are necessary and in the public interest, to decouple the recovery of the utilities' revenues from the amount of electricity or natural gas sold. Further, the APSC should identify appropriate incentives that are necessary and in the public interest, to further encourage the utilities to offer energy efficiency, conservation, and DSM programs.

## Federal Weatherization Program

**HUD Code for Manufactured Homes**—HUD 1976 Federal Manufactured Home Construction and Safety Standards Acts, commonly known as the "HUD Code."

## ENERGY STAR-Qualified Manufactured Homes

**Arkansas Weatherization Program**—This program has an approximate cost of \$4,369,266. The program is modeled after the existing U.S. Department of Energy weatherization assistance program that is currently administered by the Arkansas Department of Human Services and the Arkansas Community Action Agencies. The program, which targets the most energy-inefficient homes, is designed to provide weatherization assistance for approximately 2,500 homes over the initial 2-year period ending December 31, 2009. Approved measures include attic insulation, floor insulation, wall insulation, duct insulation, duct sealing, window sealing, window replacement, furnace and air conditioner tune-up and replacement, lighting, and smart thermostats. The program pays up to 50% of the cost of a home energy audit and up to 50% of the cost of weatherization measures up to a maximum of \$1,500 per home.

### Type(s) of GHG Reductions

CO<sub>2</sub>, CH<sub>4</sub>, and N<sub>2</sub>O emissions are reduced by avoided electricity generation from fossil fuel sources.

### Estimated GHG Reductions and Costs or Cost Savings

**Table G-8. Estimated GHG reductions and costs of or cost savings from RCI-6**

Quantification Factors	2015	2025	Units
GHG emission reductions	0.15	0.78	MMtCO <sub>2</sub> e
Net present value	-\$15.4	-\$117.6	\$ Million
Cumulative GHG reductions	0.46	5.13	MMtCO <sub>2</sub> e
Cost-effectiveness	-\$33.62	-\$22.93	\$/tCO <sub>2</sub> e

GHG = greenhouse gas; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; \$/tCO<sub>2</sub>e = dollars per metric ton of carbon dioxide equivalent.

Negative values in the Net Present Value and the Cost-Effectiveness rows represent net cost savings.

**Data Sources:** See RCI-1.

- U.S. Department of Energy, Energy Information Administration. "2001 Residential Energy Consumption Survey: Household Energy Consumption and Expenditures Tables." Table CE1-3c: Total Energy Consumption in U.S. Households by Household Income, 2001." Available at: [http://www.eia.doe.gov/emeu/recs/recs2001/ce\\_pdf/enduse/ce1-3c\\_hhincome2001.pdf](http://www.eia.doe.gov/emeu/recs/recs2001/ce_pdf/enduse/ce1-3c_hhincome2001.pdf).
- Martin Schweitzer, Donald W. Jones, Linda G. Berry, and Bruce E. Tonn. *Estimating Energy and Cost Savings and Emissions Reductions for the State Energy Program Based on*

*Enumeration Indicators Data*. ORNL/CON-487. Oak Ridge National Laboratory. January 2003. Available at: <http://www.ornl.gov/~webworks/cppr/y2001/rpt/116341.pdf>.

**Quantification Methods:** See RCI-1.

**Key Assumptions:**

- For levelized costs of energy efficiency measures and avoided costs of energy, see RCI-1.
- Federally eligible housing units eligible for the energy efficiency package consumed an average of 9800 KWh/year in 2010, and consumption grows at 1.1%/year.
- Beginning year 1 of the program, 2,400 homes a year receive weatherization assistance each year for the next 5 years. The number of homes receiving weatherization increases until 10,000 homes are being retrofitted annually by 2015.
- Energy efficiency improvements are 33% per upgraded residence.
- The costs and benefits of expanding energy audits are not quantified.
- Estimated based on relative usage of electricity and gas by sector. Ratio of electricity savings to gas savings (BBtu/GWh):
  - Residential sector—101.4%.

**Key Uncertainties**

The quantification of costs and benefits of energy efficiency only includes technologies that are currently commercialized. New technologies, such as building-integrated solar PV panels, LED lighting, etc., that might lead to additional CO<sub>2</sub> reductions at a reduced cost, are not included in the cost analysis.

**Additional Benefits and Costs**

Statewide increases in the green renovation construction market lead to increased economic development.

Older manufactured housing is typically very energy inefficient, and the state should consider ways to improve energy efficiency for these homes.

**Feasibility Issues**

None identified.

**Status of Group Approval**

Complete.

**Level of Group Support**

Super Majority (1 objection).

**Barriers to Consensus**

One member does not believe this policy recommendation will result in net cost savings.



## RCI-7. Green Power Purchasing for Consumers

### Policy Description

Green power purchasing refers to a variety of consumer-driven strategies to increase the production and delivery of low-GHG power sources beyond levels achieved through RPS and other mandatory programs. These sources include solar, wind, geothermal, biogas, biomass, and low-impact hydroelectric. Green power purchasing programs provide consumers with information about alternative green sources of energy they can select, rather than the traditional, more carbon-intensive sources.

As of April 2008, the leading green power program in the country had a customer participation rate of over 20%, but green power accounted for 4.6% of its load (NREL, 2008). This implies that participating customers were purchasing green power for less than 25% of their total electricity consumption, or else only small electricity users were participating. Therefore, this policy not only provides incentives for participation, but also encourages large-scale purchases so that customers may use green power to offset their entire electricity consumption.

### Policy Design

#### Goals:

- By 2025, this voluntary program incentivizes one of four residential customers to participate in green power purchasing programs, and those who do participate purchase up to 25% of their total electricity use from renewable resources.
- Develop a mechanism that strongly encourages utilities purchasing this power to develop green power in Arkansas.

**Timing:** Consumers participate in green power purchasing programs beginning in 2010, achieving the 25% goal linearly by 2025.

**Implementing Parties:** State facilities, electric utilities, renewable energy producers, electricity consumers, and buyers of energy-using appliances and equipment.

### Implementation Mechanisms

Arkansas will implement programs to provide consumers the option to purchase green power.

According to Bird et al. (2007), the premium paid by consumers for green power declined from \$34.80/MWh to \$21.20/MWh between 2000 and 2006. In 2025, the green power premium estimated under this policy for Arkansas is closer to \$10.

### Related Policies/Programs in Place

**Green Power Purchasing for Consumers**—In the near future, the Electric Cooperatives of Arkansas plan to introduce a green power purchasing option for customers. It will be initially based on available hydropower credits. Additionally, the generation portfolios of several utilities include hydropower, and the generation portfolios of two electric utilities include wind generation.

**Net Metering Service**—Pursuant to Ark. Code Ann. 23-18-601 *et seq.*, the APSC adopted net metering rules (see [http://www.apscservices.info/rules/net\\_metering\\_rules.pdf](http://www.apscservices.info/rules/net_metering_rules.pdf)). Net metering permits customers to provide all or part of their monthly electricity needs through generating facilities powered by renewable resources. The maximum size is 25 kW for residential customers and 300 kW for other customers. Customers are able to offset their usage and receive a credit for any excess generation delivered to the electric utility during a 12-month period.

### Type(s) of GHG Reductions

CO<sub>2</sub>, CH<sub>4</sub>, and N<sub>2</sub>O emissions are reduced by avoided electricity generation from fossil fuel sources.

### Estimated GHG Reductions and Costs or Cost Savings

**Table G-9. Estimated GHG reductions and costs of or cost savings from RCI-7**

Quantification Factors	2015	2025	Units
GHG emission reductions	0.19	0.60	MMtCO <sub>2</sub> e
Net present value	\$2.7	\$60.7	\$ Million
Cumulative GHG reductions	0.69	4.75	MMtCO <sub>2</sub> e
Cost-effectiveness	\$3.90	\$12.79	\$/tCO <sub>2</sub> e

GHG = greenhouse gas; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; \$/tCO<sub>2</sub>e = dollars per metric ton of carbon dioxide equivalent.

**Data Sources:** See RCI-1.

- Lori Bird, Leila Dagher, and Blair Swezey. *Green Power Marketing in the United States: A Status Report*, (Tenth Edition). National Renewable Energy Laboratory. Technical Report NREL/TP-670-42502. December 2007. Available at: <http://www.eere.energy.gov/greenpower/resources/pdfs/42502.pdf>.
- National Renewable Energy Laboratory. "NREL Highlights Leading Utility Green Power Programs: Pricing Programs Give Consumers Clean Power Choices." April 22, 2008. Available at: <http://www.nrel.gov/news/press/2008/348.html>.

**Quantification Methods:** See RCI-1.

### Key Assumptions:

- For levelized costs of energy efficiency measures and avoided costs of energy, see RCI-1.
- One-in-four (25%) residential electricity consumers purchases green power by 2025. Of these participating customers, renewable energy purchases equal 25% of their electricity needs.
- Green power purchasing starts at 1.2% in 2010 and rises linearly each year to meet the target of 25% by 2025.
- The renewable energy mix supplied to the program is 75% wind, 15% biomass, 5% hydro, and 5% municipal solid waste or landfill gas.

- In 2025, the additional cost of renewables is approximately \$9.50 above business-as-usual generation sources.

### **Key Uncertainties**

The quantification of costs and benefits of energy efficiency only includes technologies that are currently commercialized. New technologies, such as building-integrated solar PV panels, LED lighting, etc., that might lead to additional GHG reductions at a reduced cost are not included in the cost analysis

### **Additional Benefits and Costs**

None identified.

### **Feasibility Issues**

None identified.

### **Status of Group Approval**

Complete.

### **Level of Group Support**

Unanimous.

### **Barriers to Consensus**

Not applicable.

## RCI-8. Nonresidential Energy Efficiency

### Policy Description

This policy recommendation removes regulatory impediments and modifies utility rates to remove financial barriers to combined heat and power (CHP). CHP refers to any system that simultaneously or sequentially generates electric energy and utilizes the thermal energy that is normally wasted. The recovered thermal energy can be used for industrial process steam, space and water heating, air conditioning, water cooling, product drying, or nearly any other thermal energy need in the commercial and industrial sectors. The end result is significantly increased efficiency over generating electric and thermal energy separately. In fact, many CHP systems are capable of an overall efficiency of over 80%—double that of conventional systems. Another significant advantage is the reduced T&D losses associated with centralized power generation.

There are significant opportunities for CHP plants in Arkansas. Fully 47% of industrial natural gas use in the South Census region is used for process heating or cooling that might be suitable for CHP (U.S. DOE/EIA, 2002).

Industrial and commercial facilities served by 480-volt, three-phase power from a utility typically use dry-type transformers to distribute power internally at lower voltages, such as for lighting and plug power. Efficient transformers are able to reduce T&D losses throughout the period of use. When combined with incentives, the electricity saved by such energy-efficient transformers typically has a 3-year payback period. The Energy Policy Act of 2005 set a standard for National Electrical Manufacturing Association (NEMA) TP-1 low-voltage distributors, effective 2007. Standards for medium- and high-voltage distributors have been ruled to have no significant impact on the environment.<sup>22</sup> While federal standards have increased the efficiency of transformers, the RCI TWG recommends that Arkansas consider adopting incentives to encourage transformers that can efficiently handle nonlinear (variable) loads from digital equipment and lighting. The RCI TWG has not quantified the costs and benefits from such an incentive policy.

### Policy Design

#### Goals:

- Install additional CHP and waste heat recovery technical potential on 25% of new boiler installations of a minimum size rating consistent with a reasonable payout in the state.
- Encourage efficient transformers where options for improved energy efficiency are available.

**Timing:** Achieve goals by 2010.

**Implementing Parties:** APSC.

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<sup>22</sup> U.S. Environmental Protection Agency, "Finding of No Significant Impact: Energy Conservation Program for Commercial Equipment, Distribution Transformers." *Federal Register* November 9, 2007;72(217):63563-63564. Available at: <http://www.epa.gov/fedrgstr/EPA-AIR/2007/November/Day-09/a22004.htm>.

## Implementation Mechanisms

For utilities subject to the authority of the APSC, the APSC should review any allocations that are subsidies coming from ratepayers and ensure that there is not inappropriate cross-subsidization between classes of consumers. For utilities (e.g., municipal utilities) that are not subject to the authority of the APSC, the governing body for the utility should review any allocations that are subsidies coming from ratepayers and ensure that there is not inappropriate cross-subsidization between classes of consumers.

## Related Policies/Programs in Place

**EPA Combined Heat and Power Partnership**—This voluntary program seeks to reduce the environmental impact of power generation by promoting the use of CHP. The partnership works closely with energy users, the CHP industry, state and local governments, and other clean energy stakeholders to facilitate the development of new projects and to promote their environmental and economic benefits.<sup>23</sup>

**Energy Policy Act of 2005**—EPA Act 2005 set a standard for NEMA TP-1 low-voltage distributors, effective 2007. Standards for medium- and high-voltage distributors have been ruled to have no significant impact on the environment (see <http://www.epa.gov/fedrgstr/EPA-AIR/2007/November/Day-09/a22004.htm>).

**Incentives and Resources To Promote CHP (a.k.a. Cogen)**—The APSC established cogeneration rules several years ago (see [http://www.apscservices.info/rules/cogeneration\\_rules.pdf](http://www.apscservices.info/rules/cogeneration_rules.pdf)).

**Support for Switching to Less Carbon-Intensive Fuels (Coal and Oil to Natural Gas or Biomass)**—Ark. Code Ann. 23-18-701 *et seq.* requires electric utilities to consider clean energy resources as a part of any resource plans. (See the APSC's "Resource Planning Guidelines for Electric Utilities" at: [http://www.apscservices.info/rules/resource\\_plan\\_guid\\_for\\_elec\\_06-028-R\\_1-7-07.pdf](http://www.apscservices.info/rules/resource_plan_guid_for_elec_06-028-R_1-7-07.pdf)). As a part of the utilities' resource planning, they must consider clean energy sources. The APSC is empowered to encourage or require utilities to consider clean energy sources. Two electric utilities have purchased wind-generating facilities that are included in the generation portfolios of those companies.

Additionally, Southwestern Electric Power Company has constructed a natural gas-fired generating plant and plans to construct another one. Arkansas Electric Cooperative Corporation has purchased an existing natural gas-fired generating plant and is in the process of constructing a natural gas-fired generating plant. And Entergy and Oklahoma Gas & Electric each is in the process of acquiring a natural gas-fired generating plant.

## Type(s) of GHG Reductions

CO<sub>2</sub>, CH<sub>4</sub>, and N<sub>2</sub>O emissions are reduced by avoided electricity generation from fossil fuel sources.

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<sup>23</sup> U.S. Environmental Protection Agency. Combined Heat and Power Partnership. Available at: <http://www.epa.gov/chp/>.

## Estimated GHG Reductions and Costs or Cost Savings

**Table G-8. Estimated GHG reductions and costs of or cost savings from RCI-8**

Quantification Factors	2015	2025	Units
GHG emission reductions	0.43	0.95	MMtCO <sub>2</sub> e
Net present value	\$106	\$583	\$ Million
Cumulative GHG reductions	1.51	8.56	MMtCO <sub>2</sub> e
Cost-effectiveness	\$70.10	\$68.09	\$/tCO <sub>2</sub> e

GHG = greenhouse gas; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; \$/tCO<sub>2</sub>e = dollars per metric ton of carbon dioxide equivalent.

### Data Sources:

- Bruce Hedman. "CHP Market Review." Presented at Southeast Planning Session on July 6, 2005. Available at: [http://www.chpcenterse.org/pdfs/EEA-Southeast\\_Planning\\_session\\_7-6-05.pdf](http://www.chpcenterse.org/pdfs/EEA-Southeast_Planning_session_7-6-05.pdf).
- U.S. Environmental Protection Agency, Combined Heat and Power Partnership. *Catalog of CHP Technologies*. Introduction, p. 7. Available at: <http://www.epa.gov/CHP/basic/catalog.html>.
- Kim Crossman. "Woody Biomass to CHP—Characteristics, Costs, and Performance of Commercially Available Technologies." Presented to the Society of American Foresters on October 26, 2007. Available at: [www.fpl.fs.fed.us/tmu/2007safconvention/2007safconvention--crossman.ppt](http://www.fpl.fs.fed.us/tmu/2007safconvention/2007safconvention--crossman.ppt)
- APSC. "Resource Planning Guidelines for Electric Utilities." Available at: [http://www.apscservices.info/rules/resource\\_plan\\_guid\\_for\\_elec\\_06-028-R\\_1-7-07.pdf](http://www.apscservices.info/rules/resource_plan_guid_for_elec_06-028-R_1-7-07.pdf).
- U.S. Department of Energy, Energy Information Administration. U.S. Department of Energy, Energy Information Administration. *Assumptions to the Annual Energy Outlook 2008: With Projections for 2030*. Table 4: Growth Rates for Total Energy Use by Sector. DOE/EIA-0554(2008). June 2008. Available at: <http://www.eia.doe.gov/oiaf/aeo/assumption/>.
- U.S. Department of Energy, Energy Information Administration. "2002 Energy Consumption by Manufacturers—Data Tables." Table 5.7—End Uses of Fuel Consumption, March 8, 2005. Available at: <http://www.eia.doe.gov/emeu/mecs/mecs2002/data02/shelltables.html>.

**Quantification Methods:** See RCI-1.

### Key Assumptions:

- Technical potential for CHP in Arkansas in 2005 is 660 MW for commercial and 1120 MW for industrial facilities. This serves as an estimate for CHP retrofit capacity, which is implemented linearly for 15 years.
- Each year, 25% of new thermal demand is installed with CHP.
- The avoided CO<sub>2</sub> emissions are assumed to be Arkansas average emission intensities over the 2010–2025 period, estimated at 0.58 tCO<sub>2</sub>/MWh in 2009.

- The fuel for new commercial CHP is 100% gas; for new industrial and advanced biofuel refineries, the fuel is 33% coal, 33% gas, and 33% biomass.
- The program deploys only 30% of estimated technical CHP potential for commercial, industrial, and advanced biofuel refineries in the state over the life of the program.
- T&D losses are 8.1%.<sup>24</sup>
- For levelized costs of energy efficiency measures and avoided costs of energy, see RCI-1.
- Avoided capacity charges for commercial CHP are: ancillary service charge—\$0.28/kW/month; facility capacity – distribution charge—\$1.65/kW/month; on-peak demand charge—\$1.90/kW/month; system usage charge—\$0.35/kWh.
- New commercial and industrial CHP grows at 1.4% and 1.5%, respectively, over the 2006–2020 period.<sup>25</sup>
- Biofuels processing CHP supply is derived from the assumption that biofuel produced in the state will be 15% of total transportation fuel by 2025, and that waste heat will be captured in 25% of these sites to generate electricity.

### Key Uncertainties

The quantification of costs and benefits of energy efficiency only includes technologies that are currently commercialized. New technologies, such as building-integrated solar PV panels, LED lighting, etc., that might lead to additional GHG reductions at a reduced cost are not included in the cost analysis.

Estimating the costs of CHP into the distant future is tentative, because cost estimates are highly sensitive to natural gas prices, the cost of avoided power, and the assumption about the CO<sub>2</sub> intensity of displaced electricity.

Effectively addressing the efficiency of nonlinear (variable) power loads (e.g., computers, fluorescent lighting) remains a consideration under the new standards.”

### Additional Benefits and Costs

This analysis does not consider CHP benefits from avoided costs of backup power systems.

The quantification of costs and benefits of energy efficiency only includes technologies that are currently commercialized. New technologies, such as building-integrated solar PV panels, LED lighting, etc., that might lead to additional CO<sub>2</sub> reductions at a reduced cost, are not included in the cost analysis.

<sup>24</sup> U.S. Department of Energy, Energy Information Administration. "Arkansas Electricity Profile." DOE/EIA-0348. 2006. Available at: [http://www.eia.doe.gov/cneaf/electricity/st\\_profiles/arkansas.html](http://www.eia.doe.gov/cneaf/electricity/st_profiles/arkansas.html).

<sup>25</sup> U.S. Department of Energy, Energy Information Administration. U.S. Department of Energy, Energy Information Administration. *Assumptions to the Annual Energy Outlook 2008: With Projections for 2030*. Table 4: Growth Rates for Total Energy Use by Sector. DOE/EIA-0554(2008). June 2008. Available at: <http://www.eia.doe.gov/oiaf/aeo/assumption/>.

**Feasibility Issues**

None identified.

**Status of Group Approval**

Complete.

**Level of Group Support**

Unanimous.

**Barriers to Consensus**

Not applicable.

## RCI-9. Support for Energy-Efficient Communities, Including Smart Growth

### Policy Description

Smart growth dictates how the state will invest its money in community development, either by regulating local land-use decisions or by providing incentives to influence those decisions. Existing building, zoning codes, and business schedules often work against smart growth development. In the context of GHG emissions, smart growth policies can serve to revitalize and reuse commercial sites and will help preserve critical natural resources and farmland.

Improved community planning aims to create communities that are, among other attributes, livable, designed for reduced use of energy both within homes and businesses and in the transport sector, and have a reduced environmental impact relative to typical developments. Variants on the smart growth concept exist, but many call for clustering living units with easy access (often walking distance) to shops, schools, and entertainment and recreational facilities; incorporating elements of energy-efficient design and renewable energy in buildings; sharing energy facilities between buildings (for example, district heating systems); preserving open spaces, providing shared office space—especially in those buildings with higher energy efficiencies; and instituting alternative work schedules, telework options, and carpooling. Telework is an employment arrangement where an employee works or "telecommutes" remotely from home or a satellite office, part or all of the time. (See <http://wfnetwork.bc.edu/topic.php?id=4>.)

These concepts—improved building energy performance, innovative working arrangements, and community planning—offer significant synergies for Arkansas. This policy suggests a combination of incentives and targets to induce the owners and developers of buildings and the communities in which they are located to produce and operate buildings and communities that produce markedly lower GHG emissions than existing buildings and communities.

### Policy Design

#### Goals:

- By 2009, provide resources for local jurisdictions to examine and rewrite their outdated state and local codes to accommodate for smart growth initiatives in community planning and development. Implementing smart growth policies is expected to reduce (per-unit) energy consumption, GHG emissions, infrastructure costs, and new construction by 30% by 2030.
- Design all new buildings, developments, and major renovations to meet the targets in RCI-4a and RCI-4b.
- Identify the link between GHG reductions and land-use planning decisions, as well as the reduction potential and targets for Arkansas.
- Create incentives to encourage smart growth by meeting Built Green Community certification or the LEED-ND (LEED for Neighborhood Development) gold level, with minimum energy and location criteria. Encourage compact and transit-oriented, mixed-use

development within urban growth areas that results in reduced vehicle miles traveled and GHG emissions and encourages walking and biking.

- Improve planning to reduce sprawl modeled after the "California Communities Climate Action Plan" and others.
- Promote consideration of location as part of a building's GHG footprint.
- Encourage state and local governments and private firms to adopt telework policies to reduce building and transportation-related GHG emissions. Commission a study on the effects of alternative work schedules similar to West Virginia House Resolution #34 and others.
- Limit sprawl by enabling transfer of development rights, revitalizing communities through developed land, and building reuse incentives, and institute a variety of conservation measures for woodlands and wetlands.
- Support locally owned shops, restaurants, and farmers' markets to help local businesses and family farms remain profitable, thus strengthening the local economy and protecting rural legacy and lands.

**Timing:** See above.

**Implementing Parties:** State and local governments, developers and builders, private firms, land-use planners.

### Implementation Mechanisms

- Initiate a study of the potential impacts of a compressed work week and the option of telecommuting on cost and energy savings to the state and its employees, and the impact of a foreshortened work week on access to essential government operations.
- Implement executive, legislative, and administrative changes to enhance the integrated design of communities, energy systems, and transport systems.

### Related Policies/Programs in Place

Many states have instituted telework legislation and executive orders. See Jessica Jackson-Yoo. "Telework." February 2008. Boston College Sloan Work and Family Research Network. Available at: [http://wfnetwork.bc.edu/topic\\_extended.php?id=4&type=3&area=All](http://wfnetwork.bc.edu/topic_extended.php?id=4&type=3&area=All).

Utah state government's mandatory four-day operations schedule.<sup>26</sup>

### Type(s) of GHG Reductions

CO<sub>2</sub>, CH<sub>4</sub>, and N<sub>2</sub>O emissions are reduced by avoided electricity generation from fossil fuel sources.

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<sup>26</sup> Larry Copeland. "Most State Workers in Utah Shifting to 4-Day Week." *USA Today*. July 1, 2008. Available at: [http://www.usatoday.com/news/nation/2008-06-30-four-day\\_N.htm](http://www.usatoday.com/news/nation/2008-06-30-four-day_N.htm).

## Estimated GHG Reductions and Costs or Cost Savings

This policy is a qualitative study recommendation. GHG reductions and costs or cost savings for Arkansas were not calculated for this recommendation, but are calculated under other policy recommendations. Smart growth planning quantification was performed under Transportation and Land use policy recommendation TLU-4 (Smart Growth, Pedestrian and Bicycle Infrastructure), which assumes higher population density tracts due to policies of 35% compared to 10% under business as usual. This results in fewer vehicle miles traveled and lower GHG emissions. See <http://www.arclimatechange.us/TLU.cfm> for the TLU policy description.

GHG reductions and costs or cost savings for Arkansas from high-performance building policies are quantified under RCI-4a and RCI-4b.

A report for the Consumer Electronics Association estimates that each commuter with a one-way commute length of 17 miles who telecommutes three times a week saves nearly 200 gallons of gasoline per year.<sup>27</sup> Energy reductions and GHG mitigation are maximized with organizational support for telecommuting, reducing incremental floor space requirements and appliance energy consumption.

**Data Sources:** Not applicable.

**Quantification Methods:** Not applicable.

**Key Assumptions:** Not applicable.

## Key Uncertainties

The quantification of costs and benefits of energy efficiency only includes technologies that are currently commercialized. New technologies, such as building-integrated solar PV panels, LED lighting, etc., that might lead to additional GHG reductions at a reduced cost are not included in the cost analysis.

## Additional Benefits and Costs

None identified.

## Feasibility Issues

None identified.

## Status of Group Approval

Complete.

## Level of Group Support

Unanimous.

## Barriers to Consensus

Not applicable.

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<sup>27</sup>TIAX, LLC. "The Energy and Greenhouse Gas Emissions Impact of Telecommuting and e-Conference." Prepared for the Consumer Electronics Association. July 2007. page 28. Available at: [http://www.ce.org/Energy\\_and\\_Greenhouse\\_Gas\\_Emissions\\_Impact\\_CEA\\_July\\_2007.pdf](http://www.ce.org/Energy_and_Greenhouse_Gas_Emissions_Impact_CEA_July_2007.pdf).

## RCI-10. Energy-Savings Sales Tax

### Policy Description

This policy recommendation refers to a sales tax exemption for energy-efficient products, such as CFLs; geothermal heat pumps; highly efficient ( $> 14.4$  SEER [seasonal energy efficiency ratio]) heat pump systems (auxiliary heat may be supplied by electricity or natural gas); and ENERGY STAR-certified water heaters, refrigerators and freezers, clothes washers and dryers, and dishwashers. Establishing a market signal that rewards lower-carbon purchase decision making provides consumers an incentive to improve their energy efficiency and reduce their adverse impacts on climate.

The list of energy efficiency measures that this policy recommendation applies to contains the same measures that utility energy efficiency programs typically pursue. Utility programs assume that some portion (usually  $\sim 25\%$ ) of the capital costs of the efficiency measure is paid for by the participant. Thus, this policy recommendation reduces the purchase price (capital cost) of energy-efficient goods by consumers by the amount of the sales tax. However, these costs are then paid for by the state, rather than consumers.

The effect of the sales tax exemption on the purchase of energy-efficient products is a function of the price elasticity of demand. As the price of the efficient products decreases, the demand for these products increases. Price elasticity of demand for electricity in the short run is close to  $-0.20\%$  and in the long run is closer to  $-0.50\%$  (U.S. EIA, 2003). If the policy eliminates all taxes (estimated at  $6\%$ ), this would lead to a  $2\%$ – $5\%$  increase in demand.

### Policy Design

**Goals:** Implement a sales tax exemption for all consumers on energy-efficient equipment, including (but not limited to) CFLs; geothermal heat pumps; highly efficient heat pump systems; and ENERGY STAR-certified products, including water heaters, refrigerators and freezers, clothes washers and dryers, and dishwashers.

**Timing:** Implement the sales tax exemption by 2010.

**Implementing Parties:** Retail businesses and consumers.

### Implementation Mechanisms

Tax exemptions for eligible measures would need to be approved by the appropriate jurisdictions, and tax relief mechanisms at the point of sale would need to be developed.

### Related Policies/Programs in Place

Act 120 of the 1<sup>st</sup> Extraordinary Session of 1983 exempts Gross Receipts Tax and Other State Excise Tax on the first 500 kWh of electricity per month for low- and moderate-income residential customers with incomes at or below \$12,000/year. (No Web link available.)

**Compact Fluorescent Light Bulb Replacement Program**—Offered by Entergy Arkansas, Inc., Oklahoma Gas and Electric Company, and Southwestern Electric Power Company, this program provides coupons of \$1–\$4 to apply toward the purchase of CFLs. The energy savings from a single CFL will most likely outweigh the cost of the entire energy efficiency and conservation programs for an average residential customer. The cost of the program is approximately \$820,000.

### Type(s) of GHG Reductions

CO<sub>2</sub>, CH<sub>4</sub>, and N<sub>2</sub>O emissions are reduced by avoided electricity generation from fossil fuel sources.

### Estimated GHG Reductions and Costs or Cost Savings

**Table G-9. Estimated GHG reductions and costs of or cost savings from RCI-10**

Quantification Factors	2015	2025	Units
GHG emission reductions	0.02	0.11	MMtCO <sub>2</sub> e
Net present value	–\$2.5	–\$32.7	\$ Million
Cumulative GHG reductions	0.02	0.69	MMtCO <sub>2</sub> e
Cost-effectiveness	–\$47.24	–\$47.37	\$/tCO <sub>2</sub> e

GHG = greenhouse gas; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; \$/tCO<sub>2</sub>e = dollars per metric ton of carbon dioxide equivalent.

Negative values in the Net Present Value and the Cost-Effectiveness rows represent net cost savings.

### Data Sources:

- Arkansas Department of Finance and Administration, Office of Excise Tax Administration. "Sales Tax Rates." Available at: [http://www.state.ar.us/dfa/excise\\_tax\\_v2/et\\_su\\_rates\\_state.html\\_excel\\_file\\_city\\_county\\_list\\_07\\_2008.xls](http://www.state.ar.us/dfa/excise_tax_v2/et_su_rates_state.html_excel_file_city_county_list_07_2008.xls).
- U.S. Department of Energy, Energy Information Administration. "Price Responsiveness in the AEO2003 NEMS Residential and Commercial Buildings Sector Models." 2003. Available at: <http://www.eia.doe.gov/oiaf/analysispaper/elasticity/>.

**Quantification Methods:** See RCI-1.

### Key Assumptions:

- This policy recommendation reduces consumer costs of energy efficiency measures and thus increases deployment. The assumed increase in deployment is a linear function of the estimated tax level. Low tax levels are expected to have little impact on purchasing decisions. High taxes and subsequent tax holidays will have a greater impact on consumers' buying energy-efficient equipment.
- The assumed state tax rate is 6%, which is the amount used to estimate the increased purchases from the tax holiday.

- Energy efficiency deployment under RCI-2b is used for baseline demand. The measures deployed under this policy recommendation are assumed to be similar to those deployed under RCI-2b. RCI-10 leads to additional energy efficiency deployment, due to reduced participant capital costs. By 2025, this policy results in a cumulative reduction of 0.4% of annual sales.
- The price elasticity of demand for energy-efficient products is the same as the estimated price elasticity of demand for electricity in EIA (2003). The short-run price elasticity of demand for energy-efficient products begins at  $-0.2\%$  in 2010 and increases linearly to the long-run elasticity of  $-0.5\%$  in 2025.
- For levelized costs of energy efficiency measures and avoided costs of energy, see RCI-1.

### **Key Uncertainties**

The quantification of costs and benefits of energy efficiency only includes technologies that are currently commercialized. New technologies, such as building-integrated solar PV panels, LED lighting, etc., that might lead to additional GHG reductions at a reduced cost are not included in the cost analysis.

### **Additional Benefits and Costs**

None identified.

### **Feasibility Issues**

None identified.

### **Status of Group Approval**

Complete.

### **Level of Group Support**

Super Majority (1 objection).

### **Barriers to Consensus**

One member does not believe this policy recommendation will result in net cost savings.

## **Annex G-1**

### **Methodology for Calculating Existing Actions to Reduce Energy Consumption**

The policy recommendations for the RCI sectors are affected by both state and federal policies that incentivize or mandate more efficient use of energy. The federal Energy Independence and Security Act of 2007 was signed into law in December 2007. This law contains several requirements that will reduce GHG emissions as they are implemented over the next few years. During the GCGW process, sufficient information was identified (e.g., implementation schedules) to estimate GHG emission reductions associated with implementing energy efficiency requirements for new appliances and lighting in Arkansas under Title III of the EISA.

- For the residential sector emissions reductions were estimated for: external power supply efficiency standards, residential boilers, furnace fan standard process, regional standards for furnaces, central air conditioners, and heat pumps, standby mode for electrical appliances, energy standards for home appliances, efficient light bulbs, incandescent reflector lamp efficiency standards.
- For the commercial sector emissions reductions were estimated for: external power supply efficiency standards, standby mode for electrical appliances, efficient light bulbs, incandescent reflector lamp efficiency standards, regional standards for furnaces, central air conditioners, and heat pumps, walk-in coolers and walk-in freezers, electric motor efficiency standards, and metal halide lamp fixtures.
- For the industrial sector emissions reductions were estimated for: efficient light bulbs, regional standards for furnaces, central air conditioners, and heat pumps, incandescent reflector lamp efficiency standards, electric motor efficiency standards, and metal halide lamp fixtures.

The net effect of these reductions was estimated at 1,900 GWh of electricity and 1,200 BBtu of natural gas savings in Arkansas by 2025. The associated GHG reductions for these savings are projected to be 0.9 MMtCO<sub>2</sub>e for the year 2025 using the RCI TWG CO<sub>2</sub> methodology. Note, however, that GHG emission reductions associated with the Title IV (Energy Savings in Buildings and Industry) and Title V (Energy Savings in Government and Public Institutions) requirements of the federal Energy Independence and Security Act of 2007 have not been quantified because of the uncertainties in how they will be implemented. It is expected that the Title IV and Title V requirements will overlap with some of the RCI policy recommendations, especially RCI-2b, RCI-3a, RCI-3b, RCI-4a, and RCI-4b.

Arkansas has also started energy efficiency programs to reduce energy consumption within the state. The Arkansas Public Service Commission has authorized quick-start programs of approximately \$18,530,924 for the initial 2-year period ending December 31, 2009. Municipal and cooperative electric utilities are also currently pursuing energy efficiency programs. To estimate the effects of these actions, APSC authorized utility spending is extrapolated statewide as cooperative and municipal program data was not available. Using the TWG assumption of \$34/MWh and \$5.00/BBtu for electric and gas efficiency costs, estimated statewide electric efficiency deployment in 2009 is 181 GWh of electricity and 1,200 BBtu of natural gas. These

actions are expected to reduce Arkansas GHG emissions by .2 MMtCO<sub>2</sub>e in 2009 using the RCI TWG CO<sub>2</sub> methodology. These estimates assume that utilities' regulated by APSC account for three quarters of electricity sold in the state and program spending is split equally between electricity and natural gas. The electricity reduction is removed from RCI-2b, and the natural gas reduction is split into thirds and is removed equally from RCI-1, RCI-4a, and RCI-4b.

# Appendix H

## Energy Supply Sector

### Policy Recommendations

#### Summary List of Policy Recommendations

No.	Policy Recommendation	GHG Reductions (MMtCO <sub>2</sub> e)			Net Present Value (Million \$)	Cost-Effectiveness (\$/tCO <sub>2</sub> e)	Level of Support
		2015	2025	Total 2009–2025			
ES-1*	Green Power Purchases and Marketing	<i>Transferred to RCI TWG</i>					Unanimous
ES-2*	Technology Research & Development	<i>Not Quantified</i>					Unanimous
ES-3 <sup>†</sup>	3a: Renewable Portfolio Standard (RPS)	0.3	3.6	21.9	\$548	\$25.0	Majority (10 objections)
	3b: Renewable Energy Feed-In Tariff (REFIT)	0.2	2.0	12.3	\$399	\$32.5	Super Majority (4 objections)
ES-4 <sup>†</sup>	Grid-Based Renewable Energy Incentives and/or Barrier Removal	<i>Not Quantified</i>					Unanimous
ES-5 <sup>†</sup>	Approaches Benefiting From Regional Application	<i>Not Quantified</i>					Unanimous
ES-6*	Combined Heat and Power	0.6	2.9	20.0	\$886	\$44.3	Unanimous
ES-7 <sup>†</sup>	Geological Underground Sequestration for New Plants	2.9	5.6	56.5	\$1,801	\$31.9	Majority (10 objections)
ES-8 <sup>†</sup>	Transmission System Upgrades	<i>Not Quantified</i>					Unanimous
ES-9*	Nuclear Power	0.0	9.8	58.9	\$1,574	\$26.7	Unanimous
ES-10 <sup>†</sup>	Carbon Tax	<i>Not Quantified</i>					Super Majority (4 objections)
ES-11*	Efficiency Improvements and Repowering of Existing Plants	2.3	2.3	31.8	\$1,568	\$49.3	Unanimous
	<b>Sector Total After Adjusting for Overlaps<sup>‡</sup></b>	<b>6.0</b>	<b>22.6</b>	<b>179.4</b>	<b>\$6,228</b>	<b>\$34.7</b>	
	<b>Reductions From Recent Actions</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>\$0</b>	<b>\$0.0</b>	
	<b>Sector Total Plus Recent Actions<sup>‡</sup></b>	<b>6.0</b>	<b>22.6</b>	<b>179.4</b>	<b>\$6,228</b>	<b>\$34.7</b>	

GHG = greenhouse gas; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; \$/tCO<sub>2</sub>e = dollars per metric ton of carbon dioxide equivalent; RCI = Residential, Commercial, and Industrial; TWG = Technical Work Group.

Negative values in the Net Present Value and the Cost-Effectiveness columns represent net cost savings.

The numbering used to denote the above policy recommendations is for reference purposes only; it does not reflect prioritization among these important policy recommendations.

\* The GCGW approved this option at Meeting #9 (September 9, 2008); 18 members present and voting (one by phone).

<sup>†</sup> The GCGW approved this option at Meeting #10 (September 25, 2008); 21 members present and voting (none by phone).

<sup>‡</sup> The cumulative results are based on the sum of the following:

- ES-3b (Renewable Energy Feed-In Tariff [REFIT]);
- ES-6 (Combined Heat and Power);
- ES-7 (Geological Underground Sequestration for New Plants);
- ES-9 (Nuclear Power); and
- ES-11 (Efficiency Improvements and Repowering of Existing Plants).

ES-3b and ES-6 overlap with AFW-4 (Expanded Use of Agriculture and Forestry Biomass Feedstocks for Electricity, Heat, or Steam Production: Energy From Biomass and Capture of Waste Heat). These overlaps were addressed by excluding the emission reductions and costs/savings associated with the biomass and waste heat components for AFW-4 from the cumulative totals for all AFW policy recommendations combined.

## **ES-1. Green Power Purchases and Marketing**

*[The Energy Supply (ES) Technical Work Group (TWG) recommended and the Arkansas Governor's Commission on Global Warming (GCGW) approved that this recommendation be moved and combined with Residential, Commercial, and Industrial recommendation RCI-7, where it is more appropriately located and quantified.]*

## ES-2. Technology Research & Development

### Policy Description

Research and development (R&D) funding can be targeted toward a particular technology or group of technologies as part of a state initiative to build an industry around that technology in the state, and/or to set the stage for adoption of the technology for use in the state. For example, an agency can be established with a mission to help develop and deploy energy storage technologies. R&D funding can also be made available to any renewable or other advanced technology through an open bidding procedure (i.e., driven by bids received rather than by a focused strategy to develop a particular technology). Funding can also be given for demonstration projects to help commercialize technologies that have already been developed, but are not yet in widespread use. Finally, funding can be targeted to increase collaboration among existing institutions in Arkansas for R&D.

States can undertake initiatives focused on developing, promoting, and/or implementing one or more specific fossil fuel or nuclear technologies that show promise for reducing GHG emissions. Technologies could include, among others, carbon capture and storage (to sequester carbon dioxide [CO<sub>2</sub>] emissions from power plants, oil and gas operations, and/or refineries); biomass blending in coal power plants; and implementation of equipment in oil and gas operations that increases efficiency and reduces losses (e.g., remote sensors of leaks).

Policies to encourage CO<sub>2</sub> capture and storage or reuse (CCSR) could include a state agency or department within an existing agency tasked with promoting CCSR, evaluation studies to identify geologically sound reservoirs, R&D funding to improve CCSR technologies, and/or financial incentives or mandates to capture and store carbon or to capture and reuse it.

### Policy Design

#### Goals:

- Identify the likely funding mechanisms and policy tools that would provide further stimulus for the development of new, reasonable-cost, low- and zero-GHG-emitting electricity generation in Arkansas.
- Complete a detailed and comprehensive evaluation study for renewable energy potential in Arkansas.
- Complete a least one high-visibility R&D demonstration to showcase alternative energies.

**Timing:** Establish funding in the 2009 legislative session. Finish study within two years. Issue first request for proposals as soon as possible after obtaining legislative approval.

**Parties Involved:** State government, voluntary private and public partners.

### **Implementation Mechanisms**

Use of existing regulatory authority to address relevant issues—pricing, etc.

### **Related Policies/Programs in Place**

None cited.

### **Type(s) of GHG Reductions**

Reductions in all GHG emissions from the market penetration of innovative GHG-reducing technology and practices.

### **Estimated GHG Reductions and Costs or Cost Savings**

The GCGW considers this policy recommendation as not quantifiable.

**Data Sources:** Not applicable.

**Quantification Methods:** Not applicable.

**Key Assumptions:** Not applicable.

### **Key Uncertainties**

Not applicable.

### **Additional Benefits and Costs**

None cited.

### **Feasibility Issues**

None cited.

### **Status of Group Approval**

Approved.

### **Level of Group Support**

Unanimous.

### **Barriers to Consensus**

Not applicable.

## ES-3a. Renewable Portfolio Standard (RPS)

### Policy Description

A renewable portfolio standard (RPS) requires utilities to supply a certain, generally fixed percentage of electricity from an eligible renewable energy source(s). An environmental portfolio standard expands that notion to include energy efficiency or other GHG emission-reducing technologies as an eligible resource. About 20 states currently have an RPS in place. In some cases, utilities can also meet their portfolio requirements by purchasing Renewable Energy Certificates from eligible renewable energy projects.

The application of an RPS in Arkansas is provisional. That is, ES-3b (Renewable Energy Feed-In Tariff [REFIT]) is the primary recommendation for achieving greater penetration of renewable energy. However, if certain goals of the REFIT recommendation are not achieved, the RPS would go into effect, as per the threshold requirements discussed below.

### Policy Design

**Goal:** The aim of an RPS is for each investor-owned and public utility to provide 15% of its load using renewable energy resources.

**Timing:** Beginning in 2015.

**Parties Involved:** Investor-owned utilities, electric cooperatives, state government.

**Other:** The RPS recommendation is provisional, depending on the success of the REFIT recommendation, the primary policy for achieving greater penetration of renewable energy in Arkansas. The time frame for which the RPS would be triggered would follow the goals of ES-3b. For example, ES-3b states that by 2015, Arkansas will produce 500 megawatts (MW) of renewable energy. If the REFIT recommendation has not achieved 250 MW (half of the 2015 goal) by 2012, an RPS mandate will go into effect to ensure the 500-MW target is reached by 2015.

### Implementation Mechanisms

The Arkansas Public Service Commission (APSC) will evaluate the potential cost impact on consumers. For utilities subject to the authority of the APSC, the APSC should review any allocations that are subsidies coming from ratepayers and ensure that there is not inappropriate cross-subsidization between classes of consumers. For utilities (e.g., municipal utilities) that are not subject to the authority of the APSC, the governing body for the utility should review any allocations that are subsidies coming from ratepayers, and ensure that there is not inappropriate cross-subsidization between classes of consumers.

### Related Policies/Programs in Place

None cited.

## Type(s) of GHG Reductions

Reductions in all GHG emissions from energy production and GHG emissions associated with process operational emissions and energy consumption.

## Estimated GHG Reductions and Costs or Cost Savings

The results of this policy recommendation are summarized in Table H-3a-1, below. The sections that follow describe the data sources, quantification approach, and key assumptions used in the development of these results.

**Table H-3a-1. Estimated GHG reductions and costs of or cost savings from the RPS**

No.	Policy Recommendation	GHG Reductions (MMtCO <sub>2</sub> e)			Net Present Value 2009–2025 (Million \$)	Cost-Effectiveness (\$/tCO <sub>2</sub> e)
		2015	2025	Total 2009–2025		
ES-3a	RPS	0.3	3.6	21.9	\$548	\$25.04

GHG = greenhouse gas; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; \$/tCO<sub>2</sub>e = dollars per metric ton of carbon dioxide equivalent.

### Data Sources:

- U.S. Department of Energy, Energy Information Administration. *Assumptions to the Annual Energy Outlook 2007: With Projections to 2030*. DOE/EIA-0554. April 2007. Available at: <http://www.eia.doe.gov/oiaf/aeo/assumption/pdf/electricity.pdf>.
- Research and Development Solutions. *Cost and Performance Baseline for Fossil Energy Plants. Volume 1: Bituminous Coal and Natural Gas to Electricity*. DOE/NETL-2007/1281. Prepared for the National Energy Technology Laboratory. May 2007; revision 1, August 2007. Available at: [http://www.netl.doe.gov/energy-analyses/pubs/Bituminous%20Baseline\\_Final%20Report.pdf](http://www.netl.doe.gov/energy-analyses/pubs/Bituminous%20Baseline_Final%20Report.pdf).
- Plant-specific Arkansas capacity addition data are based on Arkansas ES TWG input.

### Quantification Methods:

See Annex 1 for the overall approach to the quantification of this and all other ES recommendations.

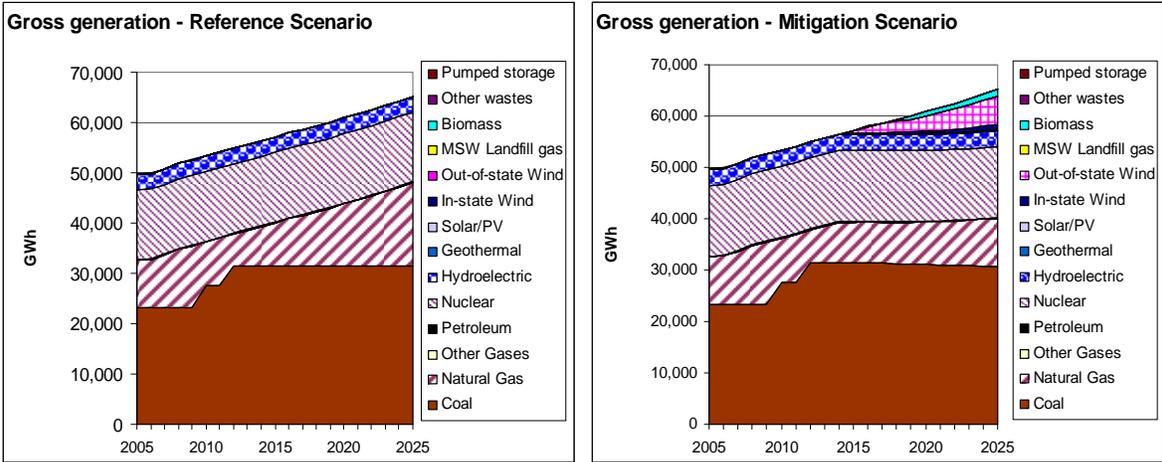
This policy recommendation requires that utilities and other load-serving entities supply a certain, generally fixed, percentage of electricity from eligible (e.g., low-GHG-emitting) renewable energy sources. The TWG has made the following key assumptions for the analysis of this recommendation:

- One reference scenario is modeled, assuming the Hempstead plant is built.
- The start year for the policy recommendation is 2015.
- Incremental renewable energy generation associated with the implementation of the RPS displaces marginal generation comprising 90% natural gas-fired and 10% coal-fired generation in each year new renewable capacity comes on line.

- The mix of new renewable resources to come on line would be modeled after the results of the U.S. Department of Energy, Energy Information Administration's *Assumptions to the Annual Energy Outlook 2007* for the Southwest Power Pool region, assumed to be a reasonable proxy for a least-cost renewable energy mix.
- 15% of all new wind capacity is reserved to be installed in high-wind resource areas in Arkansas; the balance is installed in high-wind resource areas in the surrounding region.
- Additional transmission capacity is built to accommodate all new wind energy resources.
- The capacity credit for intermittent renewables (i.e., wind and solar photovoltaic [PV]) is 15%. For these intermittent resources, spinning reserve is provided in the form of natural gas-fired combustion turbines.
- The cost of new renewables is compared to the average avoided cost of electricity expansion in Arkansas, as obtained from the RCI TWG (i.e., \$58.3/MWh).

Figure H-3a-1 summarizes the impact of ES-3a on in-state gross generation. The incremental effect of the RPS by 2025 is about 7,984 gigawatt-hours (GWh), with 69% of this amount coming from out-of-state wind, 12% from in-state wind, 17% from biomass, and 2% from solar PVs. Displaced coal-fired generation in 2025 is 798 GWh, and natural gas-fired generation is 7,185 GWh.

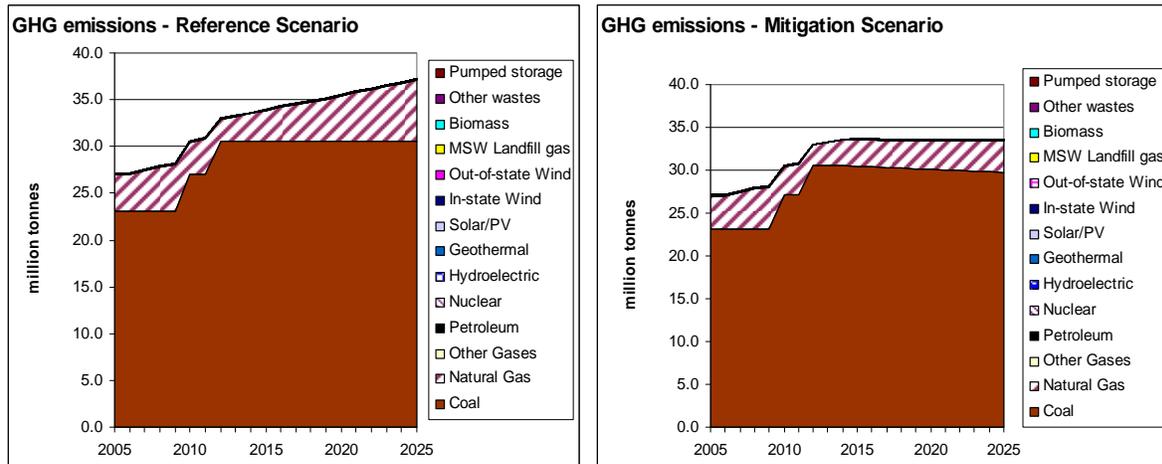
**Figure H-3a-1. Effect of RPS on gross generation**



RPS = renewable portfolio standard; GWh = gigawatt-hour; MSW = municipal solid waste; PV = photovoltaic.

Figure H-3a-2 summarizes the impact of ES-3a on CO<sub>2</sub>-equivalent (CO<sub>2</sub>e) emission reductions. The annual reductions due to the RPS by 2025 reach about 3.6 million metric tons (MMt) of CO<sub>2</sub>e emission reductions. Cumulatively over the period 2015–2025, the RPS leads to a total of 21.9 MMtCO<sub>2</sub>e avoided.

**Figure H-3a-2. Annual GHG reductions from the RPS**



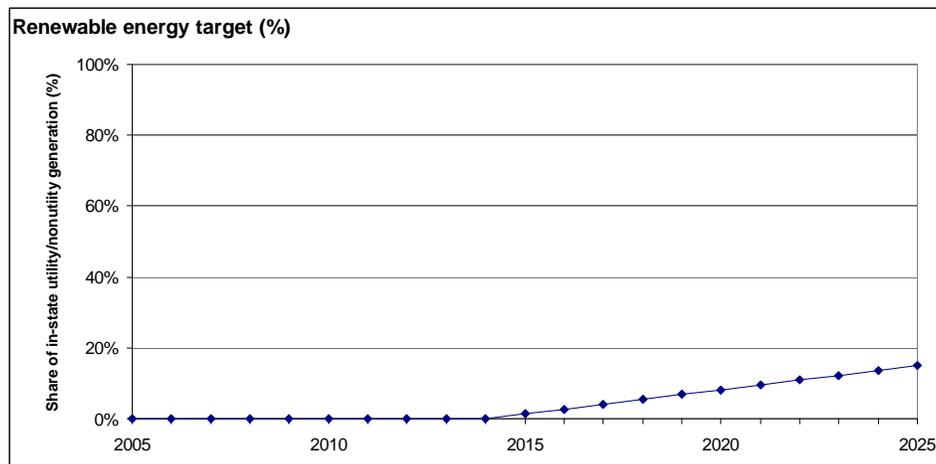
GHG = greenhouse gas; RPS = renewable portfolio standard; MSW = municipal solid waste; PV = photovoltaic.

Cost savings are associated with avoided capital, fuel, and operation and maintenance (O&M) costs. Incremental costs are associated with the capital, transmission, variable and fixed O&M, and fuel costs associated with the RPS. The annual product of real levelized costs and displaced generation is an estimate of the annual costs. The net present value (NPV) of the costs is \$0.72 billion over the same period (2005\$). The recommendation's cost-effectiveness is calculated as the quotient of the net present value (NPV) and cumulative GHG emission reductions. It is \$32.8/tCO<sub>2</sub>e (2005\$) (i.e., \$0.72 billion divided by 21.9 MMtCO<sub>2</sub>e and multiplied by a conversion factor of 1,000).

**Key Assumptions:**

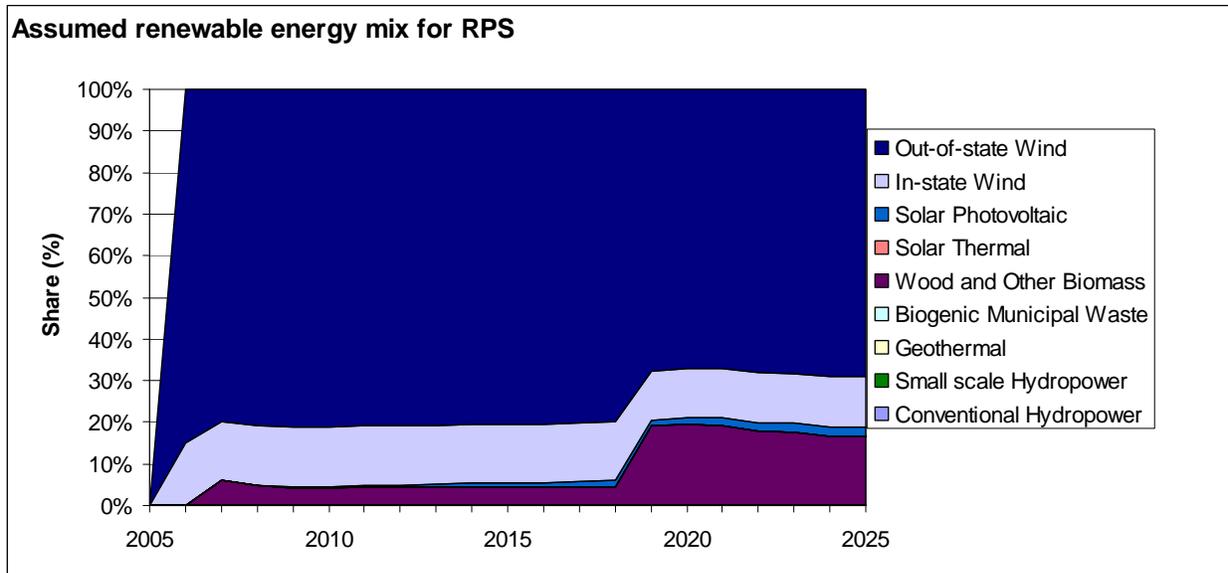
*Renewable Energy Target*—Defined as the percentage of in-state electricity production, the renewable energy target is summarized in Figure H-3a-3.

**Figure H-3a-3. Assumed renewable energy target**



*Renewable Energy Mix*—This is defined as the least-cost plan for the expansion of renewable capacity in the state and is summarized in Figure H-3a-4.

**Figure H-3a-4. Assumed renewable energy mix**



*Assumed Cost and Performance Characteristics of New Capacity in Arkansas*—These are obtained from the various sources indicated earlier and are summarized in Table H-3a-2.

**Table H-3a-2. Assumed cost and performance characteristics of new capacity in Arkansas**

	Cost component						Source	EPC Percenta
	Capital	Trans	Fixed O&M	Variable O&M	Cap factor	Heat rate		
	2005 \$/kW	2005 \$/kW	2005 \$/kW-	2005 mills/kW	%	btu/kWh		
Hydroelectric	1,530	0	13.13	3.30	47%	10,107	EIA	2%
Geothermal	1,530	0	13.13	3.30	47%	10,107	EIA	2%
MSW	1,627	0	107.50	0.01	75%	13,648	EIA	2%
Landfill gas	1,627	0	107.50	0.01	75%	13,648	EIA	2%
Biomass	1,871	0	50.18	2.96	75%	8,911	EIA	2%
Solar	4,406	0	10.99	0.00	35%	10,280	EIA	2%
In-state Wind	1,845	80	28.51	0.00	35%	10,280	EIA	2%
Out-of-state Wind	1,845	80	28.51	0.00	35%	10,280	EIA+	2%

MSW = municipal solid waste; O&M = operation and maintenance; \$/kW = dollars per kilowatt; Btu/kWh = British thermal units per kilowatt-hour; EIA = [U.S. Department of Energy] Energy Information Administration.

*Levelized Costs of New Renewable Capacity*—These costs are computed using an annual inflation rate of 2.5%, a real discount rate of 5%, an after-tax weighted cost of capital of 9%, and a levelization period of 20 years and are summarized in Table H-3a-3 in units of 2005\$/MWh.

**Table H-3a-3. Assumed levelized costs of new renewable capacity**

Capacity type	Capacity	Transmission	Fixed O&M	Variable O&M	Fuel	Total
Hydroelectric	59.9	0.0	3.1	3.3	0.0	66.3
Geothermal	40.4	0.0	3.1	3.3	0.0	46.8
MSW	27.1	0.0	16.2	0.0	0.0	43.2
Landfill gas	27.1	0.0	16.2	0.0	0.0	43.2
Biomass	31.1	0.0	7.5	2.9	22.0	63.6
Distributed solar PV	157.0	0.0	0.0	0.0	0.0	163.4
In-state Wind	65.7	2.9	9.2	0.0	0.0	77.8
Out-of-state Wind	65.7	2.9	9.2	0.0	0.0	77.8

MSW = municipal solid waste; O&M = operation and maintenance; PV = photovoltaic.

*Levelized Costs for Natural Gas Combustion Turbine (NGCT) Used for Reliability Purposes—* These are computed using the same financial parameters indicated above and are summarized in Table H-3a-4 in units of 2005\$/MWh. Note that a 50% capacity factor is assumed in the calculation.

**Table H-3a-4. Assumed levelized costs for NGCT used for reliability purposes**

Capacity type	Capacity	Transmission	Fixed O&M	Variable O&M	Fuel	Total	Capacity factor (%)	Fuel factor (%)
CT	13.4	0.0	0.3	3.5	20.0	37.2	50%	25%

O&M = operation and maintenance; CT = combustion turbine; NGCT = natural gas combustion turbine.

### Key Uncertainties

The costs of renewable energy technologies, the price forecast for natural gas and coal delivered to regional power stations, and the applicability of avoided costs over the planning period for both reference scenarios.

### Additional Benefits and Costs

None cited.

### Feasibility Issues

The functioning of the electric transmission network is somewhat analogous to the nation's system of roadways. High-voltage transmission lines were originally constructed to efficiently transport power from local utility bulk power plants, usually constructed in nearby rural areas, to large load centers in metropolitan areas. This has evolved over time to building transmission to even more remote baseload generation and interconnecting with neighboring utilities to take advantage of jointly owned generating stations and emergency assistance. Central station wind and solar have significant cost advantages over distributed resources, but prime locations are remote from Arkansas and in very rural areas without significant electric transmission infrastructure. If regional and national bulk electric transmission lines (the equivalent of the interstate highway system) are not built, access to significant and cost-effective renewable

generation will be obstructed, and goals for such must be scaled back to levels reliably and economically achievable.

### **Status of Group Approval**

Complete.

### **Level of Group Support**

Majority (10 objections).

### **Barriers to Consensus**

Ten of the 21 GCGW members present objected to this policy because (1) they do not agree with the mandatory requirement of the RPS if the REFIT policy has not achieved 250 MW (half of the 2015 goal) of renewables by 2012, and (2) the policy has a high associated cost.

## ES-3b. Renewable Energy Feed-In Tariff (REFIT)

### Policy Description

Renewable Energy Feed-In Tariff (REFIT) is a policy recommendation that provides guaranteed above-market rates for a given period to entities that install qualifying sources of renewable energy and sell energy back to the grid. The higher rate helps overcome the cost disadvantages of renewable energy sources and may be set at different levels for the various forms of renewable power generation. Utilities would be able to recover the cost of the program, plus a reasonable profit, from their ratepayer base. In cases where the entity does not have the capital available to finance the renewable energy installation, it can display this utility guarantee to a financial institute to aid in obtaining a loan for the purchase price of the installation.

“Renewable energy” is defined as energy from wind, solar (to include at least PVs and concentrating solar), advanced biomass (i.e., biomass other than corn-based ethanol), geothermal, and new hydroelectric installations, including additional generated power at existing installations. This definition puts no restriction on the size of a qualifying facility. The size of the installation should be taken into account by a sliding payment scale that gives smaller per-kilowatt-hour (kWh) payments to larger facilities (facilities having a larger maximum power output).

Some observers contend that Arkansas has significant amounts of such electricity-producing new renewable energy resources, while others contend that these resources exist only in insignificant amounts. It is partly for this reason that a mandated RPS is controversial and, for utilities, risky. By avoiding mandates, the REFIT avoids these controversies and risks, while maximizing investments in renewable energy sources. This type of program was pioneered by Germany during 1990–2000, and is behind the large growth in wind power in Spain, Germany, and Denmark. These countries now get 9%, 5%, and 20% of their electricity, respectively, from wind, and are beginning to branch out into solar PV and other forms of renewable electricity.

### Policy Design

#### Goals:

- Require utilities to purchase electricity from individuals, municipal or local governments, or companies that own qualifying renewable energy facilities by means of a REFIT. The REFIT will stipulate government-set, above-market electricity rates and for a guaranteed 20-year period, for renewable electricity from approved sources. The rates should be high enough to provide an incentive for individuals or companies to install renewable energy systems.
- Establish a program that will encourage financing for such individuals or companies to install approved renewable electricity sources, and to allow utilities to recover the cost of this program (plus a reasonable profit) from their ratepayer base.
- Approved forms of renewable energy should include at least wind and solar, where “solar” should include at least PV and solar-thermal (often called “concentrating solar”). The above-market guaranteed rate is expected to be different for different forms of renewable energy.

The REFIT can be controlled by putting a limit on ratepayer impact, whereby an increase of 5% or less in rates is dedicated to the program.

**Timing:** Such a program should not take long to establish and could be in operation by perhaps 2010. It is difficult to say how many individuals or firms will want to take advantage of this incentive program, so it is difficult to predict the amount of electricity that might be generated renewably. A reasonable goal (which is not to be construed as a mandate) might be 500 MW by 2015, with at least 20 MW going to wind and 20 MW going to solar. The program might be expected to start small and to grow, depending on how viable wind and solar and other renewable forms of electricity turn out to be in Arkansas.

**Parties Involved:** Investor-owned utilities, electric cooperatives, state government.

### Implementation Mechanisms

For utilities subject to the authority of the APSC, the APSC should review any allocations that are subsidies coming from ratepayers and ensure that there is not inappropriate cross-subsidization between classes of consumers. For utilities (e.g., municipal utilities) that are not subject to the authority of the APSC, the governing body for the utility should review any allocations that are subsidies coming from ratepayers and ensure that there is not inappropriate cross-subsidization between classes of consumers.

### Related Policies/Programs in Place

None cited.

### Type(s) of GHG Reductions

Reductions in all GHG emissions from energy production and GHG emissions associated with process operational emissions and energy consumption.

### Estimated GHG Reductions and Costs or Cost Savings

This policy recommendation was analyzed relative to several plausible scenarios regarding the efficacy of feed-in tariffs when applied to the Arkansas context. This was necessary insofar as there is limited literature on the transferability of the German and Japanese experiences with the use of feed-in tariffs for the stimulation of renewable energy development in other settings.

Following are three major assumptions regarding the transferability of the German and Japanese experiences with the use of feed-in tariffs. They have:

- Half the efficacy of the German experience.
- Three-fourths of the efficacy of the German experience.
- One-to-one transferability of the German experience. *This was the default assumption.*

In addition to these assumptions, different trajectories in the penetrations of renewable energy resulting in the application of the feed-in tariffs in Arkansas were assumed, as follows:

- Achieve the same level as the RPS (i.e., 15% of gross in-state electricity generation by 2025).

- Achieve renewable energy penetration in 2025 consistent with a rate impact of less than 5% of the projected retail electricity rate. *This was the default assumption.*
- Achieve a greater level than the RPS (i.e., 25% of gross in-state electricity generation by 2025).

The above combination of scenarios and sensitivities results in a total of 18 sets of results for this policy recommendation. However, only the results for the default assumptions for this recommendation are provided in Table H-3b-1, below. The sections that follow describe the data sources, quantification approach, and key assumptions used in the development of these results.

**Table H-3b-1. Summarized results of policy recommendation ES-3b**

No.	Policy Recommendation	GHG Reductions (MMtCO <sub>2</sub> e)			Net Present Value (Million \$)	Cost-Effectiveness (\$/tCO <sub>2</sub> e)
		2015	2025	Total 2009–2025		
ES-3b	REFIT	0.2	2.0	12.3	\$398.7	\$32.5

GHG = greenhouse gas; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; \$/tCO<sub>2</sub>e = dollars per metric ton of carbon dioxide equivalent; RPS = renewable portfolio standard.

**Data Sources:**

- John Farrell. “Minnesota Feed-In Tariff Could Lower Cost, Boost Renewables and Expand Local Ownership.” New Rules Project. January 2008. Available at: <http://www.newrules.org/de/feed-in-tariffs.pdf>.
- Friends of the Earth. “What Is a Feed-in Tariff and Why Does the UK Need One To Support Renewable Energy?” Briefing Note. April 2008. Available at: [http://www.foe.co.uk/resource/briefing\\_notes/feedin\\_tariff.pdf](http://www.foe.co.uk/resource/briefing_notes/feedin_tariff.pdf).
- Paul Gipe. “Feed Law Powers Germany to New Renewable Energy Record.” February 5, 2007. Available at: <http://www.renewableenergyworld.com/rea/news/story?id=47322>.
- All other data sources, including cost and performance assumptions as well as plant-specific Arkansas capacity addition data, are the same as assumed for ES-3a.

**Quantification Methods:**

See Annex H-1 for the overall approach to the quantification of this and all other energy supply policy recommendations.

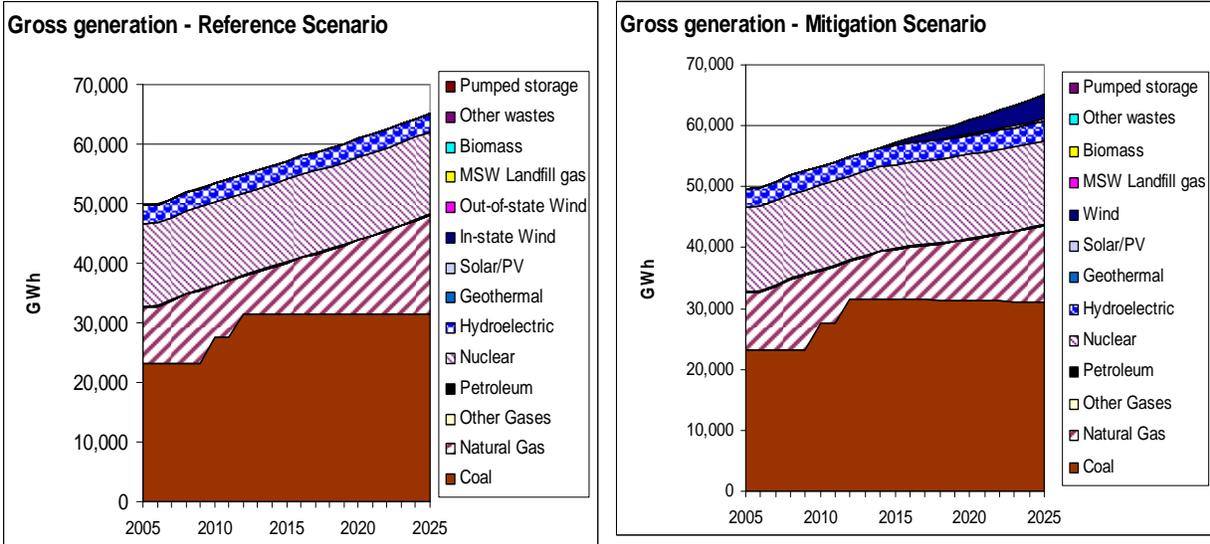
This is a policy recommendation to implement incentives available to residential, commercial, and industrial electricity customers to install renewable energy technologies. The TWG has made the following key assumptions for the analysis of this recommendation:

- One reference scenario is modeled, assuming the Hempstead plant is built.
- The start year for the policy recommendation is 2015 (500 MW minimum renewable capacity additions).

- Incremental renewable energy generation associated with the implementation of the feed-in tariff displaces marginal generation comprising 90% natural gas-fired and 10% coal-fired generation in each year new renewable capacity comes on line.
- The mix of new renewable resources to come on line is assumed to be wind and solar PV due to the fact that these resources were the ones for which data were available for the German experience.
- All new wind capacity is installed at demand sites in high wind resource areas in Arkansas.
- Additional transmission capacity will need to be built to accommodate new wind energy generation in excess of that needed to satisfy installer demand.
- No capacity credit for intermittent renewables is assumed (i.e., wind and solar PV), as the recommendation focuses on demand-side installation outside utility planning protocols.
- The cost of new renewable resources is compared to the average avoided cost of electricity expansion in Arkansas, as obtained from the RCI TWG (i.e., \$58.3/MWh). This value was assumed to be applicable for all scenarios and sensitivities.

Figure H-3b-1 summarizes the impact of ES-3b on in-state gross generation. An additional 4,024 GWh of wind and 447 GWh of solar PV is achieved by 2025.

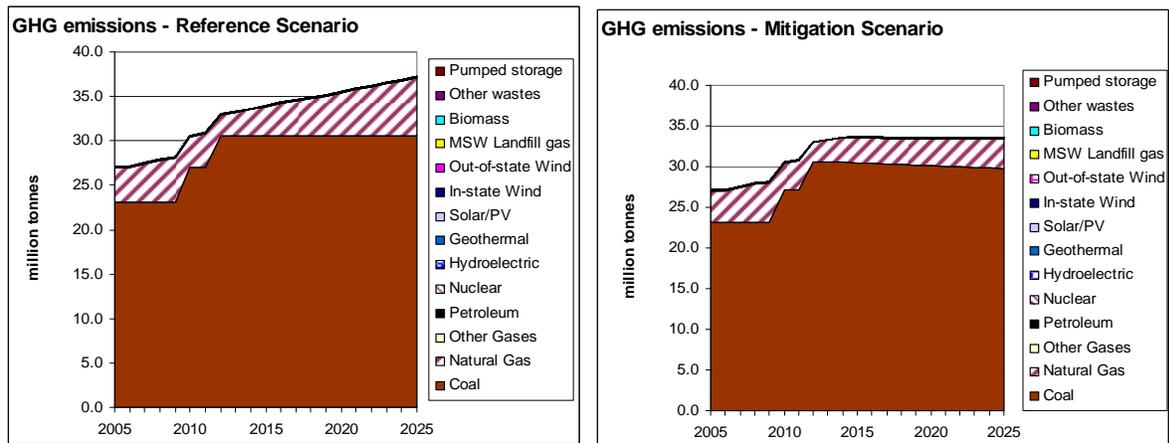
**Figure H-3b-1. Gross generation**



GWh - gigawatt-hours; MSW = municipal solid waste; PV = photovoltaic.

Figure H-3b-2 summarizes the impact of ES-3b on CO<sub>2</sub>e emission levels. The annual reductions due to the feed-in tariff reach about 2.0 MMtCO<sub>2</sub>e by 2025. Cumulative emission reductions over the planning period total 12.3 MMtCO<sub>2</sub>e.

**Figure H-3b-2. GHG emissions**



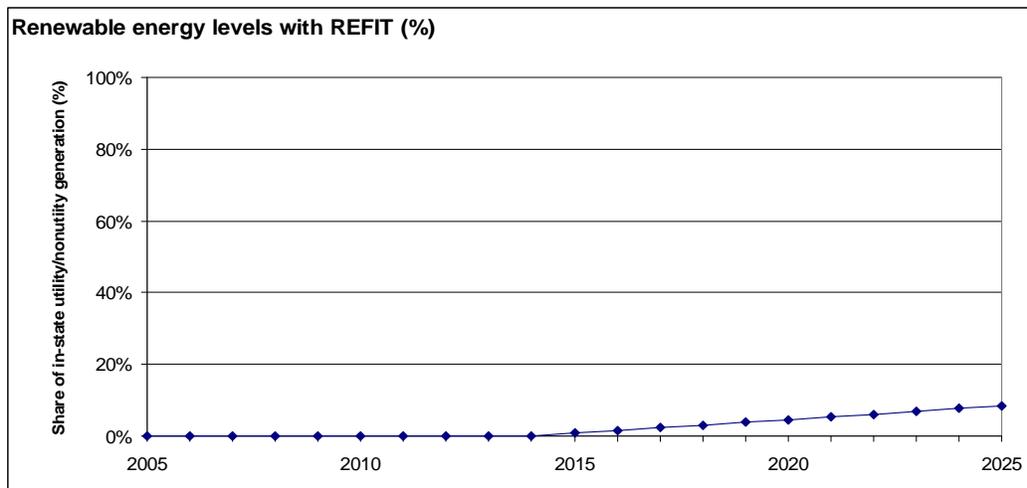
GWh - gigawatt-hours; MSW = municipal solid waste; PV = photovoltaic.

Cost savings are associated with avoided capital, fuel, and O&M costs. Incremental costs are associated with the capital, transmission, variable and fixed O&M, and fuel costs associated with the RPS. The annual product of real levelized costs and displaced generation is an estimate of the annual costs. The sum of the annual costs and annual benefits provides an estimate of the net costs of the feed-in tariff. The NPV of the costs is \$0.51 billion over the 2015–2025 period (2005\$). The cost-effectiveness of the various runs is calculated as the quotient of the NPV and cumulative GHG emission reduction and is equal to \$41.7/MWh (2005\$).

**Key Assumptions:**

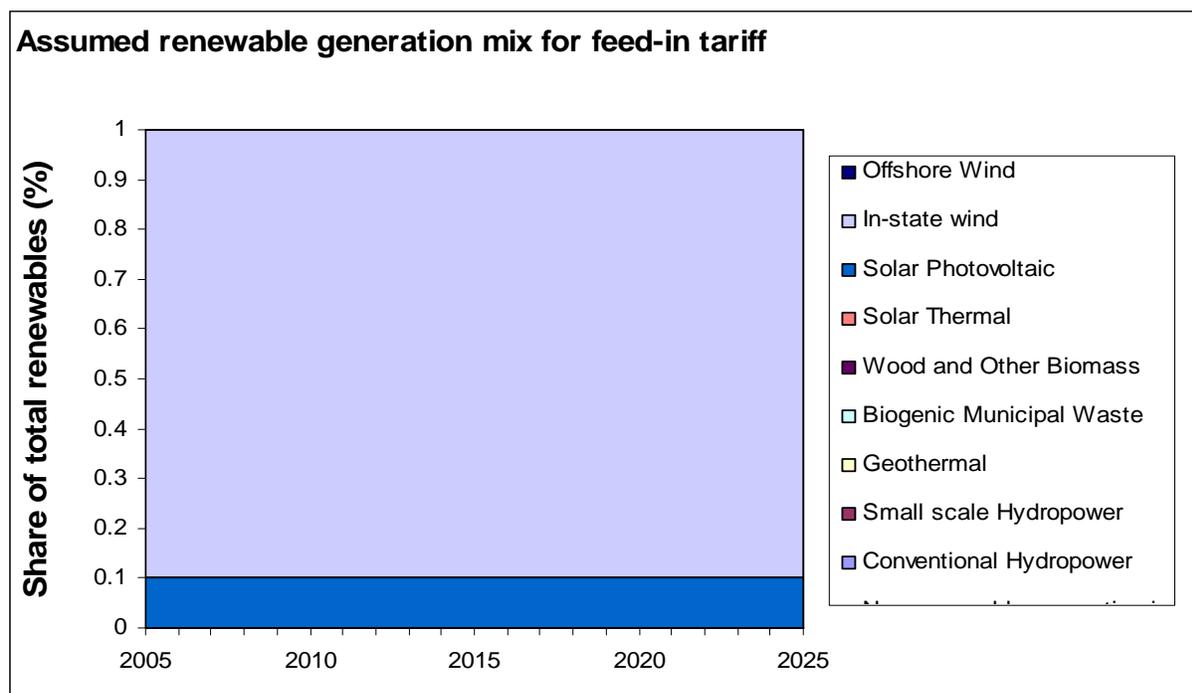
*Renewable Energy Target*—This is defined as the percentage of in-state electricity production, and is summarized in Figure ES-3b-3.

**Figure H-3b-3. Assumed renewable energy target**



*Renewable Energy Mix*—This is defined as the least-cost plan for the expansion of renewable capacity in the state, and is summarized in Figure H-3b-4.

**Figure H-3b-4. Assumed renewable generation energy mix for REFIT**



*Assumed Cost and Performance Characteristics of New Capacity in Arkansas*—These are obtained from the various sources indicated earlier, and are summarized in Table H-3a-2.

*Levelized Costs of New Renewable Capacity*—These are computed using an annual inflation rate of 2.5%, a real discount rate of 5%, an after-tax weighted cost of capital of 9%, and a levelization period of 20 years, and are summarized in Table H-3a-3.

*Levelized Costs for NGCT Used for Reliability Purposes*—As noted earlier, NGCT units are not assumed, given that much of the reliability needs are mitigated by the fact that these are demand-side options that do not need transmission and distribution (T&D) for meeting customer demand.

**Key Uncertainties**

The costs of renewable energy technologies, the price forecast for natural gas and coal delivered to regional power stations, the applicability of avoided costs over the planning period for both reference scenarios, and the reliability needs for dispatchable power under a REFIT regime.

**Additional Benefits and Costs**

None cited.

**Feasibility Issues**

The functioning of the electric transmission network is somewhat analogous to the nation’s system of roadways. High-voltage transmission lines were originally constructed to efficiently transport power from local utility bulk power plants, usually constructed in nearby rural areas, to large load centers in metropolitan areas. This has evolved over time to building transmission to even more remote baseload generation and interconnecting with neighboring utilities to take

advantage of jointly owned generating stations and emergency assistance. Central station wind and solar have significant cost advantages over distributed resources, but prime locations are remote from Arkansas and in very rural areas without significant electric transmission infrastructure. If regional and national bulk electric transmission lines (the equivalent of the interstate highway system) are not built, access to significant and cost-effective renewable generation will be obstructed, and goals for such must be scaled back to levels reliably and economically achievable.

### **Status of Group Approval**

Complete.

### **Level of Group Support**

Super Majority (4 objections).

### **Barriers to Consensus**

Four of the 21 GCGW members present objected to this policy because of its high cost, and they believe an increase of 5% or less in rates is too high (the limit on ratepayer impact associated with REFIT should be in the 1%–2% range at most).

## ES-4. Grid-Based Renewable Energy Incentives and/or Barrier Removal

### Policy Description

Arkansas should enact tax incentives and innovative financing programs for residential and commercial utility users who develop or apply successful renewable energy systems. The tax and loan incentives should be proportional to the amount of renewable energy they are using, with the greatest incentives for those who use net metering and return energy to the grid for use by other utility customers. The Legislative Council, the Arkansas Department of Finance and Revenue, the Arkansas Development Finance Authority, the Arkansas Department of Environmental Quality, and the Arkansas Science and Technology Authority, in coordination with the GCGW and the appropriate legislative leaders, should research model programs in other states and countries and make recommendations on specific policies in time for the next legislative session. In addition, pilot and demonstration programs should be established to demonstrate the effectiveness of these policies as they are implemented. Alternative sources of funding, including foundations, utility companies, and others, should be sought to supplement state revenue for these policies.

This policy recommendation reflects financial incentives to encourage investment in renewable energy resources. Examples include: (1) direct subsidies for purchasing/selling renewable technologies, (2) tax credits or exemptions for purchasing renewable technologies, (3) tax credits for each kWh generated from a qualifying renewable facility, and (4) regulatory policies that provide incentives and/or assurance of cost recovery for utilities that invest in central station renewable energy systems. In addition, this recommendation would make it a priority for the legislature, the APSC, and other relevant state agencies to identify and rectify barriers to the development of renewable resources in the state.

### Policy Design

**Goals:** The initial evaluation should include several different types of financial incentives to represent the range of opportunities.

- Offer tax credits or other incentives of \$1,500 per kW-equivalent for small solar PV, micro-hydro, and small wind.
- Provide a subsidy to renewable energy generators of \$0.01/kWh for electricity generated from a renewable resource, unless that electricity is used to meet a federal, state, or voluntary renewable energy standard.
- Offer low-interest loans for feasible and desirable biomass generation that meets exemplary environmental performance standards, with partial loan forgiveness for equipment that fails to perform to standard.

**Timing:** Tax credits beginning in 2010 and subsidies beginning in 2015.

**Parties Involved:** All power producers operating qualifying facilities for incentives other than tax credits, which would be available to any grid-connected customer.

## Implementation Mechanisms

None specified

## Related Policies/Programs in Place

None cited.

## Type(s) of GHG Reductions

Not applicable.

## Estimated GHG Reductions and Costs or Cost Savings

**Table H-4-1. Estimated GHG reductions and costs of or cost savings from policy recommendation ES-4**

No.	Policy Recommendation	GHG Reductions (MMtCO <sub>2</sub> e)			Net Present Value 2009–2025 (Million \$)	Cost-Effectiveness (\$/tCO <sub>2</sub> e)
		2015	2025	Total 2009–2025		
ES-4	Grid-Based Renewable Energy Incentives and/or Barrier Removal	<i>Not Quantified</i>				

GHG = greenhouse gas; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; \$/tCO<sub>2</sub>e = dollars per metric ton of carbon dioxide equivalent.

**Data Sources:** See ES-3a.

**Quantification Methods:** See ES-3a.

**Key Assumptions:** See ES-3a

## Key Uncertainties

None cited.

## Additional Benefits and Costs

Not applicable.

## Feasibility Issues

None cited.

## Status of Group Approval

Complete.

## Level of Group Support

Unanimous.

## Barriers to Consensus

Not applicable.

## ES-5. Approaches Benefiting From Regional Application

### Policy Description

The primary goal of this policy recommendation is to establish a mechanism that will allow Arkansas to adapt to and be prepared for a federally implemented cap-and-trade system and other federal climate policy. A cap-and-trade system is a market mechanism by which GHG emissions are limited or capped at a specified level, and those participating in the system are required to hold permits for each unit of emissions. Through trading, participants with lower costs of compliance can choose to overcomply and sell their additional reductions to participants for whom compliance costs are higher. In this fashion, overall costs of compliance are lower than they would otherwise be.

### Policy Design

**Goals:** Not quantifiable.

**Timing:** Beginning as soon as possible.

**Parties Involved:** The GCGW or its designee.

### Implementation Mechanisms

None cited.

### Related Policies/Programs in Place

None cited.

### Type(s) of GHG Reductions

Reductions in all GHG emissions from energy production in state and out of state associated with a carbon cap-and-trade system.

### Estimated GHG Reductions and Costs or Cost Savings

The GCGW considers this policy recommendation as not quantifiable.

**Data Sources:** Not applicable.

**Quantification Methods:** Not applicable.

**Key Assumptions:** Not applicable.

### Key Uncertainties

None cited.

**Additional Benefits and Costs**

None cited.

**Feasibility Issues**

None cited.

**Status of Group Approval**

Complete.

**Level of Group Support**

Unanimous.

**Barriers to Consensus**

Not applicable.

## ES-6. Combined Heat and Power

### Policy Description

Combined heat and power (CHP) refers to any system that simultaneously or sequentially generates electric energy and utilizes the thermal energy that is normally wasted. The recovered thermal energy can be used for industrial process steam, space heating, hot water, air conditioning, water cooling, product drying, or nearly any other thermal energy need in the commercial and industrial sectors. The end result is significantly increased efficiency over generating electric and thermal energy separately. In fact, many CHP systems are capable of an overall efficiency of over 80%—double that of conventional systems. Another significant advantage is the reduced T&D losses associated with centralized power generation.

### Policy Design

Reports from the Energy Information Administration (EIA) show 16 distributed generation (DG) units in Arkansas with a capacity of 1–20 MW with a combined capacity of 126 MW. Annual energy production from these facilities exceeds 785 GWh, equivalent to less than 2% of retail energy sales. Though no assessment of the thermal efficiency is available, the units operate at a relatively high capacity factor, exceeding 70%. According to an assessment by the Electric Power Research Institute, the market adoption of CHP has been limited due to a confluence of barriers, including a lack of compelling savings and economics for end users and a lack of high enough margins for utility or third-party business models.

The combination of higher natural gas prices, the potential increased cost of all fuel-based energy production due to CO<sub>2</sub> restrictions, impediments to expanding the use of coal-based generation, the escalating costs for T&D facilities, and dramatic increases in the capital cost for all bulk power supply options will enhance the savings and economics for CHP. In addition to this natural market incentive for CHP, this policy recommendation proposes incentives in the form of payments to utilities, industries, individuals, or other entities that reduce CO<sub>2</sub> emissions by installing new CHP systems either to capture and use waste heat from electric power plants, or to generate electricity from waste heat produced in industrial processes. The incentives would be paid on a per-ton basis for each ton of saved CO<sub>2</sub>, and would be accompanied by a 20-year guarantee of payment for future avoided CO<sub>2</sub> emissions, paid on a declining scale to phase out in 20 years (see example below under “Goals”). The purpose of the incentives is to encourage small generating facilities to be located next to industries that can use their waste heat, to encourage industries that use process heat to use their waste heat to generate electricity or for other lower-temperature heating applications, and to encourage industries using process heat to locate their operations close enough to existing generating facilities so that they can use the waste heat from those facilities.

Funding for the incentives should come from the utility’s customer base, overseen by the APSC, or from tax money appropriated by the legislature.

The state should expand on EIA survey data to determine the number of existing DG projects that have CHP potential, assessing the energy reductions achievable with forecasted escalating energy costs.

**Goals:** Reduce use of fossil fuel from industrial sources through the employment of new CHP applications incentivized by payments for CO<sub>2</sub> emission reductions. A typical incentive might be a 20-year guaranteed payment of \$40 per ton of avoided CO<sub>2</sub>, with the amount to decline in increments over time, phasing out at the end of 20 years. For example, the amount might decline to \$30 per ton after 5 years, \$20 per ton after 10 years, and \$10 per ton after 15 years. It is hoped that this would reduce the direct use of natural gas in Arkansas by 10%, and would also increase the average energy efficiency of electric power plants by 10% (e.g., from 40% to 50%).

**Timing:** The incentives should be introduced right away, beginning in 2010.

**Parties Involved:** State government and regulators, electric utilities, and renewable energy and CHP industry.

### Implementation Mechanisms

For utilities subject to the authority of the APSC, the APSC should review any allocations that are subsidies coming from ratepayers and ensure that there is not inappropriate cross-subsidization between classes of consumers. For utilities (e.g., municipal utilities) that are not subject to the authority of the APSC, the governing body for the utility should review any allocations that are subsidies coming from ratepayers and ensure that there is not inappropriate cross-subsidization between classes of consumers.

### Related Policies/Programs in Place

None cited.

### Type(s) of GHG Reductions

CO<sub>2</sub>e reductions from avoided electricity production and avoided on-site fuel combustion less additional on-site CO<sub>2</sub>e emissions from fuel used in CHP systems.

### Estimated GHG Reductions and Costs or Cost Savings

**Table H-6-1. Estimated GHG reductions from and costs of or cost savings from CHP**

No.	Policy Recommendation	GHG Reductions (MMtCO <sub>2</sub> e)			Net Present Value 2009–2025 (Million \$)	Cost-Effectiveness (\$/tCO <sub>2</sub> e)
		2015	2025	Total 2009–2025		
ES-6	CHP	0.6	2.9	20.0	\$886	\$44.30

GHG = greenhouse gas; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; \$/tCO<sub>2</sub>e = dollars per metric ton of carbon dioxide equivalent.

### **Data Sources:**

- U.S. Department of Energy, Energy Information Administration. "Electrical Power Annual 2006—State Data Tables." Form EIA-906: 1990–2006 Fossil Fuel Consumption for Electricity Generation by Year, Industry Type, and State. October 26, 2007. Available at: [http://www.eia.doe.gov/cneaf/electricity/epa/epa\\_sprdshts.html](http://www.eia.doe.gov/cneaf/electricity/epa/epa_sprdshts.html).
- Minnesota Planning Minnesota Environmental Quality Board. *Inventory of Cogeneration Potential in Minnesota*. August 2001, page iv. Available at: <http://www.eqb.state.mn.us/pdf/2001/CogenInventory.pdf>
- U.S. Department of Energy, Energy Information Administration. *Assumptions to the Annual Energy Outlook 2007*. DOE/EIA-0554(2007). April 2007. Available at: <http://www.eia.doe.gov/oiaf/archive/aeo07/assumption/index.html>
- Spreadsheet entitled "Arkansas CHP 7-17-08.xls." Received July 17, 2008, from Katrina Pielli, Clean Energy Program Manager, U.S. Environmental Protection Agency (EPA).

### **Quantification Methods:**

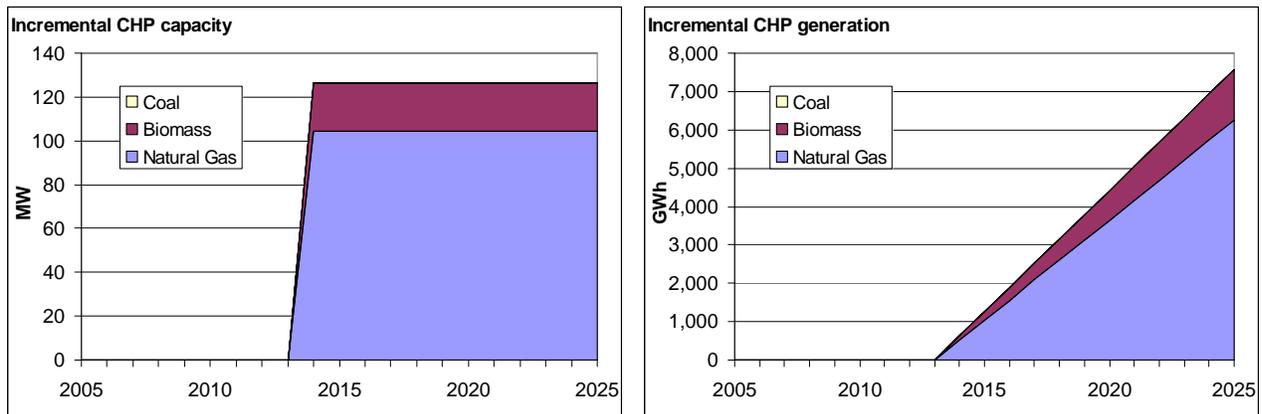
See Annex H-1 for the overall approach to the quantification of this and all other energy supply recommendations.

This policy recommendation requires increased used of highly efficient CHP facilities in Arkansas. The TWG is making the following key assumptions for the analysis of this recommendation:

- One reference scenario is modeled, assuming the Hempstead plant is built.
- The start year for the policy recommendation is 2013.
- Incremental electricity generation provided to the grid from new CHP systems displaces marginal generation comprising 90% natural gas-fired and 10% coal-fired generation in each year new renewable capacity comes on line.

Regarding incremental CHP capacity and corresponding electricity generation, the following capacity trajectory in Figure H-6-1 was assumed based on a recent study by the U.S. Environmental Protection Agency regarding the maximum achievable potential of CHP systems in Arkansas.

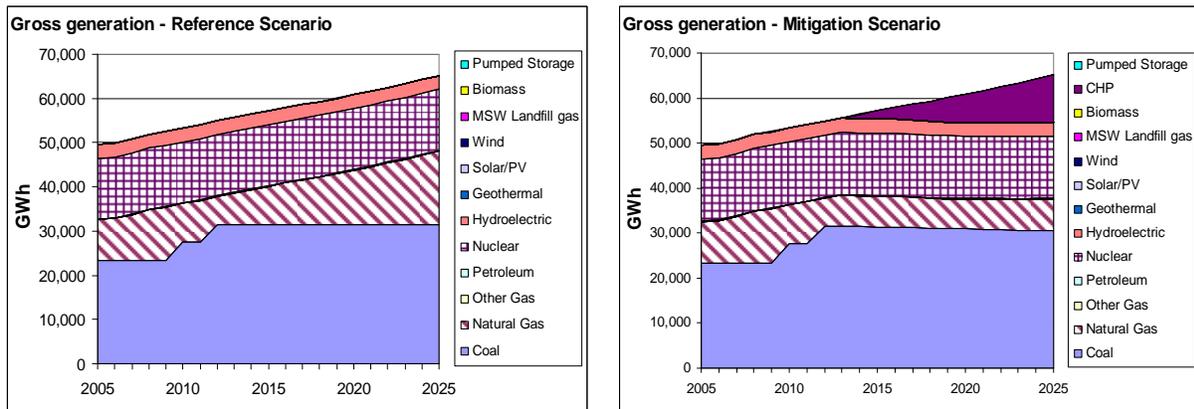
**Figure H-6-1. Assumed CHP capacity trajectory in Arkansas**



MW = megawatts; GWh = gigawatt-hours; CHP = combined heat and power

Figure H-6-2 summarizes the incremental impact of CHP on gross generation. The incremental effect of CHP by 2025 is about 7,574 GWh, with 83% of this amount coming from natural gas and the balance from biomass. After accounting for avoided T&D losses, displaced coal-fired generation in 2025 is 1,055 GWh, and natural gas-fired generation is 9,494 GWh.

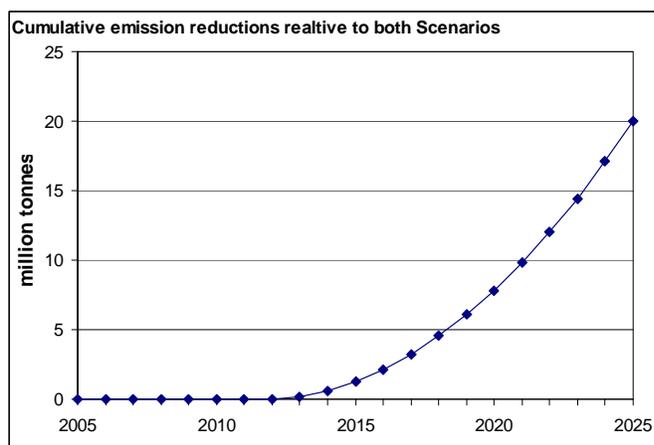
**Figure H-6-2. Incremental impact of CHP on gross generation**



GWh = gigawatt-hours; CHP = combined heat and power; MSW = municipal solid waste; PV = photovoltaic.

Figure H-6-3 summarizes the impact of this policy recommendation on cumulative CO<sub>2</sub>e emission reductions. The cumulative reductions due to new CHP facilities reach about 20.0 MMtCO<sub>2</sub>e avoided emissions by 2025.

**Figure H-6-3. Cumulative emission reductions with CHP**



Cost savings are associated with avoided capital, fuel, and O&M costs. Incremental costs are associated with the capital, transmission, variable and fixed O&M, and fuel costs associated with new CHP facilities. The annual product of real levelized costs and displaced generation is an estimate of the annual costs. The sum of the annual costs and annual benefits provides an estimate of the net costs of the policy recommendation. The NPV of the costs is \$0.89 billion over the 2015–2025 period (2005\$). The recommendation's cost-effectiveness is calculated as the quotient of the NPV and cumulative GHG emission reductions and is \$44.3/tCO<sub>2</sub>e (2005\$) (i.e., \$0.89 billion divided by 20.0 MMtCO<sub>2</sub>e and multiplied by a conversion factor of 1,000).

**Key Assumptions:**

**Table H-6-2. Existing CHP in Arkansas**

Application	Sites	MW
SIC 20: Food Processing	3	18.7
SIC 24: Wood Products	2	22.5
SIC 26: Paper	4	423.5
SIC 4952: WWTP	1	1.7
SIC 8060: Healthcare	1	8.5
SIC 8220: College/Univ	1	4.1
Total	12	479.0

CHP = combined heat and power; MW = megawatts.

**Table H-6-3. CHP potential at existing industrial and commercial/institutional facilities, 2003: within-the-fence thermal and electric**

	100 kW to 1 MW		1 MW to 5 MW		5 MW to 20 MW		> 20 MW		Total	
	Sites	MW	Sites	MW	Sites	MW	Sites	MW	Sites	MW
Industrial	509	79	222	322	57	499	5	206	793	1,105
Commercial	2,001	220	109	117	13	73	0	0	2,123	410
Total	2,510	298	331	439	70	572	5	206	2,916	1,515

CHP = combined heat and power; kW = kilowatts; MW = megawatts.

**Table H-6-4. CHP cost and performance**

Parameter	NG	Biomass	Coal
Average full-capacity-equivalent hours of operation	5,000	5,000	5,000
Fraction of new capacity	90%	5%	5%
Average net heat rate by fuel (btu per kWh)	10,000	13,000	12,000
Useable cogenerated heat output (% energy input)	40%	40%	40%
Fraction useable heat output replacing space/water/process heat	90%	90%	90%
Average overnight installed capital costs by fuel type (2005\$/kW)	\$2,000	\$2,500	\$2,500
CHP transmission cost (2005\$/kW)	\$0	\$0	\$0
Economic life of system (years)	20	20	20
Fixed O&M costs (2005\$/kW)	0	0	0
Variable O&M costs (2005 \$/MWh)	16.00	20.00	20.00

Btu = British thermal unit; CHP = combined heat and power; kW = kilowatts; kWh = kilowatt-hours; MWh = megawatt-hours; NG = natural gas; O&M = operation and maintenance.

**Table H-6-5. Industrial sector energy costs in West South Central Region (2005\$/MMBtu)**

	2005	2010	2015	2020	2025	Source
Distillate Fuel	14.00	15.58	13.82	14.38	14.84	AEO2007 for West North Central region
Natural Gas	7.87	6.47	5.42	5.60	6.00	AEO2007 for West North Central region
Steam Coal	1.48	1.82	1.88	1.93	1.97	AEO2007 for West North Central region
Biomass	2.50	2.50	2.50	2.50	2.50	AEO2007 for West North Central region
electricity	20.01	20.46	18.55	18.59	18.98	AEO2007 for West North Central region

\$/MMBtu = dollars per million British thermal units

### Key Uncertainties

The costs of new CHP units, integration into electric system, projected fuel prices, available markets for heat production, and CHP potential in Arkansas.

### Additional Benefits and Costs

None cited.

### Feasibility Issues

None cited.

### Status of Group Approval

Approved.

### Level of Group Support

Unanimous.

### Barriers to Consensus

Not applicable.

## ES-7. Geological Underground Sequestration for New Plants

### Policy Description

This policy refers to the capture of CO<sub>2</sub> from fossil fuel-fired power plant emissions and its sequestration in geologic formations, including oil and gas reservoirs, coal seams that cannot be mined, and deep saline reservoirs. Broadly, three different types of technologies exist: post-combustion, pre-combustion, and oxyfuel combustion. After capture, the CO<sub>2</sub> must be transported to suitable storage sites; this is often accomplished via pipeline.

### Policy Design

This policy affects all new coal-fired power plants, both those that are currently under construction and those that have not yet received full approval for construction in Arkansas. Plants currently under construction (including the Plum Point plant) should install and employ post-combustion carbon capture and storage (CCS) as soon after the plant's opening as the technology becomes available. Plants that have not yet received full approval for construction (including the Hempstead plant) should employ CCS as soon as they begin operations. All other new coal-fired generating plants should employ state-of-the-art pre-combustion CCS as soon as they begin operations.

This policy implies that, except for the already-permitted Plum Point plant, there will be no new coal-fired generating plants in Arkansas until sequestration is ready. Until that time, the electricity that would have been generated by new plants should be replaced with expanded energy efficiency, renewable energy, and, as a last resort, natural gas combined-cycle (NGCC) technology.

**Goals:** Capture 80%–90% of CO<sub>2</sub> emissions from new power plants.

**Timing:** Reductions achieved beginning in 2020.

**Parties Involved:** Large, new, coal-fired power plants.

### Implementation Mechanisms

None cited.

### Related Policies/Programs in Place

None cited.

### Type(s) of GHG Reductions

Avoided emissions from fossil-fuel generation.

### Estimated GHG Reductions and Costs or Cost Savings

This policy recommendation was analyzed relative to the scenario described below:

- In place of the 2012 date for bringing the Hempstead plant on line, introduce expanded demand-side energy efficiency, renewable energy (wind), and NGCC units to replace the power that would have been generated by the Hempstead plant.
- In 2020, build the Hempstead plant (pulverized coal) with post-combustion (i.e., chemical absorption with monoethanolamine) CCS technology and in-state sequestration. Export power generated to SPP and SERC regions.
- In 2020, add post-combustion CCS technology (i.e., chemical absorption with monoethanolamine) and in-state sequestration to the Plum Point plant.

The results for the analysis of the above scenario are summarized in Table H-7-1. The sections that follow describe the data sources, quantification approach, and key assumptions used in the development of these results.

**Table H-7-1. Estimated GHG reductions from and costs of or cost savings from ES-7**

No.	Policy Recommendation	GHG Reductions (MMtCO <sub>2</sub> e)			Net Present Value (Million \$)	Cost-Effectiveness (\$/tCO <sub>2</sub> e)
		2015	2025	Total 2009–2025		
ES-7	Geological Underground Sequestration for New Plants	2.9	5.6	36.8	\$1,801	\$31.9

\$/CO<sub>2</sub>e = dollars per metric ton of carbon dioxide equivalent; GHG = greenhouse gas; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent.

#### Data Sources:

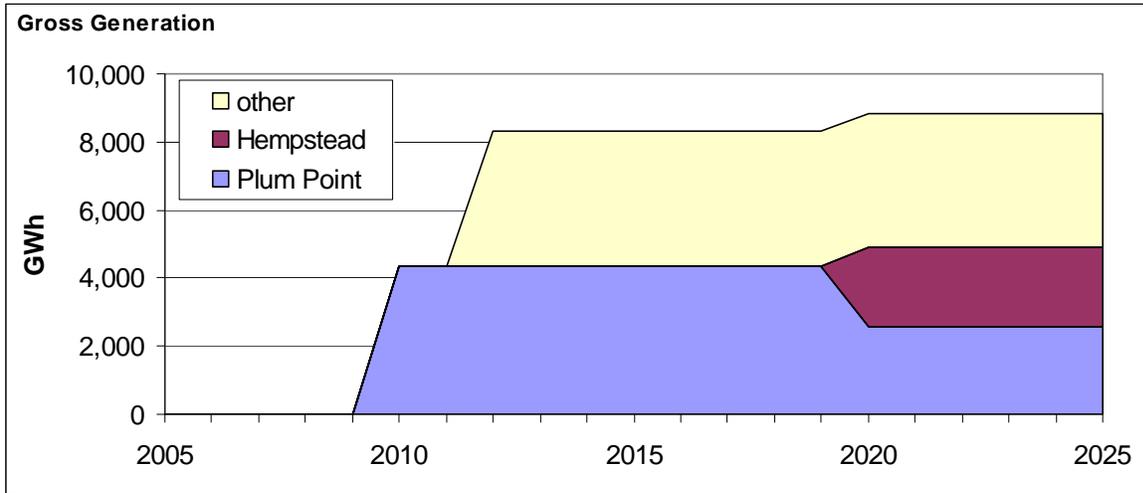
- U.S. Department of Energy, Energy Information Administration. *State Electricity Profiles 2005*. DOE/EIA-0348(01)/2. March 6, 2007. Available at: [http://tonto.eia.doe.gov/ftproot/electricity/stateprofiles/05st\\_profiles/062905.pdf](http://tonto.eia.doe.gov/ftproot/electricity/stateprofiles/05st_profiles/062905.pdf).
- Other renewables for CHP units are from U.S. Department of Energy, Energy Information Administration. Table 5. State Renewable Electric Power Industry Net Generation, by Energy Source. Derived from Form EIA-906: Power Plant Report and EIA-920: Combined Heat and Power Plant Report. Available at: [http://www.eia.doe.gov/cneaf/solar.renewables/page/state\\_profiles/rspt05ar.xls](http://www.eia.doe.gov/cneaf/solar.renewables/page/state_profiles/rspt05ar.xls).
- Spreadsheet entitled GenY06-summary.xls, obtained from Arkansas ES TWG detailing 2006 annual generation for electric production facilities in Arkansas.

#### Quantification Methods:

Regarding in-state gross generation, the impact of this recommendation on the Plum Point and Hempstead plants is summarized in Figure H-7-1. The incremental effect of the recommendation on the Plum Point plant shows that during 2020–2025, the period post-combustion carbon capture technology is operational, generation decreases by about 1,800 GWh due to derating associated with the retrofit. During 2012–2019, a combination of demand-side efficiency, wind, and NGCC generation are added to compensate for the deferral of the online year for the Hempstead plant. These resources are assumed to continue in the 2020–2025 period, when the

Hempstead plant comes on line. During this period, annual generation for the Hempstead plant is 2,326 GWh, after accounting for derating from the installation of post-combustion carbon capture technology.

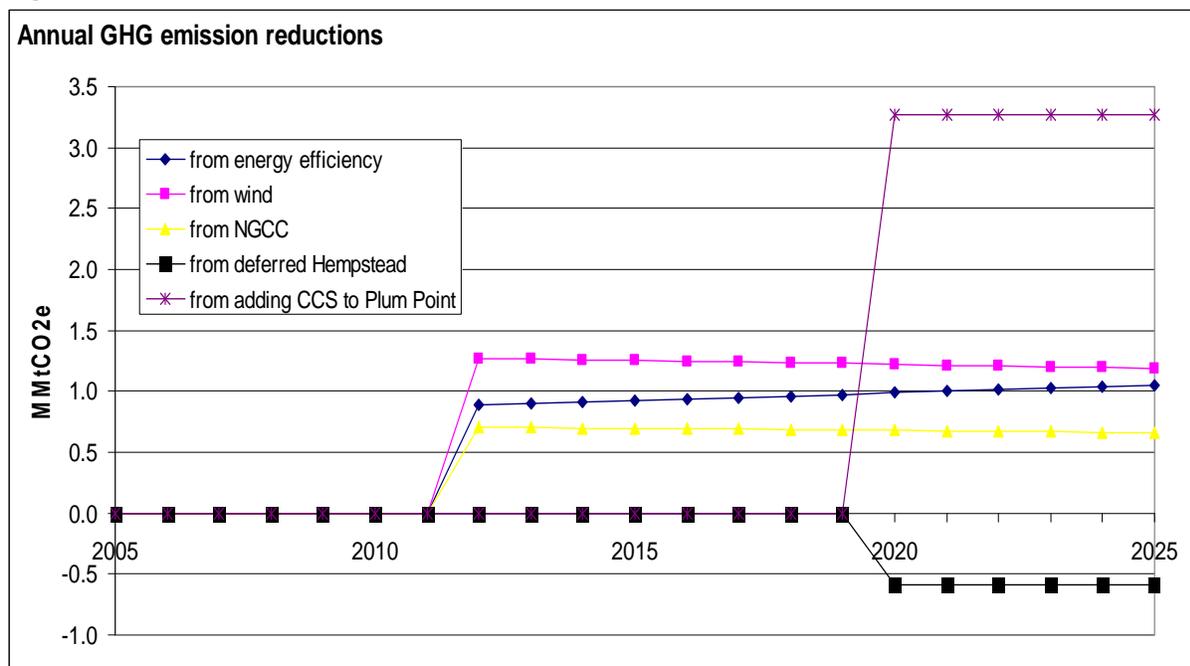
**Figure H-7-1. Generation profile**



GWh = gigawatt-hours.

Regarding CO<sub>2</sub>-equivalent (CO<sub>2</sub>e) emission reductions, the impact of this policy recommendation is summarized in Figure H-7-2 on a production basis. By 2025 the policy results in annual emission reductions of about 5.9 MMtCO<sub>2</sub>e. This is made up of reductions of 3.33 MMtCO<sub>2</sub>e (from adding carbon capture to the Plum Point plant), reductions of about 3 MMtCO<sub>2</sub>e (from energy efficiency, wind, and natural gas-fired generation to offset Hempstead generation), and an increase of 0.6 MMtCO<sub>2</sub>e (from additional emissions associated with construction of the Hempstead plant, whose generation is exported). On a cumulative basis, the recommendation leads to reductions of 56.5 MMtCO<sub>2</sub>e.

**Figure H-7-2. GHG emission reduction profile**



CCS = carbon capture and storage; GHG = greenhouse gas; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; NGCC = natural gas combined cycle.

Cost savings are associated with avoided capital, fuel, and O&M costs for coal and natural gas facilities from the additional demand-side efficiency measures. Incremental costs are associated with capital, transmission, variable and fixed O&M, and fuel costs associated with the new wind, NGCC stations, and CCS technology. The annual product of real levelized costs and displaced generation is an estimate of the annual costs. The sum of the annual costs and annual benefits provides an estimate of the net costs of the policy recommendation. The NPV of the costs is \$1.8 billion over the 2012–2025 period (2005\$). The policy's cost-effectiveness is calculated as the quotient of the NPV and cumulative GHG emission reductions. For the central estimate of cost and performance, it is \$31.9/tCO<sub>2</sub>e (2005\$) (i.e., \$1.8 billion divided by 56.5 MMt and multiplied by a conversion factor of 1,000).

**Key Assumptions:**

Tables H-7-3, H-7-4, and H-7-5 summarize key assumptions used in the analysis.

**Table H-7-3. Real levelized costs for new power supply (2005\$/MWh)**

Capacity type	Capacity	Transmission	Fixed O&M	Variable O&M	Fuel	Total
Pulverized coal	24.6	0.0	3.2	4.6	12.1	44.4
IGCC	30.9	0.0	4.8	6.2	12.4	54.4
Natural Gas CC	8.9	0.0	1.3	1.3	54.9	66.4
IGCC/CCS (low)	42.3	0.0	5.2	6.2	17.1	70.8
IGCC/CCS (mid): out-of-state	47.5	0.0	5.2	6.2	15.2	74.1
IGCC/CCS (high)	51.8	0.0	5.2	6.2	13.4	76.5
Wind	65.7	2.9	9.2	0.0	0.0	77.8

CC = combined cycle; CCS = carbon capture and storage; IGCC = integrated gasification combined cycle; MWh = megawatt-hour; O&M = operation and maintenance.

**Table H-7-4. Real levelized costs for retrofitting existing coal stations with CCS technology (2005\$/MWh)**

	Capacity	Transport in state	Transport out-of-state	Fixed O&M	Variable O&M	Fuel	Storage	Monitoring	Total
MEA	29.3	1.5	13.3	0.0	11.9	10.2	13.3	6.2	85.9
Oxy-firing	19.1	1.5	13.3	0.0	15.9	8.0	13.3	6.2	77.4

CCS = carbon capture and storage; MEA = monoethanolamine; MWh = megawatt-hour; O&M = operation and maintenance.

**Table H-7-5. Real levelized costs NGCT for reliability associated with intermittent renewables (2005\$/MWh)**

Capacity type	Capacity	Transmission	Fixed O&M	Variable O&M	Fuel	Total	Capacity factor (%)	Fuel factor (%)
CT	13.4	0.0	0.3	3.5	20.0	37.2	50%	25%

NGCT = natural gas combustion turbine; O&M = operation and maintenance.

DSM measure costs: \$30/MWh (average).

### Key Uncertainties

Costs and availability of post-combustion CCS technology, availability of suitable CO<sub>2</sub> storage sites in Arkansas, price forecast for natural gas and coal delivered to regional power stations, reliability needs for wind power, and uncertainty about potential liability and insurance issues associated with CCS.

### Additional Benefits and Costs

None cited.

### Feasibility Issues

None cited.

### Status of Group Approval

Complete.

### Level of Group Support

Majority (10 objections).

### Barriers to Consensus

Ten of the 21 GCGW members present objected to this policy because it recommends that construction of the Hempstead (Turk) coal plant be delayed until 2020, the Hempstead plant will be the cleanest and most efficient coal plant built to date, it is uncertain if CCS technology can be demonstrated to be commercially viable and cost-effective by 2020, potential cost issues are associated with relying on renewables and other resources that may not be able to fulfill baseload demand that otherwise would be fulfilled by a coal plant like Hempstead, and the APSC is

requiring the Southwestern Electric Power Company to review annually all carbon sequestration and capture technologies as available in the future.

One GCGW member objected on the basis that this would be de facto retroactive policymaking. Industry has a right to presume that the rules will not change in midstream on projects once they are begun. If the Commission wants to draw a line in the sand on the issue of coal-fired power plants, that must be done in the future and must not impact plants in which significant investments have already been made under a current policy structure.

## ES-8. Transmission System Upgrades

### Policy Description

Measures to improve transmission systems to reduce bottlenecks and enhance throughput may be required to satisfy long-term electricity demands, improve the efficiency of operations, and allow for delivery of diverse and renewable energy sources located outside of the state. Opportunities may exist to substantially increase transmission line carrying capacity through the implementation of new construction and retrofit activities on the transmission grid, including incorporating advanced composite conductor technologies, capacitance technologies, and grid management software. Siting new transmission lines can be a difficult process, given their cost and their local impact on the environment and on the use, enjoyment, and value of property.

### Policy Design

A primary goal of this policy recommendation can be to provide incentives to utilities to upgrade existing transmission systems and reduce barriers to siting new transmission lines to provide access to new energy sources often far from existing transmission lines and load centers.

Another goal of this policy can be to reduce T&D line losses. Utilities use a variety of components throughout the T&D system to manage losses. Increasing the efficiency of these components can further reduce losses and associated GHG emissions. For example, Vermont offers a rebate to encourage the installation of energy-efficient transformers. Regulations, incentives, and/or support programs can be applied to achieve greater efficiency of T&D system components.

A third goal can be the general distribution of generation support (interconnection rules, net metering, etc.). Well-designed interconnection rules will ensure that distributed power products meet minimum requirements for performance, safety, and maintenance, while at the same time significantly advance the commercialization of these technologies.

#### Goals:

- Achieve a 5% effective improvement in energy efficiency through reduced T&D system losses (i.e., losses reduced from 6.5% to 6.2%).
- Achieve a 5% increase in renewable energy sources through improved transmission access to these sources.

**Timing:** Phased in, beginning in 2013, with the established goal achieved by 2018.

**Parties Involved:** APSC, investor-owned utilities, generation and transmission electric cooperatives, municipalities, representatives of environmental and economic development organizations, the Federal Energy Regulatory Commission, and transmission owners and operators.

## Implementation Mechanisms

None cited.

## Related Policies/Programs in Place

None cited.

## Type(s) of GHG Reductions

Not applicable.

## Estimated GHG Reductions and Costs or Cost Savings

**Table H-8-1. Estimated GHG reductions from and costs of or cost savings from ES-8**

No.	Policy Recommendation	GHG Reductions (MMtCO <sub>2</sub> e)			Net Present Value 2009–2025 (Million \$)	Cost-Effectiveness (\$/tCO <sub>2</sub> e)
		2015	2025	Total 2009–2025		
ES-8	Transmission System Upgrades	<i>Not Quantified</i>				

GHG = greenhouse gas; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; \$/tCO<sub>2</sub>e = dollars per ton of carbon dioxide equivalent.

**Data Sources:** See ES-3a.

**Quantification Methods:** See ES-3a.

### Key Assumptions:

- A) The program begins in 2013 and continues through 2018.
- B) 90% of reductions in electricity production will come from coal and 10% from natural gas.
- C) Effective improvements in energy efficiency through reduced T&D line losses occur at a rate of 0.5% per year in 2013 and 2014. The rate increases to 1% per year between 2015 and 2018.
- D) The expected annual cost of line upgrades is \$30 million.
- E) The escalation rate for gross generation and associated CO<sub>2</sub>e emissions beyond 2025 is 0.51%.
- F) The rate at which costs are discounted annually is 5%.
- G) NPV is calculated in 2008 dollars.

## Key Uncertainties

See the Feasibility Issues section.

### **Additional Benefits and Costs**

None cited.

### **Feasibility Issues**

The functioning of the electric transmission network is somewhat analogous to the nation's system of roadways. High-voltage transmission lines were originally constructed to efficiently transport power from local utility bulk power plants, usually constructed in nearby rural areas, to large load centers in metropolitan areas. This has evolved over time to building transmission to even more remote baseload generation, and interconnecting with neighboring utilities to take advantage of jointly owned generating stations and emergency assistance. Central station wind and solar have significant cost advantages over distributed resources, but prime locations are remote from Arkansas and in very rural areas without significant electric transmission infrastructure. If regional and national bulk electric transmission lines (the equivalent of the interstate highway system) are not built, access to significant and cost-effective renewable generation will be obstructed, and goals for such must be scaled back to levels reliably and economically achievable.

### **Status of Group Approval**

Complete.

### **Level of Group Support**

Unanimous.

### **Barriers to Consensus**

Not applicable.

## ES-9. Nuclear Power

### Policy Description

Nuclear power has historically been a low-GHG source of electric power. However, no new nuclear power plants have come on line in the United States since 1996 due to high capital costs. Long-term disposal of nuclear waste and public safety are public policy concerns with nuclear power. With the national pricing of the GHG cost of fossil fuel generation, with either a cap-and-trade system or a carbon tax, nuclear power will be more cost-competitive.

The Energy Policy Act of 2005 included provisions encouraging the construction of new nuclear units. There are currently nine applications for a new plant on file with the Nuclear Regulatory Commission (NRC). The one nearest to Arkansas is adjacent to the existing Grand Gulf unit in Port Gibson, Mississippi; it has been accepted for docketing by the NRC. As new nuclear power plants come on line in the future in the Arkansas region, they will offer Arkansas electric utilities an alternative to the construction of fossil fuel generation units.

Nuclear plant relicensing allows an existing plant to extend the life of the facility for 20 years past its original 40-year license terms. The two existing nuclear units in Arkansas have already completed this process. Thus, no further reductions in current GHG emissions can be achieved through the relicensing process.

### Policy Design

Given the uncertainty of when new nuclear generating capacity will be on line in this region, the GCGW does not recommend a reduction goal achievable with this action. However, the GCGW does go on record supporting the construction of new nuclear power plants.

**Goal:** One new 1,500-MW nuclear plant operating at 95% capacity factor.

**Timing:** Operational in 2020.

**Parties Involved:** APSC.

### Implementation Mechanisms

None cited.

### Related Policies/Programs in Place

None cited.

### Type(s) of GHG Reductions

Avoided emissions from fossil-fuel generation.

## Estimated GHG Reductions and Costs or Cost Savings

Table H-9-1 summarizes the results of this policy recommendation. The sections that follow describe the data sources, quantification approach, and key assumptions used in the development of these results.

**Table H-9-1. Estimated GHG reductions and costs or cost savings from ES-9**

No.	Policy Recommendation	GHG Reductions (MMtCO <sub>2</sub> e)			Net Present Value 2009–2025 (Million \$)	Cost-Effectiveness (\$/tCO <sub>2</sub> e)
		2015	2025	Total 2009–2025		
ES-9	Nuclear Power	0.0	9.8	58.9	\$1,574	\$26.7

GHG = greenhouse gas; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; \$/tCO<sub>2</sub>e = dollars per ton of carbon dioxide equivalent.

### Data Sources:

- California Public Utilities Commission. "New Nuclear Generation Resource, Cost, and Performance Assumptions." November 2007. Available at: <http://www.ethree.com/GHG/25%20Nuclear%20Assumptions%20v2.doc>.
- Upstream carbon emissions for nuclear, coal, and natural gas-fired generation are from Arthur D. Little, Inc. *Guidance for Transportation Technologies: Fuel Choice for Fuel Cell Vehicles—Final Report*. February 2, 2002. Available at: [http://www.eere.energy.gov/hydrogenandfuelcells/pdfs/fuel\\_choice\\_fcvs.pdf](http://www.eere.energy.gov/hydrogenandfuelcells/pdfs/fuel_choice_fcvs.pdf).
- Plant-specific Arkansas capacity addition data are based on Arkansas ES TWG input.
- U.S. Department of Energy. *Energy Technologies and the Environment: Environmental Information Handbook*. Report DOE/EH-077, Washington DC, 1988.
- R.A. Bradley, E.C. Watts, and E.R. Williams, eds. *Limiting Net Greenhouse Gas Emissions in the United States. Volume —Energy Technologies*. Report DOE/PE-0101-Vol.1. Washington, DC, 1991.
- Coal production statistics derived from U.S. Department of Energy, Energy Information Administration. "Annual Coal Report 2003 Data Tables." Available at: [http://www.eia.doe.gov/cneaf/coal/page/acr/acr\\_html\\_tabs.html](http://www.eia.doe.gov/cneaf/coal/page/acr/acr_html_tabs.html).

### Quantification Methods:

See Annex H-1 for the overall approach to the quantification of this and all other energy supply recommendations.

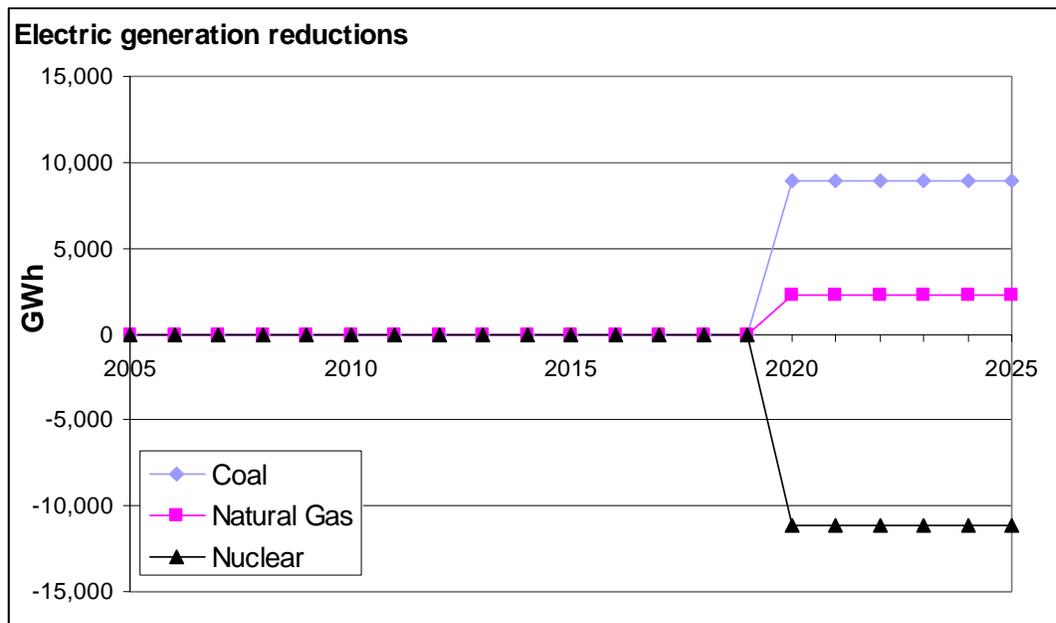
The analysis of this policy recommendation examines the installation a one nuclear power station during the planning period. The following key assumptions were used for the analysis of this recommendation:

- One reference scenario is modeled, assuming the Hempstead plant is built.
- The start year for the policy recommendation is 2020.

- Incremental renewable energy generation associated with the installation of the nuclear station displaces 80% coal-fired and 20% natural gas-fired generation in each year the nuclear station is operational.
- The cost of new nuclear power is compared to the average avoided cost of electricity expansion in Arkansas, as obtained from the RCI TWG (i.e., \$58.3/MWh).
- Full fuel-cycle GHG emissions are considered.
- Three sensitivities are considered for cost and performance assumptions for nuclear stations, low, mid, and high estimates. *The mid estimate is the default assumption.*

Figure H-9-1 summarizes the impact of this policy recommendation on in-state gross generation. The incremental effect by 2025 is an additional 11,169 GWh of new nuclear generation over the period 2020–2025, leading to reductions of 8,935 GWh of coal-fired generation and 2,234 GWh of natural gas-fired generation.

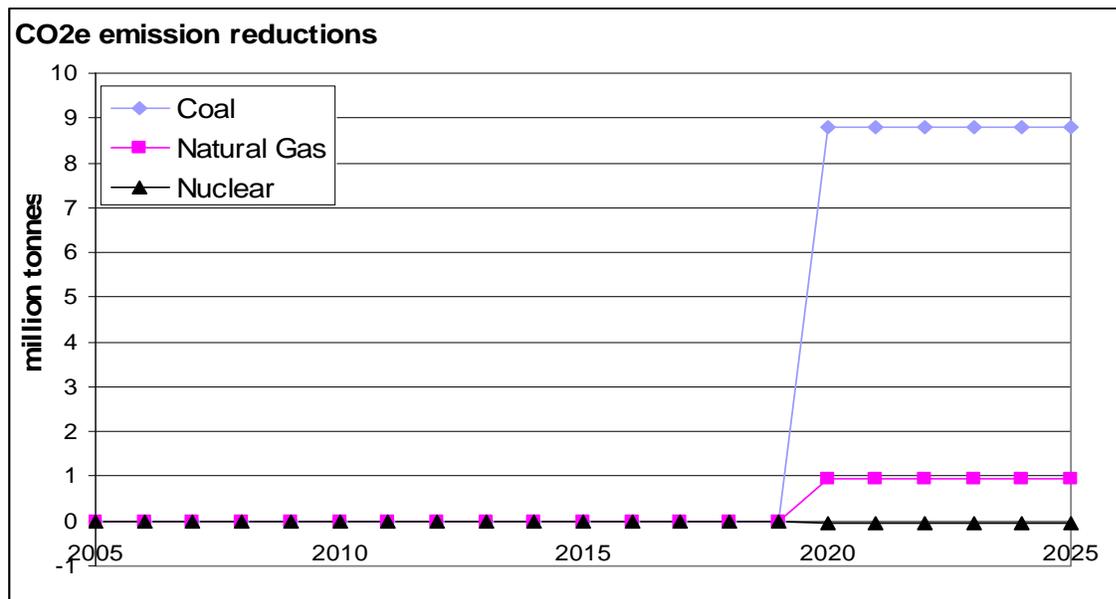
**Figure H-9-1. Effect of ES-9 on in-state gross generation**



GWh = gigawatt-hour.

Figure H-9-2 summarizes the impact of the recommendation on CO<sub>2</sub>e emission reductions across the full fuel cycle. The annual effect of the recommendation by 2025 results in about a 9.82 MMtCO<sub>2</sub>e emission reduction across the full fuel cycle. This is made up of reductions of 8.93 MMtCO<sub>2</sub>e from less coal-fired generation, reductions of 0.93 MMtCO<sub>2</sub>e from less natural gas-fired generation associated with domestic supplies of natural gas, and an increase of 0.04 MMtCO<sub>2</sub>e from upstream emissions associated with nuclear power generation. On a cumulative basis, the recommendation leads to emission reductions of 8.9 MMtCO<sub>2</sub>e.

**Figure H-9-2. Effect of ES-9 on CO<sub>2</sub>e emission reductions across the full fuel cycle**



CO<sub>2</sub>e = carbon dioxide equivalent.

Cost savings are associated with avoided capital, fuel, and O&M costs for coal and natural gas facilities. Incremental costs are associated with the capital, transmission, variable and fixed O&M, and fuel costs associated with the new nuclear station. The annual product of real levelized costs and displaced generation is an estimate of the annual costs. The sum of the annual costs and annual benefits provides an estimate of the net costs of the recommendation. For the central estimate of cost and performance, the NPV of the costs is \$1.57 billion over the 2020–2025 period (2005\$). The recommendation's cost-effectiveness is calculated as the quotient of the NPV and cumulative GHG emission reductions. For the central estimate of cost and performance, it is \$26.7/tCO<sub>2</sub>e (2005\$) (i.e., \$1.57 billion divided by 58.9 MMtCO<sub>2</sub>e and multiplied by a conversion factor of 1,000).

**Key Assumptions:**

Tables H-9-2 through H-9-7 summarize the key assumptions used in the analysis of this policy recommendation.

**Table H-9-2. Assumed coal fuel cycle inputs for power generation**

	Extraction	Beneficiation and processing	Transport	Generation	Fuel Chain
<b>Coal</b> (GJ input per GJ of coal delivered to the power station)					
<b>Feedstock-INCLUDING ALL LOSSES</b>					
Natural gas	-	-	-		-
Petroleum	-	-	-		-
Hydrogen gasoline	-	-	-		-
Diesel	-	-	-		-
heavy fuel oil	-	-	-		-
Coal	1.0000	-	-		<b>1.0000</b>
electricity (end use)	-	-	-		-
<b>Total-feedstocks</b>	<b>1.0000</b>	-	-		<b>1.0000</b>
<b>Fuels</b>					
Natural gas	0.0001	-	-		<b>0.0001</b>
petroleum	0.0051	-	-		<b>0.0051</b>
Coal	0.0006	-	-		<b>0.0006</b>
gasoline	0.0002	-	-		<b>0.0002</b>
diesel	0.0039	-	0.0088		<b>0.0128</b>
heavy fuel oil	0.0005	-	-		<b>0.0005</b>
Biomass	-	-	-		-
electricity (end use)	0.0017	-	-		<b>0.0017</b>
<b>Total-fuels</b>	<b>0.0122</b>	-	<b>0.0088</b>		<b>0.0210</b>
<b>Total-fuel &amp; feedstock losses</b>	<b>1.0122</b>	-	<b>0.0088</b>	-	<b>1.0210</b>

GJ = gigajoule.

**Table H-9-3. Assumed domestic natural gas fuel cycle inputs for power generation**

	Extraction	NG Processing	NG Transport	Fuel Chain
<b>Natural Gas</b> (GJ input per GJ of NG delivered to the power station)				
<b>Feedstock-INCLUDING ALL LOSSES</b>				
Natural gas	1.00000	-	-	<b>1.00000</b>
Petroleum	-	-	-	-
Hydrogen gasoline	-	-	-	-
Diesel	-	-	-	-
heavy fuel oil	-	-	-	-
Biomass	-	-	-	-
electricity (end use)	-	-	-	-
<b>Total-feedstocks</b>	<b>1.00000</b>	-	-	<b>1.00000</b>
<b>Fuels</b>				
Natural gas	0.02253	0.02467	0.00367	<b>0.05088</b>
petroleum	-	-	-	-
Coal	-	-	-	-
gasoline	0.00022	-	-	<b>0.00022</b>
diesel	0.00245	0.00024	-	<b>0.00269</b>
heavy fuel oil	0.00022	-	-	<b>0.00022</b>
Biomass	-	-	-	-
electricity (end use)	0.00022	0.00072	-	<b>0.00095</b>
<b>Total-fuels</b>	<b>0.02564</b>	<b>0.02564</b>	<b>0.00367</b>	<b>0.05496</b>
<b>Total-fuel &amp; feedstock losses</b>	<b>1.02564</b>	<b>0.02564</b>	<b>0.00367</b>	<b>1.05496</b>

GJ = gigajoule; NG = natural gas.

**Table H-9-4. Assumed nuclear fuel cycle inputs for power generation**

Nuclear (GJ input per GJ of nuclear fuel delivered to the power station)	Conversion &				Fuel Chain
	Mining & milling	transformation	Enrichment	fuel fabrication	
<b>Feedstock-INCLUDING ALL LOSSES</b>					
Natural gas	-	-	-	-	-
Petroleum	-	-	-	-	-
Uranium	1.00000	-	-	-	<b>1.00000</b>
gasoline	-	-	-	-	-
Diesel	-	-	-	-	-
heavy fuel oil	-	-	-	-	-
Biomass	-	-	-	-	-
electricity (end use)	-	-	-	-	-
Total-feedstocks	1.00000	-	-	-	<b>1.00000</b>
<b>Fuels</b>					
Natural gas	-	-	-	-	-
petroleum	-	-	-	-	-
Coal	-	-	-	-	-
gasoline	-	-	-	-	-
diesel	0.00077	0.00077	0.00326	0.00004	<b>0.00483</b>
heavy fuel oil	-	-	-	-	-
Biomass	-	-	-	-	-
electricity (end use)	0.00000	0.00000	0.00002	0.00000	<b>0.00002</b>
Total-fuels	0.00077	0.00077	0.00328	0.00004	<b>0.00485</b>
Total-fuel & feedstock losses	<b>1.000765</b>	<b>0.000765</b>	<b>0.003284</b>	<b>0.000041</b>	<b>1.00485</b>

GJ = gigajoule.

**Table H-9-5. Key assumptions for new nuclear station**

Online year	2020
Size	1,500 MW
Capacity factor	85%
Generation (GWh)	11,169
Technology	light water reactor using enriched uranium fuel

GWh = gigawatt-hour; MW = megawatt.

**Table H-9-6. Cost and performance assumptions for new nuclear station**

	Min	Max	Central
EPC assumption	50%	50%	50%
Base generation capital cost (2005\$/kW)	3,066	3,999	3,533
Total capital cost (2005\$/kW)	4,599	5,999	5,299
Variable O&M (2005\$/MWh)	\$0.51	\$0.51	0.51
Fixed O&M (2005\$/kW-yr)	\$63.29	\$82.55	72.92
Nominal Heat Rate (BTU/kWh)	10,400	10,400	10,400
Capacity factor (%)	80%	90%	85%
Fuel (2005\$/mmbtu)	1.0	1.0	1.0

Btu = British thermal unit; kW = kilowatt; kWh = kilowatt-hour; MWh = megawatt-hour; \$/MMBtu = dollars per million British thermal units.

**Table H-9-7. Full fuel cycle emission factors (tCO<sub>2</sub>e/MWh)**

Coal	1.0109
Natural gas	0.43751
Nuclear	0.00367

tCO<sub>2</sub>e/MWh = metric tons of carbon dioxide equivalent per megawatt-hour.

### **Key Uncertainties**

Nuclear fuel availability; nuclear waste storage and disposal; security requirements; changes in federal policy (e.g., NRC relicensing, long-term waste repository); technology and economics of new units; industry-wide developments.

### **Additional Benefits and Costs**

None cited.

### **Feasibility Issues**

None cited.

### **Status of Group Approval**

Complete.

### **Level of Group Support**

Unanimous.

### **Barriers to Consensus**

Not applicable.

## ES-10. Carbon Tax

### Policy Description

The primary goal of this policy recommendation is to establish a mechanism that will allow Arkansas to adapt to and be prepared for a federally implemented carbon tax and other federal climate policies.

A carbon tax sets a fee, or tax, for the release of carbon to the atmosphere. It does not set a limit, reduce, or otherwise control the tons of carbon released. The tax raises the cost of carbon-based emissions and, therefore, encourages investment in low-carbon or no-carbon alternatives. It also generates revenue for the government, which could be directed toward energy efficiency, the development and use of renewable energy, climate change adaptation investments, and other measures to mitigate or address the impacts of climate change. Many proposals also have options to rebate the tax back to the ratepayer, particularly low-income ratepayers. A carbon tax could be implemented as a tax on fossil fuels according to the amount of CO<sub>2</sub> emitted by their combustion. One of the benefits is that the tax can be more easily applied across all sectors. To achieve the stated goal, the amount of the tax must be high enough to trigger financial and behavioral decisions toward conservation or a shift to lower-emitting fuels.

Several examples exist where carbon taxes have been implemented. In 1990, Finland became the first country to adopt a carbon tax, setting its level at about \$1.45 per metric ton of CO<sub>2</sub>, which was raised to \$8.34 in 1995. Other countries, such as Denmark, Holland, and Sweden, followed suit. In North America, several examples exist. In November 2006, Boulder, Colorado, passed the first-ever municipal "carbon tax," a tax on electricity consumption (utility bills) that funds programs by the City of Boulder to reduce GHG emissions. In February 2008, British Columbia announced its intention to implement a \$10/metric ton carbon tax beginning in July 2008. And in May 2008, the Bay Area Air Quality Management District, which covers nine counties in the San Francisco Bay Area, passed a carbon tax of 4.4 cents per metric ton.

Additionally, many businesses and others have opted for what amounts to voluntary carbon taxes through participation in voluntary offsetting programs, such as Native Energy and TerraPass. For example, many online travel companies give customers the option of paying into these programs to offset the carbon costs of their travel. Such a program could be designed in Arkansas with utility bills to help implement many of the carbon capture projects discussed elsewhere in this report.

### Policy Design

- Arkansas should only consider carbon tax programs that are national in scope, and in conjunction with other carbon tax and "cap-and-trade" programs that are proposed. The state should opt for national programs that use revenue sharing back to state government for purposes of implementing state initiatives on global warming. The state should promote a national carbon tax that does not put Arkansas at a competitive disadvantage with other states.

- Arkansas should make the cost of inefficient or higher CO<sub>2</sub>-emitting activities more expensive than alternatives, thereby creating a financial incentive to discourage activities that result in CO<sub>2</sub> emissions. The amount of revenue that the carbon tax generates annually should depend on the facilities subject to the tax. The amount of the tax should be high enough to contribute to the reduction targets specified in a statute. From a competitive perspective, one advantage of a carbon tax is that it is constant and predictable, making a business case more stable than some alternatives.
- A carbon tax should include options to rebate the tax back to the ratepayer, thus creating a true cost of carbon but keeping ratepayers from paying more on their utility bills. This should include rebates on income and payroll taxes, particularly for low-income ratepayers.
- Voluntary carbon offset programs should be established in Arkansas through utility bills and other mechanisms.

**Goals:**

- Integrate a carbon tax program in correlation with a national cap-and-trade system.
- Work with surrounding states to establish a market-base value and standard that include Arkansas-specific opportunities based on economic and environmental benefits.
- Integrate a low-income credit initiative that focuses on efficiency.
- Establish a program that will easily allow Arkansas to adapt to a federal cap-and-trade system.
- Establish a voluntary carbon offset program in Arkansas.

**Timing:** Beginning in 2009 and the system in place by late 2010, depending on the status of efforts at the national level.

**Parties Involved:** All entities included in all other Arkansas climate change processes.

**Other:** None cited.

### **Implementation Mechanisms**

A carbon tax is both an incentive mechanism and a revenue-raising instrument. The tax should be structured in such a way as to shift the tax burden away from low-income households. This can be done by recycling the revenue back into the economy through corresponding reductions in personal income taxes or by altering the rate recovery regulations for electricity use.

Another option would be to create a voluntary check-off program on utility bills that would account for carbon tax costs of household bills, giving customers the option of offsetting it with a Native Energy or TerraPass type of program, only inside Arkansas. The state should work with the APSC and public utilities, and other stakeholders, in establishing such a voluntary program.

The state of Arkansas should work with the Arkansas congressional delegation and other parties on designing and implementing a carbon tax on a national level, working in conjunction with other similar goals, such as a national cap-and-trade system.

### **Related Policies/Programs in Place**

None cited.

### **Type(s) of GHG Reductions**

The GCGW considers this policy recommendation as not quantifiable.

### **Estimated GHG Reductions and Costs or Cost Savings**

The GCGW considers this policy recommendation as not quantifiable.

**Data Sources:** Not applicable.

**Quantification Methods:** Not applicable.

**Key Assumptions:** Not applicable.

### **Key Uncertainties**

Not applicable.

### **Additional Benefits and Costs**

None cited.

### **Feasibility Issues**

None cited.

### **Status of Group Approval**

Complete.

### **Level of Group Support**

Super Majority (4 objections).

### **Barriers to Consensus**

Four of 21 GCGW members present objected to this recommendation in general, noting that this is a national issue because imposing a carbon tax on a local market will cause Arkansas to be uncompetitive with other states that do not choose to impose such a tax. One GCGW member objected to the roll-back provision to adjust income and payroll taxes to offset any tax increase associated with a carbon tax, believing this defeats the purpose of the tax, which is to provide an incentive to decrease energy use.

## ES-11. Efficiency Improvements and Repowering of Existing Plants

### Policy Description

Improving efficiency at existing plants refers to increasing generation efficiency through such improvements as more efficient boilers and turbines, improved control systems, or combined-cycle technology. This could also include switching to lower- or zero-emitting fuels at existing plants, or new capacity additions. Policies to encourage efficiency improvements and repowering of existing plants could include incentives and/or regulations. Although most economic improvements have already been made, existing power plants should be encouraged to reach specific energy efficiency goals before new plants are constructed.

### Policy Design

**Goals:** Beginning in 2010, power plants should commence efficiency measures by improvement in heat rates from existing levels. The policy will include a linear ramp-up schedule until a maximum 10% efficiency obtainable is reached by 2020.

**Timing:** 5% improvement achieved by 2015; 10% achieved by 2020.

**Parties Involved:** Public/consumers, state and local governments, APSC.

### Implementation Mechanisms

An estimated cost of carbon should be included to help drive further improvements in efficiency.

For utilities subject to the authority of the APSC, the APSC should review any allocations that are subsidies coming from ratepayers and ensure that there is not inappropriate cross-subsidization between classes of consumers. For utilities (e.g., municipal utilities) that are not subject to the authority of the APSC, the governing body for the utility should review any allocations that are subsidies coming from ratepayers and ensure that there is not inappropriate cross-subsidization between classes of consumers.

### Related Policies/Programs in Place

None cited.

### Type(s) of GHG Reductions

Avoided emissions from fossil-fuel generation.

### Estimated GHG Reductions and Costs or Cost Savings

Table H-11-1 summarizes the results of this policy recommendation. The sections that follow describe the data sources, quantification approach, and key assumptions used in the development of these results.

**Table H-11-1. Estimated GHG reductions and costs of or cost savings from ES-11**

No.	Policy Recommendation	GHG Reductions (MMtCO <sub>2</sub> e)			Net Present Value 2009–2025 (Million \$)	Cost-Effectiveness (\$/tCO <sub>2</sub> e)
		2015	2025	Total 2009–2025		
ES-11	Repower existing coal station with NGCC	2.3	2.3	31.8	\$1,568	\$49.33

GHG = greenhouse gas; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; \$/tCO<sub>2</sub>e = dollars per ton of carbon dioxide equivalent; NGCC = natural gas combined cycle.

**Data Sources:**

- U.S. Department of Energy, Energy Information Administration. *Assumptions to the Annual Energy Outlook 2007*. DOE/EIA-0554. April 2007. Available at: <http://www.eia.doe.gov/oiaf/aeo/pdf/pdf>.
- National Energy Technology Laboratory. *Cost and Performance Baseline for Fossil Energy Plants*. DOE/NETL-2007/1281. August 2007. Available at: [http://www.netl.doe.gov/energy-analyses/pubs/Bituminous%20Baseline\\_Final%20Report.pdf](http://www.netl.doe.gov/energy-analyses/pubs/Bituminous%20Baseline_Final%20Report.pdf)
- Plant-specific Arkansas capacity addition data are based on Arkansas ES TWG input.

**Quantification Methods:**

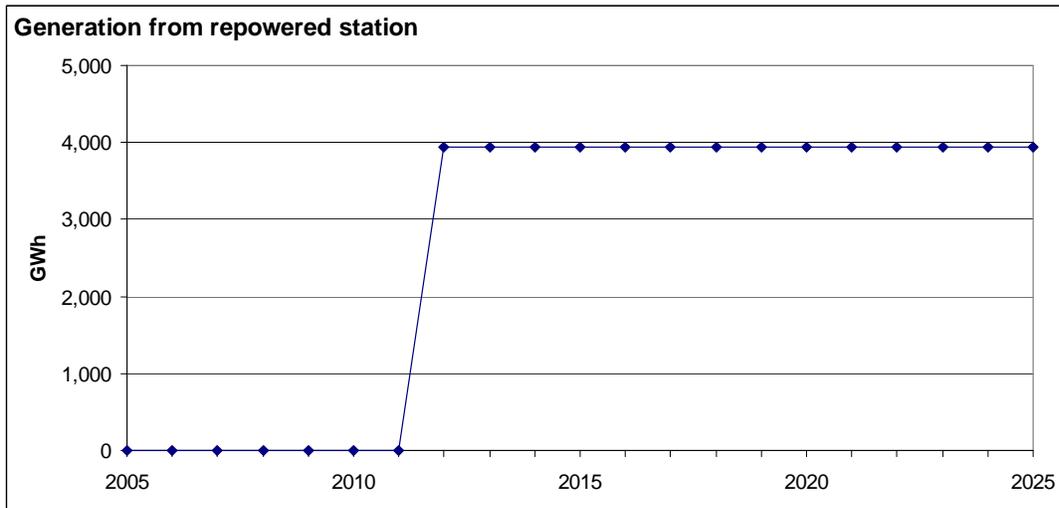
See Annex H-1 for the overall approach to the quantification of this and all other ES recommendations.

This policy recommendation would promote the identification and pursuit of cost-effective emission reductions from existing generating units by improving their operating efficiency and fuel changes, or by adding carbon capture technology. It has been modeled as the repowering of an existing pulverized coal station with NGCC technology. The TWG is making the following key assumptions for the analysis of this recommendation:

- The start year for the policy recommendation is 2012.
- One existing pulverized coal plant is repowered with an NGCC unit sized to provide equivalent annual power generation
- The coal station is be fully depreciated.

Figure H-11-1 presents the total generation associated with the repowered station.

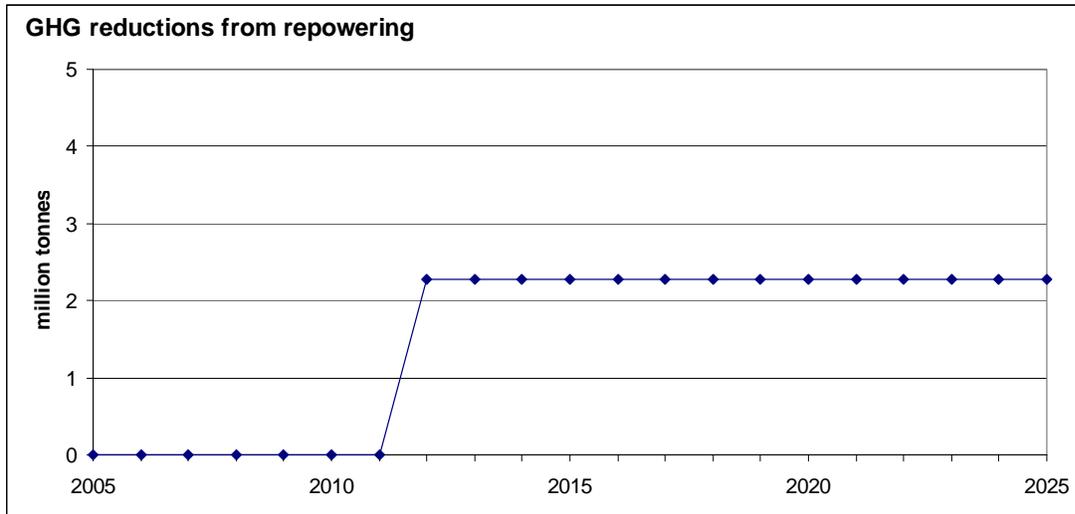
**Figure H-11-1. Generation from repowered pulverized coal plant**



GWh = gigawatt-hour.

Figure H-11-2 presents the annual CO<sub>2</sub>e emission reductions associated with the repowered unit. The annual emission reductions in both 2015 and 2025 are 2.3 MMtCO<sub>2</sub>e. The cumulative emission reductions over the 2005–2025 forecast period are 31.8 MMtCO<sub>2</sub>e.

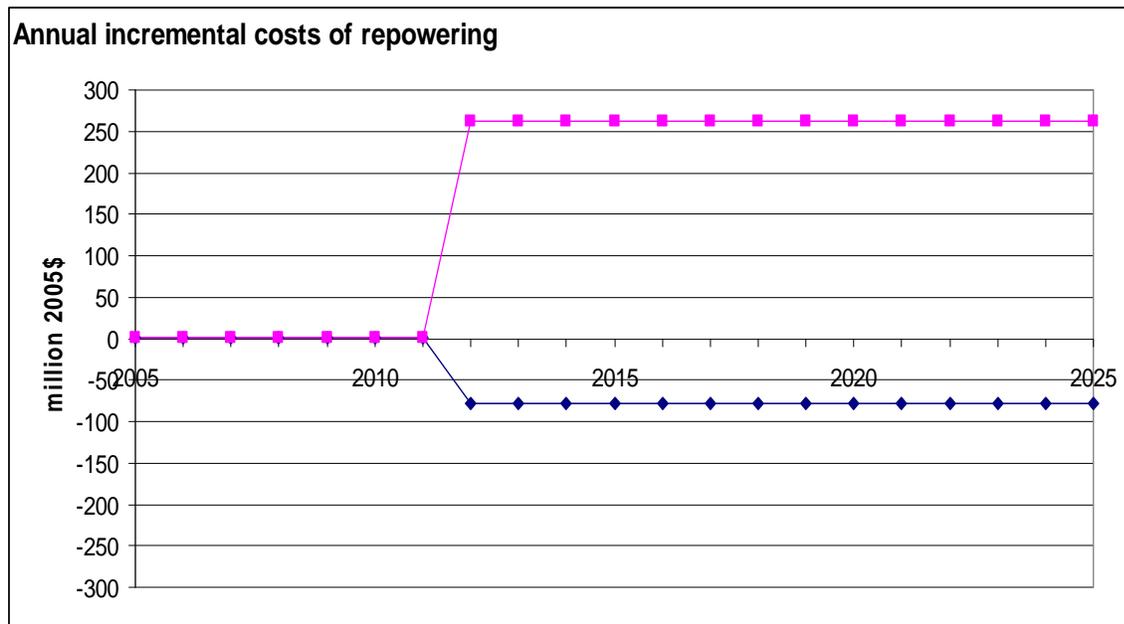
**Figure H-11-2. Annual CO<sub>2</sub>e emission reductions associated with the repowered unit**



GHG = greenhouse gas.

There are incremental capital, O&M, and fuel costs from the NGCC unit and incremental fuel and O&M savings from coal, as summarized in Figure H-11-3. The coal station was assumed to be fully depreciated. The NPV of these annual costs is \$1.6 billion over the 2012–2025 period (2005\$).

**Figure H-11-3. Annual incremental costs of repowering**



The recommendation's cost-effectiveness was calculated as the quotient of the NPV and cumulative GHG emission reductions, or \$49.3/tCO<sub>2</sub>e (2005\$) (i.e., \$1.6 billion divided by 31.8 MMtCO<sub>2</sub>e and multiplied by a conversion factor of 1,000).

**Key Assumptions:**

*Performance Characteristics of the Existing Coal Station*—The existing pulverized coal plant to be repowered has the following characteristics:

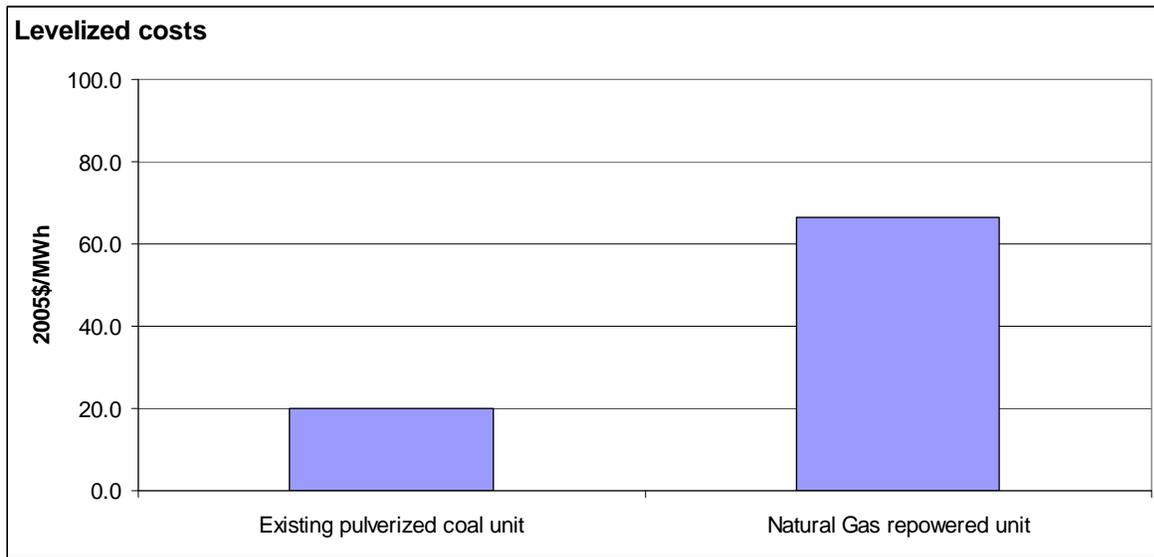
- Type: pulverized coal
- Age: 30+ years
- Size: 600 MW
- Heat rate: 10,000 Btu/kWh
- Average annual capacity factor: 75%

*Performance Characteristics of the Repowered Unit*—The repowered unit has the following characteristics:

- Type: natural gas combined cycle
- Size: 600 MW
- Heat rate: 7,200 Btu/kWh
- Average annual capacity factor: 75%

*Levelized Costs*—Figure H-11-4 defines the levelized costs.

**Figure H-11-4. Levelized costs**



MWh = megawatt-hour.

### **Key Uncertainties**

Two key uncertainties have been identified: (1) whether and how the new source review provisions of the Clean Air Act would affect the promotion of plant upgrades, and (2) how this policy recommendation may relate to a cap-and-trade proposal.

### **Additional Benefits and Costs**

None cited.

### **Feasibility Issues**

None cited.

### **Status of Group Approval**

Approved.

### **Level of Group Support**

Unanimous.

### **Barriers to Consensus**

Not applicable.

## Annex H-1

### Overall Quantification Approach for Energy Supply Policy Recommendations

This Annex outlines key elements of the quantification approach the Center for Climate Strategies (CCS) adopted for quantifying the greenhouse gas (GHG) impacts and costs for those policy recommendations that are considered amenable to quantification. The list of topics addressed in the memo is summarized below.

#### A. Premises

The analysis was based on a number of key premises, as briefly outlined below.

- *CCS role:* Unless a member of the Energy Supply (ES) Technical Work Group (TWG) offered to undertake an analysis of any of the recommendations, CCS prepared the analysis for review, comment, and revision by the TWG. Where an ES TWG member offered to undertake the analysis of one or more recommendations, CCS would provide analytical support (e.g., review and technical feedback) as needed.
- *Transparency:* Data sources, methods, key assumptions, and key uncertainties are clearly indicated for TWG review and comment.
- *Analytical approach:* The approach adopted was of cost-effectiveness (and net present value [NPV]) analysis, as widely applied to GHG mitigation policy recommendations.<sup>1</sup> Included were direct, economic costs from the perspective of the state as whole (e.g., avoided costs of electricity, rather than consumer electricity prices).
- *Bottom-up analysis:* A bottom-up approach was adopted, which was amenable to transparency and was capable of reflecting the costs (and cost savings) associated with individual policy recommendations. This was chosen in contrast to macroeconomic analysis, which aims to capture flows and interactions across all sectors of the economy. Potential macroeconomic impacts, cost, or benefits that fall disproportionately on specific groups or actors, as well external costs and benefits, should be noted qualitatively where studies or other information are available.

#### B. Outputs

The analysis of policy recommendations was organized so as to produce the following results:

- *Net GHG reduction potential* in million metric tons of carbon dioxide equivalent (MMtCO<sub>2</sub>e) using Intergovernmental Panel on Climate Change 100-year global warming potential, reported annually for the years 2015, 2020, and 2025, and cumulatively for the period 2010–2025. Where significant additional GHG reductions or costs occur beyond the project period as a direct result of actions taken during the project period, these were indicated as appropriate.

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<sup>1</sup> For more discussion of various economic analysis approaches, see, e.g., Section 2.4 of: Intergovernmental Panel on Climate Change. *Climate Change 2007—Mitigation of Climate Change. Contribution of Working Group III to the Fourth Assessment Report of the IPCC*. Available at: [http://www.mnp.nl/ipcc/pages\\_media/AR4-chapters.html](http://www.mnp.nl/ipcc/pages_media/AR4-chapters.html).

- *NPV cost* (or cost savings) for the period 2010–2025 in 2007 constant dollars, using a 5% real discount rate.<sup>2</sup> Positive numbers represent recommendations with net costs; negative numbers represent recommendations with net cost savings.
- *Cost per metric ton of CO<sub>2</sub> equivalent* (tCO<sub>2</sub>e) emissions reduced (or removed) in units of \$/tCO<sub>2</sub>e. This figure represents the NPV cost divided by the cumulative emission reductions, both over the 2010–2025 period.

### C. Methodology

As much as possible, the analysis preceded using simple spreadsheet modeling techniques in which assumptions were transparent and readily accessible to any TWG member for review and adjustment. To ensure consistent results across recommendations, common factors and assumptions were used for such items as:

- *Electricity avoided costs and emissions*—Common values (\$/megawatt-hour [MWh] and tCO<sub>2</sub>/MWh) were developed based on available studies. Each policy recommendation was first analyzed individually and then addressed as part of an overall integrated analysis.
- *Fuel costs and projected escalation*—Fuel cost estimates were based on common sources, wherever possible. For example, fossil fuel price escalations were indexed to U.S. Department of Energy (DOE) projections, as indicated in DOE's most recent *Annual Energy Outlook*.
- *Overlap with other TWGs*—Some ES policy recommendations overlap with policy recommendations analyzed by other Arkansas Governor's Commission on Global Warming TWGs. The analysis for these recommendations took place in close coordination with the assumptions and other inputs used in those TWGs.
- *Consumption-based approach*—This approach aims to reflect the emissions associated with electricity sources used to deliver electricity to consumers in Arkansas. It is distinct from a production-basis approach, which considers the emissions from Arkansas power plants, regardless of where the electricity is delivered.

### D. Assumptions

As much as possible, the analysis sought to rely on data sources that are Arkansas-specific, and that TWG members were in a good position to obtain and provide. The success of this approach depended on how accessible the information was to TWG members and the timeliness in which it was provided to the CCS analytical team.

Where Arkansas-specific information could not be readily obtained, the analysis relied on published data from DOE, the National Laboratories, and other state climate change processes. Specific assumptions that were needed to undertake the analysis are outlined below. Some of these assumptions were obtained from non-Arkansas sources:

- Avoided costs associated with the most recent electric capacity expansion plans in Arkansas;
- New centralized renewable installation energy cost and performance assumptions;

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<sup>2</sup> Capital investments with lifetimes longer than 2025 are represented in terms of levelized or amortized costs, in order to avoid “end effects.”

- New centralized fossil power station cost and performance assumptions;
- Fossil fuel price forecasts to electric generators through 2025 (i.e., distillate, residual oil, natural gas, coal, biomass);
- Any studies that provide spatial and temporal (as appropriate) quantitative estimates of renewable resource potential in Arkansas (wind, solar, biomass, animal wastes);
- Any studies that provide an indication of the technical and economic potential of combined heat and power systems in Arkansas (both commercial and industrial applications);
- Any studies that provide the costs associated with integrating large amounts of intermittent renewable technologies into the system (where integration costs are expected to increase with increasing amounts of intermittent capacity);
- Any studies that examine alternative electric sector expansion plans in Arkansas that have considered decoupling profits from sales, lost revenue adjustments, inverted block rates for residential consumers, and/or use of carbon adders; and
- Any studies that examine the installation and operating costs of integrated gasification combined-cycle systems in Arkansas.

## **E. Cost Inclusion**

Several types of costs were explicitly considered in the analysis, and several types were excluded, as summarized below.

- Sample costs included:
  - Capital costs levelized (amortized) where appropriate, e.g., for new energy supply facilities and associated infrastructure;
  - Operation and maintenance and other labor costs (or incremental costs relative to standard practice);
  - Fuel and material costs, e.g., for natural gas, electricity, biomass resources, water, fertilizer, material use, electricity transmission and distribution; and
  - Other direct costs (e.g., administrative) and other costs (where readily estimated), such as the grid integration costs for renewable energy technologies.
- Sample costs excluded:
  - External costs, such as the monetized environmental or social benefits/impacts (value of damage by air pollutants on structures, crops, etc.), quality-of-life improvements, or improved road safety or other health impacts and benefits;
  - Energy security benefits; and
  - Macroeconomic impacts related to the impact of reduced or increased consumer spending, shifting of cost and benefits among actors in the economy.

# Appendix I

## Transportation and Land Use Sectors Policy Recommendations

### Summary List of Policy Recommendations

No.	Policy Recommendation	GHG Reductions (MMtCO <sub>2</sub> e)			Net Present Value 2009–2025 (Million \$)	Cost-Effectiveness (\$/tCO <sub>2</sub> e)	Level of Support
		2015	2025	Total 2009–2025			
TLU-1*	Study the Feasibility of Plug-In Vehicles	<i>Not Quantified—Qualitative Study Recommendation</i>					Unanimous
TLU-2 <sup>†</sup>	Research and Development of Renewable Transportation Fuels	<i>Incorporated Into Analysis for TLU-3</i>					Super Majority (1 objection)
TLU-3 <sup>†</sup>	Advanced Biofuels Development and Expansion	0.88	2.54	21.26	–\$2,293	–\$108	Super Majority (1 objection)
TLU-4*	Smart Growth, Pedestrian and Bicycle Infrastructure	0.06	0.17	1.39	≤0 (Net Savings)	≤0 (Net Savings)	Unanimous
TLU-5*	Improve and Expand Transit Service and Infrastructure	0.001	0.007	0.03	1.5	\$1,479	Unanimous
TLU-6 <sup>†</sup>	School and University Transportation Bundle	0.006	0.013	0.113	N/A	N/A	Unanimous
TLU-7*	Promote and Facilitate Freight Efficiency	0.33	0.47	6.1	\$48	\$104	Unanimous
TLU-8 <sup>†</sup>	Procurement of Efficient Fleet Vehicles (Passenger and Freight)	<i>State "Lead by Example" Qualitative Recommendation</i>					Unanimous
TLU-9 <sup>†</sup>	Fuel Efficiency: Clean Car Incentive	<i>Not Quantified—Qualitative Study Recommendation</i>					Super Majority (1 objection)
TLU-10*	Public Education	<i>Not Quantified</i>					Unanimous
	<b>Sector Total After Adjusting for Overlaps</b>	<b>1.28</b>	<b>3.2</b>	<b>28.89</b>	<b>–\$2,244</b>	<b>–\$78</b>	
	<b>Reductions From Recent Actions (Federal CAFE Requirements)</b>	<b>1.02</b>	<b>3.26</b>	<b>26.9</b>	<b><i>Not Quantified</i></b>		
	<b>Sector Total Plus Recent Actions</b>	<b>2.29</b>	<b>6.45</b>	<b>30.2</b>	<b>–\$2,244</b>	<b>–\$78</b>	

CAFE = corporate average fuel economy; GHG = greenhouse gas; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; \$/tCO<sub>2</sub>e = dollars per metric ton of carbon dioxide equivalent; N/A = not applicable.

Negative values in the Net Present Value and the Cost-Effectiveness columns represent net cost savings.

The numbering used to denote the above policy recommendations is for reference purposes only; it does not reflect prioritization among these important policy recommendations.

\* The GCGW approved this option at Meeting #9 (September 9, 2008); 18 members present and voting (one by phone).

<sup>†</sup> The GCGW approved this option at Meeting #10 (September 25, 2008); 21 members present and voting (none by phone).

## **Overlap Discussion:**

The amount of greenhouse gas (GHG) emissions reduced and the costs of a policy recommendation within the Transportation and Land Use (TLU) sectors overlap with some of the quantified benefits and costs of policy recommendations within other sectors. Where this overlap has been determined to exist, the sector totals have been adjusted and each instance is outlined below. Overlaps between recommendations within TLU have been accounted for within the goal-setting process.

TLU-2 (Research and Development of Renewable Transportation Fuels) and TLU-3 (Advanced Biofuels Development and Expansion) overlap with AFW-5 (Expanded Use of Liquid Biofuels). This overlap was determined to be a partial overlap for the years 2010 to 2015 and a full overlap for years after 2015. The policy overlap for both time periods has been accounted for by adjusting the emission reductions and costs for AFW-5 by the proportion determined to be included under the TLU analysis to avoid double counting.

Smart growth, transit, school siting, and school access are all closely related and interact directly with one another. Because of this close interaction, three policy recommendations, TLU-4 (Smart Growth, Pedestrian and Bicycle Infrastructure), TLU-5 (Improve and Expand Transit Service and Infrastructure), and TLU-6 (School and University Transportation Bundle) all overlap to some extent with one another as each of these policy recommendations is complimentary of one another. The complimentary nature of these policies did not, however, impact their quantification. Each of these policies has been independently quantified for both emissions reductions and costs.

To account for their complimentary nature, these three policy recommendations each identify policies which would enhance their viability. TLU-4 specifically mentions the use of transit and transit oriented development as part of the vehicle miles traveled (VMT) reduction associated with this policy recommendation, all of which is further discussed in TLU-5. TLU-5, discusses the need to have appropriate land use policies in place for the success of transit, including utilizing transit in higher density areas and the ability for municipalities to use eminent domain to purchase the land necessary to develop transit and rail corridors, all of which could be associated with the Smart Growth measures in TLU-4. TLU-6 discusses land use policies necessary to be associated with school siting and the development of both pedestrian and bicycling infrastructure (mentioned in TLU-4) as part of the safe routes to school program as a method of reducing VMT. Although these three policies overlap concerning their implementation and that each one would benefit from the implementation of the other, all of their emissions reductions and costs were quantified separately and no overlap was identified as each of these policies could be implemented separately.

No reductions from recent actions as identified in the policy recommendations have been made to the TLU sector totals.

## TLU-1. Study the Feasibility of Plug-In Electric Vehicles

### Policy Description

Increasing the contribution of motor vehicles that are "plugged in" to the electrical grid may reduce GHG emissions in Arkansas, depending on the degree to which power generation in the state relies on fossil fuels and renewable fuels now and in the future. The goal of this policy recommendation is to study a set of actions that would further evaluate the benefits and feasibility of plug-in hybrid electric vehicles (PHEVs), accelerate the deployment of a commercially viable technology, remove barriers to more rapid adoption, create initial incentives, and provide for the integration of PHEVs with other systems, including the power supply and transportation systems.

### Policy Design

Undertake a study that will review relevant completed, ongoing, and forthcoming studies, including the 3-year national study (begun in 2007 and expected to be completed by 2010) by the Electric Power Research Institute (EPRI), Ford Motor Company, and Southern California Edison (SCE), which will develop and evaluate technical approaches for integrating PHEVs into the nation's electric grid system.<sup>1</sup> Following the review of the relevant studies, assess the potential effectiveness of implementing some or all of the items noted in the Implementation Mechanisms section that follows.

**Goals:** Undertake a study that reviews relevant research, including the 3-year national study by EPRI, Ford, and SCE. Thereafter, assess the effectiveness of the additional goals, actions, and implementation timetables for other policy design options listed above.

**Timing:** As indicated above for each individual activity.

**Parties Involved:** Auto users, power utilities, auto dealers, others.

### Implementation Mechanisms

- Assess the impacts of plug-in electric fleets on the state's power infrastructure at various levels of market penetration, and identify technology and system requirements to maximize use of off-peak and underutilized power resources. Engage power utilities as partners in the study, and consider the future sources of power generation and their current and future impacts on GHG emissions from PHEVs. Since automakers are preparing to introduce PHEVs by 2010, and since it will be advantageous for car owners to plug in at night, utility companies should be encouraged, and compensated for, installing "smart meters" allowing time-of-day pricing for plug-in vehicles.

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<sup>1</sup> Ford Motor Company. "EPRI Joins Ford-SCE Analysis of Plug-In Hybrids on Grid." March 27, 2008. Available at <http://www.ford.com/about-ford/news-announcements/press-releases/press-releases-detail/pr-epri-joins-fordsce-analysis-of-27955>.

- Provide funding for state and local government fleet conversions of standard hybrids to PHEVs. In the future, set a goal for a certain number of conversions, and allocate funding to reach that goal. Require that these vehicles be grid-aware, and include funding for equipment to accomplish this task.
- In the future, provide funding for school districts to acquire plug-in electric hybrid school buses.
- Commit the Arkansas state government to purchase PHEVs as they become commercially available, allowing purchase at a price premium to reflect taking into account carbon-reduction benefits and reductions in state expenditures on imported fuels.
- Direct the state to provide rate recovery for utility research and development (R&D) investments in pilot tests of vehicle-to-grid systems.
- Fund the study of an assessment of electric vehicle charging needs in state parking facilities.
- Develop and fund at least one vehicle-to-grid pilot involving a fleet of public plug-ins parked in a state garage.
- Fund a study by the state to identify Arkansas companies and economic sectors with potential vehicle electrification markets, and develop a strategy to help Arkansas companies' position themselves for success in those markets.

#### **Related Policies/Programs in Place**

As described in the above implementation section. No other related programs identified at this time.

#### **Type(s) of GHG Reductions**

Since this policy calls for a study, this policy is not quantified at this time. Following the completion of the study, it is expected that better information will be available in order to provide quantitative estimates of the potential impact of PHEVs on Arkansas.

#### **Estimated GHG Reductions and Costs or Cost Savings**

Not quantified at this time, since results will likely be available following completion of the proposed study.

#### **Key Uncertainties**

The basic question as to whether motor vehicles powered by the electrical grid in Arkansas will produce more or less GHG emissions on a life-cycle per-mile basis is unanswered. The study is being recommended to provide information in an attempt to answer this question.

#### **Additional Benefits and Costs**

To be identified during the course of the study.

**Feasibility Issues**

The feasibility and effectiveness of the proposed implementation actions will be assessed as part of the study process.

**Status of Group Approval**

Complete.

**Level of Group Support**

Unanimous.

**Barriers to Consensus**

Not applicable.

## TLU-2. Research and Development of Renewable Transportation Fuels

### Policy Description

This policy recommendation indicates support to assist in the development of low-carbon fuels that are not yet commercially available in Arkansas, such as cellulosic ethanol. It will also attempt to identify potential funding sources to conduct analyses to identify which renewable fuels will provide the best options for Arkansas and its constituent regions and cities.

General support for research and development of advanced biofuels at the state's research facilities, primarily the Arkansas State University System, is to be encouraged, and external sources of research support should be identified.

### Policy Design

Among other leading research institutions in Arkansas, the University of Arkansas' Division of Agriculture has expanded its involvement in research and education on biomass issues, especially biofuels. New faculty members have been hired, and others have redirected their efforts (e.g., plant breeding for alternative feedstock opportunities). The division dedicated the recent higher education bond monies for capital improvements for new construction and renovation of the Rice Research and Extension Center at Stuttgart. Two laboratories in that facility have been designated as field biofuel laboratories. New resources are needed to expand both the research and the agricultural extension output in these areas. Additional capacity is needed to work on by-products and co-products (e.g., increased uses for glycerin, a by-product of biodiesel production), new feedstocks, application of cellulosic technologies, marketing strategies, and policy information support systems. Financial support is needed for field stations to adapt to these changing crops in their research and education systems.

**Goals:** The goal of the policy should be to support R&D of renewable transportation fuels in order to increase the capacity of the state university system to develop and produce such fuels cost-effectively.

**Timing:** Legislation to be passed in the 2009 Regular Session, with funds to be available in fiscal year (FY) 2009–2010.

**Parties Involved:** State of Arkansas, University of Arkansas Division of Agriculture, other state research institutions.

### Implementation Mechanisms

This policy will provide funding to promote in-state R&D related to biofuel/biodiesel production, such as investigating the production of biofuels from Arkansas-based biomass feedstocks (e.g., residues or by-products) from agricultural production (crop residues, chicken fat, beef tallow), agricultural processing, forest or wood resources or production processes (material not being utilized by pulp mill plants), or other cellulosic crops (e.g., switchgrass). It could also include the reuse of food oils for use as biodiesel, possibly encouraging the production

of “homemade” biofuels (for example, by farmers for their farm equipment).<sup>2</sup> Such research could be linked to life-cycle analyses of feedstock production and conversion.

The state should consider providing continuing annual funding for program enhancement for biofuels and other biomass.

### **Related Policies/Programs in Place**

Arkansas State University has established a Center of Excellence on BioFuels and BioBased Products. One research project is designed to develop an inexpensive supply of enzymes for cellulosic biomass conversion. In addition, the environmental sustainability of various potential energy crop systems will be evaluated based on soil quality, water quality, and water use in addition to crop and fuel yields from the management of these energy crops. A third area will be testing spark-ignition and compression-ignition engine categories to determine the impact on emissions and engine performance when fueled by specific alternative fuels. We are investigating the fuel production comparisons that suggest that algae have the potential to produce up to 100,000 liters (L) of oil/hectare (ha), nearly 17 times the level of the highest terrestrial crop, oil palm.<sup>3</sup> Finally, we are investigating valuable new bio-based products from protein and carbohydrate components present in low-value plant processing residues, such as algae, rice bran, or other residues generated from the emerging Mid-South bioenergy industry.

### **Type(s) of GHG Reductions**

Second-generation biofuels have the potential to significantly reduce carbon dioxide (CO<sub>2</sub>) and other GHG emissions in comparison to existing petroleum-based fuels.

### **Estimated GHG Reductions and Costs or Cost Savings**

Quantified as part of the analysis for TLU-3, Advanced Biofuels Development and Expansion.

**Data Sources:** Please see analysis for TLU-3.

**Quantification Methods:** Please see analysis for TLU-3.

**Key Assumptions:** Please see analysis for TLU-3.

### **Key Uncertainties**

Universities are well suited for R&D activities; outcomes and timeframes can be uncertain.

### **Additional Benefits and Costs**

R&D often has benefits that are difficult to predict before undertaking the R&D.

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<sup>2</sup> The Council for Agricultural Science and Technology (CAST) has published a map showing the leading candidates for lignocellulose-based biofuel feedstocks. See CAST, *Biofuel Feedstocks: The Risk of Future Invasions*. CAST Commentary QTA 2007-1. Ames, IA, 2007. Available at: <http://www.cast-science.org/websiteUploads/publicationPDFs/Biofuels%20Commentary%20Web%20version%20with%20color%20%207927146.pdf>.

<sup>3</sup> See "Oil From Algae!" Available at: <http://www.oilgae.com>.

### **Feasibility Issues**

None noted.

### **Status of Group Approval**

Complete.

### **Level of Group Support**

Super Majority (one objection).

### **Barriers to Consensus**

A member objected because the cost of this recommendation was included in the cost for TLU-3, and the member does not believe TLU-2 and TLU-3 will result in net cost savings.

## TLU 3. Advanced Biofuels Development and Expansion

### Policy Description

Arkansas should adopt standards that require a certain amount or percentage of transportation motor fuels, as measured by volume, to be sold in the state to be advanced biofuels.<sup>4</sup> The goals for the amounts or percentages to be sold should gradually increase over time, as in-state and out-of-state supply and production capacities increase. The state should also help facilitate the transition to advanced biofuels by regulating quality standards for fuel blends.

According to H.R. 6, the Energy Independence and Security Act of 2007, the term "advanced biofuel" means renewable fuel, other than ethanol derived from corn starch, which has life-cycle GHG emissions that are at least 50% less than baseline life-cycle GHG emissions. "Baseline life-cycle GHG emissions" means the average life-cycle GHG emissions for gasoline or diesel.

The types of fuels eligible for consideration as "advanced biofuels" may include any of the following: ethanol derived from cellulose, hemicellulose, or lignicellulose; ethanol derived from sugar or starch (other than corn starch); ethanol derived from waste material, including crop residue, other vegetative waste material, animal waste, and food and yard waste; biomass-based diesel; biogas (including landfill gas and sewage waste treatment gas) produced through the conversion of organic matter from renewable biomass; butanol or other alcohols produced through the conversion of organic matter from renewable biomass; and other fuel derived from cellulosic biomass. Advanced biofuels also include fuels derived from biomass, such as algae. Biomass-based diesel fuel also includes bio-based lipids harvested from feedstocks, such as algae and biogas.

### Policy Design

Arkansas should encourage state and national fuel industries to reach for specific goals, as measured by specific volume amounts or percentages of advanced biofuels, which would produce fewer GHG emissions when considered on a per-volume and/or per-energy-unit basis. The state should encourage industry and research universities to work together to create an Arkansas Alternative Energy Institute.

The state does not wish to encourage the conversion of any human food sources, such as corn, to alternative fuels, because this is likely to increase the price of food. The Governor's Commission on Global Warming (GCGW) also does not wish to encourage the production of alternative fuels that would lead to higher GHG emissions than are produced from petroleum-based fuels. As a result, the state is supportive of development of advanced biofuels, as listed above under the Policy Description.

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<sup>4</sup> A definition of "advanced biofuels" can be found in Section 201 of the text of federal legislation "H.R.6: Energy Independence and Security Act of 2007." The text of the legislation can be found online at: <http://thomas.loc.gov/>.

**Goals:**

- Increase the use of advanced biofuels that emit less GHG emissions in automobiles and other on-road transportation vehicles to the level of at least 3% of the total consumed by 2015.

**Timing:**

By 2012, an appropriate state agency will:

- Develop incentives for industry to produce advanced biofuels that reduce GHG emissions.
- Develop an industry/research university institute that will continually work toward commercially available solutions for advanced biofuels.

By 2015, the state or appropriate agency will:

- Reduce GHG vehicle emissions by converting to fuels that burn much more efficiently, with the goal of advanced biofuels comprising 3% of the statewide use of fuels by 2015.
- Work with the Arkansas Alternative Energy Institute to promote biofuel production to aid in control of GHG emissions and to promote state industries that will provide “green” jobs for Arkansas workers.
- Establish legislation to set standards for biofuel production that meets federal and state regulations for GHG emission levels.

**Parties Involved:** Arkansas Departments of Natural Resources, Highway and Transportation, Agriculture, Economic Development, Labor, Forestry, and Energy.

Table I-1 shows life cycle (“well-to-wheels”) GHG impacts of various biofuel options.

**Table I-1. Estimated alternative fuels impacts on GHG emissions**

Fuel/Technology	Blend	Feedstock	Reduction (GHGs per mile)*
Ethanol	E10	Corn	1.4%
Ethanol	E10	Cellulosic	7.4%
Ethanol	E85	Corn	15.9%
Ethanol	E85	Cellulosic	83.8%
Biodiesel	B20	Soy	17.7%

\* Ethanol reductions estimated relative to gasoline; biodiesel reductions estimated relative to diesel fuel. Actual reductions depend on many factors in the production, distribution, and use of fuels. Source: Argonne National Laboratory. GREET model version 1.8 outputs.

## Implementation Mechanisms

To aid in biofuel development, state money could be used to establish partnerships with state and national laboratories that have already worked on some of the issues of biofuel conversion. This would bring knowledge of established production/conversion protocols into the state and develop processing parameters for Arkansas-specific feedstocks.

The state could incentivize the development of in-state industries and businesses that produce and distribute alternative fuels:

- Arkansas should provide incentives to private industries to establish alternative-fuel infrastructure that could aid in the promotion of alternative-fuel use.
- The expense of equipment and installation may be offset by the increasing use of these alternative fuels.
- The biofuel production plants should optimally be situated within a radius of their feedstocks as feasible, with use of both rail and truck as appropriate, and with a focus on minimizing the energy used to distribute the fuel.
- The distributors of alternative fuels should be in convenient locations to be able to offer fuels at competitive prices.

### Related Policies/Programs in Place

Federal Energy Independence and Security Act (EISA) of 2007: Fuel suppliers must increase the amount of renewable fuel blended into transportation fuels annually, to reach a level of 36 billion gallons in 2022.

### Type(s) of GHG Reductions

CO<sub>2</sub> and other GHG emissions from the combustion of surface transportation fuels.

### Estimated GHG Reductions and Costs or Cost Savings

**Table I-2. Estimated GHG reductions and costs of or cost savings from TLU-3**

Quantification Factors	2015	2025	Units
GHG emission savings	0.88	2.54	MMtCO <sub>2</sub> e
Net present value (2009–2025)	N/A	–\$2,293	Million \$
Cumulative reductions (2009–2025)	N/A	21.26	MMtCO <sub>2</sub> e
Cost-effectiveness	N/A	–\$108	\$/tCO <sub>2</sub> e

GHG = greenhouse gas; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; \$/tCO<sub>2</sub>e = dollars per metric ton of carbon dioxide equivalent; N/A = not applicable.

Negative values in the Net Present Value and the Cost-Effectiveness rows represent net cost savings.

**Table I-3. Estimated GHG reductions and costs or cost savings from current federal law**

Quantification Factors	2015	2025	Units
GHG emission savings	0.70	2.07	MMtCO <sub>2</sub> e
Net present value (2009–2025)	N/A	–\$2,472	Million \$
Cumulative reductions (2009–2025)	N/A	17.31	MMtCO <sub>2</sub> e
Cost-effectiveness	N/A	–\$143	\$/tCO <sub>2</sub> e

GHG = greenhouse gas; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; \$/tCO<sub>2</sub>e = dollars per metric ton of carbon dioxide equivalent; N/A = not applicable; analysis scenario based on Federal Renewable Fuels Standard.

Negative values in the Net Present Value and the Cost-Effectiveness rows represent net cost savings.

This analysis assumes a “fuel-neutral,” low-carbon fuels policy requiring increased use of biofuels that could be met by a variety of scenarios. A sample scenario is assessed that would achieve the stated goal for overall increase in advanced biofuels use to 3% of total transportation fuel consumed in Arkansas.

#### **Data Sources:**

- *Life-cycle impacts of biofuels*—Argonne National Laboratory. "The Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (GREET) Model," version 1.8. Available at: <http://www.transportation.anl.gov/software/GREET/>.
- *Fuel economy and gasoline and ethanol prices*—U.S. Department of Energy, Energy Information Administration. *Annual Energy Outlook 2008: With Projections for 2030 (Revised Early Release)*. DOE/EIA-0383(2008). March 2008. Available at: <http://www.eia.doe.gov/oiaf/aeo>.
- *Price of biodiesel relative to conventional diesel*—U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy. *Clean Cities Alternative Fuel Price Report*, January 2008. Available at: [http://www.eere.energy.gov/afdc/price\\_report.html](http://www.eere.energy.gov/afdc/price_report.html).

#### **Quantification Methods:**

The estimate of GHG emission reductions from this policy is based upon an increase of alternative-fuel use to 14% of all on-road fuels in the state by 2015 and 25% by 2025. A ramp-up period is estimated so that alternative-fuel use would increase steadily on a yearly basis between 2010 and 2025.

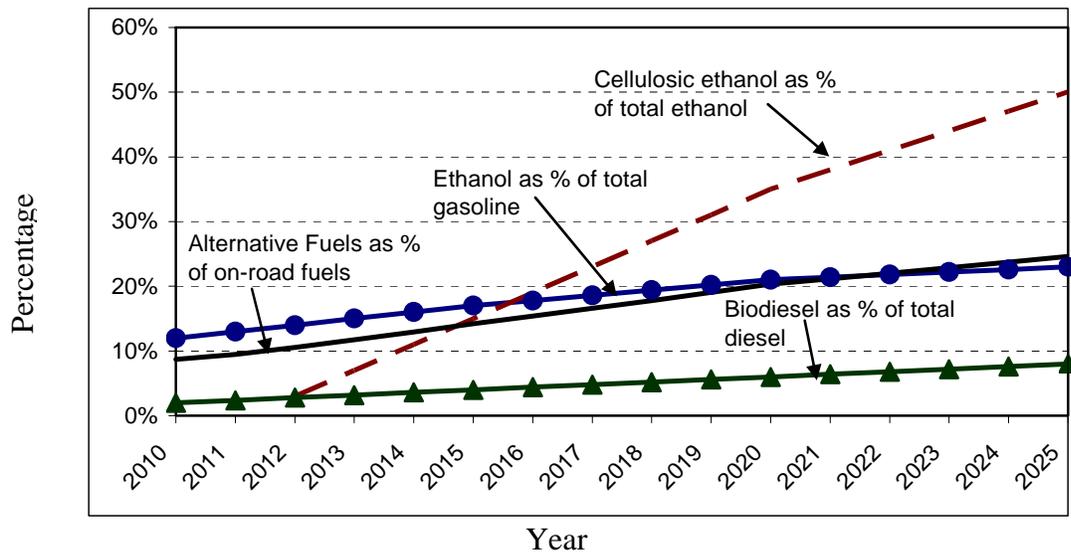
To estimate the likely ramp-up in alternative-fuel use needed to meet the policy, a potential scenario was developed for analysis. This scenario is intended to reflect requirements under current federal law (per the Renewable Fuel Standard), with additional emphasis on advanced biofuels (represented in this scenario by cellulosic ethanol and biodiesel). In the scenario, by 2025, ethanol sales in Arkansas would represent 23% of gasoline sales, with 18% of the ethanol used in flex-fuel vehicles (E85) and the remainder used in conventional vehicles operating on E10. For analysis purposes, ethanol was assumed to be used in the form of either E10 or E85. In reality, flex-fuel vehicles will be able to operate on any blend of ethanol up to 85%. The analysis assumptions are intended to reflect that range of blends. In addition, 100% of ethanol is assumed to come from corn feedstocks in 2010. Starting in 2012, it is assumed that cellulosic ethanol would begin to make up a significant portion of the ethanol market, ramping up to 50% of ethanol by 2025. Biodiesel (from soy) is assumed to make up 8% of total Arkansas diesel sales by 2025. The cumulative effect of this increase in biofuels would be that alternative fuels would make up 14%, and advanced biofuels would make up 3% of on-road fuels used in Arkansas by 2015, while alternative fuels would make up 25% and advanced biofuels would make up 10% by 2025. Table I-3 shows the assumptions used for this scenario.

**Table I-4. Analysis scenario assumptions**

Time Period	E85 Ethanol Market Share	E10 Ethanol Market Share	% Ethanol in Gasoline	Ethanol Feedstocks		% Biodiesel in Diesel	% Alternative Fuels	% Advanced Biofuels
				% Corn	% Cellulosic			
2010	3%	97%	12%	100%	0%	2%	9%	1%
2015	10%	90%	17%	85%	15%	4%	14%	3%
2020	15%	85%	21%	65%	35%	6%	20%	7%
2025	18%	82%	23%	50%	50%	8%	25%	10%

Figure I-1 illustrates the assumed blends of ethanol and biodiesel as percentages of gasoline and diesel, respectively, cellulosic ethanol as a percentage of total ethanol, and the percentage of total on-road transportation fuels displaced by alternative fuels.

**Figure I-1. Analysis scenario illustration**



Cost is calculated as the incremental cost of biofuels per gallon of gasoline equivalent (for ethanol) or diesel equivalent (for biodiesel), multiplied by total consumption of each fuel. Ethanol and gasoline prices in future years are drawn from the Energy Information Administration's (EIA's) *Annual Energy Outlook 2008* (AEO2008). Based on January 2008 information from the U.S. Department Energy's (DOE's) *Clean Cities Alternative Fuels Price Report*, the difference in the average price of biodiesel compared to conventional diesel in the Gulf Coast region is approximately \$0.11/gallon (less for biodiesel). Note that the cost calculation does not include federal subsidies in the form of tax credits for ethanol or biodiesel. In addition, costs related to any vehicle upgrades (e.g., flex-fuel vehicles that can operate on ethanol blends up to E85) are not included.

### **Key Assumptions:**

- Program starts in 2010, the first year of emission reduction.
- Program reaches the goal of advanced biofuels as at least 3% of total fuels consumed in Arkansas by 2015.
- Program applies to all on-road vehicles, “replacing” or (displacing) current gasoline and diesel fuel.
- Baseline scenario accounts for:
  - 0% ethanol existing market share and
  - 0% existing biodiesel market share.

### **Key Uncertainties**

Cellulosic ethanol is assumed to be a significant component of this policy. The timeline for availability of cellulosic ethanol on a large scale is unknown, although production facilities are beginning to come on line as of the date of this analysis. Another unknown is the price difference between cellulosic and corn-based ethanol.

The price differential between biodiesel and diesel is extremely dynamic. The results of the cost component of this analysis could vary, depending on future changes in that price differential.

Also, to achieve the goals, transportation fuel providers would need to undertake changes in their production and distribution methods. Because the policy does not prescribe particular technology pathways, there is uncertainty surrounding which fuels and technologies fuel providers will use to meet the standard. The program assumes that providers will use the most cost-effective options to meet the standard, but compliance costs are unknown at this time.

### **Additional Benefits and Costs**

It is generally agreed that increased domestic production of advanced transportation biofuels will reduce the need to import petroleum-based motor fuels and crude oil from other countries.

### **Feasibility Issues**

Please see the Key Uncertainties section.

### **Status of Group Approval**

Complete.

### **Level of Group Support**

Super Majority (one objection).

### **Barriers to Consensus**

One member does not believe this policy recommendation will result in net cost savings.

## TLU-4. Smart Growth, Pedestrian and Bicycle Infrastructure

### Policy Description

This policy recommendation calls for incentives and programs to encourage smart growth, including enhancing the pedestrian and bicycle infrastructure. Current land-use development practices increase vehicle travel by dispersing destinations, which separates activities and favors automobile travel over alternative modes. "Smart growth" planning by local, regional, and state governments refers to development that reduces sprawl and maximizes environmental, fiscal, and economic resources. It incorporates such planning tools as mixed use, open-space protections, downtown revitalization, "greyfield" redevelopment,<sup>5</sup> infill development, transit-oriented development, and pedestrian and bicycle infrastructure. It seeks to preserve open, recreational, and agricultural spaces and to prevent sprawl, especially on the periphery of urban areas where sprawling development may otherwise occur.

It is difficult to envision a solution to either global warming or energy security issues that does not involve slowing the growth of transportation emissions. To date, the national discussion of climate and energy initiatives has focused on technological solutions—namely, developing more fuel-efficient vehicles or lower-carbon fuels. Experts recognize, however, that all such technological solutions will be overwhelmed by the continued growth in automobile travel, thanks to our increasingly spread-out, car-dependent development patterns. During 1982–2002, these land-intensive development patterns caused development acreage to increase at twice the rate of population growth. This in turn caused per-capita vehicle miles traveled (VMT) to increase three times faster than America's population growth over that same period. It's no accident that VMT is increasing as the country continues to build and develop more areas where residents have no realistic choice but to drive long distances each day to meet their daily needs. A 2002 study by Smart Growth America found that the degree of sprawl was the most significant cause of a high VMT rate.<sup>6</sup>

The good news is that we can make enormous progress simply by shaping future building to create communities where people can accomplish more by driving less. Numerous studies demonstrate that when people are given the option to live in a less automobile-dependent place, they drive less. According to the report *Growing Cooler: The Evidence on Urban Development and Climate Change*, residents of more compact neighborhoods drive 20%-40% less on average, saving oil and reducing GHG emissions.<sup>7</sup> If we combine compact neighborhoods with increased investment in public transit of all shapes and sizes (TLU-6, School and University Transportation Bundle), the resulting synergies can reduce dangerous emissions enormously.

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<sup>5</sup> Greyfields are underutilized land in the form of parking lots, declining strip malls, and vacant parcels.

<sup>6</sup> Smart Growth America. "Energy and Climate." Available at: <http://www.smartgrowthamerica.org/climate.html>.

<sup>7</sup> Reid Ewing, Keith Bartholomew, Steve Winkelman, Jerry Walters, and Don Chen. *Growing Cooler: The Evidence on Urban Development and Climate Change*, Washington, DC: Urban Land Institute, 2008. Available at: <http://www.smartgrowthamerica.org/gcindex.html>.

## Policy Design

Arkansas should allow, encourage, facilitate, and undertake a set of smart growth activities related to the following initiatives:

- Downtown and neighborhood revitalization,
- Greyfield redevelopment,
- Infill development,
- Transit-oriented development (TOD),
- Sprawl reduction,
- Bike and pedestrian infrastructure,
- Incentives for urban school districts,
- Highway access management and corridor maintenance, and
- Smart growth planning, modeling, and tools.

**Goals:** Overall goals for the set of activities would be the following:

- By 2010, 35% of new development and redevelopment will occur in higher-density tracts (> 2,000 people per square mile), compared to only 10% under the business as usual (BAU) scenario.
- By 2010, begin providing economic development incentives and liberalized zoning and permitting processes (parking requirements, density restrictions, mixed-use restrictions, etc.) to encourage investment in central business districts.
- By 2010, begin providing economic incentives, liberalized zoning and land-use restrictions, and streamlined permitting processes to encourage brownfield redevelopment, infill development, and TOD.
- By 2010, develop and adopt a comprehensive plan to preserve open space on the edges of urban areas where sprawling development may otherwise occur, and to encourage regional cooperation in reducing sprawl.
- By 2010, develop a program for information dissemination and technical assistance to facilitate the adoption of smart growth planning processes, models, and tools by local and regional jurisdictions.
- By 2015, require "complete streets" policies, providing for systematic adoption of sidewalks and bikeways.

**Timing:** See above, with most strategies to be implemented by 2010.

**Parties Involved:** State government, local government, city planners from around the state (including, specifically, the city planners in Fayetteville), individual property owners, and investors.

## **Implementation Mechanisms**

### *Downtown and Neighborhood Revitalization*

Many U.S. towns and cities are crowded during business days, but are deserted by night and on weekends because few people live there. Some cities have begun turning this problem around by revitalizing their downtowns and centrally located neighborhoods. Downtown revitalization can be profitable (by reusing existing infrastructure), can provide a better quality of life (by centralizing entertainment and retail, providing a critical mass for success), and can improve the environment (by reducing VMT, providing sufficient density for walking, bicycling, and transit, reducing sprawling-edge development, and preserving greenfields).

Arkansas should provide economic development incentives and liberalized zoning and permitting processes (parking requirements, density restrictions, mixed-use restrictions, etc.) to encourage investment in central business districts and neighborhoods. The state could provide tax incentives for property owners to do historic preservation and restoration on buildings located in historic downtowns. (Arkansas is one of the few states lacking a personal income tax incentive for historic preservation.) State agencies should lead by example and locate offices and services in downtowns and centrally located neighborhoods. Main Street Arkansas is a state program that assists downtowns in their revitalization efforts and provides training and support to 30 participating communities. A major principle of sustainable building practices is to rehabilitate, refurbish, remodel, or convert existing structures.

### *Greyfield Redevelopment*

"Infill" development of all sorts reduces sprawl and VMT. Many of Arkansas' urban areas have a large percentage of greyfields. Redeveloping greyfields has the additional advantage of improving the quality of life in city centers, which increases the number of downtown residents, workers, and visitors. Arkansas should provide economic incentives, liberalized zoning and land-use restrictions, and streamlined permitting processes to encourage greyfield redevelopment. This can be a key factor in urban revitalization by providing new centrally located areas for residential, commercial, or mixed-use development. It also reduces average trip distances, and encourages walking, bicycling, and public transit.

### *Infill Development*

Development of vacant or underused parcels of land within existing developed areas reduces average trip distances and saves public funds by taking advantage of existing infrastructure and public utilities. By increasing the local population density, it also encourages walking, bicycling, and public transit. Arkansas should provide economic incentives, liberalized zoning and land-use restrictions, and streamlined permitting processes to encourage infill development. Toward this end, Arkansas should pass Transfer of Development Rights (TDR) enabling legislation, so that cities can preserve high-value agricultural land and natural resources by transferring

development rights to designated infill areas and allow market forces to determine the price of development credits (additional units per acre).<sup>8</sup>

Additionally, enabling cities to adopt tiered impact fees, especially with regard to roads, would help guide development to appropriate infill locations. Tiered impact fees charge less for developments located near the core of the city and more for developments located on the urban fringe. The lack of county zoning in most of Arkansas severely limits the ability for cities to discourage sprawl. Development often happens just over the line, resulting in leap-frog development patterns and an increased tax burden for providing urban services, such as fire and police protection. A major initiative should be made to bring planning and zoning to all counties having significant urban centers.

### *Transit-Oriented Development*

Transit-Oriented Development (TOD) is the creation of compact, mixed-use commercial or residential communities designed to maximize access to public transit (see TLU-6), while also creating a community attractive to pedestrians and bicyclists. TOD thus reduces VMT and the associated GHG emissions. Arkansas should provide economic incentives, liberalized zoning and land-use restrictions, and streamlined permitting processes to encourage TOD. Regional Mobility Authorities throughout Arkansas should devote at least 20% of their funds to mass transit options to facilitate this mechanism.

### *Reducing Sprawl*

For smart growth policies to be truly effective, the efforts must be regional or, better yet, statewide. If all municipalities in an area are not practicing smart growth, development may gravitate to greenfields at the edges of cities or between cities, resulting in sprawl. Arkansas should adopt a comprehensive plan to preserve open space on the edges of urban areas where sprawling development may otherwise occur, and to encourage regional cooperation in reducing sprawl. One approach would be to encourage "green zones" at the edges of cities that would be permanently zoned for agricultural use only, and off limits to developers.<sup>9</sup> Also, the state should provide for TDR programs, discussed above.

### *Bike and Pedestrian Infrastructure*

Smart growth aims to encourage alternative (non-automobile) transportation modes, especially walking and bicycling. Arkansas towns, cities, and counties should improve and construct sidewalks and bikeways, and the state should provide economic incentives to encourage such infrastructure development. This is particularly true in commercial areas without adequate

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<sup>8</sup> TDR is a voluntary, market-based implementation process by which the development rights of a landowner in the area to be protected (the "sending" zone) are transferred to an appropriate, community-designated area (the "receiving" zone). The sending zone is placed in a permanent conservation easement, such as a land bank, and the receiving zone is granted an increase in land-use intensity, such as density bonuses or increases in building height. Since this process does not require local governments to purchase any lands, and since concentrated development in the receiving zone saves money on municipal services, very little public funding is required. At least 23 states have adopted TDR enabling legislation.

<sup>9</sup> For further discussion, see Smart Growth America. "Open Space & Farmland." Available at: <http://www.smartgrowthamerica.org/openspace.html>.

sidewalks and in residential and other areas where pedestrian and bicycle safety is a concern. The attraction of bicycling and walking is greatly enhanced by facilities that are safe and that also "feel" safe to bicyclers and walkers.

Bikeways can take the form of designated bike lanes on shared streets, or of trails that are separated from roadways, except at crossings. The former are typically four or more feet wide. Separate bike trails are usually designed as multi-use trails that also serve joggers, strollers, skaters, etc. Bikeways are not just for recreational use; they also serve commuters, shoppers, school children, and others. Indeed, real reductions in automobile VMT can occur by using bikeways for transportation. For example, in Scandinavian countries, despite the cold weather, 30% of all commuters commute by bicycle. Other infrastructure improvements could include bicycle parking and shower or locker amenities at places of employment. Cities, regional jurisdictions, and universities can institute "free bicycles" programs, as is done in many U.S. and European cities.

Arkansas should require "complete streets" policies, providing for systematic adoption of sidewalks and bikeways to help achieve these goals. All state road projects should include infrastructure to accommodate bikes and pedestrians as a complete street model. At the local level, cities should also be encouraged to create complete streets and adopt trail and on-street bikeway master plans. These master plans should be recognized and included in the planning of all state and city improvement projects. Grant funding should be increased and made available to communities for the construction of multi-use trails and on-street bike facilities. Legislation should be created to allow road turn-back funds to be used for alternative transportation projects. Arkansas should also encourage property owners to donate necessary portions of property for multi-use trails through tax incentives or other benefits. New residential and commercial developments should be required to dedicate rights of way for multi-use trails when identified on the trail master plans. Riparian corridors should be identified for multi-use trails and protected as an enduring green network through their communities.

#### *Incentives for Urban School Districts*

Arkansas should provide incentives for school districts to develop new facilities within existing urban cores. Locating new school facilities on the urban fringe encourages sprawl and VMT. A first step would be to remove the excessive acreage requirement that the state mandates for locating new schools (80–100 acres). Rehabilitation and adaptive reuse of existing facilities should be the first option when school expansion is necessary. The Arkansas Department of Education needs to revisit its long-range planning and goals in order to place higher priorities on issues related to sustainability and reasonable location requirements. The placement of school facilities has broad and often drastic effects on how communities grow and evolve. Auto-dependent models of developing schools will quickly fade as the era of cheap energy comes to a close. An emphasis on central location and the ability for alternative transportation options should have significant weight when making policy decisions regarding school locations. Forward-thinking, yet common-sense, approaches are necessary to implement this policy.

#### *Highway Access Management and Corridor Maintenance*

The Arkansas State Highway and Transportation Department should adopt access management standards to apply to all Arkansas road projects. Adequate prior transportation planning reduces

the number of access/conflict points along state highways and municipal arterial roads and ensures that future roadway capacity is not significantly diminished over time. Arkansas should promote the development of “complete, compact, and connected” neighborhoods through the adoption of smart growth policies. Cul-de-sac subdivisions should be discouraged because of the increased VMT associated with them. Arkansas could significantly reduce GHGs and the maintenance cost of mowing highways by funding a wildflower and native plant corridor program modeled after the program that exists in Texas.

### *Smart Growth Planning, Modeling, and Tools*

Arkansas should provide state funding, information dissemination, and technical assistance to facilitate the adoption of smart growth planning processes, models, and tools by local and regional jurisdictions. A smart growth toolkit should be developed and distributed to all cities and counties.

### **Related Policies/Programs in Place**

As described above.

### **Type(s) of GHG Reductions**

Transportation sector surface transportation fuels produce CO<sub>2</sub> (which accounts for approximately 96% of transportation GHG emissions) and other GHG emissions (methane [CH<sub>4</sub>], nitrous oxide [N<sub>2</sub>O], and hydrofluorocarbons).

### **Estimated GHG Reductions and Costs or Cost Savings**

This analysis considers potential GHG reductions from reductions in VMT for personal (non-truck) travel, as a result of a shift toward more compact development patterns following smart growth principles. The analysis relies on estimates of per-capita VMT by census tract population density range, as developed by Steve Polzin, Director of the Center for Urban Transportation Research (CUTR) Mobility Program for the CUTR VMT forecasting model. The CUTR model is based on analysis of the U.S. Department of Transportation’s 2001 National Household Travel Survey data.<sup>10</sup> The model provides estimates of per-capita VMT by state for five density ranges. It is currently set up for years 2005, 2035, and 2055; for this analysis, results were interpolated for Center for Climate Studies (CCS) analysis years.

The observed relationship between per-capita VMT and population density serves as a proxy for the effects of smart growth development, as described above. Higher levels of population density are associated with overall shorter trips, because destinations are closer together. In addition, areas with higher population densities are more likely to have pedestrian-friendly design (walkability, mixed use, etc.) and to support transit service. It is difficult to separate out the individual effects of the various smart growth strategies at this aggregate level of analysis, but the analysis provides an indicator of what can be achieved through a combined set of smart growth policies.

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<sup>10</sup> P.S. Hu and T.R. Reuscher. *Summary of Travel Trends: 2001 National Household Travel Survey*. Prepared for the U.S. Department of Transportation Federal Highway Administration. December 2004. Available at: <http://nhts.ornl.gov/2001/pub/STT.pdf>.

**Table I-5. Estimated GHG reductions and costs of or cost savings from TLU-4**

Quantification Factors	2015	2025	Units
GHG emission savings	0.06	0.17	MMtCO <sub>2</sub> e
Net present value (2009–2025)	N/A	≤ 0 (Net savings)	Million \$
Cumulative reductions (2009–2025)	N/A	1.39	MMtCO <sub>2</sub> e
Cost-effectiveness	N/A	< 0 (Net savings)	\$/tCO <sub>2</sub> e

GHG = greenhouse gas; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; \$/tCO<sub>2</sub>e = dollars per metric ton of carbon dioxide equivalent; N/A = not applicable.

**Data Sources:**

- Total population and population density by census tracts in Arkansas and other states, 1990 and 2000.
- Per-capita VMT by census tract population density in Arkansas, from CUTR VMT forecasting model.
- Forecast statewide population growth. U.S. Bureau of the Census, Population Division. Arkansas Population Projections: 1995 to 2025. Available at: <http://www.census.gov/population/projections/state/9525rank/arprsrrel.txt/>  
Campbell, Paul. "Population Projections by States, 1995–2025." Current Population Reports. P25-1131.U.S. Department of Commerce, Census Bureau. May 1997. Available at: <http://www.census.gov/prod/2/pop/p25/p25-1131.pdf>

**Quantification Methods:**

The specific method used to estimate GHG benefits of smart growth strategies is as follows:

- Total population in 2000 was identified by five census tract density ranges, as identified in the CUTR model (< 500, 500–1,999, 2000–3,999, 4,000–9,999, and 10,000 or more people per square mile) for metropolitan versus nonmetropolitan areas.
- The change in population from 1990 to 2000, and associated share of change by density range, was identified from census data.
- Statewide population by tract density range for 2010 (to use as the base year when policy changes are proposed to begin) was estimated by taking state population forecasts for 2010, and allocating 2000–2010 growth to tract density range in the same proportion as 1990–2000 growth.
- For the baseline (BAU) scenario, new population growth between 2010 and 2025 (as determined from state forecasts developed for the CCS baseline) was allocated to tract density ranges based on the share of growth in the 1990–2000 time frame. Total statewide growth is forecast at 363,000 people, or 13%. The proportion of existing housing stock (population) that would be redeveloped over this time frame was estimated at 9%, representing a rate of 6% per decade between 2010 and 2025. Two-thirds of this

redevelopment is assumed to occur in place, and one-third is redeveloped elsewhere, with this redevelopment allocated to tract density ranges based on the 1990–2000 share of population growth. (The 6% and two-thirds figures come from the 2007 *Growing Cooler* report's Section 1.7.3, citing analysis of census data by Nelson [2006].)

- For the Climate Action scenario, a significant shift in the proportion of new development and relocated redevelopment was assumed to take place, with higher-density tracts (> 2,000 people per square mile) receiving 35% of new development under this scenario, compared to only 10% under the BAU scenario. Total population by tract density under this scenario was then calculated. This relatively conservative reallocation scenario reflects the largely rural and small-city nature of population growth in Arkansas, based on analysis of census data from 1990 and 2000 showing that most (two-thirds) of the growth occurred in non-metropolitan areas, while most of the remainder occurred in smaller metropolitan areas. The analysis assumes that rural growth would occur in a more clustered pattern, with shifts in population from the lowest density range (fewer than 500 people per square mile, typical of rural tracts) to the second lowest density range (500–1,999 people per square mile, typical of smaller cities/towns), and that metropolitan growth would shift more toward the third and fourth density ranges (2,000–9,999 people per square mile), representing an increase in higher-density infill and redevelopment.
- Total personal-travel VMT was calculated under the BAU and Climate Action scenarios, based on VMT per capita (from the CUTR model) and total 2025 population by tract density range, and the percentage reduction in personal-travel VMT was calculated.
- The percentage reduction in VMT was adjusted by 90%, to estimate the percentage reduction in GHG emissions. This factor is the same as used in the *Growing Cooler* report, to account for the fact that higher-density areas may experience somewhat lower travel speeds and, therefore, slightly reduced fuel economy.<sup>11</sup>
- BAU GHG emissions in 2025 for passenger travel were estimated as those from all light-duty VMT. To estimate cumulative emission reductions over the 2010–2025 period, a linear ramp-up of benefits was assumed over this time frame.

### **Key Assumptions:**

- The fraction of new population growth and redevelopment by census tract density, under the BAU scenario.
- The assumed shift in the fraction of new population growth and redevelopment from lower-density to higher-density census tracts, under the Climate Action versus the BAU scenario.
- The percentage of residential building stock redeveloped (off site) over the analysis time frame.

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<sup>11</sup> Reid Ewing, Keith Bartholomew, Steve Winkelman, Jerry Walters, and Don Chen. *Growing Cooler: The Evidence on Urban Development and Climate Change*, Washington, DC: Urban Land Institute, 2008. Available at: <http://www.smartgrowthamerica.org/gcindex.html>.

### **Corroborating Methodologies:**

This methodology is consistent with another methodology that was tested, based on the parameters assumed in the *Growing Cooler* report estimate of CO<sub>2</sub> reductions in 2050. The methodology was adapted to 2025 conditions, and some adjustments were made for Arkansas-specific data where available, including population growth and proportion of VMT in urban areas. The previous methodology used a number of factors from the *Growing Cooler* report. The primary differences are that *Growing Cooler* assumes a 30% reduction in VMT for “compact development” (rather than the VMT levels by census tract density range); includes a blanket assumption of 60% of new (urban) growth reallocated to “compact development”; and does not assign any VMT reduction to growth in rural areas. The methodology produces a result similar to that of the original analysis, projecting a GHG reduction of 1% for passenger travel, compared to the 2025 BAU scenario, or a savings of 0.15 million metric tons of carbon dioxide equivalent (MMtCO<sub>2</sub>e) in 2025, compared to 0.17 in the methodology above that was utilized.

### **Key Uncertainties**

Smart growth depends upon the decisions of many individual property and business owners, as well as the efficacy of incentives and other programs.

### **Additional Benefits and Costs**

Smart growth generally has very low direct costs to implement, comprised of the governmental costs of altering regulations and zoning and providing education and technical assistance. Tax incentives are an income transfer that results in a public-sector cost but offsetting developer revenue. As most smart growth policies (e.g., allowing higher density and mixed use, reducing parking requirements) are deregulatory in nature, they are opening the development market and have significant indirect as well as direct benefits. An exception is growth boundaries, which restrict the land-use market and have an indirect cost.

Alternative patterns of development have a large number of additional impacts that may provide both benefits and costs. Smart growth provides a range of co-benefits that are well documented in other places. Prominent among these is the reduced cost of providing utilities and infrastructure, as smart growth makes better use of existing facilities and infrastructure and, on average, has lower demand. Improved air quality, public health (e.g., due to walking), and quality of life are also notable co-benefits.

### **Feasibility Issues**

Smart growth policies are being considered and implemented around the country in a wide range of communities. Because most policies are deregulatory in nature, this significantly lowers political barriers. Much of the timing, feasibility, effectiveness and impacts of smart growth measures involve building development and population growth depending upon business and economic cycles.

### **Status of Group Approval**

Complete.

### **Level of Group Support**

Unanimous.

### **Barriers to Consensus**

Not applicable.

## TLU-5. Improve and Expand Transit Service and Infrastructure

### Policy Description

Improvements to existing transit service and expansion of transit routes can shift passenger transportation from single-occupant vehicles to public transit, thereby reducing GHG emissions. This mitigation recommendation involves a number of actions to be undertaken by state and local governments and transit agencies.

### Policy Design

#### Goals:

- Reduce light-duty vehicle (LDV) total VMT in urban areas from 2008 baseline growth by 1% per year starting in 2010 until 2025.
- Increase investment in transit service and infrastructure by 2015.

**Timing:** As described above.

**Parties Involved:** State and local governments and transit agencies.

### Implementation Mechanisms

The state should implement transit investments that encourage greater use of public transportation, such as the following:

- Improve service frequency on selected existing intra- and intercity transit routes (selected routes would emphasize those for which the measure would generate the greatest additional ridership or cost-effectiveness).
- Support and encourage improvements in intra- and intercity bus service.
- Reduce travel times on selected existing transit routes (signal prioritization, exclusive lanes, etc.).
- Improve the quality of service on selected existing transit routes (safety, cleanliness, improvements to shelters/stations).
- Provide financing, regulatory relief, and the use of eminent domain to develop and expand transit service and infrastructure (commuter rail, light rail, bus). In particular, the state should dedicate funding for the planning and development of commuter/light rail systems, especially in locations having higher population densities and other characteristics conducive to successful systems. The first project of this nature could be a case study for the rest of the state. Where such rail corridors are studied, municipalities in the affected corridor should begin to address zoning issues around likely future transit stops in order to promote increased residential and commercial densities. In addition, Regional Mobility Authorities throughout

Arkansas should always include mass transit options in their considerations and should devote 5%–50% of their funding to mass transit options.

- Offer incentives to potential passengers, and provide loans and/or subsidies to operators (public or private) to offer improved and less expensive intercity bus service.
- Provide financing, regulatory relief, and the use of eminent domain to develop, publicly or privately, a high-speed intercity passenger rail system serving major urban areas. Provide additional financial assistance to improve services already provided by Amtrak on other routes.

### Related Policies/Programs in Place

- Arkansas State Highway and Transportation Department, *Arkansas Statewide Long-Range Intermodal Transportation Plan: 2007 Update*, available at: <http://www.arkansashighways.com/planning/F%20&%20E/Final%202007%20Statewide%20Long%20Range%20Plan.pdf>.
- Regional long-range transportation plans, including the possibility of passenger rail in northwest Arkansas.

### Type(s) of GHG Reductions

Transportation sector surface transportation fuels produce CO<sub>2</sub> (which accounts for approximately 96% of transportation GHG emissions) and other GHG emissions (CH<sub>4</sub>, N<sub>2</sub>O, and hydrofluorocarbons).

### Estimated GHG Reductions and Costs or Cost Savings

This analysis examines the reductions in GHGs possible from a shift from personal motor vehicles to transit, which typically emit fewer GHGs per passenger mile. The calculation of GHG reductions must account both for the reduction in the number of private vehicle miles, but also for the partly offsetting increase in transit VMT. In addition to these direct reductions from individuals' shift of modes, two more long-term, indirect effects will be estimated. The shifting of trips from personal vehicles to transit can reduce the number of vehicles on the road, and thus the amount of congestion in urban areas. Reducing congestion improves traffic flow and improves actual average vehicle fuel economy. Studies have also demonstrated that increased transit service can help shape land-use patterns, enabling densities and proximity to the center of urban areas, and resulting in reduced VMT by those living in transit corridors, even if they never use public transit.

**Table I-6. Estimated GHG reductions and costs of or cost savings from TLU-5**

Quantification Factors	2015	2025	Units
GHG emission savings	0.001	0.007	MMtCO <sub>2</sub> e
Net present value (2009–2025)	\$4.0	\$1.5	Million \$
Cumulative reductions (2009–2025)	0.001	0.03	MMtCO <sub>2</sub> e
Cost-effectiveness	\$3,980	\$1,479	\$/MtCO <sub>2</sub> e

GHG = greenhouse gas; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; \$/tCO<sub>2</sub>e = dollars per metric ton of carbon dioxide equivalent.

## Data Sources:

- The National Transit Database<sup>12</sup> was used to derive (1) current and historical transit ridership, by mode type (urban/rural, bus or paratransit); (2) operating cost per passenger and per passenger-mile, by mode type (urban/rural, bus or paratransit); and (3) revenue per passenger and per passenger-mile, by mode type (urban/rural, bus or paratransit).
- Linda Bailey, P.L. Mokhtarian, and Andrew Little. The Broader Connection Between Public Transportation, Energy Conservation and Greenhouse Gas Reduction. Produced by ICF International for the American Public Transportation Association. February 2008. Available at: [http://www.apta.com/research/info/online/documents/land\\_use.pdf](http://www.apta.com/research/info/online/documents/land_use.pdf).
- Texas Transportation Institute. *2007 Annual Urban Mobility Report*. Quantification Methods. Available at: <http://mobility.tamu.edu/ums/>.

Direct quantification was undertaken for improvements in service frequency, travel time reductions, and the introduction of new and expansion of existing routes and services. These were applied to intra- and inter-city bus, vanpools, and rail services. Selected routes were assumed to emphasize those for which the measure would generate the greatest additional ridership or cost-effectiveness.

Travel time improvements provide a well-documented means of improving transit service and ridership. There is a direct benefit to riders as the improved service reduces the “generalized cost” (time cost plus financial cost) of their trip. In addition to co-benefits in improving service frequency, there is about a  $-0.4$  elasticity for transit travel time.

Service frequency increases ridership from existing riders and attracts new riders. As waiting time between vehicles has been shown to be valued about two times more on average than actual travel time, this mechanism can prove very effective. There is a reported  $-0.5$  elasticity for service frequency alone (time between buses), while the aggregate impacts for service improvements in time between vehicles and travel time have shown an elasticity of between  $-0.6$  and  $-1.0$ , incorporating the time and frequency impacts of aggregate increases in service miles provided. An aggregate elasticity of  $-0.9$  was applied to the total increase in vehicle revenue service miles to capture both factors together and reflect that the focus would be on the most effective implementation locations.

For service expansions and introduction, both the literature and a first-order statistical analysis show a long-run elasticity for service expansion of between  $-0.6$  and  $-1.0$ . As above, an aggregate elasticity of  $-0.9$  was applied to the total increase in vehicle revenue service miles to capture both factors together and reflect that the focus would be on the most effective implementation locations.

Estimates for the effects of new light rail and commuter rail services were based upon aggregate information from projects in similar urban areas in other states due to the lack of historical data in Arkansas.

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<sup>12</sup> U.S. Department of Transportation, Federal Transit Administration. "National Transit Database." 2006. Available at: <http://www.ntdprogram.gov/ntdprogram/>.

Congestion reduction benefits from transit were represented by using a factor of 0.00822 private vehicle gallons saved per passenger-mile of transit ridership based on the Texas Transportation Institute's *2007 Annual Urban Mobility Report*.<sup>13</sup>

Synergies with land-use development were represented as equaling a reduction in VMT equal to one-quarter of the direct reduction from transit ridership 10 years prior, based on an adjustment of ICF's *The Broader Connection Between Public Transportation, Energy Conservation and Greenhouse Gas Reduction* very long-term factor, reduced to represent the actual pace of development.<sup>14</sup>

### **Key Assumptions:**

- Transit services can be expanded and introduced at the same average operating cost as current services.
- New or improved services will attract ridership in a manner consistent with service improvements in other similar areas of the country (i.e., the Arkansas transit market is not at saturation). Current fuel price increases provide a strong argument for this assumption.

### **Key Uncertainties**

As described above. The timing for availability of additional transit service depends upon the availability of funding and program implementation.

### **Additional Benefits and Costs**

Transit services have a large number of additional impacts, which provide additional benefits. Transit service provides mobility, accessibility, and safety benefits that are not included in the analysis above. Important other co-benefits include improved air quality, public health (e.g., due to walking), and quality of life. Transit benefits in reducing congestion and facilitating land-use patterns, such as transit-oriented development and smart growth, are very significant and, as noted, are partly reflected in the analysis above.

### **Feasibility Issues**

Implementation of additional transit service depends upon availability of funding. The use of eminent domain for the use of new rail right of ways may also impact feasibility.

### **Status of Group Approval**

Complete.

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<sup>13</sup> Texas Transportation Institute. *2007 Annual Urban Mobility Report*. Quantification Methods. Available at: <http://mobility.tamu.edu/ums/>.

<sup>14</sup> Linda Bailey, P.L. Mokhtarian, and Andrew Little. *The Broader Connection Between Public Transportation, Energy Conservation and Greenhouse Gas Reduction*. Produced by ICF International for the American Public Transportation Association. February 2008. Available at: [http://www.apta.com/research/info/online/documents/land\\_use.pdf](http://www.apta.com/research/info/online/documents/land_use.pdf).

**Level of Group Support**

Unanimous.

**Barriers to Consensus**

Not applicable.

## TLU-6. School and University Transportation Bundle

### Policy Description

In 1969, approximately 50% of students walked or biked to school; by 2001 this number was less than 16%. These numbers indicate our growing dependence on the combustion engine and specifically on automotive travel. The reasons behind this drastic decrease in the number of students walking or riding their bikes to school are many, but include the growing distance of students' homes from their schools and an unsafe travel environment, including major road crossings and the lack of access to sidewalks or multi-use paths. The use of passenger vehicles to transport students to and from schools, colleges, and universities burns a significant amount of fossil fuel, which not only releases GHGs into the atmosphere, but also teaches students to travel by car, instead of utilizing healthier alternatives, such as walking, bicycling, riding the bus, or carpooling. Schools, colleges, and universities are well positioned to effect the changes in transportation habits that Arkansas needs if it is to reduce automobile use.

An October 2003 study by the U.S. Environmental Protection Agency (EPA) examined the relationship between school location, the built environment around schools, mode choices for trips to school, and the impacts these choices had on air emissions. The study found that school proximity matters to students, as students with shorter walk and bike times to and from school were more likely to walk and bike. Additionally, students traveling through higher-quality built environments were also more likely to bicycle and walk. And finally, because of these travel behavior choices, centrally located schools that can be reached by walking and bicycling served to reduce air emissions and demonstrated better air quality within the immediate vicinity surrounding the school.<sup>15</sup>

### Policy Design

This policy focuses on encouraging the reduction of transportation sector GHG emissions when transporting students to schools, colleges, and universities.

#### Goals:

- By 2010, colleges and universities will study and report on the environmental impacts, the health and financial costs, and other costs and benefits associated with reduction of student VMT.
- By 2012, K-12 schools should consider establishing programs, such as ride sharing and ride-sharing clearinghouses; supervised walking to school, including "walking school buses" and safe routes to schools; and bicycling and mobility education programs that teach students about the health and environmental benefits of using alternative transportation. Additionally, these programs should present these alternatives in a manner that students should relate to in an effort to make it "cool" to walk, bicycle, carpool, or ride the bus.

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<sup>15</sup> U.S. Environmental Protection Agency. *Travel and Environmental Implications of School Siting*. EPA 231-R-03-004. October, 2003. Available at: <http://www.smartgrowth.umd.edu/pdf/SchoolLocationReport.pdf>.

- By 2012, K-12 schools should consider developing a program to teach students about the consequences automobile overuse has on both the environment and on their own personal health as well as other potential consequences of automobile overuse.
- By 2012, high schools should consider establishing programs to reduce or abolish student parking.
- By 2012, colleges and universities should consider establishing more comprehensive commuting programs that may include options, such as free bus programs, expanded bicycle storage, free student bicycles, carpooling programs, and abundant multifamily housing on or near campus, that also provide nearby access to such services as food, drugstore, etc.
- By 2012, through a combination of all of these programs, schools, colleges, and universities should consider reducing the total VMT transporting students by 5%
- By 2015, through a combination of all of these programs, schools, colleges, and universities should consider reducing the total VMT transporting students by 10%.
- By 2025, through a combination of all of these programs, schools, colleges, and universities should consider reducing the total VMT transporting students by 10%.

**Timing:** As described above.

**Parties Involved:** State of Arkansas, local school districts, parents, students.

### Implementation Mechanisms

- K-12 schools will establish alternative transportation programs by 2012, such as ride sharing and ride-sharing clearinghouses; supervised walking to school, including "walking school buses" and safe routes to schools; and bicycling and mobility education programs that teach students about the health and environmental benefits of using alternative transportation. Additionally, these programs will present these alternatives in a manner that students will relate to in an effort to make it "cool" to walk, bicycle, or ride the bus, not only to school, but also in their daily lives.
- Arkansas schools will work with the federal "Safe Routes to School" program, which provides money for local sidewalks and crosswalks to develop safe routes to school.<sup>16</sup>
- Schools will examine their bus routes to determine the most efficient routes to take and will examine the potential for eliminating stops and having children walk farther to reach the bus. Having children walk just five to ten more minutes to a bus stop could save each district substantial sums of money while significantly reducing VMT by district buses.
- Education programs aimed at addressing the potential risks posed by having students walking or riding their bikes to school will be implemented for both parents and students. These

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<sup>16</sup> U.S. Department of Transportation, Federal Highway Administration. "Safe Routes to School." Available at: <http://safety.fhwa.dot.gov/saferoutes/>.

programs will identify how the routes to school are designed for safety, provide perspectives on risk, identify how the routes will be made both visible and accessible, and provide information and training on the use of safety equipment and how to appropriately dress for walking and cycling in various weather conditions.

- K-12 is a critical time to teach children the environmental, health, and other consequences of automobile overuse. K-12 should make lessons about the environment—why we need it, how to preserve it, how we affect it, etc.—a routine part of all courses in health, biology, physical science, and environmental science curricula.

### **Implementation Mechanisms to Consider:**

- Suggest that all streets near any K-12 school or university have sidewalks for pedestrian use.
- Suggest that all K-12 schools, colleges, and universities have bicycle access either via multi-use paths or through bike lanes on the surrounding street.
- Suggest that all K-12 schools, colleges, and universities have bicycle parking conveniently located near the entrances to buildings and in well-lit areas.
- Raise the legal age for receiving a driver's permit to 16, and raise the legal age for receiving a driver's license to 17. This would help to increase safety on the roads as well as serve to reduce GHG emissions by having fewer drivers at the high school level.
- Suggest that state high schools reduce the size of their parking lots to encourage carpooling and the use of other alternative transportation, including walking, cycling, and using public or school-provided transportation. The parking that is available should be neither free nor subsidized; rather, it should reflect the true cost of the lot and land. Schools can restrict student parking to seniors or outstanding students.
- Suggest that Arkansas colleges and universities require first-year, or first- and second-year, students to live on campus, and to store their cars in distant lots for out-of-town travel.
- Revise Arkansas' minimum acreage planning requirements for schools, so that they favor small, centrally located schools that encourage the use of walking and biking, while minimizing driving distances.
- Suggest that the energy required for transporting students to and from a K-12 school, college, or university is considered as a component when calculating a school building's energy ratings.
- Encourage colleges and universities to establish free bus programs for students, bicycle storage facilities, free student bicycles, and/or abundant multifamily housing on or near campus with services (food, drugstore, etc.) nearby.
- Encourage interviews with state officials or compare with peer states to estimate the number of students driving to school to develop an estimate of the number of parking spaces that can be eliminated.

- Encourage “ride matching” by examining the U.S. Department of Transportation National Household Travel Survey (NHTS) data to determine average vehicle occupancy for current school trips (e.g., siblings, current ride sharing) and estimating what additional penetration may be available for vehicles not fully occupied.

### **Related Policies/Programs in Place**

Arkansas Safe Routes to School Program. Available at:  
<http://www.arkansashighways.com/planning/safe%20routes/index.htm>.

The Active and Safe Routes To School program in Toronto, Ontario, launched a “No Idling” at schools campaign across Ontario. The program determined that an idling engine uses 3.5 liters of gasoline per hour, and that 12% of urban smog is attributable to idling vehicles. This program resulted in an estimated reduction of 247 hours per day of auto idling resulting in an estimated 210.5 fewer metric tons of CO<sub>2</sub> emissions.<sup>17</sup>

One year after being implemented at 16 participating schools, Marin Safe Routes To Schools noted that the schools in Marin County, California, experienced a 57% increase in the number of children walking and biking, and a 29% decrease in the number of children being driven in a car.<sup>18</sup>

### **Type(s) of GHG Reductions**

Reduced GHG emissions from reduction in combustion of transportation fuels, including CO<sub>2</sub>.

### **Estimated GHG Reductions and Costs or Cost Savings**

Emission reductions from these programs were not quantified for Arkansas at this time due to the lack of available data on travel patterns for students to Arkansas schools and post-secondary institutions. While some data, such as modal splits for accessing schools, were located, important elements, such as VMT by personal vehicles and disaggregation by school type and location for all factors were not. The latter is critical to estimation, due to the predominantly rural and smaller town and city population of the state. This demographic characteristic also made it impossible to compare with most existing studies, which include the results from higher-density urban areas.

Qualitatively, emission reductions in the shorter term will come primarily from mode shifting from passenger vehicle travel to ride sharing, walking, and cycling. The more efficient use of district busing may also serve to both reduce GHG emissions and provide a significant cost savings. In the longer term, school siting and sizing will allow greater baseline penetration of each of these modes, increase the feasibility of bus use, and allow for shorter trip distances for all transportation modes.

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<sup>17</sup> U.S. Department of Transportation, National Highway Traffic Safety Administration, Center for Health Training. *Safe Routes to School: Practice and Promise*. Available at:  
<http://www.nhtsa.dot.gov/people/injury/pedbimot/bike/Safe-Routes-2004/images/SafeRoute2Schlo.pdf>.

<sup>18</sup> [Ibid.](#)

**Table I-7. Estimated GHG reductions and costs of or cost savings from TLU-6**

Quantification Factors	2015	2025	Units
GHG emission savings	.006	.013	MMtCO <sub>2</sub> e
Net present value (2009–2025)	N/A	N/A	Million \$
Cumulative reductions (2009–2025)	N/A	.113	MMtCO <sub>2</sub> e
Cost-effectiveness	N/A	N/A	\$/MtCO <sub>2</sub> e

Year	2001	2002	2003	2004	2005	2010	2015	2020	2025
<b>Total Ark Bus VMT</b>	50,128,000	50,955,112	51,782,224	52,609,336	53,436,448	57,572,008	61,707,568	65,843,128	69,978,688
<b>Tonnes CO<sub>2</sub>eq</b>	94,369	95,926	97,483	99,040	100,597	108,382	116,167	123,952	131,737
<b>% Reduction in VMT</b>						0%	5%	7.50%	10%
<b>VMT Reduction</b>							3,085,378	4,938,235	6,997,869
<b>Revised VMT</b>	n/a	n/a	n/a	n/a	n/a	n/a	58,622,190	60,904,893	62,980,819
<b>Revised CO<sub>2</sub> emissions</b>							110,359	114,657	118,564
<b>CO<sub>2</sub>eq Reduction (Tonnes)</b>							5,808	9,295	13,173

**Total CO<sub>2</sub>eq Reduction (Tonnes) between 2009 and 2025: 113,754**

**Total VMT Reduction between 2009 and 2025: 60,780,823**

at 6.7 mpg that is a savings of 9,071,765 gallons of diesel.

at \$4.80 per gallon = \$43,544,472 cost savings from reduced VMT

Federal Average Mileage Per Bus: 8,000

By 2015 this policy could result in as many as 385 less buses needed to be in operation

By 2025 this policy could result in as many as 874 less buses needed to be in operation

**Note:** This policy does not identify the cost of implementation for this program

GHG = greenhouse gas; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; \$/tCO<sub>2</sub>e = dollars per metric ton of carbon dioxide equivalent; VMT = vehicle miles traveled; N/A = not applicable.

### Quantification Methods:

The quantification for this policy recommendation was based upon Arkansas school buses and VMT reduction goals of 5% by 2015 and 10% by 2025. Emission reductions were quantified by estimating the reduction in VMT and multiplying that number by the amount of emissions per mile.

Total Arkansas school bus VMT for 2015 is expected to be 61,707,568 miles. A 5% reduction in this number would bring the total mileage down to 58,622,190. CO<sub>2</sub> emissions would drop from 116,167 tons down to 110,359 tons, for a savings of 5,808 tons of CO<sub>2</sub> emissions.

For 2025, total Arkansas school bus VMT is expected to increase to 69,978,688, but reaching the 10% VMT reduction goal would drop this number to 62,980,819. CO<sub>2</sub> emissions would fall from 131,737 without VMT reductions to 118,564 upon reaching the goal of a 10% reduction in school bus VMT.

Other programs that are suggested in this policy if implemented could lead to much more significant reductions in CO<sub>2</sub> emissions. However, many of them would need to be implemented

on an institution-by-institution basis, and much of the information necessary to accurately calculate these reductions has not been developed.

Estimating that 200,000 passenger vehicle miles are driven annually to transport students to and from schools, colleges, and universities, a reduction of 10% through this policy recommendation, would result in a reduction of 20,000 VMT. If the state average fuel economy at the time this program is implemented (2012) reaches the 2008 CAFE average of 22.5 miles per gallon (mpg), that would equal a savings of 889 gallons of gasoline. EPA estimates that each gallon of gasoline burned results in 19.4 pounds of CO<sub>2</sub> emissions. Therefore, a savings of 889 gallons of gasoline would result in 17,244 pounds of reduced CO<sub>2</sub> emissions.

Percentage improvements/increases in the penetration rate for nonmotorized access will be taken and applied from programs, such as the “walking school bus,” the national pedestrian and bicycle clearinghouse, Safe Routes to School, and university student commute trip benefit programs.

**Key Assumptions:**

- Current mode splits from NHTS will be based on a collection of peer states and assumed to be similar for Arkansas.
- Estimates of the number of available seats for ride sharing will be based on vehicle occupancy and assumptions regarding the vehicle fleet (e.g., minivans).

**Data Sources:** School enrollment, school size, bus fleet utilization, and mode splits.

**Key Uncertainties**

As described above.

**Additional Benefits and Costs**

None noted.

**Feasibility Issues**

None noted.

**Status of Group Approval**

Complete.

**Level of Group Support**

Unanimous.

**Barriers to Consensus**

Not applicable.

## TLU-7. Promote and Facilitate Freight Efficiency

### Policy Description

Today, nearly 2 million tractor trailers are registered in the United States. Between 1990 and 2006, total U.S. truck tonnage increased by nearly 40%. By 2018, truck tonnage is estimated to increase by almost 30%, to about 14 billion tons, up from nearly 11 billion tons in 2006. Much of this traffic routes its way through Arkansas. The state should offer incentives to truck carriers that invest in low-emission engines.

Typical switch locomotives idle 75% of the time, accounting for 27% of their total fuel use. Conversion to electrification may be impeded by institutional factors and access—both perceived and actual—to necessary infrastructure. A check of the DOE truck stop electrification site locator shows three facilities within a 100-mile radius of Little Rock.

Technologies to reduce heavy-vehicle idling are readily available and cost-effective for long-haul trucking, and include auxiliary power units and truck stop electrification. According to Argonne National Laboratory, long-haul trucks idle an average of 6 hours per day or 1,830 hours per year, consuming 20 million barrels of diesel fuel. The use of existing technology can reduce fuel use by 90%.<sup>19</sup>

Improving freight efficiency by expanding the use of short-haul rail over trucking alternatives will require a fundamental shift in regulatory oversight of the railroads. This will require the adoption of federal legislation reforming the Surface Transportation Board (STB), reversing anticompetitive practices, and creating an obligation to serve. The combination of mergers, bottleneck rules, paper barriers, and antitrust exemption creates an environment that often eliminates competition and alternatives for small or captive shippers. The state should take an active role in influencing national rail policies that improve railroad infrastructure, increase rail capacity, and improve rail yards to expand intermodal options.

### Policy Design

This policy focuses on promoting and facilitating freight efficiency by:

- Improving railroad infrastructure and rail yards;
- Increasing rail and river shipping capacity, which may allow some freight to shift from trucks to either rail or ships;
- Providing economic assistance and regulatory streamlining for the improvement of intermodal rail yards and the relief of rail freight bottlenecks;
- Providing electrification at truck stops to reduce idling;

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<sup>19</sup> Argonne National Laboratory. "Reducing Heavy Vehicle Idling." Available at: <http://www.transportation.anl.gov/engines/idling.html>.

- Supporting and promoting policies and legislation that improve regulatory oversight of the railroad industry;
- Providing plug-in power at port sites to enable vessels to turn off engines and reduce idling; and
- Providing incentives for more efficient trucks.

**Goals:**

- Reduce diesel truck idling by Class 8 (tractor-trailer) trucks by 80% by 2010 and 100% by 2020.

**Timing:** As described above.

**Parties Involved:** Freight movement operators and other stakeholders.

**Implementation Mechanisms**

As noted above and as follows:

- Restore antitrust laws to the railroads.
- Reform the STB in a manner that reverses anticompetitive rulings, protects the public interest, creates a proactive STB that will investigate unreasonable rail practices, and creates and enforces an obligation-to-serve standard.
- Require timely investments in rail infrastructure, including increased rail capacity and rail yard enhancements to accelerate intermodal transportation and truck to short-haul rail.
- Establish standards for truck stop electrification by August 2009, determining the appropriate technology (such as Idle Aire or Shorepower systems) that will provide an alternative to idling or auxiliary power units; and establish a reasonable conversion period for transient vehicles and Arkansas-based organizations to retrofit and adapt their systems before assessing the need for restrictive ordinances.
- Complete a similar assessment of port facilities and rail-switching yards to determine the costs and benefits by mid-2010.
- Provide incentives to trucking companies that invest in the purchase of low-emission engines and lightweight tractor/trailer combinations.

**Related Policies/Programs in Place**

EPA provides partnership support to trucking companies through the “Smartway” program.

**Type(s) of GHG Reductions**

GHG emissions from combustion of transportation fuels include CO<sub>2</sub> predominantly.

## Estimated GHG Reductions and Costs or Cost Savings

**Table I-8. Estimated GHG reductions and costs of or cost savings from TLU-7**

Quantification Factors	2015	2025	Units
GHG emission savings	0.33	0.47	MMtCO <sub>2</sub> e
Net present value (2009–2025)	N/A	\$48	Million \$
Cumulative reductions (2009–2025)	N/A	6.1	MMtCO <sub>2</sub> e
Cost-effectiveness	N/A	\$104	\$/MtCO <sub>2</sub> e

GHG = greenhouse gas; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; \$/tCO<sub>2</sub>e = dollars per metric ton of carbon dioxide equivalent; N/A = not applicable.

### Quantification Methods:

Estimate the reduction in CO<sub>2</sub> emissions from reduced idling based on estimating the portion of emissions and fuel consumption in the Arkansas inventory that is attributable to Class 8 diesel trucks, estimate the portion of the total fuel consumption that would be consumed during idling, and apply a targeted reduction of 80% to this amount starting in 2008 and a reduction of 100% starting in 2015. The assumptions below were used for this estimation.

### Key Assumptions:

- Idle reductions are achieved only by the Class 8 diesel trucks, which idle for an average of 6 hours per day, and consume 0.8–1.2 gallons of diesel per hour during idling.
- Class 8 diesel trucks will reduce idling by 80% by 2010 or 100% by 2020.
- The VMT traveled by long-haul combination tractor-trailers (the vehicles that would conduct the long idling applicable to this analysis) was estimated at 1,841,000 million miles in 2010, increasing to 3,549,000 million miles by 2025.
- Idling was assumed to occur for 6 hours every 500 miles (the approximate average distance a truck would travel between required rest periods).
- The cost analysis will assume a 5-year lifetime for idling technology equipment, applied to 80% of Class 8 vehicles starting in 2008 and 100% of Class 8 vehicles starting in 2015, at a cost of \$6,000 per vehicle and a \$4.80 per gallon of diesel.
- Program administration costs, enforcement costs, fines, and reduced vehicle maintenance costs will not be factored into the cost analysis.
- Rail investment is assumed to occur over a 10-year period and to be sufficient to achieve a 6% shift in modal choice. An estimate of 250 miles of track upgrade at \$4.4 million per mile was used to represent the cost of rail investment (implicitly including rail yard improvements if needed).

- The shift to intermodal rail was assumed to represent a 30% reduction in emissions, accounting for greater rail circuitry, switch-yard locomotives, and the necessary truck haul to/from rail yard to final destination.

### **Key Uncertainties**

The ability of trucking companies to invest in new equipment depends upon economic conditions.

### **Additional Benefits and Costs**

Fuel savings are generally recognized as having positive financial impacts upon trucking companies and truck operators. Some of these positive savings may be passed on to consumers of the goods that are being transported.

### **Feasibility Issues**

Some technologies are "off the shelf," while others are not yet widely implemented in the marketplace.

### **Status of Group Approval**

Complete.

### **Level of Group Support**

Unanimous.

### **Barriers to Consensus**

Not applicable.

## TLU-8. Procurement of Efficient Fleet Vehicles (Passenger and Freight)

### Policy Description

Arkansas state and local government agencies should "lead by example" by enacting procurement policies and or joining the EPA's SmartWay program and utilizing the SmartWay Upgrade Kits that result in adoption of lower-emitting vehicle fleets. The three primary components of the SmartWay program are: (1) creating partnerships between shippers, carriers, and program sponsors; (2) reducing all unnecessary engine idling; and (3) increasing the efficiency of LDVs, heavy-duty vehicles (HDVs), rail, and intermodal operations.

This policy recommendation strengthens Arkansas' commitment to reduce GHG emissions through fuel efficiency in vehicles owned by the state, while also encouraging private and public agencies to develop incentive programs that might, for example, help with the initial costs of purchasing such vehicles.

### Policy Design

In leading by example, state government will ensure that its own fleet of vehicles meets or exceeds the targets set for the state as a whole, while providing available means for all public and private vehicles to also exceed these standards voluntarily. To the extent possible, the state should be encouraged to purchase domestically produced vehicles when all other vehicle characteristics are comparable.

#### Goals:

- By 2010, identify barriers to purchasing hybrid vehicles, and research and develop solutions to procure hybrid or other lower-GHG-emitting vehicles in the state.
- By 2010, ensure that the overall state of Arkansas fleet considers the EPA fuel efficiency rating calculated over the life cycle of the vehicles purchased for the fleet.
- By 2015, ensure that low-carbon fuels are purchased for the state motor pool fleet, wherever they are available and if applicable for the vehicle type.
- By 2019, at least 70% of all HDVs and by 2014 at least 90% of all LDVs are "fuel efficient," meeting, on average, a higher mpg rate for the state's HDV and LDV fleets.

**Timing:** See above.

**Parties Involved:** Arkansas state and local government agencies, private industries and fleets, trucking industry.

**Other:** None noted.

### Implementation Mechanisms

None noted.

## Related Policies/Programs in Place

None noted.

## Type(s) of GHG Reductions

None noted.

## Estimated GHG Reductions and Costs or Cost Savings

GHGs and fuel costs will be reduced primarily through the purchase of HDVs that are more fuel efficient within their vehicle class, and through better “right-sizing” of the state vehicle fleet, so that vehicles of a heavier class are not purchased and/or utilized when a lighter, more fuel-efficient vehicle would suffice. Care must be taken to account for the fact that the state may dispose of some vehicles before the end of their useful lives. This could imply the pushing of either less or more fuel-efficient vehicles into the non-state-owned vehicle fleet in Arkansas.

### Data Sources:

- State HDV fleet composition and utilization.
- Average annual HDV acquisitions.
- State vehicle fleet diesel and biodiesel use.

### Quantification Methods:

- Based on the 2010 initiation and 2019 70% goal, penetration of more fuel-efficient HDVs into the state fleet will be calculated, along with the percentage reduction in fuel use.
- Based on the 2015 low-carbon fuel target, an estimate will be made of the potential penetration (accounting for national fuel availability) rate and the GHG benefits (using a life-cycle analysis of fuel emissions) of using biodiesel.

### Key Assumptions:

- Fleet turnover and procurement will continue at the same rate as previously. Accelerated procurement rates would be considered to displace less fuel-efficient vehicles into the non-state fleet more rapidly, counteracting some benefits.
- Biodiesel is assumed to be the only low-carbon fuel available by 2015, with the exception of natural gas, which buses may also run on.

## Key Uncertainties

None noted.

## Additional Benefits and Costs

None noted.

**Feasibility Issues**

None noted.

**Status of Group Approval**

Complete.

**Level of Group Support**

Unanimous.

**Barriers to Consensus**

Not applicable.

## TLU-9. Fuel Efficiency: Clean Car Incentive

### Policy Description

To reduce gasoline consumption and GHG emissions, Arkansas should adopt a "clean car incentive" system. Unlike a tailpipe emissions mandate or mpg mandate, a market-based incentives program would give rebates to Arkansans who purchase new vehicles that reduce oil consumption and GHG emissions by being more fuel efficient. The program would be self-financed by being paid for with disincentives (fees) to those who purchase new vehicles that are less fuel-efficient. The rebates (or fees) would be subtracted from (or added to) the purchase price of the vehicle at the point of sale. The "pivot point"—the mileage standard that divides rebates from fees—would be calculated from recent Arkansas vehicle sales based on the condition that the program be self-financing. To protect light truck (pickup truck) owners, light trucks would be treated as a separate class with their own pivot point. The clean car incentive would apply only once for each vehicle, at the point of sale of new cars, and so would not affect the price of used cars.

This incentive plan, often called a "feebate," has been adopted in various forms by Canada, Austria, Germany, Sweden, Denmark, and France, and is being seriously considered by California, Massachusetts, Vermont, and at least five other states. This plan was endorsed by the U.S. National Research Council in a 2002 study.<sup>20</sup> The Rocky Mountain Institute, a well-known energy analysis organization, makes this plan the centerpiece of its automobile policy recommendations.<sup>21</sup>

Incentive programs of this sort have two kinds of effects: They encourage consumers to purchase more efficient vehicles, and they encourage manufacturers to produce more efficient vehicles that can take advantage of the rebates.

Vehicle incentive programs have the potential to affect consumer behavior in terms of choices of motor vehicles. The uncertainty of these programs is the degree to which they will result in measureable changes in consumer choices and behavior. Most studies to date have indicated that state and local policies in states with small populations of vehicles are likely to have little impact upon the types of vehicles that are offered in the marketplace.<sup>22</sup> It is possible that state and local policies can affect some individual choices, but studies to date (including studies by Oak Ridge

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<sup>20</sup> National Research Council, *Effectiveness and Impact of Corporate Average Fuel Economy (CAFE) Standards*. Washington, DC: National Academy Press, 2002. Available at: [http://www.nap.edu/openbook.php?record\\_id=10172&page=R1](http://www.nap.edu/openbook.php?record_id=10172&page=R1).

<sup>21</sup> A.B. Lovins, E.K. Datta, O-E. Bustnes, J.G. Koomey, and N.J. Glasgow. *Winning the Oil Endgame: Innovation for Profits, Jobs, and Security*. Rocky Mountain Institute. 2007. Available at: <http://nc.rmi.org/Page.aspx?pid=269&srcid=269>.

<sup>22</sup> The 13 states have about one-third of the nation's registered automobiles. Michael Benjamin, Jon Taylor, and Paul Hughes. "California Air Resources Board Technical Assessment: Comparison of Greenhouse Gas Reductions Under CAFE Standards and ARB Regulations Adopted Pursuant to AB1493." January 2, 2008.

National Laboratory)<sup>23,24,25</sup> indicate that the overall effect of these individual choices is small, unless the program is coordinated with other states and thereby has an effect on the range of vehicles offered in the marketplace.

To promote energy efficiency and GHG reductions, Arkansas should study the adoption of a "clean car incentive" system. Unlike a tailpipe emissions mandate or mpg mandate, an incentives program would encourage Arkansans to purchase new vehicles that save social costs (global warming costs) by being more fuel efficient.

## Policy Design

**Goals and Timing:** Have the clean car incentive program in place by 2010. As a plausible goal, increase the percentage of new high-efficiency vehicles (those with gasoline mileages above the initial pivot point) and decrease the percentage of new low-efficiency vehicles by several percentage points (perhaps 10%) by 2015. As another kind of plausible goal, might move the pivot point toward higher gasoline mileage by a few miles per gallon by 2015.

By 2012, the state or appropriate agency will:

- Develop a program to help reduce GHG vehicle emissions by encouraging greater use of vehicles that produce less GHGs.
- Develop incentives and/or disincentives for purchasing new, lower-GHG, more energy-efficient vehicles.

By 2020:

- The majority of vehicles on the road (greater than 50%) will produce less GHG emissions than the average for the U.S. fleet, and will be in compliance with federal and state GHG emission levels.
- The state or appropriate agency will establish legislation to set standards for new vehicles with mandatory manufacture labeling.

**Parties Involved:** Arkansas Departments of Motor Vehicles and Transportation, American and foreign automobile industries, EPA, Arkansas Energy Office.

## Implementation Mechanisms

The program would be self-financed by being paid for with disincentives to those who purchase new vehicles that impose social costs by being less fuel efficient. The incentives (or

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<sup>23</sup> California Air Resources Board. Zero Emission Vehicle Incentive Programs. Available at: <http://www.arb.ca.gov/msprog/zevprog/zip/zip.htm>.

<sup>24</sup> D.L. Greene. TAFV: Alternative Fuels And Vehicles Choice Model Documentation. . Oak Ridge, TN: Oak Ridge National Laboratory, Center for Transportation Analysis, July 2001. Available at: [http://www-cta.ornl.gov/cta/Publications/Reports/ORNL\\_TM\\_2001\\_134.pdf](http://www-cta.ornl.gov/cta/Publications/Reports/ORNL_TM_2001_134.pdf).

<sup>25</sup> D.L. Greene and Y. Fan. *Transportation Energy Efficiency Trends, 1972–1992*. Report ORNL-6828. Oak Ridge, TN: Oak Ridge National Laboratory, Center for Transportation Analysis. December 1994. Available at: [http://www.osti.gov/bridge/product.biblio.jsp?osti\\_id=10110523](http://www.osti.gov/bridge/product.biblio.jsp?osti_id=10110523).

disincentives) would be subtracted from (or added to) the purchase price of the vehicle at the point of sale. The "pivot point"—the mileage standard that divides incentives from disincentives—would be calculated from recent Arkansas vehicle sales based on the condition that the program be self-financing. To protect pickup truck owners, light trucks would be treated as a separate class, with their own pivot point between those vehicles that receive rebates and those that pay fees.

Incentives and disincentives should be zero at the pivot point and should rise in proportion to each vehicle's gasoline savings or consumption relative to the pivot point. Studies suggest that this rise should be around \$1,000 per 0.01 gallons per mile (gpm); that is, for each 0.01 gpm that a particular vehicle type saves (relative to the pivot point), the owner receives a rebate of \$1,000, and similarly for each 0.01 gpm that a particular vehicle consumes (above the pivot point). For example, if the pivot point for all passenger cars is, say, 23 mpg (or 0.043 gpm), then a car getting 18 mpg (0.056 gpm) is 0.013 gpm worse than the pivot point, and so incurs a \$1,300 fee. Another car getting 36 mpg (0.028 gpm) is 0.015 gpm better than the pivot point, so it earns a \$1,500 rebate. With a \$1,000 per 0.01 gpm rise, the maximum incentives and disincentives would run around \$2,500.

Because vehicles will (it is hoped) become more efficient, the pivot point will need to be re-adjusted every year to reflect the most recent year's gasoline mileage data. The clean car incentive would apply only once for each vehicle, at the point of sale of new cars, and so would not affect the price of used cars.

### **Related Policies/Programs in Place**

The federal Energy Independence and Security Act requires automakers to increase the average fuel economy of LDVs offered in the marketplace to an equivalent of 35 mpg by 2020.

### **Type(s) of GHG Reductions**

This policy recommendation will assess the potential for GHG reductions from state policies.

### **Estimated GHG Reductions and Costs or Cost Savings**

GHG reductions and costs or cost savings are not estimated, as the results of the study will provide further information about the potential for state action in this area to significantly reduce GHG emissions.

### **Key Uncertainties**

Consumer response to incentive programs varies from region to region.

### **Additional Benefits and Costs**

The use of more fuel-efficient vehicles is recognized as reducing the need for importing petroleum and petroleum products from other countries.

### **Feasibility Issues**

The feasibility of incentive programs, such as that described above, is yet to be determined. Some European nations and Canada have initiated such programs. The analysis should include a review of these programs in other countries.

### **Status of Group Approval**

Complete.

### **Level of Group Support**

Super Majority (one objection).

### **Barriers to Consensus**

One member favors a national program and objected to this recommendation being implemented in just Arkansas.

## TLU-10. Public Education

### Policy Description

This policy focuses on better informing the public of the measures individuals can take to reduce their transportation-related GHG emissions. Drivers will voluntarily reduce fuel use and GHG emissions from their activities when they have the information necessary to make proper decisions.

The recommendation would involve development and implementation of a curriculum that addresses limiting GHGs in transportation through:

- Education about transportation choices and consequences: low-GHG-emitting vehicles, carpooling, use of alternative fuels, walking, biking, telecommuting, mass transit, safety issues, ride sharing in schools, etc.
- Improved vehicle operation and maintenance: regular vehicle tune-ups, fuel-efficient tires, coolest temperature fueling, tire pressures, engine lubricants, slower acceleration, shifting at lower revolutions per minute, cruise control, turning off vehicles when parked, eliminating "jack-rabbit" starts.
- Education about city planning choices.

The curriculum would be a requirement for all driver training programs and would be distributed through other possible venues as deemed appropriate by the agency(ies) developing the program. This program should include questions pertinent to training included on the written/driving portion of private and commercial driver licensing tests. (Driver training programs in Utah and Arizona currently incorporate this type of curriculum in classroom settings.) In addition, programs that include this curriculum are to be mandated for both state and municipal fleet operators. All GHG-saving application methods included in the curriculum would be enforced at state and municipality fleet levels.

In the interest of time and expense, it is recommended that existing curricula from such entities as DOE or the National Energy Foundation be examined for application and modified as needed.

### Policy Design

#### Goals:

- Reduce transportation GHG emissions through education to promote intelligent transportation purchasing choices and vehicle operation. *[Unable to quantify effects of educational programs at this time.]*
- Begin the consumer information program in 2008, and extend it as resources become available.

**Timing:**

- By 2010, the state or appropriate agency would develop a marketing program for fuel-efficient replacement tires and energy-efficient driving practices and devices.
- By 2010, the state or appropriate agency would ensure that training be delivered for all state and municipal fleet operators.
- By 2010, private and commercial driver licensing tests would be modified to incorporate information about fuel-saving driving practices.

**Parties Involved:** Driver training programs; Arkansas Department of Motor Vehicles; state, commercial, and municipal fleets.

**Implementation Mechanisms**

The Arkansas Department of Education should make science standards part of the curriculum.

**Related Policies/Programs in Place**

None noted.

**Type(s) of GHG Reductions**

None noted.

**Estimated GHG Reductions and Costs or Cost Savings**

The potential GHG reductions from this policy recommendation will not be quantified, since they are associated with other policies that complement public education.

**Key Uncertainties**

None noted.

**Additional Benefits and Costs**

None noted.

**Feasibility Issues**

None noted.

**Status of Group Approval**

Complete.

**Level of Group Support**

Unanimous.

**Barriers to Consensus**

None.

# Appendix J

## Agriculture, Forestry, and Waste Management Policy Recommendations

### Summary List of GCGW Recommendations

No.	Policy Recommendation		GHG Reductions (MMtCO <sub>2</sub> e)			Net Present Value 2009–2025 (Million \$)	Cost-Effectiveness (\$/tCO <sub>2</sub> e)	Level of Support
			2015	2025	Total 2009–2025			
AFW-1*	Manure Management		Not quantified					Unanimous
AFW-2†	Promotion of Farming Practices That Achieve GHG Benefits	Soil Carbon	0.5	1.3	11	–\$71	–\$6	Super Majority (1 objection)
		Nutrient Efficiency	0.1	0.3	2.4	–\$66	–\$27	
AFW-3†	Improved Water Management and Use	Increased Surface Water	0.005	0.01	0.10	\$86	\$835	Super Majority (1 objection)
		Improved Purification	0.001	0.001	0.01	–\$0.4	–\$39	
AFW-4†	Expanded Use of Agriculture and Forestry Biomass Feedstocks for Electricity, Heat, or Steam Production	Energy From Biomass	2.1	4.2	41	\$1,637	\$40	Super Majority (1 objection)
		Energy From Livestock Manure and Poultry Litter	0.01	0.02	0.2	\$0.8	\$4	
		Capture of Waste Heat	0.02	0.06	0.50	–\$70	–\$140	
AFW-5†	Expanded Use of Advanced Biofuels		1.4	2.2	20	\$114	\$6	Unanimous
AFW-6†	Expanded Use of Locally Produced Farm and Forest Products		0.03	0.06	0.6	\$2	\$4	Unanimous
AFW-7†	Forest Management and Establishment for Carbon Sequestration	Urban Forestry	0.02	0.1	0.4	\$17	\$41	Unanimous
		Sustainable Forest Management	4.1	10.4	91	\$1,139	\$21	
		Afforestation	0.7	1.8	16	\$201	\$12	
AFW-8†	Advanced Recovery and Recycling		1.5	4.4	36	–\$283	–\$8	Super Majority (1 objection)
AFW-9†	End-of-Use Waste Management Practices		0.02	0.02	0.4	–\$1	–\$3	Super Majority (1 objection)
	<b>Sector Total After Adjusting for Overlaps</b>		<b>7.8</b>	<b>18.3</b>	<b>162.2</b>	<b>\$1,045</b>	<b>\$6.4</b>	
	<b>Reductions From Recent Actions</b>		<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>\$0.0</b>	<b>\$0.0</b>	
	<b>Sector Total Plus Recent Actions</b>		<b>7.8</b>	<b>18.3</b>	<b>162.2</b>	<b>\$1,045</b>	<b>\$6.4</b>	

GHG = greenhouse gas; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; \$/tCO<sub>2</sub>e = dollars per metric ton of carbon dioxide equivalent.

Negative values in the Net Present Value and the Cost-Effectiveness columns represent net cost savings.

The numbering used to denote the above policy recommendations is for reference purposes only; it does not reflect prioritization among these important policy recommendations.

\* The GCGW approved this option at Meeting #8 (July 31, 2008); 19 members present and voting (two by phone).

† The GCGW approved this option at Meeting #9 (September 9, 2008); 18 members present and voting (one by phone).

**Overlap Discussion:**

The amount of greenhouse gas (GHG) emissions reduced or sequestered and the costs of a policy recommendation within the Agriculture, Forestry and Waste Management (AFW) sectors overlap with some of the quantified benefits and costs of policy recommendations within other sectors. Where this overlap has been determined to exist, the sector totals have been adjusted, and each instance is outlined below. Overlaps between recommendations within AFW have been accounted for within the goal-setting process.

AFW-4 outlines how biomass may be utilized for energy production. The Energy Supply (ES) Technical Working Group (TWG) also quantified the use of biomass for energy production (e.g., ES-3 [Renewable Portfolio Standard]). The analysis assumes complete overlap between the ES and AFW biomass-to-energy recommendations.

AFW-7 (Urban Forestry) addresses planting trees in urban settings. The Residential, Commercial, and Industrial (RCI) sector TWG does not specifically include tree planting to reduce energy use in buildings as part of demand-side management and other energy efficiency programs. As such, no adjustments were made to the sector total.

AFW-5 focuses on biofuels. Similar to biomass utilization for energy production, the utilization of biomass for the production of cellulosic biofuels was greater under the Transportation and Land Use (TLU) policies than AFW for all years after 2015, although the AFW policy was slightly larger from 2010 to 2015. To adjust for the overlap between these two sectors, the AFW sector total GHG emission reductions and costs were reduced by the proportion determined to be included under the TLU analysis. Full overlap was assumed for years after 2015, and the GHG reductions and costs have been removed from the AFW sector totals accordingly.

No reductions from recent actions have been made to the AFW sector totals.

**Table J-1. Biomass supply/demand assessment**

<b>Biomass Resource</b>	<b>2015 Annual Biomass Supply (10<sup>3</sup> dry short tons)</b>	<b>2025 Annual Biomass Supply (10<sup>3</sup> dry short tons)</b>	<b>Notes</b>
Forest residue	5,265	5,265	Biomass availability from Annual Biomass Supply Study. <sup>1</sup>
Mill residue	3,239	3,239	Annual Biomass Supply Study.
Urban wood waste	1,534	1,534	Annual Biomass Supply Study.
Agricultural residue	3,198	3,198	Annual Biomass Supply Study.
Municipal paper waste	342	523	Taken from AFW-8 analysis.
Municipal solid waste organics	117	175	Taken from AFW-8 analysis.
Energy crops	1,094	2,189	Energy crop biomass supply taken from the goals identified under AFW-4 identified through marginal agricultural land conversion.
<b>Total Annual Biomass Supply</b>	<b>14,789</b>	<b>16,123</b>	
<b>Policy Requiring Biomass</b>	<b>2015 Annual Biomass Demand (10<sup>3</sup> dry short tons)</b>	<b>2025 Annual Biomass Demand (10<sup>3</sup> dry short tons)</b>	<b>Notes</b>
AFW-4	See below	See below	See below.
Methane from livestock manure and poultry litter	N/A	N/A	10% of available methane from livestock manure and poultry litter. Methane derived from Inventory and Forecast.
Total forest feedstocks	502	1,004	10% of available in-state forest residue by 2025.
Total agriculture residue	160	320	10% of available agriculture residue biomass by 2025.
Energy crop (e.g., switchgrass)	1,094	2,189	10% of marginal agriculture land by 2025.
AFW-5 (Biofuels)	1,500	2,208	10% of biomass supply to produce advanced biofuels.
<b>Total Demand</b>	<b>3,256</b>	<b>5,721</b>	

N/A = not applicable.

<sup>1</sup> Arkansas Economic Development Commission. *Arkansas Biomass Resource Assessment*. Annual Biomass Supply. Available at: [http://arkansasedc.com/business\\_development/energy/?page=bioenergy](http://arkansasedc.com/business_development/energy/?page=bioenergy).

## AFW-1. Manure Management

### Policy Description

Potential manure management practices that reduce GHG emissions associated with manure handling and storage include manure composting to reduce methane (CH<sub>4</sub>) emissions, movement of manure from nutrient-rich to nutrient-deficient areas, and improved methods for application to fields (for reduced nitrous oxide [N<sub>2</sub>O] emissions). Application improvements include incorporating manure into soil instead of surface spraying or spreading. Also, implementing digester and energy recovery projects at confined animal operations reduces methane emissions and uses the energy to displace fossil fuels. To date, most of these projects have been implemented at dairies and swine operations.

### Policy Design

**Goals:** Reduce CH<sub>4</sub> and N<sub>2</sub>O emissions from dairy, hog, and poultry operations by 40% by 2025, through improved manure handling and storage practices, compared to business as usual (BAU).

**Timing:** As described above.

**Parties Involved:** Arkansas Department of Environmental Quality, Arkansas Department of Agriculture, Arkansas Natural Resources Commission, research institutions, and farmers.

**Other:** Previous studies have determined that deep stacking litter produces significant N<sub>2</sub>O emissions (deep stacking litter is very similar to composting). While composting may lower CH<sub>4</sub> emissions, it will probably raise N<sub>2</sub>O emissions. This process also generates and wastes ammonia emissions.

Velthof et al. (2003)<sup>2</sup> found that more N<sub>2</sub>O was emitted when manure was incorporated into soil compared to when applied to the surface. They looked at applying manure at different depths, but found surface application was the best. It is suspected that incorporating manure into soil increases the potential for denitrification. Nevertheless, incorporating manure into soil may still be considered good practice, as it reduces nutrient runoff and ammonia emissions and improves nitrogen uptake.

### Implementation Mechanisms

A variety of management practices could lead to reductions in GHG emissions, including dry management systems, wet management systems (e.g., anaerobic lagoons, pit storage, and liquid/slurry), daily spread, composting, covering, and modifying animal feed. The key uncertainties section includes a discussion on each of these.

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<sup>2</sup> Gerard Velthof, Peter Kuikman, and Oene Oenema. "Nitrous Oxide Emission From Animal Manures Applied to Soil Under Controlled Conditions." *Biology and Fertility of Soils* April 2003;37(4):221–230. Available at: <http://www.springerlink.com/content/19gx2jtlrq2fp3y9/>.

## Related Policies/Programs in Place

### Poultry Litter

*Act 1061 (HB 1654)*—The act declares various areas of Arkansas to be nutrient surplus areas for phosphorus and nitrogen, authorizes the Arkansas Natural Resources Commission to make rules concerning management of nutrients in nutrient surplus areas, and creates penalties for violations of the act.

### Poultry Feeding—Management Plans

*Act 2294 (SB 1160)*—This act requires that, after January 1, 2007, poultry litter be applied to soils or associated crops within a nutrient surplus area in accordance with a nutrient management plan or poultry litter management plan.

## Type(s) of GHG Reductions

**CH<sub>4</sub>:** Manure management captures and utilizes or prevents the creation of CH<sub>4</sub>.

**N<sub>2</sub>O:** Reductions occur when nitrogen runoff and leaching are reduced. (Runoff and leaching lead to the formation and emission of N<sub>2</sub>O.)

## Estimated GHG Reductions and Costs or Cost Savings

### Data Sources:

X. Hao, C. Chang, F.J. Larney, and G.R. Travis. “Greenhouse Gas Emissions During Cattle Feedlot Manure Composting.” *Journal of Environmental Quality* 2001;30:376–386. Available at: <http://jeq.scijournals.org/cgi/content/abstract/30/2/376>.

**Quantification Methods:** Not applicable.

**Key Assumptions:** Not applicable.

## Key Uncertainties

A variety of sources have been considered in attempting to quantify the best manure management practices to reduce GHG emissions. While it is very likely that manure management can reduce emissions, the achievable level of emission reductions is uncertain. It is unclear if the goal of reducing emissions by 40% is overly ambitious.

In general, difficulties in quantifying this level of reductions come from the tradeoff between N<sub>2</sub>O emissions and CH<sub>4</sub> emissions. Dry management systems typically keep CH<sub>4</sub> emissions low, but can lead to higher N<sub>2</sub>O emissions. Wet management systems, such as anaerobic lagoons, pit storage, and liquid/slurry, help reduce N<sub>2</sub>O emissions, but often increase CH<sub>4</sub> emissions. For areas with temperatures similar to those of Arkansas, the Intergovernmental Panel on Climate Change (IPCC) recommends daily spread as the best practice for reducing CH<sub>4</sub> emissions, although N<sub>2</sub>O emissions from this approach are not quantified by the IPCC, and instead are considered as part of soil emissions.<sup>3</sup> Composting manures can suppress CH<sub>4</sub> emissions, but can

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<sup>3</sup> Paul Jun, Michael Gibbs, and Kathryn Gaffney. “CH<sub>4</sub> and N<sub>2</sub>O Emissions From Livestock Manure.” In Intergovernmental Panel on Climate Change. *Good Practice Guidance and Uncertainty Management in National*

also increase formation of N<sub>2</sub>O.<sup>4</sup> Covering manure can reduce N<sub>2</sub>O emissions, but has an uncertain impact on CH<sub>4</sub> formation.<sup>5</sup> Manure management can be achieved by modifying animal feed or by composting manure, but further study of the impacts of these practices is necessary to determine their true efficacy.<sup>6</sup>

In addition, the Arkansas Natural Resources Commission recommended that Dr. Philip Moore at the University of Arkansas could provide assistance in quantifying this recommendation. Dr. Moore did not have any specific recommendations for how to reduce emissions, but he did outline several methods that increase N<sub>2</sub>O emissions, such as deep stacking manure, directly injecting manure into the soil, and composting poultry litter.<sup>7</sup> Other studies have found that composting manure increases GHG emissions,<sup>8</sup> and N<sub>2</sub>O emissions increase by applying manure just below the surface.<sup>9</sup>

A recent article pertaining to GHG emissions from swine found that an “on-farm wastewater treatment system consisting of liquid–solid separation, treatment of the separated liquid using aerobic biological N [nitrogen] removal, chemical disinfection and soluble P [phosphorus] removal using lime” could reduce GHG emissions by 97%.<sup>10</sup> Swine emissions in Arkansas are 9% of total manure management emissions. Because this particular practice is not applicable to poultry litter or cow manure, it most likely would not produce significant benefits for Arkansas. However, this does show a significant decrease is possible through a new manure management approach.

Additional research is required on the best management practices for reducing GHG emissions. Because swine emissions are responsible for the majority of manure emissions in the country, the majority of research has focused on the best management practices for swine farms. Poultry litter

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*Greenhouse Gas Inventories*. 2000. Available at: [http://www.ipcc-nggip.iges.or.jp/public/gp/bgp/4\\_2\\_CH4\\_and\\_N2O\\_Livestock\\_Manure.pdf](http://www.ipcc-nggip.iges.or.jp/public/gp/bgp/4_2_CH4_and_N2O_Livestock_Manure.pdf).

<sup>4</sup> Bert Metz, Ogunlade Davidson, Peter Bosch, Rutu Dave, and Leo Meyer, eds. *Climate Change 2007: Mitigation of Climate Change. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. New York, NY: Cambridge University Press, 2007. Available at: <http://www.ipcc.ch/ipccreports/ar4-wg3.htm>.

<sup>5</sup> Ibid.

<sup>6</sup> Ibid.

<sup>7</sup> Personal communication, Dr. Phillip Moore, June 23, 2008.

<sup>8</sup> X. Hao, C. Chang, F.J. Larney, and G.R. Travis. “Greenhouse Gas Emissions During Cattle Feedlot Manure Composting.” *Journal of Environmental Quality* 2001;30:376-386. Available at: <http://jeq.scijournal.org/cgi/content/abstract/30/2/376>.

<sup>9</sup> Gerard Velthof, Peter Kuikman, and Oene Oenema. “Nitrous Oxide Emission From Animal Manures Applied to Soil Under Controlled Conditions.” *Biology and Fertility of Soils* April 2003;37(4):221–230. Available at: <http://www.springerlink.com/content/19gx2jtrq2fp3y9/>.

<sup>10</sup> M.B. Vanotti, A.A. Szogi, and C.A. Vives. “Greenhouse Gas Emission Reduction and Environmental Quality Improvement From Implementation of Aerobic Waste Treatment Systems in Swine Farms.” *Waste Management* 2008;28(4):759-766. [http://www.sciencedirect.com/science?\\_ob=ArticleURL&\\_udi=B6VFR-4R8KT18-3&\\_user=10&\\_rdoc=1&\\_fmt=&\\_orig=search&\\_sort=d&view=c&\\_acct=C000050221&\\_version=1&\\_urlVersion=0&\\_userid=10&md5=db75fa272fe41653220c60dc09cb4733](http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6VFR-4R8KT18-3&_user=10&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=db75fa272fe41653220c60dc09cb4733).

is by far the largest contributor to GHG emissions from manure sources in Arkansas; therefore, state research should focus on controlling emissions from poultry.

### **Additional Benefits and Costs**

Improved manure management can have benefits in terms of reduced local air pollutants and improved odor.

### **Feasibility Issues**

See Key Uncertainties.

### **Status of Group Approval**

Complete.

### **Level of Group Support**

Unanimous.

### **Barriers to Consensus**

Not applicable.

## AFW-2. Promotion of Farming Practices That Achieve GHG Benefits

### Policy Description

The state could provide incentives to farmers for using production processes that achieve net GHG benefits. For example, some organic farming practices could reduce GHG emissions compared to conventional farming, depending on the specific practices implemented (e.g., use of no-till cultivation and fewer chemicals).

### Policy Design

#### Goals:

- By 2025, implement cultivation practices to enhance soil carbon levels on 40% of the acreage that is not already using these practices.
- By 2025, implement cultivation practices to increase nutrient efficiency by 20%, compared to BAU.

**Timing:** As described above.

**Parties Involved:** Arkansas Department of Environmental Quality, Arkansas Department of Agriculture, Arkansas Natural Resources Commission, research institutions, and farmers.

**Other:** None identified.

### Implementation Mechanisms

- Provide education outreach—information about the most up-to-date research.
- Document the environmental co-benefits of carbon sequestration practices.
- Encourage farmers to adopt voluntary best management practices.
- Encourage research and development of farming practices and cropping systems that increase carbon input (e.g., reversion to native vegetation, setting aside agricultural land as grassland, improved crop rotations, yield enhancement measures, organic amendments, cover crops, improved irrigation practices) or decrease carbon output (e.g., proper tillage methods), while maintaining crop yield, so that GHG emissions are reduced.
- Evaluate and implement economical mechanisms that may affect crop choice (e.g., support payments, crop insurance, disaster relief) and farmland preservation (e.g., conservation easement, use-value taxation, agricultural zoning) as incentives to increase the carbon stock of agricultural soil.
- Continue to research, implement, and evaluate genetically modified (GM) crops for their significant contributions to reducing GHG emissions through reduced fuel consumption and additional soil sequestration associated with reduced- or no-tillage cultivation. Further

development and use of biocatalysts and nitrogen-use efficiency are expected to elaborate upon biotech contributions to improved practices.<sup>11</sup>

### Related Policies/Programs in Place

None identified.

### Type(s) of GHG Reductions

**Carbon Dioxide (CO<sub>2</sub>):** Improved efficiency can reduce electricity and fuel consumption and the associated GHGs.

### Estimated GHG Reductions and Costs or Cost Savings

#### GHG Reduction Potential in 2015, 2025 (MMtCO<sub>2</sub>e):

- *Soil Carbon:* 0.5 and 1.3, respectively.
- *Nutrient Efficiency:* 0.1 and 0.3, respectively.

#### Net Cost per tCO<sub>2</sub>e:

- *Soil Carbon:* -\$6.
- *Nutrient Efficiency:* -\$27.

**Data Sources:** Annual CO<sub>2</sub>e emissions from synthetic fertilizer and manure applications were taken from the Arkansas Inventory & Forecast.<sup>12</sup> Cost information for synthetic fertilizers was taken from the U.S. Department of Agriculture's (USDA's) Economic Research Service.<sup>13</sup>

#### Quantification Methods:

##### *Soil Carbon*

Total cropland in Arkansas was estimated at about 10 million acres in 2007.<sup>14</sup> For the purposes of this analysis, it is assumed that conservation practices include conservation till (no-till and

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<sup>11</sup> Co-existence of genetically modified (GM) and non-GM, including organic, crops has been occurring not only in Arkansas, but in all of North America. While the first generation of GM crops has concentrated mostly on herbicide tolerance and resistance to insect pests, consideration of climate stresses on crop yields is expected to influence further consideration of drought- and salt-tolerant crops that require less fertilizer. Biotech crops have been shown to save farmers 441 million gallons of fuel through reduced fuel operations, which eliminated nearly 10.2 million pounds of CO<sub>2</sub> emissions from 1996 to 2005. See: Graham Brookes and Peter Barfoot. "Global Impact of Biotech Crops: Socio-Economic and Environmental Effects in the First Ten Years of Commercial Use." *AgBioForum* 2006;9(3):139-151. Available at: <http://www.agbioforum.org/v9n3/v9n3a02-brookes.pdf>.

<sup>12</sup> Arkansas Governor's Commission on Global Warming. "Arkansas Greenhouse Gas Inventory and Reference Case Projections, 1990–2025: Waste Appendix." Available at: [http://www.arclimatechange.us/Inventory\\_Forecast\\_Report.cfm](http://www.arclimatechange.us/Inventory_Forecast_Report.cfm).

<sup>13</sup> U.S. Department of Agriculture, Economic Research Service. National Agricultural Statistics Service Table 7. "Average U.S. Farm Prices of Selected Fertilizers." Available at: <http://www.ers.usda.gov/Data/FertilizerUse/Tables/Table7.xls>.

<sup>14</sup> U.S. Department of Agriculture, Economic Research Service. Data Sets. State Fact Sheets: Arkansas. Available at: <http://www.ers.usda.gov/statefacts/AR.htm>.

strip-till), and other conservation farming practices that provide enhanced ground cover, or other crop management practices that achieve similar soil carbon benefits. Conservation tillage is defined as any system that leaves 50% or more of the soil covered with residue.<sup>15</sup>

Based on the policy design parameters, the schedule for acres to be put into conservation tillage/no-till cultivation is displayed in Table J-2-1. This table represents the percentage of cropland required by the policy. The estimate for crops currently in no-till comes from the Conservation Technology Information Center's National Crop Residue Management Surveys, which found that 12% of Arkansas currently employs no-till practices.<sup>16</sup>

For the policy period, it is assumed that the sequestration rate provided by the Chicago Climate Exchange for the carbon credit program (0.4 metric tons of carbon dioxide per acre per year [tCO<sub>2</sub>/ac/yr], as Arkansas is considered to be 50% in "Zone A" [0.6 tCO<sub>2</sub>/ac/yr] and 50% in "Zone D" [0.2 tCO<sub>2</sub>/ac/yr]) is indicative of the sequestration that would occur as a result of improved tillage practices.<sup>17</sup> As such, 0.4 tCO<sub>2</sub>/ac/yr was used to estimate the amount of carbon to be sequestered.

Additional GHG savings from reduced fossil fuel consumption are estimated by multiplying the fossil diesel emission factor and diesel fuel reduction per acre estimate. The reduction in fossil diesel fuel use from the adoption of conservation tillage methods is 3.5 gallons (gal)/ac.<sup>18</sup> The life-cycle fossil diesel GHG emission factor of 12.31 metric tons of carbon dioxide equivalent (tCO<sub>2e</sub>)/1,000 gal was used.<sup>19</sup> Results are shown in Table J-2-1, along with a total estimated benefit from both carbon sequestration and fossil fuel reductions.

It is assumed that there is no reduction in crop yield as a result of implementing conservation tillage practices.

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<sup>15</sup> The definitions of tillage practices from the Conservation Technology Information Center are used under this policy. However, only no-till/strip-till and ridge-till are considered "conservation tillage" practices. No-till means leaving the residue from last year's crop undisturbed until planting. Strip-till means no more than one-third of the row width is disturbed with a coulter, residue manager, or specialized shank that creates a strip. If shanks are used, nutrients may be injected at the same time. Ridge-till means that 4–6-inch-high ridges are formed at cultivation. Planters using specialized attachments scrape off the top 2 inches of the ridge before placing the seed in the ground.

<sup>16</sup> Iowa State University, Agronomy Department. "Percent of Cropland in No-Till, 2004". Sourced from the Conservation Technology Information Center, National Crop Residue Management Surveys.

<sup>17</sup> Chicago Climate Exchange (CCX). Agricultural Soil Carbon Offsets. Available at: <http://www.chicagoclimatex.com/content.jsf?id=781>.

<sup>18</sup> Reduction associated with conservation tillage compared to conventional tillage. See: Purdue University, Conservation Technology Information Center. "Reductions Associated With Conservation Tillage Compared With Conventional Tillage." Available at: <http://www.ctic.purdue.edu/Core4/CT/CRM/Benefits.html>.

<sup>19</sup> Life-cycle emissions factor for fossil diesel from J. Hill et al. "Environmental, Economic, and Energetic Costs and Benefits of Biodiesel and Ethanol Biofuels." *Proceedings of the National Academy of Sciences* July 25, 2006;103(30):11206–11210. From the assessment used to evaluate U.S. soybean-based biodiesel life-cycle impacts. Available at: <http://www.pnas.org/cgi/content/full/103/30/11099>.

**Table J-2-1. GHG reductions from conservation tillage practices**

Year	Percentage of Available Cropland Under Conservation Tillage	New Acres Under Conservation Tillage	MMtCO <sub>2</sub> e Sequestered	Diesel Saved (1,000 gal)	MMtCO <sub>2</sub> e from Diesel Avoided	Total MMtCO <sub>2</sub> e Saved per Annum
2008	12%					
2009	13%	105,860	0.042	371	0.005	0.047
2010	15%	340,593	0.136	1,192	0.015	0.15
2011	17%	506,288	0.203	1,772	0.022	0.22
2012	19%	671,982	0.269	2,352	0.029	0.30
2013	20%	837,676	0.335	2,932	0.036	0.37
2014	22%	1,003,370	0.401	3,512	0.043	0.44
2015	24%	1,169,064	0.468	4,092	0.050	0.52
2016	25%	1,334,758	0.534	4,672	0.058	0.59
2017	27%	1,500,452	0.600	5,252	0.065	0.66
2018	29%	1,666,146	0.666	5,832	0.072	0.74
2019	30%	1,831,841	0.733	6,411	0.079	0.81
2020	32%	1,997,535	0.799	6,991	0.086	0.89
2021	34%	2,163,229	0.865	7,571	0.093	0.96
2022	35%	2,328,923	0.932	8,151	0.100	1.03
2023	37%	2,494,617	0.998	8,731	0.107	1.11
2024	38%	2,660,311	1.064	9,311	0.115	1.18
2025	40%	2,816,800	1.127	9,859	0.121	1.25
<b>Total Reductions</b>						<b>11.3</b>

MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; gal = gallon.

The costs of adopting soil management practices (e.g., conservation tillage/no-till practices) are based on cost estimates from the Minnesota Agriculture Best Management Practices (AgBMP) program.<sup>20</sup> This program provides farmers a low-interest loan as an incentive to initiate or improve their current tillage practices. The equipment funded is generally specialized tillage or planting implements that leave crop residues covering at least 15%–30% of the ground after planting. The average total cost for this equipment is \$23,000, though the average loan for tillage equipment is \$16,000. The average-size farm using an AgBMP loan to purchase conservation tillage equipment is 984 acres. The average loan size was determined based on the average size of a farm in Arkansas (308 acres)<sup>21</sup> and the amount of a loan per acre as estimated in the Minnesota AgBMP program (\$16.26/acre).<sup>22</sup> This put the average loan size at \$5,008 to finance

<sup>20</sup> Minnesota Department of Agriculture. *Agricultural Best Management Practices Loan Program State Revolving Fund Status Report*. February 28, 2006. Available at: <http://www.mda.state.mn.us/grants/loans/agbmploan.htm>.

<sup>21</sup> U.S. Department of Agriculture, National Agricultural Statistics Service. “Arkansas State Agriculture Overview–2007.” Available at: [http://www.nass.usda.gov/Statistics\\_by\\_State/Ag\\_Overview/AgOverview\\_AR.pdf](http://www.nass.usda.gov/Statistics_by_State/Ag_Overview/AgOverview_AR.pdf).

<sup>22</sup> Minnesota Department of Agriculture. *Agricultural Best Management Practices Loan Program: State Revolving Fund Status Report*. February 28, 2006.

no-till/conservation tillage practices. This loan payment was applied to each new acre entering the program to determine an approximate cost of encouraging the use of soil management practices. It was further assumed that carbon credits would be available through future programs similar to the National Farmers Union Carbon Credit Program<sup>23</sup> or the Iowa Farm Bureau's AgraGate Climate Credits Corporation. In addition, the diesel fuel savings were considered as a reduced cost of the program. The resulting cost-effectiveness of soil carbon management is a cost savings of about \$6/tCO<sub>2</sub>e. See Table J-2-2 for more details.

**Table J-2-2. Costs of a conservation tillage program**

Year	Cost of Loan	Cost Savings of Program	Total Costs of Program	Discounted Costs of Program
2008	\$0	\$0	\$0	\$0
2009	\$1,458,015	-\$1,110,955	\$610,331	\$502,121
2010	\$3,232,989	-\$3,132,916	\$683,848	\$535,813
2011	\$2,282,110	-\$4,502,198	-\$1,808,012	-\$1,349,166
2012	\$2,282,110	-\$5,744,033	-\$3,049,847	-\$2,167,469
2013	\$2,282,110	-\$6,875,715	-\$4,181,529	-\$2,830,223
2014	\$2,282,110	-\$7,914,270	-\$5,220,083	-\$3,364,912
2015	\$2,282,110	-\$9,073,658	-\$6,379,471	-\$3,916,442
2016	\$2,282,110	-\$9,996,831	-\$7,302,645	-\$4,269,705
2017	\$2,282,110	-\$10,939,175	-\$8,244,989	-\$4,591,118
2018	\$2,282,110	-\$12,155,271	-\$9,461,084	-\$5,017,415
2019	\$2,282,110	-\$13,488,580	-\$10,794,393	-\$5,451,902
2020	\$2,282,110	-\$14,844,411	-\$12,150,224	-\$5,844,466
2021	\$2,282,110	-\$16,191,259	-\$13,497,073	-\$6,183,165
2022	\$2,282,110	-\$17,533,193	-\$14,839,006	-\$6,474,209
2023	\$2,282,110	-\$18,925,935	-\$16,231,749	-\$6,744,627
2024	\$2,282,110	-\$20,428,383	-\$17,734,197	-\$7,018,024
2025	\$2,155,326	-\$21,930,884	-\$19,386,375	-\$7,306,521
<b>Total Costs</b>				<b>-\$71,491,431</b>

*Nutrient Efficiency*

The GHG benefits of this recommendation are quantified by calculating the CO<sub>2</sub>e emissions per kilogram (kg) of nitrogen (N) applied in Arkansas. This uses a figure of the nitrogen emissions from fertilizer (4.70 kgCO<sub>2</sub>e/kgN applied), calculated from the Arkansas Inventory and Forecast (AR I&F).<sup>24</sup> This is then combined with a figure for the life-cycle emissions of nitrogen fertilizer

<sup>23</sup> Price of \$2.10 per metric ton of CO<sub>2</sub>e sourced from CCX Web site on November 13, 2007. Available at: <http://www.chicagoclimatex.com/>.

<sup>24</sup> Arkansas Governor's Commission on Global Warming. "Arkansas Inventory and Forecast." Available at: <http://www.arclimatechange.us/ewebeditpro/items/O94F17378.pdf>.

(0.857 kgCO<sub>2</sub>e/kgN).<sup>25</sup> Thus, the total CO<sub>2</sub>e emissions in Arkansas are 5.55 kgCO<sub>2</sub>e/kgN applied. The BAU estimate of nitrogen fertilizer use in the Arkansas Inventory and Forecast (I&F) assumes constant rates of nitrogen application from 2005. To increase nutrient efficiency by 20%, nitrogen fertilizer use is then reduced from the BAU estimate. This reduction of nitrogen application is then multiplied by the nitrogen emissions factor to determine the GHG benefits of this proposed nutrient efficiency policy (see Table J-2-3).

**Table J-2-3. GHG reductions from the proposed nutrient efficiency policy**

Year	Arkansas Fertilizer Used (baseline) (metric tons of nitrogen)	Efficiency Improvement	Nitrogen Fertilizer Used With Policies (metric tons)	Nitrogen Fertilizer Reduction	Emission Reductions (MMtCO <sub>2</sub> e)
2008	242,797	0.0%	242,797	0	0.00
2009	242,797	1.2%	239,941	2,856	0.02
2010	242,797	2.4%	237,084	5,713	0.03
2011	242,797	3.5%	234,228	8,569	0.05
2012	242,797	4.7%	231,371	11,426	0.06
2013	242,797	5.9%	228,515	14,282	0.08
2014	242,797	7.1%	225,658	17,139	0.10
2015	242,797	8.2%	222,802	19,995	0.11
2016	242,797	9.4%	219,946	22,851	0.13
2017	242,797	10.6%	217,089	25,708	0.14
2018	242,797	11.8%	214,233	28,564	0.16
2019	242,797	12.9%	211,376	31,421	0.17
2020	242,797	14.1%	208,520	34,277	0.19
2021	242,797	15.3%	205,663	37,134	0.21
2022	242,797	16.5%	202,807	39,990	0.22
2023	242,797	17.6%	199,950	42,847	0.24
2024	242,797	18.8%	197,094	45,703	0.25
2025	242,797	20.0%	194,238	48,559	0.27
<b>Total Reductions</b>					<b>2.43</b>

MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent.

<sup>25</sup> The avoided life-cycle GHG emissions (i.e., emissions associated with the production, transport, and energy consumption during application) were taken from: Sam Wood and Annette Cowie. *A Review of Greenhouse Gas Emission Factors for Fertiliser Production*. Research and Development Division, State Forests of New South Wales, Cooperative Research Centre for Greenhouse Accounting. June 2004. Available at: [http://www.ieabioenergy-task38.org/publications/GHG\\_Emission\\_Fertilizer%20Production\\_July2004.pdf](http://www.ieabioenergy-task38.org/publications/GHG_Emission_Fertilizer%20Production_July2004.pdf).

The estimate provided for the United States in Wood and Cowie was taken from: T.O. West and G. Marland. "A Synthesis of Carbon Sequestration, Carbon Emissions and Net Carbon Flux in Agriculture: Comparing Tillage Practices in the United States." *Agriculture, Ecosystems and Environment* September 2002:91(1-3):217-232. Available at: [http://www.sciencedirect.com/science?\\_ob=ArticleURL&\\_udi=B6T3Y-46MBDPX-10&\\_user=10&\\_rdoc=1&\\_fmt=&\\_orig=search&\\_sort=d&\\_view=c&\\_acct=C000050221&\\_version=1&\\_urlVersion=0&\\_userid=10&md5=4bf71c930423acddffbc6d46d763c3](http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6T3Y-46MBDPX-10&_user=10&_rdoc=1&_fmt=&_orig=search&_sort=d&_view=c&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=4bf71c930423acddffbc6d46d763c3).

The costs of the nutrient efficiency policy were estimated based on the implementation of a soil-testing policy to optimize fertilizer application. This policy assumes a \$20 cost to test a 75-acre field, with the field tested every 5 years, across all of Arkansas. There are also staffing costs for the testing and information program (\$500,000/year) and the costs of preparing a guidance document (\$75,000). Subtracted from these costs are the savings from reduced fertilizer use, which results in a net savings over the policy period. See Table J-2-4 for more details.

**Table J-2-4. Costs of a nutrient efficiency program**

Year	Target Fertilizer Reduction (kgN)	Annual Cost of Fertilizer Programs (\$MM)	Avoided Cost of Fertilizer (\$MM)	Costs+Savings (\$MM)	Discounted Costs+Savings (\$MM)
2009	2,856	\$1.90	-\$1.10	\$0.00	\$0.00
2010	5,713	\$1.83	-\$2.20	\$0.80	\$0.66
2011	8,569	\$1.83	-\$3.30	-\$0.37	-\$0.29
2012	11,426	\$1.83	-\$4.39	-\$1.47	-\$1.10
2013	14,282	\$1.83	-\$5.49	-\$2.57	-\$1.82
2014	17,139	\$1.83	-\$6.59	-\$3.66	-\$2.48
2015	19,995	\$1.83	-\$7.69	-\$4.76	-\$3.07
2016	22,851	\$1.83	-\$8.79	-\$5.86	-\$3.60
2017	25,708	\$1.83	-\$9.89	-\$6.96	-\$4.07
2018	28,564	\$1.83	-\$10.99	-\$8.06	-\$4.49
2019	31,421	\$1.83	-\$12.08	-\$9.16	-\$4.86
2020	34,277	\$1.83	-\$13.18	-\$10.26	-\$5.18
2021	37,134	\$1.83	-\$14.28	-\$11.35	-\$5.46
2022	39,990	\$1.83	-\$15.38	-\$12.45	-\$5.71
2023	42,847	\$1.83	-\$16.48	-\$13.55	-\$5.91
2024	45,703	\$1.83	-\$17.58	-\$14.65	-\$6.09
2025	48,559	\$1.83	-\$18.68	-\$15.75	-\$6.23
<b>Total</b>					<b>-\$66.04</b>

kgN = kilograms of nitrogen; \$MM = millions of dollars.

**Key Assumptions:** The conservation tillage policy assumes that 0.4 tCO<sub>2</sub>/ac/yr is a good estimate for the sequestration that comes from no-till. If this is not an accurate estimate of the benefits of conservation tillage on Arkansas soils, then this number will need to be changed. Soil carbon management includes all conservation farming practices that reduce GHG emissions and increase soil carbon sequestration. Conservation tillage has been used as an example for quantification purposes, and other options, such as cover crops, different rotations, and perennial crops, are of equal interest.

It is assumed that there is no reduction in crop yield as a result of implementing conservation tillage practices. While the impact of conservation tillage on yield is uncertain and dependent on site-specific conditions, this assumption is based on a study from the University of Arkansas

Rice Research and Extension Center (RREC).<sup>26</sup> This study indicated that “rice grain yields from no-till plots were equal-to or greater than those from conventional-till plots in 4 of 6 years.” In all years grain yields were higher than the state average. In a recent analysis of the economic returns from this study it was found that “both the tenant and the landlord can benefit monetarily from no-till management.”

Several other key assumptions include: the carbon sequestration potential is representative of all the crop systems to which the policy is applied, a 20-year period is used for accumulating the soil carbon, any potential increase in N<sub>2</sub>O emissions is not large enough to significantly affect the estimated CO<sub>2</sub> benefits, and cost savings used are representative of average savings to be achieved across all crop systems.

The nutrient efficiency policy assumes that fertilizer use can be reduced without a decrease in yield. If yield decreases with reduced fertilizer application, determining both the costs and the GHG reductions of this policy will be more difficult. BAU fertilizer rates are assumed under historic fertilizer costs. The current explosion in energy and fertilizer costs may substantially alter BAU rates.

### **Key Uncertainties**

The rate of no-till practices used is based on the national average, which may not reflect Arkansas conditions. The costs/acre for no-till management come from the Minnesota AgBMP program, which may not reflect Arkansas costs/acre.

There are key uncertainties surrounding the potential GHG benefits associated with no-till and conservation-till practices compared to conventional tillage practices. The soil sequestration rates associated with land management practices, including conservation tillage, remain extremely uncertain, and studies (including those by Manley et al.) highlight this uncertainty. Manley et al. suggest that determining the level of carbon being sequestered is difficult, and further research is required to clarify this issue.<sup>27</sup>

In relation to nitrogen fertilizer use efficiency, it should also be noted that there may be competing forces between the nitrogen efficiency goal and the tillage goal. For example, if there is a major shift to no-till, farmers may need to increase nitrogen rates because of reduced mineralization rates (less aeration and physical disturbance), cooler surface temperatures, and increased losses from volatilized unincorporated urea. Reduced-tillage systems will also make capturing nitrogen from manure more difficult.

The impact of conservation tillage on yield is uncertain and dependent on site-specific conditions. This analysis assumes that the conservation tillage practices result in no reduced yield. This is based on the above-cited study from the University of Arkansas RREC, which

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<sup>26</sup> Dr. Merle M. Anders. "Farming for Carbon: Can It Work and Does It Pay?" Presentation at the 2008 Conservation Tillage Conference Proceedings January 21–22, 2008, Tunica, Mississippi. Available at: <http://www.cottoninc.com/Engineering/2008-Conservation-Tillage-Conference/?Pg=2>.

<sup>27</sup> James Manley, G. van Kooten, Klaus Moeltner, and Johnson Dale. “Creating Carbon Offsets in Agriculture Through No-Till Cultivation: A Meta-Analysis of Costs and Carbon Benefits.” *Climatic Change* January 2005;68(1-2):41-65. Available at: <http://ideas.repec.org/p/rep/wpaper/2003-05.html>.

indicated that rice grain yields from no-till plots were equal to or greater than those from conventional-till plots.

### **Additional Benefits and Costs**

Soil carbon management (e.g., no-tillage) systems provide a number of important ecological services, including erosion control and water quality benefits.

### **Feasibility Issues**

- If changes in management result in decreased crop yields, the net carbon flux can be greater under the new system, assuming that crop demand remains the same and additional lands are brought into production. Conversely, if increasing crop yields lead to less land under cultivation, the overall carbon savings from changes in management will be greater than when soil carbon sequestration alone is considered.
- Options to increase carbon can be implemented in the short term, but the amount of carbon sequestered typically is low initially, then rising for a number of years before tapering off again as the total potential is achieved. There is also a significant risk that the carbon sequestered may be released again by natural phenomena or human activities.
- Practices for conserving carbon affect emissions of other GHGs. Of particular importance is the interaction of carbon sequestration with N<sub>2</sub>O emissions, because N<sub>2</sub>O is such a potent GHG. In some environs, carbon-sequestration practices, such as reduced tillage, can stimulate N<sub>2</sub>O emissions, thereby offsetting part of the benefit. Elsewhere, carbon-conserving practices may suppress N<sub>2</sub>O emissions, amplifying the net benefit. Similarly, carbon-sequestration practices might affect CH<sub>4</sub> emissions if the practice, such as increased use of forages in rotations, leads to higher livestock numbers. Policies designed to suppress emission of one GHG need to also consider complex interactions to ensure that net emissions of total GHGs are reduced.
- International and domestic interactions of the marketplace have not been considered in the foregoing cost/benefit analysis. Current escalating energy costs may lead to sharp changes in crop production practices, while international commodity prices may lead to more intense crop inputs.

### **Status of Group Approval**

Complete.

### **Level of Group Support**

Super Majority (1 objection).

### **Barriers to Consensus**

One member does not believe this recommendation will result in net cost savings.

## AFW-3. Improved Water Management and Use

### Policy Description

Using surface water versus groundwater and decreasing water consumption reduce pumping and energy consumption, in addition to other ancillary benefits. Implementing best management practices improves the efficiency of water use. Additionally, excess surface water can lead to runoff of nitrogen, with subsequent emission of N<sub>2</sub>O to the atmosphere. Managing and improving water consumption and nutrients spread on crops will result in a minimal loss of carbon from the soil. Reusing water can create nutrient management problems, and must be considered when implemented. Water purification is an energy-intensive process that is an issue for farmers and land users in addition to other sectors, such as the residential, commercial, and industrial (RCI) sector (this is related to recommendations under the RCI Technical Work Group [TWG]). As such, water use in rural, suburban, and urban areas should be included under this policy recommendation. The impact of catfish farms on GHG emissions could also be investigated under this recommendation.

### Policy Design

#### Goals:

- Increase the use of surface water for irrigation by 10% by 2025, compared to BAU, offsetting the need for energy-intensive groundwater (reducing energy consumption associated with groundwater pumping).
- Decrease energy use for water purification by 20% in 2025, compared to BAU (includes efficiency gains from reducing water and energy consumption).

**Timing:** As described above.

**Parties Involved:** Arkansas Department of Environmental Quality, Arkansas Department of Agriculture, Arkansas Natural Resources Commission, research institutions, and land owners.

**Other:** None identified.

### Implementation Mechanisms

Enhance current capabilities/capacities of storing surface water, such that it is available at appropriate times and in the necessary quantities.

### Related Policies/Programs in Place

Through Act 341 of 1995, Arkansas has invested significant funding and technical support (in addition to local and federal funding) toward using surface water as opposed to groundwater. Three projects currently under way are:

- Bayou Metro Water Management District,
- Boeuff Tensas Water Management District, and
- White River Irrigation District.

Each of the above projects is in various stages of development toward realizing its goals to use surface water instead of groundwater for irrigation.

### **Type(s) of GHG Reductions**

**CO<sub>2</sub>:** Less energy used to pump water results in reduced CO<sub>2</sub> emissions.

**N<sub>2</sub>O:** Reductions occur when nitrogen runoff and leaching are reduced. (Runoff and leaching lead to the formation and emission of N<sub>2</sub>O.)

### **Estimated GHG Reductions and Costs or Cost Savings**

#### **GHG Reduction Potential in 2015, 2025 (MMtCO<sub>2</sub>e):**

- *Increased Surface Water:* 0.005 and 0.01, respectively.
- *Improved Purification:* 0.001 and 0.001, respectively.

#### **Net Cost per tCO<sub>2</sub>e:**

- *Increased Surface Water:* \$835.
- *Improved Purification:* -\$39.

#### **Data Sources:**

##### **Fuel price estimates:**

- U.S. Department of Energy, Energy Information Administration. *Annual Energy Outlook 2007: With Projections to 2030*. IDOE/EIA-0383(2007). Washington, DC, February 2006. Available at: [http://tonto.eia.doe.gov/ftproot/forecasting/0383\(2007\).pdf](http://tonto.eia.doe.gov/ftproot/forecasting/0383(2007).pdf).
- U.S. Department of Energy, Energy Information Administration. *Annual Energy Outlook 2003: With Projections to 2025*. IDOE/EIA-0383(2003). Washington, DC, January 2003. Available at: [http://tonto.eia.doe.gov/ftproot/forecasting/0383\(2003\).pdf](http://tonto.eia.doe.gov/ftproot/forecasting/0383(2003).pdf).

##### **Amount of energy used for irrigation in Arkansas:**

- U.S. Department of Agriculture, National Agricultural Statistics Service. “2003 Farm and Ranch Irrigation Survey.” Arkansas Table 20—Energy Expenses for On-Farm Pumping of Irrigation Water by Water Source and Type of Energy: 2003 and 1998. Available at: [http://www.agcensus.usda.gov/Publications/2002/FRIS/tables/fris03\\_20.pdf](http://www.agcensus.usda.gov/Publications/2002/FRIS/tables/fris03_20.pdf).

##### **Growth rate for water use:**

- U.S. Department of Energy, Energy Information Administration. *Annual Energy Outlook 2007: With Projections to 2030*. IDOE/EIA-0383(2007). Washington, DC, February 2006. Available at: [http://tonto.eia.doe.gov/ftproot/forecasting/0383\(2007\).pdf](http://tonto.eia.doe.gov/ftproot/forecasting/0383(2007).pdf).

##### **Other:**

- Sustainable Sites Initiative. *Standards & Guidelines: Preliminary Report*. Lady Bird Johnson Wildflower Center, American Society of Landscape Architects, and U.S. Botanic Garden. November 1, 2007. Available at: [www.sustainablesites.org/SustainableSitesInitiative\\_PreliminaryReport\\_110107.pdf](http://www.sustainablesites.org/SustainableSitesInitiative_PreliminaryReport_110107.pdf)

### Energy use:

- U.S. Department of Energy, Energy Information Administration. *Annual Energy Outlook 2007: With Projections to 2030*. IDOE/EIA-0383(2007). Washington, DC, February 2006. Available at: [http://tonto.eia.doe.gov/ftproot/forecasting/0383\(2007\).pdf](http://tonto.eia.doe.gov/ftproot/forecasting/0383(2007).pdf).

### U.S. and Arkansas population figures:

- U.S. Census Bureau. “State & County QuickFacts, People QuickFacts.” Available at: <http://quickfacts.census.gov/qfd/states/19000.html>; <http://quickfacts.census.gov/qfd/states/05000.html>.

### Emission factors for electricity and diesel fuel:

- Arkansas Governor's Commission on Global Warming. "Arkansas Inventory and Forecast." Available at: <http://www.arclimatechange.us/ewebeditpro/items/O94F17378.pdf>.

### Quantification Methods:

*Surface Water*—This analysis used an Arkansas Natural Resources Commission and U.S. Geological Survey estimate of the amount of groundwater (6.9 billion gal/day) and surface water (1.3 billion gal/day) used for irrigation in Arkansas.<sup>28</sup> Thus, by 2025, surface water use will increase by (10%\*1.3 billion gal/day) in this policy. Groundwater and surface water use carry with them different electricity requirements (1.7 kilowatt-hours [kWh]/1,000 gal for groundwater and 1.3 kWh/1,000 gal for surface water). Thus, every thousand gallons of water that comes from surface water saves 0.4 kWh of electricity.<sup>29,30</sup> This electricity savings figure is then multiplied by the emissions factor for electricity (.592 tCO<sub>2</sub>e/megawatt-hour [MWh]) to get the metric tons of CO<sub>2</sub>e saved. Costs were estimated based on Iowa average estimates of groundwater and surface water costs per 1,000 gal, which came from a publication by the Iowa Association of Municipal Utilities.<sup>31</sup> The costs for the largest groundwater suppliers averaged \$0.56/1,000 gal, while the costs for the largest surface water suppliers averaged \$0.72/1,000 gal. This cost difference (\$0.15/1,000 gal) in 2000 was then discounted forward to 2005 dollars, and multiplied by the number of gallons switched in a given year. See Table J-3-1 for details.

*Water Purification*—The amount of energy going toward water purification in Arkansas could not be determined. National electricity consumption for water purification (1.1 million MWh)<sup>32</sup> was used as a proxy, and then applied to Arkansas based on the Arkansas percentage of the total

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<sup>28</sup> Terrence W. Holland. *Water Use in Arkansas, 2005*. Scientific Investigations Report 2007–5241. U.S. Department of the Interior/U.S. Geological Survey and Arkansas Natural Resources Commission. 2007. Available at: <http://pubs.usgs.gov/sir/2007/5241/pdf/SIR2007-5241.pdf>.

<sup>29</sup> Scott Olson and Alan Larson. *Opportunities and Barriers in Madison, Wisconsin: Understanding Process Energy Use in a Large Municipal Water Utility*. Madison Gas and Electric Company and Madison Water Utility. Available at: <http://www.cee1.org/ind/mot-sys/ww/mge2.pdf>.

<sup>30</sup> Todd Elliot et al. *Energy Use at Wisconsin's Drinking Water Facilities*. Report Number 222-1. Energy Center of Wisconsin. July 2003. Available at: <http://www.ecw.org/prod/222-1.pdf>.

<sup>31</sup> Iowa Association of Municipal Utilities. *Energy Costs to Treat Water and Wastewater in Iowa*. November 2002. Available at: [http://www.iamu.org/main/studies\\_reports/reports.htm](http://www.iamu.org/main/studies_reports/reports.htm).

<sup>32</sup> U.S. Department of Energy, Energy Information Administration. *Annual Energy Outlook 2007: With Projections to 2030*. IDOE/EIA-0383(2007). Washington, DC, February 2006. Available at: [http://www.eia.doe.gov/oiaf/archive/aeo07/pdf/0383\(2007\).pdf](http://www.eia.doe.gov/oiaf/archive/aeo07/pdf/0383(2007).pdf).

U.S. population (.94%).<sup>33</sup> The electricity consumption for water purification was assumed to increase at 0.8% annually, based on U.S. Department of Energy (DOE) Energy Information Administration (EIA) *Annual Energy Outlook* (AEO) estimates.<sup>34</sup> This was used to create a BAU estimate for Arkansas energy consumption. As per the goal, electricity consumption was then reduced by 20% in 2025. This electricity saved was then multiplied by the state emissions factor for electricity to determine the CO<sub>2</sub>e reduced. See Table J-3-2 for details of the analysis.

**Table J-3-1. GHG benefits and costs of surface water policies**

Year	Implementation Path	Gallons Switched (Groundwater to Surface Water) (million gallons)	Electricity Saved (MWh)	MMtCO <sub>2</sub> e Reduced	Additional Costs of Surface Water Use
2008	0	0	0	0.00	\$0
2009	0.59%	2,834	1,134	0.00	\$560,655
2010	1.18%	5,668	2,267	0.00	\$1,121,311
2011	1.76%	8,502	3,401	0.00	\$1,681,966
2012	2.35%	11,336	4,535	0.00	\$2,242,622
2013	2.94%	14,171	5,668	0.00	\$2,803,277
2014	3.53%	17,005	6,802	0.00	\$3,363,933
2015	4.12%	19,839	7,936	0.00	\$3,924,588
2016	4.71%	22,673	9,069	0.01	\$4,485,244
2017	5.29%	25,507	10,203	0.01	\$5,045,899
2018	5.88%	28,341	11,336	0.01	\$5,606,555
2019	6.47%	31,175	12,470	0.01	\$6,167,210
2020	7.06%	34,009	13,604	0.01	\$6,727,866
2021	7.65%	36,844	14,737	0.01	\$7,288,521
2022	8.24%	39,678	15,871	0.01	\$7,849,177
2023	8.82%	42,512	17,005	0.01	\$8,409,832
2024	9.41%	45,346	18,138	0.01	\$8,970,488
2025	10.00%	48,180	19,272	0.01	\$9,531,143
<b>Total</b>				<b>0.10</b>	<b>\$85,780,288</b>

MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; MWh = megawatt-hours.

The costs of improved efficiency in water purification were estimated based on the costs of improved efficiency in Texas water purification. That particular analysis found that variable-

<sup>33</sup> U.S. Census Bureau. "State Interim Population Projections by Age and Sex: 2004–2030." Table 6: Total Population for Regions, Divisions, and States: 2000 to 2030. Available at: <http://www.census.gov/population/www/projections/projectionsagesex.html>.

<sup>34</sup> U.S. Department of Energy, Energy Information Administration. *Annual Energy Outlook 2007: With Projections to 2030*. IDOE/EIA-0383(2007). Washington, DC, February 2006. Available at: [http://www.eia.doe.gov/oiaf/archive/aeo07/pdf/0383\(2007\).pdf](http://www.eia.doe.gov/oiaf/archive/aeo07/pdf/0383(2007).pdf).

frequency drives for water purification cost \$85,000 and could save 206 MWh annually.<sup>35</sup> Assuming that this type of cost-savings ratio is typical of water purification efficiency investments, the costs of the efficiency improvements in Arkansas can be estimated. The cost savings of reduced electricity consumption were also considered, using the commercial cost of electricity in 2008 multiplied by the MWh of energy saved (Table J-3-2).<sup>36</sup>

**Table J-3-2. GHG benefits and costs of water purification policies**

Year	Energy Use Water Purification (million kWh)	Reduction Goal	Energy Savings (million kWh)	tCO <sub>2</sub> e Avoided	Costs of Modifications	Electricity Savings	Total Costs
2008	10.59	0%	0.00	0		\$0	\$0
2009	10.67	1.2%	0.13	74	\$51,666	-\$8,914	\$42,752
2010	10.76	2.4%	0.25	150	\$52,492	-\$18,224	\$34,268
2011	10.84	3.5%	0.38	227	\$53,329	-\$27,555	\$25,774
2012	10.93	4.7%	0.51	305	\$54,176	-\$36,520	\$17,656
2013	11.02	5.9%	0.65	384	\$55,032	-\$44,718	\$10,314
2014	11.11	7.1%	0.78	464	\$55,899	-\$53,307	\$2,592
2015	11.19	8.2%	0.92	546	\$56,777	-\$62,690	-\$5,913
2016	11.28	9.4%	1.06	629	\$57,664	-\$72,218	-\$14,554
2017	11.37	10.6%	1.20	713	\$58,563	-\$81,896	-\$23,333
2018	11.47	11.8%	1.35	799	\$59,472	-\$93,072	-\$33,600
2019	11.56	12.9%	1.50	885	\$60,392	-\$103,198	-\$42,807
2020	11.65	14.1%	1.64	974	\$61,322	-\$113,480	-\$52,158
2021	11.74	15.3%	1.80	1,063	\$62,264	-\$123,921	-\$61,657
2022	11.84	16.5%	1.95	1,154	\$63,217	-\$134,521	-\$71,304
2023	11.93	17.6%	2.11	1,246	\$64,181	-\$145,282	-\$81,101
2024	12.03	18.8%	2.26	1,340	\$65,157	-\$156,208	-\$91,051
2025	12.12	20.0%	2.42	1,435	\$66,144	-\$167,298	-\$101,154
<b>Total Reductions</b>				<b>12,387</b>	<b>Total Costs</b>		<b>-\$445,275</b>

kWh = kilowatt-hours; tCO<sub>2</sub>e = metric tons of carbon dioxide equivalent.

**Key Assumptions:** The energy consumption that comes with groundwater and surface water use comes from two reports from the state of Wisconsin.<sup>37,38</sup> The difference in energy consumption

<sup>35</sup> B.A. Philips, C.H. Burnett, and J. James. "Energy Conservation Measures for a Large Metropolitan Groundwater Utility." *Proceedings from the 2001 American Water Works Association Annual Conference*. June 1, 2001. Cited in Todd Elliot et al. *Energy Use at Wisconsin's Drinking Water Facilities*. Report Number 222-1. Energy Center of Wisconsin. July 2003. Available at: <http://www.ecw.org/prod/222-1.pdf>.

<sup>36</sup> U.S. Department of Energy, Energy Information Administration. "Short Term Energy Outlook." Table 2: U.S. Energy Nominal Prices." July 2008. Available at: <http://www.eia.doe.gov/emeu/steo/pub/2tab.pdf>.

<sup>37</sup> Scott Olson and Alan Larson. *Opportunities and Barriers in Madison, Wisconsin: Understanding Process Energy Use in a Large Municipal Water Utility*. Madison Gas and Electric Company and Madison Water Utility. Available at: <http://www.cee1.org/ind/mot-sys/ww/mge2.pdf>.

(0.4 kWh/1,000 gal) found in these studies is assumed to reflect Arkansas conditions. Costs from increased use of surface water come from an Iowa source.<sup>39</sup> It is assumed that these costs are comparable to those in Arkansas.

The water purification recommendation assumes that water purification energy use in Arkansas occurs at the same rate as the national average. If this is not the case, the costs and benefits will need to be adjusted. Likewise the 0.8% increase in water purification energy use from the EIA<sup>40</sup> may not reflect Arkansas conditions. The costs of efficiency improvements in water purification come from a case study in Texas,<sup>41</sup> and are assumed to reflect Arkansas efficiency improvements.

### **Key Uncertainties**

It may not be possible or practical to increase the amount of surface water being used in Arkansas to the extent that is recommended by this policy recommendation's goal.

### **Additional Benefits and Costs**

Decreasing the rate of groundwater pumping will have benefits in terms of maintaining underground water reservoirs. Because these reservoirs replenish themselves over a very long time period, decreasing the consumption of this water could have significant benefits in the future.

The interrelationships between ecology and hydrology present both challenges and opportunities to establish more effective management, with input of various stakeholder groups with different and sometimes conflicting interests: for recreation, wildlife habitat, drainage, water supply, and residential, industrial, and agricultural uses. Managers not only realize that protection of natural ecological processes helps protect some of the utilitarian values, but that temporal environmental variability and disturbance continually shapes and regulates aquatic community structure and function. Climate change and the integration of the human component into natural ecosystem management continues to establish new fields of endeavor in applied surface water management.

### **Feasibility Issues**

None identified.

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<sup>38</sup> Todd Elliot et al. *Energy Use at Wisconsin's Drinking Water Facilities*. Report Number 222-1. Energy Center of Wisconsin. July 2003. Available at: <http://www.ecw.org/prod/222-1.pdf>.

<sup>39</sup> Pat Sauer and Anne Kimber. *Energy Consumption and Costs to Treat Water and Wastewater in Iowa. Part 1: An Overview of Energy Consumption and Treatment Costs in Iowa*. November 2002. Available at: [http://www.iamu.org/main/studies\\_reports/reports.htm](http://www.iamu.org/main/studies_reports/reports.htm).

<sup>40</sup> U.S. Department of Energy, Energy Information Administration. *Annual Energy Outlook 2007. With Projections to 2030*. DOE/EIA-0383(2007). Page 46. Washington, DC, February 2006. Available at: [http://www.eia.doe.gov/oiaf/archive/aeo07/pdf/0383\(2007\).pdf](http://www.eia.doe.gov/oiaf/archive/aeo07/pdf/0383(2007).pdf)

<sup>41</sup> B.A. Philips, C.H. Burnett, and J. James. "Energy Conservation Measures for a Large Metropolitan Groundwater Utility." *Proceedings from the 2001 American Water Works Association Annual Conference*. June 1, 2001. Cited in Todd Elliot et al. *Energy Use at Wisconsin's Drinking Water Facilities*. Report Number 222-1. Energy Center of Wisconsin. July 2003. Available at: <http://www.ecw.org/prod/222-1.pdf>.

**Status of Group Approval**

Complete.

**Level of Group Support**

Super Majority (1 objection).

**Barriers to Consensus**

One member does not believe this recommendation will result in net cost savings.

## AFW-4. Expanded Use of Agriculture and Forestry Biomass Feedstocks for Electricity, Heat, or Steam Production

### Policy Description

Increasing the amount of biomass available from forests or agriculture for generating electricity can displace the use of fossil energy sources. This strategy also encourages the capture of waste heat at facilities using biomass (or fossil fuels), wherever possible. The waste heat could be used for cogeneration to displace heating costs and fossil fuel use. Local electricity or steam production yields the greatest net energy payoff.

### Policy Design

#### Goals:

- *Agricultural Residues*—Increase the use of agricultural residues for electricity, steam, and heat generation to utilize 5% of available in-state agricultural residue biomass by 2015 and 10% of available biomass by 2025.
- *Forest Residues*—Increase the use of forest residues for electricity, steam, and heat generation to utilize 5% of available biomass by 2015, and 10% of available in-state forest residue by 2025.
- *Energy Crops*—Increase the production of energy crops to produce biomass feedstock for electricity, steam, and heat generation.
- *Energy From Livestock Manure and Poultry Litter*—By 2025, utilize 10% of available energy from livestock manure and poultry litter for renewable electricity, heat, and steam generation. [Note potential overlap with AFW-1.]
- *Capture of Waste Heat*—By 2025, ensure that facilities using biomass for electricity, heat, and steam production are capturing and utilizing 10% of waste heat.

**Timing:** As described above.

**Parties Involved:** Agriculture landowners, forest owners and managers, utilities, and energy-using industries.

**Other:** One land type potentially suitable for energy crop production is marginal agricultural land. The Arkansas Natural Resources Conservation Service (NRCS) provided an estimate of marginal agricultural land in Arkansas, using a combination of the State Soil Geographic Databases (STASGO) and Gap Analysis Program (GAP)/Land Use Land Cover (LULC) data. Soils of capability Classes<sup>42</sup> III, IV, and V from STASGO were used as the primary criteria for

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<sup>42</sup> Soil capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and how they respond to management. The criteria used in grouping the soils do not include major and generally expensive land forming that would change slope, depth, or other characteristics of the soils, nor do they include possible, but unlikely, major reclamation projects. Capability classes are designated by the numbers I through VIII. The numbers indicate progressively greater limitations and narrower

marginal lands. Soil capability Classes VI, VII, and VIII are economically prohibitive, due to steepness of slope, depth to bedrock, or other limitation, so were excluded. The data set was overlaid and clipped using GAP/LULC data to produce marginal lands currently in forest, pasture, and crop. Acreage data for land use were generated through the 1997 National Resources Inventory (NRI). This acreage does not include federal agency managed lands or lands enrolled in federal conservation programs. The results of the above analysis indicate the following acres of marginal land by land use type:

- Agriculture: Crops—1,505,300 acres
- Herbaceous/Pasture/Forage—2,871,700 acres
- Forestland—7,233,000 acres

Other sources of energy are also potentially available, such as using ammonia from waste water as a potential source of hydrogen.<sup>43</sup>

### **Implementation Mechanisms**

- Add incentives to encourage energy from biomass. Establish incentives for utilizing renewable heating fuels (such as tax credits).
- Plant energy crops so the feedstock is available. Pilot projects may be needed in the near term to assess the economics of broader-scale commercialization in the long term.
- Provide outreach and education.

### **Related Policies/Programs in Place**

#### **Electric Public Utility Renewable Energy Resources**

*Act 755 (HB 2812)*—The Arkansas Public Service Commission (APSC) is authorized to consider, propose, develop, solicit, approve, implement, and monitor measures by electric public utilities subject to its jurisdiction that cause customers to incur costs of service and investments that utilize, generate, or involve clean energy resources or renewable energy resources, or both. The APSC may encourage or require electric public utilities subject to its jurisdiction to consider clean energy or renewable energy resources, or both, as part of any resource plan. After proper notice and hearings, the APSC may approve any clean energy resource or renewable energy resource that it determines to be in the public interest. If the APSC determines that the cost of a clean energy resource or renewable energy resource is in the public interest, the APSC may allow the affected electric public utility to implement a temporary surcharge to recover a portion of the costs of such a resource until the implementation of new rate schedules in connection with

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choices for practical use. Capability classification is not a substitute for interpretations that show suitability and limitations of groups of soils for rangeland, for woodland, and for engineering purposes.

<sup>43</sup> Frédéric Vitse, Matt Cooper, and Gerardine G. Botte. "On the Use of Ammonia Electrolysis for Hydrogen Production." *Journal of Power Sources* 2005;142:18-26. Available at:

<http://webche.ent.ohiou.edu/eerl/documents/vitse-cooper-botte%20JPS-2005-Ammonia.pdf>.

the utility's next general rate filing, wherein such costs can be included in the utility's base rate schedules.<sup>44</sup>

### Type(s) of GHG Reductions

CO<sub>2</sub>, N<sub>2</sub>O, CH<sub>4</sub>: Displaces emissions from fossil fuel combustion.

### Estimated GHG Reductions and Costs or Cost Savings

#### GHG Reduction Potential in 2015, 2025 (MMtCO<sub>2</sub>e):

- *Energy From Biomass*: 2 and 4, respectively.
- *Energy From Livestock Manure and Poultry Litter*: 0.01 and 0.02, respectively.
- *Capture of Waste Heat*: 0.02 and 0.06, respectively.

#### Net Cost per tCO<sub>2</sub>e:

- *Energy From Biomass*: \$40.
- *Energy From Livestock Manure and Poultry Litter*: \$4.
- *Capture of Waste Heat*: -\$140.

#### Data Sources:

- Princeton Energy Resources International, LLC and Exeter Associates Inc. *The Potential for Biomass Cofiring in Maryland*. DNR 12-2242006-107, PPES-06-02. Prepared for the Maryland Department of Natural Resources, Power Plant Research Program. March 2006. Available at: [http://esm.versar.com/PPRP/bibliography/PPES\\_06\\_02/PPES\\_06\\_02.pdf](http://esm.versar.com/PPRP/bibliography/PPES_06_02/PPES_06_02.pdf).
- U.S. Department of Energy, Energy Information Administration. "Average Heat Content of Selected Biomass Fuels." Table 10 Annual Electric Generator. Available at: <http://www.eia.doe.gov/cneaf/solar.renewables/page/trends/table10.html>.
- Oak Ridge National Laboratory. Table A.2: Approximate Heat Content of Selected Fuels for Electric Power Generation. Available at: [http://cta.ornl.gov/bedb/appendix\\_a/Approximate\\_Heat\\_Content\\_of\\_Selected\\_Fuels\\_for\\_Electric\\_Power\\_Generation.xls](http://cta.ornl.gov/bedb/appendix_a/Approximate_Heat_Content_of_Selected_Fuels_for_Electric_Power_Generation.xls) (6,000–8,000 Btu per pound for solid wood products).
- Arkansas Economic Development Commission. *Arkansas Biomass Resource Assessment*. Annual Biomass Supply. Available at: [http://arkansasedc.com/business\\_development/energy/?page=bioenergy](http://arkansasedc.com/business_development/energy/?page=bioenergy).

#### Quantification Methods:

##### *Energy From Biomass GHG Benefits*

This analysis focuses on the incremental GHG benefits associated with the utilization of additional biomass to offset the consumption of fossil fuels. It assumes that biomass will be used

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<sup>44</sup> From the ARKLEG Web site. See:

<http://www.arkleg.state.ar.us/NXT/gateway.dll?f=templates&fn=default.htm&vid=blr:ar>.

to replace coal in the RCI and electricity sectors (where coal represents about 49% of electricity generated in Arkansas).<sup>45</sup>

The GHG benefits were calculated by the difference in emissions associated with each of the input fuels (0.0959 tCO<sub>2</sub>e/million British thermal units [MMBtu]) for sub-bituminous coal, 0.0539 tCO<sub>2</sub>e/MMBtu for natural gas, and 0.0019 tCO<sub>2</sub>e/MMBtu for biomass, including non-CH<sub>4</sub> and non-N<sub>2</sub>O emissions).<sup>46</sup>

The amount of biomass utilized by each of the three components (agriculture, forestry, and energy crops) is illustrated in Tables J-4-1, J-4-2, and J-4-3. The biomass available for energy crop utilization was assumed to be 437,700 acres. Energy crop production on agricultural land is assumed to be 5 t/ac/yr based on Graham (1994).<sup>47</sup>

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<sup>45</sup> Based on eGRID data: coal 49%, nuclear 30%, oil 1%, natural gas 10%, biomass 4%, hydro 4%, and wind 0%. U.S. Environmental Protection Agency. "Emissions & Generation Resource Integrated Database (eGRID). Data for Arkansas." Available at: <http://www.epa.gov/cleanenergy/energy-resources/egrid/index.html>.

<sup>46</sup> Emission factors obtained from the Center for Climate Strategies' energy fuel emission factors.

<sup>47</sup> R.L. Graham. "An Analysis of the Potential Land Base for Energy Crops in the Conterminous United States." *Biomass and Bioenergy* 1994;6(3):175-189, Oak Ridge National Laboratory. Available at: [http://www.sciencedirect.com/science?\\_ob=ArticleURL&\\_udi=B6V22-49BS3BD-3F&\\_user=10&\\_rdoc=1&\\_fmt=&\\_orig=search&\\_sort=d&\\_view=c&\\_acct=C000050221&\\_version=1&\\_urlVersion=0&\\_userid=10&md5=d9a6715f872fc7795810c68146db7720](http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6V22-49BS3BD-3F&_user=10&_rdoc=1&_fmt=&_orig=search&_sort=d&_view=c&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=d9a6715f872fc7795810c68146db7720). Lands that could not produce this minimum biomass yield were considered unsuitable.

**Table J-4-1. GHG benefits from agriculture crop residue**

Year	Percentage of Utilization	Agriculture Residue Biomass (tons)	Agriculture Residue Biomass (MMBtu)	Avoided Emissions Agriculture Residue (MMtCO <sub>2</sub> e)
2009	0.1%	3,807	31,401	0.003
2010	1.0%	30,457	251,211	0.024
2011	1.8%	57,107	471,020	0.044
2012	2.6%	83,757	690,829	0.065
2013	3.5%	110,407	910,638	0.086
2014	4.3%	137,057	1,130,447	0.106
2015	5.0%	159,900	1,318,855	0.124
2016	5.5%	175,890	1,450,741	0.136
2017	6.0%	191,880	1,582,626	0.149
2018	6.5%	207,870	1,714,512	0.161
2019	7.0%	223,860	1,846,397	0.174
2020	7.5%	239,850	1,978,283	0.186
2021	8.0%	255,840	2,110,168	0.198
2022	8.5%	271,830	2,242,054	0.211
2023	9.0%	287,820	2,373,939	0.223
2024	9.5%	303,810	2,505,825	0.236
2025	10.0%	319,800	2,637,710	0.248
<b>Cumulative Benefits</b>				<b>2.37</b>

MMBtu = million British thermal units; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent.

**Table J-4-2. GHG benefits from forestry biomass**

Year	Percentage of Utilization	Forest Feedstocks* (dry tons)	Forest Feedstocks* (MMBtu)	Avoided Emissions All Forest Feedstocks (MMtCO <sub>2</sub> e)
2009	0.7%	71,700	714,204	0.067
2010	1.4%	143,400	1,428,407	0.134
2011	2.1%	215,100	2,142,611	0.201
2012	2.9%	286,800	2,856,815	0.269
2013	3.6%	358,500	3,571,019	0.336
2014	4.3%	430,200	4,285,222	0.403
2015	5.0%	501,900	4,999,426	0.470
2016	5.5%	552,090	5,499,368	0.517
2017	6.0%	602,280	5,999,311	0.564
2018	6.5%	652,470	6,499,254	0.611
2019	7.0%	702,660	6,999,196	0.658
2020	7.5%	752,850	7,499,139	0.705
2021	8.0%	803,040	7,999,081	0.752
2022	8.5%	853,230	8,499,024	0.799
2023	9.0%	903,420	8,998,967	0.846
2024	9.5%	953,610	9,498,909	0.893
2025	10.0%	1,003,800	9,998,852	0.940
<b>Cumulative Benefits</b>				<b>9.17</b>

MMBtu = million British thermal units; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent.

\*Includes forest residue, mill residue, and urban wood waste.

**Table J-4-3. GHG benefits from dedicated energy crops**

Year	Land Available for Energy Crops (acres)	Total Energy Crops (dry tons)	Total Energy Crops (MMBtu)	Avoided Emissions, Energy Crops (MMtCO <sub>2</sub> e)
2009	31,264	156,321	2,297,925	0.216
2010	62,529	312,643	4,595,850	0.432
2011	93,793	468,964	6,893,775	0.648
2012	125,057	625,286	9,191,700	0.864
2013	156,321	781,607	11,489,625	1.08
2014	187,586	937,929	13,787,550	1.30
2015	218,850	1,094,250	16,085,475	1.51
2016	240,735	1,203,675	17,694,023	1.66
2017	262,620	1,313,100	19,302,570	1.81
2018	284,505	1,422,525	20,911,118	1.97
2019	306,390	1,531,950	22,519,665	2.12
2020	328,275	1,641,375	24,128,213	2.27
2021	350,160	1,750,800	25,736,760	2.42
2022	372,045	1,860,225	27,345,308	2.57
2023	393,930	1,969,650	28,953,855	2.72
2024	415,815	2,079,075	30,562,403	2.87
2025	437,700	2,188,500	32,170,950	3.02
<b>Cumulative Benefits</b>				<b>29.5</b>

MMBtu = million British thermal units; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent.

#### *Energy From Biomass Costs*

The cost calculation has two main components: fuel costs and capital costs. The fuel component is based on the difference in costs between supply of biomass fuel and the assumed fossil fuel that it is replacing (i.e., coal). The assumed costs used in the analysis are identified in Table J-4-4.

The costs are calculated by assuming the replacement of coal with biomass. The difference in costs (\$/MMBtu) is multiplied by the amount of coal energy (MMBtu) being replaced by biomass (see Table J-4-5). The assumed incremental capital costs and operation and maintenance (O&M) costs are based on the capital costs associated with establishing a biomass plant compared to a coal plant (as indicated in Table J-4-6). Capital costs and O&M costs were taken from Table 38 of EIA's 2008 Electricity Market Module.<sup>48</sup> The assumed costs for biomass included in the module are based on the cost and performance characteristics of new generating technologies, which in the case of biomass is assumed to be integrated gasification combined-cycle (IGCC) technology. While use of biomass may be pursued through a variety of technology types (e.g., gasification, cofiring, direct firing) or end uses (e.g., heat, steam), this methodology

<sup>48</sup> U.S. Department of Energy, Energy Information Administration. "Electricity Market Module." In *Assumptions to the Annual Energy Outlook 2008*. DOE/EIA-0554(2007). June 2008. Available at: <http://www.eia.doe.gov/oiaf/aeo/assumption/pdf/electricity.pdf>.

was used to provide an estimate of possible additional capital and operational costs required to enable the utilization of biomass (Table J-4-7).<sup>49</sup>

**Table J-4-4. Assumed costs of biomass feedstocks**

Fuel Type	Cost \$/Ton Delivered	Heat Content (MMBtu/ton)	Cost \$/MMBtu Delivered
Agricultural residues <sup>50</sup>	\$42.50	8.3	\$5.12
Energy crop (e.g., switchgrass) <sup>51</sup>	\$60.00	14.7	\$4.09
Forest feedstocks <sup>52</sup>	\$35.00	10.0	\$3.51
Native seasonal grasses <sup>53</sup>	Prices for Native seasonal grasses fluctuate with the hay market.		

MMBtu/ton = million British thermal units per ton; \$/MMBtu = dollars per million British thermal units.

<sup>49</sup> The capital costs associated with using biomass as an alternative to fossil-based generation are dependent on many factors, including the end use (i.e., electricity, heat, or steam), the design and size of the system, the technology employed, and the configuration specifications of the system. Each system implemented under this policy would require a detailed analysis (incorporating specific engineering design and cost aspects) to provide a more accurate cost estimate of the system.

<sup>50</sup> The price of agriculture residues and energy crops comes from the mid-point of the range provided in S.C. Brechbill and W.E. Tyner. "The Economics of Biomass Collection, Transportation, and Supply to Indiana Cellulosic and Electric Utility Facilities." Working Paper 08-03. Purdue University, College of Agriculture, Department of Agricultural Economics (April 2008). Available at: <http://ideas.repec.org/p/pae/wpaper/08-03.html>. Cost components include seed, fertilizer, and herbicide application, mowing/shredding, raking, baling, storage, handling, and transportation in the 30-mile range. The cost estimates also include nutrient replacement for corn stover. The heat content of selected fuels comes from Oak Ridge National Laboratory. Table A.2: Approximate Heat Content of Selected Fuels for Electric Power Generation. Available at: [http://cta.ornl.gov/bedb/appendix\\_a/Approximate\\_Heat\\_Content\\_of\\_Selected\\_Fuels\\_for\\_Electric\\_Power\\_Generation.xls](http://cta.ornl.gov/bedb/appendix_a/Approximate_Heat_Content_of_Selected_Fuels_for_Electric_Power_Generation.xls).

<sup>51</sup> Ibid.

<sup>52</sup> Princeton Energy Resources International, LLC, and Exeter Associates, Inc. *The Potential for Biomass Cofiring in Maryland*. DNR 12-2242006-107; PPES-06-02. Annapolis, MD: Maryland Department of Natural Resources, Maryland Power Plant Research Program, March 2006. Available at: [http://esm.versar.com/PPRP/bibliography/PPES\\_06\\_02/PPES\\_06\\_02.pdf](http://esm.versar.com/PPRP/bibliography/PPES_06_02/PPES_06_02.pdf).

<sup>53</sup> Native seasonal grasses have been identified as a potential feedstock in Table J-4-4 but were not included in the quantification analysis because their availability and price are relatively uncertain (particularly in the short term). More market information about native seasonal grasses is available from McCracken Hay Company at <http://www.mccrackenhay.com/haypage-1.htm> and from Equine Management, Auction, and Appraisal Services, Inc., at <http://www.saddlefitting.net/haycompany/index.html>.

**Table J-4-5. Assumed costs of coal feedstocks<sup>54</sup>**

Year	Coal (in \$/MMBtu)	Natural Gas (in \$/MMBtu)
2009	\$2.20	\$7.40
2010	\$2.22	\$6.97
2011	\$2.17	\$6.65
2012	\$2.12	\$6.46
2013	\$2.09	\$6.24
2014	\$2.06	\$6.05
2015	\$2.04	\$5.92
2016	\$2.02	\$5.87
2017	\$2.01	\$5.93
2018	\$1.97	\$6.01
2019	\$1.96	\$6.07
2020	\$1.95	\$6.05
2021	\$1.94	\$5.99
2022	\$1.94	\$6.11
2023	\$1.94	\$6.20
2024	\$1.94	\$6.33
2025	\$1.94	\$6.43

MMBtu = million British thermal units.

**Table J-4-6. Assumed capital and O&M costs of biomass compared to coal**

Cost Component <sup>55</sup>	Cost <sup>56</sup>	Units
Capital costs of coal unit	\$1,461	\$/kW of capacity
Capital costs of biomass unit	\$2,675	\$/kW of biomass capacity
<b>Additional Capital Costs for Biomass</b>	<b>\$1,214</b>	<b>\$/kW of biomass capacity</b>
Variable O&M coal	\$4.25	\$2005 mills/kWh <sup>57</sup>
Variable O&M biomass	\$6.22	\$2005 mills/kWh
<b>Additional Variable O&amp;M Costs for Biomass</b>	<b>\$1.97</b>	<b>\$2005 mills/kWh</b>
Fixed O&M coal	\$25.51	\$2005/kW
Fixed O&M biomass	\$59.71	\$2005/kW
<b>Additional Fixed O&amp;M Costs for Biomass</b>	<b>\$34.20</b>	<b>\$2005/kW</b>

O&M = operation and maintenance; kW = kilowatt; kWh = kilowatt-hour.

<sup>54</sup> Fossil fuel costs taken from U.S. Department of Energy, Energy Information Administration. *Supplemental Tables to the Annual Energy Outlook 2008*. June 2008. Available at: <http://www.eia.doe.gov/oiaf/aeo/supplement/index.html>.

<sup>55</sup> Taken from the overnight costs in Table 38 of U.S. Department of Energy, Energy Information Administration. "Electricity Market Module." In *Assumptions to the Annual Energy Outlook 2007*. DOE/EIA-0554(2007). Available at: <http://www.eia.doe.gov/oiaf/aeo/assumption/pdf/electricity.pdf>.

<sup>56</sup> Note costs were converted from 2006 dollars to 2005 dollars, assuming a 5% discount rate.

<sup>57</sup> A mill is one-tenth of a penny.

**Table J-4-7. Estimated costs of biomass to energy**

Year	Total Biomass Utilization (MMBtu)	Approximate Cumulative Capacity (MW)	Annualized Capital Costs	Estimated Additional Variable Operational and Maintenance Costs	Estimated Additional Fixed Operational and Maintenance Costs	Total Additional Biomass Fuel Costs	Total Costs (Million 2005\$)
2009	3,043,530	39	\$3,074,985	\$571,438	\$1,331,347	\$5,852,273	\$11
2010	6,275,468	80	\$6,340,325	\$1,178,251	\$2,745,111	\$11,908,406	\$22
2011	9,507,406	122	\$9,605,666	\$1,785,064	\$4,158,874	\$18,052,076	\$34
2012	12,739,344	163	\$12,871,006	\$2,391,877	\$5,572,638	\$24,768,074	\$46
2013	15,971,282	204	\$16,136,346	\$2,998,690	\$6,986,402	\$31,902,340	\$58
2014	19,203,220	246	\$19,401,687	\$3,605,502	\$8,400,165	\$38,975,736	\$70
2015	22,403,756	287	\$22,635,301	\$4,206,420	\$9,800,193	\$46,143,805	\$83
2016	24,644,132	315	\$24,898,831	\$4,627,061	\$10,780,212	\$51,251,068	\$92
2017	26,884,507	344	\$27,162,361	\$5,047,703	\$11,760,231	\$56,447,946	\$100
2018	29,124,883	373	\$29,425,891	\$5,468,345	\$12,740,250	\$61,151,941	\$109
2019	31,365,259	401	\$31,689,421	\$5,888,987	\$13,720,270	\$67,110,547	\$118
2020	33,605,634	430	\$33,952,951	\$6,309,629	\$14,700,289	\$72,240,214	\$127
2021	35,846,010	458	\$36,216,481	\$6,730,271	\$15,680,308	\$77,414,688	\$136
2022	38,086,385	487	\$38,480,012	\$7,150,913	\$16,660,327	\$82,633,970	\$145
2023	40,326,761	516	\$40,743,542	\$7,571,555	\$17,640,347	\$87,494,792	\$153
2024	42,567,137	544	\$43,007,072	\$7,992,197	\$18,620,366	\$92,355,614	\$162
2025	44,807,512	573	\$45,270,602	\$8,412,839	\$19,600,385	\$97,216,436	\$171
<b>Cumulative Costs</b>							<b>\$1,637</b>

MMBtu = million British thermal units; MW = megawatt.

The capital infrastructure life span is assumed to be 30 years, and the interest rate is assumed to be 5%, giving a capital recovery factor of 0.065 (i.e., a \$1 million plant is assumed to cost approximately \$65,000/year over the life of the project).

*Energy From Livestock Manure and Poultry Litter GHG Benefits*

Methane emissions (in MMtCO<sub>2</sub>e) data from the Arkansas I&F were used as the starting point to estimate the GHG benefits of capturing and controlling the volumes of methane targeted by the policy and to include the additional benefit of electricity generation using this captured methane (through offsetting fossil-based generation). The first portion of GHG benefit is obtained through reduced methane emissions through the capture of emissions from manure and poultry litter. An assumed collection efficiency of 75%<sup>58</sup> was applied to methane emissions from manure and poultry litter, which was then multiplied by the assumed policy target, ramping up to achieve 10% collection by 2025.

<sup>58</sup> The collection efficiency is an assumed value based on engineering judgment. No applicable studies were identified that provided information on methane collection efficiencies achieved using manure digesters (as it relates to collection of entire farm-level emissions).

The second portion of the GHG benefit is obtained through the offsetting of fossil-based electricity generation. This was estimated by converting the methane captured in each year to its heat content (in Btus), and then multiplying by an energy recovery factor of 17,100 Btu/kWh to estimate the electricity produced (assumes a 25% efficiency for conversion to electricity in an engine and generator set). The CO<sub>2</sub>e associated with this amount of electricity in each year was estimated by converting the kWh to MWh, and then multiplying this value by the Arkansas-specific emissions. The emissions factor for grid electricity was derived from the Arkansas I&F by dividing total electricity consumption emissions in 2005 by electricity sales in 2005. This provided an electricity emissions factor of 0.592 tCO<sub>2</sub>e/MWh.

The total GHG benefit was estimated as the sum of both portions of the benefits described above and indicated in Table J-4-8.

**Table J-4-8. GHG benefits for energy utilization from livestock manure and poultry litter**

Year	Methane Emissions From Dairy, Swine, and Poultry (MMtCO <sub>2</sub> e)	Policy Utilization Objective	Methane Captured and Utilized Under Policy (MMtCO <sub>2</sub> e)	MMtCH <sub>4</sub>	Methane (MMBtu)	CO <sub>2</sub> e Offset as Electricity (metric tons)	Total Emission Reductions (MMtCO <sub>2</sub> e)
2009	0.247	1%	0.001	0.000	2,733	95	0.001
2010	0.247	1%	0.002	0.000	5,469	189	0.002
2011	0.248	2%	0.003	0.000	8,225	285	0.004
2012	0.248	2%	0.004	0.000	10,996	381	0.005
2013	0.249	3%	0.005	0.000	13,783	477	0.006
2014	0.250	4%	0.007	0.000	16,587	574	0.007
2015	0.251	4%	0.008	0.000	19,409	672	0.008
2016	0.251	5%	0.009	0.000	22,243	770	0.010
2017	0.252	5%	0.010	0.000	25,095	869	0.011
2018	0.253	6%	0.011	0.001	27,966	968	0.012
2019	0.253	6%	0.012	0.001	30,856	1,068	0.013
2020	0.254	7%	0.013	0.001	33,766	1,169	0.015
2021	0.255	8%	0.015	0.001	36,688	1,270	0.016
2022	0.256	8%	0.016	0.001	39,630	1,372	0.017
2023	0.257	9%	0.017	0.001	42,592	1,474	0.018
2024	0.257	9%	0.018	0.001	45,576	1,578	0.020
2025	0.258	10%	0.019	0.001	48,582	1,682	0.021
<b>Total</b>							<b>0.186</b>

MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; MMtCH<sub>4</sub> = million metric tons of methane; MMBtu = million British thermal units.

*Energy From Livestock Manure and Poultry Litter Costs*

The costs for the dairy and swine components were estimated using the NRCS analysis *An Analysis of Energy Production Costs From Anaerobic Digestion Systems on U.S. Livestock*

*Production Facilities.*<sup>59</sup> The production costs were assumed to be \$0.11/kWh for swine anaerobic digesters and \$0.05/kWh for dairy anaerobic digesters.<sup>60</sup> These costs are in 2006 dollars and assume a 30% thermal efficiency. They include annualized capital costs for the digester, generator, and O&M.<sup>61</sup> The assumed costs for the poultry component were taken from Flora and Riahi-Nezhad's *Availability of Poultry Manure as a Potential Bio-Fuel Feedstock for Energy Production* (\$0.103/kWh in 2005 dollars using anaerobic digestion).<sup>62</sup> The value of electricity produced was taken from the all-sector average projected electricity price for the Southeastern Electric Reliability Council from EIA's AEO2008.<sup>63</sup> This price represents the value to the farmer for the electricity produced (to offset on-farm use) and is netted out from the production costs to estimate net costs. Total production costs are presented in Table J-4-9.

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<sup>59</sup> J.C. Beddoes, K.S. Bracmort, R.T. Burns, and W.F. Lazarus. *An Analysis of Energy Production Costs from Anaerobic Digestion Systems on U.S. Livestock Production Facilities*. Technical Note No. 1. Washington, DC: U.S. Department of Agriculture, Natural Resources Conservation Service, October 2007. Available at: [policy.nrcs.usda.gov/TN\\_BIME\\_1\\_a.pdf](http://policy.nrcs.usda.gov/TN_BIME_1_a.pdf).

<sup>60</sup> It was assumed that the technology employed for both swine and dairy anaerobic digesters was covered anaerobic lagoon. Costs were obtained from Table 1 of the NRCS economic analysis cited above.

<sup>61</sup> The economic analysis conducted by Beddoes et al. does not include feedstock and digester effluent transportation costs. It also does not address the economics of centralized digesters where biomass is collected from several farms and then processed in a single unit.

<sup>62</sup> Joseph R.V. Flora and Cyrus Riahi-Nezhad. *Availability of Poultry Manure as a Potential Bio-Fuel Feedstock for Energy Production*. Columbia, SC: University of South Carolina, Department of Civil and Environmental Engineering, August 31, 2006. Available at: [http://www.scbiomass.org/Publications/Poultry Litter Final Report.pdf](http://www.scbiomass.org/Publications/Poultry_Litter_Final_Report.pdf).

<sup>63</sup> U.S. Department of Energy, Energy Information Administration. *Supplemental Tables to the Annual Energy Outlook 2008*. June 2008. Available at: <http://www.eia.doe.gov/oiaf/aeo/supplement/index.html>.

**Table J-4-9. Production costs for dairy, swine, and poultry technologies**

Year	Cost of Dairy Technology (2005\$)	Cost of Swine Technology (2005\$)	Cost of Poultry Technology (2005\$)	Total Costs (2005\$)
2008	-\$210	\$2,480	\$2,400	\$4,671
2009	-\$385	\$4,895	\$4,793	\$9,303
2010	-\$532	\$7,595	\$7,516	\$14,579
2011	-\$645	\$10,544	\$10,549	\$20,448
2012	-\$747	\$13,525	\$13,668	\$26,446
2013	-\$849	\$16,419	\$16,748	\$32,318
2014	-\$947	\$19,273	\$19,839	\$38,165
2015	-\$1,064	\$21,828	\$22,646	\$43,410
2016	-\$1,186	\$24,219	\$25,316	\$48,349
2017	-\$1,302	\$26,581	\$27,998	\$53,278
2018	-\$1,378	\$29,323	\$31,151	\$59,095
2019	-\$1,455	\$31,974	\$34,253	\$64,771
2020	-\$1,512	\$34,814	\$37,603	\$70,906
2021	-\$1,574	\$37,496	\$40,824	\$76,746
2022	-\$1,621	\$40,329	\$44,269	\$82,978
2023	-\$1,689	\$42,762	\$47,304	\$88,377
2024	-\$1,742	\$45,333	\$50,546	\$94,137
<b>Total</b>				<b>\$827,976</b>

*Capture of Waste Heat GHG Benefits*

The amount of biomass being used for electricity production was determined using eGRID (257 MW).<sup>64</sup> This was then converted into MWh and then into MMBtu, based on the amount of biomass feedstock necessary to produce 1 MWh of energy.<sup>65</sup> The amount of usable (waste) heat available from a biomass plant is estimated to be 60% of biomass inputs, so this total MMBtu figure is multiplied by 60% to get the amount of energy that is lost as waste heat.<sup>66</sup> This heat is then captured at an increasing rate across the program, with 10% captured in 2025, as per the policy goal. This heat is assumed to go toward commercial heating, with 92% efficiency in transportation.<sup>67</sup> Assuming that natural gas boilers are 85% efficient,<sup>68</sup> we can determine the

<sup>64</sup> U.S. Environmental Protection Agency. “eGRID 2006 Year 2004 Summary Tables.” April 2007.

<sup>65</sup> U.S. Department of Energy, Energy Information Administration, Office of Energy Statistics. “Electricity Market Module.” In *Assumptions to the Annual Energy Outlook 2007*. DOE/EIA-0554(2007). April 2007. Available at: <http://www.eia.doe.gov/oiaf/aeo/assumption/pdf/electricity.pdf>.

<sup>66</sup> Bioenergy Knowledge Center. “Options for Electricity Production from Biomass.” Available at: [http://www.bkc.co.nz/Portals/0/docs/options\\_for\\_electricity\\_generation\\_from\\_biomass.pdf](http://www.bkc.co.nz/Portals/0/docs/options_for_electricity_generation_from_biomass.pdf).

<sup>67</sup> Hannes Schwaiger and Gerfried Jungmeier. “Overview of CHP plants in Europe and Life Cycle Assessment (LCA) of GHG Emissions for Biomass and Fossil Fuel CHP Systems.” Institute of Energy Research. September 2007. Available at: <http://www.atee.fr/cp/37/6-%2018-09%20SCHWAIGER%20JOANNEUM%20R.pdf>.

<sup>68</sup> U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy. Technology Fact Sheet: “Combined Heat and Power.” Available at: [http://www.ezec.gov/rbs/farbill/Combined Heat and Power.doc](http://www.ezec.gov/rbs/farbill/Combined%20Heat%20and%20Power.doc).

total energy being replaced by the Btus provided to commercial consumers in the form of heat. This figure is then multiplied by the emissions factor for natural gas (0.0531 tCO<sub>2</sub>e/MMBtu), which the heat is replacing.<sup>69</sup> This results in the GHG benefits of combined heat and power (CHP) for each year (Table J-4-10).

**Table J-4-10. GHG benefits of combined heat and power**

Year	Implementation Path	MMBtu Captured in the Program	MMBtu Available for Heating	MMBtu Natural Gas Avoided	MMtCO <sub>2</sub> e Avoided
2009	0%	0	0	0	0.00
2010	0.63%	64,021	58,899	69,293	0.00
2011	1.25%	128,041	117,798	138,586	0.01
2012	1.88%	192,062	176,697	207,879	0.01
2013	2.50%	256,083	235,596	277,172	0.01
2014	3.13%	320,104	294,495	346,465	0.02
2015	3.75%	384,124	353,394	415,758	0.02
2016	4.38%	448,145	412,293	485,051	0.03
2017	5.00%	512,166	471,192	554,344	0.03
2018	5.63%	576,186	530,092	623,637	0.03
2019	6.25%	640,207	588,991	692,930	0.04
2020	6.88%	704,228	647,890	762,223	0.04
2021	7.50%	768,249	706,789	831,516	0.04
2022	8.13%	832,269	765,688	900,809	0.05
2023	8.75%	896,290	824,587	970,102	0.05
2024	9.38%	960,311	883,486	1,039,395	0.06
2025	10.00%	1,024,331	942,385	1,108,688	0.06
<b>Cumulative</b>					<b>0.50</b>

MMBtu = million British thermal units; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent.

### *Capture of Waste Heat Costs*

To determine the costs of installing cogeneration in Arkansas, we first determine the amount of capacity that will need to be modified with CHP. This is then multiplied by the capital costs of installing these modifications (\$1,148/kW).<sup>70</sup> O&M costs of \$1.10/MWh are then multiplied by the total CHP production for the given year, which is then combined with capital costs to get

<sup>69</sup> Arkansas Governor's Commission on Global Warming. "Arkansas Inventory and Forecast." Available at <http://www.arclimatechange.us/ewebeditpro/items/O94F17378.pdf>.

<sup>70</sup> U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy. Technology Fact Sheet: "Combined Heat and Power." Available at: [http://www.ezec.gov/rbs/farbill/Combined Heat and Power.doc](http://www.ezec.gov/rbs/farbill/Combined%20Heat%20and%20Power.doc).

total costs.<sup>71</sup> Cost savings come from the revenue of steam sold to the plant making an investment in CHP. Due to the difficulty of determining a market price for steam heat, this is assumed to be equal to the cost of the natural gas it is replacing.<sup>72</sup> This was determined by multiplying the amount of natural gas avoided by the cost of 1 MMBtu of natural gas. See Table J-4-11 for more details.

**Table J-4-11. Costs and cost savings of CHP**

Year	Necessary CHP To Be installed (MW)	CHP To Be installed That Year (MW)	Cost of CHP Installation	CHP O&M Costs	Revenue From Steam Sales (Assumed To Be Equal to Natural Gas Costs)	Total Cost/Savings
2009	0	0	0	\$0	\$0	\$0
2010	2.68	2.68	\$3,076,879	\$25,826	\$902,483	\$2,200,223
2011	5.36	2.68	\$3,076,879	\$51,653	\$1,804,966	\$1,323,566
2012	8.04	2.68	\$3,076,879	\$77,479	\$2,707,449	\$446,910
2013	10.7	2.68	\$3,076,879	\$103,306	\$3,609,932	-\$429,746
2014	13.4	2.68	\$3,076,879	\$129,132	\$4,512,414	-\$1,306,403
2015	16.1	2.68	\$3,076,879	\$154,959	\$5,414,897	-\$2,183,059
2016	18.8	2.68	\$3,076,879	\$180,785	\$6,317,380	-\$3,059,716
2017	21.4	2.68	\$3,076,879	\$206,612	\$7,219,863	-\$3,936,372
2018	24.1	2.68	\$3,076,879	\$232,438	\$8,122,346	-\$4,813,028
2019	26.8	2.68	\$3,076,879	\$258,265	\$9,024,829	-\$5,689,685
2020	29.5	2.68	\$3,076,879	\$284,091	\$9,927,312	-\$6,566,341
2021	32.2	2.68	\$3,076,879	\$309,918	\$10,829,795	-\$7,442,998
2022	34.8	2.68	\$3,076,879	\$335,744	\$11,732,277	-\$8,319,654
2023	37.5	2.68	\$3,076,879	\$361,571	\$12,634,760	-\$9,196,310
2024	40.2	2.68	\$3,076,879	\$387,397	\$13,537,243	-\$10,072,967
2025	42.9	2.68	\$3,076,879	\$413,224	\$14,439,726	-\$10,949,623
<b>Cumulative Costs</b>						<b>-\$69,995,203</b>

CHP = combined heat and power; MW = megawatts; O&M = operation and maintenance.

**Key Assumptions:**

It is uncertain how willing and able farmers will be to develop on-site projects (i.e., the technical expertise of farmers in energy utilization or electricity production). It is anticipated that it would be difficult to convince poultry farmers to adopt energy generation on site. Off-site cooperative and regional energy-generating facilities may be more viable.

<sup>71</sup> Kim Crossman. “Woody Biomass to CHP—Characteristics, Costs, and Performance of Commercially Available Technologies.” U.S. Environmental Protection Agency, Combined Heat and Power Partnership. October 26, 2007. Available at: <http://www.fpl.fs.fed.us/tmu/2007safconvention/2007safconvention--crossman.ppt>.

<sup>72</sup> U.S. Department of Energy, Energy Information Administration. “Short-Term Energy Outlook.” Table 2: U.S. Energy Nominal Prices.” July 2008. Available at: <http://www.eia.doe.gov/emeu/steo/pub/2tab.pdf>.

In “Poultry Litter to Energy: Technical and Economic Feasibility,”<sup>73</sup> Bock notes that poultry litter is a more challenging fuel than wood for several reasons, including “that the nitrogen content is about 10 times higher in poultry litter than wood. This increases the potential for fuel nitrogen oxide emissions and requires special measures to reduce these emissions. The sulfur content of poultry litter is more than 10 times higher than that of wood. High chloride levels, in conjunction to [sic] high alkali levels, increase the potential for particulate emissions, corrosion problems, and acid gas emissions, and require special measures. Ash levels are much higher in poultry litter than in wood, requiring higher-volume ash-handling equipment and more attention to particulate removal, slagging, and fouling.” These factors indicate that emission control measures may be more elaborate and more expensive on systems utilizing poultry litter compared to other feedstocks.

It is assumed that the biomass plants installing CHP have a market for steam readily available. If steam must be transported long distances, that will reduce both the cost-effectiveness and the environmental benefits of CHP. In addition, many of the costs of CHP installation are from sites dedicated to CHP, rather than sites where generation is already in place and capture of waste heat is being installed.

The costs of CHP mostly come from installing CHP in new biomass power plants, rather than retrofitting currently existing biomass plants to include a CHP component. This could make a significant difference in the cost-effectiveness of CHP.

## Key Uncertainties

The capital costs associated with using biomass as an alternative to fossil-based generation are dependent on many factors, including the end use (i.e., electricity, heat, or steam), the design and size of the system, the technology employed, and the configuration specifications of the system. Each system implemented under this policy would require a detailed analysis (incorporating specific engineering design and costs aspects) to provide a more accurate cost estimate of the system. Similar issues also surround the production of energy from livestock manure and poultry litter.

The fuel mix being replaced by biomass is assumed to be 100% coal. Biomass is assumed to have a reduction of 0.0940 tCO<sub>2</sub>e/MMBtu when replacing coal combustion. Methane utilization is assumed to replace electricity.

The price of biomass as an energy feedstock is relatively uncertain, particularly as the prices for alternative uses change (e.g., food or feed). It is likely that forest products will be cheaper than agricultural residue or energy crops. For all biomass feedstock sources, collection and transportation will represent a significant component of delivered feedstock price.

The analysis assumes that biomass replaces coal. While the generation characteristics of biomass may lend themselves to the replacement of coal, the feedstock price suggests that biomass generation is more likely to be dispatched at the margin, where it is likely to be displacing higher-cost/lower-emission sources, such as natural gas. Displacement of natural gas (rather than

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<sup>73</sup> B.R. Bock. “Poultry Litter to Energy: Technical and Economic Feasibility.” Muscle Shoals, AL: TVA Public Power Institute. TVA Public Power Institute. Available at: <http://www.msenergy.ms/Bock-National Poultry Waste 8-15-00 .pdf>.

coal) will most likely reduce both emission savings and the total cost of implementing the recommendation.

The future price of electricity will affect the analysis.

### **Additional Benefits and Costs**

The expansion of crops as an energy feedstock needs to ensure that the energy crops are grown on appropriate land and in ways that do not damage terrestrial or aquatic resources or displace food and fiber production.

The use of mixed grasslands native to Arkansas as an alternative to switchgrass monocultures can provide additional benefits, such as improved or increased wildlife habitat, and may allow for ecosystems to better adapt to any future impacts of climate change. Additionally, the conversion of wetlands could reduce or remove the contribution that wetlands make to flood control, groundwater replenishment, storm protection, sediment and nutrient retention and export, and wildlife habitat.

### **Feasibility Issues**

Many existing power plants, including biomass plants, are located some distance from population centers so as to avoid concerns of local air pollution. This makes establishing CHP more difficult, because the heat will need to be transported a greater distance.

The feasibility of installing digesters on a small-scale farm is uncertain, and the costs may make this unattractive. Digester facilities tend to require a critical number of animals before the projects are feasible. As such, implementation at the community or cooperative scale may be more feasible and realistic.

### **Status of Group Approval**

Complete.

### **Level of Group Support**

Super Majority (1 objection).

### **Barriers to Consensus**

One member does not believe this recommendation will result in net cost savings.

## AFW-5. Expanded Production and Use of Advanced Biofuels

### Policy Description

This strategy increases production of advanced biofuels from agriculture and/or forestry feedstocks (raw materials) to displace the use of conventional petroleum-based fuels. It promotes the development of emerging biofuel technologies (such as cellulosic ethanol technologies) and biofuel production systems that use renewable fuels to improve the embedded energy content of biofuel. Increased in-state production and consumption result in the highest benefits.

### Policy Design

**Goals:** Increase the production of liquid advanced biofuels in Arkansas, such that by 2025 the state utilizes approximately 10% of available biomass supply per year to produce advanced biofuels with significantly lower embedded GHG emissions compared to conventional fuel products (from a life-cycle perspective).

**Timing:** The above goal identifies a time frame to achieve the final utilization goal. However, the Governor’s Commission on Global Warming (GCGW) has suggested that the Agriculture, Forestry, and Waste Management (AFW) TWG investigate the level of development of relevant biofuel technologies. Using this information, the AFW TWG should determine an appropriate commercialization pathway for Arkansas, including identifying when the technology will most likely become commercially available.

**Parties Involved:** Agriculture land owners, forest owners and managers, biofuel producers and large fuel distributors, retailers, and users.

**Other:** The intent of this recommendation is to focus on non-food biomass resources.

According to the U.S. Energy Independence and Security Act of 2007, advanced biofuel “means renewable fuel, other than ethanol derived from corn starch, that has lifecycle greenhouse gas emissions, as determined by the Administrator, after notice and opportunity for comment, that are at least 50 percent less than baseline lifecycle greenhouse gas emissions.”<sup>74</sup> The bill stipulates that “the types of fuels eligible for consideration as ‘advanced biofuel’ may include any of the following:

“(I) Ethanol derived from cellulose, hemicellulose, or lignin.

“(II) Ethanol derived from sugar or starch (other than corn starch).

“(III) Ethanol derived from waste material, including crop residue, other vegetative waste material, animal waste, and food waste and yard waste.

“(IV) Biomass-based diesel.

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<sup>74</sup> See Section 201—Definitions. The text of the bill is available from the Library of Congress—Thomas, at <http://thomas.loc.gov/home/c110query.html>, by searching for “Energy Independence and Security Act of 2007.”

“(V) Biogas (including landfill gas and sewage waste treatment gas) produced through the conversion of organic matter from renewable biomass.

“(VI) Butanol or other alcohols produced through the conversion of organic matter from renewable biomass.

“(VII) Other fuel derived from cellulosic biomass.”<sup>75</sup>

## Implementation Mechanisms

- Incorporate a low-carbon index for biofuels production, along with feedstock sustainability standards.
- Create efficiency incentives for ethanol facilities to upgrade their equipment to consume less heat and power
- Implement a life-cycle certification/labeling process for low-carbon fuels.

## Related Policies/Programs in Place

### Alternative Fuels Development Program

*Act 873 (HB 1379)*: The act creates the Arkansas Alternative Fuels Development Program, to be administered by the Arkansas Agriculture Department, with the purpose of providing grant incentives for alternative fuel producers and distributors, and feedstock processors. The act also creates the Arkansas Alternative Fuels Development Fund, and repeals obsolete sections of the Arkansas Code related to alternative fuels.

## Type(s) of GHG Reductions

**CO<sub>2</sub>**: Life-cycle emissions are reduced to the extent that biofuels are produced with lower embedded fossil-based carbon than conventional (fossil) fuel. Feedstocks used for producing biofuels can be made from crops or other biomass that contain carbon sequestered during photosynthesis (e.g., biogenic or short-term carbon).

## Estimated GHG Reductions and Costs or Cost Savings

**GHG Reduction Potential in 2015, 2025 (MMtCO<sub>2</sub>e)**: 1.4 and 2.2, respectively.

**Net Cost per tCO<sub>2</sub>e**: \$6.

**Data Sources**: “Arkansas Biomass Resource Assessment” from the Arkansas Economic Development Commission,<sup>76</sup> as summarized in “Table 1—Biomass Supply Assessment” at the front of this document; other sources as cited in the text.

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<sup>75</sup> Ibid.

<sup>76</sup> Arkansas Economic Development Commission. *Arkansas Biomass Resource Assessment*. Annual Biomass Supply. Available at: [http://arkansasedc.com/business\\_development/energy/?page=bioenergy](http://arkansasedc.com/business_development/energy/?page=bioenergy).

## Quantification Methods:

### *Biofuel GHG Reductions*

For this policy recommendation, several different technologies can be used to meet the policy goal, including cellulosic ethanol, pyrolysis, Fischer-Tropsch esterification, and others. The GHG reduction as well as the cost will depend on the feedstock and conversion technology used. For the purpose of quantification, it is assumed that cellulosic ethanol production via fermentation will be used to meet the policy goal. An example of an additional feedstock type that could be used to meet the goal is producing biodiesel from algae.

For cellulosic ethanol, the benefits for this recommendation are dependent on developing in-state production capacity that achieves benefits beyond petroleum fuels.

The incremental benefit of cellulosic production targeted by this policy over gasoline is 9.79 tCO<sub>2e</sub> reduced/1,000 gal. The emission factor value is based on the difference between the life-cycle CO<sub>2e</sub> emission factor of gasoline (10.30 t/1,000 gal)<sup>77</sup> and the life-cycle CO<sub>2e</sub> emission factor of cellulosic ethanol (1.38 t/1,000 gal).<sup>78</sup> Emission factors for gasoline and cellulosic ethanol are based on the Argonne National Laboratory GREET model.<sup>79</sup> The cellulosic benefit value will be used along with the production in each year to estimate GHG reductions.

Table J-5-1 shows the number of cellulosic plants that will need to go on line in Arkansas to achieve the goal of using 10% of biomass available in Arkansas (2.19 million short tons) annually by 2025, according to the *Arkansas Biomass Resource Assessment*.<sup>80</sup> Annual cellulose production is multiplied by the estimated ethanol yield per ton of biomass, based on the projection that ethanol yield will increase from 70 gal/ton biomass to 90 gal/ton biomass by 2012 and to 100 gal/ton biomass by 2020, as shown in Table J-5-1.<sup>81</sup> This analysis is primarily based on a report from the National Renewable Energy Laboratory (NREL) regarding the capital costs of building a 69.3-million gal/year cellulosic ethanol plant that uses corn stover as the feedstock.<sup>82</sup> The emission reductions from this plant are calculated by multiplying the number of gallons produced in a given year by the emission reductions per gallon (9.79 tCO<sub>2e</sub>/1,000 gal).

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<sup>77</sup> Argonne National Laboratory. GREET model 1.8b emission factor for 50% conventional gasoline, 50% reformulated gasoline blend in g/mi x GREET model average fuel economy (100 mi/4.7 gal). Available at: <http://www.transportation.anl.gov/software/GREET/>.

<sup>78</sup> Argonne National Laboratory. GREET model 1.8b emission factor for mixed feedstock cellulosic E100 for flex-fuel vehicle in g/mi x GREET model average fuel economy (100 mi/4.7 gal). Available at: <http://www.transportation.anl.gov/software/GREET/>.

<sup>79</sup> Downloadable from <http://www.transportation.anl.gov/software/GREET/>.

<sup>80</sup> Arkansas Economic Development Commission. *Arkansas Biomass Resource Assessment*. Annual Biomass Supply. Available at: [http://arkansasedc.com/business\\_development/energy/?page=bioenergy](http://arkansasedc.com/business_development/energy/?page=bioenergy).

<sup>81</sup> Personal communication between J. Ashworth (National Renewable Energy Laboratory) and Steve. Roe (Center for Climate Strategies) April 2007.

<sup>82</sup> A. Aden et al. *Lignocellulosic Biomass to Ethanol Process Design and Economics Utilizing Co-Current Dilute Acid Prehydrolysis and Enzymatic Hydrolysis for Corn Stover*. NREL/TP-510-32438. Golden, CO: National Renewable Energy Laboratory, June 2002. Accessed June 2008 at: <http://www.nrel.gov/docs/fy02osti/32438.pdf>.

**Table J-5-1. Annual biomass utilization and cellulosic ethanol production**

Year	Biomass Feedstock Production (million short dry tons)	Ethanol Yield From Cellulosic Feedstock (gal/ton biomass)	Cellulosic Ethanol Production (million gal)	Avoided Emissions Compared to Gasoline (MMtCO <sub>2</sub> e reduction)
2009	0.0	70	—	—
2010	1.0	70	69	0.68
2011	1.0	70	69	0.68
2012	0.8	90	69	0.68
2013	0.8	90	69	0.68
2014	0.8	90	69	0.68
2015	1.5	90	139	1.35
2016	1.5	90	139	1.35
2017	1.5	90	139	1.35
2018	1.5	90	139	1.35
2019	1.5	90	139	1.35
2020	1.4	100	139	1.35
2021	1.4	100	139	1.35
2022	1.4	100	139	1.35
2023	1.4	100	139	1.35
2024	2.1	100	208	2.03
2025	2.2	100	221	2.15

gal/ton = gallons per metric ton; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent.

### *Biofuel Costs*

The costs of this recommendation are estimated based on the capital and operating costs of cellulosic ethanol production plants. An NREL study estimated total capital costs for a 70-million gal/year cellulosic ethanol plant would be \$200 million.<sup>83</sup> An EIA study cited a major biofuels manufacturer who estimated the costs of a first-of-its-kind 50-million gal/year cellulosic ethanol plant to be \$375 million.<sup>84</sup> An average of these costs was used in our estimate of capital costs. A new plant will need to be built for every 70 million gallons of annual ethanol production needed. It was assumed that the capital costs will be paid according to a cost recovery factor over the 20-year lifetime of the plant. O&M costs were also taken from the NREL study. The cost of biomass feedstocks made up a significant portion (~60%) of variable costs. Therefore, we replaced the NREL estimate of feedstock costs (\$30/ton) with a more current estimate of the cost of delivered biomass (\$74/ton).<sup>85</sup> The plant proposed by the NREL study produces some excess

<sup>83</sup> Ibid.

<sup>84</sup> U.S. Department of Energy, Energy Information Administration. “Biofuels in the U.S. Transportation Sector.” February 2007. Available at: <http://www.eia.doe.gov/oiaf/analysispaper/biomass.html>.

<sup>85</sup> William Edwards. “Estimating a Value for Corn Stover.” Ag Decision maker File A1-70. Iowa State University Extension. December 2007. Available at: [http://www.corrim.org/factsheets/fs\\_04/index.asp](http://www.corrim.org/factsheets/fs_04/index.asp). Additional transportation costs of \$14.75 were assumed, taken from Michael Duffy. “Estimated Costs for Production, Storage and Transportation of Switchgrass.” Iowa State University, University Extension. December 2007. Available at:

electricity that is sold back to the grid by the plant. Another revenue source for the ethanol plant is the value of the ethanol produced. The wholesale price of ethanol was taken from AEO2008, and is multiplied by the number of gallons produced annually.<sup>86</sup> Table J-5-2 outlines the estimated cost and revenue streams for the policy. The analysis shows a profit being made in the production of ethanol for several years in the policy period. This is primarily due to the increasing price of ethanol predicted. The total cost of the policy for 2008–2025 is estimated to be \$114 million.

**Table J-5-2. Capital costs of constructing cellulosic ethanol plants**

Year	Million Gallons of Ethanol Produced	Sale Price per Gallon of Ethanol (2005\$)	Annual Operating Costs (\$MM)	Annualized Capital Costs (\$MM)	Annual Revenue (\$MM)	Net Costs/Revenue (discounted million 2005\$)
2009	—	\$1.91	—	—	—	—
2010	69	\$1.72	\$102	\$31.0	\$126	\$5.49
2011	69	\$1.95	\$102	\$31.0	\$141	-\$6.61
2012	69	\$1.96	\$102	\$31.0	\$142	-\$6.56
2013	69	\$1.59	\$102	\$31.0	\$117	\$10.82
2014	69	\$1.68	\$102	\$31.0	\$122	\$ 6.57
2015	139	\$1.63	\$ 203	\$61.9	\$239	\$16.25
2016	139	\$1.62	\$203	\$61.9	\$237	\$16.45
2017	139	\$1.60	\$203	\$61.9	\$235	\$16.93
2018	139	\$1.61	\$203	\$61.9	\$236	\$15.51
2019	139	\$1.83	\$203	\$61.9	\$267	-\$0.85
2020	139	\$1.91	\$203	\$61.9	\$278	-\$5.90
2021	139	\$1.81	\$203	\$61.9	\$264	\$ 0.55
2022	139	\$1.83	\$203	\$61.9	\$266	-\$0.48
2023	139	\$1.74	\$203	\$61.9	\$254	\$4.80
2024	208	\$1.59	\$305	\$92.9	\$349	\$19.46
2025	219	\$1.57	\$324	\$98.6	\$366	\$21.27

\$MM = millions of dollars.

**Key Assumptions:** Advanced biofuel production is assumed to ramp up linearly from zero production in 2008, to full implementation of the policy goal by 2025.

For the purpose of initial quantification, it is assumed that cellulosic ethanol production via fermentation will be used to meet the policy goal. This quantification may be updated, however, as other technologies are considered.

<https://www.extension.iastate.edu/store/ItemDetail.aspx?ProductID=12708&SeriesCode=&CategoryID=23&Keyword=>

<sup>86</sup> U.S. Department of Energy, Energy Information Administration. *Annual Energy Outlook 2008: With Projections to 2030*. IDOE/EIA-0383(2008). Reference Case Table 12—Petroleum Product Prices. Washington, DC, June 2008. Available at: <http://www.eia.doe.gov/oiaf/aeo/pdf/tables.pdf>.

## Key Uncertainties

The cost competitiveness of biofuels will depend on the cost of oil.

Algae may be able to serve as a sustainable feedstock; it is unknown how much of this feedstock will be cultivated in Arkansas.

*Carbon Emissions From Land-Use Change:* Recent publications, such as Searchinger et al. 2008,<sup>87</sup> have attempted to estimate the carbon emissions that result from land use being converted to cropland to grow crops for fuel. This is based on the argument that the conversion of current cropland from food/feed/fiber production in one part of the world will drop the food/feed/fiber supply on the market and drive grassland or forest conversion to cropland in other parts of the world. There is still significant uncertainty regarding the value of carbon emissions due to land-use change. Additionally, conversion of cropland to fuel production may have impacts on food prices and supply.

*Cost of Cellulosic Ethanol Production:* EIA has stated: “Capital costs for a first-of-a-kind cellulosic ethanol plant with a capacity of 50 million gallons per year are estimated by one leading producer to be \$375 million (2005 dollars), as compared with \$67 million for a corn-based plant of similar size, and investment risk is high for a large-scale cellulosic ethanol production facility. Other studies have provided lower cost estimates. A detailed study by the National Renewable Energy Laboratory in 2002 estimated total capital costs for a cellulosic ethanol plant with a capacity of 69.3 million gallons per year at \$200 million.”<sup>88</sup>

In June 2006, the U.S. Senate was told that the current cost of producing cellulosic ethanol is U.S. \$2.25/U.S. gal. This is primarily due to the current poor conversion efficiency. At that price, it would cost about \$120 to substitute a barrel of oil (42 gal), taking into account the lower energy content of ethanol. However, DOE is optimistic and has requested a doubling of research funding. The same Senate hearing was told that the research target was to reduce the cost of production to U.S. \$1.07/U.S. gal by 2012.

## Additional Benefits and Costs

There is potential for the cultivation of biomass resources to compete with the production of food. For example, land that could be cultivated for food crops might be converted to energy crop production. Additionally, some feedstocks, such as oilseeds, could be diverted from food to fuel production. The intent of this policy is to focus on nonfood feedstocks. Analysis provided by DOE Secretary Bodman and USDA Secretary Schafer suggests that the impact of biofuels on food prices and demand is minimal.<sup>89</sup> They state that:

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<sup>87</sup> T. Searchinger, Heimlich, R., Houghton, R.A., Dong, F., Elobeid, A., Fabiosa, J., Tokgoz, S., Hayes, D., Yu T-H. “Use of U.S. Croplands for Biofuels Increases Greenhouse Gases Through Emissions From Land Use Change.” *Science* February 2008;319(5867):1238-1240. Available at: <http://www.sciencemag.org/cgi/content/abstract/1151861>.

<sup>88</sup> U.S. Department of Energy, Energy Information Administration. “Biofuels in the U.S. Transportation Sector.” February 2007. Available at: <http://www.eia.doe.gov/oiaf/analysispaper/biomass.html>.

<sup>89</sup> Letter from Secretaries Bodman and Schafer to Senator Jeff Bingaman, dated June 11, 2008.

“In 2007, the expansion in ethanol and biodiesel consumption is estimated to have increased the Consumer Price Index (CPI) for all food by 0.10–0.15 percentage point. In other words, ethanol and biodiesel consumption accounted for approximately 3–4 percent of the overall rise in retail food prices.

“Increased demand for biofuel feedstocks has benefited corn and soybean producers. Higher prices have encouraged production increases and some switching of acreage from soybeans to corn. More dried distiller grains are available for feed, but higher grain prices are also prompting adjustments by livestock producers. In future years, production adjustments by livestock and dairy producers in response to higher feed costs resulting from the expansion in ethanol and biodiesel consumption could add a total of 0.6–0.7 percentage point to the CPI for all food.

“Commodities prices, both agricultural and nonagricultural, have risen sharply in recent years for a number of reasons unrelated to biofuels development. For agricultural commodities, higher incomes, population growth, and depreciation of the dollar are increasing the demand for food; drought and dry weather have lowered production and reduced stocks; and some countries have imposed export restrictions. All these factors contribute to higher commodity prices. In addition, record prices for gasoline and diesel fuel are increasing the costs of producing, transporting, and processing food products.”<sup>90</sup>

*Other Benefits and Costs:* Cellulosic ethanol could have less of an impact than corn ethanol on water quality and could actually reduce nutrient loads in some circumstances; could provide permanent new sources of income for farmers and foresters; could use current waste streams to replace U.S. fuel consumption; could result in environmental benefits or costs; could provide recycling money in local economies; could stimulate potential markets for other biomass feedstocks (forest treatment biomass, municipal solid waste fiber); could increase transportation energy security with shorter transport distances and on-farm use of fuel produced; and could reduce reliance on imported petroleum.

### **Feasibility Issues**

Implementation of this recommendation requires additional research and development in cellulosic ethanol production methods, development of feedstock collection and delivery infrastructure, and successful negotiations with cellulosic technology leaders to establish pilot- and commercial-scale plants in the state. Sourcing of feedstocks and the size and location of facilities (both crushing and biodiesel production) must be addressed for optimization and planning. Trade-offs between food and fuel crops will be an important issue.

There may be an overlap among agricultural recommendations that seek to increase/maintain crop acreage in no-till production or in conservation management programs. This could be in conflict with the higher levels of crop production proposed in this recommendation.

### **Status of Group Approval**

Complete.

### **Level of Group Support**

Unanimous.

### **Barriers to Consensus**

Not applicable.

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<sup>90</sup> Ibid.

## AFW-6. Expanded Use of Locally Produced Farm and Forest Products

### Policy Description

The production and consumption of locally produced agricultural goods displace the consumption of goods transported from other states or countries, and thus reduce transportation-related GHG emissions. Increasing the amount of renewable wood products used for residential and commercial buildings can increase carbon sequestration in wood products and displace GHG emissions associated with processing high-energy input materials, such as steel, plastic, and concrete. Also, using locally grown wood can lower transportation-associated GHG emissions.

### Policy Design

This policy recommendation places responsibility on local governments to be part of the solution by ensuring that zoning does not preclude intelligent, sustainable uses that support this objective, such as constraining local value-added mills or limiting the location of or participation in local markets.

#### Goals:

- *Local Produce*—By 2025, of the food Arkansans consume, 30% will consist of locally<sup>91</sup> grown produce and fish, meats, and poultry.
- *Locally Grown and Processed Wood Products*—
  - Increase the use of wood as a building product to displace products with higher embodied energy, such as concrete and steel.
  - Displace the amount of imported wood products with locally grown and processed products by 15% by 2015 and 30% by 2025.

**Timing:** As described above.

**Parties Involved:** University of Arkansas System, Extension, USDA.

**Other:** A “wood product” includes composite lumber and products with recycled content.

### Implementation Mechanisms

To achieve the local produce goal, a number of actions could and should be taken within Arkansas, including the continued promotion of farmers’ markets in the state, an enhanced information and research program, and a re-evaluation of the most appropriate land use within Arkansas. Each of these is outlined below:

- *Farmers’ Markets*—Increase the number of local farmers’ markets in Arkansas from 54 to 65 (or 20% increase) by 2025, thereby increasing market access to locally and regionally grown fresh produce and fish, meats, and poultry products.

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<sup>91</sup> There is currently no universally accepted definition of “locally grown.” For the purposes of the local produce goal, a distance of less than 100–150 miles is considered to be local.

- *Information*—By 2010, the state, in coordination with the University of Arkansas System, Extension, USDA, and others, will collect and analyze data on the number of acres in Arkansas converted to local food production systems, and, to the extent practical, evaluate the positive economic and environmental impacts on Arkansas farmers, communities, and the state as a whole.
- *Land Use*—By 2025, convert 10% of existing Arkansas agricultural land to locally based food systems, and convert another 5% of rural and urban nonagricultural land to gardens, saving emissions from reduced petroleum-based transportation, packaging, refrigeration, marketing, and production costs.

In addition there is the potential for the extension of programs, such as farmers' markets, farm to school, community-supported agriculture share programs, 4-H Youth Development, community gardens, extension programs, and home gardening. Incentives could also be provided for buying products made from recycled materials.

### **Related Policies/Programs in Place**

*Energy and Natural Resource Conservation Act*—The act encourages the use of wood in green buildings and requires certain state buildings to meet specified environmental construction standards (AR Code 22-3-1801). The Leadership in Energy and Environmental Design Green Building Rating System™ (LEED) was reformed in Arkansas to explicitly encourage the use of wood products in green buildings. (Previously it was eligible, but not encouraged.) Initiated by the Arkansas legislature and subsequently adopted by a number of other states, this reform specifically includes the use of products that promote the sequestration of carbon.

Increasing the number of farmers' markets in the state, as well as encouraging existing ones to grow, are major goals for the Arkansas Agriculture Department. The Agriculture Department has an ongoing program financed by block grants from USDA. Participants in the program total 54 markets, some of which are relatively small. The Agriculture Department has organized an Arkansas Farmers' Market Association, which has 32 members, mostly representing the larger markets. Encouraging multi-county regional markets in some locations, such as Hot Springs, provides a greater opportunity for a larger variety of home-grown products over a longer period of time.

### **Type(s) of GHG Reductions**

**CO<sub>2</sub>:** Extends carbon sequestration in durable wood products and wood construction. Maintains carbon sequestration in healthy forests. Avoids emissions through reduced transportation miles, refrigeration, and use of high-energy-input construction materials.

### **Estimated GHG Reductions and Costs or Cost Savings**

**GHG Reduction Potential in 2015, 2025 (MMtCO<sub>2</sub>e):** 0.03 and 0.06, respectively.

**Net Cost per tCO<sub>2</sub>e:** \$4.

**Data Sources:** Estimates of harvested acres were taken from the National Agricultural Statistics Service agricultural census publication for Arkansas.<sup>92</sup> Crop yields were provided by Craig R. Andersen, Extension Horticulture Specialist–Vegetables, Department of Horticulture, University of Arkansas U.S. per capita consumption rates were obtained from the USDA Economic Research Service Food Consumption (Per Capita) Data System.<sup>93</sup> Arkansas population data were obtained from the Center for Climate Strategies AR I&F.

### **Quantification Methods:**

#### *Local Produce*

The amount of each crop produced in Arkansas was estimated using harvested acres and estimates of crop yields per acre. The amount of each crop consumed in Arkansas was estimated using U.S. per capita consumption rates and the Arkansas population.

The amount consumed for each crop was then subtracted from the amount produced to determine how much of the crop was imported. For each imported crop, a likely state of origin was assumed. The estimated amount of imports for each crop and the estimated round-trip mileage were used to estimate ton-miles transported and CO<sub>2</sub> emissions.

Transportation emissions were estimated by assuming 23 tons of payload per truck, 6 truck-miles per gallon of diesel fuel, and 22.4 pounds (lb) of CO<sub>2</sub> per gallon of diesel fuel. To estimate miles traveled, food from California was assumed to travel from Fresno, California, to Little Rock (~1,700 miles). These mileage estimates were then doubled, since it was assumed that each truck would return to its point of origin empty. The amount of food produced and exported is assumed to remain constant, while consumption is assumed to grow with population. The GHG benefits were estimated by reducing the imported food and increasing consumption of locally produced food by the proportion described by the policy goal, ramping up to achieve 30% local consumption by 2025.

Costs were based on the estimated need for one additional full-time-equivalent (FTE) employee employed by the state (e.g., Arkansas Agriculture Department) to implement the elements of this policy. The total cost for this additional FTE is \$75,000, escalated using a salary escalation rate of 4% per year. Some of the elements of this policy could be incorporated into existing programs, but it is assumed that program costs of \$100,000 (at an escalation rate of 4%) are required to implement a buy-local program.<sup>94</sup> These funds could be used to stimulate local programs, such as the establishment of an Arkansas buy-local brand, education programs for growers in food safety and agriculture handling, the promotion of farmers markets, or additional labor to produce local products.

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<sup>92</sup> U.S. Department of Agriculture, National Agricultural Statistics Service. “Arkansas State and County Data.” Volume 1, Geographic Area Series, Part 4. AC-02-A-4. 1997. *2002 Census of Agriculture*. June 2004. Available at: <http://www.nass.usda.gov/census/census02/volume1/ar/ARVolume104.pdf>.

<sup>93</sup> U.S. Department of Agriculture, Economic Research Service. Data Sets. Food Availability: Spreadsheets. Food Consumption (Per Capita) Data System. Available at: <http://www.ers.usda.gov/Data/FoodConsumption/FoodAvailSpreadsheets.htm>.

<sup>94</sup> Program costs are based on existing specialty crop block grants, which are approximately \$100,000 per year. The continuation of such grants is unknown. Personal communications with Tim Ellison, Arkansas State Plant Board, on July 25, 2008.

The policy results are summarized in Table J-6-1.

**Table J-6-1. Benefits of locally produced food**

Year	Policy Goal (%)	Emission Savings (MMtCO <sub>2</sub> e)	Program Costs	Staffing Costs	Discounted Costs
2009	2%	0.003	\$100,000	\$75,000	\$143,973
2010	4%	0.007	\$104,000	\$78,000	\$142,602
2011	5%	0.010	\$108,160	\$81,120	\$141,244
2012	7%	0.014	\$112,486	\$84,365	\$139,898
2013	9%	0.017	\$116,986	\$87,739	\$138,566
2014	11%	0.020	\$121,665	\$91,249	\$137,246
2015	12%	0.024	\$126,532	\$94,899	\$135,939
2016	14%	0.027	\$131,593	\$98,695	\$134,645
2017	16%	0.031	\$136,857	\$102,643	\$133,362
2018	18%	0.034	\$142,331	\$106,748	\$132,092
2019	19%	0.037	\$148,024	\$111,018	\$130,834
2020	21%	0.041	\$153,945	\$115,459	\$129,588
2021	23%	0.044	\$160,103	\$120,077	\$128,354
2022	25%	0.048	\$166,507	\$124,881	\$127,132
2023	26%	0.051	\$173,168	\$129,876	\$125,921
2024	28%	0.054	\$180,094	\$135,071	\$124,722
2025	30%	0.058	\$187,298	\$140,474	\$123,534
<b>Cumulative Total</b>		<b>0.520</b>			<b>\$2,269,652</b>

MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent.

#### *Locally Grown and Processed Wood Products*

The science is very clear and compelling that wood products contain much less embodied energy than other building materials and, unlike other building materials, function as long-term sequesters of carbon. Additionally, wood products sourced locally have additional energy and carbon advantages compared to products transported from distant sources.

For example, a lumber framed wall or floor system requires just 40% of the fossil fuel energy needed to manufacture a concrete wall or floor system and only 20% of the fossil fuel energy need to manufacture a steel wall or floor (Boyer et al., 2008). Table J-6-2 displays the fossil fuel consumption needed to manufacture wall assemblies of wood and steel in a typical cold-climate setting. Selecting the lumber wall instead of the steel wall achieves a 24% reduction in fossil fuel consumption per square foot. Table J-6-3 displays a similar comparison between wood and concrete in a typical warm-climate setting. If the lumber wall design is selected instead of the concrete wall, fossil fuel consumption is reduced by 60%. Table J-6-4 shows that selecting a dimension wood joist floor instead of a concrete slab or steel joist floor system results in respective reductions in fossil fuel consumption of 60% and 79%.

**Table J-6-2. Energy consumed by three exterior wall designs in a cold-climate home<sup>95</sup>**

Fuel Consumption Factors	Lumber Wall (MJ/ft <sup>2</sup> )	Steel Wall (MJ/ft <sup>2</sup> )
Structural <sup>96</sup>	9.54	15.22
Insulation <sup>97</sup>	12.63	21.02
Covering <sup>98</sup>	22.42	22.42
<b>Total<sup>99</sup></b>	<b>44.59</b>	<b>58.66</b>

Note: 1 megajoule (MJ) is equivalent to 0.28 kilowatt-hours or 947.8 British thermal units.

**Table J-6-3. Total consumption of fossil fuels associated with two exterior wall designs in a warm-climate home<sup>100</sup>**

Fuel Consumption Factors	Lumber Wall (MJ/ft <sup>2</sup> )	Concrete Wall (MJ/ft <sup>2</sup> )
Structural	6.27	75.89
Insulation	8.51	8.51
Cladding	22.31	8.09
<b>Total</b>	<b>37.09</b>	<b>92.49</b>

Note: 1 megajoule (MJ) is equivalent to 0.28 kilowatt-hours or 947.8 British thermal units.

**Table J-6-4. Consumption of fossil fuels associated with three floor designs<sup>101</sup>**

Floor Design	Fossil Fuel Consumption (MJ/ft <sup>2</sup> )
Dimension wood joist floor	9.93
Concrete slab floor	24.75
Steel joist floor	48.32

Note: 1 megajoule (MJ) is equivalent to 0.28 kilowatt-hours or 947.8 British thermal units.

<sup>95</sup> L. Edmonds and B. Lippke. "Reducing Environmental Consequences of Residential Construction Through Product Selection and Design." Fact Sheet #4. Consortium for Research on Renewable Industrial Materials. September 2004. Available at: [http://www.corrim.org/factsheets/fs\\_04/index.asp](http://www.corrim.org/factsheets/fs_04/index.asp).

<sup>96</sup> Includes studs and plywood sheathing.

<sup>97</sup> Includes fiberglass (lumber wall and steel wall designs), extruded polystyrene (steel wall design only), and insulation created with recycled paper products (lumber wall with substitutes). All three designs include a 6-mil polyethylene vapor barrier.

<sup>98</sup> Includes interior and exterior wall coverings. Exterior wall coverings for lumber wall and steel wall are vinyl cladding and interior wall coverings are gypsum.

<sup>99</sup> Includes subtotals from Structural, Insulation, and Covering categories.

<sup>100</sup> L. Edmonds and B. Lippke. "Reducing Environmental Consequences of Residential Construction Through Product Selection and Design." Fact Sheet #4. Consortium for Research on Renewable Industrial Materials. September 2004. Available at: [http://www.corrim.org/factsheets/fs\\_04/index.asp](http://www.corrim.org/factsheets/fs_04/index.asp).

<sup>101</sup> Excludes any consideration of insulation.

Manufacturing a ton of concrete and a ton of steel produces net carbon emissions of 265 kgC/t and 220 kgC/t, respectively, compared to just 33 kgC/t for framing lumber (Table J-6-5). However, wood is 50% carbon by content, so the net carbon emissions for manufacturing a ton of framing lumber are actually -457 kgC/t when the carbon stored in the product is included (Boyer et al.<sup>102</sup>).

**Table J-6-5. Net carbon emissions in producing a ton of various materials**

Material	Net Carbon Emissions (kgC/t) <sup>103</sup>	Net Carbon Emissions, Including Carbon Storage Within Material (kgC/t) <sup>104</sup>
Framing lumber	33	-457
Medium-density fiberboard (virgin fiber)	60	-382
Brick	88	88
Glass	154	154
Recycled steel (100% from scrap)	220	220
Concrete	265	265
Concrete block <sup>105</sup>	291	291
Recycled aluminum (100% recycled content)	309	309
Steel (virgin)	694	694
Plastic	2,502	2,502
Aluminum (virgin)	4,532	4,532

kgC/t = kilograms of carbon per metric ton.

Source: Boyer et al. 2008.

The data also indicate that actively managed forests sequester more carbon and thus play an important role in offsetting GHG emissions. Because wood products store carbon, and because actively managed forest stands with periodic harvests sequester carbon at an increased rate relative to unmanaged stands, more carbon is sequestered over time when periodic harvests occur and wood products are produced and utilized (Perez-Garcia et al.<sup>106</sup>).

<sup>102</sup> J. Boyer, S. Bratkovich, A. Lindburg, and K. Fernholz. *Wood Products and Carbon Protocols: Carbon Storage and Low Energy Intensity Should Be Considered*. Dovetail Partners, Inc. April 28, 2008. . Available at: <http://www.dovetailinc.org/reportView.php?action=displayReport&reportID=92>.

<sup>103</sup> Values are based on life-cycle assessment and include gathering and processing of raw materials, primary and secondary processing, and transportation.

<sup>104</sup> A carbon content of 49% is assumed for wood.

<sup>105</sup> Derived based on EPA value for concrete and consideration of additional steps involved in making blocks.

<sup>106</sup> J. Perez-Garcia, B. Lippke, J. Connick, and C. Manriquez. "An Assessment of Carbon Pools, Storage, and Wood Products Market Substitution Using Life-Cycle Analysis Results." *Wood and Fiber Science* 2005;37:140-148. Corrim Special Issue. Available at: <http://www.corrim.org/reports/2005/swst/140.pdf>.

AFW-7 includes an analysis that incorporates the sequestration benefits from actively managed forests, including the benefits associated with harvested wood products.

### **Key Assumptions:**

- The amount of each crop consumed in Arkansas was estimated using U.S. per capita consumption rates and the Arkansas population.
- Transportation emissions were estimated by assuming 23 tons of payload per truck, 6 truck-miles/gal of diesel fuel, and 22.4 lb of CO<sub>2</sub>/gal of diesel fuel.

### **Key Uncertainties**

One uncertainty is the amount of food products leaving the state. State export/import data were not available. As such, the above analysis does not include state-to-state exports.

Also, this analysis does not take into account the portion of some crops that may be shipped out of Arkansas when they are in season, and imported into the state when they are not in season. The benefits were quantified at the state level. As such, they do not capture additional GHG benefits where local (e.g., community-level) production and consumption take place (resulting in addition ton-mile reductions). The quantified benefits could also be conservatively low, since the assumptions for out-of-state-produce were based on California as the likely producer state. Many commodities come from farther away (including foreign countries) and can travel by more energy-intensive methods (e.g., air transport). Further, the assumed transport routes are a single trip from the city of origin to Little Rock. Many commodities will make several trips prior to reaching their final point of consumption (for packaging, storage, processing, etc.).

This analysis only incorporates emission reductions due to reduced transportation. Other environmental and economic benefits associated with localizing packaging, refrigeration, storage, and processing are not included. The overall impact of all of the assumptions is that the benefits are likely to be underestimated.

It is assumed that the fuel savings accrued through reduced ton-miles offset the likely increase in production costs associated with more localized food production. While the exact interaction of these competing economic factors is uncertain, locally produced and consumed food products will become more cost-effective as fuel costs increase.

### **Additional Benefits and Costs**

None identified.

### **Feasibility Issues**

None identified.

### **Status of Group Approval**

Complete.

### **Level of Group Support**

Unanimous.

### **Barriers to Consensus**

Not applicable.

## AFW-7. Forest Management and Establishment for Carbon Sequestration

### Policy Description

Arkansas is blessed with abundant and expanding forests—approximately 18.52 million acres, mostly in private ownership, covering 54% of the state. Arkansas’ forests and forest management have a significant role to play in the state’s strategies to reduce or offset GHGs and adapt to future climate effects. Nationally, managed forests and forest products store enough carbon each year to offset approximately 10% of U.S. CO<sub>2</sub> emissions.

Arkansas’ forests naturally sequester GHGs (producing 1.07 metric tons of oxygen for every 1.47 metric tons of CO<sub>2</sub> absorbed through the power of photosynthesis) and produce biomass for alternative fuels, wood-building products, and paper containing sequestered carbon. Beyond atmospheric and economic benefits, a healthy forest also provides wildlife habitat, enhanced water quality, recreation, and an aesthetically pleasing backdrop for the Natural State tourism promotion. On the other hand, conversion of forests to other land uses, poor forest health, natural decay, and wildfires reduce the sequestration and carbon storage values of the forests, as well as the potential economic values of forest products and carbon sequestration in regulated CO<sub>2</sub> offset markets.

This policy recommendation establishes or re-establishes forests on land not currently forested, such as fallow or marginal agricultural land (“afforestation”); promotes retaining forest cover and associated carbon stocks by regenerating forests (“reforestation” or “restoration”); helps maintain and improve the health and longevity of trees in urban and residential areas (urban forestry); and implements, in a carbon-sensitive manner, such practices as site preparation, erosion control, and stand stocking to ensure conditions that support forest growth. Forest management activities promote forest productivity and increase the rate of CO<sub>2</sub> sequestration in forest biomass and soils and in harvested wood products. Also, specific trees could be selected that sequester other non-GHG chemicals in addition to sequestering CO<sub>2</sub>. Practices may include planting open land, replanting harvested land, increased stocking of poorly stocked lands, extending the age of managed stands, thinning, fertilizing, recycling waste, expanding the short rotation of woody crops (for fiber and energy), expanding the use of genetically preferred species, modifying biomass removal practices, managing and reducing the risk of, pests and disease and managing and reducing the risk of intense wildfire through the appropriate use of controlled burning.

### Policy Design

#### Goals:

- Implement urban tree-planting and -retention programs in Arkansas urban areas. Plant 100,000 additional trees each year between 2009 and 2025, resulting in 1.7 million new trees in urban areas statewide (or a 4% increase in the number of urban trees).
- Implement sustainable forest management practices to achieve carbon benefits on 25% of privately owned land by 2025.

- Implement sustainable forest management practices to achieve carbon benefits on 17% of publicly owned resource lands by 2025.
- Maintain existing forest cover by replanting harvested acres; restoring timbered acres lost to insects, wildfire, or natural causes; and establishing a net 500,000 new acres of forest by 2025.

The above goals were based on land area information from the NRCS National Resources Inventory and U.S. Department of Agriculture, Forest Service, Forest Inventory and Analysis National Program. This information is displayed in Tables J-7-1 and J-7-2. Table J-7-3 indicates the approximate acres required by each goal and any potential for overlap.

**Table J-7-1. Current land area by land use type in Arkansas**

Land Use Type	Data Year	Acres	Data Source	Notes
Agricultural	2003	12,844,100	NRI	Cropland + pastureland
Forest	2008	18,519,705	FIA	All ownerships
Developed	2003	1,996,100	NRI	Developed + other rural

FIA = U.S. Department of Agriculture, Forest Service, Forest Inventory and Analysis National Program; NRI = U.S. Department of Agriculture, Natural Resources Conservation Service, "2003 Annual National Resources Inventory: State Report."

**Table J-7-2. Forestland area by ownership class in Arkansas**

Ownership Group	Acres	% of Total Forestland
Private ownership	14,842,619	80%
Public: federal	3,153,894	17%
Public: state/county/municipal	523,192	3%

Source: U.S. Department of Agriculture, Forest Service, Forest Inventory and Analysis National Program.

**Table J-7-3. Forestland area by required by forestry goals**

Goal	Approximate Acres by 2025	Additional or Existing Acreage	Potential Overlap	Notes
Increase urban canopy.	N/A	N/A	No	N/A
Increase carbon benefits on privately owned land.	3,710,655	Existing	No	No new forest—improve management on existing land.
Increase carbon benefits on publicly owned resource lands.	536,162	Existing	No	No change to forest coverage—improve management on existing land.
Restore/establish 500,000 acres of forest.	500,000	Additional	Yes	There is a potential for overlap with the energy crop (marginal agriculture land) component of AFW-4.
Sustain existing forests to ensure no net loss of existing forests.	18,403,654	Existing	Yes	N/A

N/A = not applicable.

**Timing:** As described above.

**Parties Involved:** Arkansas Forestry Commission, Arkansas Game and Fish Commission, forest owners and managers, and private landowners.

**Other:**

*Sustainable Forestry Definition*—To meet the needs of the present without compromising the ability of future generations to meet their own needs by practicing a land stewardship ethic that integrates reforestation and the managing, growing, nurturing, and harvesting of trees for useful products with the conservation of soil, air and water quality, biological diversity, wildlife and aquatic habitat, recreation, and aesthetics.

While wildfire can have negative consequences on ecosystems and GHG emissions, prescribed burning can have both ecosystem and GHG benefits through reduced wildfire intensity. The GCGW supports the appropriate use of prescribed burning.

### **Implementation Mechanisms**

Arkansas should redouble its efforts to promote reforestation, forest restoration, and new afforestation on lands in public as well as private ownership. It can do so by:

- Ensuring that forest landowners are eligible for CO<sub>2</sub> offset credits and incentives in any state, regional, or national market-based initiatives.
- Providing financial and legislative incentives to landowners (in addition to offset market revenue) to increase carbon sequestration and storage.
- Supporting the development of market demand for forest biomass for energy (electricity and fuels) in lieu of fossil fuel energy.
- Taking a leadership role in regional and national policy development and efforts to encourage the participation of all forest landowners in ways that provide increased climate benefits.

Education and outreach, especially for citizens and land managers, will also be an important part of this goal, both to underscore the importance of forests and to teach forest management practices that promote carbon sequestration.

Minimum standards or best practice standards with certification could be used to promote sustainable forest management practices, which include the promotion of carbon benefits.

The implementation of this recommendation should consider non-GHG benefits, such as the provision of wildlife habitat, biodiversity, stream buffers, and water quality.

### **Related Policies/Programs in Place**

None identified.

## Type(s) of GHG Reductions

**CO<sub>2</sub>:** Removes fuels that contribute to wildfire emissions. Maintains carbon sequestration through the production of durable wood products. Reduces emissions by reducing the use of fossil fuels replaced by energy from woody biomass, and by preventing the release of carbon from dead and dying trees. Reduces wildfire emissions by maintaining healthy forests. Avoids emission of CO<sub>2</sub> and associated GHGs by reducing heating and cooling needs in urban areas. Sequesters carbon due to tree growth.

## Estimated GHG Reductions and Costs or Cost Savings

### GHG Reduction Potential in 2015, 2025 (MMtCO<sub>2</sub>e):

*Urban Forestry:* 0.02 and 0.1, respectively.

*Sustainable Forest Management:* 4.1 and 10.4, respectively.

*Afforestation:* 0.7 and 1.8, respectively.

### Net Cost per tCO<sub>2</sub>e:

*Urban Forestry:* \$41.

*Sustainable Forest Management:* \$21.

*Afforestation:* \$12.

### Data Sources:

*Urban Forestry:*

- D.J. Nowak et al. “Effects of Urban Forests and Their Management on Human Health and Environmental Quality. State Urban Forest Data: Arkansas.” USDA Forest Service, Northern Research Station. Available at: [http://www.fs.fed.us/ne/syracuse/Data/State/data\\_AR.htm](http://www.fs.fed.us/ne/syracuse/Data/State/data_AR.htm).
- E.G. McPherson and J.R. Simpson. *Carbon Dioxide Reduction Through Urban Forestry: Guidelines for Professional and Volunteer Tree Planters*. Gen. Tech. Rep. PSW-GTR-171. Washington, DC: U.S. Department of Agriculture, U.S. Forest Service, 1999. Available at: <http://www.treearch.fs.fed.us/pubs/6779>.
- E.G. McPherson, J.R. Simpson, P.J. Peper, S.L. Gardner, K.E. Vargas, S.E. Maco, and Qingfu Xiao, *Piedmont Community Tree Guide: Benefits, Costs, and Strategic Planting*, USFS PSW-GTR-200, USDA/USFS Pacific Southwest Research Station, November 2006. Available at: [http://www.fs.fed.us/psw/programs/cufr/products/2/cufr\\_647\\_gtr200\\_piedmont\\_tree\\_guide.pdf](http://www.fs.fed.us/psw/programs/cufr/products/2/cufr_647_gtr200_piedmont_tree_guide.pdf).
- U.S. Environmental Protection Agency. *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2006*. USEPA #430-R-08-005. April 2008. Available at: <http://www.epa.gov/climatechange/emissions/usinventoryreport.html>.

*Restore/Establish Forest Cover:*

- J.E. Smith, L.S. Heath, K.E. Skog, and R.A. Birdsey. *Methods for Calculating Forest Ecosystem and Harvested Carbon With Standards Estimates for Forest Types of the United States*. General Technical Report NE-343. U.S. Department of Agriculture, Forest Service, Northern Research Station, December 21, 2005. Available at: <http://www.treearch.fs>.

[fed.us/pubs/22954](http://www.fed.us/pubs/22954). (Also published as part of the U.S. Department of Energy Voluntary GHG Reporting Program.)

- J.A. Stanturf, C.J. Schweitzer, and E.S. Gardiner. “Afforestation of Marginal Agricultural Land in the Lower Mississippi River Alluvial Valley, U.S.A.” *Silva Fennica* 1998;32(3):281-297.
- S. Walker et al. “Opportunities for Improving Carbon Storage Through Afforestation of Agricultural Lands.” Part 3A in *Terrestrial Carbon Sequestration in the Northeast: Quantities and Costs*, The Nature Conservancy, Winrock International, and The Sampson Group. October 2007. Available at: <http://www.sampsongroup.com/Papers/carbon.htm>.

## Quantification Methods:

### *Urban Forestry GHG Benefit*

#### **Carbon Sequestration in Urban Trees**

Approximately 43,412,000 urban trees currently grow in Arkansas, resulting in an average of 25% canopy cover in urban areas statewide.<sup>107</sup> Planting 100,000 additional trees each year between 2009 and 2025 would add 1.7 million trees in urban areas statewide, for a 3.9% increase in the number of trees, and boost the canopy cover in urban areas to about 26%.

The average annual per-tree gross carbon sequestration value for urban trees was found by dividing the total estimated annual carbon sequestration in Arkansas urban trees (258,000 metric tons of carbon/year, equating to 946,000 tCO<sub>2</sub>e/yr) by the total number of urban trees. Annual gross carbon sequestration per urban tree was thus calculated as 0.006 metric tons of carbon (0.022 tCO<sub>2</sub>e) per tree per year. Gross sequestration as calculated above does not account for the emissions resulting from tree mortality, disposal, and decomposition. To account for these emissions, the estimated gross carbon sequestration per tree was multiplied by 0.72, which is the ratio of gross to net sequestration for urban trees reported by Nowak and Crane (2002)<sup>108</sup> and used in EPA’s *Inventory of U.S. Greenhouse Gas Emissions and Sinks*.<sup>109</sup> Annual net carbon sequestration per urban tree in Arkansas is 0.004 metric tons of carbon (0.015 tCO<sub>2</sub>e) per tree per year.

Since trees planted in one year continue to accumulate carbon in subsequent years, annual carbon sequestration in any given year was calculated as the sum of carbon stored in trees planted in that year, plus sequestration by trees that were planted in prior years. It was assumed that new trees planted in urban areas in Arkansas would sequester carbon at a rate consistent with sequestration by the average urban tree statewide.

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<sup>107</sup> D.J. Nowak et al. “Effects of Urban Forests and Their Management on Human Health and Environmental Quality. State Urban Forest Data: Arkansas.” U.S. Department of Agriculture, U.S. Forest Service, Northern Research Station. Available at: [http://www.fs.fed.us/ne/syracuse/Data/State/data\\_AR.htm](http://www.fs.fed.us/ne/syracuse/Data/State/data_AR.htm).

<sup>108</sup> D.J. Nowak and D.E. Crane. “Carbon Storage and Sequestration by Urban Trees in the USA.” *Environmental Pollution* March 2002;116(3):381-389. Available at: [http://www.sciencedirect.com/science?\\_ob=ArticleURL&\\_udi=B6VB5-44JYXWH-5&\\_user=10&\\_rdoc=1&\\_fmt=&\\_orig=search&\\_sort=d&\\_view=c&\\_acct=C000050221&\\_version=1&\\_urlVersion=0&\\_userid=10&md5=3ce67e03c1680fd2dcf04ddad0469d79](http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6VB5-44JYXWH-5&_user=10&_rdoc=1&_fmt=&_orig=search&_sort=d&_view=c&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=3ce67e03c1680fd2dcf04ddad0469d79).

<sup>109</sup> U.S. Environmental Protection Agency. *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2006*. USEPA #430-R-08-005. April 2008. Available at: <http://www.epa.gov/climatechange/emissions/usinventoryreport.html>.

### **Avoided Fossil Fuel Emissions**

GHG reductions from avoided fossil fuel use for heating and cooling can occur as a result of planting trees that provide additional shade and wind protection to buildings, though these benefits are not likely to be achieved the first year after planting. Normally, trees are quite small when they are planted, so some time is required before the full effect of the avoided emissions can be realized. To account for this, a sliding scale was employed, such that trees planted in 2009 would achieve the full avoided GHG emissions benefit in 2025, and a linear phase-in of avoided GHG benefits would occur each year. Avoided GHG benefits for trees planted in each year from 2009 to 2025 were thus calculated proportionally to their expected size in 2025, as shown in Table J-7-4. Using this approach, it was assumed that the trees planted in 2009 would achieve their full shade and wind protection potential (shown in Tables J-7-5a and J-7-5b) in 2025. It was further assumed that any trees planted in 2010 or later would reach their full avoided GHG emissions potential sometime after the conclusion of the policy implementation period.

The total avoided GHG benefits are a function of three different types of impacts: reduced cooling demand, reduced demand for heating due to wind reduction, and increased demand for heating due to wintertime shading. An average potential GHG reduction factor of 0.075 tCO<sub>2</sub>e/tree/year for trees in the Southeast region was calculated from data in McPherson and Simpson.<sup>110</sup> The estimate assumed that the trees planted are split among residential settings with pre-1950, 1950–1980, and post-1980 homes using McPherson's and Simpson's respective default distributions for the Southeast of 28%, 54%, and 18%. This estimate further assumes a default distribution of trees planted around buildings, based on measured data from existing urban canopy in the region.

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<sup>110</sup> E.G. McPherson and J.R. Simpson. *Carbon Dioxide Reduction Through Urban Forestry: Guidelines for Professional and Volunteer Tree Planters*. Appendix A, Table V.5. Gen. Tech. Rep. PSW-GTR-171. Washington, DC: U.S. Department of Agriculture, U.S. Forest Service, 1999. Available at: <http://www.treearch.fs.fed.us/pubs/6779>.

**Table J-7-4. Sliding scale applied to calculate the avoided GHG emissions resulting from urban tree planting**

Year	Proportion of Potential Benefit Achieved by Trees Planted in This Year																
	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
2009	0.06																
2010	0.12	0.06															
2011	0.18	0.12	0.06														
2012	0.24	0.18	0.12	0.06													
2013	0.29	0.24	0.18	0.12	0.06												
2014	0.35	0.29	0.24	0.18	0.12	0.06											
2015	0.41	0.35	0.29	0.24	0.18	0.12	0.06										
2016	0.47	0.41	0.35	0.29	0.24	0.18	0.12	0.06									
2017	0.53	0.47	0.41	0.35	0.29	0.24	0.18	0.12	0.06								
2018	0.59	0.53	0.47	0.41	0.35	0.29	0.24	0.18	0.12	0.06							
2019	0.65	0.59	0.53	0.47	0.41	0.35	0.29	0.24	0.18	0.12	0.06						
2020	0.71	0.65	0.59	0.53	0.47	0.41	0.35	0.29	0.24	0.18	0.12	0.06					
2021	0.76	0.71	0.65	0.59	0.53	0.47	0.41	0.35	0.29	0.24	0.18	0.12	0.06				
2022	0.82	0.76	0.71	0.65	0.59	0.53	0.47	0.41	0.35	0.29	0.24	0.18	0.12	0.06			
2023	0.88	0.82	0.76	0.71	0.65	0.59	0.53	0.47	0.41	0.35	0.29	0.24	0.18	0.12	0.06		
2024	0.94	0.88	0.82	0.76	0.71	0.65	0.59	0.53	0.47	0.41	0.35	0.29	0.24	0.18	0.12	0.06	
2025	1.00	0.94	0.88	0.82	0.76	0.71	0.65	0.59	0.53	0.47	0.41	0.35	0.29	0.24	0.18	0.12	0.06

To calculate potential avoided GHG emissions due to increased shading, it was assumed that all of the new trees are planted where they can have shading effects. Because these data were used as potential maxima, large trees (half evergreen, half deciduous) planted and average tree distribution around buildings were also assumed. Note that these fossil fuel reduction factors are average for existing buildings, and do not necessarily assume that trees are optimally placed around buildings to maximize energy efficiency. These factors are also dependent on the electricity fuel mix (coal, hydroelectric, nuclear, etc.) in the regions of interest, and may thus change if the mix changes. The average urban tree planted in Arkansas was assumed to result in avoided emissions of 0.075 tCO<sub>2</sub>e/yr (Tables J-7-5a and J-7-5b).

**Table J-7-5a. Net GHG emission reductions from evergreen shade trees planted in the Southeast climate region**

Housing Age	Proportion of Urban Trees in This Housing Age Category	Cooling (tCO <sub>2</sub> saved/tree)	Heating (tCO <sub>2</sub> emitted/tree)	Wind (tCO <sub>2</sub> saved/tree)	Net Effect (tCO <sub>2</sub> e/tree)
Pre-1950	0.28	0.0378	-0.0237	0.0708	0.0849
1950–1980	0.54	0.0507	-0.0270	0.0784	0.1021
Post-1980	0.18	0.0641	-0.0319	0.0635	0.0957
<b>Weighted Average (tCO<sub>2</sub>e/tree/year)</b>					<b>0.0961</b>

tCO<sub>2</sub> = metric tons of carbon dioxide.

Source: McPherson and Simpson, PSW-GTR-171, Appendix A, Table V.5.

**Table J-7-5b. Net GHG emission reductions from deciduous shade trees planted in the Southeast climate region**

Housing Age	Proportion of Urban Trees in This Housing Age Category	Cooling (tCO <sub>2</sub> saved/tree)	Heating (tCO <sub>2</sub> emitted/tree)	Wind (tCO <sub>2</sub> saved/tree)	Net Effect (tCO <sub>2</sub> e/tree)
Pre-1950	0.28	0.0586	-0.0197	0.0000	0.0389
1950–1980	0.54	0.0785	-0.0224	0.0000	0.0561
Post-1980	0.18	0.0993	-0.0264	0.0000	0.0729
<b>Weighted Average (tCO<sub>2</sub>e/tree/year)</b>					<b>0.0543</b>

tCO<sub>2</sub> = metric tons of carbon dioxide; tCO<sub>2</sub>e = metric tons of carbon dioxide equivalent.

Source: McPherson and Simpson, PSW-GTR-171, Appendix A, Table V.5.

The annual avoided GHG benefit of trees in each year of the policy implementation period was calculated proportionally to the expected size of the trees in each age cohort in each year (Table J-7-6). For each year between 2009 and 2025, this was calculated by multiplying the number of trees planted in each preceding year by the maximum potential avoided GHG effect. This was then multiplied by the scaling factor (Table J-7-4) that represents the proportion of the maximum benefit achieved in a given year by trees planted in a prior year. For each year of policy implementation, the shade- and wind-protection effects of trees planted in that year and each prior year were summed to find the total avoided GHG impact of urban tree planting in that year (Table J-7-6).

**Table J-7-6. Avoided GHG emissions from urban tree planting over the policy implementation period**

Year	GHG Benefit of Trees Planted in This Year (MMtCO <sub>2</sub> e/year)																	Total GHGs Avoided in This Year
	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	
2009	0.000																	0.000
2010	0.001	0.000																0.001
2011	0.001	0.001	0.000															0.003
2012	0.002	0.001	0.001	0.000														0.004
2013	0.002	0.002	0.001	0.001	0.000													0.007
2014	0.003	0.002	0.002	0.001	0.001	0.000												0.009
2015	0.003	0.003	0.002	0.002	0.001	0.001	0.000											0.012
2016	0.004	0.003	0.003	0.002	0.002	0.001	0.001	0.000										0.016
2017	0.004	0.004	0.003	0.003	0.002	0.002	0.001	0.001	0.000									0.020
2018	0.004	0.004	0.004	0.003	0.003	0.002	0.002	0.001	0.001	0.000								0.024
2019	0.005	0.004	0.004	0.004	0.003	0.003	0.002	0.002	0.001	0.001	0.000							0.029
2020	0.005	0.005	0.004	0.004	0.004	0.003	0.003	0.002	0.002	0.001	0.001	0.000						0.034
2021	0.006	0.005	0.005	0.004	0.004	0.004	0.003	0.003	0.002	0.002	0.001	0.001	0.000					0.040
2022	0.006	0.006	0.005	0.005	0.004	0.004	0.004	0.003	0.003	0.002	0.002	0.001	0.001	0.000				0.046
2023	0.007	0.006	0.006	0.005	0.005	0.004	0.004	0.004	0.003	0.003	0.002	0.002	0.001	0.001	0.000			0.053
2024	0.007	0.007	0.006	0.006	0.005	0.005	0.004	0.004	0.004	0.003	0.003	0.002	0.002	0.001	0.001	0.000		0.060
2025	0.008	0.007	0.007	0.006	0.006	0.005	0.005	0.004	0.004	0.004	0.003	0.003	0.002	0.002	0.001	0.001	0.000	0.068

MMtCO<sub>2</sub>e/year = million metric tons of carbon dioxide equivalent per year; GHGs = greenhouse gases.

The total GHG benefit was calculated as the sum of direct carbon sequestration plus fossil fuel offset from reduced cooling demand and wind reduction. The avoided emissions and carbon sequestration benefits are summed in Table J-7-7 to show the total net benefits of urban tree planting.

**Table J-7-7. Carbon sequestered and avoided emissions from urban forestry in AFW-7**

Year	Number of Trees Planted This Year	Number of Trees Planted in Prior Years	Carbon Sequestered in Cumulative Trees Planted (MMtCO <sub>2</sub> e/year)	Carbon Savings From Shading Effects (MMtCO <sub>2</sub> e/year)	Total Carbon Savings (MMtCO <sub>2</sub> e/year)
2009	100,000	0	0.002	0.000	0.002
2010	100,000	100,000	0.003	0.001	0.004
2011	100,000	200,000	0.005	0.003	0.007
2012	100,000	300,000	0.006	0.004	0.011
2013	100,000	400,000	0.008	0.007	0.014
2014	100,000	500,000	0.009	0.009	0.019
2015	100,000	600,000	0.011	0.012	0.023
2016	100,000	700,000	0.013	0.016	0.028
2017	100,000	800,000	0.014	0.020	0.034
2018	100,000	900,000	0.016	0.024	0.040
2019	100,000	1,000,000	0.017	0.029	0.046
2020	100,000	1,100,000	0.019	0.034	0.053
2021	100,000	1,200,000	0.020	0.040	0.061
2022	100,000	1,300,000	0.022	0.046	0.068
2023	100,000	1,400,000	0.024	0.053	0.077
2024	100,000	1,500,000	0.025	0.060	0.085
2025	100,000	1,600,000	0.037	0.068	0.105
<b>Total</b>	<b>1,700,000</b>		<b>0.250</b>	<b>0.161</b>	<b>0.411</b>

MMtCO<sub>2</sub>e/year = million metric tons of carbon dioxide equivalent per year.

#### *Urban Forestry Costs*

The costs and cost savings of urban tree planting are calculated separately for the one-time cost of tree purchase and planting; cost of annual maintenance (including pruning, removal and disposal, pest and disease treatment, infrastructure repair, cleanup, liability and legal coverage); and cost savings from avoided energy use. Data are available on the estimated economic benefits of such services as provision of clean air, hydrologic benefits (e.g., stormwater control), and aesthetic enhancement, but these indirect co-benefits are not included in this analysis.

State-specific data for Arkansas were not available for cost estimates, so data from the Piedmont region, which includes states immediately to the south and east of Arkansas, were used. The *Piedmont Community Tree Guide* reports that on average it costs \$100 to purchase and plant an

urban tree.<sup>111</sup> The report also provides average annual maintenance costs and cost savings per tree for four tree types; an average across these tree types was calculated and used for this cost analysis (Table J-7-8) (see Appendices A1-A4 in the guide for the original data).

**Table J-7-8. Average costs of and cost savings from urban tree planting**

Costs and Cost Savings	A1 Red Maple	A2 Southern Magnolia	A3 Dogwood	A4 Loblolly Pine	Average
Cost savings (\$saved/year/tree):					
Cooling savings	-\$16.45	-\$12.14	-\$9.05	-\$14.79	-\$13.11
Heating savings	-\$3.75	-\$1.39	-\$2.27	-\$2.18	-\$2.40
<b>Total Average Cost Savings</b>	<b>-\$20.20</b>	<b>-\$13.53</b>	<b>-\$11.32</b>	<b>-\$16.97</b>	<b>-\$15.51</b>
Maintenance costs (\$spent/year/tree)	\$6.85	\$5.49	\$5.17	\$3.54	\$5.26

The number of trees planted each year was multiplied by a cost of \$100/tree/yr to estimate initial tree purchase and planting costs (Table J-7-9). Then, the total number of additional trees planted to date (cumulative since the year planted) on existing urban areas was multiplied by \$5.26/tree/yr to estimate annual maintenance costs (Table J-7-9). The cost savings of -\$15.51/tree/yr was multiplied by the number of trees planted for energy efficiency to date (cumulative since the year planted); this cost savings value was not adjusted for tree size. Cumulative values are used for the latter two estimates because the maintenance costs and cost savings occur in the year the tree is planted and each year thereafter.

Annual net costs are the sum of costs and cost savings. Annual net costs are discounted using a 5% discount rate. Net present value (NPV) is the sum of the annual net discounted costs and is estimated to be \$17 million. Cost-effectiveness is calculated by dividing the NPV by cumulative GHG reductions for 2009–2025. Cost-effectiveness is estimated to be \$41.49/tCO<sub>2</sub>e reduced.

*Sustainable Management in Public and Private Lands: GHG Benefits*

The above Policy Design section articulates a goal of 17% of publicly owned and 25% of privately owned forests under sustainable management regimes by 2025. Assuming that federal forestland is not under state jurisdiction, this suggests that a total of 3.69 million acres of private forestland and 87,806 acres of state-owned resource lands would be managed in this way (Table J-7-2). To achieve these cumulative levels, approximately 216,973 additional acres of privately owned land and 5,165 additional acres of publicly owned land would be managed in this way each year between 2009 and 2025.

<sup>111</sup> E.G. McPherson, J.R. Simpson, P.J. Peper, S.L. Gardner, K.E. Vargas, S.E. Maco, and Qingfu Xiao. *Piedmont Community Tree Guide: Benefits, Costs, and Strategic Planting*. USFS PSW-GTR-200. U.S. Department of Agriculture, Forest Service Pacific Southwest Research Station, November 2006. Available at: [http://www.fs.fed.us/psw/programs/cufr/products/2/cufr\\_647\\_gtr200\\_piedmont\\_tree\\_guide.pdf](http://www.fs.fed.us/psw/programs/cufr/products/2/cufr_647_gtr200_piedmont_tree_guide.pdf).

**Table J-7-9. Summary of economic benefits of urban forest policy implementation**

Year	Number of Trees Planted This Year	Number of Trees Planted in Prior Years	Planting Cost	Maintenance Cost	Cost Savings (Not Proportional to Tree Size)	Net Economic Cost	Discounted Cost
2009	100,000	0	\$10,000,000	\$0	-\$1,550,500	\$8,449,500	\$8,449,500
2010	100,000	100,000	\$10,000,000	\$526,250	-\$3,101,000	\$7,425,250	\$7,071,667
2011	100,000	200,000	\$10,000,000	\$1,052,500	-\$4,651,500	\$6,401,000	\$5,805,896
2012	100,000	300,000	\$10,000,000	\$1,578,750	-\$6,202,000	\$5,376,750	\$4,644,639
2013	100,000	400,000	\$10,000,000	\$2,105,000	-\$7,752,500	\$4,352,500	\$3,580,813
2014	100,000	500,000	\$10,000,000	\$2,631,250	-\$9,303,000	\$3,328,250	\$2,607,771
2015	100,000	600,000	\$10,000,000	\$3,157,500	-\$10,853,500	\$2,304,000	\$1,719,280
2016	100,000	700,000	\$10,000,000	\$3,683,750	-\$12,404,000	\$1,279,750	\$909,494
2017	100,000	800,000	\$10,000,000	\$4,210,000	-\$13,954,500	\$255,500	\$172,932
2018	100,000	900,000	\$10,000,000	\$4,736,250	-\$15,505,000	-\$768,750	-\$495,543
2019	100,000	1,000,000	\$10,000,000	\$5,262,500	-\$17,055,500	-\$1,793,000	-\$1,100,746
2020	100,000	1,100,000	\$10,000,000	\$5,788,750	-\$18,606,000	-\$2,817,250	-\$1,647,188
2021	100,000	1,200,000	\$10,000,000	\$6,315,000	-\$20,156,500	-\$3,841,500	-\$2,139,091
2022	100,000	1,300,000	\$10,000,000	\$6,841,250	-\$21,707,000	-\$4,865,750	-\$2,580,411
2023	100,000	1,400,000	\$10,000,000	\$7,367,500	-\$23,257,500	-\$5,890,000	-\$2,974,850
2024	100,000	1,500,000	\$10,000,000	\$7,893,750	-\$24,808,000	-\$6,914,250	-\$3,325,872
2025	100,000	1,600,000	\$10,000,000	\$8,420,000	-\$26,358,500	-\$7,938,500	-\$3,636,718
<b>Total</b>	<b>1,700,000</b>		<b>\$170,000,000</b>	<b>\$71,570,000</b>	<b>-\$237,226,500</b>	<b>\$4,343,500</b>	<b>\$17,061,571</b>

### 1. Impacts of Improved Management on Carbon Sequestration

Net changes in carbon stocks in forest biomass and soil are influenced by growth, mortality, and decay processes, and the amount of carbon removed during harvest, all of which are influenced by forest management to some degree. A range of forest management activities can promote productivity and increase the rate of carbon sequestration in Arkansas (see the Policy Description section, above, for details). Increasing productivity involves increasing the rate at which forests accumulate biomass—i.e., a high-productivity stand accumulates more carbon in biomass over the same amount of time as an otherwise equivalent low-productivity stand. This leads to a relatively higher growing-stock volume (i.e., the volume of living trees above the ground), some portion of which is harvested at periodic intervals (providing for potentially greater harvest volumes).

Data are available to estimate the carbon stock and growing-stock volume changes associated with increasing productivity of loblolly-shortleaf pine stands in Arkansas. Loblolly-shortleaf pine forests are the second most abundant type of forest in Arkansas, making up 29% of all classes of forest (oak-hickory is the most abundant forest type, making up 39% of forest area).<sup>112</sup>

<sup>112</sup> J.E. Smith, L.S. Heath, K.E. Skog, and R.A. Birdsey. *Methods for Calculating Forest Ecosystem and Harvested Carbon With Standards Estimates for Forest Types of the United States*. General Technical Report NE-343. USDA/USFS, Northern Research Station, 2006. Available at: <http://www.treesearch.fs.fed.us/pubs/22954>.

Because the loblolly-pine forests are the most heavily managed forest type in Arkansas, an analysis of this forest group alone is believed to be a good approximation of the overall potential GHG benefits of forest management on privately owned forests in Arkansas. Publicly owned state resource lands are more likely to be in hardwood or mixed forest types. However, since data are not readily available to quantify the impact of a shift from low- to high-productivity stands in these forest types, this analysis assumes that the effect of enhanced forest management on publicly owned resource lands is consistent with the effect of enhanced management on privately owned lands. Thus, the analysis below is indexed to shifting productivity levels from average or below-average levels to high levels in loblolly-shortleaf stands, which results in roughly a doubling of carbon sequestration in all forest types over a standard rotation.

The index was developed by comparing carbon and growing-stock volume yield tables for average- and high-productivity loblolly-shortleaf pine stands in the South Central region published by U.S. Forest Service (USFS).<sup>113</sup> This type of comparison assumes that the newly treated stands will realize gains as if they were growing according to the yield table of a high-producing forest from their beginning. In reality, total gains will be influenced by the age of the stand when treatment is initiated.

The net impact of a shift from low- to high-productivity forests involves both forest carbon and harvested wood product (HWP) pools. From a carbon accounting perspective, harvested carbon represents a carbon stock loss to the forest and a carbon stock gain into the HWP pool, with only a portion of the carbon that is shifted into the HWP pool at harvest remaining stored for long periods of time. The changes in carbon stocks in both forest and HWP pools are quantified below.

## **2. Estimated Increases in Carbon Sequestration Rates and Growing-Stock Volumes**

USFS publishes carbon stock tables for forest types by region for the entire country. In some regions, for some forest types, USFS provides tables for both average- and high-productivity stands. Such tables are available for loblolly-shortleaf pine in the South Central region. Carbon stock and growing-stock volume data in the USFS tables (see Tables J-7-10 and J-7-11) were used to calculate an annual carbon sequestration rate for average- and high-productivity loblolly-shortleaf pine forests in Arkansas (carbon stocks in 30-year-old stands were subtracted from carbon stocks in new stands and divided by 30). An average over 30 years is assumed to encompass the range of age classes for this forest type, though in reality, sequestration rates vary by stand age. Note that soil carbon stocks are constant over time and between productivity classes, so carbon stock gains occur only in biomass pools. Comparing Tables J-7-10 and J-7-11 shows that high-productivity stands sequester approximately 0.79 metric tons more carbon per acre per year. Therefore, regardless of the initial carbon stock levels, a forest stand that moves to higher productivity status will gain roughly 0.79 more metric tons of carbon per acre per year than it would if left as is.

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<sup>113</sup> Ibid.

**Table J-7-10. Carbon stocks and mean growing-stock volumes by selected age class for loblolly-shortleaf pine in the southeastern United States**

Age (years)	Mean Volume (cf/acre)	Biomass (tC/acre)	Soils (tC/acre)	Total (tC/acre)
0	0	10.4	17	27.4
30	1,554	32.9	17	49.9
<b>Average Annual Sequestration (30-year average)</b>				<b>0.75</b>

cf/acre = cubic feet per acre; tC/acre = metric tons of carbon per acre.

Source: Smith et al., GTR NE-343, Table A47.

**Table J-7-11. Carbon stocks and mean growing-stock volumes by selected age class for high-productivity sites (growth rates greater than 120 cubic feet/acre/year), with high-intensity management (replanting with genetically improved stocks)**

Age (years)	Mean Volume (cf/acre)	Biomass (tC/acre)	Soils (tC/acre)	Total (tC/acre)
0	0	14.9	17	31.9
30	4,963	61.1	17	78.1
<b>Average Annual Sequestration (30-year average)</b>				<b>1.54</b>

cf/acre = cubic feet/acre; tC/acre = metric tons of carbon per acre.

Source: Smith et al., GTR NE-343, Table A48.

In addition, the growing-stock volume is greater in all age classes of high-productivity stands. Assuming that, on average, stands are harvested at 30 years, USFS HWP accounting methods were used to convert the 3,409-cubic-feet-per-acre (cf/ac) incremental increase in growing-stock volume into the equivalent carbon volume of 35.6 tC/ac. Note that this is the carbon stored in the incremental increase in growing stock, only a portion of which is removed during harvest (this analysis assumes 35% is removed, see below).

### 3. Calculation of Net Carbon Stock Change in Forests and HWP

The calculation of net forest carbon stock change takes into account each year gains in biomass carbon stocks from higher accumulation rates are offset by the removal of larger volumes of carbon during harvest (Table J-7-12). The incremental increase in biomass carbon stocks is calculated by multiplying the cumulative number of acres treated by 0.79 tC/ac/yr (Table J-7-12, Column A). Cumulative acres are used because once an area is treated, it continues to sequester carbon at a higher rate in subsequent years.

The incremental increase in carbon removed during harvest is calculated by multiplying the number of acres harvested each year by 35% of the carbon increase in growing-stock volume (i.e., 35% of 35.6 tC/ac = 12.5 tC/ac) (Table J-7-12, Column B). This assumes that 35% of the growing-stock volume is removed during a harvest (based on a study of carbon removals at different harvest levels, 35% is roughly the proportion removed from moderate harvest

levels).<sup>114</sup> The number of acres harvested is calculated by assuming 4% of the acres treated each year are harvested the following year.<sup>115</sup>

Carbon removed during harvest is subtracted from the carbon gains in biomass due to sequestration to yield a net change in forest carbon stocks each year (Table J-7-12, Column C). If the calculation stopped here, this would imply that all carbon removed is essentially emitted to the atmosphere. Therefore, a subsequent step is taken to account for the portion of carbon that remains stored in HWP for a total carbon stock balance.

Standard USFS HWP accounting methods were used to estimate the incremental increase in harvested carbon that remains stored in HWP indefinitely. The amount of carbon stored in HWP carbon stocks is time-dependent relative to the year of harvest (carbon stocks are high initially and decrease over time as a result of disposal and decay), making carbon stock accounting for HWP complex. Therefore, an approach has been developed to standardize and simplify HWP carbon accounting, which applies the amount of carbon still stored in HWP 100 years after harvest as the estimated net increase in HWP carbon stocks; this gain is attributed to the year of harvest.

The USFS methods from Smith et al. were applied to coefficients for loblolly-shortleaf pine stands in the South Central region to estimate that approximately 22% of harvested carbon remains stored in HWP 100 years after harvest.<sup>116</sup> Therefore, the long-term storage of carbon in HWP increases by approximately 2.7 tC/ac when stands go from average- to high-productivity forests (i.e., an additional 12.45 tC/ac are harvested, of which 22% remains stored indefinitely). The net carbon stock increase in HWP attributable to increased productivity was calculated by multiplying the number of acres harvested by 2.7 tC/ac (Table J-7-12, Column D). For standardization across all policy recommendations, units are converted to MMtCO<sub>2e</sub> in Table J-7-13.

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<sup>114</sup> T.F. Strong. "Harvesting Intensity Influences the Carbon Distribution in a Northern Hardwood Ecosystem." USFS Research Paper NC-329. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Research Station, 1997. Available at: <http://www.ncrs.fs.fed.us/pubs/812-20k>.

<sup>115</sup> Roughly 4% of acres in Arkansas are harvested each year. Personal communication between John Shannon (Arkansas Forestry Commissions) and J. Jenkins (Center for Climate Strategies), July 2008.

<sup>116</sup> J.E. Smith, L.S. Heath, K.E. Skog, and R.A. Birdsey. *Methods for Calculating Forest Ecosystem and Harvested Carbon With Standards Estimates for Forest Types of the United States*. General Technical Report NE-343. USDA/USFS, Northern Research Station, 2006. Available at: <http://www.treesearch.fs.fed.us/pubs/22954>.

**Table J-7-12. Summary of calculated net changes in forest and HWP carbon stocks**

Year	Privately Owned Acres/ Year	State-Owned Acres/ Year	Cumulative Private Acres	Cumulative Public Acres	Column A	Column B	Column C (A minus B)	Column D	Column E (C plus D)
					Increased Carbon Stocks in Forest Biomass (tC)	Increased Carbon Stocks Removed at Harvest (tC)	Net Change in Forest Carbon Stocks (tC)	Net Increase in HWP Carbon Stocks (tC)	Total Increase in Forest and HWP Carbon Stocks (tC)
2009	216,973	5,165	216,973	5,165	175,489		175,489	0	175,489
2010	216,973	5,165	433,946	10,330	346,898	110,666	236,232	24,368	260,600
2011	216,973	5,165	650,919	15,495	518,306	110,666	407,641	24,368	432,009
2012	216,973	5,165	867,892	20,660	689,715	110,666	579,050	24,368	603,417
2013	216,973	5,165	1,084,865	25,825	861,124	110,666	750,458	24,368	774,826
2014	216,973	5,165	1,301,838	30,990	1,032,532	110,666	921,867	24,368	946,235
2015	216,973	5,165	1,518,811	36,156	1,203,941	110,666	1,093,276	24,368	1,117,643
2016	216,973	5,165	1,735,784	41,321	1,375,350	110,666	1,264,684	24,368	1,289,052
2017	216,973	5,165	1,952,757	46,486	1,546,758	110,666	1,436,093	24,368	1,460,461
2018	216,973	5,165	2,169,730	51,651	1,718,167	110,666	1,607,502	24,368	1,631,869
2019	216,973	5,165	2,386,703	56,816	1,889,576	110,666	1,778,910	24,368	1,803,278
2020	216,973	5,165	2,603,676	61,981	2,060,984	110,666	1,950,319	24,368	1,974,687
2021	216,973	5,165	2,820,649	67,146	2,232,393	110,666	2,121,728	24,368	2,146,095
2022	216,973	5,165	3,037,622	72,311	2,403,802	110,666	2,293,136	24,368	2,317,504
2023	216,973	5,165	3,254,595	77,476	2,575,210	110,666	2,464,545	24,368	2,488,913
2024	216,973	5,165	3,471,568	82,641	2,746,619	110,666	2,635,954	24,368	2,660,321
2025	216,973	5,165	3,688,541	87,806	2,918,028	110,666	2,807,362	24,368	2,831,730
<b>Total</b>	<b>3,688,541</b>	<b>87,806</b>					<b>12,201,520</b>	<b>268,045</b>	<b>12,469,565</b>

tC = metric tons of carbon; HWP = harvested wood product.

**Table J-7-13. Summary results**

Year	Net Change in Forest Carbon Stocks (MMtCO <sub>2</sub> e)	Net Increase in HWP Carbon Stocks (MMtCO <sub>2</sub> e)	Total Increase in Forest and HWP Carbon Stocks (MMtCO <sub>2</sub> e)
2009	0.6	0.000	0.6
2010	0.9	0.089	1.0
2011	1.5	0.089	1.6
2012	2.1	0.089	2.2
2013	2.8	0.089	2.8
2014	3.4	0.089	3.5
2015	4.0	0.089	4.1
2016	4.6	0.089	4.7
2017	5.3	0.089	5.4
2018	5.9	0.089	6.0
2019	6.5	0.089	6.6
2020	7.2	0.089	7.2
2021	7.8	0.089	7.9
2022	8.4	0.089	8.5
2023	9.0	0.089	9.1
2024	9.7	0.089	9.8
2025	10.3	0.089	10.4
<b>Total</b>	<b>90</b>	<b>1.43</b>	<b>91</b>

MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; HWP = harvested wood product.

*Sustainable Management in Public and Private Forests: Economic Costs*

The economic cost of implementing enhanced forest management on forest acreage is a one-time cost of improved management practices accounted for in the first year of treatment, and is estimated to be approximately \$520/acre. Costs are broken down as described in Table J-7-14.

**Table J-7-14. Costs of implementing forest practices on southern pine plantation acreage**

Treatment	Cost (\$/acre)
Spray	\$90
Mechanical preparation	\$200
Planting	\$90
Herbaceous release (year 1)	\$50
Woody release (year 14)	\$90
<b>Total Costs</b>	<b>\$520</b>

Source: Aubra Anthony, personal communication.

The total cost of implementing this recommendation is presented in Table J-7-15. In 2008 dollars, the NPV of implementing this recommendation totals \$1.1 billion, for an estimated cost-effectiveness of \$21.26/tCO<sub>2</sub>e stored.

**Table J-7-15. Economic costs of implementing sustainable forest management on private and public acreage in AFW-7**

Year	Acres Added This Year	Total GHG Benefit (MMtCO <sub>2</sub> e)	Cost	Discounted Costs
2009	222,138	0.6	\$115,511,802	\$115,511,802
2010	222,138	1.0	\$115,511,802	\$110,011,240
2011	222,138	1.6	\$115,511,802	\$104,772,609
2012	222,138	2.2	\$115,511,802	\$99,783,437
2013	222,138	2.8	\$115,511,802	\$95,031,845
2014	222,138	3.5	\$115,511,802	\$90,506,519
2015	222,138	4.1	\$115,511,802	\$86,196,685
2016	222,138	4.7	\$115,511,802	\$82,092,081
2017	222,138	5.4	\$115,511,802	\$78,182,934
2018	222,138	6.0	\$115,511,802	\$74,459,937
2019	222,138	6.6	\$115,511,802	\$70,914,226
2020	222,138	7.2	\$115,511,802	\$67,537,358
2021	222,138	7.9	\$115,511,802	\$64,321,293
2022	222,138	8.5	\$115,511,802	\$61,258,375
2023	222,138	9.1	\$115,511,802	\$58,341,309
2024	222,138	9.8	\$115,511,802	\$55,563,152
2025	222,138	10.4	\$115,511,802	\$52,917,287
<b>Total</b>	<b>3,688,541</b>	<b>54.0</b>		<b>\$1,139,321,968</b>

MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; HWP = harvested wood product.

*Restore/Establish Forest Cover: GHG Benefits*

Due to intense competition for land among various uses, it is likely that afforestation and reforestation will be most successful on lands where crop production is likely to fail. Land in the Lower Mississippi River Alluvial Valley that is subject to spring and early summer backwater flooding is ideal for forest establishment. It has been suggested that roughly 500,000 acres of this land could be available for planting.<sup>117</sup> To achieve the goal of 500,000 acres by 2025, a linear ramp to the goal level was assumed, such that 29,412 acres would be planted each year between 2009 and 2025.

Forests grown or planted on land not currently in forest cover will most likely accumulate carbon at a rate consistent with the accumulation rates of average forests in the region. Therefore, carbon sequestered by afforestation activities can be assumed to occur at the same rate as carbon sequestration in average Arkansas forests. For this analysis, the forest type distribution used for the Arkansas I&F was used: roughly 39% oak-hickory, 29% loblolly-shortleaf pine, 17% oak-pine, and 15% oak-gym-cypress.

Average carbon storage was found using methods described in Smith et al., assuming that afforestation activity would occur on forests that were consistent with the existing forest type

<sup>117</sup> J.A. Stanturf, C.J. Schweitzer, and E.S. Gardiner. "Afforestation of Marginal Agricultural Land in the Lower Mississippi River Alluvial Valley, U.S.A." *Silva Fennica* 1998;32(3):281-297. Available at: <http://www.metla.fi/silvafennica/full/sf32/sf323281.pdf>.

distribution in Arkansas.<sup>118</sup> Annual carbon sequestration rates in each forest type group were calculated by subtracting carbon stocks in new stands (0 years) from carbon stocks in 35-year-old stands and dividing by 35 years. A weighted statewide average carbon sequestration rate for afforestation activity was calculated, taking into account the variation in carbon sequestration across forest types (Table J-7-16). The 35-year period was chosen to reflect the average length of an afforestation project period. In this afforestation calculation, soil carbon was assumed to accumulate at a rate consistent with soil carbon accumulation in afforested stands in Smith et al. The average rate of carbon accumulation on afforested land in Arkansas is roughly 3.6 tCO<sub>2</sub>e/ac/yr (Table J-7-16). This calculation of carbon sequestration under afforestation accounts for carbon accumulation in below-ground and soil carbon pools.

**Table J-7-16. Carbon sequestration rates in afforested stands in Arkansas**

Forest Type	tCO <sub>2</sub> e/acre (0 year)	tCO <sub>2</sub> e/acre (35 year)	tCO <sub>2</sub> e/acre/year (35-year average)	Proportion of Arkansas Forest
Oak-hickory (Table B50)	49.1	169.0	3.4	39%
Loblolly-shortleaf pine (Table B47)	52.8	183.0	3.7	29%
Oak-pine (Table B51)	52.8	183.3	3.7	17%
Oak-gum-cypress (Table B49)	61.2	187.7	3.6	15%
<b>Weighted-Average Carbon Accumulation Rate for Afforestation</b>	61.2	187.7	3.6	<b>3.6%</b>

tCO<sub>2</sub>e/acre/year = metric tons of carbon dioxide equivalent per acre per year.

Source: Smith et al., NE-GTR-343.

Forests planted in one year will continue to store carbon in subsequent years. Therefore, the GHG benefit of afforestation in one year is the cumulative impact of forests planted in prior years. The overall GHG benefit of afforestation activity in Arkansas is described in Table J-7-17.

<sup>118</sup> J.E. Smith, L.S. Heath, K.E. Skog, and R.A. Birdsey. *Methods for Calculating Forest Ecosystem and Harvested Carbon With Standards Estimates for Forest Types of the United States*. General Technical Report NE-343, Tables A47, A48, B47, B49, B50, and B51. U.S. Department of Agriculture, Forest Service, Northern Research Station, December 21, 2005. Available at: <http://www.treesearch.fs.fed.us/pubs/22954>.

**Table J-7-17. Cumulative effect of afforestation in AFW-7**

Year	Acres Planted This Year (acre/year)	Acres Planted in Prior Years	Carbon Sequestered in Cumulative Planted Acreage (tCO <sub>2</sub> e/year)	Carbon Sequestered in Cumulative Planted Acreage (MMtCO <sub>2</sub> e/year)
2009	29,412	0	105,609.2	0.106
2010	29,412	29,412	211,218.5	0.211
2011	29,412	58,824	316,827.7	0.317
2012	29,412	88,235	422,437.0	0.422
2013	29,412	117,647	528,046.2	0.528
2014	29,412	147,059	633,655.5	0.634
2015	29,412	176,471	739,264.7	0.739
2016	29,412	205,882	844,873.9	0.845
2017	29,412	235,294	950,483.2	0.950
2018	29,412	264,706	1,056,092.4	1.056
2019	29,412	294,118	1,161,701.7	1.162
2020	29,412	323,529	1,267,310.9	1.267
2021	29,412	352,941	1,372,920.2	1.373
2022	29,412	382,353	1,478,529.4	1.479
2023	29,412	411,765	1,584,138.7	1.584
2024	29,412	441,176	1,689,747.9	1.690
2025	29,412	470,588	1,795,357.1	1.795
<b>Total</b>	<b>500,000</b>			<b>16.158</b>

MMtCO<sub>2</sub>e/year = million metric tons of carbon dioxide equivalent per year; tCO<sub>2</sub>e/acre/year = metric tons of carbon dioxide equivalent per acre per year.

*Restore/Establish Forest Cover: Economic Costs*

Analyses of vegetation planting costs typically employ four categories: opportunity cost (of planting forest rather than another, potentially more lucrative land use), conversion cost, maintenance cost, and measuring/monitoring costs.<sup>119</sup> The opportunity cost for afforestation activity was assumed to be \$51.82/ac/yr, which was the annual average rental payment to farmers in Arkansas with land enrolled in the Conservation Reserve Program as of 2007.<sup>120</sup> One-time costs of vegetation establishment include site preparation and vegetation planting, and vary with planting method (hand planting or machine planting) and forest type (hardwood or softwood).<sup>121</sup> For afforestation in Arkansas, the average cost of planting softwoods is \$141/acre

<sup>119</sup> S. Walker, S. Grimland, J. Winsten, and S. Brown. “Opportunities for Improving Carbon Storage Through Afforestation of Agricultural Lands.” Part 3A in *Terrestrial Carbon Sequestration in the Northeast: Quantities and Costs*, The Nature Conservancy, Winrock International, and The Sampson Group. October 2007. Available at: <http://www.sampsongroup.com/Papers/carbon.htm>.

<sup>120</sup> U.S. Department of Agriculture, Farm Service Agency. *Conservation Reserve Program Summary and Enrollment Statistics: FY 2007*. Prepared by Alex Barbarika. April 2008. Available at: [http://www.fsa.usda.gov/Internet/FSA\\_File/annual\\_consv\\_2007.pdf](http://www.fsa.usda.gov/Internet/FSA_File/annual_consv_2007.pdf).

<sup>121</sup> Personal communication between J. Shannon (Arkansas Forestry Commission) and J. Jenkins (Center for Climate Strategies), July 2008.

and the average planting cost for hardwoods is \$183/acre (Table J-7-18). Since planting will occur on both hardwood and softwood forest types, a weighted average for planting was computed for afforestation at \$170.82/acre. Maintenance and monitoring costs on afforested land were assumed to be negligible between 2009 and 2025.

**Table J-7-18. One-time costs of vegetation establishment for afforestation (pasture or open land forest establishment)**

Forest Types	Hand Planting (\$/acre)	Machine Planting (\$/acre)	Average
Softwood forest types			
Site preparation: ripping*	\$28	\$0	
Site preparation: chemical band spraying**	\$44	\$44	
Planting: labor & seedlings	\$82	\$84	
<b>Totals</b>	<b>\$154</b>	<b>\$128</b>	<b>\$141</b>
Hardwood forest types			
Site preparation: ripping	\$28	\$0	
Site preparation: chemical band spraying	\$44	\$44	
Planting: labor & seedlings	\$125	\$125	
<b>Totals</b>	<b>\$197</b>	<b>\$169</b>	<b>\$183</b>

\*Some properties that are machine planted will also do ripping, as the ripper may go deeper than the machine planter.

\*\*Some properties do not have to have chemical band spraying if the vegetation is not requiring treatment.

Source: Arkansas Forestry Commission.

Discounted costs to 2025 were calculated using a 5% discount rate. Results, including annual costs, are summarized in Table J-7-19. The NPV of this recommendation, expressed in 2009 dollars, is roughly \$201 million, and the overall cost of implementing this recommendation was calculated to be \$12.44/tCO<sub>2</sub>e stored.

### Key Assumptions:

The Smith et al. NE-GTR-343 methodologies for carbon sequestration were adopted for afforestation.<sup>122</sup> These methodologies account for below-ground carbon storage (i.e., in all dead organic matter pools, including forest floor and soil organic matter). However, the reforestation methodologies assume that there is no change in soil carbon pools.

<sup>122</sup> J.E. Smith, L.S. Heath, K.E. Skog, and R.A. Birdsey. *Methods for Calculating Forest Ecosystem and Harvested Carbon With Standards Estimates for Forest Types of the United States*. General Technical Report NE-343, Tables A47, A48, B47, B49, B50, and B51. U.S. Department of Agriculture, Forest Service, Northern Research Station, December 21, 2005. Available at: <http://www.treesearch.fs.fed.us/pubs/22954>.

**Table J-7-19. Summary of net economic cost of afforestation activity in Arkansas**

Year	Acres Planted This Year (acre/year)	Acres Planted in Prior Years	Opportunity Cost	Establishment Cost	Total Cost	Discounted Cost
2009	29,412	0	\$1,524,118	\$5,024,118	\$6,548,235	\$6,548,235
2010	29,412	29,412	\$3,048,235	\$5,024,118	\$8,072,353	\$7,687,955
2011	29,412	58,824	\$4,572,353	\$5,024,118	\$9,596,471	\$8,704,282
2012	29,412	88,235	\$6,096,471	\$5,024,118	\$11,120,588	\$9,606,382
2013	29,412	117,647	\$7,620,588	\$5,024,118	\$12,644,706	\$10,402,831
2014	29,412	147,059	\$9,144,706	\$5,024,118	\$14,168,824	\$11,101,644
2015	29,412	176,471	\$10,668,824	\$5,024,118	\$15,692,941	\$11,710,314
2016	29,412	205,882	\$12,192,941	\$5,024,118	\$17,217,059	\$12,235,842
2017	29,412	235,294	\$13,717,059	\$5,024,118	\$18,741,176	\$12,684,766
2018	29,412	264,706	\$15,241,176	\$5,024,118	\$20,265,294	\$13,063,189
2019	29,412	294,118	\$16,765,294	\$5,024,118	\$21,789,412	\$13,376,809
2020	29,412	323,529	\$18,289,412	\$5,024,118	\$23,313,529	\$13,630,938
2021	29,412	352,941	\$19,813,529	\$5,024,118	\$24,837,647	\$13,830,531
2022	29,412	382,353	\$21,337,647	\$5,024,118	\$26,361,765	\$13,980,207
2023	29,412	411,765	\$22,861,765	\$5,024,118	\$27,885,882	\$14,084,266
2024	29,412	441,176	\$24,385,882	\$5,024,118	\$29,410,000	\$14,146,713
2025	29,412	470,588	\$25,910,000	\$5,024,118	\$30,934,118	\$14,171,276
<b>Total</b>	<b>500,000</b>					<b>\$200,966,180</b>

### Key Uncertainties

The quantification assumes that there is no enhanced soil carbon storage under improved forest management practices. However, soil carbon storage may be increased with improved forest management practices.

While ongoing forestry management costs, such as planting costs, may increase over time, costs are assumed to remain constant in real terms across the period.

### Additional Benefits and Costs

Appropriate species selection and placement of trees can provide additional benefits through continuity of wildlife habitat, wetland buffer and protection, and adaptation to climate change.

### Feasibility Issues

None identified.

### Status of Group Approval

Complete.

**Level of Group Support**

Unanimous.

**Barriers to Consensus**

Not applicable.

## AFW-8. Advanced Recovery and Recycling

### Policy Description

Increasing waste recovery and recycling and reducing waste generation limit GHG emissions associated with landfill methane generation and with the production of raw materials. Additional actions include increasing existing recycling programs, creating new recycling programs, providing incentives for recycling construction materials, developing markets for recycled materials, and increasing average participation/recovery rates for all existing recycling programs.

### Policy Design

**Goals:** Increase the recycling rate for “GHG significant solid waste streams” by 2% every 5 years where geographically cost-effective.

**Timing:** Continuing on from the statutory recycling goal of 45% by 2010:

- The 2015 goal would be a 2% improvement on the 2010 actual recycling rate;
- The 2020 goal would be a 2% improvement on the 2015 actual recycling rate; and
- The 2025 goal would be a 2% improvement on the 2020 actual recycling rate.

**Parties Involved:** Arkansas Department of Environmental Quality (ADEQ), Regional Solid Waste Management District, waste collection providers, and recycling industry.

**Other:** To measure the GHG impacts of municipal solid waste (MSW), the U.S. Environmental Protection Agency (EPA) first decided which wastes to analyze. The universe of materials and products found in MSW was surveyed, and those that are most likely to have the greatest impact on GHGs were identified. These determinations were based on (1) the quantity generated, (2) the differences in energy use for manufacturing a product from virgin versus recycled inputs, and (3) the potential contribution of materials to CH<sub>4</sub> generation in landfills. By this process, EPA limited the analysis to the following 21 single-material items:

- Three categories of metal: aluminum cans, steel cans, and copper wire;
- Glass;
- Three types of plastic: HDPE (high-density polyethylene); LDPE (low-density polyethylene); and PET (polyethylene terephthalate);
- Six categories of paper products: corrugated cardboard, magazines/third-class mail, newspaper, office paper, phonebooks, and textbooks;
- Two types of wood products: dimensional lumber and medium-density fiberboard;
- Food discards;
- Yard trimmings;
- Clay bricks;

- Concrete;
- Fly ash; and
- Tires.

EPA's researchers also included two products that are composites of several materials: carpet and personal computers.

The goals in this policy represent a linear extrapolation of Arkansas' state recycling goals set forth by Act 94 (HB 1055). Data for 2006 document an overall solid waste recycling rate of 42%. (See Table J-8-1 for waste streams and tons recycled.) It is not known how many tons of these waste streams were disposed in Arkansas landfills, as there is no reporting requirement for these data.

To increase the diversion of recycled materials from the solid waste disposal stream for those waste identified as having the biggest global warming impacts, several factors need to be considered:

- *Economics*—Arkansas disposal rates at MSW landfills are some of the lowest in the nation. Communities, businesses, and industries have no incentives to collect and divert recyclable materials from waste streams directed to landfills.
- *Curbside Programs Enhanced*—Currently 97 communities have curbside recycling programs. Some 190 communities offer recycling opportunities at drop-off centers. Programs need to be encouraged to expand the number of items collected and to offer residents incentives to reduce waste destined for the landfills. Pay-As-You-Throw rewards residents for reuse and recycling by charging lower solid waste disposal rates.
- *Pre-Consumer Recycling*—Arkansas industries should be offered more incentives to reduce waste destined to MSW landfills.
- *Commercial Recycling*—Less than 10% of Arkansas municipalities offer local businesses the opportunity to reduce the amount of waste deposited in landfills. Incentives need to be developed at the local level to encourage participation in recycling programs.
- *End User*—The development of state or regional end users should be encouraged. Long-haul transportation costs to end users affect profit margins, and profits are how recycling programs exist. Arkansas offers the 30% State Income Tax Credit for collection and use of recyclable materials in the manufacturing process.

**Table J-8-1. Municipal solid waste streams and tons recycled**

Waste Streams	Tons/Year Recycled in 2006	Point of Generation <sup>123</sup>	Comments	Potential to Increase Amount Recycled
Batteries (lead acid)	357	Residential and nonresidential	Return policy in place (Act 749 of 1991).	No.
Computers/electronic	23,211	Residential and nonresidential	Banned from landfilling in 2010 (Act 512 of 2007). Incentive funding will be available in 2009 for collection and recycling.	Will happen under existing laws.
Cooking oil	5,265	Nonresidential	Private companies purchase and collect for use as a biofuel.	Yes, for use as an energy source.
Glass	2,646	Non-residential	Need Arkansas-based recycling and approved alternative uses.	Yes, need better markets.
Metals	806,978	Residential and nonresidential	Good programs in place for collection and recycling.	No.
Motor oil	60,292	Residential and nonresidential		Yes, for use as an energy source.
Pallets and other wood wastes	910,518	Nonresidential		Yes, for use as an energy source.
Paper—cardboard	40,030	Nonresidential		Yes.
Paper—mixed	11,230	Nonresidential		Yes.
Paper—newsprint	22,977	Residential		Yes.
Paper—white ledger	72,987	Nonresidential		Yes.
Paper—magazines	106	Residential		Yes.
Paper—other	1,521	Nonresidential		Yes.
Plastic—HDPE, LDPE and PET	1,648; 3,283; 1,374	Residential	Mostly going out of state for processing.	Yes, need better collection.
Plastics—poly pipe	25,517	Nonresidential	Mostly going out of state for processing.	Yes.
Plastics—other	2,054	Nonresidential	Mostly going out of state for processing.	Yes.
Sawdust	5,800	Nonresidential		Yes.
Textiles and leather	472	Residential and nonresidential		No, too small a waste stream.
Tires and rubber	34,508	Residential and nonresidential	Currently banned from disposal in a landfill (Act 749 of 1991). Mostly shipped out of state for recycling.	Yes, for more in-state uses.
Yard wastes	79,086	Residential and nonresidential	Currently banned from disposal in a landfill (Act 751 of 1991). Mostly being composted.	Yes, potential use as an energy source.

HDPE = high-density polyethylene; LDPE = low-density polyethylene; PET = polyethylene terephthalate.

<sup>123</sup> For the purposes of this discussion, the point of generation will be categorized as either residentially or nonresidentially generated.

## Implementation Mechanisms

Examples of potential implementation mechanisms that could help achieve the policy goals through encouraging advanced recycling and recovery include:

- Strengthening existing recycling legislation or providing incentives/subsidies to the municipalities to have more aggressive recycling efforts (currently it is more expensive to recycle than to landfill).
- Encouraging reuse and recycling through best management practices for corporations, businesses, and government organizations.
- Introducing container deposit legislation (bottle bill) that requires that a deposit on beverage packaging material (glass, plastic, and/or aluminum containers<sup>124</sup>) be collected when the item is sold. The deposit is then refunded to the consumer when the container is returned to an authorized redemption center.
- Encouraging centralized recycling locations, perhaps through corporation-based locations—e.g., supermarket chains could have recycling centers.
- Encouraging the procurement of products produced from recycled material.

## Related Policies/Programs in Place

### Recycling Goals

*Act 94 (HB 1055)*—The act adds a new goal to the year 2000 recycling goals for Arkansas, which is to recycle 40% of the MSW by the end of 2005 and 45% of the MSW by the end of 2010. The act also defines MSW.

### Solid Waste Management and Recycling Fund

*Act 1325 (SB 575)*—This act permits grants from the Solid Waste Management and Recycling Fund to be used for the cost of “recycling programs.” Previous law permitted grants to be used for “recycling programs and market development.”

### Opportunity to Recycle

*Arkansas Code Annotated 8-6-720(a)(1)*—Beginning July 1, 1992, each regional solid waste management board must ensure that its residents have an “opportunity to recycle,” which means the availability of curbside pickup or collection centers for recyclable materials at sites that are convenient for people to use.

## Type(s) of GHG Reductions

**CO<sub>2</sub>:** *Reductions in Upstream Energy Use*—The energy and GHG intensity of manufacturing a product are generally less when using recycled, rather than virgin, feedstocks.

**CH<sub>4</sub>:** Diverting biodegradable wastes from landfills decreases methane gas releases from landfills.

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<sup>124</sup> The market share of beverage type and packaging material is 59% aluminum cans, 25% plastic, and 12% glass. Based on Container Recycling Institute. “Beverage Market Data Analysis.” January 2004. Available at: <http://www.container-recycling.org/bmda/index.htm>.

## Estimated GHG Reductions and Costs or Cost Savings

**GHG Reduction Potential in 2015, 2025 (MMtCO<sub>2e</sub>):** 1.5, 4.4, respectively.

**Net Cost per tCO<sub>2e</sub>:** -\$8.

### Data Sources:

Key data sources for the development of the quantification of AFW-8 are:

- Arkansas Department of Environmental Quality. *State of Recycling in Arkansas*. Reports available from 1999 through 2006. Accessed on June 12, 2008, from: [http://www.adeq.state.ar.us/solwaste/branch\\_recycling/default.htm](http://www.adeq.state.ar.us/solwaste/branch_recycling/default.htm).
- U.S. Environmental Protection Agency. *2006 MSW Characterization Data Tables (PDF)*. Accessed on July 7, 2008, from: <http://www.epa.gov/epaoswer/non-hw/muncpl/pubs/06data.pdf>.
- U.S. Environmental Protection Agency. “Waste Reduction Model (WARM).” Version 8, May 2006. Available at: [http://www.epa.gov/climatechange/wyacd/waste/calculators/Warm\\_home.html](http://www.epa.gov/climatechange/wyacd/waste/calculators/Warm_home.html).

Additional background information was obtained from: The Container Recycling Institute. *Market Data Analysis*, January 2004.

### Quantification Methods:

#### *GHG Benefits*

The GHG benefits resulting from increased waste diversion in Arkansas are quantified by:

- Establishing BAU projections for landfill disposal, incineration, recycling, and composting. (As recycling and composting are fundamentally two different processes, they will be considered separately, with the sum of the two being equal to total waste “diversion.”)
- Using the goals set forth by the TWG to project the policy scenario for waste management.
- Using recycling data from the ADEQ *State of Recycling in Arkansas* reports and national-level generation and disposal data from the EPA *2006 Municipal Solid Waste Characterization Data Tables*, and disaggregating the Arkansas recycling, composting, and disposal data.
- Inserting the resulting waste characterization for the baseline and policy scenarios into WARM to determine the incremental GHG benefit resulting from the goals set forth in this policy. WARM provides a life-cycle estimate of the GHG benefits from additional recycling and composting. These benefits include the energy required to produce materials from virgin inputs and to recycle materials, and the change in landfill gas emissions.

The baseline recycling and composting rates for MSW in Arkansas are 40.3% and 1.8%, respectively. Based on the change in MSW generation over the last 5 years, it is assumed that the BAU average annual increase in MSW generation is 4.7%. Population projections are consistent

with those used in the development of the Arkansas I&F.<sup>125</sup> These assumptions are used to develop the BAU waste management scenario presented in Table J-8-2.

**Table J-8-2. Business-as-usual waste management projections for Arkansas**

Item	2006	2010	2015	2020	2025
MSW generation (4.7%/year growth 2002–2006)	5,012,531	6,020,073	7,568,897	9,516,197	11,964,492
AR population (from AR I&F)	2,800,397	2,897,236	3,018,285	3,139,334	3,260,383
MSW generation per capita (tons/person)	1.79	2.08	2.51	3.03	3.67
MSW recycled (tons) (40.3% of generation, not including organics)	2,021,709	2,428,082	3,052,771	3,838,177	4,825,650
Organic composting (tons) (1.8% of generation)	90,133	108,250	136,100	171,116	215,140
MSW disposed in landfills (tons)	2,900,689	3,483,741	4,380,026	4,343,047	5,111,005

MSW = municipal solid waste; AR I&F = Arkansas Inventory and Forecast.

The policy goals set forth by the TWG are applied to the baseline recycling and composting tonnages to project future waste management under the policy scenario. The remainder of the waste generated is assumed to be disposed in landfills. Table J-8-3 shows the projected management of waste generated in Arkansas under the policy scenario. Table J-8-4 shows the incremental waste diversion, or the difference between the policy and BAU scenarios.

**Table J-8-3. Waste management projection for Arkansas, including policy goals (short tons)**

Item	2006	2010	2015	2020	2025
MSW generation	5,012,531	6,020,073	7,568,897	9,516,197	11,964,492
MSW recycled	2,021,709	2,593,412	3,405,553	4,463,923	5,841,464
Organic composting	90,133	115,621	151,828	199,013	260,428
MSW disposed in landfills	2,900,689	3,311,040	4,011,515	4,853,261	5,862,601

MSW = municipal solid waste.

**Table J-8-4. Incremental diversion under policy goals (short tons)**

Item	2006	2010	2015	2020	2025
Recycling	—	165,330	352,783	625,746	1,015,813
Organic composting	—	7,371	15,728	27,897	45,288
Landfill disposal	—	-172,701	-368,511	-653,644	-1,061,101

The national baseline composition of waste generated is used to develop the breakdown of waste generation for Arkansas by waste type.<sup>126</sup> The waste types used for this analysis correspond to

<sup>125</sup> Arkansas Governor's Commission on Global Warming. "Arkansas Greenhouse Gas Inventory and Reference Case Projections, 1990-2025." Available at: [http://www.arclimatechange.us/Inventory\\_Forecast\\_Report.cfm](http://www.arclimatechange.us/Inventory_Forecast_Report.cfm).

the disaggregated recycling information provided in the 2002–2006 *State of Recycling in Arkansas* annual reports and the inputs available for the WARM. Table J-8-5 shows the waste generation characteristics of broad waste categories, and Table J-8-6 shows the mix of generation by specific waste type within some of these categories. Again, these tables present an estimated waste characterization for Arkansas, based on national generation and diversion rates that are assumed to adequately represent the Arkansas waste stream. Due to cases where a larger quantity of a given material was recycled than projected to be generated under the BAU scenario, adjustments to the raw national data were made to fit the Arkansas waste profile.

The mix of waste generation shown in Tables J-8-5 and J-8-6 is applied to the total waste generation in Arkansas. Next, the shares of waste recycled and composted (Table J-8-7) within each of these categories are multiplied by the total amount of waste recycled (or composted for food waste, yard trimmings, and mixed organics), to yield the amount of waste recycled or composted by waste type.

Once the tonnages of waste generated, recycled, and composted are established, the recycled and composted wastes are subtracted from the amount generated, leaving the amount of waste that has not been diverted. This amount is the assumed quantity of waste landfilled by waste type. The results of this process are entered into WARM. Tables J-8-8 and J-8-9 display WARM inputs for 2025.

**Table J-8-5. Waste generation characteristics, by category**

Category	Baseline Generation Composition (% of total generation)
Paper	12.6%
Organics	5.1%
Mixed plastic	9.7%
Metals	44.2%
Glass	0.2%
Other	28.0%

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<sup>126</sup> U.S. Environmental Protection Agency. *2006 MSW Characterization Data Tables (PDF)*. Accessed on July 7, 2008, from: <http://www.epa.gov/epaoswer/non-hw/muncpl/pubs/06data.pdf>.

**Table J-8-6. Waste generation characteristics, by waste type**

<b>Waste Type</b>	<b>Baseline Generation Composition (% of total generation)</b>
Paper	
Corrugated cardboard	1.1%
Magazines/third-class mail	0.0%
Newspaper	0.5%
Office paper	0.0%
Phonebooks	0.3%
Textbooks	0.4%
Mixed paper, residential	3.3%
Mixed paper, office	6.9%
Organics	
Food waste	1.1%
Yard trimmings	2.5%
Mixed organics	1.5%
Plastics	
HDPE	7.2%
LDPE	1.5%
PET	0.1%
Other (assumed mixed plastics)	0.9%
Metals	
Aluminum cans	4.3%
Steel cans	0.1%
Mixed metals	39.9%
Glass	
Glass	0.2%
Other	
Mixed recyclables	25.9%
Personal computers	1.2%
Tires	1.0%

HDPE = high-density polyethylene; LDPE = low-density polyethylene; PET = polyethylene terephthalate.

**Table J-8-7. Recycled and composted waste characteristics, by waste type: 2006**

<b>Material</b>	<b>BAU Percentage Recycled</b>	<b>BAU Percentage Composted</b>	<b>Policy Percentage Recycled</b>	<b>Policy Percentage Composted</b>
Aluminum cans	3.8%	N/A	3.8%	
Steel cans	0.1%	N/A	0.1%	
Glass	0.1%	N/A	0.1%	
HDPE	1.3%	N/A	1.3%	
LDPE	0.2%	N/A	0.2%	
PET	0.1%	N/A	0.1%	
Corrugated cardboard	2.0%	N/A	2.0%	
Magazines/third-class mail	0.0%	N/A	0.0%	
Newspaper	1.1%	N/A	1.0%	
Office paper	0.1%	N/A	0.1%	
Phonebooks	0.0%	N/A	0.2%	
Textbooks	0.0%	N/A	0.5%	
Food scraps	N/A	0.0%		3.3%
Yard trimmings	N/A	87.7%		87.7%
Mixed paper (primarily residential)	0.6%	N/A	0.6%	
Mixed paper (primarily from offices)	3.6%	N/A	3.6%	
Mixed metals	36.0%	N/A	36.0%	
Mixed plastics	0.1%	N/A	0.1%	
Mixed recyclables	48.1%	N/A	47.5%	
Mixed organics	N/A	12.3%		9.0%
Personal computers	1.1%	N/A	1.1%	
Tires	1.7%	N/A	1.7%	
<b>Totals</b>	<b>100.0%</b>	<b>100.0%</b>	<b>100.0%</b>	<b>100.0%</b>

BAU = business as usual; N/A = not applicable; HDPE = high-density polyethylene; LDPE = low-density polyethylene; PET = polyethylene terephthalate.

**Table J-8-8. 2025 baseline WARM inputs**

<b>Material</b>	<b>Tons Generated</b>	<b>Tons Recycled</b>	<b>Tons Landfilled</b>	<b>Tons Combusted</b>	<b>Tons Composted</b>
Aluminum cans	511,531	182,105	329,426		N/A
Steel cans	7,172	4,540	2,632		N/A
Copper wire					N/A
Glass	29,213	6,316	22,897		N/A
HDPE	861,933	64,841	797,092		N/A
LDPE	183,592	7,836	175,756		N/A
PET	16,187	3,280	12,907		N/A
Corrugated cardboard	132,704	95,548	37,155		N/A
Magazines/third-class mail	645	253	392		N/A
Newspaper	62,362	54,844	7,518		N/A
Office paper	5,529	3,630	1,898		N/A
Phonebooks	32,370	—	32,370		N/A
Textbooks	53,791	—	53,791		N/A
Dimensional lumber					N/A
Medium-density fiberboard					N/A
Food scraps	130,987	N/A	130,987		—
Yard trimmings	304,219	N/A	115,491		188,729
Grass		N/A			
Leaves		N/A			
Branches		N/A			
Mixed paper (general)					N/A
Mixed paper (primarily residential)	396,503	26,805	369,698		N/A
Mixed paper (primarily from offices)	825,027	174,214	650,813		N/A
Mixed metals	4,775,362	1,739,544	3,035,818		N/A
Mixed plastics	103,881	4,903	98,978		N/A
Mixed recyclables	3,098,342	2,319,221	779,121		N/A
Mixed organics	176,565	N/A	150,153		26,411
Mixed MSW		N/A			N/A
Carpet					N/A
Personal computers	138,048	55,403	82,645		N/A
Clay bricks		N/A		N/A	N/A
Concrete				N/A	NA
Fly ash				N/A	N/A
Tires	118,531	82,368	36,163		N/A

WARM = [EPA's] WAste Reduction Model; N/A = not applicable; HDPE = high-density polyethylene; LDPE = low-density polyethylene; PET = polyethylene terephthalate; MSW = municipal solid waste.

**Table J-8-9. 2025 policy WARM inputs<sup>127</sup>**

<b>Material</b>	<b>Baseline Generation</b>	<b>Tons Recycled</b>	<b>Tons Landfilled</b>	<b>Tons Combusted</b>	<b>Tons Composted</b>
Aluminum cans	511,531	220,439	291,092		
Steel cans	7,172	5,496	1,676		
Copper wire		—			
Glass	29,213	7,645	21,567		
HDPE	861,933	78,490	783,443		
LDPE	183,592	9,486	174,106		
PET	16,187	3,970	12,217		
Corrugated cardboard	132,704	115,661	17,042		
Magazines/third-class mail	645	306	338		
Newspaper	62,362	58,415	3,947		
Office paper	5,529	4,395	1,134		
Phonebooks	32,370	12,447	19,923		
Textbooks	53,791	27,766	26,025		
Dimensional lumber					
Medium-density fiberboard					
Food scraps	130,987		122,465		8,522
Yard trimmings	304,219		75,763		228,457
Grass					
Leaves					
Branches					
Mixed paper, broad					
Mixed paper, residential	396,503	32,448	364,055		
Mixed paper, office	825,027	210,886	614,141		
Mixed metals	4,775,362	2,105,723	2,669,639		
Mixed plastics	103,881	5,935	97,946		
Mixed recyclables	3,098,342	2,775,185	323,157		
Mixed organics	176,565		153,116		23,449
Mixed MSW					
Carpet					
Personal computers	138,048	67,065	70,983		
Clay bricks					
Concrete					
Fly ash					
Tires	118,531	99,706	18,825		

<sup>127</sup> Due to insufficient data on the characterization of waste landfilled in Arkansas, CCS was required to project the BAU and policy scenarios using a default national waste characterization from EPA. The adjustments and aggregation of material types required to fit the data to the WARM reduce the certainty of the GHG benefit estimates. As a consequence, the results in Table J-8-9 do not directly correlate with ADEQ data in Table J-8-1.

WARM = [EPA's] WASTE Reduction Model; HDPE = high-density polyethylene; LDPE = low-density polyethylene; PET = polyethylene terephthalate; MSW = municipal solid waste.

The WARM analysis predicts a GHG benefit of 1.5 MMtCO<sub>2</sub>e in 2015 and 4.4 MMtCO<sub>2</sub>e in 2025. Assuming the program implementation begins in 2010 and a linear increase in emission reductions between target years, the cumulative GHG benefit is estimated to be 36 MMtCO<sub>2</sub>e through 2025 (Table J-8-10).

**Table J-8-10. Overall policy results—GHG benefits**

Year	Avoided Emissions (MMtCO <sub>2</sub> e)	Incremental Waste Diversion (tons)	Incremental Recycling (tons)	Incremental Composting (tons)	Avoided Landfill Emplacement (tons)
2009	—	—	—	—	—
2010	0.25	172,701	165,330	7,371	-172,701
2011	0.51	223,533	213,993	9,540	-223,533
2012	0.76	268,797	257,325	11,472	-268,797
2013	1.02	308,232	295,077	13,155	-308,232
2014	1.27	341,565	326,987	14,578	-341,565
2015	1.52	368,511	352,783	15,728	-368,511
2016	1.80	440,210	421,422	18,788	-440,210
2017	2.08	504,909	483,359	21,549	-504,909
2018	2.35	562,279	538,281	23,998	-562,279
2019	2.63	611,977	585,858	26,119	-611,977
2020	2.91	653,644	625,746	27,897	-653,644
2021	3.18	753,583	721,420	32,163	-753,583
2022	3.46	844,720	808,668	36,052	-844,720
2023	3.73	926,643	887,094	39,549	-926,643
2024	4.01	998,921	956,287	42,634	-998,921
2025	4.35	1,061,101	1,015,813	45,288	-1,061,101
<b>Total</b>	<b>35.8</b>	<b>9,041,325</b>	<b>8,655,443</b>	<b>385,882</b>	<b>-9,041,325</b>

GHG = greenhouse gas; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent.

### *Cost-Effectiveness*

*Recycling*—The net cost of increased recycling rates in Arkansas was estimated by adding the increased costs of collection for two-stream recycling, revenue obtained for the value of recycled materials, and avoided landfill tipping fees. The additional cost for separate curbside collection of recyclables is \$2.50/household/month, or \$30/household/year.<sup>128</sup> Dividing this number by the incremental recycling per capita in 2025,<sup>129</sup> and multiplying that number by the average

<sup>128</sup> T. Brownell, Eureka Recycling, personal communication with S. Roe (Center for Climate Strategies), December 17, 2007. This value compares favorably with data provided to the AFW TWG (T. Troolin, St. Louis County) on recycling costs incurred by Minnesota counties.

<sup>129</sup> Population projection for 2025 from the Arkansas I&F.

household size of 2.49,<sup>130</sup> yields the maximum collection cost of \$6.73/ton. The capital cost of additional recycling facilities in Arkansas is \$134 million.<sup>131</sup> Annualized over the 15-year policy period at 5% interest, the capital cost is \$8.7 million/year. The avoided cost for landfill tipping is \$28/ton.<sup>132</sup> The Center for Climate Strategies (CCS) also factored in the commodity value of recycled materials with a value of \$38/ton.<sup>133</sup> Table J-8-11 provides the results of the cost analysis. The analysis assumes that costs begin to be incurred in 2010. The estimated cost savings result in an NPV of -\$295 million. Cumulative reductions are 17.0 MMtCO<sub>2</sub>e, and the estimated cost-effectiveness is -\$17/tCO<sub>2</sub>e.

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<sup>130</sup> U.S. Census Bureau. "State & County QuickFacts—Arkansas." Accessed on July 10, 2008, at: <http://quickfacts.census.gov/qfd/states/05000.html>.

<sup>131</sup> Based upon the ratio of capital cost per household used in the Vermont analysis. The Vermont capital cost is a result of personal communication between P. Calabrese (Cassella Waste Management) and S. Roe (Center for Climate Strategies) on June 5, 2007.

<sup>132</sup> Georgia Department of Community Affairs, Office of Environmental Management. "MSW and C&D Landfill Tipping Fees: 2005 Solid Waste Management Update." Available at: [http://www.dca.state.ga.us/development/research/programs/downloads/SWAR\\_2005\\_Chap01.pdf](http://www.dca.state.ga.us/development/research/programs/downloads/SWAR_2005_Chap01.pdf). Note that this tip fee estimate is for Arkansas MSW landfills.

<sup>133</sup> RecycleNet Composite Index. "U.S. Municipal Recycling Index—Spot Market Prices: February 1, 2008." Accessed on February 1, 2008, at: <http://www.scrapindex.com/municipal.html>. Adjusted to 2005\$ using the Consumer Price Index calculator found at Federal Reserve Bank of Minneapolis, "What Is a Dollar Worth?" Available at: <http://minneapolisfed.org/Research/data/us/calc/>.

**Table J-8-11. Cost analysis results for recycling**

Year	Tons Recycled	Annual Collection Cost (MM\$)	Annual Capital Cost (MM\$)	Annual Recycled Material Revenue (MM\$)	Landfill Tip Fees Avoided (MM\$)	Net Policy Cost (Recycling) (MM\$)	Discounted Costs (MM\$)	GHG Reductions (MMtCO <sub>2</sub> e)	Cost-Effectiveness (\$/tCO <sub>2</sub> e)
2009	—	\$0.0	\$0	\$0	\$0	\$0	\$0	—	
2010	165,330	\$1.1	\$6	\$6	\$6	-\$5	-\$5	0.3	
2011	213,993	\$1.4	\$6	\$8	\$8	-\$8	-\$8	0.5	
2012	257,325	\$1.7	\$6	\$10	\$10	-\$11	-\$10	0.8	
2013	295,077	\$2.0	\$6	\$11	\$11	-\$14	-\$12	1.0	
2014	326,987	\$2.2	\$6	\$13	\$12	-\$16	-\$13	1.3	
2015	352,783	\$2.4	\$6	\$14	\$13	-\$18	-\$14	1.5	
2016	421,422	\$2.8	\$6	\$16	\$16	-\$23	-\$16	1.8	
2017	483,359	\$3.3	\$6	\$19	\$18	-\$27	-\$18	2.1	
2018	538,281	\$3.6	\$6	\$21	\$20	-\$31	-\$20	2.3	
2019	585,858	\$3.9	\$6	\$22	\$22	-\$34	-\$21	2.6	
2020	625,746	\$4.2	\$6	\$24	\$24	-\$37	-\$22	2.9	
2021	721,420	\$4.9	\$6	\$28	\$27	-\$44	-\$24	3.2	
2022	808,668	\$5.4	\$6	\$31	\$31	-\$50	-\$26	3.4	
2023	887,094	\$6.0	\$6	\$34	\$34	-\$55	-\$28	3.7	
2024	956,287	\$6.4	\$6	\$37	\$36	-\$60	-\$29	4.0	
2025	1,015,813	\$6.8	\$6	\$39	\$39	-\$64	-\$29	4.3	
<b>Total</b>						<b>-\$499</b>	<b>-\$295</b>	<b>17.0</b>	<b>-\$17</b>

MM = million; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; \$/tCO<sub>2</sub>e = dollars per metric ton of carbon dioxide equivalent.

*Composting*—Composting is included in the total recycling volume in the *State of Recycling in Arkansas* reports. However, as WARM considers the sole form of diversion for yard trimmings and food waste to be composting, the tons of these items that are “recycled” are assumed to be composted. The net costs for increased composting in Arkansas were estimated by adding the additional costs for collection (same calculation as recycling) and the net cost for composting operations. The net cost for composting operations is the sum of the annualized capital and operating costs of composting, increased collection fees, revenue generated through the sale of compost, and the avoided tipping fees for landfilling. Information on the capital and operating costs of composting facilities was received from Cassella Waste Management during the analysis of a similar policy in Vermont.<sup>134</sup> These data are summarized in Table J-8-12.

<sup>134</sup> P. Calabrese (Cassella Waste Management), personal communication with S. Roe (Center for Climate Strategies) on June 5, 2007. Because the cost was not originally specified in terms of 2007\$, the TWG assumed the cost to be valid for 2005.

**Table J-8-12. Capital and operating costs of composting facilities**

Annual Volume (tons)	Capital Cost (\$1,000)	Operating Cost (\$/ton)
< 1,500	\$75	\$25
1,500–10,000	\$200	\$50
10,000–30,000	\$2,000	\$40
30,000–60,000+	\$8,000	\$30

CCS assumed that the composting facilities to be built within the policy period would tend to be from the largest category (achieving the most efficient operating costs) shown in Table J-8-12. The composting volumes in 2015 and 2025 shown in Table J-8-13 suggest the need for one additional large composting operation to meet the incremental increase in composting through 2025. To annualize the capital costs of these facilities, CCS assumed a 15-year operating life and a 5% interest rate. Other cost assumptions include an assumed landfill tipping fee of \$28/ton,<sup>135</sup> an additional source-separated organics collection fee of \$2.50/household (or \$51/ton, as used above in the recycling element), a compost facility tipping fee of \$30/ton,<sup>136</sup> and a compost value of \$25/ton.<sup>137</sup>

Table J-8-13 presents the results of the cost analysis for composting. GHG reductions were assumed not to begin until 2010, and the cumulative reductions estimated were 0.06 MMtCO<sub>2</sub>e. An NPV of \$12 million was estimated, along with a cost-effectiveness of \$182/tCO<sub>2</sub>e.

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<sup>135</sup> Georgia Department of Community Affairs, Office of Environmental Management. “MSW and C&D Landfill Tipping Fees: 2005 Solid Waste Management Update.” Accessed on July 10, 2008, from: [http://www.dca.state.ga.us/development/research/programs/downloads/SWAR\\_2005\\_Chap01.pdf](http://www.dca.state.ga.us/development/research/programs/downloads/SWAR_2005_Chap01.pdf).

<sup>136</sup> Personal communication from R. Hunter (ADEQ) to J. Pryor (Center for Climate Strategies) on August 21, 2008.

<sup>137</sup> Ibid.

**Table J-8-13. Cost analysis results for composting**

Year	Annual Cost O&M (\$MM)	Capital Cost (\$MM)	Annualized Capital Cost (\$MM)	Annual Collection Cost (\$MM)	Incremental Landfill Tipping Fee Cost (\$MM)	Value of Composted Material (\$MM)	Tons of Waste Composted	Total Annual Composting Cost (\$MM)	Discounted Costs (\$MM)	GHG Reductions (MMtCO <sub>2</sub> e)	Cost-Effectiveness (\$/t)
2009	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	—	\$0.0	\$0.0	—	
2010	\$0.2	\$8.0	\$0.8	\$0.0	\$0.0	\$0.2	7,371	\$0.9	\$0.8	0.00	
2011	\$0.3	\$0.0	\$0.8	\$0.1	\$0.0	\$0.2	9,540	\$0.9	\$0.8	0.00	
2012	\$0.3	\$0.0	\$0.8	\$0.1	\$0.0	\$0.3	11,472	\$0.9	\$0.8	0.00	
2013	\$0.4	\$0.0	\$0.8	\$0.1	\$0.0	\$0.3	13,155	\$1.0	\$0.8	0.00	
2014	\$0.4	\$0.0	\$0.8	\$0.1	\$0.0	\$0.4	14,578	\$1.0	\$0.8	0.00	
2015	\$0.5	\$0.0	\$0.8	\$0.1	\$0.0	\$0.4	15,728	\$1.0	\$0.7	0.01	
2016	\$0.6	\$0.0	\$0.8	\$0.1	\$0.0	\$0.5	18,788	\$1.0	\$0.7	0.01	
2017	\$0.6	\$0.0	\$0.8	\$0.1	\$0.0	\$0.5	21,549	\$1.1	\$0.7	0.01	
2018	\$0.7	\$0.0	\$0.8	\$0.2	\$0.0	\$0.6	23,998	\$1.1	\$0.7	0.01	
2019	\$0.8	\$0.0	\$0.8	\$0.2	\$0.1	\$0.7	26,119	\$1.1	\$0.7	0.01	
2020	\$0.8	\$0.0	\$0.8	\$0.2	\$0.1	\$0.7	27,897	\$1.2	\$0.7	0.01	
2021	\$1.0	\$0.0	\$0.8	\$0.2	\$0.1	\$0.8	32,163	\$1.2	\$0.7	0.01	
2022	\$1.1	\$0.0	\$0.8	\$0.2	\$0.1	\$0.9	36,052	\$1.3	\$0.7	0.01	
2023	\$1.2	\$0.0	\$0.8	\$0.3	\$0.1	\$1.0	39,549	\$1.3	\$0.7	0.01	
2024	\$1.3	\$0.0	\$0.8	\$0.3	\$0.1	\$1.1	42,634	\$1.4	\$0.7	0.01	
2025	\$1.4	\$0.0	\$0.8	\$0.3	\$0.1	\$1.1	45,288	\$1.4	\$0.6	0.02	
<b>Total</b>									<b>\$12</b>	<b>0.06</b>	<b>\$182</b>

O&M = operation and maintenance; \$MM = millions of dollars; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent; \$/t = dollars per metric ton.

The overall cost analysis, as seen in Table J-8-14, yields an NPV of -\$283 and a cost-effectiveness of -\$7.9/tCO<sub>2</sub>e, based on the cumulative emission reductions of 35.8 MMtCO<sub>2</sub>e.

**Table J-8-14. Overall policy results—cost-effectiveness**

Year	Net Program Cost: Recycling (\$MM)	Net Program Cost: Composting (\$MM)	Total Net Program Cost (\$MM)	Discounted Cost (\$MM)	Cost-Effectiveness (\$/tCO <sub>2</sub> e)
2009	\$0.0	\$0.0	\$0.0	\$0	
2010	-\$5.1	\$0.9	-\$4.2	-\$4	
2011	-\$8.4	\$0.9	-\$7.5	-\$7	
2012	-\$11.5	\$0.9	-\$10.5	-\$9	
2013	-\$14.1	\$1.0	-\$13.1	-\$11	
2014	-\$16.3	\$1.0	-\$15.3	-\$12	
2015	-\$18.1	\$1.0	-\$17.1	-\$13	
2016	-\$22.9	\$1.0	-\$21.9	-\$16	
2017	-\$27.2	\$1.1	-\$26.1	-\$18	
2018	-\$31.0	\$1.1	-\$29.9	-\$19	
2019	-\$34.3	\$1.1	-\$33.2	-\$20	
2020	-\$37.1	\$1.2	-\$36.0	-\$21	
2021	-\$43.8	\$1.2	-\$42.6	-\$24	
2022	-\$49.9	\$1.3	-\$48.6	-\$26	
2023	-\$55.3	\$1.3	-\$54.0	-\$27	
2024	-\$60.1	\$1.4	-\$58.8	-\$28	
2025	-\$64.3	\$1.4	-\$62.9	-\$29	
<b>Total</b>				<b>-\$283</b>	<b>-\$7.9</b>

\$MM = millions of dollars; \$/tCO<sub>2</sub>e = dollars per metric ton of carbon dioxide equivalent.

Sum of columns may not equal totals due to independent rounding.

**Key Assumptions:** For the MSW management input data to WARM, the key assumption is that none of the goals would be achieved via existing programs in place. To the extent that those programs will fully or partly achieve the goals of this policy, the GHG reductions estimated would be lower (no additional penetration from the current Arkansas recycling and composting campaigns has been incorporated into the BAU assumptions for this analysis). Therefore, the most important assumption relates to the assumed BAU projection for solid waste management. This BAU forecast is based on current practices, and does not factor in the effects of further gains in recycling or composting rates during the policy period. The BAU assumptions are needed to tie into the assumptions used to develop the GHG forecast for the waste management sector, which does not factor in these changes in waste management practices during the policy period (2010–2025). To the extent that these gains in recycling and composting would occur without this policy, the benefits and costs are overstated.

The other key assumptions relate to the use of WARM in estimating life-cycle GHG benefits and the use of the stated assumptions regarding costs for increased source reduction, recycling, and organics recovery (composting in this example) programs.

Another important assumption is that under BAU, the waste directed to landfilling would include methane recovery (75% collection efficiency) and utilization. The need for this assumption is partly based on limitations of WARM (which doesn't allow for management of landfilled waste into both controlled and uncontrolled landfills), but is also based on the overall direction of the policy recommendations of AFW-8.

Additionally, transportation emissions for WARM are taken as default. This analysis has not considered the impacts of reduced exports as a result of the goals in this recommendation's Policy Design section.

This analysis assumes that no additional uncontrolled landfill sites trigger EPA control requirements during the policy period.

### Key Uncertainties

One factor of uncertainty with the analysis, as performed above, is the interest rate used for capital expenditures. Table J-8-15 displays the effect on the results of this policy recommendation that 8% and 10% interest rates would have on the results, which are based on a 5% interest rate.

**Table J-8-15. Sensitivity to interest rate on capital expenditure**

Interest Rate	Annualized Capital Cost (\$MM/year)	Net Present Value Policy Cost (\$MM)	Cost-Effectiveness (\$/tCO <sub>2</sub> e)
5%	\$7.2	-\$283.3	-\$7.9
8%	\$8.8	-\$266.6	-\$7.4
10%	\$9.9	-\$254.7	-\$7.1

\$MM = millions of dollars; \$/tCO<sub>2</sub>e = dollars per metric ton of carbon dioxide equivalent.

Negative values in the Net Present Value and the Cost-Effectiveness columns represent net cost savings.

Currently, the amount of clay bricks, concrete, fly ash, or carpet disposed in Arkansas is not tracked by ADEQ. Bricks and concrete go to class four landfills in a mixture of materials. At this time, fly ash and carpet can be very costly to transport to disposal sites, and the markets for these materials are not very strong. Although these materials are a discernable part of the waste stream in Arkansas, resources could be concentrated on them in the future in order to better understand both current and potential disposal strategies.

It is possible that the impacts of this goal will cross state lines. Recycled materials in Arkansas may be reprocessed into finished products in other states. Also, the recycled materials may be replacing virgin inputs that are mined, processed, and manufactured into finished goods outside of Arkansas' borders. Thus, the practice of increased recycling in Arkansas may create benefits outside of the state's boundary.

Due to insufficient data on the characterization of waste landfilled in Arkansas, CCS was required to project the BAU and policy scenarios using a default national waste characterization from EPA. The adjustments and aggregation of material types required to fit the data to the WARM model reduce the certainty of the GHG benefit estimates.

### **Additional Benefits and Costs**

None identified.

### **Feasibility Issues**

None identified.

### **Status of Group Approval**

Complete.

### **Level of Group Support**

Super Majority (1 objection).

### **Barriers to Consensus**

One member does not believe this recommendation will result in net cost savings.

## AFW-9. End-of-Use Waste Management Practices

### Policy Description

These programs use the renewable energy created at landfills by anaerobic digesters (methane) to make electric power, space heat, or liquefied natural gas. New processes for converting waste energy include biomass gasification and pyrolysis. A range of renewable products can be developed from these processes, including gaseous and liquid fuels, biochar, and chemical products. Existing processes include waste combustion and energy recovery (as electricity, steam, or both).

### Policy Design

**Goals:** By 2025, 25% of all landfills develop landfill gas-to-energy (LFGTE) and anaerobic digester projects.

**Timing:** As indicated above.

**Parties Involved:** Landfill owners, ADEQ, and energy industries.

**Other:** There are currently 24 municipal solid waste landfills operating in Arkansas. Of those, 6 have an active gas collection system, 4 of the 6 are or will be flaring landfill gases, and 2 are collecting and using these gases for energy.

Based on the baseline data from the Arkansas I&F, the 2005 GHG emissions averted through flaring or LFGTE projects is 12% of the total CH<sub>4</sub> emissions from MSW generation.

### Implementation Mechanisms

All landfills could be required to examine the current costs and value of collecting and/or utilizing landfill gas, to ensure that owners and operators are aware of current costs (which are decreasing, possibly making collecting and/or utilizing landfill gas more feasible or economical than some are aware).

Incentives in the form of payments to utilities, industries, individuals, or other entities that utilize energy from landfill sites could be provided to encourage recipients to locate their operations close enough to existing landfill sites so that they can use the methane and/or electricity generated from those facilities.

Cost incentives, such as carbon credits, could make methane capture and/or utilization more attractive. State tax incentives/tax credits may encourage utilization of landfill gas

### Related Policies/Programs in Place

None identified.

## Type(s) of GHG Reductions

**CO<sub>2</sub>:** Reduction of fossil fuels and associated GHGs through the generation of electricity from landfill methane or heat/steam or electricity at waste-to-energy facilities.

**CH<sub>4</sub>:** Diverting biodegradable wastes from landfills will decrease methane gas releases from landfills.

## Estimated GHG Reductions and Costs or Cost Savings

**GHG Reduction Potential in 2015, 2025 (MMtCO<sub>2</sub>e):** 0.02, 0.02, respectively.

**Net Cost per tCO<sub>2</sub>e:** -\$3.

### Data Sources:

- U.S. Environmental Protection Agency, Landfill Methane Outreach Program. “Energy Projects and Candidate Landfills.” Online database accessed on May 22, 2008, at: <http://www.epa.gov/lmop/proj/index.htm>.
- U.S. Environmental Protection Agency. Landfill Methane Outreach Program. Landfill Gas Energy Cost Model (LFGcost), Version 1.4. “Summary Report, Pechan for NC GHG Mitigation Plan.” March 2, 2007.
- ADEQ. “2007 MSW Quarterly Report Yearly Totals.” Received by B. Strode via e-mail communication with K. Bassett on July 9, 2008.
- ADEQ. “LFGTE List.” Excel spreadsheet of landfills in AR highlighting those with LFGTE capabilities, and those with currently installed gas collection systems. Received by B. Strode via e-mail communication with K. Bassett on July 9, 2008.
- Arkansas Governor's Commission on Global Warming. "Arkansas Greenhouse Gas Inventory and Reference Case Projections, 1990–2025: Waste Appendix." Available at: [http://www.arclimatechange.us/Inventory\\_Forecast\\_Report.cfm](http://www.arclimatechange.us/Inventory_Forecast_Report.cfm).

### Quantification Methods:

#### *GHG Benefits*

The goal of this policy recommendation requires 25% of all landfills in Arkansas to utilize LFGTE technology by 2025. According to ADEQ, there are currently 24 landfills in Arkansas. Thus, LFGTE technology will have to be installed at six landfills in order to meet the goal. Currently, two landfills already utilize LFGTE technology, and four others have installed active gas collection systems, flaring the collected gas.<sup>138</sup> It was assumed that these four landfills that already have an active gas collection system will be the most cost-efficient landfills to target for LFGTE.

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<sup>138</sup> ADEQ. “LFGTE List.” Excel spreadsheet of landfills in Arkansas highlighting those with LFGTE capabilities, and those with currently installed gas collection systems. Sent by K. Bassett (ADEQ) to B. Strode (Center for Climate Strategies) on July 9, 2008.

The potential GHG benefit from the installation of LFGTE technologies at landfills comes from two sources: the conversion of the methane in landfill gas to CO<sub>2</sub> (a gas with a lower global warming potential) and the indirect benefit from the offset electricity or natural gas use. Since CCS assumed that the four additional landfills installing LFGTE needed to meet the goal will be those that already have active gas collection systems, only the indirect benefit of offset fossil energy use will be considered incremental to the BAU scenario.

CCS used the EPA LFGcost model to estimate the amount of electricity that could be generated in each year by the four additional landfills installing LFGTE.<sup>139</sup> Based on 2007 waste generation rates,<sup>140</sup> the LFGcost model predicted that 46,160 MWh could be generated at the landfills with new LFGTE equipment. Using the same emission factor for offset electricity as the ES TWG used in its analysis of recommendation ES-3a (Renewable Energy Portfolio Standard), it was estimated that the fulfillment of the goal for AFW-9 would produce a GHG benefit of 0.02 MMtCO<sub>2</sub>e in 2025, with a cumulative benefit of 0.4 MMtCO<sub>2</sub>e for the policy period 2010–2025.

### *Cost-Effectiveness*

The cost-effectiveness of this recommendation was determined using the LFGcost model.<sup>141</sup> The current model inputs assume an 8% interest rate over 15 years for capital and an electricity price of \$0.045/kWh. The LFGcost model predicts the total capital expense and average annual O&M costs.<sup>142</sup> The sum of the annualized capital and O&M costs, less revenue generated from the sale of electricity, yields the net cost of this policy recommendation. The NPV of this recommendation was estimated to be –\$1.1 million, with a cost-effectiveness of –\$3/tCO<sub>2</sub>e (see Table J-9-1).

### **Key Assumptions:**

The modeling that produced the above results was based on the assumption that the landfills that would implement LFGTE were those that already utilize active gas collection. However, as this analysis was not intended to be prescriptive, it should be noted that the AFW TWG did not specify which landfills should implement LFGTE to meet the goals of this recommendation.

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<sup>139</sup> U.S. Environmental Protection Agency, Landfill Methane Outreach Program. Landfill Gas Energy Cost Model (LFGcost), Version 1.4. Model run performed by B. Strode on June 24, 2008. For more information on LFGcost, visit <http://www.epa.gov/lmop/res/index.htm>.

<sup>140</sup> Arkansas Department of Environmental Quality. “2007 MSW Quarterly Report Yearly Totals.” Sent by K. Bassett (ADEQ) to B. Strode (Center for Climate Strategies) on July 9, 2008.

<sup>141</sup> U.S. Environmental Protection Agency, Landfill Methane Outreach Program. Landfill Gas Energy Cost Model (LFGcost), Version 1.4. Model run performed by B. Strode on June 24, 2008. For more information on LFGcost, visit <http://www.epa.gov/lmop/res/index.htm>.

<sup>142</sup> O&M costs are assumed to inflate by 2.5% per year, while the price of electricity is assumed to increase by 2% per year.

**Table J-9-1. Summary of results**

Year	Avoided Emissions (MMtCO <sub>2</sub> e)	Annual Capital Cost (MM\$)	Annual O&M Cost (MM\$)	Electricity Purchase Price (\$/kWh)	Annual Revenue (MM\$)	Net Annual Cost (MM\$)	Discounted Costs (MM\$)	Cost Effectiveness (\$/tCO <sub>2</sub> e)
2009	—	\$0.0	\$0.0	\$0.045	\$0.0	\$0.0	\$0.0	
2010	0.03	\$1.0	\$1.0	\$0.045	\$2.1	-\$0.1	-\$0.1	
2011	0.03	\$1.0	\$1.1	\$0.046	\$2.1	-\$0.1	-\$0.1	
2012	0.02	\$1.0	\$1.1	\$0.047	\$2.2	-\$0.1	-\$0.1	
2013	0.02	\$1.0	\$1.1	\$0.048	\$2.2	-\$0.1	-\$0.1	
2014	0.02	\$1.0	\$1.1	\$0.049	\$2.2	-\$0.1	-\$0.1	
2015	0.02	\$1.0	\$1.2	\$0.050	\$2.3	-\$0.1	-\$0.1	
2016	0.02	\$1.0	\$1.2	\$0.051	\$2.3	-\$0.2	-\$0.1	
2017	0.02	\$1.0	\$1.2	\$0.052	\$2.4	-\$0.2	-\$0.1	
2018	0.02	\$1.0	\$1.3	\$0.053	\$2.4	-\$0.2	-\$0.1	
2019	0.02	\$1.0	\$1.3	\$0.054	\$2.5	-\$0.2	-\$0.1	
2020	0.02	\$1.0	\$1.3	\$0.055	\$2.5	-\$0.2	-\$0.1	
2021	0.02	\$1.0	\$1.4	\$0.056	\$2.6	-\$0.2	-\$0.1	
2022	0.02	\$1.0	\$1.4	\$0.057	\$2.6	-\$0.3	-\$0.1	
2023	0.02	\$1.0	\$1.4	\$0.058	\$2.7	-\$0.3	-\$0.1	
2024	0.02	\$1.0	\$1.5	\$0.059	\$2.7	-\$0.3	-\$0.1	
2025	0.02	\$1.0	\$1.5	\$0.061	\$2.8	-\$0.3	-\$0.1	
<b>Total</b>	<b>0.4</b>	<b>\$15.6</b>	<b>\$20.1</b>		<b>\$38.7</b>	<b>-\$3.0</b>	<b>-\$1.1</b>	<b>-\$3.0</b>

\$MM = millions of dollars; MMtCO<sub>2</sub>e = millions of metric tons of carbon dioxide equivalent; \$/tCO<sub>2</sub>e = dollars per metric ton of carbon dioxide equivalent.

### Key Uncertainties

One factor of uncertainty with the analysis, as performed above, is the interest rate used for capital expenditures. Table J-9-2 displays the effect on the results of this policy recommendation that 5% and 10% interest rates would have on the results, which are based on an 8% interest rate.

**Table J-9-2. Sensitivity to interest rate on capital expenditure**

Interest Rate	Annualized Capital Cost (\$MM/year)	Net Present Value Policy Cost (\$MM)	Cost-Effectiveness (\$/tCO <sub>2</sub> e)
5%	\$0.8	-\$2.6	-\$6.7
8%	\$1.0	-\$1.1	-\$3.0
10%	\$1.1	-\$0.1	-\$0.3

\$MM = millions of dollars; \$/tCO<sub>2</sub>e = dollars per metric ton of carbon dioxide equivalent.

Negative values in the Net Present Value and the Cost-Effectiveness columns represent net cost savings.

It is assumed that the most likely candidates to use LFGTE are the sites that are currently required by regulation to have an active gas collection system. Environmental regulation could

push other sites into required active collection in the future, either by air rules or solid waste rules. EPA has four federally recognized modeling protocols for predicting air emissions that, in turn, determine who has to have active control and by what year. Those models could change and cause more facilities to become affected. Another possibility also exists that any of the 24 landfills currently in operation could end up “hot” with gas, to the point where solid waste rules could push them into active collection. There is no way to predict this, because the geology and historic construction of each site are unique. If a site were required to control gas through collection within the site’s regular business activities, then it is likely that the site owners would at least consider the possibility of utilizing that gas through either selling the gas or generating energy as a way to offset costs.

LFG collection can be expensive. Methane utilization can also be expensive and can take the site to a new level of complexities. For example, electricity generation is a different industry and requires a different from that required by waste management industry different from the waste management industry. Also, the quantification of this recommendation does not account for the costs that may arise from the added complexity of LFG collection and utilization.

It is possible that landfill sites not considered in the quantification of this recommendation may trigger EPA requirements during the policy period. However, for the purposes of the quantification of AFW-9, this is assumed not to occur.

### **Additional Benefits and Costs**

None identified.

### **Feasibility Issues**

The collection of methane at landfill gas sites can be expensive. Additionally, the utilization of methane can increase both expenses and the level of complexity—electricity generation is a different industry and requires a different from the waste management industry different from that required by the waste management industry. The expenses associated with installing capture and utilization technology may affect the feasibility of implementing this recommendation in the absence of alternative financial mechanisms (e.g., carbon credits).

The opportunities to utilize the methane and/or electricity at the waste generation site could be limited. The relocation of industries to utilize the energy from landfill sites or the transportation of energy from the landfill site to industry could present additional barriers to implementation.

### **Status of Group Approval**

Complete.

### **Level of Group Support**

Super Majority (1 objection).

### **Barriers to Consensus**

One member does not believe this recommendation will result in net cost savings.

# Appendix K

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## **Appendix J – Agriculture, Forestry, and Waste Management Sectors Policy Recommendations**

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# Appendix L

## Public Comments

This appendix is a compilation of the comments that members of the public provided during the public comment period at each of the meetings of the Governor's Commission on Global Warming (GCGW). The GCGW started its deliberative process for developing its policy recommendations for mitigating greenhouse gas (GHG) emissions at its third meeting. The commenters appear in the order in which they spoke at the meetings.

### **GCGW Meeting #3, February 7, 2008**

*Dr. Joe Bates* (Deputy Director of Health of the Arkansas Department of Health), spoke as an individual, not representing the collective views of the Department of Health. He expressed his concerns about emissions from coal-fired electricity generation plants in the state. Death rates from lung cancer, stroke, and heart disease are higher in areas where these plants are located, and mercury disseminated into the atmosphere, to the ground, to the water, and to the fish we eat can lead to brain damage. Young children cannot achieve their full intellectual capacity, because their mothers' breast milk is contaminated. Although Arkansas is a small player in the global scheme, it can do much more to improve its environment and the health of its citizens.

### **GCGW Meeting #4, February 28, 2008**

There were no comments from members of the public.

### **GCGW Meeting #5, April 9, 2008**

*Jim Shirrell*, (FTN Associates, Ltd.), was pleased to note that the Agriculture, Forestry, and Waste Management (AFW) Technical Work Group (TWG) is considering including the beneficial use of landfill methane gas in its policy options. He suggested that the Residential, Commercial, and Industrial (RCI) TWG also consider adding landfill methane gas to its RCI-1 renewable energy option.

### **GCGW Meeting #6, May 19, 2008**

*Venita McClellan-Allen* (President and Chief Executive Officer of Southwestern Electric Power Company [SWEPCO]), presented a case for supporting the new Hempstead coal plant recently approved by the Arkansas Public Service Commission (APSC). Recognizing the need to balance the goals of environmental protection and affordable electricity, she contended that rejecting the state's abundant coal resources would significantly raise the cost of electricity to consumers and would be harmful to the state's economy. She proposed that Arkansas adopt a portfolio of options that includes advanced coal technology, renewable energy, demand-side management, new nuclear plants, and new transmission and distribution (T&D) infrastructure. The Hempstead plant will contain the most energy-efficient technology available, including ultra-supercritical technology.

*Leah Arnold* (American Coalition for Clean Coal Electricity) commented that coal is a major factor in keeping the price of electricity affordable. Farmers making less than \$50,000 spend 22% of their after-tax income on electricity, and people making less than \$10,000 a year spend

50% of their after-tax income on electricity. She contended that an advanced ultra-supercritical coal-fired power plant will be an important factor in achieving the goal of emission-free electricity generation.

*Kenny Henderson* (Assistant General Counsel, CenterPoint Energy, Inc.) said using natural gas for electricity generation is a cost-effective approach to reducing GHG emissions. He contended that increasing the use of natural gas for space and water heating can offset the need for new power plants. A Black & Vetch study has found that emissions from natural gas-fueled space and water heaters produce 40% less carbon dioxide (CO<sub>2</sub>) emissions than do space and water heaters powered by electricity generated from fossil fuels, when considering emissions from the power plant. The industry believes that establishing a goal for direct use of natural gas will provide benefits to all consumers.

*Glen Schwarz* (Little Rock Environmental Action) believes a carbon tax on gasoline is a simple solution to global warming. The United States has the lowest gasoline tax of all oil-importing nations. The highest GHG-producing fuels—fossil fuels, such as diesel and coal—could be taxed the highest; followed by a mid-level tax on less polluting fuels, such as natural gas; and perhaps no tax on very low-GHG-emitting fuels. The United States must prepare for a world without oil. The tax money could be used toward smart growth, mass transit, and other GHG-reducing initiatives.

*Glen Hooks* (Sierra Club) commended the GCGW on its work. He noted the Sierra Club's concern about coal-fired power plants and its support for carbon sequestration recommended under policy option ES-7, citing the technology's potential to trap pollutants and prevent them from entering the air and water.

*Van Warren* (WOV, formerly of the National Aeronautic and Space Administration's Jet Propulsion Laboratory) believes the state's "addiction to dirty coal" is not serving Arkansans well. He supports the GCGW's recommendations for wind, photovoltaic, and solar cell technologies. He added that natural gas could be used as a transition fuel, solar concentrators are being overlooked, and the potential for biodiesel fuel technologies is untapped. He pointed to the need to educate Arkansas students on climate forces and issues, and suggested that the University of Arkansas at Little Rock's Energy Institute could provide support toward this effort.

*Eddy Moore* (Arkansas Public Policy Panel) also commended the GCGW on its work, particularly regarding the feed-in tariff recommended under policy option RCI-2, which places Arkansas in a leadership position by taking this initiative. However, he noted that energy efficiency experts recommend a 6% per year reduction in natural gas use, rather than the 1% target under RCI-2. Also, he believes the target addresses only a small part of the problem, and recommended broadening its focus to include reductions in total sales.

*William Ball* (Arkansas Renewable Energy Office) recommended that Arkansas adopt a feed-in tariff for electricity use. As opposed to net metering, a feed-in tariff would enable the state to pay farmers above-market rates. The more electricity consumed, the more it would cost. The revenue generated could help the state finance its energy efficiency targets.

*Doug Barton* (Arkansas Coalition for Peace and Justice) expressed the urgency of the need to address global warming, and recommended that Arkansas aggressively increase its energy efficiency through improvements in building design and increased use of renewable energy technologies. He noted that while a healthy economy is dependent on a healthy environment, the reverse doesn't apply. He concluded that if the world continues to burn fossil fuels at the current rates, we won't have a world to worry about the economy.

### **GCGW Meeting #7, June 17, 2008**

*Sammie Cox* (Manager, Governmental Affairs, American Electric Power–Southwestern Electric Power Company [SWEPCO]) is opposed to placing a "moratorium on SWEPCO building the Turk plant until carbon capture and storage technology is available." He believes, that if implemented, such a policy will "harm Arkansas' ratepayers and economy, and ignores the eventuality of a national cap-and-trade program, which will enable our [SWEPCO's] companies to reduce CO<sub>2</sub> [carbon dioxide] emissions in the most cost-effective manner." He recommended that the GCGW focus instead on promoting incentives for development of renewable energy technologies, encouraging energy efficiency and demand-side management (DSM), and providing tax incentives for developing clean-coal technologies.

Mr. Cox also is opposed to taxing utilities based on the carbon content of their fuels and restricting their ability to recover these costs. He noted that a carbon tax at the state level will place additional burdens on ratepayers, "harm economic development, and place Arkansas at a competitive disadvantage when recruiting new business and industry."

*Ron Bank* (retired building contractor) expressed his doubt about the predicted environmental catastrophes resulting from climate change. He then said that the LEED certification requirement has overstated benefits and understated costs and restricts trade. He added that 90% of a building's costs are related to design, and 90% of Arkansas building contractors don't have LEED certification. He asked why LEED needs to be mandated if it makes economic sense, adding that overregulation may produce unintended consequences. He concluded that if LEED truly produces cost savings, contractors will become certified voluntarily.

*Matthew Petty* (Co-Chair, Carbon Caps Task Force) noted the GCGW is tasked with recommending policies for reducing total greenhouse gas (GHG) emissions. He urged the commissioners look to science as a guide to their work; to "require all energy production proposals to include a reasonably up-to-date and comprehensive economic and environmental analysis of alternatives to new plant construction, such as infrastructure development or expansion of efficiency programs"; and to "prevent those results from being redacted from rulings by" the Arkansas Public Service Commission (APSC). Finally, he requested that the GCGW make strong recommendations to the Governor "to ensure the APSC acts in Arkansas' best interests and only endorses the best solutions," and to place a "permanent moratorium on [building new] unsequestered coal" plants.

*Mike Callen* (President, Arkansas Oklahoma Gas Corporation) observed that using natural gas for electricity generation is cost-effective and can reduce peak requirements. Using natural gas for energy results in 90% efficiency, compared to 27% efficiency from using other fossil fuels. The gas utilities don't agree with the statement in the Residential, Commercial, and Industrial RCI-2 (Utility and Non-Utility DSM for Electricity and Natural Gas) policy description that says

that because of the decline in sales to consumers that natural gas utilities have experienced over the last 10 years, it is not necessary to impose a state goal for utilizing DSM programs to reduce consumption of natural gas. He added that RCI-5 (Education for Consumers, Industry Trades, and Professions) should include education for consumers on the benefits of natural gas.

*William Ball* (Chairman of the Arkansas Renewable Energy Association and President of Natural Environments, Inc.) made the following observations: "(1) there are too many options and there is overlap between policies of the different TWGs, (2) just one or two good policies that will make it through the legislature and survive the interpretation of the APSC will be better than a slue of weaker ideas, and (3) mandates may produce less desirable results than incentives and goals with "teeth".... [W]hat started as a 1.3 billion-dollar budget to build a coal-fired power plant would cover the cost of installing enough PV [photovoltaic energy] in Arkansas, and do so at a time of day and year that is semi-coincident with peak demand." He added that improving building shells and mechanical equipment can require less than half the energy the average building requires.

*Michelle Kitchens* (Associate Director, National Affairs, Arkansas Farm Bureau) expressed the Farm Bureau's strong support of the renewable fuels industry. She pointed out that renewable fuels have a small effect on the rising price of food, and that the bigger challenge food markets face is the grain losses in the Midwest as a result of the recent widespread floods. She observed that the increasing use of cellulosic ethanol could be limiting gas prices. Without expansion of renewable fuels, world food prices would be even higher than today. More research and development needs to be devoted to developing alternative sources of energy. Arkansas has tremendous potential for developing biodiesel and cellulosic ethanol fuels, and should also increase carbon sequestration and conservation easements.

*Ken Smith* (State Director, Audobon Arkansas) stated that we know for a fact that GHGs are rising. Worldwide temperature increases are having profound effects on species, particularly birds. History has proven that environmental restrictions, such as those imposed by the Clean Air and Clean Water Acts and the Superfund program, have not harmed the economy. Audobon Arkansas supports recommendations for national and regional cap-and-trade programs, a carbon tax, and energy efficiency programs.

### **GCGW Meeting #8, June 31, 2008**

*Ludwik J. Kozlowski, Jr.* (Arkansas Community Action Agencies Association) pointed to the need to expand the federal Weatherization Assistance Program to provide funding for no-cost green loans to low-income households to heat their homes.

*Ken Smith* (Audobon Arkansas) commented that each of the four planned power plants will cost \$1.5-\$2 billion, and together they will contribute 32% of the carbon emitted in the state. He recommended investing in energy conservation, energy efficiency, and renewable energy as aggressively as possible before constructing the new plants. He also commended the seven utilities that are participating in APSC's energy efficiency programs, and recommended that they be rewarded with perhaps performance-based incentives. He concluded, however, that these energy efficiency initiatives may not be sufficient to meet the state's future energy demand, and suggested that the GCGW consider providing a source of revenue to fund a reinvigorated Arkansas Energy Office to make the necessary energy efficiency improvements.

*Bill Lord* (Program Director, Northwest Arkansas Regional Solid Waste Management District, and President, Arkansas Association of Regional Solid Waste Management Districts) suggested that the GCGW look into providing carbon credits to assist landfills with collecting methane. He also recommended providing incentives to companies to convert high energy-consuming diesel solid waste collection vehicles to energy-efficient vehicles that run on biofuels. He believes that Arkansas can substantially improve its recycling rates, noting that more than 60% of all solid waste generated can be recycled or composted. He recommended the state pass container deposit legislation, noting that some states with "bottle bills" are recycling 70%–95% of all plastic, glass, and aluminum containers. Increased recycling of containers would create many green jobs in Arkansas, save landfill space, provide a giant step toward recycling goals, and significantly reduce GHG emissions and use of electricity, oil, and gasoline.

*Reagan Sutterfield* (business consultant and farmer) suggested that the GCGW look at the positive and negative economic development impacts and macroeconomic effects of the four planned coal plants. He pointed to the state's brain drain of younger people who are leaving the state for technology centers, and suspects the plants won't cause them to stay in or return to Arkansas.

*Danny Traylor* informed the GCGW that 100 stakeholders in the Anthracite Coal Company are developing the Scranton Coal Company close to Morrison Bluff and Scranton. He said that semi-anthracite coal is a good candidate for integrated gasification combined cycle (IGCC) technology. The economics appear promising for dusting off the old River Mountain hydroelectric project and developing an underground gasification facility. The critical enabling technology is CO<sub>2</sub> storage. Arkansas is blessed with good opportunities for enhanced natural gas recovery, sitting at the top of natural gas-producing reservoirs and coal seams (enhanced coalbed methane). Deep-well injection has the potential to sequester 3–6 million tCO<sub>2</sub>/year. He suggested that the GCGW look at the Massachusetts Institute of Technology study *The Future of Coal* ([http://web.mit.edu/coal/The\\_Future\\_of\\_Coal.pdf](http://web.mit.edu/coal/The_Future_of_Coal.pdf)). The stakeholders are going to try to develop a 21st-century project on a scale that hasn't been achieved. All the infrastructure is in place in the Arkansas River Valley.

*Andrew Endicott* (Social Sustenance Organization) supports four items for addressing global warming that could create thousands of green jobs and reduce GHG emissions: (1) demand-side management can align the interests of utilities and the environment with energy-efficient devices and appliances; (2) stricter building codes for new construction can reduce the energy use of and CO<sub>2</sub> emissions from future buildings; (3) implementation of commercial-scale renewable energy feed-in tariffs can reduce risk and increase returns on investment in renewable energy; and (4) a carbon capture and storage requirement in the state can preclude future investment in dirty coal toward renewable energy and environmentally friendly energy options. He concluded that avoiding the catastrophic impacts of climate change will require tremendous investment and work.

## **GCGW Meeting #9, September 9, 2008**

*Randy Eminger* (American Coalition for Clean Coal Electricity)

In 2001, average Arkansans spent 11% of their income on energy costs; in 2008, that figure rose to 19%. About 123,000 families in Arkansas are living below the poverty level, and spend 34% of their income on energy costs. While there may be a global warming trend, that trend is not evident in Arkansas.

*J.D. Harper* (Arkansas Manufactured Housing Association)

The GCGW should amend RCI-1 to acknowledge ongoing efforts by the manufactured housing industry to enhance the energy efficiency of manufactured homes.

*Tommy Foltz* (Arkansas Biofuels Alliance)

The GCGW should support the production of cellulosic biofuels. AFW-5 precludes first-generation biofuel technology. Arkansas should simultaneously be using the technology that's available today while working toward advanced biofuels. Foltz offered to share with the GCGW the language that he is recommending be added to AFW-5.

*Nathan Pittman* (Arkansas Soy Energy Group)

The GCGW should expand the program for strengthening the Arkansas biodiesel industry because biodiesel burns clean and significantly reduces GHG emissions, local biodiesel feedstocks are abundant, biodiesel is cost competitive compared to fossil fuels, and the state has several existing biodiesel producers. Non-food feedstock should be evaluated as they become available.

*Eddy Moore* (Arkansas Public Policy Panel)

Under the Energy Supply policy options, the GCGW should account for some range of carbon pricing. Power companies have considered carbon pricing in modeling future opportunities, and private-sector markets and public service commissions take it into account as well.

*J.P. Bell* (Physician, Fort Smith, Arkansas)

Arkansas' air is becoming dirtier primarily due to emissions from coal-fired power plants. The GCGW should recommend that the state put a moratorium on building new capacity for coal-generated power plants, whose emissions are impairing the health of Arkansans.

*Gladys Tiffany* (Omni Center for Peace, Justice & Ecology and Clean Air Arkansas Coalition)

The GCGW should limit coal-fired electricity generation as much as possible.

*Shelly Buonaeto* (Omni Center for Peace, Justice & Ecology and Clean Air Arkansas Coalition)

Arkansans should limit the energy they use. The GCGW should recommend that the state provide tax credits to citizens who install solar, wind, and other renewable energy technology.

*Michael Buonaeto* (Omni Center for Peace, Justice & Ecology and Clean Air Arkansas Coalition)

The GCGW should limit coal-fired electricity generation as much as possible.

*Joe Bender* (Clean Air Arkansas Coalition)

A 600-MW coal plant will result in significant emissions of CO<sub>2</sub>, SO<sub>2</sub>, particulate matter, and mercury, threatening health and ecosystems. Arkansans need to use energy more efficiently, and the electrical grid needs to be decentralized. RCI-7 is a significant step toward reducing the state's emissions and boosting its economy.

*Amos* (Little Rock)

Northeastern and northwestern Arkansas have good wind resources. Potential producers of wind energy in the state are poised to start production as soon as Arkansas enacts legislation that offers producers of renewable energy financial incentives similar to those that other states offer.

*Robert Huston* (Clean Air Arkansas Coalition)

Building a coal-fired plant will have significant negative impacts on Arkansas' environment and economy.

*Jack Sundale* (Citizen)

There is no such thing as clean coal. Coal already accounts for a major share of Arkansas' GHG emissions. The state should place a higher tax on coal-fired electricity to discourage its use, and should encourage energy efficiency and the production of renewable energy.

*Joe Sundale* (Citizen)

The GCGW should recommend that the state make coal-fired electricity production the most expensive form of electricity to purchase, while maximizing economic incentives to citizens who install solar power and to local governments that provide the best available public transportation.

### **GCGW Meeting #10, September 25, 2008**

*Sammie Cox* (AEP–Southwestern Electric Power Company (SWEPCO))

The Turk (Hempstead County) plant should be built. The Arkansas Public Service Commission has approved the ultra-supercritical plant, which will be one of the most efficient coal plants in North America and will be retrofitted for carbon capture and storage technology when it becomes available.

*David "Bubba" Powers* (Arkansas House of Representatives)

The majority of citizens of Hempstead County support construction of the Turk plant and are confident that SWEPCO will be a good steward of the environment.

*Jim Kirchhoff* (Hope Water and Light Corp.)

The Turk (Hempstead County) plant should be built. SWEPCO has been a long-time provider of low-cost power and energy for Arkansans. Replacing coal with natural gas-fired electrical generation will significantly increase the cost of electricity.

*Wes Woodward* (Hempstead County Economic Development Corporation)

Portions of southwestern Arkansas have experienced surges in energy costs caused by replacement of coal with natural gas-fired electrical generation, which have significantly hurt businesses in the area. Arkansas' demand for electricity will continue to grow. Arkansas needs to rely on a broad range of reliable, cost-efficient energy resources to maintain and grow its economy.

*Matthew Petty* (Omni Center for Peace, Justice & Ecology /Social Sustenance Organization)

The Turk (Hempstead County) plant should not be built. With the implementation of a tax on carbon, energy efficiency measures will be far more cost effective than electricity production from fossil fuels, will create permanent jobs in the state, and will reduce GHG emissions.

*Kelly Mulhollan* (Citizen)

The Turk (Hempstead County) plant should not be built. It's folly to be working to reduce global warming and at the same time allow more coal plants to be built.

*Larry Brown* (Citizen)

The Turk (Hempstead County) plant should not be built. Geothermal energy should be considered as an alternative source of energy. Arkansas has some hot areas that show promise. Smaller units could be built close to substations.

*Malcolm Cleaveland* (Professor Emeritus, University of Arkansas, Fayetteville)

The Turk (Hempstead County) plant should not be built. There's substantial evidence that global warming is occurring, and catastrophic changes are inevitable. (See written comments below.)

*James Burke* (Ecological Conservation Organization)

Mr. Burke read a quote from Al Gore stating why the Turk (Hempstead County) plant should not be built.

*Joanna Pollock* (Omni Center for Peace, Justice & Ecology)

Building the Turk (Hempstead County) plant will harm Arkansas' ecology, and the costs will far exceed the benefits. The state should invest in renewable energy, which will protect the environment and create lasting employment for Arkansans.

*Barbara Horn* (Arkansas State Senate)

Southwestern Arkansas residents support building the Turk (Hempstead County) plant.

*Eddy Moore* (Arkansas Public Policy Panel)

The Turk (Hempstead County) plant should not be built. The Arkansas Public Policy Panel hired an independent expert who found that the cheapest source of energy in the state will be natural gas-fired generation and energy efficiency measures.

*Steve Copley* (The Interfaith Alliance of Arkansas)

In its recommendations to the Governor, the GCGW should keep in mind the value of creation and the need and responsibility to protect the planet.

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To the Governor's Commission:

I wish to discuss some reasonably complex concepts and apologize for expression of my frustration when limited to two minutes in the public comment session. I will try to be succinct here.

I would like to inject some urgency into what some seem to see as just an attempt to put a useless restraint on industry. Unfortunately, the issues are much more serious than that. Today the scientific evidence is clear, despite a well-funded disinformation program that would do credit to the CIA. Global warming is occurring, and humans are responsible.

But some will say, "We have hundreds of years to solve this problem and why should we make any effort now, when there is still at least some scientific uncertainty about our vulnerability and we are still developing key technologies to mitigate the problem?"

Wrong! We may not have much time and we could see catastrophic changes in the lifetimes of many people on the Commission. The paleo-climatic record shows that step changes in climate may occur in decades, perhaps even years in some cases.

How could this happen? Changes are often:

1. Nonlinear-some are exponential functions, like rabbit populations when there are no predators.
2. The result of positive feedbacks in the climate system. What is a positive feedback? Think of an explosion that starts with a spark but quickly escalates. An example of a positive feedback is warming of the Arctic tundra, which releases large quantities of frozen methane. Methane itself is a potent greenhouse gas, and as methane concentrations increase, temperature will increase, releasing more methane in a vicious cycle.
3. Threshold effects or tipping points. Past a certain points, positive feedbacks take over and catastrophic change becomes inevitable. We could be very close to a threshold for revolutionary climate changes.

What are possible consequences? How severe could they be? An example is the deglaciation of the polar regions. Deglaciation is proceeding at a phenomenal rate and it appears to be accelerating. The Greenland ice cap is shrinking; if it were to go completely, sea level would rise at least 20 feet, submerging trillions of dollars of infrastructure and displacing hundreds of millions of people. The West Antarctic Ice Sheet (WAIS) is also losing mass and could easily

become destabilized. That would raise sea levels 10 to 20 feet. In addition to the huge human costs, critical coastal ecosystems would be destroyed.

Other impacts of global warming are already being felt widely. For example, the ongoing loss of mountain glaciers and snowpacks that provide water supplies and hydroelectric power to over a billion people and the extension of fire seasons, resulting in catastrophic fires.

Are we sure that bad things will happen if we continue business as usual? Bad things are already happening, but we cannot say with complete certainty that catastrophic changes will follow, and will follow quickly. Do we want to gamble with huge chunks of our civilization? If change will be catastrophic, prudent people make those preparations necessary to avoid that outcome.

Ask the Chinese - they gambled that a big earthquake would not occur during school, so they did not quakeproof their schools in a known high risk seismic zone. The results? More than 10,000 children dead and many more injured and psychologically traumatized.

We are in a known climate change hazard zone. In the face of uncertainty, but with horrific consequences for inaction, prudent people act. Reduction of greenhouse gases (GHGs) is critical. We should at least take "no regrets" actions toward that goal, such as increasing economic efficiency. It is my understanding that new coal fired power is much more expensive than conservation efforts to reduce demand. And improvement of the national transmission grid would move existing excess power where it is needed.

In a way it is unfair that Arkansas should have to undertake to limit GHGs without leadership from the Federal level. Unfortunately, there has been no semblance of guidance from the feds, so the states have been taking the lead. It is time that Arkansas joined them and showed a little leadership of our own.

-- Malcolm Cleaveland