South Carolina Climate, Energy, and Commerce Committee

Final Report

July 2008

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Members of the South Carolina Climate, Energy and Commerce Advisory Committee

Rep. Ben Hagood, South Carolina House of Representatives/Chairman
Dana Beach, Executive Director, South Carolina Coastal Conservation League
Crandall Close Bowles, Chairman, Springs Industries, Inc.
Jim Byrd, Deputy Director, Market Services Division, South Carolina Department of Insurance
Lonnie Carter, President and CEO, Santee Cooper
John Clark, Director, South Carolina Energy Office
Giff Daughtridge, Vice President and Division General Manager, Nucor Steel (replaced Ladd Hall who attended the first CECAC meeting)
Barry Falin, Vice President (retired), Performance Polymers Manufacturing, Eastman Chemical Company
Bob Fledderman, Manager, Environment and Regulatory Assurance, MeadWestvaco
John Frampton, Director, South Carolina Department of Natural Resources
Dr. Paul Gayes, Director, Center for Marine and Wetlands Studies, Coastal Carolina University
Emerson Gower, Vice President, Southern Region, Progress Energy Carolinas
Ladd Hall, Vice President and General Manager, Nucor Steel
Joe James, CEO, Corporation for Economic Opportunity
Bob King, Deputy Commissioner, South Carolina Department of Health and Environmental Control
Kevin Marsh, President, South Carolina Electric & Gas (replaced Bill Timmerman who attended the first CECAC meeting)
Dr. Marcus Newberry, Former Dean, Medical University of South Carolina College of Medicine
Mike Olbrich, Plant Manager, BP Chemical
James E. Rogers, Chairman, President, and CEO, Duke Energy Corporation
Bob Scott, President, South Carolina Forestry Association
Lanneau H. Siegling, Past Chairman, Hospitality Association of South Carolina
David Smalls, President, Walterboro-Colleton Chamber of Commerce
Dr. Stephen Smith, Executive Director, Southern Alliance for Clean Energy
John Tiencken, Special Counsel to the Electric Cooperatives of South Carolina
Sen. Danny Verdin, South Carolina Senate
Hugh Weathers, Commissioner, South Carolina Department of Agriculture
Johnny Williamson, CEO, South Carolina Soya, LLC
Brad Wyche, Executive Director, Upstate Forever

Acronyms and Abbreviations

$/kWh	dollars per kilowatt-hour
$/MWh	dollars per megawatt-hour
$/$tCO_2e$	dollars per metric ton of carbon dioxide equivalent
ac	acre
ACEEE	American Council for an Energy Efficient Economy
ADA	Americans with Disabilities Act
AEO 2006	Annual Energy Outlook 2006 [US DOE/EIA]
AEO 2007	Annual Energy Outlook 2007 [US DOE/EIA]
AEO 2008	Annual Energy Outlook 2008 [US DOE/EIA]
AFO	animal feeding operation
AFW	Agriculture, Forestry, and Waste Management [TWG]
AL	Alabama
ANL	Argonne National Laboratory [US DOE]
AR	Arkansas
ARS	Agricultural Research Service [USDA]
ASAP	Appliance Standards Awareness Project
AWWA	American Water Works Association
AZ	Arizona
B5	fuel blend of 5% biodiesel
B20	fuel blend of 20% biodiesel
B100	100% biodiesel
BAU	business as usual
Bbtu	billion British thermal units
BCAP	Building Codes Assistance Project
BCB	[South Carolina] Budget and Control Board
BLS	Bureau of Labor Statistics [U.S. Department of Labor]
Btu	British thermal unit
C	carbon
C&D	construction and demolition
CA	California
CAA	Clean Air Act
CAFE	corporate average fuel economy
CARB	California Air Resources Board
CBECS	Commercial Buildings Energy Consumption Survey
CC	Cross-Cutting Issues [TWG]
CCS	Center for Climate Strategies

CECAC	[South Carolina] Climate, Economic, and Commerce Advisory Committee
CEPCI	Central Electric Power Cooperative, Inc.
cf	cubic foot/feet
CH_4	methane
CHP	combined heat and power
CMAQ	Congestion Mitigation and Air Quality [Improvement Program]
CO	Colorado
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
COGs	councils of government
CRF	capital recovery factor
CRP	Conservation Reserve Program [USDA]
CS	Cambridge Systematics
CT	Connecticut
CT ECMB	Connecticut Energy Conservation Management Board
CU	Clemson University
CWNS	Clean Watershed Needs Survey
DG	distributed generation
DOE	[United States] Department of Energy
DOTs	[state] departments of transportation
DRD	Division of Regional Development
DSM	demand-side management
DVD	digital versatile disc
E85	fuel blend of 85% ethanol
EE	energy efficiency
EIA	Energy Information Administration [US DOE]
EPA	[United States] Environmental Protection Agency
EQIP	Environmental Quality Incentives Program
ES	Energy Supply [TWG]
ESCO	energy service company
ESPC	energy savings performance contract
FETSIM	fuel-efficient traffic signal management
FHWA	Federal Highway Administration
FIA	Forest Inventory and Analysis
FL	Florida
FLEET	Freight Logistics Environmental and Energy Tracking
FRA	Federal Railroad Administration
FRPP	Farm and Ranch Lands Protection Program

FTA	Federal Transit Administration
FTE	full-time equivalent
FY	fiscal year
gal	gallon
GHG	greenhouse gas
g/mi	grams per mile
GREET	Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation [model]
GRI	Gas Research Institute
GUTD	gear up, throttle down
GWh	gigawatt-hours
GWP	global warming potential
ha	hectare
HDPE	high-density polyethylene
HDV	heavy-duty vehicle
HFC	hydrofluorocarbon
HM	heavy metal
H.R.	House Resolution
hr	hour
HUD	[United States] Department of] Housing and Urban Development
HWP	harvested wood product
I&F	Inventory and Forecast
IA	Iowa
ICC	International Code Council
ICE	internal combustion engine
ICLEI	Local Governments for Sustainability [formerly International Council for Local Environmental Initiatives]
IECC	International Energy Conservation Code
IOU	investor-owned utility
IPL	Interstate Power & Light
IRC	International Residential Code
ITC	investment tax credit
k	thousand
kg	kilogram
km^2	square kilometers
kW	kilowatt
kWh	kilowatt-hour
lb	pound
LCOE	levelized cost of electricity

LDGT	light-duty gasoline truck
LDGV	light-duty gasoline vehicle
LDPE	low-density polyethylene
LDV	light-duty vehicle
LEED	Leadership in Energy and Environmental Design Green Building Rating System™
LFG	landfill gas
LFGcost	landfill gas cost model
LFGTE	landfill gas-to-energy
LMOP	Landfill Methane Outreach Program
LNG	liquefied natural gas
m^3	cubic meters
MA	Massachusetts
MAC	[California] Market Advisory Committee
MAP	[Statewide] Motor Assistance Program
MECS	Manufacturing Energy Consumption Survey
MGD	million gallons per day
MM	million
MMBtu	million British thermal units
MMgal/yr	million gallons per year
$MMtCO_2e$	million metric tons of carbon dioxide equivalent
MPO	management planning organization
MSW	municipal solid waste
MW	megawatt
MWh	megawatt-hours [one thousand kilowatt-hours]
N_2O	nitrous oxide
N/A	not applicable
NAAQS	National Ambient Air Quality Standards
NASS	National Agricultural Statistics Service [USDA]
NC	North Carolina
NGO	nongovernmental organization
NHTSA	National Highway Traffic Safety Administration [US DOT]
NO_x	nitrogen oxides
NPS	National Park Service
NPV	net present value
NQ	not quantified
NRCS	Natural Resource Conservation Service [USDA]
NREL	National Renewable Energy Laboratory [US DOE]
NRI	National Resources Inventory

NTD	National Transit Database
NY	New York
O&M	operation and maintenance
OR	Oregon
PA	Pennsylvania
PaCE	Palmetto Clean Energy
PC/LDT	passenger car/light-duty truck
PET	polyethylene terephthalate
PG&E	Pacific Gas and Electric
PIA	Priority Investment Act
PSC	Public Service Commission
PTC	production tax credit
PTO-hp	power take-off horsepower
PURPA	Public Utility Regulatory Policies Act of 1978
PV	photovoltaic
R&D	research and development
RCI	Residential, Commercial, and Industrial [TWG]
RECs	renewable energy credits
REPS	renewable energy and energy efficiency portfolio standard
RFS	renewable fuels standard
RMDEC	[South Carolina] Recycled Market Development Advisory Council
SC	South Carolina
SCBCC	South Carolina Building Codes Council
SC BEA	South Carolina Bureau of Economic Advisers
SCCB	South Carolina Conservation Bank
SCDA	South Carolina Department of Agriculture
SC DHEC	South Carolina Department of Health and Environmental Control
SC DNR	South Carolina Department of Natural Resources
SC DOC	South Carolina Department of Commerce
SC DOT	South Carolina Department of Transportation
SCE	Southern California Edison
SCE&G	South Carolina Electric & Gas
SCEO	South Carolina Energy Office
SCFA	South Carolina Forestry Association
SCFB	South Carolina Farm Bureau
SCFC	South Carolina Forestry Commission
SC I&F	South Carolina Inventory and Forecast
SCPSC	South Carolina Public Service Commission

SCRA	South Carolina Research Authority
SC SCO	South Carolina State Climatology Office
SDG&E	San Diego Gas & Electric
SGIP	[California] Self-Generation Incentive Program
SHW	solar hot water
SMUD	Sacramento Municipal Utility District
SOV	single-occupant vehicle
SUV	sport utility vehicle
SWH	solar water heating
SWM	solid waste management
t	metric ton
T&D	transmission and distribution
tCO_2e	metric tons of carbon dioxide equivalent
TDM	transportation demand management
TLU	Transportation and Land Use [TWG]
TSM	transportation system management
TWG	Technical Work Group
TX	Texas
USDA	United States Department of Agriculture
US DOE	United States Department of Energy
US DOT	United States Department of Transportation
US EPA	United States Environmental Protection Agency
USFS	United States Forest Service [USDA]
USFWS	United States Fish & Wildlife Service [U.S. Department of the Interior]
VMT	vehicle miles traveled
W	watt
WA	Washington
WACC	weighted-average cost of capital
WARM	WAste Reduction Model [US EPA]
WGA	Western Governors' Association
WTE	waste-to-energy
WWTP	wastewater treatment plant
yr	year

Executive Summary

Background

On February 16, 2007, South Carolina Governor Mark Sanford issued Executive Order No. 2007-04 establishing the Governor's Climate, Energy, and Commerce Advisory Committee (CECAC) to develop a Climate, Energy, and Commerce Action Plan (Action Plan) containing specific recommended actions for mitigating greenhouse gas (GHG) emissions. This broad-based group of South Carolina citizens and leaders was charged with developing a comprehensive set of state-level policy recommendations to the Governor through a stakeholder-based consensus-building process. In developing its recommendations, the CECAC considered the potential benefits, costs, savings, and feasibility of furthering building and infrastructure efficiency, and related energy policy and economic opportunities. The Governor asked the Center for Climate Strategies (CCS) to work in partnership with his office and agencies of the state to provide facilitation and technical support for a process to complete a series of tasks through joint activities of the CECAC, five Technical Work Groups (TWGs) that supported the CECAC, state agencies, and members of the public.

In response to the Governor's charge, the CECAC has prepared this "Climate, Energy, and Commerce Action Plan," which documents the CECAC's recommendations and associated analyses to reduce GHG emissions and enhance energy and economic policy in South Carolina by 2020 and beyond. More than 90 South Carolinians who were members of the CECAC and the TWGs held over 70 meetings to identify, analyze, deliberate, and ultimately recommend a comprehensive set of specific policies for South Carolina. The CECAC presents this report covering:

- An inventory of historical, current, and forecasted GHG emissions in South Carolina;
- A description and analysis of recent policies and programs that will reduce GHG emissions in South Carolina;
- GHG emission reduction goals for South Carolina and recommended policies to achieve these goals;
- Recommended mechanisms for implementing these goals and policies across all sectors of South Carolina's economy;
- Estimated GHG emission reductions from the recommended policies, expressed in metric tons of carbon dioxide equivalents (tCO_2e);
- Consideration of the costs or cost savings associated with the recommendations; and
- Challenges inherent in each recommendation, as well as feasibility issues.

Key recommendations and accomplishments of the CECAC are:

- Recommendation of a comprehensive set of 51 specific policies to reduce GHG emissions and address climate-, energy-, and commerce-related issues in South Carolina. The CECAC members present and voting approved 46 policy actions unanimously, and approved 5 by a super majority (four objections or fewer). Explanations of objections are in the appendixes to this report, which contain detailed accounts of the CECAC's recommendations.

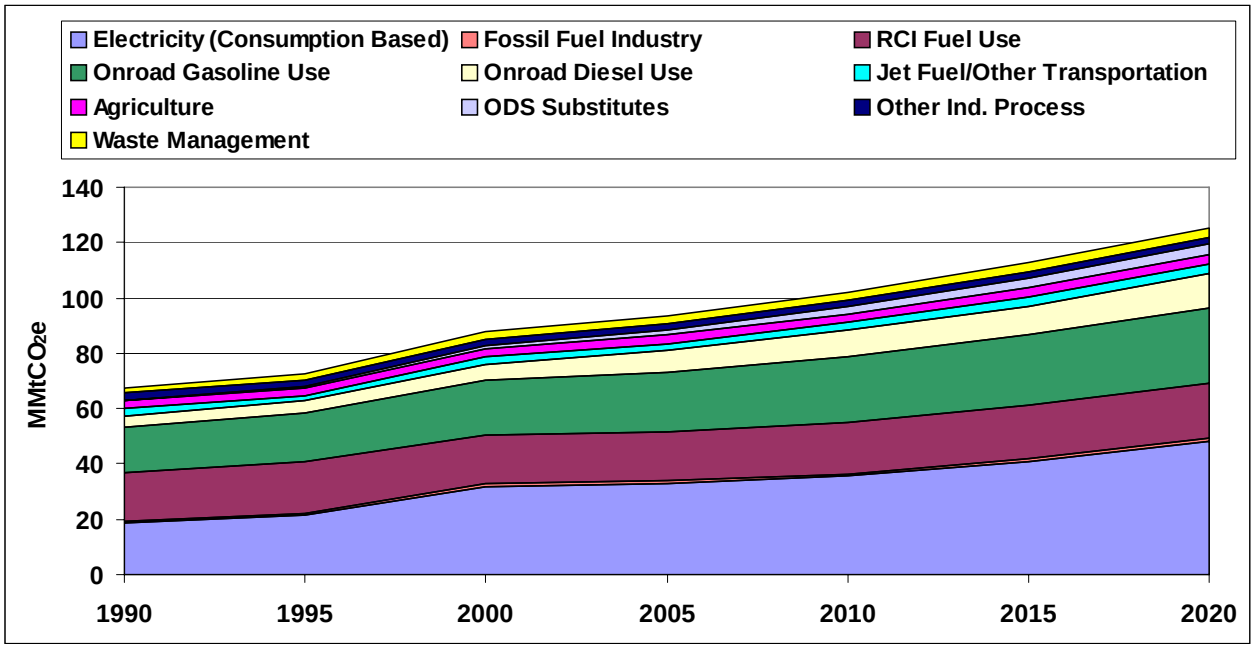
- Recommendation of a voluntary, economy-wide goal for South Carolina to reduce gross GHG emissions to 5% below 1990 levels by 2020, equal to successful implementation of the policy recommendations. The state should (1) evaluate progress toward meeting the recommended goal at least once every 5 years and report the results of this evaluation to the public, and (2) consider reviewing at least once every 5 years realistic GHG reduction goals for years beyond 2020. Of the 51 policy recommendations, 38 were analyzed quantitatively to have a cumulative effect of reducing emissions by about 55 million metric tons of carbon dioxide equivalent ($MMtCO_2e$) in 2020. Together, if the 38 quantified policy recommendations and the recent federal actions (or their functional equivalent) are successfully implemented, the 2020 GHG emission reduction goal would come very close to being achieved.
- Evaluation of the costs, savings, and feasibility of building and infrastructure efficiency to enhance energy and economic policy in South Carolina. The CECAC analyzed quantitatively the costs or cost savings of 33 of its 51 policy recommendations. Although the total net cost associated with the 33 policies analyzed is estimated at about $1.6 billion between now and 2020, the weighted-average cost-effectiveness of the 33 policies is estimated to be approximately $\$5/tCO_2e$ reduced. Many of the policies are estimated to yield significant cost-saving opportunities for South Carolinians. Other policies will incur net costs because they are targeting changes in current practices that require incentives, capital investment, or other cost outlays.
- Review, update, and approval of a comprehensive inventory and forecast of GHG emissions in South Carolina from 1990 through 2020. This is the first comprehensive, statewide GHG inventory and forecast that has been developed for South Carolina. It has benefited from the expertise of many CECAC and TWG members who provided state-specific data.

Inventory of South Carolina's Greenhouse Gas Emissions

In June 2007, CCS prepared a draft GHG emissions inventory and reference case projection to assist the CECAC and TWGs in understanding past, current, and possible future GHG emissions in South Carolina, and thereby inform the policy development process.[1] The preliminary draft was improved by incorporating comments provided by the CECAC and TWGs. As shown in Figure EX-1, the inventory and projections revealed substantial emissions growth rates and related mitigation challenges. South Carolina's gross emissions of GHGs grew by 39% between 1990 and 2005, twice the national average of 16%. South Carolina's emissions growth was driven by the growth of its population and many other factors. In addition, the state's emissions on a per-capita basis increased by about 15% between 1990 and 2005, while U.S. per-capita emissions declined slightly (2%) over this period due to many other factors. South Carolina's gross GHG emissions are projected to rise fairly steeply to about 125 $MMtCO_2e$ by 2025, or 87% over 1990 levels.

[1] Center for Climate Strategies. *Draft South Carolina Greenhouse Gas Inventory and Reference Case Projections, 1990–2020*. Prepared by the for the Climate, Energy, and Commerce Advisory Committee of the Office of the Governor of South Carolina. June 2007 .

Figure EX-1. Gross GHG emissions by sector, 1990–2020: historical and projected (consumption-based approach) business-as-usual/base case



$MMtCO_2e$ = million metric tons of carbon dioxide equivalent; RCI = direct fuel use in residential, commercial, and industrial sectors; ODS = ozone depleting substance; Ind. = industrial.

The principal sources of South Carolina's GHG emissions in 2005 are electricity use (excluding emissions associated with electricity exported to other states) and transportation, accounting for 35% and 34% of South Carolina's 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 19% of the state's emissions in 2005. .

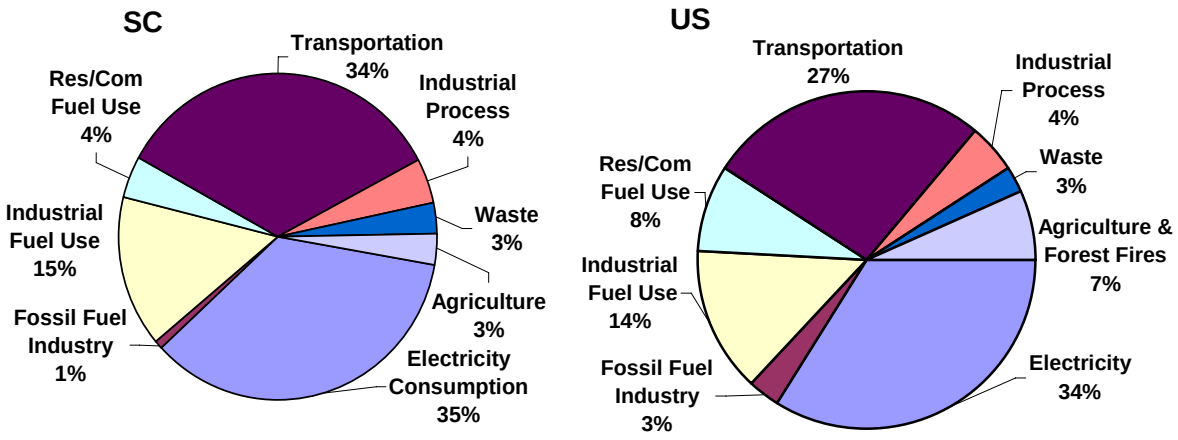
Industrial process emissions accounted for about 4% of the state's GHG emissions in 2005, and these emissions are rising due to the increasing use of hydrofluorocarbons and perfluorocarbons (PFCs) as substitutes for ozone-depleting chlorofluorocarbons.[2] Other industrial process emissions result from cement manufacturing; CO_2 released during soda ash, limestone, and dolomite use; PFCs released during aluminum production; and sulfur hexafluoride released from transformers used in electricity transmission and distribution systems. Agricultural activities, such as manure management, fertilizer use, livestock (enteric fermentation), and changes in soil carbon due to cultivation practices, result in methane (CH_4) and nitrous oxide (N_2O) emissions that accounted for another 3% of state GHG emissions in 2005. Similarly, landfills and wastewater management facilities produce CH_4 and N_2O emissions that accounted for 3% of total gross GHG emissions in South Carolina in 2005. Emissions associated with the

[2] 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 Deplete the Ozone Layer. See Appendix I in the *Final Inventory and Reference Case Projections* report for South Carolina. Available at: http://www.scclimatechange.us/Inventory_Forecast_Report.cfm

transmission and distribution of natural gas accounted for 1% of the gross GHG emissions in 2005.

Forestry activities in South Carolina are estimated to be net sinks for GHG emissions, and accounted for a sink of about 31 $MMtCO_2e$ in 2005. This sector includes emissions from urban forestry and land use.

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



Recent Actions

During the CECAC process, 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. 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 (CAFE) 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 South Carolina were estimated and included in the baseline of related CECAC policy recommendations. Together, these federal requirements are estimated to reduce emissions in South Carolina by about 5.7 $MMtCO_2e$ (a 4.5% reduction) from the business-as-usual emissions in 2020 for all sectors combined. 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-5, RCI-6, RCI-7, and RCI-8.

South Carolina adopted several pieces of legislation in the 2007–2008 legislative session relevant to renewable energy, energy efficiency, and transportation. The following provides a brief summary of the legislation adopted. A detailed listing of the legislation has been complied by the South Carolina Energy Office and is available at the following website: http://www.energy.sc.gov/index.aspx?m=1&t=67.

Renewable Energy

- H. 3649 enhances incentives for biomass energy development by removing legislative caps on tax credits for biomass energy equipment, biodiesel and ethanol production, and other alternative energy incentives. It also removes caps on incentive payments for alternative fuel retailers and biomass energy producers.
- S. 1143 allows South Carolina gas suppliers to continue to blend fuel with ethanol instead of buying a pre-blended version from national oil companies.
- H. 4766 requires the South Carolina Energy Office to report on agency progress towards goals and staff the Wind Energy Production Farms Feasibility Study Committee, which will release a report by January 2010.

Energy Efficiency

- The Energy Independence and Sustainable Construction Act of 2007 (H. 3034) requires application of "green building" or comparable standards to major facilities to be constructed on state property with 10,000 or more square feet.
- H. 3395 requires the South Carolina Energy Office and the Office of Regulatory Staff to recommend process and procedures for establishing net metering programs at all distribution electric utilities in the state.
- H. 4766 creates specific energy reduction and reporting requirements for state agencies by requiring state agencies to prepare Energy Conservation Plans in order to meet an energy consumption reduction goal of 20% by 2020, using 2000 as a baseline year. It also requires incandescent light bulbs used by a state agency to be replaced with compact fluorescent bulbs when the incandescent bulb needs replacing. Relating to purchase of energy conservation products by a state agency, the South Carolina Energy Office may certify for procurement only a product that meets or exceeds federal Energy Star standards.
- Beginning in 2009, S. 1141 creates a new sales tax rebate program for ENERGY STAR manufactured homes. It amends the state solar tax credit to include credits for small hydropower and energy efficient products worth up to 25% of the cost of the purchase and installation, with a maximum of $3,500 per year for up to 10 years.
- Beginning in 2009, S. 1143 provides a sales tax holiday for the entire month of October each year for purchase of Energy Star appliances and other Energy Star products costing $2,500 or less.
- Non-legislative efforts are also taking off. For example, a partnership of the South Carolina Energy Office, local homebuilder associations, and Southface Energy Institute is piloting an EarthCraft house program, through which over 200 EarthCraft homes have been built. These actions indicate growing momentum for improving energy efficiency and reducing GHG emissions in the state.

Transportation

- S. 368 requires South Carolina to give purchasing preference to hybrid, plug-in hybrid, biodiesel, hydrogen fuel cell and flex-fuel vehicles when the performance, quality and life cycle costs are comparable to other available motor vehicles.

- H. 3279 creates a study committee charged with reviewing all mass transit systems in South Carolina.
- H. 3853 prohibits commercial diesel vehicles from idling more than ten minutes in any 60-minute period.

CECAC Policy Recommendations (Beyond Recent Actions)

The CECAC recommended 51 policy actions. The CECAC members present and voting approved 46 policy actions unanimously, and approved 5 by a super majority (four objections or fewer). Explanations of objections are in the appendixes to this report, which contain detailed accounts of the CECAC's recommendations.

A total of 38 of the 51 policy recommendations were analyzed quantitatively to estimate their effects on emissions. Of these 38 analyzed, 33 were analyzed quantitatively to estimate their costs or cost savings. The 38 recommendations for which emission reductions were quantified were estimated to have a cumulative effect of reducing emissions by about 55 $MMtCO_2e$ in 2020.

Figure EX-3 presents a graphical summary of the potential cumulative emission reductions associated with the recent federal actions and the 38 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,

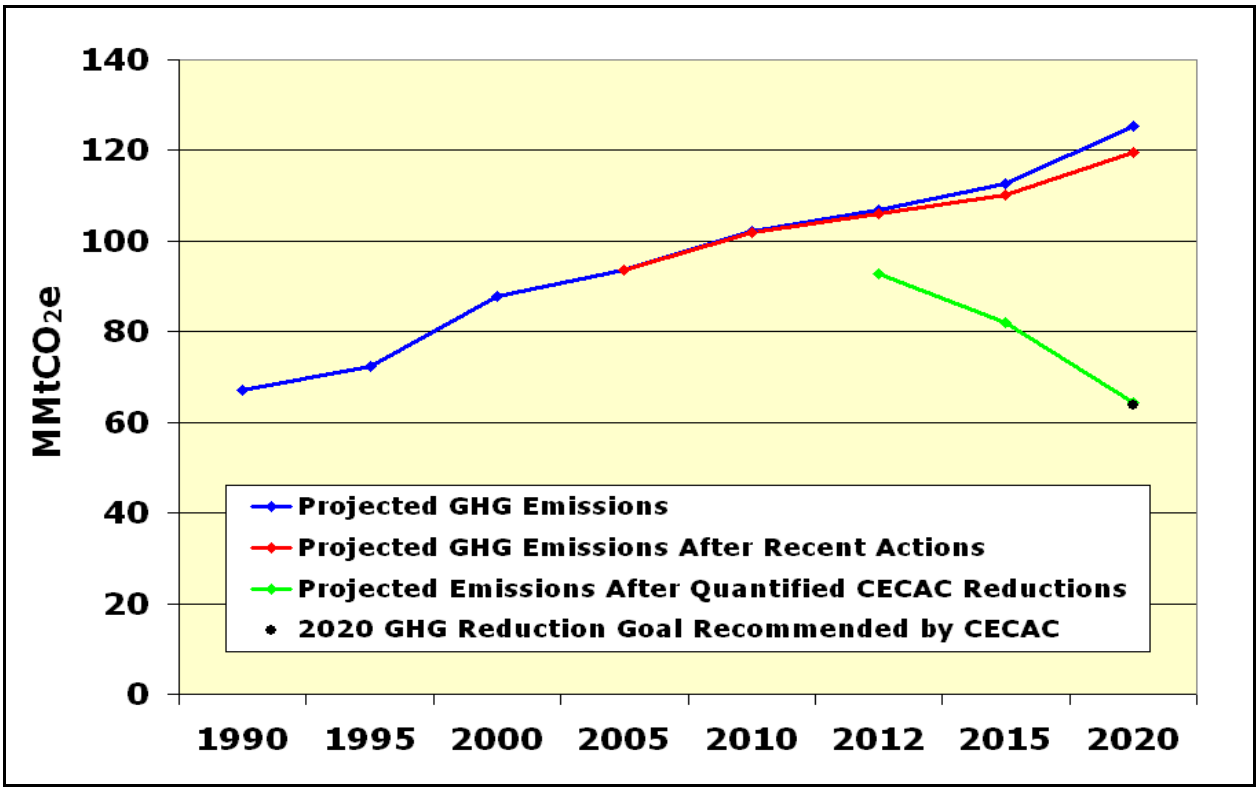
- The blue line shows actual (for 1990, 2000, and 2005) and projected (for 2010, 2012, 2015, and 2020) levels of South Carolina's gross GHG emissions on a consumption basis. (The consumption-based approach accounts for emissions associated with the generation of electricity in-state to meet South Carolina's demand for electricity, and excludes emissions associated with the generation of electricity in-state that is exported to other states, since these emissions would be included in the accounts of the other states.)
- 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 CECAC's 38 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 CECAC 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 dot shows the projected emission level associated with the CECAC's recommendation of a voluntary, economy-wide goal for South Carolina to reduce its GHG emissions economy-wide by 5% below 1990 emissions by 2020. Together, if the 38 quantified policy recommendations and the recent federal actions (or their equivalent) are successfully implemented, the 2020 GHG emission reduction goal would come very close to being achieved based on results of analysis of CECAC proposals conducted through the CECAC and TWG process. CECAC's economic evaluation of the policy options was guided by an overall approach limited to estimation of the direct cost or savings of implementation on a statewide level (see Appendix E, CCS Quantification Memo for more detail). The

CECAC did not break those costs or savings down to the individual, household, or organization levels for each option, and has not fully evaluated the costs or benefits of each policy from a broader macroeconomic, social or environmental standpoint. Further evaluation of both the broader impacts of the policy recommendations and the breakdown of costs and benefits should be considered prior to adoption by the state.

The 33 recommendations analyzed in terms of their costs or cost savings were estimated to have a total net cost of about $1.6 billion between now and 2020, and the weighted-average cost-effectiveness of the 33 policies is estimated to be approximately $5/t$CO_2$e reduced. While the emission reductions and costs or cost savings of the CECAC's 13 other policy recommendations were not readily quantifiable, some of them would most likely achieve additional reductions at a net savings (e.g., recommendations for the TLU sector). In addition, emerging technologies may hold the potential to reduce emissions even further.

Table EX-2 provides a summary by sector of the estimated cumulative impacts if all of the CECAC's recommendations are successfully implemented. Table EX-3 shows the estimated GHG reductions, the costs or savings from each policy recommendation, and each policy's cost-effectiveness (cost or savings per ton of reduction) upon which the cumulative impacts in Table EX-2 are based. Note that the cumulative impacts shown in Table EX-2 account for overlaps between policies by eliminating potential double counting of emission reductions and costs or cost savings. Chapters 3 through 7 and the appendixes provide detailed descriptions and analyses of GHG reductions, costs or cost savings, additional impacts, feasibility, etc., for each policy developed by the CECAC for each sector.

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



$MMtCO_2e$ = million metric tons of carbon dioxide equivalent; GHG = greenhouse gas; CECAC = Climate, Energy, and Commerce Advisory Committee.

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

Annual Emissions ($MMtCO_2e$)	1990	2000	2005	2010	2012	2015	2020
Projected GHG Emissions	67.2	87.8	93.5	102.2	106.9	112.6	125.4
Reductions From Recent Actions*			0.0	0.3	1.0	2.4	5.7
Projected GHG Emissions After Recent Actions			93.5	102.0	106.0	110.1	119.7
Total GHG Reductions From 38 Analyzed CECAC Recommendations					13.2	29.0	55.4
Projected Annual Emissions After Quantified CECAC Reductions†					92.8	82.1	64.3
2020 GHG Reduction Goal Recommended by CECAC							63.9

$MMtCO_2e$ = million metric tons of carbon dioxide equivalent; GHG = greenhouse gas; CECAC = Climate, Energy, and Commerce Advisory Committee.

* Reductions from recent actions include the Energy Independence and Security Act of 2007, Title III. Refer to Annex 1 to Appendix G for more information. 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-5, RCI-6, RCI-7, and RCI-8.

†Projected annual emissions also include reductions from recent actions.

For the policies recommended by the CECAC to yield the levels of estimated emission reductions and cost savings shown in Table EX-2, they must be implemented in a timely, aggressive, and thorough manner. In some cases, the recommended actions are precise, concrete steps. In other cases, they are more general, and work must be done to develop precise, concrete steps to achieve the goals recommended by the CECAC. In the latter case, precise, concrete actions need to be identified before the recommended policies can be implemented. Careful, comprehensive, and detailed planning and implementation, as well as consistent support, of these policies will be required if benefits are to be achieved.

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

Sector	GHG Reductions ($MMtCO_2e$)			Net Present Value 2008–2020 (Million $)	Cost-Effectiveness ($/tCO_2e$)
	2012	2020	Total 2008–2020		
Residential, Commercial, and Industrial	4.3	27.7	141.6	–$2,941	–$21
Energy Supply	0.3	3.0	22.5	$1,012	$45
Transportation and Land Use	0.8	5.5	29.3	$2,582	$88
Agriculture, Forestry, and Waste Management	7.8	19.2	135.0	$987	$7.3
Cross-Cutting Issues	Non-quantified, enabling options				
TOTAL (includes all adjustments for overlaps)	**13.2**	**55.4**	**328.4**	**$1,640**	**$5.0**

GHG = greenhouse gas; MMtCO2e = million metric tons of carbon dioxide equivalent; $/tCO2e = dollars per metric ton of carbon dioxide equivalent.

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 E of this report provides 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 2008–2020. 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 2008–2020. There can be considerable variations in the estimates of GHG emission reductions as well as the exact cost (or cost savings) per ton of reduction associated with the range of policy recommendations. Having the emissions reduction and cost-effectiveness values was helpful, but the CECAC was mindful that these are estimates. CECAC members noted that even though the quantification of impacts associated with the policies were developed using the best information that could be identified during the CECAC process, the results may be uncertain and subject to change as better information becomes available in the future. While individual members of the CECAC may not endorse each and

every quantification method or data input, the members of the CECAC acknowledge the quantification analyses as helpful in evaluating the GHG reductions and implementation costs or savings that may be expected from the various recommendations contained in this report.

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

No.	Policy Recommendation	GHG Reductions ($MMtCO_2e$)			Net Present Value 2009–2020 (Million $)	Cost-Effectiveness ($/tCO_2e$)	Level of Support
		2012	2020	Total 2009–2020			
RCI-1	Energy Efficiency Programs, Funds, or Goals for Electricity (Residential, Commercial, and Industrial)	1.5	8.2	43.0	–$1,127	–$26	Unanimous
RCI-2	Demand-Side Management/Energy Efficiency Programs, Funds, or Goals for Natural Gas, Propane, and Fuel Oil	0.2	0.8	4.5	–$379	–$85	Unanimous
RCI-3	Incentives and Regulatory Reform To Promote Implementation of Renewable Energy Systems, Including Solar Hot Water (Residential, Commercial, and Industrial)*	0.2	0.6	4.0	$164	$41	Unanimous
RCI-4	Energy Management Training/Training of Building Operators	Not quantified					Unanimous
RCI-5	Incentives, Resources, and Regulatory Reform To Promote Energy Recycling, Including Combined Heat and Power	1.0	8.2	39.5	–$332	–$8	Unanimous
RCI-6	Incentives and Policies for Improving Building Efficiency, Including Building Energy Codes	1.6	7.2	40.4	–$665	–$16	Unanimous
RCI-7	Improved Design and Construction in New and Existing State and Local Government Buildings, "Government Lead by Example"	0.5	5.0	24.6	–$800	–$33	Unanimous
RCI-8	Participation in Voluntary Industry–Government Partnerships (Including Incentives)	0.0	0.0	0.05	Not quantified*		Unanimous
RCI-9	Incentives and Policies for Improving Appliance Efficiency, Including Appliance Standards	0.3	0.9	5.6	–$94	–$17	Unanimous
	Sector Total After Adjusting for Overlaps (excluding RCI-8)†	**4.3**	**27.7**	**141.6**	**–$2,941**	**–$21**	
	Reductions From Recent Actions‡	**0.5**	**2.2**	**12.6**	**Not quantified**		
	Sector Total Plus Recent Actions	**4.9**	**29.9**	**154.2**	**–$2,941**	**–$21**	

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent.

All costs are reported in 2005 U.S. dollars, net present value as of January 1, 2009. 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 numbering used to denote the above policy recommendations is for reference purposes only; it does not reflect prioritization among these policy recommendations.

*The costs of RCI-8 have not been quantified, due to lack of publicly available data. For more information, refer to the discussion of Key Uncertainties under RCI-8 in Appendix G of this report.

† The benefits and costs of RCI policies overlap as follows: between residential and commercial new construction in RCI-1 and RCI–6; between residential and commercial new construction in RCI-2 and RCI–6; between RCI–7 and energy efficiency efforts in government and schools within RCI-1 and RCI-2; and between RCI-9 and parts of RCI-1, RCI-2, and RCI-7. Overlaps also occur between RCI-1 and the energy efficiency component of ES-1, and between the electricity load reductions from RCI policies in general and ES-1; adjustments for these overlaps are made in the

ES totals. The benefits and costs of renewable energy in RCI-7 overlap with ES renewable energy policies and are not included.

‡ Reductions from recent actions include the Energy Independence and Security Act of 2007, Title III. Refer to Annex 1 to Appendix G for more information. 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-5, RCI-6, RCI-7, and RCI-8.

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

No.	Policy Recommendation	GHG Reductions ($MMtCO_2e$)			Net Present Value 2008–2020 (Million $)	Cost-Effectiveness ($/tCO$_2$e)	Level of Support
		2012	2020	Total 2008–2020			
ES-1	Efficiency and Renewable Portfolio Standard and Statement of Support for Nuclear Energy	1.9	12.6	66.5	$689	$10	Super Majority (Three objections)
ES-1a	Energy Efficiency: 5% of energy met with energy efficiency resources by 2020	0.8	4.2	22.4	–$586	–$26	
ES-1b	Renewables: 5% of energy served by new renewable resources by 2020	1.1	3.8	25.3	489	$19	
ES-1c	Nuclear: 6% of energy served by new nuclear resources by 2020	0.0	4.6	18.9	$786	$42	
ES-2	Technology Research and Development, Including State Funding	Not quantified					Unanimous
ES-3	Renewable Energy Financing, Tax Incentives, Loans	0.4	0.9	7.1	$591	$84	Unanimous
ES-4	Regulatory Model To Equalize Utility Earnings on Energy Efficiency With Earnings on Traditional Power Supply	Not quantified					Super Majority (One objection)
ES-5	Nuclear Fuel Reprocessing	Not quantified					Unanimous
ES-6	Green Power Purchases and Marketing, 1% Participation by 2012	0.2	0.2	1.7	$46	$27	Unanimous
ES-7	Attract Renewable Energy Technology Businesses to South Carolina	Not quantified					Unanimous
ES-8	Distributed Renewable Energy Incentives and/or Barrier Removal (Including Interconnection Rules)	0.05	0.1	0.8	$42	$50	Unanimous
	Sector Total After Adjusting for Overlaps	**0.3**	**3.0**	**22.5**	**$1,201**	**$53**	
	Reductions From Recent Actions	**0.0**	**0.0**	**0.0**	**0**	**0**	
	Sector Total Plus Recent Actions	**0.3**	**3.0**	**22.5**	**$1,201**	**$53**	

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent.

All costs are reported in 2005 U.S. dollars, net present value as of January 1, 2009. 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 numbering used to denote the above policy recommendations is for reference purposes only; it does not reflect prioritization among these policy recommendations.

General definition: For the purposes of the policies discussed here, and unless otherwise noted, “renewable energy” is defined as follows: A renewable energy resource includes solar; wind; small hydroelectric geothermal; ocean current or wave energy; biomass resources, including agricultural waste, animal waste, wood waste, spent pulping liquors, combustible residues, combustible liquids, combustible gases, energy crops, and landfill methane; waste heat derived from a renewable energy resource and used to produce electricity; and hydrogen derived from a renewable energy resource.

For the combined impact of all ES policy recommendations, the incentives for utility-scale renewable energy projects in ES-3 are assumed to be redundant with the renewable energy mandate in ES-1; however, the distributed energy incentives in ES-3 are found to be larger than the impact of ES-8, and ES-8 is found to have no incremental impact over ES-3. These distributed renewable energy incentives, as well as voluntary green power initiatives (ES-6) are assumed to be incremental, and not to overlap with ES-1. Further, the energy efficiency component of ES-1 is assumed to overlap with the energy efficiency policy under RCI-1, and the goals for the nuclear and renewables components of ES-1 are reduced to reflect energy savings under RCI-1.

Several ES sector policy recommendations rely on biomass feedstock to replace fossil-based electricity generation. Similarly, a number of AFW policies also rely on the use of biomass for both electricity production and other energy-related uses. Specifically, the biomass generation benefits in ES policies 1, 3, and 6 are found to overlap with AFW policies 2, 5, and 9. The fundamental limit that creates an overlap among these policies is the limited availability of biomass feedstock in South Carolina.

To accommodate this limit, the cumulative impact analysis for the ES sector does not include any of the electricity generation from woody biomass, swine waste, or poultry litter resulting from ES policies, and the impact of landfill gas generation has been reduced by 18%. Either this generation is already accounted for in AFW policies, or the feedstock is used for another purpose that has a similar or greater impact in mitigating GHG emissions in the state.

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

No.	Policy Recommendation		GHG Reductions ($MMtCO_2e$) 2012	2020	Total 2008–2020	Net Present Value 2008–2020 (Million $)	Cost-Effectiveness ($/tCO_2e$)	Level of Support
TLU-1	Adopt a South Carolina Clean Car Standard		0.21	1.14	7.04	–$323 to $1,598	–$46 to $227	Super Majority (Two objections)
TLU-2	Transportation System Management		0.01	0.04	0.22	< $0	< $0	Unanimous
TLU-3	Tax Credits for Efficient Vehicles		0.02	0.12	0.68	$244	$359	Unanimous
TLU-4	Improve Development Patterns		0.41	2.31	14.02	< $0	< $0	Unanimous
TLU-5	Transit & Bike-Pedestrian [Incorporates TLU-11]		0.02	0.02	0.22	–$1	–$1	Unanimous
TLU-6	Alternative-Fuel Infrastructure		0.02	0.24	0.77	$54	$70	Unanimous
TLU-7	Diesel Engine Emission Reductions and Fuel Efficiency Improvements	Efficiency Improvements	0.03	0.19	0.96	–$110	–$114	Unanimous
		Biodiesel	0.05	0.38	1.95	–$291 to $319	–$15 to $164	Super Majority (Two objections)
TLU-8	Stricter Enforcement of Speed Limits		0.10	0.12	1.18	Not quantified	Not quantified	Unanimous
TLU-9	Make Full Use of CMAQ Funds		Not quantified					Unanimous
TLU-10	Commuter Choice and Commuter Benefits Programs		0.12	0.43	2.63	–$631	–$240	Unanimous
TLU-12*	Low-GHG Fuel Standard		0.38	3.67	17.89	$20 to $3,276	$1 to $183	Super Majority (Two objections)
TLU-14	Rail		Not quantified					Unanimous
	Sector Total Before Adjusting for Overlaps		**1.37**	**8.64**	**47.57**	**Not quantified**		
	Sector Total After Adjusting for Overlaps†		**0.75**	**5.53**	**29.29**	**$2,582**	**$88**	
	Reductions From Recent Actions		**0.45**	**3.51**	**16.37**	**Not quantified**		
	Sector Total Plus Recent Actions		**1.20**	**9.04**	**45.66**	**$2,582**	**$88**	

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent; CMAQ = Congestion Mitigation and Air Quality.

All costs are reported in 2005 U.S. dollars, net present value as of January 1, 2009. 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 numbering used to denote the above policy recommendations is for reference purposes only; it does not reflect prioritization among these policy recommendations.

* TLU-12 overlaps with AFW-4. The individual totals for TLU-12 do not reflect this overlap.

† Accounts for overlap between TLU-12 and AFW-4.

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

No.	Policy Recommendation	GHG Reductions ($MMtCO_2e$)			Net Present Value 2008–2020 (Million $)	Cost-Effectiveness ($/tCO2e)	Level of Support
		2012	2020	Total 2008–2020			
AFW-1*	On-Farm Energy Efficiency	0.052	0.16	1.0	–$43	–$41	Unanimous
AFW-2a	On-Farm Waste Energy Recovery—Swine/Dairy	0.006	0.019	0.13	$0.58	$5	Unanimous
AFW-2b†	On-Farm Waste Energy Recovery—Poultry Litter	0.010	0.031	0.20	–$3.2	–$16	Unanimous
AFW-3	Expanded Use of Local Agricultural Products	0.012	0.030	0.21	Not quantified	Not quantified	Unanimous
AFW-4a†,‡	In-State Liquid Biofuels Production—Biodiesel	0.12	0.13	1.5	$26	$17	Unanimous
AFW-4b†	In-State Liquid Biofuels Production—Ethanol	0.86	1.5	13	$281	$22	Unanimous
AFW-5‖	Expanded Use of Biomass Feedstocks for Electricity, Heat, or Steam Production	2.7	4.9	41	$156	$4	Unanimous
AFW-6a	Terrestrial Carbon Sequestration—Agriculture	0.21	0.39	3.1	–$191	–$62	Unanimous
AFW-6bi	Terrestrial Carbon Sequestration—Forestry: Forest Management	0.33	0.85	5.8	$53	$9	Unanimous
AFW-6bii	Terrestrial Carbon Sequestration—Forestry: Afforestation/Reforestation	0.81	2.4	16	$158	$10	Unanimous
AFW-6biii¶	Terrestrial Carbon Sequestration—Forestry: Urban Forestry	0.37	1.2	7.5	$456	$60	Unanimous
AFW-7a	Conservation and Restoration of Agriculture Lands for Enhanced Carbon Sequestration	0.080	0.21	1.5	$54	$37	Unanimous
AFW-7b	Conservation and Restoration of Forestlands for Enhanced Carbon Sequestration	0.42	3.1	16	$117	$7	Unanimous
AFW-8	Advanced Recycling and Composting	1.18	3.0	20	–$44	–$2	Unanimous
AFW-9‖	Waste-to-Energy Reclamation	0.41	1.0	7.2	$0.23	$0.03	Unanimous
AFW-10*	Water and Wastewater Energy Efficiency Improvements	0.16	0.18	1.6	–$33	–$21	Unanimous
	Sector Total After Adjusting for Overlaps**	**7.8**	**19.2**	**135**	**$987**	**$7**	
	Reductions From Recent Actions	**—**	**—**	**—**	**—**	**—**	
	Sector Total Plus Recent Actions**	**7.8**	**19.2**	**135**	**$987**	**$7**	

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/tCO2e = dollars per metric ton of carbon dioxide equivalent.

All costs are reported in 2005 U.S. dollars, net present value as of January 1, 2009. 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 numbering used to denote the above policy recommendations is for reference purposes only; it does not reflect prioritization among these policy recommendations.

* AFW-1 and AFW-10 may overlap with RCI-6. However, for reasons stated in the documentation of AFW-1 and AFW-10, no overlap is counted.

† AFW-4 overlaps with TLU-12 (Transportation and Land Use). This overlap is accounted for in the cumulative analysis of the TLU options.

‡ AFW-4 biodiesel targets were unachievable with in-state feedstock supplies. These reductions and costs refer to modified goals based on in-state feedstock. See text under AFW-4 in Appendix J of this report.

|| AFW-2, AFW-5, and AFW-9 overlap with ES-1. These overlaps are accounted for in the cumulative analysis of the ES policy recommendations.

¶ AFW-6biii represents the combined costs and benefits of two elements of urban forestry: tree planting and avoided deforestation. The net cost of avoided deforestation was not quantified because of insufficient information regarding the costs of such programs.

** Totals may not equal sum of rows because of independent rounding. The cost-effectiveness totals represent the total net present value divided by the cumulative (2008–2020) GHG reductions for those options for which quantitative cost analyses were performed (i.e., excludes AFW-3).

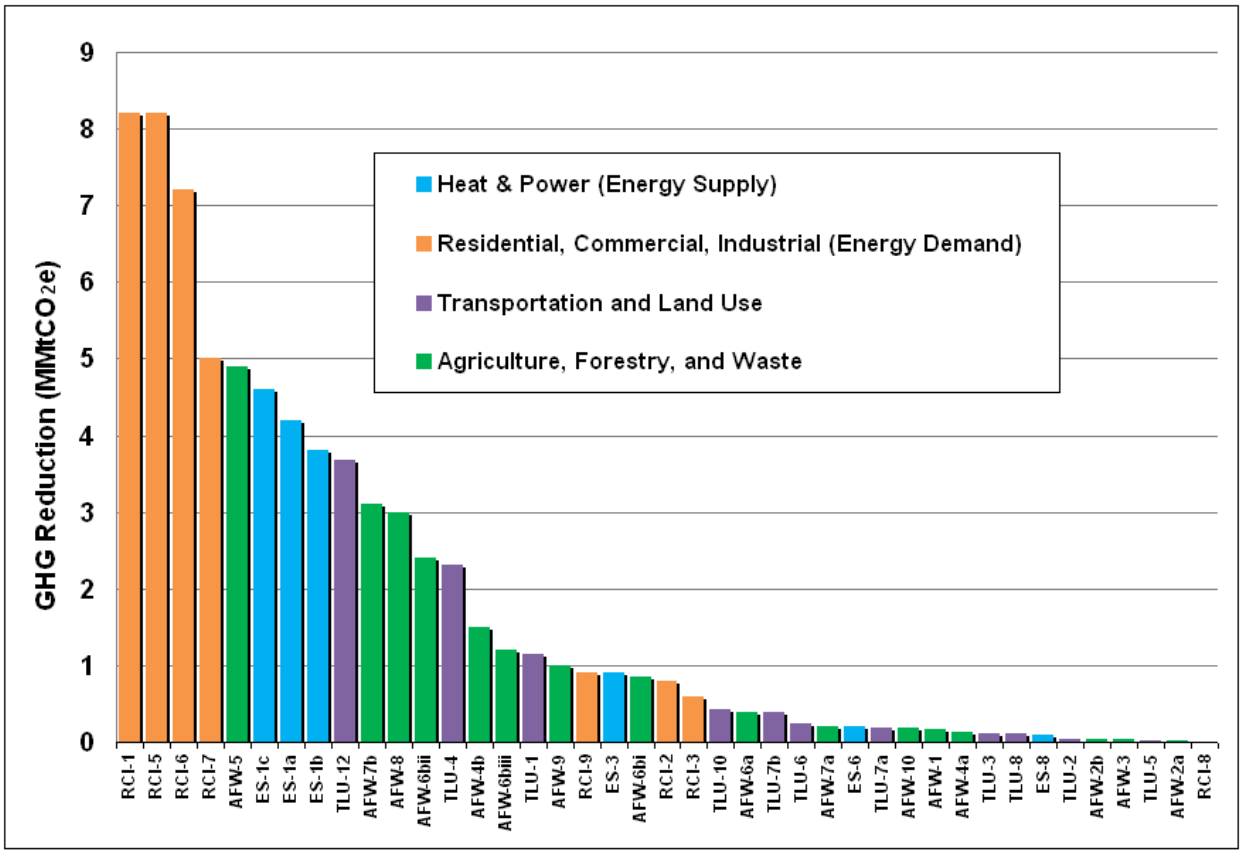
Table EX-3 (continued) Cross-Cutting Issues Policy Recommendations

No.	Policy Recommendation	GHG Reductions ($MMtCO_2e$)			Net Present Value 2008–2020 (Million $)	Cost-Effective-ness ($/tCO_2e$)	Level of Support
		2012	2020	Total 2008–2020			
CC-1	Inventories and Forecasting	Not quantified					Unanimous
CC-2	GHG Reporting and Registry	Not quantified					Unanimous
CC-3	State Government GHG Emissions (Lead by Example)	Not quantified					Unanimous
CC-4	Comprehensive Local Government Climate Action Plans (Counties, Cities, etc.)	Not quantified					Unanimous
CC-5	Public Education and Outreach	Not quantified					Unanimous
CC-6	Adaptation & Vulnerability	Not quantified					Unanimous
	Sector Total After Adjusting for Overlaps	**Not quantified**					
	Reductions From Recent Actions	**Not quantified**					
	Sector Total Plus Recent Actions	**Not quantified**					

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent.

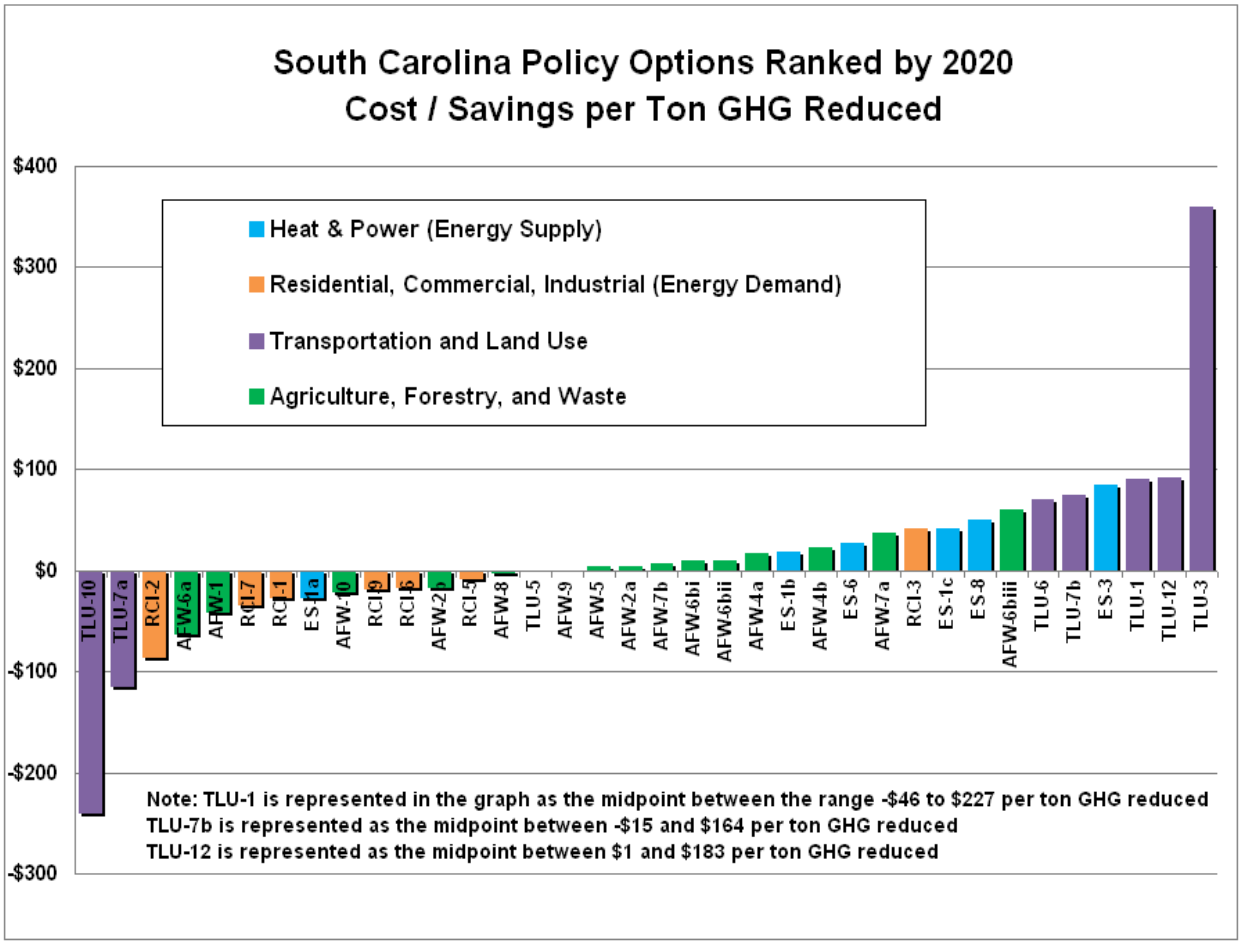
The numbering used to denote the above policy recommendations is for reference purposes only; it does not reflect prioritization among these policy recommendations.

Figure EX-4. CECAC policy recommendations ranked by 2020 annual GHG reduction potential



GHG = greenhouse gas; $MMtCO_2e$ = 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. CECAC policy recommendations ranked by 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.

Chapter 1
Background and Overview

The Governor's Initiative

Creation of and Charge to the Climate, Energy, and Commerce Advisory Committee

On February 16, 2007, South Carolina Governor Mark Sanford issued Executive Order No. 2007-04 establishing the Governor's Climate, Energy, and Commerce Advisory Committee (CECAC) with the following charges:[1]

1. The CECAC shall consider the potential benefits, costs, savings, and feasibility of furthering building and infrastructure efficiency, and of carbon dioxide (CO_2) mitigation options and related energy policy and economic opportunities, and develop specific recommended actions.

2. The CECAC shall not exceed 30 members appointed by the Governor, including representatives from some or all of the following sectors: Tourism and Recreation, Agriculture and Forestry, Renewable Energy, Transportation, Insurance, Banking and Finance, Manufacturing, Electric Power Generation, Advanced Technology, Construction and Building, Small Business, Public Health, Conservation Organizations, State and Local Government, Educational Institutions, and the General Public.

3. The CECAC shall be authorized to hold public meetings and take such actions as it deems necessary and advisable to achieve its purpose.

4. The CECAC shall meet as needed and submit a Climate, Energy, and Commerce Action Plan to the Governor by July 2008.[2]

5. The CECAC may receive support from the Departments of Natural Resources and Health and Environmental Control in achieving its mission.

The Governor asked the Center for Climate Strategies (CCS) to work in partnership with his office and agencies of the state to provide facilitation and technical support for a process to complete the following tasks through joint activities of the CECAC, a set of Technical Work Groups (TWGs), state agencies, and members of the public. To develop an Action Plan as directed by the Governor's Executive Order, the CECAC was tasked with completion of the following specific planning recommendations:[3]

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[1] State of South Carolina, Executive Department, Office of the Governor, Executive Order No. 2007-04 (http://www.scgovernor.com/executive/orders/ex_orders_2007.htm).

[2] The South Carolina Governor's office issued an extension for completion of the CECAC's final recommendations from March to July 2008 to provide the CECAC with the time needed to fully complete its work.

[3] These planning recommendations are included in the CECAC Process Memo which provides a detailed work plan and description of the Action Plan process. The Process Memo is provided in Appendix B of this report.

1. Review and approval of a current and comprehensive inventory and forecast of greenhouse gas (GHG) emissions in South Carolina from 1990 to 2020;

2. Development and recommendation of a comprehensive set of specific policy recommendations and associated analyses to reduce GHG emissions and enhance energy and economic policy in South Carolina by 2020 and beyond;

3. Development and recommendation of a set of statewide GHG reduction goals and targets for implementation of these actions; and

4. Issuance of recommendations in the form of a final report to the Governor by July 2008.

CECAC's Response to Governor's Charge

In response to the Governor's charge, the CECAC has prepared this "Climate, Energy, and Commerce Action Plan," which documents the CECAC's recommendations and associated analyses to reduce GHG emissions and enhance energy and economic policy in South Carolina by 2020 and beyond. More than 90 South Carolinians who were members of the CECAC and the five TWGs that supported the CECAC held over 70 meetings to identify, analyze, deliberate, and ultimately recommend a comprehensive set of specific policies for South Carolina. The CECAC presents this report covering:

- An inventory of historical, current, and forecasted GHG emissions in South Carolina;
- A description and analysis of recent policies and programs that will reduce GHG emissions in South Carolina;
- GHG emission reduction goals for South Carolina and recommended policies to achieve these goals;
- Recommended mechanisms for implementing these goals and policies across all sectors of South Carolina's economy;
- Estimated GHG emission reductions from the recommended policies, expressed in metric tons of carbon dioxide equivalents (tCO_2e);
- Consideration of the costs or cost savings associated with the recommendations; and
- Challenges inherent in each recommendation, as well as feasibility issues.

Key recommendations and accomplishments of the CECAC are:

- Recommendation of a comprehensive set of 51 specific policies to reduce GHG emissions and address climate-, energy-, and commerce-related issues in South Carolina. The CECAC members present and voting approved 46 policy actions unanimously, and approved 5 by a super majority (four objections or fewer). Explanations of objections are in the appendixes to this report, which contain detailed accounts of the CECAC's recommendations.
- Recommendation of a voluntary, economy-wide goal for South Carolina to reduce gross GHG emissions to 5% below 1990 levels by 2020, equal to successful implementation of the policy recommendations. The state should (1) evaluate progress toward meeting the recommended goal at least once every 5 years and report the results of this evaluation to the

public, and (2) consider reviewing at least once every 5 years realistic GHG reduction goals for years beyond 2020. Of the 51 policy recommendations, 38 were analyzed quantitatively to have a cumulative effect of reducing emissions by about 55 million metric tons of carbon dioxide equivalent ($MMtCO_2e$) in 2020. Together, if the 38 quantified policy recommendations and the recent federal actions (or their equivalent) are successfully implemented, the 2020 GHG emission reduction goal would come very close to being achieved.

- Evaluation of the costs, savings, and feasibility of building and infrastructure efficiency to enhance energy and economic policy in South Carolina. The CECAC analyzed quantitatively the costs or cost savings of 33 of its 51 policy recommendations. Although the total net cost associated with the 33 policies analyzed is estimated at about $1.6 billion between now and 2020, the weighted-average cost-effectiveness of the 33 policies is estimated to be approximately $\$5/tCO_2e$ reduced. Many of the policies are estimated to yield significant cost-saving opportunities for South Carolinians. Other policies will incur net costs because they are targeting changes in current practices that require incentives, capital investment, or other cost outlays.
- Review, update, and approval of a comprehensive inventory and forecast of GHG emissions in South Carolina for 1990 through 2020. This is the first comprehensive, statewide GHG inventory and forecast that has been developed for South Carolina. It has benefited from the expertise of many CECAC and TWG members who provided state-specific data.

Recent Actions

GHG Reductions Associated With Recent Federal Actions

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 CECAC process, sufficient information was identified (e.g., implementation schedules) to estimate GHG emission reductions associated with implementing the Corporate Average Fuel Economy (CAFE) requirements and energy efficiency requirements for new appliances and lighting in South Carolina. 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 emissions in South Carolina by about 5.7 $MMtCO_2e$ (a 4.5% reduction) from the business-as-usual emissions in 2020 for all sectors combined. 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-5, RCI-6, RCI-7, and RCI-8.

Recent State Actions

South Carolina adopted several pieces of legislation in the 2007–2008 legislative session relevant to renewable energy, energy efficiency, and transportation. The following provides a brief summary of the legislation adopted. A detailed listing of the legislation has been complied by the

South Carolina Energy Office and is available at the following website: http://www.energy.sc.gov/index.aspx?m=1&t=67.

Renewable Energy

- H. 3649 enhances incentives for biomass energy development by removing legislative caps on tax credits for biomass energy equipment, biodiesel and ethanol production, and other alternative energy incentives. It also removes caps on incentive payments for alternative fuel retailers and biomass energy producers.
- S. 1143 allows South Carolina gas suppliers to continue to blend fuel with ethanol instead of buying a pre-blended version from national oil companies.
- H. 4766 requires the South Carolina Energy Office to report on agency progress towards goals and staff the Wind Energy Production Farms Feasibility Study Committee, which will release a report by January 2010.

Energy Efficiency

- The Energy Independence and Sustainable Construction Act of 2007 (H. 3034) requires application of "green building" or comparable standards to major facilities to be constructed on state property with 10,000 or more square feet.
- H. 3395 requires the South Carolina Energy Office and the Office of Regulatory Staff to recommend process and procedures for establishing net metering programs at all distribution electric utilities in the state.
- H. 4766 creates specific energy reduction and reporting requirements for state agencies by requiring state agencies to prepare Energy Conservation Plans in order to meet an energy consumption reduction goal of 20% by 2020, using 2000 as a baseline year. It also requires incandescent light bulbs used by a state agency to be replaced with compact fluorescent bulbs when the incandescent bulb needs replacing. Relating to purchase of energy conservation products by a state agency, the South Carolina Energy Office may certify for procurement only a product that meets or exceeds federal Energy Star standards.
- Beginning in 2009, S. 1141 creates a new sales tax rebate program for ENERGY STAR manufactured homes. It amends the state solar tax credit to include credits for small hydropower and energy efficient products worth up to 25% of the cost of the purchase and installation, with a maximum of $3,500 per year for up to 10 years.
- Beginning in 2009, S. 1143 provides a sales tax holiday for the entire month of October each year for purchase of Energy Star appliances and other Energy Star products costing $2,500 or less.
- Non-legislative efforts are also taking off. For example, a partnership of the South Carolina Energy Office, local homebuilder associations, and Southface Energy Institute is piloting an EarthCraft house program, through which over 200 EarthCraft homes have been built. These actions indicate growing momentum for improving energy efficiency and reducing GHG emissions in the state.

Transportation

- S. 368 requires South Carolina to give purchasing preference to hybrid, plug-in hybrid, biodiesel, hydrogen fuel cell and flex-fuel vehicles when the performance, quality and life cycle costs are comparable to other available motor vehicles.
- H. 3279 creates a study committee charged with reviewing all mass transit systems in South Carolina.
- H. 3853 prohibits commercial diesel vehicles from idling more than ten minutes in any 60-minute period.

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

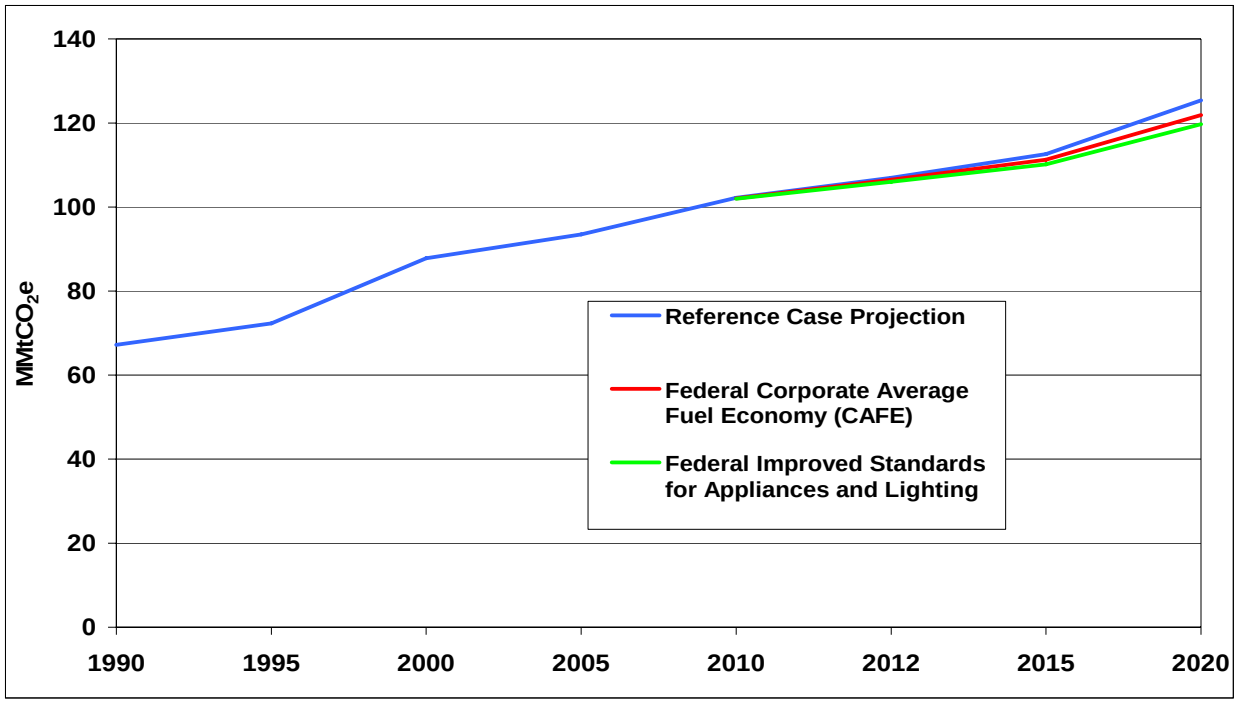

Table 1-1. Estimated emission reductions associated with the effect of recent federal actions in South Carolina (consumption-basis, gross emissions)

Sector / Recent Action	GHG Reductions ($MMtCO_2e$)		GHG Emissions ($MMtCO_2e$)	
			Business as Usual	With Recent Actions
	2012	2020	2020	2020
Residential, Commercial and Industrial (RCI)				
Energy Efficiency Requirements for New Appliances and Lighting	0.50	2.19	19.88	17.69
Transportation and Land Use (TLU)				
Corporate Average Fuel Economy (CAFE) Requirements	0.45	3.51	43.57	40.06
Total (RCI + TLU Sectors)	**0.96**	**5.70**	**63.45**	**57.75**
Total (All Sectors)			**125.4**	**119.7**

GHG = greenhouse gas; MMtCO2e = million metric tons of carbon dioxide equivalent.

The CECAC Process

The CECAC first met on April 27, 2007, and met a total of nine times, with the final decisional meeting held on May 9, 2008, and then a conference call for review of this report. The CECAC also held via conference call an information session on cap-and-trade and carbon tax mechanisms. In all, more than 70 meetings and teleconference calls of the CECAC and the five supporting TWGs were held to identify and analyze various potential policy actions in advance of the CECAC's May 9, 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).

CCS provided facilitation and technical assistance to the CECAC and each of the TWGs. The TWGs consisted of CECAC members as well as individuals who were not on the CECAC but who did have an interest in and expertise regarding the issues being addressed by each TWG (see Appendix C for a listing of the members of each TWG). The TWGs served as advisers to the CECAC and helped generate initial recommendations on priority policy recommendations for analysis. They then developed draft proposals on the design characteristics and quantification of the proposed policy recommendations. Where members of a TWG did not fully agree on recommendations to the CECAC, the summary of their efforts was reported to the CECAC for further consideration and actions. The CECAC then made its decisions after reviewing the TWGs' proposals.

The CECAC process involved a model of informed self-determination through a facilitated, stepwise, consensus-building approach. With oversight by the South Carolina Governor's Office, the process was conducted by CCS, an independent, expert facilitation and technical analysis team. It was based on procedures that CCS consultants have used in a number of other state climate change planning initiatives since 2000, but was adapted specifically for South Carolina. The CECAC process sought but did not mandate consensus, and it explicitly documented the level of CECAC support for some policies and key findings established through a voting process established in advance.

The 51 policy recommendations (out of more than 250 potential options considered) adopted by the CECAC and presented in this report underwent two levels of screening by the CECAC. First, a potential policy recommendation being considered by a TWG was not accepted as a "priority for analysis" and fleshed out for full analysis unless it had a super majority of support from CECAC members present at the decisional meetings (with "super majority" defined as four objections or fewer by CECAC members attending a meeting). Second, after the analyses were conducted, only policy recommendations that received at least majority support (defined as less

than half of those present objecting) from CECAC members present at the decisional meetings were adopted by the CECAC and included in this report. The TWGs' recommendations to the CECAC were documented and presented to the CECAC at each CECAC meeting. All of the CECAC and TWG meetings were open to the public, and all materials for and summaries of the CECAC and TWG meetings were posted on the CECAC Web site (www.scclimatechange.us).

Analysis of Policy Recommendations

With CCS providing facilitation and technical analysis, the five TWGs submitted recommendations for policies for CECAC 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 CECAC modified and embraced various policy recommendations. The final versions for each sector, conforming to the policy option templates, appear in Appendixes F through J and constitute the most detailed record of decisions of the CECAC. Appendix E describes the methods used for quantification of the 38 policy recommendations that were analyzed quantitatively. The quantitative analysis produced estimates of the GHG emission reductions and costs (or cost savings) of various policies, both in terms of a net present value from 2008 to 2020 and a dollars-per-ton cost (i.e., cost-effectiveness).[4] The key methods are summarized below.

Estimates of GHG Reductions: Using the projection of future GHG emissions (see below) as a starting point, 38 policy recommendations were analyzed by CCS to estimate GHG reductions attributable to each policy in the individual years of 2012 and 2020 and cumulative reductions over the period 2008–2020. The estimates were prepared in accordance with guidance by the appropriate TWG and the CECAC, which later reviewed the estimates and, in some cases, directed that they be revised with respect to such elements as goals, data sources, and methodology. Many policies were estimated to affect the quantity or type of fossil fuel combusted; others affected methane or CO_2 sequestered. Among the many assumptions involved

[4] The analysis addressed emission reductions and associated costs or cost savings and did not attempt to estimate specific price changes or utility rate changes that might result from implementation of a policy recommendation. There was no attempt to monetize the benefit of emission reductions in atmospheric concentration (e.g., health benefits).

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.[5] The CECAC took a "production-based" approach in all sectors except the electricity sector, in both forecasting emissions and in estimating the GHG impacts of policies. This issue, along with other GHG estimation issues (e.g., analysis of overlapping or interacting policy impacts), is discussed in detail in Appendix E (Methods for Quantification).

Estimates of Costs/Cost Savings: The analyses of 33 policy recommendations included estimates of the cost of those policies, both in terms of net costs or cost savings during 2008–2020 and a dollars-per-ton cost (i.e., cost-effectiveness).[6] (The other 5 policy recommendations that were analyzed with respect to their GHG reductions were such that their costs or cost savings could not be readily estimated.) The following provides a brief summary of the approach used to estimate costs or cost savings associated with the policy recommendations:

- *Discounted and annualized costs or cost savings*—Fairly 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 2008–2020 was analyzed.
- *Cost savings*—Many policies created easily monetized cost savings (e.g., fuel savings and electricity savings). In these cases, monetized cost savings were subtracted from monetized costs, resulting in net costs. These net costs could be positive or negative; negative costs indicated that the policy saved money or produced "cost savings."
- 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).7 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).

Contributing Issues: The CECAC recommendations were guided in part by the GHG reductions and monetized costs and cost savings of various policies, but members also felt that other considerations (e.g., social, economic, and environmental) should also have weight. The TWGs were asked to examine these qualitative terms where deemed important and quantify

[5] 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). South Carolina is an example of a state that is a net exporter of electric power.

[6] The analysis addressed the costs or cost savings of each policy recommendation and, with the exception of a few recommendations that address rate structures, did not attempt to estimate specific price changes or utility rate changes that might result from implementation of a policy.

[7] "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.

them on a case-by-case basis, as needed, depending on need and where data were readily available. In some cases, the recommended actions are precise, concrete steps. In other cases, they are more general, and work must be done to develop precise, concrete steps to achieve the goals recommended by the CECAC. In the latter case, precise, concrete actions need to be identified before the recommended policies can be implemented.

South Carolina GHG Emissions Inventory and Reference Case Projections

In June 2007, CCS prepared a draft GHG emissions inventory and reference case projection for the CECAC to assist the CECAC and TWGs in understanding past, current, and possible future GHG emissions in South Carolina, and thereby inform the policy development process.[8] The CECAC 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 CECAC and were subsequently approved by the CECAC at its ninth meeting.[9]

The inventory and reference case projections included detailed coverage of all economic sectors and GHGs in South Carolina, including future emission trends and assessment issues related to energy, economic, and population growth. The assessment included estimates of total statewide "gross emissions" (leaving aside carbon sequestration[10]) 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 Projections of GHG Emissions) and discussed in detail in the final report for the inventory and reference case projections.

The inventory and reference case projections revealed substantial emissions growth rates and related mitigation challenges. Figure 1-2 shows the reference case projections for South Carolina's gross GHG emissions as rising fairly steeply to 125 $MMtCO_2e$ by 2020, growing by 87% over 1990 levels. Figure 1-2 also provides the sectoral breakdown of projected GHG emissions.

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

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[8] Center for Climate Strategies. Draft South Carolina Greenhouse Gas Inventory and Reference Case Projections, 1990–2020. Prepared for the Climate, Energy, and Commerce Advisory Committee of the Office of the Governor of South Carolina. June 2007.

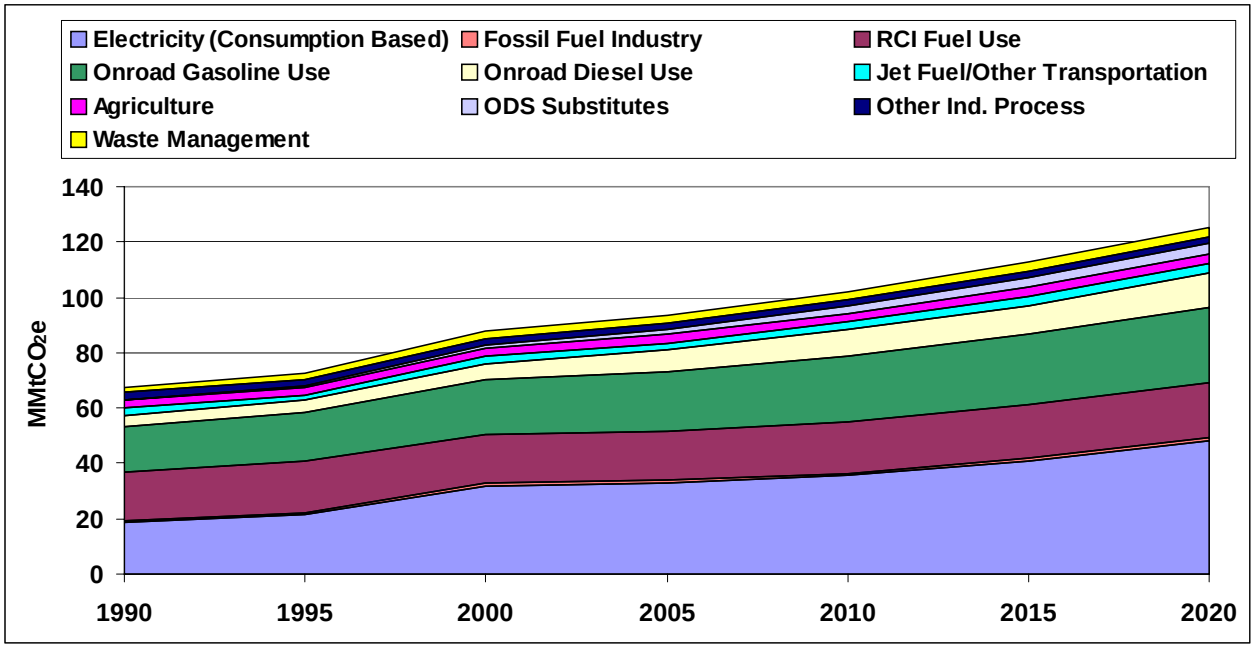
[9] Center for Climate Strategies. Final South Carolina Greenhouse Gas Inventory and Reference Case Projections, 1990–2020. Prepared for the Climate, Energy, and Commerce Advisory Committee of the Office of the Governor of South Carolina. June 2008 (http://www.scclimatechange.us/Inventory_Forecast_Report.cfm).

[10] Sequestration refers to the storing of carbon in mines, brine strata, oceans, plants and soil. As trees and other plants grow they remove CO_2, the principal GHG, from the atmosphere transforming the carbon (C) through photosynthesis into cellulose, starch and sugars, thus sequestering it in their structures and roots. The oxygen (O_2) is released back into the atmosphere. South Carolina's forests and agricultural lands are capable of sequestering much CO_2, as described in Chapter 7 (Agriculture, Forestry, and Waste Management).

- As is common in many states, the production and consumption of electricity and transportation are the sectors with the largest emissions, and they are expected to continue to grow faster than other sectors.
- From 2005 to 2020, 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 South Carolina's estimated emissions growth rate, presents challenges, it also provides major opportunities. Key choices regarding technologies and infrastructure can have a significant impact on the emissions of a fast-growing state. The CECAC'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; increasing the use of cleaner transportation modes, technologies, and fuels; and encouraged the use of more nuclear energy.

Figure 1-2. Gross GHG emissions by sector, 1990–2020: historical and projected (consumption-based approach) business-as-usual/base case



RCI = direct fuel use in residential, commercial, and industrial sectors; ODS = ozone-depleting substance; Ind. = industrial.

CECAC Policy Recommendations (Beyond Recent Actions)

The CECAC recommended 51 policy actions. The CECAC members present and voting approved 46 policy actions unanimously, and approved 5 by a super majority (four objections or

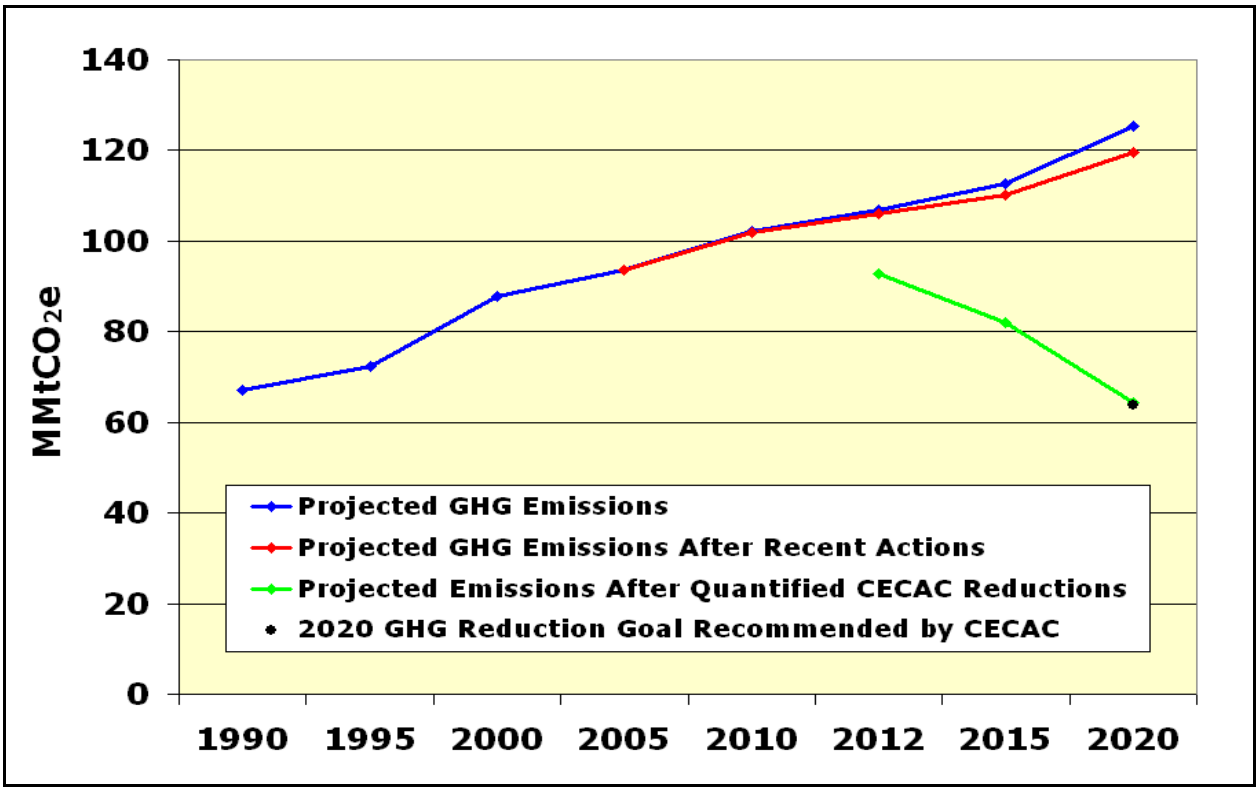
fewer). Explanations of objections are in the appendixes to this report, which contain detailed accounts of the CECAC's recommendations.

A total of 38 of the 51 policy recommendations were analyzed quantitatively to estimate their effects on emissions. Of these 38 analyzed, 33 were analyzed quantitatively to estimate their costs or cost savings. The 38 recommendations for which emission reductions were quantified were estimated to have a cumulative effect of reducing emissions by about 55 $MMtCO_2e$ in 2020.

Figure 1-3 presents a graphical summary of the potential cumulative emission reductions associated with the recent federal actions and the 38 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, 2000, and 2005) and projected (for 2010, 2012, 2015, and 2020) levels of South Carolina's gross GHG emissions on a consumption basis. (The consumption-based approach accounts for emissions associated with the generation of electricity in-state to meet South Carolina's demand for electricity, and excludes emissions associated with the generation of electricity in-state that is exported to other states, since these emissions would be included in the accounts of the other states.)
- 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 CECAC's 38 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 CECAC 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 dot shows the projected emission level associated with the CECAC's recommendation of a voluntary, economy-wide goal for South Carolina to reduce its GHG emissions economy-wide by 5% below 1990 emissions by 2020. Together, if the 38 quantified policy recommendations and the recent federal actions (or their equivalent) are successfully implemented, the 2020 GHG emission reduction goal would come very close to being achieved based on results of analysis of CECAC proposals conducted through the CECAC and TWG process. CECAC's economic evaluation of the policy options was guided by an overall approach limited to estimation of the direct cost or savings of implementation on a statewide level (see Appendix E, CCS Quantification Memo for more detail). The CECAC did not break those costs or savings down to the individual, household, or organization levels for each option, and has not fully evaluated the costs or benefits of each policy from a broader macroeconomic, social or environmental standpoint. Further evaluation of both the broader impacts of the policy recommendations and the breakdown of costs and benefits should be considered prior to adoption by the state.

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



$MMtCO_2e$ = million metric tons of carbon dioxide equivalent; GHG = greenhouse gas; CECAC = Climate, Energy, and Commerce Advisory Committee.

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

Annual Emissions ($MMtCO_2e$)	1990	2000	2005	2010	2012	2015	2020
Projected GHG Emissions	67.2	87.8	93.5	102.2	106.9	112.6	125.4
Reductions From Recent Actions*			0.0	0.3	1.0	2.4	5.7
Projected GHG Emissions After Recent Actions			93.5	102.0	106.0	110.1	119.7
Total GHG Reductions From 38 Analyzed CECAC Recommendations					13.2	29.0	55.4
Projected Annual Emissions After Quantified CECAC Reductions†					92.8	82.1	64.3
2020 GHG Reduction Goal Recommended by CECAC							63.9

$MMtCO_2e$ = million metric tons of carbon dioxide equivalent; GHG = greenhouse gas; CECAC = Climate, Energy, and Commerce Advisory Committee.

* Reductions from recent actions include the Energy Independence and Security Act of 2007, Title III. Refer to Annex 1 to Appendix G for more information. 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-5, RCI-6, RCI-7, and RCI-8.

† Projected annual emissions also include reductions from recent actions.

The 33 recommendations analyzed in terms of their costs or cost savings were estimated to have a total net cost of about $1.6 billion between now and 2020; however, the weighted-average cost-effectiveness of the 33 policies is estimated to be approximately $5/t$CO_2$e reduced. While the emission reductions and costs or cost savings of the CECAC's 13 other policy recommendations were not readily quantifiable, some of them would most likely achieve additional reductions at a net savings (e.g., recommendations for the TLU sector). In addition, emerging technologies may hold the potential to reduce emissions even further.

Table 1-3 provides a summary by sector of the estimated cumulative impacts if all of the CECAC's recommendations are successfully implemented. Table 1-4 shows the estimated GHG reductions, the costs or savings from each policy recommendation, and each policy's cost-effectiveness (cost or savings per ton of reduction) upon which the cumulative impacts in Table 1-3 are based. Note that the cumulative impacts shown in Table 1-3 account for overlaps between policies by eliminating potential double counting of emission reductions and costs or cost savings. Chapters 3 through 7 and the appendixes provide detailed descriptions and analyses of GHG reductions, costs or cost savings, additional impacts, feasibility, etc., for each policy developed by the CECAC for each sector.

For the policies recommended by the CECAC to yield the levels of estimated emission reductions shown in Table 1-3, they must be implemented in a timely, aggressive, and thorough manner. In some cases, the recommended actions are precise, concrete steps. In other cases, they are more general, and work must be done to develop precise, concrete steps to achieve the goals recommended by the CECAC. In the latter case, precise, concrete actions need to be identified before the recommended policies can be implemented. Careful, comprehensive, and detailed planning and implementation, as well as consistent support, of these policies will be required if benefits to consumers and the environment are to be achieved.

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

Sector	GHG Reductions ($MMtCO_2e$)			Net Present Value 2008–2020 (Million $)	Cost-Effectiveness ($/tCO_2e$)
	2012	2020	Total 2008–2020		
Residential, Commercial, and Industrial	4.3	27.7	141.6	–$2,941	–$21
Energy Supply	0.3	3.0	22.5	$1,012	$45
Transportation and Land Use	0.8	5.5	29.3	$2,582	$88
Agriculture, Forestry, and Waste Management	7.8	19.2	135.0	$987	$7.3
Cross-Cutting Issues	Non-quantified, enabling options				
TOTAL (includes all adjustments for overlaps)	**13.2**	**55.4**	**328.4**	**$1,640**	**$5.0**

GHG = greenhouse gas; MMtCO2e = million metric tons of carbon dioxide equivalent; $/tCO2e = dollars per metric ton of carbon dioxide equivalent.

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 E of this report provides 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 ($MMtCO_2e$)			Net Present Value 2009–2020 (Million $)	Cost-Effectiveness ($/tCO_2e$)	Level of Support
		2012	2020	Total 2009–2020			
RCI-1	Energy Efficiency Programs, Funds, or Goals for Electricity (Residential, Commercial, and Industrial)	1.5	8.2	43.0	–$1,127	–$26	Unanimous
RCI-2	Demand-Side Management/Energy Efficiency Programs, Funds, or Goals for Natural Gas, Propane, and Fuel Oil	0.2	0.8	4.5	–$379	–$85	Unanimous
RCI-3	Incentives and Regulatory Reform To Promote Implementation of Renewable Energy Systems, Including Solar Hot Water (Residential, Commercial, and Industrial)*	0.2	0.6	4.0	$164	$41	Unanimous
RCI-4	Energy Management Training/Training of Building Operators	Not quantified					Unanimous
RCI-5	Incentives, Resources, and Regulatory Reform To Promote Energy Recycling, Including Combined Heat and Power	1.0	8.2	39.5	–$332	–$8	Unanimous
RCI-6	Incentives and Policies for Improving Building Efficiency, Including Building Energy Codes	1.6	7.2	40.4	–$665	–$16	Unanimous
RCI-7	Improved Design and Construction in New and Existing State and Local Government Buildings, "Government Lead by Example"	0.5	5.0	24.6	–$800	–$33	Unanimous
RCI-8	Participation in Voluntary Industry–Government Partnerships (Including Incentives)	0.0	0.0	0.05	Not quantified*		Unanimous
RCI-9	Incentives and Policies for Improving Appliance Efficiency, Including Appliance Standards	0.3	0.9	5.6	–$94	–$17	Unanimous
	Sector Total After Adjusting for Overlaps (excluding RCI-8)†	**4.3**	**27.7**	**141.6**	**–$2,941**	**–$21**	
	Reductions From Recent Actions††	**0.5**	**2.2**	**12.6**	**Not quantified**		
	Sector Total Plus Recent Actions	**4.9**	**29.9**	**154.2**	**–$2,941**	**–$21**	

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent.

All costs are reported in 2005 U.S. dollars, net present value as of January 1, 2009. 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 numbering used to denote the above policy recommendations is for reference purposes only; it does not reflect prioritization among these policy recommendations.

*The costs of RCI-8 have not been quantified, due to lack of publicly available data. For more information, refer to the discussion of Key Uncertainties under RCI-8 in Appendix G of this report.

† The benefits and costs of RCI policies overlap as follows: between residential and commercial new construction in RCI-1 and RCI–6; between residential and commercial new construction in RCI-2 and RCI–6; between RCI–7 and energy efficiency efforts in government and schools within RCI-1 and RCI-2; and between RCI-9 and parts of RCI-1, RCI-2, and RCI-7. Overlaps also occur between RCI-1 and the energy efficiency component of ES-1, and between

the electricity load reductions from RCI policies in general and ES-1; adjustments for these overlaps are made in the ES totals. The benefits and costs of renewable energy in RCI-7 overlap with ES renewable energy policies and are not included.

†† Reductions from recent actions include the Energy Independence and Security Act of 2007, Title III. Refer to Annex 1 to Appendix G for more information. 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-5, RCI-6, RCI-7, and RCI-8.

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

No.	Policy Recommendation	GHG Reductions ($MMtCO_2e$)			Net Present Value 2008–2020 (Million $)	Cost-Effectiveness ($/tCO_2e$)	Level of Support
		2012	2020	Total 2008–2020			
ES-1	Efficiency and Renewable Portfolio Standard and Statement of Support for Nuclear Energy	1.9	12.6	66.5	$689	$10	Super Majority (Three objections)
ES-1a	Energy Efficiency: 5% of energy met with energy efficiency resources by 2020	0.8	4.2	22.4	–$586	–$26	
ES-1b	Renewables: 5% of energy served by new renewable resources by 2020	1.1	3.8	25.3	489	$19	
ES-1c	Nuclear: 6% of energy served by new nuclear resources by 2020	0.0	4.6	18.9	$786	$42	
ES-2	Technology Research and Development, Including State Funding	Not quantified					Unanimous
ES-3	Renewable Energy Financing, Tax Incentives, Loans	0.4	0.9	7.1	$591	$84	Unanimous
ES-4	Regulatory Model To Equalize Utility Earnings on Energy Efficiency With Earnings on Traditional Power Supply	Not quantified					Super Majority (One objection)
ES-5	Nuclear Fuel Reprocessing	Not quantified					Unanimous
ES-6	Green Power Purchases and Marketing, 1% Participation by 2012	0.2	0.2	1.7	$46	$27	Unanimous
ES-7	Attract Renewable Energy Technology Businesses to South Carolina	Not quantified					Unanimous
ES-8	Distributed Renewable Energy Incentives and/or Barrier Removal (Including Interconnection Rules)	0.05	0.1	0.8	$42	$50	Unanimous
	Sector Total After Adjusting for Overlaps	**0.3**	**3.0**	**22.5**	**$1,201**	**$53**	
	Reductions From Recent Actions	**0.0**	**0.0**	**0.0**	**0**	**0**	
	Sector Total Plus Recent Actions	**0.3**	**3.0**	**22.5**	**$1,201**	**$53**	

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent.

All costs are reported in 2005 U.S. dollars, net present value as of January 1, 2009. 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 numbering used to denote the above policy recommendations is for reference purposes only; it does not reflect prioritization among these policy recommendations.

General definition: For the purposes of the policies discussed here, and unless otherwise noted, “renewable energy” is defined as follows: A renewable energy resource includes solar; wind; small hydroelectric; geothermal; ocean current or wave energy; biomass resources, including agricultural waste, animal waste, wood waste, spent pulping liquors, combustible residues, combustible liquids, combustible gases, energy crops, and landfill methane; waste heat derived from a renewable energy resource and used to produce electricity; and hydrogen derived from a renewable energy resource.

For the combined impact of all ES policy recommendations, the incentives for utility-scale renewable energy projects in ES-3 are assumed to be redundant with the renewable energy mandate in ES-1; however, the distributed energy incentives in ES-3 are found to be larger than the impact of ES-8, and ES-8 is found to have no incremental impact over ES-3. These distributed renewable energy incentives, as well as voluntary green power initiatives (ES-6) are assumed to be incremental, and not to overlap with ES-1. Further, the energy efficiency component of ES-1 is assumed to overlap with the energy efficiency policy under RCI-1, and the goals for the nuclear and renewables components of ES-1 are reduced to reflect energy savings under RCI-1.

Several ES sector policy recommendations rely on biomass feedstock to replace fossil-based electricity generation. Similarly, a number of AFW policies also rely on the use of biomass for both electricity production and other energy-related uses. Specifically, the biomass generation benefits in ES policies 1, 3, and 6 are found to overlap with AFW policies 2, 5, and 9. The fundamental limit that creates an overlap among these policies is the limited availability of biomass feedstock in South Carolina.

To accommodate this limit, the cumulative impact analysis for the ES sector does not include any of the electricity generation from woody biomass, swine waste, or poultry litter resulting from ES policies, and the impact of landfill gas generation has been reduced by 18%. Either this generation is already accounted for in AFW policies, or the feedstock is used for another purpose that has a similar or greater impact in mitigating GHG emissions in the state.

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

No.	Policy Recommendation		GHG Reductions ($MMtCO_2e$)			Net Present Value 2008–2020 (Million $)	Cost-Effectiveness ($/tCO_2e$)	Level of Support
			2012	2020	Total 2008–2020			
TLU-1	Adopt a South Carolina Clean Car Standard		0.21	1.14	7.04	–$323 to $1,598	–$46 to $227	Super Majority (Two objections)
TLU-2	Transportation System Management		0.01	0.04	0.22	< $0	< $0	Unanimous
TLU-3	Tax Credits for Efficient Vehicles		0.02	0.12	0.68	$244	$359	Unanimous
TLU-4	Improve Development Patterns		0.41	2.31	14.02	< $0	< $0	Unanimous
TLU-5	Transit & Bike-Pedestrian [Incorporates TLU-11]		0.02	0.02	0.22	–$1	–$1	Unanimous
TLU-6	Alternative-Fuel Infrastructure		0.02	0.24	0.77	$54	$70	Unanimous
TLU-7	Diesel Engine Emission Reductions and Fuel Efficiency Improvements	Efficiency Improvements	0.03	0.19	0.96	–$110	–$114	Unanimous
		Biodiesel	0.05	0.38	1.95	–$291 to $319	–$15 to $164	Super Majority (Two objections)
TLU-8	Stricter Enforcement of Speed Limits		0.10	0.12	1.18	Not quantified	Not quantified	Unanimous
TLU-9	Make Full Use of CMAQ Funds		Not quantified					Unanimous
TLU-10	Commuter Choice and Commuter Benefits Programs		0.12	0.43	2.63	–$631	–$240	Unanimous
TLU-12*	Low-GHG Fuel Standard		0.38	3.67	17.89	$20 to $3,276	$1 to $183	Super Majority (Two objections)
TLU-14	Rail		Not quantified					Unanimous
	Sector Total Before Adjusting for Overlaps		**1.37**	**8.64**	**47.57**	**Not quantified**		
	Sector Total After Adjusting for Overlaps†		**0.75**	**5.53**	**29.29**	**$2,582**	**$88**	
	Reductions From Recent Actions		**0.45**	**3.51**	**16.37**	**Not quantified**		
	Sector Total Plus Recent Actions		**1.20**	**9.04**	**45.66**	**$2,582**	**$88**	

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent; CMAQ = Congestion Mitigation and Air Quality.

All costs are reported in 2005 U.S. dollars, net present value as of January 1, 2009. 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 numbering used to denote the above policy recommendations is for reference purposes only; it does not reflect prioritization among these policy recommendations.

* TLU-12 overlaps with AFW-4. The individual totals for TLU-12 do not reflect this overlap.

† Accounts for overlap between TLU-12 and AFW-4.

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

No.	Policy Recommendation	GHG Reductions ($MMtCO_2e$)			Net Present Value 2008–2020 (Million $)	Cost-Effectiveness ($/tCO2e)	Level of Support
		2012	2020	Total 2008–2020			
AFW-1*	On-Farm Energy Efficiency	0.052	0.16	1.0	–$43	–$41	Unanimous
AFW-2a	On-Farm Waste Energy Recovery—Swine/Dairy	0.006	0.019	0.13	$0.58	$5	Unanimous
AFW-2b†	On-Farm Waste Energy Recovery—Poultry Litter	0.010	0.031	0.20	–$3.2	–$16	Unanimous
AFW-3	Expanded Use of Local Agricultural Products	0.012	0.030	0.21	Not quantified	Not quantified	Unanimous
AFW-4a†,‡	In-State Liquid Biofuels Production—Biodiesel	0.12	0.13	1.5	$26	$17	Unanimous
AFW-4b†	In-State Liquid Biofuels Production—Ethanol	0.86	1.5	13	$281	$22	Unanimous
AFW-5‖	Expanded Use of Biomass Feedstocks for Electricity, Heat, or Steam Production	2.7	4.9	41	$156	$4	Unanimous
AFW-6a	Terrestrial Carbon Sequestration—Agriculture	0.21	0.39	3.1	–$191	–$62	Unanimous
AFW-6bi	Terrestrial Carbon Sequestration—Forestry: Forest Management	0.33	0.85	5.8	$53	$9	Unanimous
AFW-6bii	Terrestrial Carbon Sequestration—Forestry: Afforestation/Reforestation	0.81	2.4	16	$158	$10	Unanimous
AFW-6biii¶	Terrestrial Carbon Sequestration—Forestry: Urban Forestry	0.37	1.2	7.5	$456	$60	Unanimous
AFW-7a	Conservation and Restoration of Agriculture Lands for Enhanced Carbon Sequestration	0.080	0.21	1.5	$54	$37	Unanimous
AFW-7b	Conservation and Restoration of Forestlands for Enhanced Carbon Sequestration	0.42	3.1	16	$117	$7	Unanimous
AFW-8	Advanced Recycling and Composting	1.18	3.0	20	–$44	–$2	Unanimous
AFW-9‖	Waste-to-Energy Reclamation	0.41	1.0	7.2	$0.23	$0.03	Unanimous
AFW-10*	Water and Wastewater Energy Efficiency Improvements	0.16	0.18	1.6	–$33	–$21	Unanimous
	Sector Total After Adjusting for Overlaps**	**7.8**	**19.2**	**135**	**$987**	**$7**	
	Reductions From Recent Actions	**—**	**—**	**—**	**—**	**—**	
	Sector Total Plus Recent Actions**	**7.8**	**19.2**	**135**	**$987**	**$7**	

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent.

All costs are reported in 2005 U.S. dollars, net present value as of January 1, 2009. 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 numbering used to denote the above policy recommendations is for reference purposes only; it does not reflect prioritization among these policy recommendations.

* AFW-1 and AFW-10 may overlap with RCI-6. However, for reasons stated in the documentation of AFW-1 and AFW-10, no overlap is counted.

† AFW-4 overlaps with TLU-12 (Transportation and Land Use). This overlap is accounted for in the cumulative analysis of the TLU options.

‡ AFW-4 biodiesel targets were unachievable with in-state feedstock supplies. These reductions and costs refer to modified goals based on in-state feedstock. See text under AFW-4 in Appendix J of this report.

|| AFW-2, AFW-5, and AFW-9 overlap with ES-1. These overlaps are accounted for in the cumulative analysis of the ES policy recommendations.

¶ AFW-6biii represents the combined costs and benefits of two elements of urban forestry: tree planting and avoided deforestation. The net cost of avoided deforestation was not quantified because of insufficient information regarding the costs of such programs.

** Totals may not equal sum of rows because of independent rounding. The cost-effectiveness totals represent the total net present value divided by the cumulative (2008–2020) GHG reductions for those options for which quantitative cost analyses were performed (i.e., excludes AFW-3).

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

No.	Policy Recommendation	GHG Reductions ($MMtCO_2e$)			Net Present Value 2008–2020 (Million $)	Cost-Effective-ness ($/tCO_2e$)	Level of Support
		2012	2020	Total 2008–2020			
CC-1	Inventories and Forecasting	Not quantified					Unanimous
CC-2	GHG Reporting and Registry	Not quantified					Unanimous
CC-3	State Government GHG Emissions (Lead by Example)	Not quantified					Unanimous
CC-4	Comprehensive Local Government Climate Action Plans (Counties, Cities, etc.)	Not quantified					Unanimous
CC-5	Public Education and Outreach	Not quantified					Unanimous
CC-6	Adaptation & Vulnerability	Not quantified					Unanimous
	Sector Total After Adjusting for Overlaps	**Not quantified**					
	Reductions From Recent Actions	**Not quantified**					
	Sector Total Plus Recent Actions	**Not quantified**					

GHG = greenhouse gas; MMtCO2e = million metric tons of carbon dioxide equivalent; $/tCO2e = dollars per metric ton of carbon dioxide equivalent.

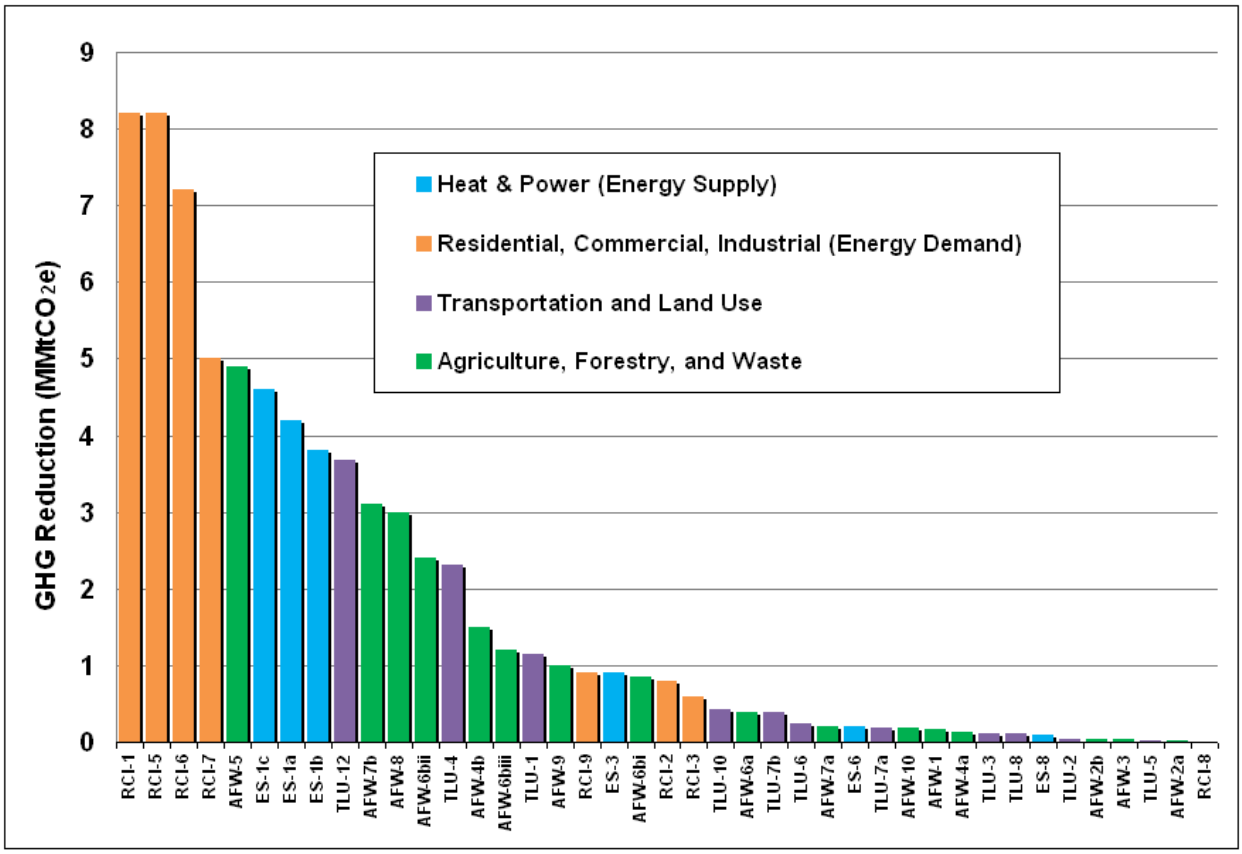
The numbering used to denote the above policy recommendations is for reference purposes only; it does not reflect prioritization among these policy recommendations.

Perspectives on Policy Recommendations

As explained above, the CECAC considered the estimates of the GHG reductions that could be achieved by 38 of its recommendations, and the costs (or cost savings) of 33 of those 38. Figure 1-4 presents the estimated tons of reductions for each policy recommendation for which

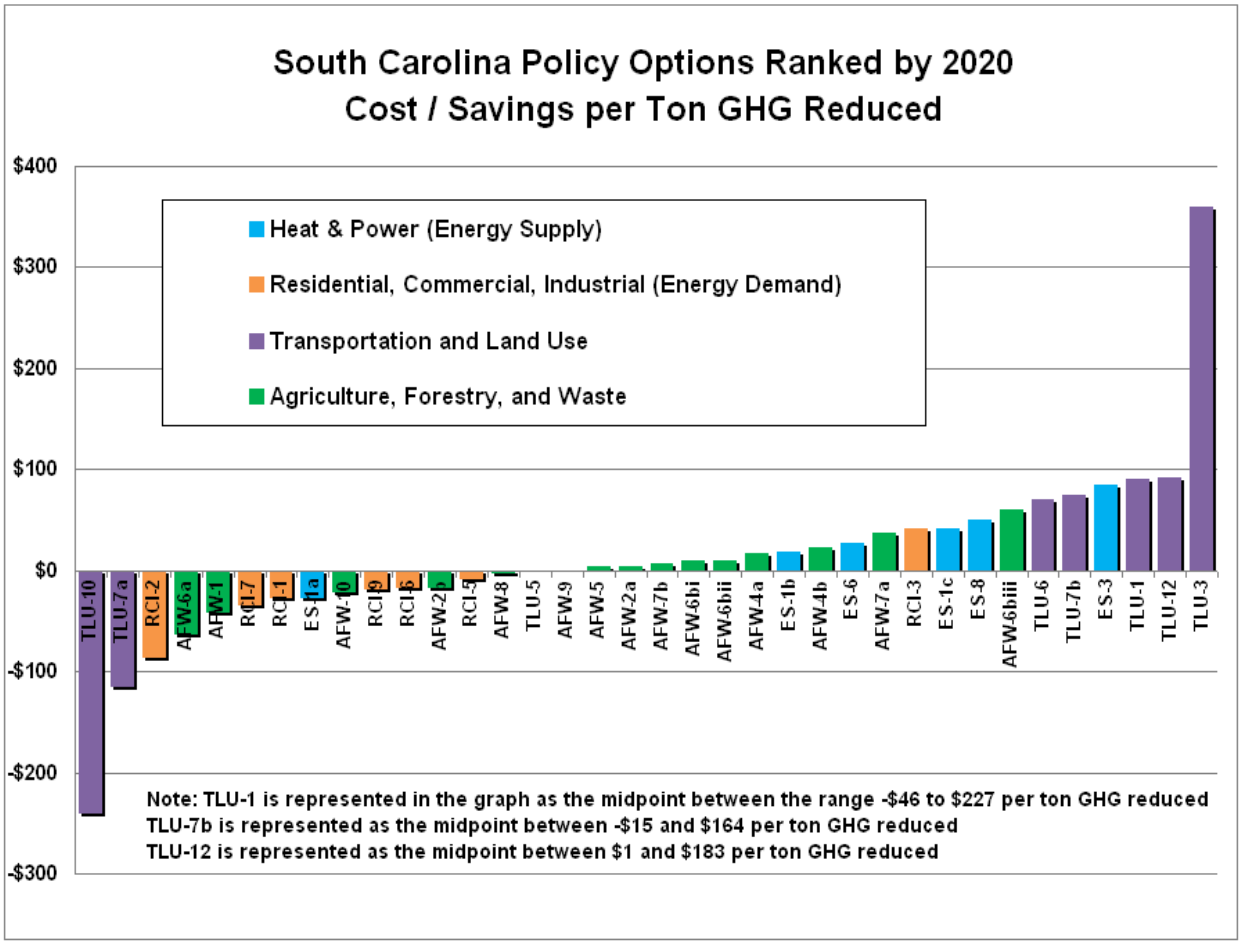
estimates were quantified, expressed as a cumulative figure for the period 2008–2020. In addition to the imprecision in GHG reductions achieved by each policy recommendation, there are also uncertainties in the exact cost (or cost savings) per ton of reduction achieved. Figure 1-5 presents the estimated dollars-per-ton cost (or cost savings, depicted as a negative number) for each policy recommendation for which cost estimates were quantified. 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 2008–2020. There can be considerable variations in the estimates of GHG emission reductions as well as the exact cost (or cost savings) per ton of reduction associated with the range of policy recommendations. Having the emissions reduction and cost-effectiveness values was helpful, but the CECAC was mindful that these are estimates. CECAC members noted that even though the quantification of impacts associated with the policies were developed using the best information that could be identified during the CECAC process, the results may be uncertain and subject to change as better information becomes available in the future. While individual members of the CECAC may not endorse each and every quantification method or data input, the members of the CECAC acknowledge the quantification analyses as helpful in evaluating the GHG reductions and implementation costs or savings that may be expected from the various recommendations contained in this report.

Figure 1-4. CECAC policy recommendations ranked by 2020 annual GHG reduction potential



GHG = greenhouse gas; $MMtCO_2e$ = 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. CECAC policy recommendations ranked by 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.

Chapter 2
Inventory and Projections of GHG Emissions

Introduction

This chapter summarizes South Carolina's greenhouse gas (GHG) emissions and sinks (carbon storage) from 1990 to 2020. The Center for Climate Strategies (CCS) prepared a draft of South Carolina's GHG emissions inventory and reference case projections for the Climate, Energy, and Commerce Advisory Committee (CECAC) of the Office of the Governor of South Carolina. The draft inventory and reference case projections, completed in June 2007, provided the CECAC with an initial, comprehensive understanding of current and possible future GHG emissions. The draft report was provided to the CECAC and its Technical Work Groups (TWGs) to assist them in understanding past, current, and possible future GHG emissions in South Carolina, and thereby inform the policy recommendation development process. The CECAC 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 CECAC. The information in this chapter reflects the information presented in the final *South Carolina Greenhouse Gas Inventory and Reference Case Projections* report (hereafter referred to as the Inventory and Projections report).[1]

Historical GHG emissions estimates (1990 through 2005)[2] were developed using a set of generally accepted principles and guidelines for state GHG emissions inventories, relying to the extent possible on South Carolina-specific data and inputs. The reference case projections (2006–2020) 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_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). Emissions of these GHGs are presented using a common metric, CO_2 equivalence (CO_2e), which indicates the relative contribution of each gas, per unit mass, to global average radiative forcing on a global warming potential-weighted basis.[3]

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[1] Center for Climate Strategies for the Climate. Final South Carolina Greenhouse Gas Inventory and Reference Case Projections: 1990–2020. Prepared for the Climate, Energy, and Commerce Advisory Committee of the Office of the Governor of South Carolina. June 2008.

[2] The last year of available historical data for each sector varies between 2000 and 2005.

[3] 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 (IPCC, 2001). 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

It is important to note that the emissions estimates reflect the GHG emissions associated with the electricity sources used to meet South Carolina's 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.

South Carolina GHG Emissions: Sources and Trends

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

Emissions of aerosols, particularly "black carbon" from fossil fuel combustion, could have significant climate impacts through their effects on radiative forcing. Estimates of these aerosol emissions on a CO_2e basis were developed for South Carolina based on 2002 and 2018 data from the Visibility Improvement State and Tribal Association of the Southeast (VISTAS) regional planning organization. The results for current levels of black carbon emissions were a total of 7.0 $MMtCO_2e$, which is the mid-point of a range of estimated emissions (4.5–9.6 $MMtCO_2e$) in 2002. Based on an assessment of the primary contributors, it is estimated that black carbon emissions will decrease substantially by 2018 after new engine and fuel standards take effect in the on-road and nonroad diesel engine sectors. These estimates are not incorporated into the totals shown in Table 2-1, because a global warming potential for black carbon has not yet been assigned by the Intergovernmental Panel on Climate Change (IPCC).

Historical Emissions

Overview

In 2005, on a gross emissions consumption basis (i.e., excluding carbon sinks), South Carolina accounted for approximately 94 million metric tons (MMt) of CO_2e emissions, an amount equal to 1.3% of total U.S. gross GHG emissions. On a net emissions basis (i.e., including carbon sinks), South Carolinians accounted for approximately 62 $MMtCO_2e$ of emissions in 2005, an amount equal to 1.0% of total U.S. net GHG emissions.[4] South Carolina's GHG emissions are

Panel on Climate Change Cambridge University Press. Cambridge, United Kingdom. Available at: http://www.grida.no/climate/ipcc_tar/wg1/212.htm

[4] 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

rising faster than those of the nation as a whole. From 1990 to 2005, South Carolina's gross GHG emissions increased by 39%, while national gross emissions rose by 16%.[5]

Table 2-1. South Carolina historical and reference case GHG emissions, by sector*

(Million Metric Tons CO_2e)	1990	2000	2005	2010	2020
Energy (Consumption Based)	**59.8**	**78.8**	**83.5**	**91.3**	**112.5**
Electricity Use (Consumption)	**18.5**	**32.0**	**33.0**	**35.7**	**48.2**
Electricity production (in-state)	21.9	36.4	38.0	40.2	54.5
Coal	18.1	31.3	31.9	32.1	44.0
Natural gas	0.32	0.42	0.86	2.99	3.44
Oil	0.05	0.29	0.19	0.55	0.62
Wood (CH_4 and N_2O)	0.02	0.02	0.02	0.02	0.04
MSW/landfill gas	0.00	0.02	0.01	0.01	0.01
Net exported electricity	–3.38	–4.37	–4.98	–4.51	–6.31
Residential/Commercial/Industrial (RCI) Fuel Use	**17.7**	**17.7**	**17.9**	**18.7**	**19.9**
Coal	5.46	4.71	3.64	4.04	4.13
Natural gas	6.49	7.96	6.75	7.36	8.20
Oil	5.64	4.81	7.39	7.18	7.38
Wood (CH_4 and N_2O)	0.16	0.18	0.15	0.16	0.17
Transportation	**22.7**	**28.4**	**31.8**	**36.1**	**43.6**
On-road gasoline	16.2	19.8	21.5	23.8	27.6
On-road diesel	4.09	5.96	7.59	9.25	12.2
Marine vessels	0.84	1.53	1.78	2.08	2.75
Rail, natural gas, LPG, other	0.43	0.28	0.24	0.25	0.27
Jet fuel and aviation gasoline	1.19	0.77	0.68	0.72	0.77
Fossil Fuel Industry	**0.83**	**0.78**	**0.76**	**0.80**	**0.89**
Natural gas industry	0.83	0.78	0.76	0.80	0.89
Transmission	0.32	0.36	0.38	0.40	0.46
Distribution	0.35	0.22	0.25	0.27	0.31
Pipeline fuel use	0.16	0.19	0.13	0.13	0.12
Industrial Processes	**2.61**	**3.28**	**4.14**	**4.98**	**6.63**
Cement manufacture (CO_2)	1.10	1.31	1.64	1.65	1.68
Limestone and dolomite use (CO_2)	0.01	0.01	0.01	0.01	0.01
Soda ash (CO_2)	0.04	0.04	0.04	0.04	0.04
ODS substitutes (HFC, PFC)	0.005	1.07	1.67	2.48	4.07
Electric power transmission and distribution (T&D) (SF_6)	0.62	0.36	0.35	0.36	0.38
Aluminum manufacturing (PFC)	0.84	0.51	0.43	0.44	0.45
Waste Management	**1.65**	**2.77**	**2.88**	**3.01**	**3.38**
Solid waste management	1.48	2.57	2.67	2.79	3.14

[5] During this period, population grew by 21% in South Carolina and by 19% nationally. However, South Carolina's economy grew at a slower rate on a per capita basis (up 30% vs. 34% nationally).

(Million Metric Tons CO_2e)	1990	2000	2005	2010	2020
Wastewater management	0.17	0.20	0.21	0.22	0.24
Agriculture	**3.11**	**3.15**	**2.98**	**2.95**	**2.89**
Enteric fermentation	0.69	0.57	0.54	0.57	0.51
Manure management	0.39	0.47	0.48	0.49	0.57
Agriculture soils and residue burning	1.86	1.76	1.76	1.71	1.63
Agriculture soils (cultivation practices)	0.18	0.18	0.18	0.18	0.18
Total Gross Emissions (Consumption Basis)	**67.2**	**87.8**	**93.5**	**102.2**	**125.4**
Increase relative to 1990		31%	39%	52%	87%
Forestry and Land Use	**–33.2**	**–31.0**	**–31.2**	**–31.2**	**–31.2**
Forested Landscape	–28.78	–28.78	–28.78	–28.78	–28.78
Urban Forestry and Land Use	–4.38	–2.24	–2.46	–2.46	–2.46
Net Emissions (Consumption Basis, Including Forestry and Land Use Sinks)	**34.0**	**56.8**	**62.3**	**71.0**	**94.1**

$MMtCO_2e$ = million metric tons of carbon dioxide equivalent; CH_4 = methane; N_2O = nitrous oxide; MSW = municipal solid waste; LPG = liquefied petroleum gas; ODS = ozone-depleting substance; HFC = hydrofluorocarbon; PFC = perfluorocarbon; SF_6 = sulfur hexafluoride; NG = natural gas; T&D = transmission and distribution; VISTAS = Visibility Improvement State and Tribal Association of the Southeast.

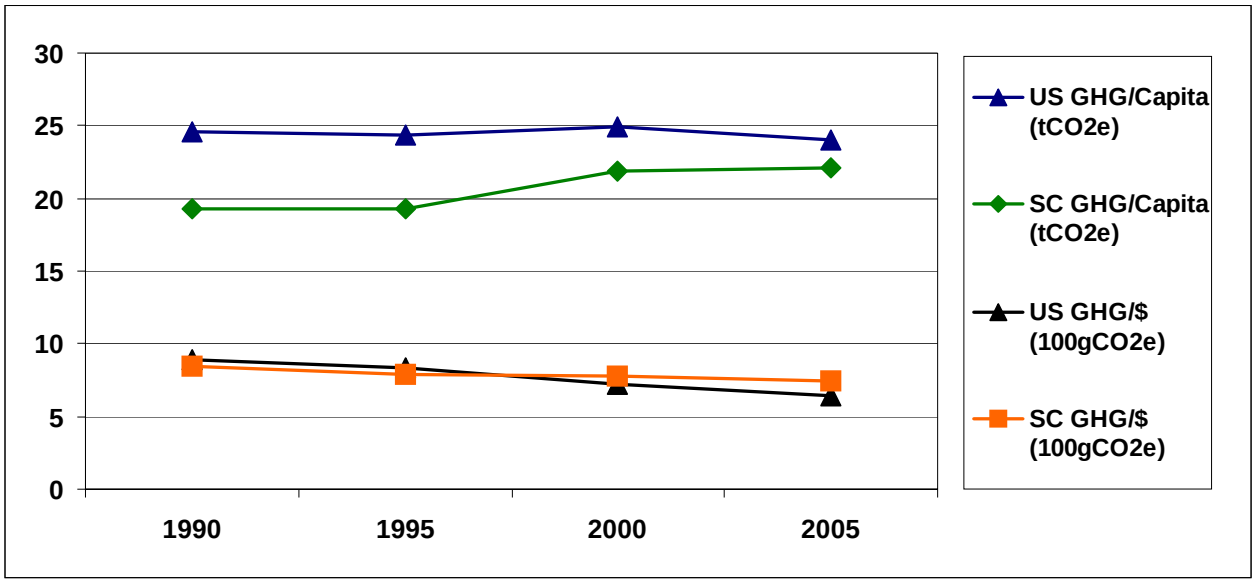
* Totals may not equal exact sum of subtotals shown in this table due to independent rounding.

On a per-capita basis, South Carolinians emitted about 22 metric tons (t) of gross CO_2e in 2005, lower than the national average of about 24 tCO_2e. Figure 2-1 illustrates the state's emissions per capita and per unit of economic output. It also shows that in South Carolina per-capita emissions have increased from 1990 to 2005, but remained fairly flat for the nation as a whole. South Carolina's per capita emissions increased between 1995 and 2001 as a result of an additional 700 megawatts of coal capacity coming on line in the state. In both South Carolina 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 27% nationally, and by 12% in South Carolina.[6]

The principal sources of South Carolina's GHG emissions in 2005 are electricity consumption and transportation, accounting for 35% and 34% of South Carolina's 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 19% of the state's emissions in 2005.

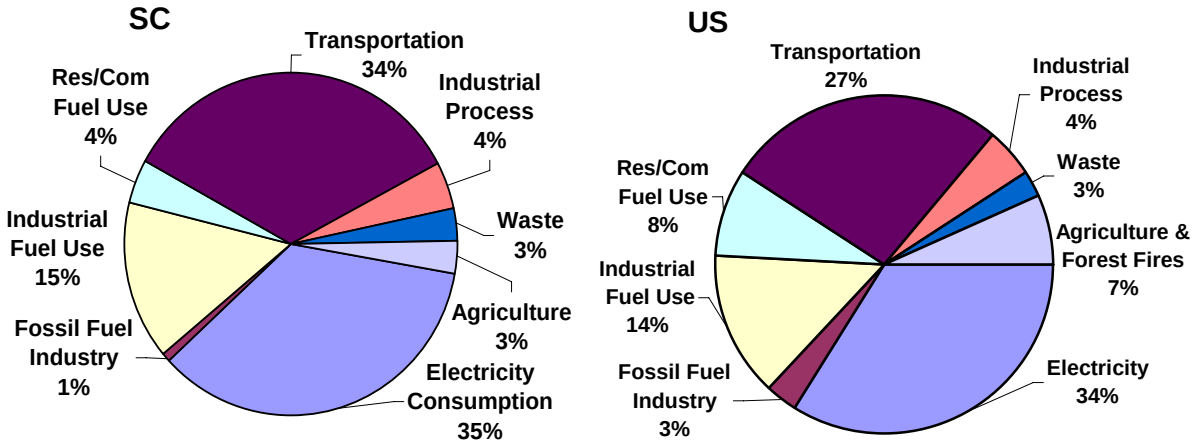
[6] Based on real gross domestic product (millions of chained 2000 dollars), that excludes the effects of inflation, available from the U.S. Department of Commerce, Bureau of Economic Analysis. "Gross Domestic Product by State." Available at: http://www.bea.gov/regional/gsp/

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



GHG = greenhouse gas; tCO_2e = metric tons of carbon dioxide equivalent.; GSP = gross state product; GDP = gross domestic product; g = grams.

Figure 2-2. Gross GHG emissions by sector, 2005: South Carolina and U.S.



Industrial process emissions accounted for about 4% 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.[7] Other industrial process emissions include CO_2 released by cement manufacturing; CO_2 released during soda ash, limestone, and dolomite use; PFCs released during aluminum production; and SF_6 released from transformers used in electricity

[7] 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 South Carolina. Available at: http://www.scclimatechange.us/Inventory_Forecast_Report.cfm

transmission and distribution systems. Agricultural activities, such as manure management, fertilizer use, livestock (enteric fermentation), and changes in soil carbon due to cultivation practices, result in CH_4 and N_2O emissions that accounted for another 3% of state GHG emissions in 2005. Similarly, landfills and wastewater management facilities produce CH_4 and N_2O emissions that accounted for 3% of total gross GHG emissions in South Carolina in 2005. Emissions associated with the transmission and distribution of natural gas accounted for 1% of the gross GHG emissions in 2005.

Forestry emissions refer to the net CO_2 flux[8] from forested lands in South Carolina, which account for about 66% of the state's land area.[9] South Carolina's forests are estimated to be net sinks of CO_2 emissions in the state, reducing net GHG emissions by 31 $MMtCO_2e$ in 2005.

Reference Case Projections

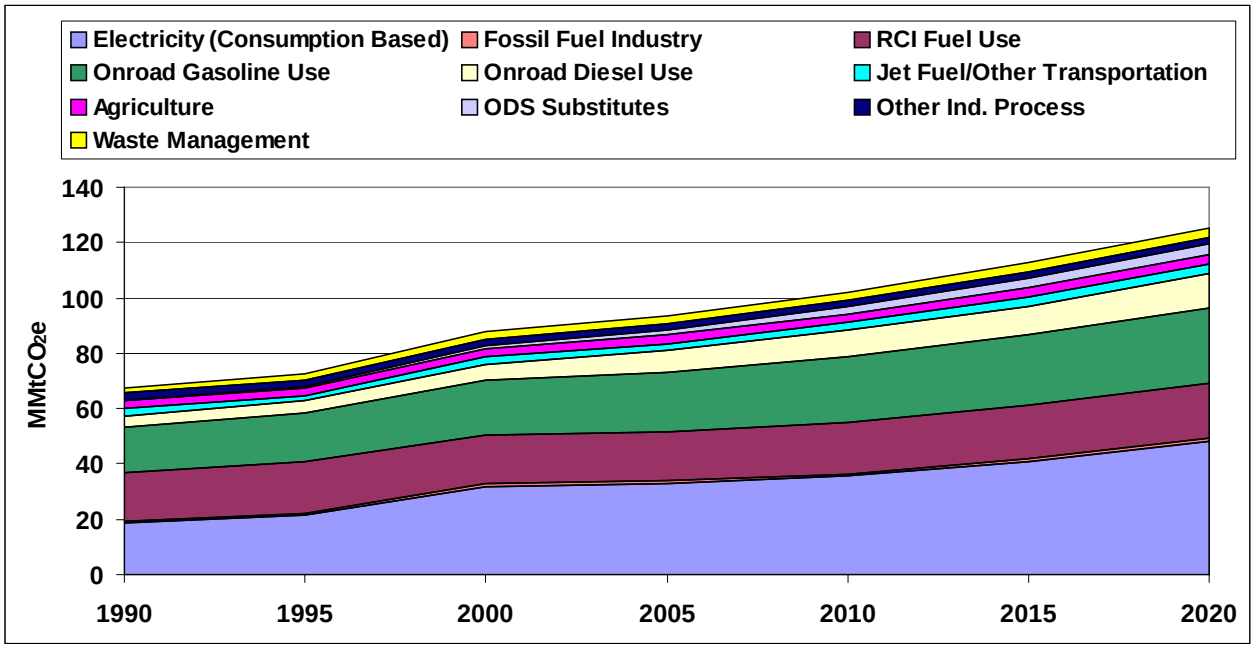
Relying on a variety of sources for projections, as noted in the Inventory and Projections report, a simple reference case projection of GHG emissions through 2020 was developed. As illustrated in Figure 2-3 and shown numerically in Table 2-1, under the reference case projections, South Carolina's gross GHG emissions continue to grow steadily, climbing to about 125 $MMtCO_2e$ by 2020, or 87% above 1990 levels. This equates to a 2% annual rate of growth. By 2020, the share of South Carolina's gross GHG emissions associated with electricity consumption grows to 38%; emissions from the RCI fuel use sector decrease to 16%; while emissions from the transportation sector stay relatively constant, at 35%.

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 (ODS) 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 South Carolina reference case projections, as well as the sources of these data.

[8] "Flux" refers to both emissions of CO_2 to the atmosphere and removal (sinks) of CO_2 from the atmosphere.

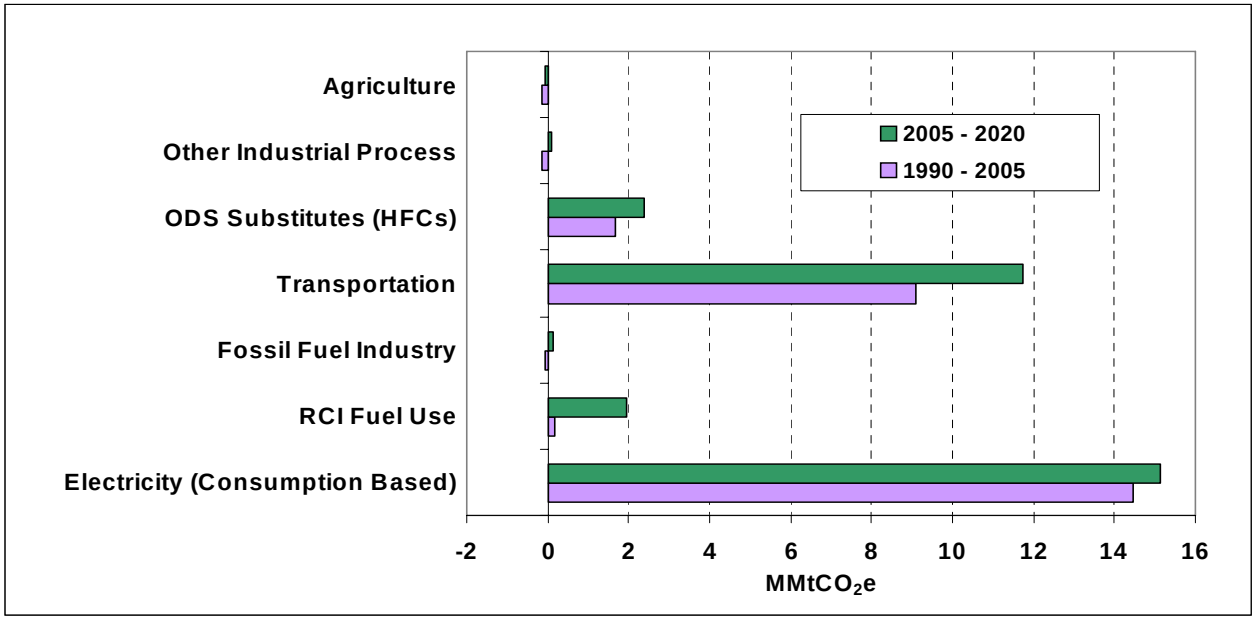
[9] Total forested acreage is 12.7 million acres. For acreage by forest type, see: Richard A. Birdsey and George M. Lewis. "Carbon in United States Forests and Wood Products, 1987–1997: State-by-State Estimates." South Carolina Estimate for 1987–1997. Available from the U.S. Department of Agriculture, Forest Service, Northern Global Change Research Program, at: http://www.fs.fed.us/ne/global/pubs/books/epa/states/SC.htm. The total land area in South Carolina is 19.3 million acres (http://www.50states.com/scarolin.htm).

Figure 2-3. South Carolina gross GHG emissions by sector, 1990–2020: historical and projected



$MMtCO_2e$ = 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 South Carolina, 1990–2020: reference case projections



$MMtCO_2e$ = million metric tons of carbon dioxide equivalent; ODS = ozone-depleting substance; HFCs = hydrofluorocarbons; RCI = direct fuel use in residential, commercial, and industrial sectors.

Table 2-2. Key annual growth rates for South Carolina, historical and projected

	1990–2005	2005–2020	Sources
Population[a]	1.3%	1.0%	South Carolina Budget and Control Board, Office of Research and Statistics
Employment[a] Goods Services	 N/A[b] N/A	 0.2% 1.7%	Growth rates based on employment data for 2000–2010 available from the South Carolina Employment Security Commission, Labor Market Information Online, Economic Data, South Carolina Data, Current Employment Statistics, Projections, Industry Projections (http://www.sces.org/lmi/data/project/projections.asp).
Electricity Sales Total sales[c] SC sales[d]	 2.26% 2.57%	 1.58% 1.79%	US DOE Energy Information Administration (EIA) data for 1990–2003. Reference case sales based on data provided by South Carolina utilities for 2003–2020.
Vehicle Miles Traveled	2.4%	2.0%	South Carolina Department of Transportation

[a] For the RCI fuel consumption sectors, population and employment projections for South Carolina were used together with U.S. DOE EIA's Annual Energy Outlook 2006 (AEO 2006) projections of changes in fuel use for the EIA's South Atlantic region on a per-capita basis for the residential sector, and on a per-employee basis for the commercial and industrial sectors.[10] For instance, growth in South Carolina's residential natural gas use is calculated as the South Carolina population growth times the change in per-capita natural gas use for the South Atlantic region.

[b] NA – Not available; historical employment data for South Carolina for the goods producing and services providing sectors could not be identified.

[c] Represents annual growth in total sales of electricity by generators in South Carolina to RCI sectors located within and outside of South Carolina.

[d] Represents annual growth in total sales of electricity by generators in South Carolina to RCI sectors located within South Carolina.

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

As shown in Figure 2-2, electricity use in 2005 accounted for 35% of South Carolina's gross GHG emissions (about 33 $MMtCO_2e$), which is slightly higher than the national share of emissions from electricity generation (34%). On a per-capita basis, South Carolina's GHG emissions from electricity consumption are lower than the national average (in 2005, 7.8 tCO_2e per capita in South Carolina, versus 8.1 tCO_2e per capita nationally). Electricity generation in South Carolina is dominated by steam units, which are primarily powered by coal and nuclear fuel. In 2003, electricity generated by nuclear power accounted for 55% of the in-state net generation. Coal-fired power plants in South Carolina accounted for another 40% of in-state net generation. The remaining in-state generation came from a mix of hydroelectric, natural gas, oil, and refuse-derived fuel facilities.[11]

As noted above, these electricity emission estimates reflect the GHG emissions associated with the electricity sources used to meet South Carolina's demand for electricity, corresponding to a consumption-based approach to emissions accounting. For many years, South Carolina power plants have produced more electricity than is consumed in the state. In 2005, for example,

[10] U.S. Department of Energy, Energy Information Administration. *Annual Energy Outlook 2006: With Projections to 2030.* IDOE/EIA-0383(2006). February 2006. Available at: http://www.scag.ca.gov/rcp/pdf/publications/1_2006AnnualEnergyOutlook.pdf.

[11] Percentages are based on net generation (excluding plant fuel use) associated with the electricity produced by facilities in South Carolina, and include generation associated with electricity exported to other states.

emissions associated with South Carolina's electricity consumption (33 $MMtCO_2e$) were lower than those associated with electricity production (38 $MMtCO_2e$). The higher level for generation-based emissions reflects GHG emissions associated with net exports of electricity to meet the electricity demand of other states.[12] Estimates of electricity sales for 2005 through 2020 indicate that South Carolina will remain a net exporter of electricity.

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 rate of 2.3%. In 2005, gasoline-powered on-road vehicles accounted for about 68% of transportation GHG emissions; on-road diesel vehicles for 24%; marine vessels for 6%; aviation fuels for 2%; and rail and other sources (natural gas- and liquefied petroleum gas-fueled vehicles used in transport applications) accounted for the remaining 1%. As a result of South Carolina's population and economic growth and an increase in total vehicle miles traveled (VMT), emissions from on-road gasoline use grew at a rate of 1.9% annually between 1990 and 2005. Meanwhile, emissions from on-road diesel use rose by 4.2% 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 2020 are projected to increase by 1.7% annually from 2005 levels, and emissions from on-road diesel vehicles are projected to increase by 3.2% annually from 2005 to 2020, with total transportation emissions expected to reach nearly 44 $MMtCO_2e$ by 2020.

CECAC Revisions

The CECAC made the following revisions that 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 June 2007:

- *Energy Supply*: Incorporated 2003 baseline generation and fuel mix data, sales forecast data for 2003 through 2020, and transmission and distribution line loss data used in the North Carolina GHG emissions inventory and projections supplied by utilities that serve both North Carolina and South Carolina.
- *RCI Direct Fuel Use*: Included State Energy Data (SED) for South Carolina that was [were?] published by the U.S. Department of Energy's Energy Information Administration (EIA) after the draft Inventory and Projections report was prepared; included EIA SED for 2004 and 2005 for natural gas, oil, and coal and 2003 through 2005 data for wood for each of the RCI sectors.

[12] 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.

- *Transportation*:
    - Incorporated the VMT forecast developed from data provided by the South Carolina Department of Transportation.
    - Included SED for 2003 through 2005 published by EIA after the draft Inventory and Projections report was prepared.
    - Revised the fuel economy values used to convert VMT to fuel consumption. The preliminary draft forecast was based only on new vehicles but this forecast should have included fuel economy associated with existing vehicles in the fleet mix. Thus, the revised forecast is based on new and existing vehicle mix for South Carolina resulting in an increase in emissions associated with a lower overall fleet fuel economy by including older, existing vehicles.
- *Fossil Fuel Production and Distribution Industry*: Added estimates for combustion of natural gas consumed by internal combustion engines to operate pipeline systems in South Carolina, based on SED data for 1990 through 2005, and projecting 2005 emissions using a -1.0% annual rate of decline, representing the state trend in pipeline fuel use during 1990–2005.
- *Industrial Processes*: For the ODS substitutes and electric power transmission and distribution categories, updated the forecasts using average annual growth rates developed from more recent national forecasts prepared by the U.S. Environmental Protection Agency (EPA). For electric power transmission and distribution, use EPA's national "no action" scenario as the basis for developing average annual growth rates to forecast emissions.
- *Forestry*: Added estimates for urban forests based on EPA default methods that were released after the draft inventory and forecast was prepared.

Key Uncertainties

Some data gaps exist in this inventory, particularly in the reference case projections. Key tasks for future refinement of this inventory and projections 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 South Carolina's future GHG emissions (see Table 2-2). 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 Climate, Energy, and Commerce Advisory Committee (CECAC) 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 CECAC's policy recommendations described in Chapters 4–7 of this report.

The CC TWG developed recommendations for each of six policies (see Table 3-1) that were then reviewed, revised, and ultimately adopted unanimously by the CECAC members present and voting. Five of the recommendations are focused on enabling GHG emission reductions; the sixth addresses adaptation to the changes expected from the effects of gases that will remain in the atmosphere for decades. These recommendations include: (1) inventorying and forecasting South Carolina's GHG emissions; (2) voluntary reporting and registration of GHG emissions and emission reductions by companies, the state, and other entities; (3) developing a state plan to address a wide variety of public education and outreach opportunities regarding climate change and healthy life styles; (4) establishing a "Blue Ribbon" Commission to develop a state Climate Change Adaptation Plan to identify and address potential climate change impacts on South Carolina's citizens, public health, and natural and wildlife resources; (5) a "lead-by-example" initiative by state government agencies and school districts to control GHG emissions associated with their own facilities and activities; and (6) and an initiative for local government agencies to develop plans, with assistance from the state, to control GHG emissions in part by implementing the CECAC's recommendations at the local level.

Some initiatives are already under way in South Carolina for voluntarily reporting and registering GHG emissions. South Carolina is also leading by example through its participation in The Climate Registry, which will help ensure that South Carolina's interests are adequately represented in the development of broader regional and national initiatives that are likely to ultimately frame national climate change policy outcomes.

Key Challenges and Opportunities

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

currently assigned to the South Carolina Department of Health and Environmental Control (DHEC).

Table 3-1 Cross-Cutting Issues Policy Recommendations

No.	Policy Recommendation	GHG Reductions ($MMtCO_2e$)			Net Present Value 2008–2020 (Million $)	Cost-Effective-ness ($/tCO_2e$)	Level of Support
		2012	2020	Total 2008–2020			
CC-1	Inventories and Forecasting	Not quantified					Unanimous
CC-2	GHG Reporting and Registry	Not quantified					Unanimous
CC-3	State Government GHG Emissions (Lead by Example)	Not quantified					Unanimous
CC-4	Comprehensive Local Government Climate Action Plans (Counties, Cities, etc.)	Not quantified					Unanimous
CC-5	Public Education and Outreach	Not quantified					Unanimous
CC-6	Adaptation & Vulnerability	Not quantified					Unanimous
	Sector Total After Adjusting for Overlaps	**Not quantified**					
	Reductions From Recent Actions	**Not quantified**					
	Sector Total Plus Recent Actions	**Not quantified**					

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/tCO_2e$ = 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 policy recommendations.

South Carolina has joined The Climate Registry as a charter member.[1] Being a charter state in this effort will help ensure that South Carolina's needs and priorities are addressed in the course of The Climate Registry's development. The CECAC recommends that GHG sources (e.g., state and local governments, academic and nonprofit institutions, and businesses and regulated industries) in South Carolina volunteer to participate in The Climate Registry, but also recommends that the state avoid duplication of reporting requirements on sources of GHG emissions.

The CECAC further recommends that all South Carolina state agencies, authorities, quasi-state entities, and school districts lead by example by reducing their own GHG emissions by at least an amount consistent with the voluntary, economy-wide GHG emission reduction goal recommended by the CECAC. State agencies and school districts are currently required under

[1] The Climate Registry (http://www.theclimateregistry.org/) is a collaboration between states, provinces, and tribes aimed at developing and managing a common GHG emissions reporting system with high integrity that is capable of supporting various GHG emission reporting and reduction policies for its member states and tribes and reporting entities. It will provide an accurate, complete, consistent, transparent, and verified set of GHG emissions data from reporting entities, supported by a robust accounting and verification infrastructure. As of June 2008, 40 U.S. states, three Tribal Authorities, seven Canadian Provinces, and six Mexican states have joined The Climate Registry.

state law to report their energy use to the state.[2] This provides the opportunity for these entities to use this information to evaluate opportunities for reducing energy use and associated GHG emissions.

Ultimately, many strategies for reducing GHG emissions will need to be developed and implemented by local communities. Thus, the CECAC has included in its set of CC recommendations a policy to encourage and support local governments and communities in efforts to develop plans to address GHG emissions. In so doing, these local governments and communities are encouraged to consider including the CECAC's recommendations in their planning efforts. This recommendation provides the state with the opportunity to support building capacity at the local level through education and outreach efforts, developing a model plan for local governments to follow, and organizing an annual workshop for sharing information and success stories.

Public education and outreach will be the foundation for the long-term success of many efforts to reduce GHGs. The CECAC recommends that South Carolina adopt and implement a Public Education and Outreach Plan for Climate Change and Public Health as soon as possible. The goals of this plan should be to inform, motivate, and simulate citizens of South Carolina to join together to protect the environment and the health of present and future generations by helping to mitigate GHG emissions. To achieve this goal, the state should appoint a statewide coordinator and a committee for public education and outreach to address climate change and related issues. In addition, the CECAC recommends that the state legislature provide funding for the basic operations of the committee and the coordinators. Funding should be structured in such a way as to take maximum advantage of established mechanisms for education of each of eight target audiences. Arrangements can be made on behalf of the committee with one of the state institutions of higher education or the Commission for Higher Education for financial management of grants, awards, and private funding of specific programs.

The changes South Carolina will face in the long term will be more manageable if it begins now to reduce emissions, but now is also the time to begin preparing to deal with the changes that are already underway and likely to become more dramatic. Recognizing that these adaptation efforts are urgent and essential, the CECAC recommends that the state empanel a "Blue Ribbon" commission to develop a state Climate Change Adaptation Plan within one year of establishment of the commission. The commission should also enlist the expertise of all appropriate state and local agencies, organizations, and institutions in developing and implementing measures for mitigating these impacts. Recognizing that this is a significant planning effort, the CECAC recommends that the state legislature provide funding to support development and ongoing revision to the state Climate Change Adaptation Plan, including funds to support the analyses needed to guide and inform the development and implementation of the plan and to cover expenses incurred by the commission and its members.

[2] The 1992 South Carolina Energy Efficiency Act requires state agencies and public school districts to consider energy efficiency and report on energy consumption (South Carolina Code of Laws Section 48-52-10 et seq. (http://www.scstatehouse.net/code/t48c052.htm).

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 emissions mitigation activities and/or other climate actions. The CECAC recommends that six such policies be adopted and implemented by South Carolina. 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 CECAC can be found in Appendix F of this report.

Cross-Cutting Issues
Policy Descriptions

CC-1. Inventories and Forecasting

GHG emissions 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 CECAC's policy recommendations.

The CECAC recommends that the state implement an inventory and forecast function as soon as possible, as allowed by funding, that includes all GHG emission sources and sinks (both man-made and natural). The function should be integrated with existing related functions, such as those carried our by DHEC, which develops inventories for the criteria air pollutants. The state should develop consistent protocols for preparing the inventory and forecast that clearly define emission source sectors and sinks, methods for estimating emissions, data sources, and uncertainties. The GHG inventory and forecast should be prepared on a periodic and consistent basis. GHG forecasts, built on solid inventories, help to predict likely impact scenarios, identify the factors that affect trends over time, and highlight opportunities for mitigating emissions or enhancing sinks. South Carolina’s forecast should be prepared for 5-year increments extending at least 20 years into the future. The GHG forecast should reflect projected growth, as well as the implementation of scheduled mitigation measures, and should, through differences year to year, provide a basis for documenting and illuminating trends in state GHG emissions.

CC-2. State GHG Reporting and Registry

GHG reporting reflects the measurement and reporting of GHG emissions to support tracking and management of emissions. GHG reporting can help sources identify emission reduction opportunities and reduce the risks associated with possible future GHG mandates by moving “up the learning curve.” Tracking and reporting of GHG emissions can also help in the construction of periodic state GHG inventories. GHG reporting is typically 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; establishes baseline protection; enables recognition of environmental leadership; and/or provides a mechanism for regional, multistate, and cross-border cooperation. Properly designed registry structures also provide a foundation for possible future trading programs.

South Carolina has joined the effort to develop a national GHG registry through The Climate Registry.[3] The Governor delegated DHEC to act on his behalf as a founding member of The Climate Registry and as a member of the Board of Directors. DHEC's leadership role will help ensure that South Carolina's needs and priorities are addressed during The Climate Registry's development. Accordingly, the CECAC recommends that the state implement a program to facilitate and encourage South Carolina GHG reporting through The Climate Registry as quickly as possible, with supplemental reporting protocols developed if necessary to meet South Carolina's needs, particularly with regard to carbon sequestration and offsets. GHG-emitting entities include state and local governments, academic and nonprofit institutions, and businesses and industries. To the extent that South Carolina's needs may not be fully met by The Climate Registry, the state may consider developing supplemental or ancillary registry capacity or opportunities. This may be particularly true for the state's agricultural and forestry sectors.

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 seek opportunities to participate with the U.S. Environmental Protection Agency in developing federal requirements for reporting of GHG emissions.

CC-3. State Government GHG Emissions (Lead by Example)

State government agencies are responsible for providing a multitude of public services that are delivered through very diverse operations and result in wide-ranging GHG emission 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 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.

Recognizing the state's responsibility to lead by example, the CECAC recommends that the state government agencies and school districts control their GHG emissions by at least an amount consistent with the voluntary, economy-wide GHG emission reduction goal recommended by the CECAC. Adopting this goal 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. 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 one year from approval by the CECAC, and will necessarily reflect initial agency-level emission inventories. The second annual report should reflect initial progress in reducing GHG emissions, as agencies begin to plan and implement operational changes. Agency and/or department reports could be aggregated into a summary report reflecting state GHG emissions.

All state agencies and school districts should make continual progress toward the goal, regardless of their starting point. The CECAC recommends that the South Carolina Budget and Control Board coordinate implementation of this recommendation through the South Carolina Energy

[3] See http://www.theclimateregistry.org/.

Office. DHEC should assist the South Carolina Budget and Control Board and South Carolina Energy Office in developing a consistent design and methodology for measurement.

CC-4. Comprehensive Local Government Climate Action Plans (Counties, Cities, etc.)

The CECAC recommends that South Carolina promote adoption of community climate action plans by all local government entities to set and achieve local GHG reductions and to help achieve the voluntary, economy-wide GHG emission reduction goal recommended by the CECAC. These locally adopted plans should be used to stimulate equivalent GHG reduction initiatives by the private sector and nongovernmental entities in each community. These initiatives can be considered economic development opportunities, as well as adaptation-oriented strategies. The CECAC recommends that local climate action plans include an assessment of opportunities for reducing GHG emissions at the community scale, specific goals or target values and a timeline for the emission reductions, and adoption of local strategies to adapt to climate change. The CECAC believes that community plans will be an effective mechanism for implementing recommendations that the CECAC approves for inclusion in the statewide Action Plan for South Carolina, and encourages communities to consider and include, to the extent possible, the CECAC's recommendations.

Every effort should be made to develop community climate action plans as rapidly as possible. To facilitate development of local plans, the CECAC recommends that an annual workshop be organized and held by the state government, associations of local governments, and/or individual cities that have developed climate action plans to help local governments initiate and strengthen their local climate protection efforts. Development of a model plan by a consortium of state and local agencies and districts could help to facilitate implementation of this recommendation as well as promote consistency and reduce costs to local agencies and districts. The state government should also provide technical assistance to local agencies and districts (specifically, DHEC should be given the resources to assist municipalities with emission inventories and forecasts) and help local agencies and districts secure funding (e.g., grants) to develop their climate action plans.

CC-5. Public Education and Outreach

South Carolina should adopt and implement a Public Education and Outreach Plan for Climate Change and Public Health as soon as possible to accomplish the following goals:

- Inform the citizens of South Carolina about climate change and their critical role in actions to mitigate and adapt to climate change.
- Motivate citizens of South Carolina to actively participate in the process of mitigation of and adaptation to climate change.
- Stimulate citizens of South Carolina to join together to protect the environment and the health of present and future generations by helping to prevent uncontrolled climate change.

The plan must address the CECAC's recommendations, as approved by the state; should be based upon the philosophy and principles of individual responsibility, community action, conservation,

and prevention; and should establish lines of communication with other states to keep abreast of best practices and to create efficiencies. The plan should be designed to accommodate the needs and conditions of the following target audiences: (1) state employees, (2) policymakers, (3) future generations, (4) community leaders and community-based organizations, (5) the general public, (6) industrial and economic sectors, (7) federal agencies, and (8) the media.

To effectively develop and implement this plan, the state should appoint a statewide coordinator and a committee for public education and outreach to address climate change and related issues. The coordinator should be a recognized educator, and appointments to the committee should be credible with each of the target audiences. The coordinator, with the direction and approval of the committee, will draft and implement the detailed plan, appoint coordinators for each of the target audiences, present annual reports to the Governor and legislature, and review and update the plan periodically.

The CECAC recognizes that healthy lifestyles are healthy for the environment and vice versa. Thus, the CECAC recommends integrating climate change and healthy lifestyle issues into educational curricula, post-secondary degree programs, and professional licensing to emphasize the common basis and goals of response to climate change with protecting the environment and achieving optimum health for all people. The CECAC recommends that the state consider creating the South Carolina Health Corps (as outlined in Annex B to Appendix F of this document), to empower younger and future generations to embrace and implement this concept.

CC-6. Adaptation and Vulnerability

While taking action to reduce GHG emissions in South Carolina, the CECAC recommends that the state empanel a "Blue Ribbon" Commission on Adaptation to Climate Change to develop a state Climate Change Adaptation Plan within one year of establishment of the commission. The commission should involve and coordinate with all appropriate state and local agencies, organizations, and institutions (e.g., universities) to ensure that all potential impacts are identified in the plan, including (1) potential short-term, mid-term, and long-term impacts of climate change scenarios likely to affect the state, and (2) implementation mechanisms for addressing these impacts. The commission should also enlist the expertise of all appropriate state and local agencies, organizations, and institutions in developing and implementing measures for mitigating these impacts. At a minimum, the Climate Change Adaptation Plan should include:

- Comprehensive identification of potential short-term, mid-term, and long-term impacts associated with climate change in South Carolina (see Appendix F for list of potential impacts).
- Recommended steps to respond to the identified impacts, so as to minimize risk in South Carolina to humans, natural and economic systems, water resources, temperature-sensitive populations and systems, energy systems, transportation systems, communications systems, vital infrastructure and public facilities, natural lands (such as coastal areas, wetlands, forests, and farmland).
- Coordination of response efforts through the appropriate state, local, and federal agencies, organizations, or other entities or initiatives.

- Characterization of the potential risks and costs of inaction; characterization of the potential costs, benefits, and co-benefits associated with specific policy and program actions; and establishment of time- and program-based goals.
- Periodic, regular review and update of the Adaptation Plan (at least every 5–10 years, or as needed based on increasing understanding of impacts) to expand or refine the plan as necessary, to improve implementation of the plan, and to incorporate new information as it becomes available.

Chapter 4
Residential, Commercial, and Industrial Sectors

Overview of Greenhouse Gas Emissions

The residential, commercial, and industrial (RCI) sectors are between them the third largest direct source of gross greenhouse gas (GHG) emissions in South Carolina, accounting for about 19% of gross GHG emissions in 2005, if emissions from the generation of the electricity they consume are not included. Direct use of oil, natural gas, coal, and wood in the RCI sectors accounted for an estimated 17.9 million metric tons of carbon dioxide equivalent ($MMtCO_2e$) (19%) gross GHG emissions in 2005.[1] Energy-related direct emissions result principally from the on-site combustion of oil and natural gas, with a smaller contribution by on-site combustion of coal. The release of CO_2 and fluorinated gases (hydrofluorocarbons [HFCs] and perfluorocarbons [PFCs]) during industrial processing, the use of sulfur hexafluoride (SF_6) in the utility industry, and the leakage of HFCs from refrigeration and related equipment accounted for an additional 4.14 $MMtCO_2e$ in 2005.[2] Including industrial process emissions, the RCI sectors are directly responsible for almost one-quarter of South Carolina's current gross GHG emissions (22.0 $MMtCO_2e$ in 2005).

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.[2] If the emissions associated with producing the electricity consumed in South Carolina are considered, RCI activities are associated with over half (about 59%) of the state's gross GHG emissions in 2005.[3] 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 historical and projected RCI GHG emissions by sector. On a percentage basis, emissions associated with the residential and commercial sectors are forecasted to experience rapid growth—on the order of 50% and 47%, respectively. Forecasted industrial GHG emissions growth is sizable, with a 20% increase from 2005 to 2020.

Figure 4-2 shows historical and projected RCI GHG emissions by fuel and source, and illustrates the large fraction of RCI emissions associated with electricity consumption. RCI emissions associated with electricity use are expected to rise by about 46% between 2005 and 2020, from 33 $MMtCO_2e$ in 2005 to about 48 $MMtCO_2e$ in 2020. While GHG emissions from the direct use of petroleum remain flat, emissions from the direct use of coal, wood, and natural gas are

[1] Emission estimates from wood combustion include only nitrous oxide (N_2O) and methane (CH_4). Carbon dioxide emissions from biomass combustion are assumed to be "net zero," consistent with U.S. Environmental Protection Agency (EPA) and Intergovernmental Panel on Climate Change (IPCC) methodologies, and any net loss of carbon stocks due to biomass fuel use should be accounted for in the land-use and forestry analysis.

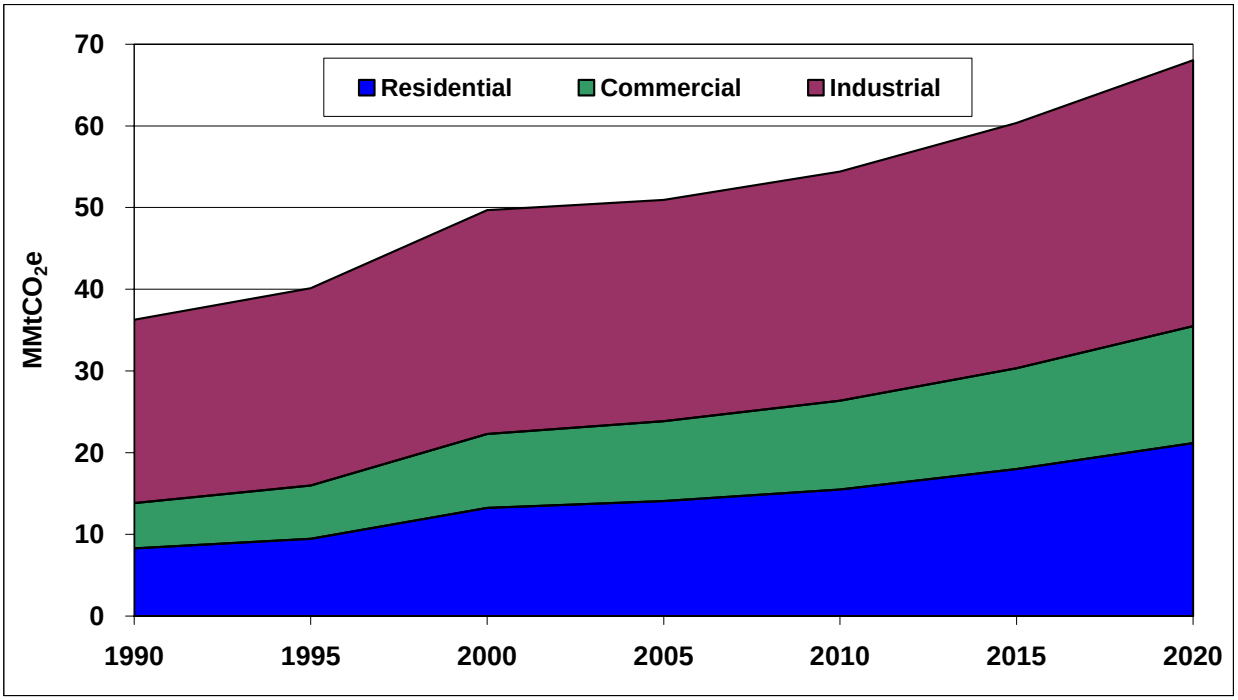
[2] Emissions associated with the electricity supply sector (discussed in chapter 5) have been allocated to each of the RCI sectors for comparison of those emissions to the emissions associated with direct fuel consumption. Note that this comparison is provided for information purposes and that emissions estimated for the electricity supply sector are not double counted in the total emissions for the state.

[3] Gross emissions here denote GHG emissions from activities in South Carolina, adjusted for exports of electricity, oil, and gas, but not including consideration of estimated "sinks" of GHGs in the forestry and land-use sectors.

projected to increase moderately (13%, 13%, and 21%, respectively) from 2005 to 2020. For the residential sector, emissions associated with the generation of electricity to meet energy consumption demand are projected to increase by 58% from 2005 to 2020, while emissions associated with the direct use of natural gas are projected to increase by 26% over this 15-year period. Residential sector emissions associated with the direct use of petroleum and wood are projected to decline by 14% and 7%, respectively, from 2005 to 2020. The residential sector has not consumed any coal since 1999, and is not projected to use any coal over the forecast period.

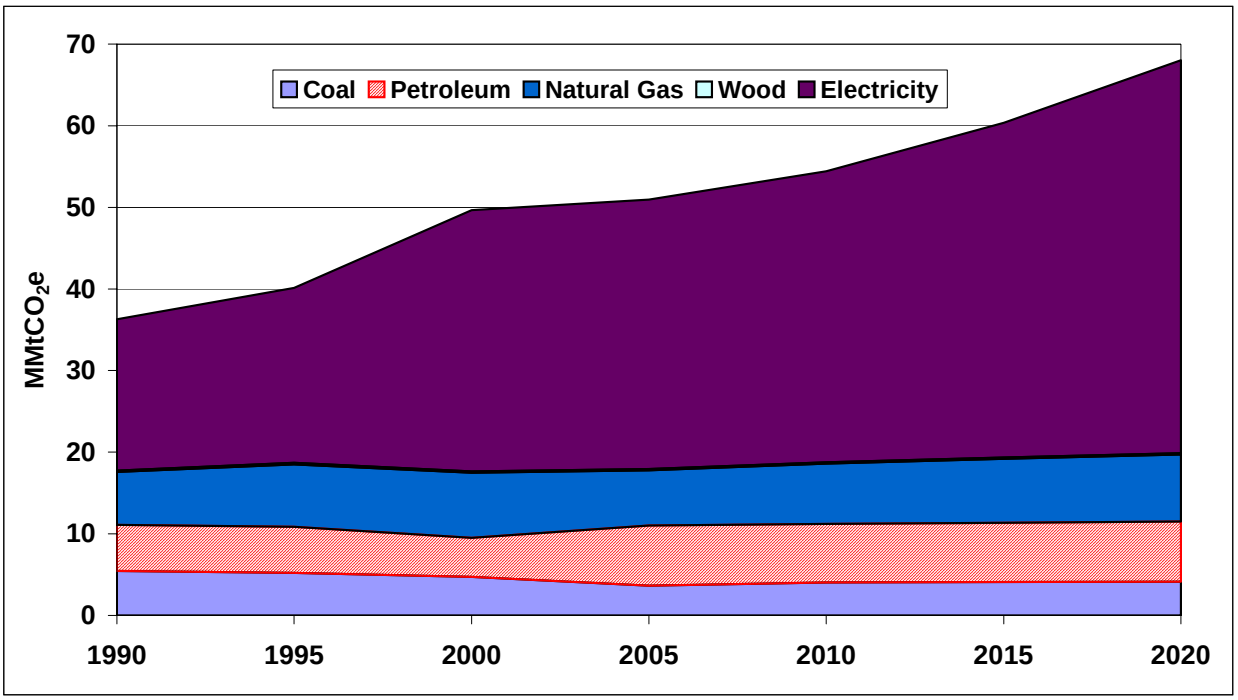
Commercial sector emissions associated with the generation of electricity to meet residential energy consumption demand are projected to increase by 52% from 2005 to 2020, while emissions associated with the direct use of natural gas are projected to increase by 29% over this 15-year period. Commercial sector emissions associated with the direct use of petroleum are not expected to increase during the 15-year forecast period. Commercial sector emissions associated with the direct use of wood are projected to decline by 6% from 2005 to 2020. The commercial sector has not consumed any coal since 1999, and is not projected to use any coal over the forecast period. Industrial sector emissions associated with the generation of electricity to meet residential energy consumption demand are projected to increase by 32% from 2005 to 2020. Emissions associated with the direct use of natural gas, wood, coal, and petroleum are projected to increase by 17%, 20%, 13%, and 2% over the 15-year forecast period.

Figure 4-1. Historical and projected residential, commercial, and industrial greenhouse gas emissions by sector in South Carolina: 1990–2020*



* Emissions associated with the direct use of natural gas, petroleum, coal, and wood and the consumption of electricity.

Figure 4-2. Historical and projected residential, commercial, and industrial (RCI) GHG emissions by type of fuel in South Carolina, 1990 to 2020



* Emissions associated with the direct use of natural gas, petroleum, coal, and wood and the consumption of electricity.

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 solar water heating and cooling), 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.

South Carolina has already taken important steps in this direction. Several pieces of legislation introduced in the 2007–2008 legislative session and signed by the Governor are particularly relevant for the RCI sectors: H. 3034, H. 3395, and H. 4766. The Energy Independence and Sustainable Construction Act of 2007 (H. 3034) requires application of "green building" or comparable standards to buildings to be constructed on state property with budgets greater than $15 million. H. 3395 requires the South Carolina Energy Office and the Office of Regulatory Staff to recommend process and procedures for establishing net metering programs at all distribution electric utilities in the state. H. 4766 creates specific energy reduction and reporting requirements for state agencies and exempts agencies that implement all available cost-effective energy conservation measures from annual reporting requirements; it also requires incandescent light bulbs used by a state agency to be replaced with compact fluorescent bulbs when the incandescent bulb needs replacing, and establishes a wind energy production farms feasibility study committee, among other things. Non-legislative efforts are also taking off. For example, a partnership of the South Carolina Energy Office, local homebuilder associations, and Southface

Energy Institute is piloting an EarthCraft house program for Charleston and Greenville, through which over 100 EarthCraft homes have been built. These actions indicate growing momentum for improving energy efficiency and reducing GHG emissions in the state.

The South Carolina Climate, Energy and Commerce Advisory Committee (CECAC) has identified significant opportunities for reducing GHG emissions growth attributable to the RCI sectors in South Carolina. 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 CECAC has also identified significant opportunities to reduce GHG emissions through policies addressing electricity production, such as tapping into the state's offshore wind potential and developing nuclear generation (detailed in Chapter 5).

Overview of Policy Recommendations and Estimated Impacts

The CECAC recommends by unanimous consent a set of nine policies for the RCI sectors that offer the potential for significant GHG emission reductions in the state. These recommendations and results are summarized in Table 4.1. The GHG emission reductions for eight of these policies were quantified, and the costs per ton of GHG avoided were quantified for seven. The eight policy recommendations with estimates for potential avoided GHG emissions could lead to emissions savings from reference case projections of:

- 28 $MMtCO_2e$ per year by 2020, and
- Cumulative savings of 142 $MMtCO_2e$ from 2009 through 2020.

The seven recommended policies for which costs were quantified could result in net cost savings of over $2.9 billion through 2020 on a net present value (NPV) basis.[4] The weighted-average cost of these policies is a net savings of $21 per $MMtCO_2e$.

Recommended policies RCI-1, -2, -4, -6, part of RCI-7 (the state and local buildings portion), and RCI-9 are all focused on efficient energy use, but are distinguished by their different approaches, their focus on varied types of energy use, or the specific energy users they target. RCI-1 (targeting electricity use) and RCI-2 (focused on natural gas, propane, and fuel oil consumption) both involve implementing general energy efficiency programs on a widespread basis. RCI-4 and RCI-6 seek to reduce energy use by buildings in all sectors but take distinct approaches toward achieving their goals. RCI-4 focuses on educating South Carolinians and building human capital in energy-efficient building management and operation. RCI-6 draws on existing building code enforcement infrastructure to implement efficiency measures, and also implements incentives to increase penetration of ENERGY STAR manufactured homes. In contrast to RCI-1, -2, -4, and -6, which affect a wide range of energy uses, RCI-9 focuses on a specific end use through adoption of appliance standards. RCI-7 targets a set of energy users—state and local governments—that are in a good position to demonstrate the benefits of energy-efficient building design and operations to the general public.

[4] The net cost savings, based on fuel expenditures, operations, maintenance, and administrative costs, and amortized, incremental equipment costs, are shown in constant 2005 dollars. All NPV analyses here use a 5% real discount rate.

Table 4-1. Summary List of RCI Policy Recommendations

No.	Policy Recommendation	GHG Reductions ($MMtCO_2e$)			Net Present Value 2009–2020 (Million $)	Cost-Effectiveness ($/tCO_2e$)	Level of Support
		2012	2020	Total 2009–2020			
RCI-1	Energy Efficiency Programs, Funds, or Goals for Electricity (Residential, Commercial, and Industrial)	1.5	8.2	43.0	–$1,127	–$26	Unanimous
RCI-2	Demand-Side Management/Energy Efficiency Programs, Funds, or Goals for Natural Gas, Propane, and Fuel Oil	0.2	0.8	4.5	–$379	–$85	Unanimous
RCI-3	Incentives and Regulatory Reform To Promote Implementation of Renewable Energy Systems, Including Solar Hot Water (Residential, Commercial, and Industrial)*	0.2	0.6	4.0	$164	$41	Unanimous
RCI-4	Energy Management Training/Training of Building Operators	Not quantified					Unanimous
RCI-5	Incentives, Resources, and Regulatory Reform To Promote Energy Recycling, Including Combined Heat and Power	1.0	8.2	39.5	–$332	–$8	Unanimous
RCI-6	Incentives and Policies for Improving Building Efficiency, Including Building Energy Codes	1.6	7.2	40.4	–$665	–$16	Unanimous
RCI-7	Improved Design and Construction in New and Existing State and Local Government Buildings, "Government Lead by Example"	0.5	5.0	24.6	–$800	–$33	Unanimous
RCI-8	Participation in Voluntary Industry–Government Partnerships (Including Incentives)	0.0	0.0	0.05	Not quantified*		Unanimous
RCI-9	Incentives and Policies for Improving Appliance Efficiency, Including Appliance Standards	0.3	0.9	5.6	–$94	–$17	Unanimous
	Sector Total After Adjusting for Overlaps (excluding RCI-8)†	**4.3**	**27.7**	**141.6**	**–$2,941**	**–$21**	
	Reductions From Recent Actions††	**0.5**	**2.2**	**12.6**	**Not quantified**		
	Sector Total Plus Recent Actions	**4.9**	**29.9**	**154.2**	**–$2,941**	**–$21**	

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

GHG = greenhouse gas; MMtCO2e = million metric tons of carbon dioxide equivalent; $/tCO2e = dollars per metric ton of carbon dioxide equivalent.

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

*The costs of RCI-8 have not been quantified, due to lack of publicly available data. Refer to discussion of Key Uncertainties under RCI-8 for more information.

† The benefits and costs of RCI policies overlap as follows: between residential and commercial new construction in RCI-1 and RCI–6; between residential and commercial new construction in RCI-2 and RCI–6; between RCI–7 and energy efficiency efforts in government and schools within RCI-1 and RCI-2; and between RCI-9 and parts of RCI-1, RCI-2, and RCI-7. Overlaps also occur between RCI-1 and the energy efficiency component of the energy supply (ES) sector ES-1, and between the electricity load reductions from RCI policies in general and ES-1; adjustments for these overlaps are made in the ES totals. Benefits and costs of renewable energy in RCI-7 overlap with ES renewable energy policies and are not included.

†† Reductions from recent actions include the Energy Independence and Security Act of 2007, Title III. Refer to Annex 1 to Appendix G for more information. 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-5, RCI-6, RCI-7, and RCI-8.

RCI-3, RCI-5, and part of RCI-7 involve energy production. The green power component of RCI-7 requires purchase or production of green power by state and local facilities. RCI-3 and RCI-5 both focus on energy production at the site of use: RCI-3 involves promoting solar hot-water and cooling systems, and RCI-5 focuses on increased implementation of combined heat and power in the state.

RCI-8 takes a multifaceted approach to reducing emissions from the industrial sector. In addition to promoting the efficient use of energy, this policy seeks emission reductions through process changes, switching to lower-carbon fuels, or implementation of other measures.

Policies RCI-1, -2, -3, -5, part of RCI-6 (the manufactured homes portion), and RCI-8 are all structured to provide incentives for energy efficiency or other measures to reduce GHG emissions. RCI-4 (energy management training), RCI-6 (the building codes portion), RCI-7 (government lead by example), and RCI-9 (appliance standards) involve mandatory implementation of measures to reduce energy consumption.

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. Some of the RCI policies target the same type of energy use and implement similar energy reduction strategies. For example, RCI-9 focuses on highly efficient appliances, either by instituting statewide appliance standards or by increasing market penetration of ENERGY STAR appliances. The energy efficiency programs in RCI-1 and RCI-2 and energy efficiency efforts by state and local governments under RCI-7 would most likely include replacement of old appliances with energy-efficient ones, which would overlap with the results for RCI-9. Another instance of overlap occurs between broad energy efficiency programs in RCI-1 and RCI-2 on the one hand, and energy efficiency measures required by building codes under RCI-6 for new construction in the residential and commercial sectors. RCI-7 focuses on government and school buildings and overlaps with the cumulative GHG emission reductions from energy efficiency in the government sector under RCI-1 and RCI-2.

Some policies are expected to have no overlaps, or negligible ones, with other RCI policies. Solar hot water and cooling (RCI-3) and combined heat and power (RCI-5) are rarely included as measures in gas or electric utility energy efficiency portfolios (RCI-1 and RCI-2). RCI-8 is intended to go above and beyond the measures that an industrial user would implement within RCI-1 and RCI-2 (e.g., by targeting process emissions, which are not taken into account in any other policy).

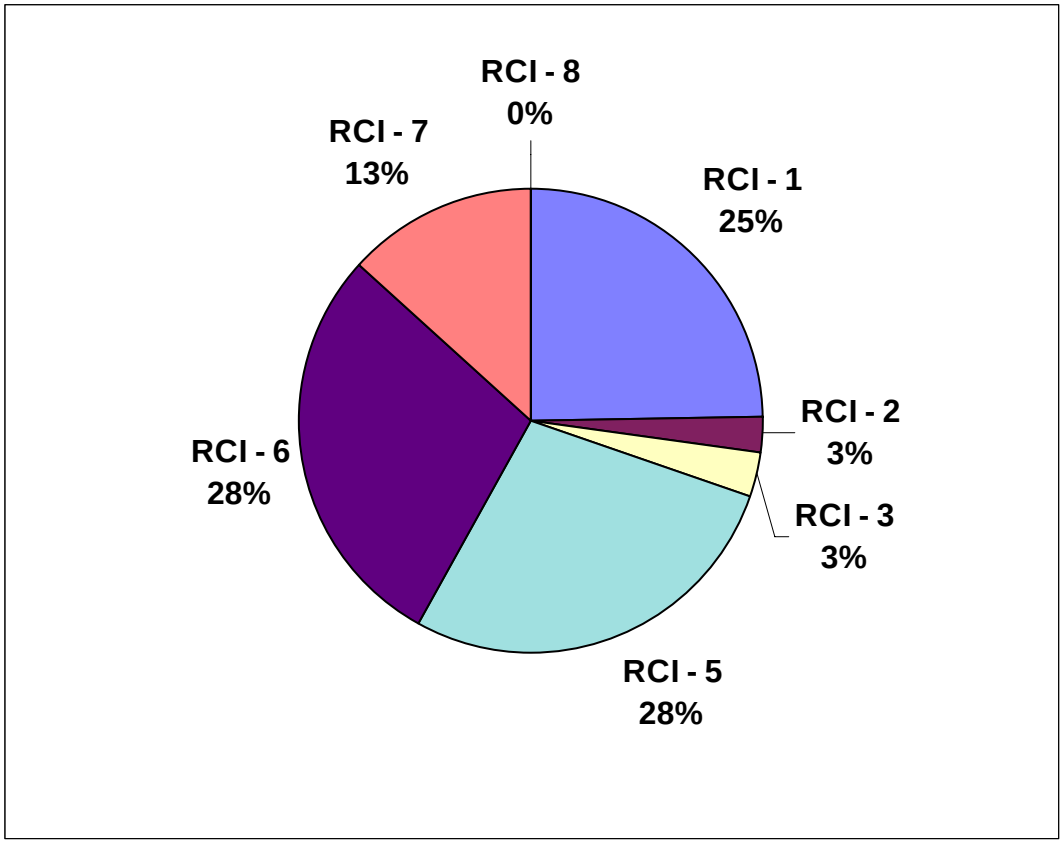
There are two primary interactions between the RCI and ES sector policies, both concerning the clean energy portfolio components in policy ES-1. First, ES-1 includes a requirement that some of the electricity demand in the state be met with energy efficiency measures. In addition, a number of the RCI policies (RCI-1, -3, -5, -6, and -7) decrease overall electricity demand. As the clean energy portfolio requirements are based on meeting a percentage of load with specific clean energy or nuclear resources, the impact of ES-1 would be reduced by reducing energy

demand through these RCI policies. A smaller interaction involves green power purchasing under RCI-7 and renewable energy generation under ES-1. Finally, an additional feedback is that certain ES policies (including ES-1) 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 described briefly below, and in more detail in Appendix G, result not only 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. In addition, several of these policies will have water conservation benefits, not only through reductions in demands from power plants for cooling, but also by reducing water consumption by the end users (e.g., RCI-9).

Figure 4-3 shows the breakdown of the projected impacts of the recommended RCI policies, taken together, in terms of avoided GHG emissions.

Figure 4-3. Aggregate GHG Emission Reductions, 2009–2020



For the RCI policies recommended by the CECAC 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 South Carolina's 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 Energy Efficiency Programs, Funds, or Goals for Electricity (Residential, Commercial, and Industrial)

The CECAC unanimously recommends that South Carolina increase the efficiency of electricity use ("energy efficiency") in the state through increased investment in energy efficiency programs run by utilities or others, energy efficiency funds, and/or energy efficiency goals. This policy would take a two-pronged approach to increasing the efficiency of electricity use in the state: implementing new or expanding existing electric utility energy efficiency programs for all sectors, and conducting consumer outreach on the value inherent in performance contracting and energy management programs for commercial, industrial, and institutional entities. To implement expanded electric energy efficiency programs, South Carolina could revise existing statutes to clarify support and provide incentives for utility investments in cost-effective energy efficiency.

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. South Carolina's efforts to date offer substantial room for improvement. As a result, the state has "low-hanging fruit" compared to states with well-established energy efficiency programs. National studies suggest that South Carolina has substantial potential to improve the efficiency of its energy use.

The goals of this policy are to reduce electricity use, adjusted for growth, by 1% per year by 2015 and by 1.5% per year by 2020. The policy would apply to all electric utilities (public and private), and would affect customers in all sectors (residential, commercial, industrial, and institutional/government). This policy would also implement an educational awareness campaign showing the value inherent in performance contracting and energy management programs for commercial, industrial, and institutional entities.

RCI-2 Demand-Side Management/Energy Efficiency Programs, Funds, or Goals for Natural Gas, Propane, and Fuel Oil

The CECAC unanimously recommends that South Carolina implement programs or policies to increase investment in demand-side management (DSM) programs for natural gas, propane, fuel oil, and other combustion fuels. Energy efficiency has been shown to be an extremely cost-effective resource for reducing natural gas use. The high costs of propane and fuel oil point to the potentially significant value of implementing DSM for these fuels.

The goals of this policy are to reduce natural gas use, adjusted for growth, by 1% per year by 2015, and sustain annual savings through 2020 through implementation of energy efficiency programs. The policy would apply to natural gas utilities (public and private) and customers in

all sectors. Similar goals should be set for other fuels, although they may need to be modified by the South Carolina Public Utility Commission due to the smaller number of affected parties who may have special circumstances. The goals may be accomplished through programs run by utilities or others, energy efficiency funds, and/or energy efficiency goals, and should be designed to complement RCI-1. To implement expanded DSM programs, South Carolina could revise existing statutes to clarify support for utility investments in cost-effective energy efficiency at the levels indicated in this policy.

Like RCI-1, this policy would also conduct consumer outreach on the value of performance contracting and energy management programs for commercial, industrial, and institutional entities. This policy also considers efficiency gains to be achieved through fuel neutrality, which refers to encouraging fuel switching where it results in reduced GHG emissions, lower energy use, economic savings, or some other metric.

RCI-3 Incentives and Regulatory Reform To Promote Implementation of Renewable Energy Systems, Including Solar Hot Water (Residential, Commercial, and Industrial)

South Carolina is endowed with good, useful solar resources for water heating throughout the state. The CECAC unanimously recommends leveraging that potential through programs and policies that encourage consumers to switch from using fossil fuels to using solar energy for water-heating applications.

The goals of this policy are that, beginning in 2009, 1% per year of all South Carolina homes and suitable business facilities will have solar hot water installations, reaching 10% of all South Carolina homes by 2020. This policy also seeks to encourage businesses to adopt solar cooling technologies, which would have significant benefits in terms of reducing peak electricity demand.

RCI-4 Energy Management Training/Training of Building Operators

In many facilities, utility bills can be significantly decreased through more efficient equipment and building operation. The CECAC unanimously recommends the development and implementation of a statewide Energy Conservation Education and Training Program for energy managers and facility operators, to learn techniques for improving the efficiency of their steam, process heat, pumping, compressed air, motors, and other systems. Classes would be conducted at the state's Technical College Facilities, and could draw on or expand preparation classes available from the South Carolina Energy Office. Energy management training would include instruction in and demonstration of successful energy management programs throughout the state, using Winthrop University and other government projects as models. The South Carolina Energy Office would develop the course curricula (to include instruction in and demonstration of successful energy management programs) and requirements for licensing, as well as maintain a database of licensed professionals.

Starting in 2018, successful completion of this training would be required for energy managers and facility operators in all sectors (residential, commercial, industrial, and institutional) by a licensing requirement, and continuing education credits would be required annually. Companies

could outsource energy management, energy planning, and facility operations, or they could retain licensed staff to oversee operations.

RCI-5 Incentives, Resources, and Regulatory Reform To Promote Energy Recycling, Including Combined Heat and Power

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 South Carolina. However, energy recycling, including CHP, is challenged by several non-economic 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 CECAC unanimously recommends increased effort toward tapping into the unrealized potential for CHP and waste heat recovery in South Carolina, with a goal of installing 100 megawatts in 2011 and realizing 40% of the additional technical potential by 2020. (Existing CHP installations are not included in the 40% goal but should be kept in service.)

RCI-6 Incentives and Policies for Improving Building Efficiency, Including Building Energy Codes

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.[5] Improving the energy efficiency of state and/or local buildings—for example, by strengthening building energy codes—will have a considerable immediate and ongoing impact on reducing building-sector GHG emissions. Although South Carolina law requires statewide use of the most up-to-date building codes as defined by the International Energy Conservation Code (IECC), conflicts between these codes and other provisions of state law have severely weakened the effectiveness of the codes.

Manufactured housing is exempt from South Carolina's building energy code. Instead, manufactured homes are subject to standards established by the U.S. Department of Housing and

[5] U.S. Department of Energy, Energy Information Administration. "U.S. Energy Consumption by Sector." Available at: http://www.architecture2030.org/building_sector/index.html.

Urban Development. A significant percentage of South Carolinians reside in manufactured housing.

The CECAC unanimously recommends that the state take action to remove provisions of state law that conflict with IECC codes and address obstacles to renewable energy use, daylighting, and nonconventional energy-efficient building materials in buildings; improve statewide enforcement of both existing and new building codes at all levels; update South Carolina energy codes regularly; consider advanced codes (i.e., beyond IECC) as appropriate for the state; implement requirements and incentives for ENERGY STAR-certified manufactured housing and manufactured nonresidential buildings; and lobby for more stringent codes for manufactured housing at the federal level.

The goals of this policy are twofold: that 100% of South Carolina's local governments adopt and fully enforce the 2006 IECC in 2009 and the 2012 IECC in 2015; and, that ENERGY STAR-certified manufactured homes achieve 25% market penetration for new manufactured homes by 2010 and 75% by 2020.

RCI-7 Improved Design and Construction in New and Existing State and Local Government Buildings, "Government Lead by Example"

The CECAC unanimously recommends that the state undertake government-led, or "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 GHC emission reductions in new and existing state and local government buildings. This policy achieves GHG reductions by setting a goal for green power purchasing by state and local facilities, as well as conducting audits of energy performance and operations of state and other government buildings and using audit results to target and prioritize investments in improving government building energy efficiency. Other elements include developing green procurement strategies (such as state bulk purchase of high-efficiency appliances and equipment); providing financial and technical assistance and incentives for implementation of energy-saving projects in existing buildings and facilities; requiring that all state and local facilities implement an energy management program; implementing design features to reduce energy use within state-funded and other government buildings through incorporation of proven planning guides and regulations; and expanding A88 to include South Carolina school buildings.[6] The effectiveness of this policy will be determined in part by sustained efforts to review and improve efficiency goals over time.

The goals of this policy are to procure and carry out a program to audit energy use and identify energy efficiency opportunities in state and local government buildings (existing, undergoing renovation, and under design), at a rate of 15% of these buildings per year over a 5-year period. In addition, this policy sets a goal that, by 2018, a minimum of 20% of electricity consumed by state and local facilities and schools should come from in-state renewable resources. The policy would apply to state government agencies, local governments, schools, and universities.

[6] South Carolina General Assembly, 117th Session, 2007_2008. *Energy Efficiency Act*. Available at: http://www.scstatehouse.net/sess117_2007-2008/bills/30\34.htm.

RCI-8 Participation in Voluntary Industry–Government Partnerships (Including Incentives)

The CECAC unanimously recommends creating a voluntary program in which businesses, government, and industry become partners in reducing the emission of process gases that have high global warming potentials. The program would be administered by state agencies and would provide technical assistance, networking, best practices exchange, and rewards and recognition (including tax incentives). Verification of emission reductions would be a critical element of this program.

The goals of this policy are to establish partnerships with industrial and other large users of energy (and/or of process gases that are GHGs) to encourage them to set emission reduction targets to return to 2000-level emissions by 2012 and 10% below 2000-level emissions by 2020, or to meet or exceed state goals. The largest emitters would be approached first. The technical assistance, networking, reward, and recognition aspects of the program would be set up by 2009. This may be accomplished through expansion and modification of already-established programs.

RCI-9 Incentives and Policies for Improving Appliance Efficiency, Including Appliance Standards

The CECAC unanimously recommends a policy to ensure high energy efficiency of appliances in the state. First, this policy would establish and regularly update appliance efficiency standards at the state level, thereby reducing the market cost of energy efficiency improvements by incorporating technological advances into base appliance models. Second, this policy involves the creation of state sales tax exemptions or income tax credits for purchase of products certified as ENERGY STAR (a joint program of the U.S. Environmental Protection Agency and the U.S. Department of Energy), designed to promote products exceeding the energy efficiency levels mandated by minimum federal and state standards in the marketplace.

The goals of this policy include implementing the efficiency standards for appliances not covered by federal standards, as recommended by the Appliance Standards Awareness Project; doubling market penetration of ENERGY STAR appliances in purchases made in the RCI sectors, where applicable, up to 100% by 2015; and achieving 100% market penetration of ENERGY STAR appliances in purchase transactions in which state funds are involved (state purchasing contracts, state grants or loans, etc.) by 2010.

Chapter 5
Energy Supply Sector

Overview of Greenhouse Gas Emissions

Greenhouse gas (GHG) emissions from the energy supply (ES) sector in South Carolina include primarily emissions from electricity production and delivery, with a small contribution from the transmission and distribution of natural gas. Electricity consumption produces the largest source of GHG emissions in South Carolina, accounting for 35% of South Carolina's gross GHG emissions in 2005.

The GHG emissions associated with South Carolina's electricity sector increased by 15 million metric tons of carbon dioxide equivalent ($MMtCO_2e$) between 1990 and 2005, accounting for 55% of the state's growth in gross GHG emissions during this period. Looking forward, by 2020 ES emissions are expected to increase from 2005 levels by approximately 43% on a production basis, from roughly 38 $MMtCO_2e$ in 2005, to about 54 $MMtCO_2e$ in 2020. On a consumption basis, total GHG emissions to meet the state's electricity demand are expected to rise from about 33 $MMtCO_2e$ in 2005 to about 48 $MMtCO_2e$ in 2020. The higher emissions total under the production-based approach reflects South Carolina's role as a net exporter of electricity.[1] Projections for 2005 through 2020 indicate that South Carolina will remain a net exporter of electricity. Figure 5-1 shows the electricity generation resource mix upon which the emissions inventory and reference case projections are based.

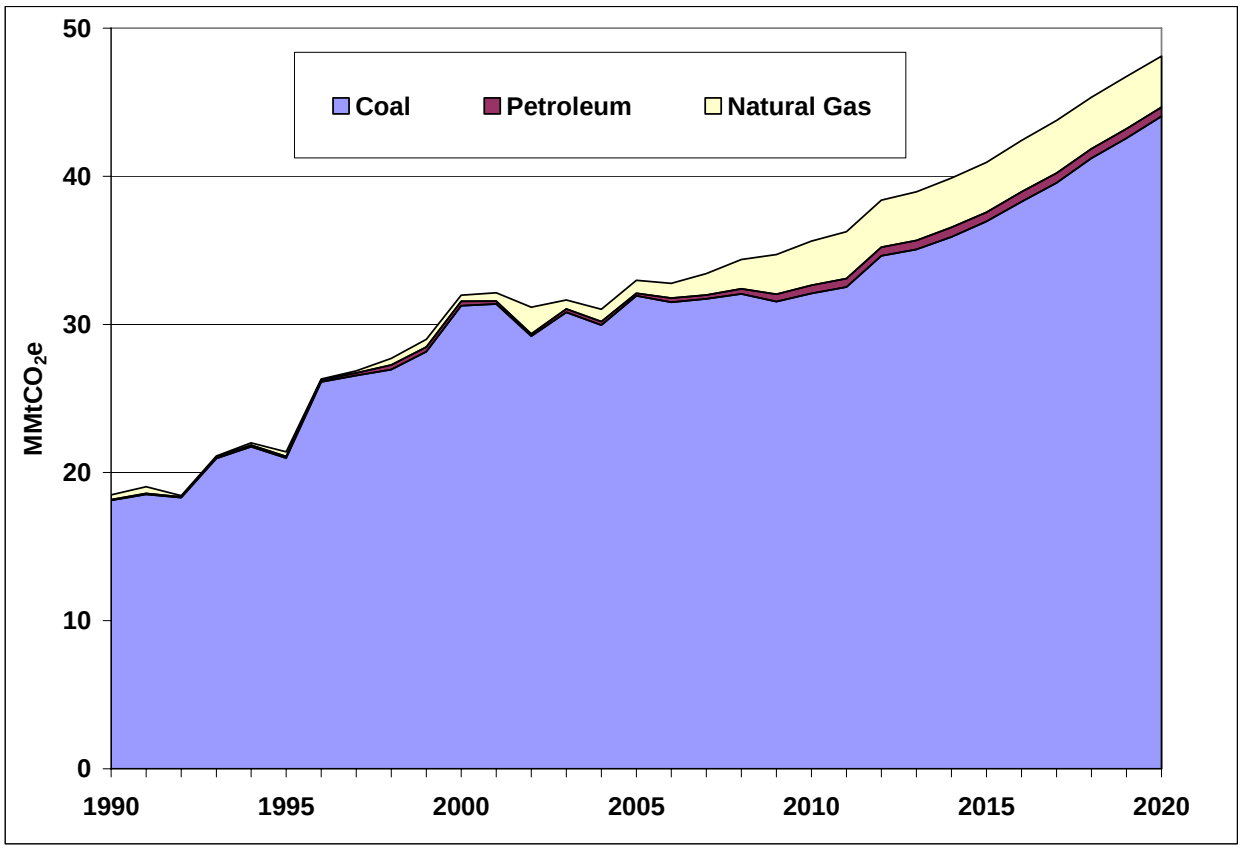
Key Challenges and Opportunities

There are significant opportunities to reduce GHG emissions growth associated with energy production and supply in South Carolina, such as promoting distributed renewable generation, investing in technology research and development in the state, and diminishing the carbon intensity of electrical generation through greater use of renewable energy and nuclear power.

There are also significant opportunities to reduce GHG emissions through policies addressing electricity consumption, and these can often provide cost savings as well as GHG mitigation benefits. The CECAC has identified two energy efficiency and conservation policies within Energy Supply: the energy efficiency component of the Efficiency and Renewable Portfolio Standard and Statement of Support for Nuclear Energy, and a regulatory model to equalize utility earnings on energy efficiency with earnings on traditional power supply. Several other opportunities to promote and develop energy efficiency and conservation measures are identified in the residential, commercial, and industrial (RCI) sector, discussed in Chapter 4.

[1] Accounting for electricity emissions on a production basis considers the GHG emissions produced by electricity generation facilities in South Carolina. This perspective is useful because the state may have policies it can use to influence electricity suppliers within the state different from those used to influence out-of-state suppliers. Emission estimates provided elsewhere in this report (including the inventory and forecast in Chapter 2) reflect the GHG emissions associated with the electricity sources used to meet South Carolina's demands, corresponding to a consumption-based approach. The consumption-based approach can better reflect the emissions (and emission reductions) associated with activities occurring in the state that affect energy use.

Figure 5-1. Historical and projected GHG emissions from South Carolina power plants: 2003–2020



South Carolina has substantial renewable energy resource potential in the form of biomass and both on-shore and off-shore wind energy. The CECAC recommends that South Carolina promote the development of these resources through a number of policies designed to address the various barriers to realizing the potential for renewable resources. Implementation of utility-scale renewable resources can be encouraged through feed-in tariffs, direct financial support for biomass and other resources, and an Energy Portfolio Standard, which mandates that a certain percentage of delivered energy in the state come from renewable resources and energy efficiency, and makes a statement of support for increasing the share of nuclear energy in the state. Smaller, distributed resources are specifically targeted through actions to reduce financial, permitting, and interconnection barriers. Green power marketing programs and state efforts to attract companies that specialize in this industry would likely boost adoption of all types of renewable resources. Technology research and development (R&D) can encourage market acceptance of a variety of technologies by lowering the cost or improving performance of renewable generation, and by encouraging collaboration between R&D, government, academic, and commercial sectors. R&D activities also produce employment and economic development benefits in the state.

Overview of Policy Recommendations and Estimated Impacts

The CECAC recommends a set of eight policies for the ES sector that offer the potential for significant GHG emission reductions in South Carolina. Four of these have been quantified to

estimate the potential for avoided GHG emissions. If implemented together with all of the policy recommendations from each of the sectors represented in the CECAC process, these four policy recommendations could lead to emissions reductions of:

- 3 $MMtCO_2e$ per year by 2020, and
- 22.5 $MMtCO_2e$ cumulative savings from 2008 through 2020.

The net cost of these four policies is estimated at $1.2 billion through the year 2020 on a net present value (NPV) basis.[2] The weighted-average cost of these policy recommendations is $53 per metric ton of CO_2e.

Six recommendations were accepted by unanimous consent of the CECAC, and two were accepted by super majority (5 or fewer objections). These recommendations and results are summarized in Table 5.1. The explanations of the objections are included in the detailed policy recommendations in Appendix H.

Recommended policies ES-1, ES-2, ES-3, ES-6, ES-7, and ES-8 are initiatives that would lead to increased reliance on renewable energy resources in the state. Policy ES-1 also requires utilities to increase the share of energy efficiency in their electricity resource portfolios, as well as providing a statement in support of increased investment in nuclear power in South Carolina. Policy ES-4 would address the financial disincentive utilities face towards investing in energy efficiency. Policy ES-5 concerns investigation into the technical, economic, and environmental feasibility of in-state nuclear fuel reprocessing, which may significantly reduce the volume of high-level radioactive waste created by new and existing nuclear resources.

The totals reported in Table 5-1 take into account overlaps in the expected emissions reduction and cost among some of the policies within the ES sector, as well as between policies in the ES, RCI, and agricultural, forestry, and waste management (AFW) sectors. Care was taken in the determination of benefits from each of the sectors to ensure that the combined calculated impact of the policies would not “double count” benefits that overlap.

In the case of the ES policies, the renewable energy component of the energy portfolio standard recommended under ES-1 overlaps with the incentives for utility-scale renewable energy projects under ES-3. The distributed energy incentives in ES-3 would overlap with promotion of distributed renewable energy in ES-8.

Figure 5-2 shows the breakdown of impacts of the recommended ES policies, taken together, in terms of avoided GHG emissions (2008–2020). The figure takes into account overlaps within the energy supply sector but not overlaps with policies from other sectors.

[2] The net cost savings are based on fuel expenditures, operations, maintenance, and administrative costs, and amortized, incremental equipment costs. All NPV analyses here use a 5% real discount rate.

Table 5-1. Summary list of energy supply policy recommendations

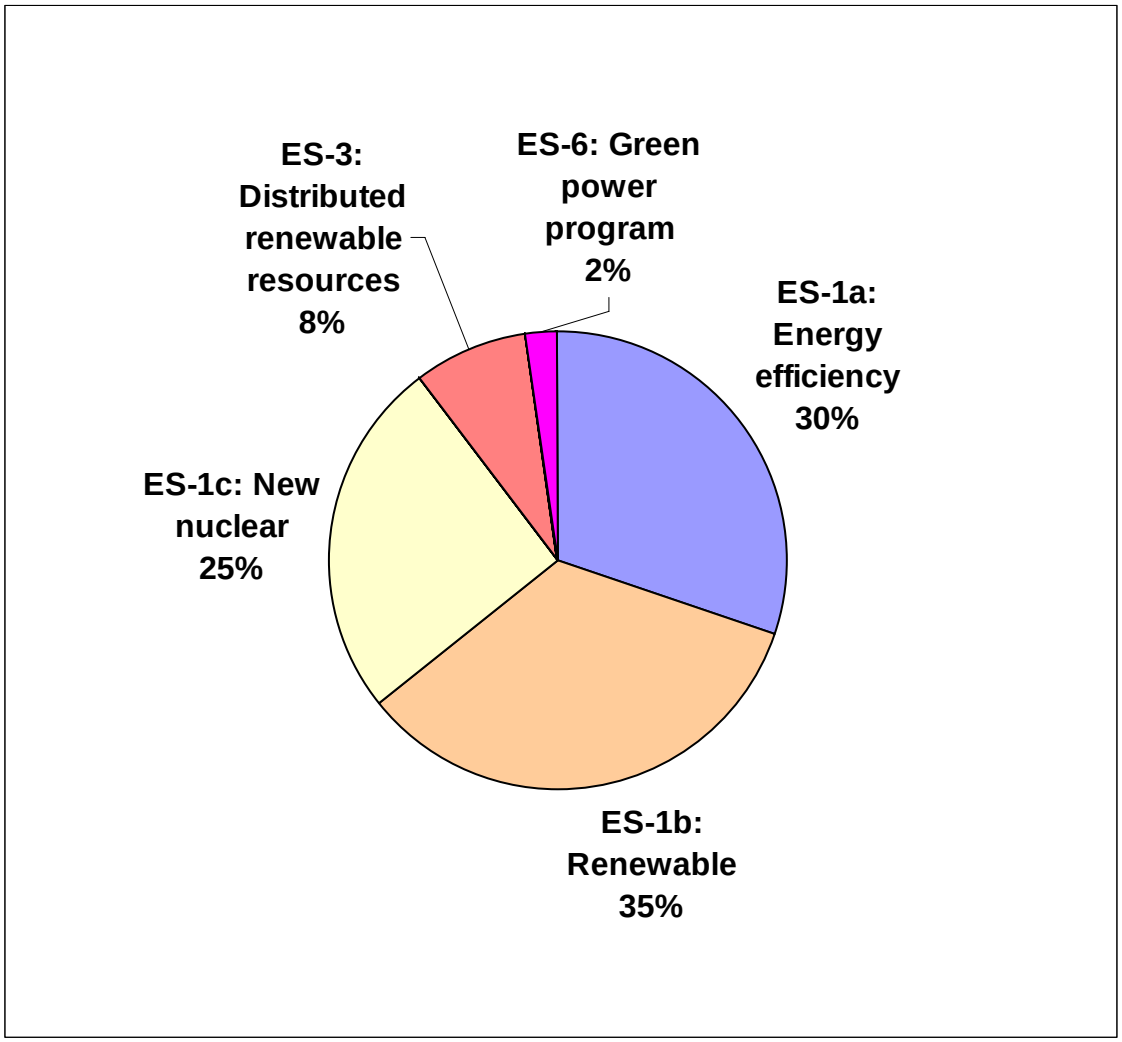
Policy No.*	Policy	GHG Reductions ($MMtCO_2e$)			Net Present Value 2008–2020 (Million $)[1]	Cost-Effectiveness ($/tCO_2e$)[1]	Level of Support
		2012	2020	Total 2008–2020			
ES-1	Efficiency and Renewable Portfolio Standard and Statement of Support for Nuclear Energy	1.9	12.6	66.5	$689	$10	Super-majority (Three objections)
ES-1a	Energy Efficiency: 5% of energy met with energy efficiency resources by 2020	0.8	4.2	22.4	–$586	–$26	
ES-1b	Renewables: 5% of energy served by new renewable resources by 2020	1.1	3.8	25.3	$489	$19	
ES-1c	Nuclear: 6% of energy served by new nuclear resources by 2020	0.0	4.6	18.9	$786	$42	
ES-2	Technology Research and Development, Including State Funding	*Not quantified*					Unanimous
ES-3	Renewable Energy Financing, Tax Incentives, Loans	0.4	0.9	7.1	$591	$84	Unanimous
ES-4	Regulatory Model To Equalize Utility Earnings on Energy Efficiency With Earnings on Traditional Power Supply	*Not quantified*					Super-majority (One objection)
ES-5	Nuclear Fuel Reprocessing	*Not quantified*					Unanimous
ES-6	Green Power Purchases and Marketing, 1% Participation by 2012	0.2	0.2	1.7	$46	$27	Unanimous
ES-7	Attract Renewable Energy Technology Businesses to South Carolina	*Not quantified*					Unanimous
ES-8	Distributed Renewable Energy Incentives and/or Barrier Removal (Including Interconnection Rules)	0.05	0.1	0.8	$42	$50	Unanimous
	Sector Total After Adjusting for Overlaps	**0.3**	**3.0**	**22.5**	**$1,201**	**$53**	
	Reductions From Recent Actions	**0.0**	**0.0**	**0.0**	**0**	**0**	
	Sector Total Plus Recent Actions	**0.3**	**3.0**	**22.5**	**$1,201**	**$53**	

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

GHG = greenhouse gas; MMtCO2e = million metric tons of carbon dioxide equivalent; $/tCO2e = dollars per metric ton of carbon dioxide equivalent.

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

Figure 5-2. Percentage of avoided greenhouse gas emissions by energy supply policy: 2008–2020



Two primary interactions between policies in the ES and RCI sectors concern the efficiency and renewable energy portfolio components in policy ES-1. First, ES-1 includes a requirement that some of the electricity demand in the state be met with energy efficiency measures and would overlap with the energy efficiency policy under RCI-1. In addition, a number of the RCI policies (RCI-1, RCI-3, RCI-5, RCI-6, and RCI-7) decrease overall electricity demand. As ES-1 sets a goal for meeting a fixed percentage of load with renewable energy, as well as a policy statement supporting new nuclear resources for a fixed percentage of load, the impact of this policy would be affected by reducing energy demand through these RCI policies. A smaller interaction involves green power purchasing under RCI-7 and renewable energy generation under ES-1. Finally, an additional feedback is that certain ES policies (including ES-1) will reduce the GHG emissions associated with energy production, so that RCI policies that target electricity use will have a reduced impact on overall emissions. This impact is small and has not been reflected in the analysis.

In addition, ES-1, ES-3, and ES-6 rely on a limited supply of biomass feedstock in the state to replace fossil-based electricity generation. These policies overlap with AFW-2, AFW-5, and AFW-9, which also rely on the use of biomass for both electricity production and other energy-related uses. See Appendix E, Methods of Quantification, for additional description of overlaps among sectors and of analyses of the cumulative GHG reductions from the combined effects of the CECAC policy recommendations that were quantified.

Energy Supply Sector Policy Descriptions

ES-1. Efficiency and Renewable Portfolio Standard and Statement of Support for New Nuclear Energy

Electricity demand is increasing each year in South Carolina, requiring the development of additional supply- or demand-side resources to meet that need. Certain resources can meet this demand without producing incremental GHG emissions, including energy efficiency resources, renewable energy, and nuclear power. (The construction and decommissioning of both nuclear and renewable resources produce GHG emissions, as do the production and transport of fuel. These have not been taken into account in this analysis.)

The CECAC recommends, by super majority, that the state develop energy portfolio standards, including renewable technologies and energy efficiency programs, and adopt a statement of policy supporting development of new nuclear power. The portfolio standards should be implemented such that the short-term and long-term demands for electricity in South Carolina are met without causing undue economic harm to its citizens, the quality of the environment in South Carolina is protected and enhanced, and the clean energy resources with the greatest economic potential in the state are developed.

The goals of this policy include a mandate on public and private utilities that energy efficiency programs and new renewable energy on the utility's retail distribution system each meets 5% of its South Carolina retail customers' electricity needs by 2020, for a total of 10% of electricity needs. Additionally, the policy provides a statement of support for new nuclear energy, with a goal that by 2020 at least 6% of the total electricity in South Carolina will be from new nuclear energy.

ES-2. Technology Research and Development, Including State Funding

Technology research and development (R&D) can encourage adoption of new, clean energy technologies by lowering their cost or improving their performance. R&D funding can be structured in various ways to move toward certain goals. For example, funding can be targeted toward a particular technology or group of technologies as part of a state initiative to build or expand an industry or core technical competency and to set the stage for adoption of the technology for use in the state; alternatively, it can focus on demonstration projects to help commercialize technologies that have already been developed but are not yet in widespread use. A number of energy technology R&D programs are already underway at organizations and academic facilities throughout South Carolina, and the state is poised through its strength in hydrogen research to become a national leader in the hydrogen economy.

The CECAC unanimously recommends that the state establish an energy technology roadmap to focus its efforts on technologies that have the greatest potential for achieving reduced GHG emissions, economic development opportunities, national security, and energy independence for the state (including offshore wind energy, hydrogen infrastructure, and nuclear energy

resources). Furthermore, the state should provide additional funding of $20 million for clean energy initiatives that encourage collaborations among R&D, government, academic, and commercial sectors. The policy would also seek to showcase alternative energies in high-visibility R&D demonstrations and create a technology advisor position in the Governor's office. In addition to the Governor's office, academic institutions, and R&D firms, parties involved include the South Carolina Department of Commerce, economic development organizations, utilities, and state technology providers.

ES-3. Renewable Energy Financing, Tax Incentives, Loans

This recommendation concerns financial incentives to encourage investment in the full range of renewable energy resources and to help overcome barriers to their development. Institutional and market barriers include price distortions, inadequate information, institutional barriers to grid interconnection, high transaction costs for small projects, and high financing costs because of lender unfamiliarity and perceived risk. These can be overcome through a suite of financial and regulatory redresses, as well as through information and public education campaigns. Financial obstacles can also be addressed through property tax exemptions, exclusions, and credits; personal income tax credits or deductions to cover the expense of purchasing and installing renewable energy equipment; loan programs to aid in financing the purchase of renewable energy equipment; and grant programs designed for R&D or to help a project achieve commercialization.

The CECAC unanimously recommends a multilateral strategy of several different types of financial incentives to represent the range of opportunities. Available from 2009 through 2025, tax credits and subsidies would be provided as follows: removing legislative caps on current tax incentives for renewable fuel use; expanding the existing 25% income tax credit for solar and biomass equipment to include micro-hydro and small wind power projects and offering tax credits of $3,500/kilowatt (kW)-equivalent for small solar photovoltaic, micro-hydro, and small wind power projects up to 50 kW; and providing a subsidy to renewable energy generators of 1 cent/kilowatt-hour for electricity generated from a renewable resource, unless that electricity is used to meet a federal or state renewable energy standard. In addition, this policy would establish feed-in tariffs for large-scale, zero-pollution renewable generation projects, providing a guaranteed price for electricity or the market rate (if higher) for the lifetime of a project, up to 25 years, for projects brought on line between 2009 and 2015. Finally, this policy would include low-interest loans for feasible and desirable biomass generation brought on line between 2009 and 2015 that meets exemplary environmental performance standards.

ES-4. Regulatory Model To Equalize Utility Earnings on Energy Efficiency With Earnings on Traditional Power Supply

Utilities generate a predictable long-term earnings stream from investments in new supply resources that are needed to meet customer demand. Energy efficiency (EE) and distributed-generation (DG) renewable energy not only reduce sales, they also reduce the predictable earnings stream that Wall Street expects for the future earnings of the utility. This policy is designed to ensure that alternative methods of meeting customer demand provide the opportunity for an equivalent earnings stream to achieve investment parity.

Under traditional ratemaking, costs incurred by utilities, including a return on investment, are recovered through the sales of electricity. Because EE and DG renewable energy sources can decrease the volume of electricity sales, traditional cost-recovery mechanisms have created a financial disincentive to utility support for EE and DG renewable energy. In the short run (between rate cases), lost sales due to EE programs reduce revenue by the full tariffed rate, thereby undermining the utility's recovery of costs. When this net lost revenue is taken into account, utilities may be unable to recover costs and may face profit losses for EE and renewable DG measures.

The CECAC recommends, by super majority, implementing a regulatory model that equalizes the incentive for utilities to invest in cost-effective EE and renewable DG with the incentive to invest in new supply resources. The contemplated regulatory model would provide for timely recovery of all costs (including program costs, lost margins, and incentives) associated with the implementation of DSM and EE programs through an annual adjustment clause and rider; recovery of lost revenues experienced by the utility as a result of the implementation of DSM/EE programs; and provision of a financial incentive for the implementation of DSM/EE programs. Incentives may include sharing of savings achieved by the DSM/EE programs, or could be based on the capitalization of a percentage of avoided costs achieved by the programs. The CECAC has not endorsed any particular formula for sharing of avoided cost benefits between the utility and consumers.

ES-5. Nuclear Fuel Reprocessing

Nuclear power accounts for approximately 50% of the electricity produced in South Carolina. South Carolina currently has seven nuclear reactors, and new units are in the planning stages. Reprocessing spent nuclear fuel could significantly reduce the volume of high-level radioactive waste. Through reprocessing, the recovered uranium and plutonium can be recycled into new fuel for use in light-water-reactor fuel assemblies. This approach offers the benefits of significantly reducing the inventories of commercial spent nuclear fuel and plutonium, as well as reducing the total volume of waste requiring geologic disposal. However, a number of technical, economic, environmental, and other hurdles must be evaluated and overcome before nuclear waste reprocessing is a viable alternative for South Carolina.

Compared to most other states, South Carolina bears a burden for the environmental and health risks associated with the disposal of nuclear reprocessing waste. The state currently has a significant amount of nuclear waste for which there is no designated disposal site. South Carolina's support for in-state nuclear reprocessing should be contingent on the shipment of the waste out-of-state to an operating facility that is actively receiving nuclear waste for long-term disposal.

The CECAC unanimously recommends evaluation of the economic, environmental, waste reduction, national security, and other implications of nuclear waste reprocessing-recycling in South Carolina. If this evaluation shows that reprocessing and recycling of spent nuclear fuel are cost-effective and viable for South Carolina, this policy calls for expeditious implementation of applicable regulatory and legislative actions to support the construction of such facilities. South Carolina's support for in-state nuclear reprocessing should be contingent on a plan for the

shipment of the waste out of state to an operating facility that is actively receiving nuclear waste for long-term disposal.

ES-6. Green Power Purchases and Marketing, 1% Participation by 2012

The CECAC unanimously recommends establishing a voluntary program that offers a green power option to consumers throughout the state, supplementing the activities of existing voluntary green power programs in South Carolina (Palmetto Clean Energy and Santee Cooper Green Power). The green power purchases would be comprised of a variety of consumer-driven strategies to increase the production and delivery of low-GHG power sources. Participation in the program would provide support for marketing green power to consumers as well as financial incentives for the developers of renewable generation through state-funded green power initiatives coordinated by the South Carolina Energy Office.

The goals of this policy include educating consumers about the power (fuel) sources and emissions associated with the electricity they use; establishing a Voluntary Green Power Utility Program, to achieve 1%–5% participation of retail customers by 2012; and providing marketing and renewable resource development assistance through state-funded green power initiatives coordinated by the South Carolina Energy Office.

ES-7. Attract Renewable Energy Technology Businesses to South Carolina

Renewable energy has recently developed into an immediate and long-term growth industry. South Carolina can capitalize on this economic potential by working to attract companies that specialize in this industry. Incentives to attract renewable energy businesses should be designed to create South Carolina as a partner in the renewable energy market. Luring these types of businesses has become a primary economic target for many states, so competition will be tough.

The CECAC unanimously recommends that South Carolina develop a plan to attract businesses to the state, with the goal of creating an internationally respected renewable energy business cluster and becoming an obvious destination point for company facilities. Also, this policy seeks to create a strong local market for renewables, placing South Carolina in the top-five U.S. states for the number of new renewable energy installations per year per capita by 2012. Finally, this policy aims to place South Carolina as a leader in higher education and technical education for R&D and implementation of renewable technologies.

ES-8. Distributed Renewable Energy Incentives and/or Barrier Removal (Including Interconnection Rules)

Distributed renewable generation is energy generated at or near the sites of consumption by naturally replenishing resources, avoiding GHG emissions and the costs associated with conventional electricity supply and electricity losses during transmission and distribution. However, institutional and market barriers to distributed renewable energy are numerous, including inadequate information, institutional barriers to grid interconnection, high transaction and financing costs (e.g., due to lender unfamiliarity and perceived risk), interconnection rules

(e.g., standby fees, exit fees), pricing of net generation, and failure of the market to value the public benefits of renewable technologies and the social cost of fossil fuel technologies. While some of these barriers have been or are being addressed through recent or current financial and regulatory redresses and through information and public education campaigns, more remains to be done.

The CECAC unanimously recommends state action to identify all renewable energy sources that could lead to possible distributed generation options for residences and commercial and industrial facilities, as well as the uncertainties and risks associated with greater adoption of these resources. An additional goal of this policy is to identify and examine current and potential barriers impeding current and potential participants. Finally, this policy should provide specific incentives or policies that would eliminate or limit barriers and expand distributed generation in South Carolina.

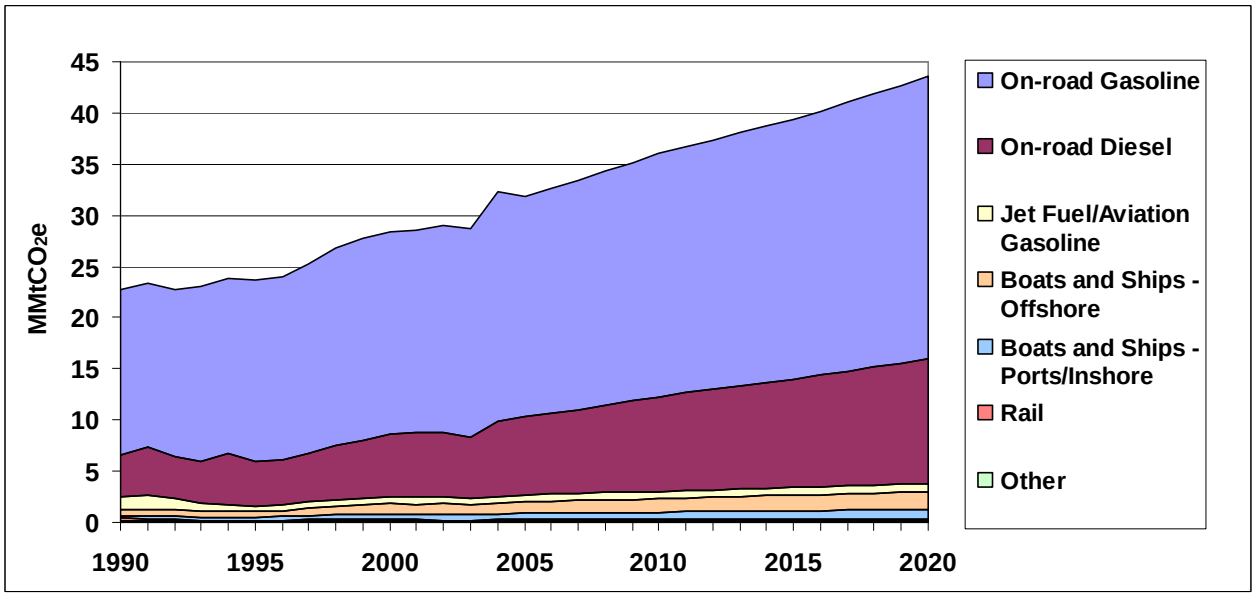
Chapter 6
Transportation and Land Use Sectors

Overview of Greenhouse Gas Emissions

The transportation sector is the second largest contributor to South Carolina's gross GHG emissions. In 2005, the sector accounted for 34%, or about 32 million metric tons of carbon dioxide equivalent ($MMtCO_2e$), of South Carolina's gross greenhouse gas (GHG) emissions. Emissions from the sector increased by 9.1 $MMtCO_2e$ between 1990 and 2005. Transportation's share of total GHG emissions has remained relatively constant over this period, accounting for about 35% of the state's net growth in gross GHG emissions. On-road gasoline vehicles account for the largest share of transportation emissions—about 68% in 2005. On-road diesel vehicles account for another 24% of emissions, and marine vessels account for roughly 6%. Air travel, rail, and other sources produce the remaining emissions.

Figure 6-1 shows historic and projected transportation GHG emissions by fuel and source. As a result of South Carolina's population and economic growth and an increase in total vehicle miles traveled (VMT), on-road gasoline consumption grew by 35% between 1990 and 2005. Meanwhile, on-road diesel use rose by 85% during that period, 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 at roughly historical rates to 2020. Total transportation emissions are projected to grow by 37%, or 11.8 $MMtC0_2e$, between 2005 and 2020.

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



The Energy Independence and Security Act of 2007 contains a provision to increase the corporate average fuel economy (CAFE) of light-duty vehicles (passenger cars and light trucks) to 35 miles per gallon by 2020. The Center for Climate Strategies (CCS) performed an analysis of this new policy to determine the resulting reduction in the business-as-usual (BAU) projected

transportation emissions in South Carolina, represented in Figure 6-1. This analysis estimated the number of vehicles on the road that would be affected by the new CAFE requirements, and then determined the amount of fuel saved by the efficiency improvements.

Table 6-1 compares the BAU emissions from on-road vehicles to emissions under the new CAFE requirements. By 2010, the new requirement will result in a decrease in emissions of 0.20 $MMtCO_2e$ annually. By 2020, the fuel efficiency improvements will reduce transportation emissions by 3.51 $MMtCO_2e$ annually, or 8.1% of total transportation GHG emissions.

Table 6-1. Historic and projected emissions for the transportation sector, including the impact of the new CAFE requirements ($MMtCO_2e$)

Transportation Mode	1990	1995	2000	2005	2010	2015	2020
On-road gas and diesel (BAU)	20.28	22.08	25.77	29.11	33.03	36.00	39.79
On-road gas and diesel (CAFE)	20.28	22.08	25.77	29.11	32.83	34.71	36.28
Emission reductions	0.00	0.00	0.00	0.00	0.20	1.29	3.51
Jet fuel/average gas	1.19	0.46	0.77	0.68	0.72	0.74	0.77
Boats and ship—ports/inshore	0.27	0.35	0.51	0.66	0.75	0.88	1.01
Boats and ships—offshore	0.57	0.59	1.02	1.12	1.33	1.53	1.74
Rail	0.30	0.07	0.16	0.12	0.12	0.12	0.12
Other	0.13	0.12	0.13	0.12	0.13	0.14	0.15
Total (BAU)	22.74	23.66	28.35	31.82	36.08	39.42	43.57
Total (CAFE)	22.74	23.66	28.35	31.82	35.88	38.13	40.06

Key Challenges and Opportunities

South Carolina 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 South Carolina 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 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 South Carolina, 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, 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 South Carolina is corn-based ethanol, which has minimal GHG benefit from a life-cycle perspective. Key determinants of impact will be the development and deployment of fuel types. At present, fuel distribution infrastructure is a constraining factor. South Carolina already offers incentive payments to retailers of alternative fuels. The state will also begin offering tax credits to purchasers of alternative-fuel and high-fuel-economy vehicles in the near future.

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, ridesharing, biking, and walking can contribute substantially to this goal. A variety of pricing polices 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 South Carolina Climate, Energy, and Commerce Advisory Committee (CECAC) recommends a set of 12 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:

- 5.5 $MMtCO_2e$ per year by 2020, and
- 29.3 $MMtCO_2e$ cumulative savings from 2008 through 2020.

The weighted-average cost of the recommended policies is \$88/$MMtCO_2e$. 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 6-2. The CECAC 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.

Technology options are an important component of the recommended policies. Notably, the Clean Car standards (TLU-1) must clear several hurdles before South Carolina or any other state can adopt it, including U.S. Environmental Protection Agency (EPA) approval of the original California Clean Car standards (that other states can then opt into). If for any reason South Carolina is not able to implement the Clean Car standards, other technology-based policy recommendations could play a larger role. For example, Tax Credits for Efficient Vehicles (TLU-3) can encourage consumers to buy the most efficient vehicles available on the market.

Some policies can improve the fuel economy of existing vehicles by changing their operating conditions. Transportation System Management (TLU-2) and Stricter Enforcement of Speed Limits (TLU-8) would help vehicles to travel closer to optimal speeds and thereby burn less fuel.

Other policies can promote technological improvements in the heavy-duty diesel fleet. TLU-7, Diesel Engine Emission Reductions and Fuel Efficiency Improvements, would regulate unnecessary idling by these vehicles and would promote technological alternatives to extended idling. Less idling means less fuel consumed.

Table 6-2. Summary list of TLU policy recommendations

No.	Policy Recommendation		GHG Reductions ($MMtCO_2e$)			Net Present Value 2008–2020 (Million $)	Cost-Effectiveness ($/tCO_2e$)	Level of Support
			2012	2020	Total 2008–2020			
TLU-1	Adopt South Carolina Clean Car Standards		0.21	1.14	7.04	–$323 to $1,598	–$46 to $227	Super Majority (Two objections)
TLU-2	Transportation System Management		0.01	0.04	0.22	< $0	< $0	Unanimous
TLU-3	Tax Credits for Efficient Vehicles		0.02	0.12	0.68	$244	$359	Unanimous
TLU-4	Improve Development Patterns		0.41	2.31	14.02	< $0	< $0	Unanimous
TLU-5	Transit & Bike-Pedestrian		0.02	0.02	0.22	–$1	–$1	Unanimous
TLU-6	Alternative-Fuel Infrastructure		0.02	0.24	0.77	$54	$70	Unanimous
TLU-7	Diesel Engine Emission Reductions and Fuel Efficiency Improvements	Efficiency Improvements	0.03	0.19	0.96	–$110	–$114	Unanimous
		Biodiesel	0.05	0.38	1.95	–$291 to $319	–$15 to $164	Super Majority (Two objections)
TLU-8	Stricter Enforcement of Speed Limits		0.10	0.12	1.18	Not quantified	Not quantified	Unanimous
TLU-9	Make Full Use of CMAQ Funds		Not quantified					Unanimous
TLU-10	Commuter Choice and Commuter Benefits Programs		0.12	0.43	2.63	–$631	–$240	Unanimous
TLU-12*	Low-GHG Fuel Standard		0.38	3.67	17.89	$20 to $3,276	$1 to $183	Super Majority (Two objections)
TLU-14	Rail		Not quantified					Unanimous
	Sector Total Before Adjusting for Overlaps		**1.37**	**8.64**	**47.57**	**Not quantified**		
	Sector Total After Adjusting for Overlaps**		**0.75**	**5.53**	**29.29**	**$2,582**	**$88**	
	Reductions From Recent Actions		**0.45**	**3.51**	**16.37**	**Not quantified**		
	Sector Total Plus Recent Actions		**1.20**	**9.04**	**45.66**	**$2,582**	**$88**	

GHG = greenhouse gas; MMtCO2e = million metric tons of carbon dioxide equivalent; $/tCO2e = dollars per metric ton of carbon dioxide equivalent; CMAQ = Congestion Mitigation and Air Quality; NQ = not quantified.

South Carolina can achieve greater alternative fuel use through a combination of voluntary and mandatory measures. The Low-GHG Fuel Standard (TLU-12) can increase the use of ethanol and biodiesel, and the policies recommended in Chapter 7 (Option AFW-4) can promote in-state production of these fuels through methods with lower lifecycle GHG emissions. The Low-GHG Fuel Standard would also promote the use of vehicles powered by electricity or hydrogen. When produced from renewable sources, these fuels can dramatically reduce GHG emissions. Tax Credits for Efficient Vehicles (TLU-3) and the promotion of expanded Alternative Fuel Infrastructure (TLU-6) would offer incentives to consumers and retailers to use more alternative fuels.

A number of policies would work together to reduce VMT by increasing the viability of multiple modes of travel and providing incentives to use modes other than single-occupant vehicles (SOVs). These policies will require increased coordination between state government, local government, and businesses in many cases. TLU-4 (Improve Development Patterns) presents the greatest institutional challenge. The promotion of more compact and mixed-use development patterns requires significant reform in local planning practices. Yet implementation of this policy is essential to make travel by walking, biking, and transit more feasible. In fact, transit use is on the rise nationwide and can be increased in many areas. TLU-5 (Transit & Bike-Pedestrian) and TLU-14 (Rail) would expand the infrastructure that supports travel by transit and other alternative modes. Commuter Choice and Commuter Benefits Programs (TLU-10), offered by employers to their employees, also promote use of transit as well as other alternatives to driving to work. Together these policies address the built environment, transportation infrastructure, and the behavior of individuals to reduce per capita VMT.

Finally, funding is always a challenge for transportation strategies and infrastructure improvements. TLU-9 (Make Full Use of CMAQ Funds) would ensure that South Carolina makes better use of federal funding to support some of the other options mentioned above.

Transportation and Land Use
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. Adopt South Carolina Clean Car Standards

This policy would reduce GHG emissions from new light-duty vehicles sold in South Carolina by adopting legislation to require a reduction in GHG emissions from new cars and light trucks sold in the state. The goal is to work with neighboring states and encourage participation in a regional clean car initiative that would incorporate the four main global warming pollutants: carbon dioxide (CO_2), methane, and nitrous oxide resulting directly from the operation of the vehicle (tailpipe emissions), as well as hydrofluorocarbon emissions resulting from leakage from or operation of the air conditioning system.

TLU-2. Transportation System Management

Transportation system management (TSM) improves vehicle flow on the roadway system, which can reduce fuel use and GHG emissions. Coordinated operation of the regional transportation network can improve system efficiency, reliability, and safety. Tools to reduce traffic congestion include high-occupancy vehicle lanes, improved mass transit services, roundabouts at intersections, synchronized signals, incident management, variable message signs, varying work schedules, and other forms of intelligent transportation systems.

This policy seeks to reduce emissions by 10% by 2020 in the most congested corridors in each of South Carolina's three largest metro areas—Charleston, Columbia, and Greenville. The goal would be achieved by implementing pilot TSM projects, including installation of fiber optic cable and computerized traffic control systems to coordinate signal timing in the corridor and transit service improvements like limited-stop or express bus service with traffic signal preemption equipment.

TLU-3. Tax Credits for Efficient Vehicles

The goal of this policy is to improve tax incentives in place for alternative-fuel and energy-efficient vehicles. Currently, two sales tax rebate programs are available in South Carolina: one is directed at in-state purchases of new, used, or leased low-GHG vehicles, while the other targets EPA-certified equipment that converts conventional vehicles to alternative-fuel vehicles. There are also two income tax credit programs in place: one is for in-state purchases of plug-in hybrid vehicles; the other is for alternative-fuel and hybrid vehicles, and is equal to 20% of the federal credit.

All of the available sales and income tax credits currently have annual cost caps. While these limits may not present a problem in the short run, as these vehicles become more common, it will be difficult to determine which buyers will be able to claim the rebate. This policy recommends removing the caps and phase-in periods associated with the sales and income tax programs mentioned above. Additionally, the income tax credit programs are to be restricted to vehicles that exceed the new federal CAFE requirements by at least 10%. This specification will ensure that the program incentivizes the purchase of vehicles that are more fuel efficient than the statewide average.

TLU-4. Improve Development Patterns

South Carolina is growing rapidly, and the location and design of development have substantial impacts on GHG emissions. Growth can be accommodated in a variety of ways that reduce emissions. The overall goal of this policy option is to help South Carolina grow in a way that protects the state's environment, climate, economy, and quality of life. Specifically, the effort will be to stabilize statewide VMT at today's levels by 2010 ("2010 VMT") by working with local governments. Each local government would be free to implement land-use tools that it determines are best suited for managing VMT within its respective jurisdiction. Such tools would be designed to promote more efficient development patterns by encouraging and promoting highly connected street networks, higher residential and employment densities, and mixed land uses in new and existing development.

TLU-5. Transit & Bike-Pedestrian

The goal of this policy recommendation is to enable personal trip making to move from SOVs to lower-GHG-emitting transportation options, such as walking, bicycling, ridesharing, and mass transit. Its implementation would ensure that the state's transportation system is fully integrated with and appropriately serves the development patterns called for under TLU-4. The goal will be accomplished by undertaking the following suite of activities:

- Expanding and improving bicycle and pedestrian networks and related facilities both as feeders and as stand-alone modes of travel in all areas of the state.
- Promoting and creating rideshare programs within the public and private sectors.
- Improving and expanding the state's existing network of mass transit systems and services.
- Implementing "complete streets" policies to ensure that all new roadways and streets accommodate all modes of personal transportation where practical and feasible.

TLU-6. Alternative-Fuel Infrastructure

This policy seeks to increase market penetration of alternative fuels in South Carolina through accelerated development of an alternative-fuel infrastructure. Potential measures include establishing storage and distribution systems, connecting key corridors in the Southeast to offset the expense of equipment and installation, and establishing stations offering alternative fuels at

competitive prices in convenient locations. Alternative fuels include ethanol, biodiesel, compressed natural gas, propane, electricity, and hydrogen. This policy will reduce GHG emissions by providing consumers increased access to cleaner-burning alternative fuels.

This recommendation supports the implementation of the TLU-12 (Low-GHG Fuel Standard) goal of decreasing the net life-cycle carbon in South Carolina's total transportation fuels by 10% in 2020.

TLU-7. Diesel Engine Emission Reductions and Fuel Efficiency Improvements

This policy would reduce diesel emissions and the use of diesel fuel in the public and private sectors, both on- and off-road, by promoting a variety of technology practices that provide alternatives to or greater efficiency in diesel fuel use. This policy has the collateral benefits of improving air quality and reducing exposure to air toxics. Specifically, this it calls for continued implementation of existing state programs and the support of new state programs that are designed to

- Broaden use of anti-idling technologies currently available but not widely used for locomotives, trucks, and other diesel engines;
- Substitute engine rebuilds, repowers, and replacements with more fuel-efficient engines or add-on technologies;
- Develop technologies to reduce rolling resistance (such as single-wide tires), low-viscosity lubricants, weight reduction, and improvements to aerodynamics;
- Augment or replace petroleum fuel use with biodiesel, biogas, natural gas, or other low-carbon fuels; and
- Replace freight-handling equipment with battery electric, hybrid, or plug-in electric hybrid equipment.

TLU-8. Stricter Enforcement of Speed Limits

Reduced vehicle speeds can improve fuel economy, reduce CO_2 emissions, and improve safety. In many cases, vehicle speeds could be reduced by increased enforcement of existing speed limits. Significant enforcement resources spread among multiple government units may be needed for this measure to achieve the expected reductions. South Carolina has a goal of reducing the average speed of speeding vehicles by 5 miles per hour (mph) on all highways and major speedways, thereby reducing emissions. Reducing speed to 55 mph on highways typically improves fuel efficiency in both light- and heavy-duty vehicles.[1,2]

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[1] Greg Dierkers et al. *CCAP Transportation Emissions Guidebook—Part One: Land Use, Transit & Travel Demand Management*. Guidebook Emissions Calculator. Washington, DC: Center for Clean Air Policy, Available at: www.ccap.org/guidebook.

[2] Cummins. "Every Drop: Secrets of Better Fuel Economy." 2006. Available at: http://www.kenworth.com.au/kenworth/pdf/Cummins_Fuel_Economy_Guide.pdf.

TLU-9. Make Full Use of CMAQ Funds

This recommendation would fully allocate all Congestion Mitigation and Air Quality (CMAQ) funding to reduce transportation-related emissions and fund various emission reduction strategies with emphasis on projects that reduce GHGs. It would also facilitate funding of local matches to support selection and implementation of high-GHG-impact projects. This goal can be met by:

- Responsively expending all CMAQ funds allocated to the state to reduce emissions in accordance with federal guidelines;
- Investing in projects and programs that reduce air pollutants in nonattainment and maintenance areas;[3]
- Quantifying emission reductions to establish prioritization of projects;
- Including public participation in diversifying projects that reduce GHG emissions; and
- Increasing public awareness concerning statewide strategies to reduce congestion and emissions.

This policy has not been quantified because it does not specify any particular types of projects or programs. It is expected to support the achievements of emission reductions under other policies, including TLU-2 (Transportation System Management), TLU-4 (Improve Development Patterns), and TLU-5 (Transit & Bike Pedestrian).

TLU-10. Commuter Choice and Commuter Benefits Programs

This policy has a goal of enabling all employers in the state with over 50 employees to provide options for employees to reduce SOV commutes and GHG emissions. Commuter Benefits programs provide employees with alternative transportation options and incentives under programs, such as

- Employers contracting with transit agencies to provide service directly to employment centers,
- Carpools,
- Pre-tax transit fare programs,
- Parking cash-out programs, and
- Guaranteed ride-home service.

Under these Commuter Benefits options, the total number of employee commuter trips would not be reduced. Rather, the trips would be consolidated into fewer vehicles and thereby decrease total VMT.

[3] Nonattainment and maintenance areas are designated relative to pollutant thresholds set by the U.S. Environmental Protection Agency in compliance with the Clean Air Act.

Commuter Choice programs, on the other hand, are designed to reduce total employee trips by substituting telecommuting for trips to and from a place of employment. The telecommuting option includes the development and use of neighborhood telecommuting centers that offer office-type services in locations close to commuters' residences.

The programs and actions recommended under this policy complement the programs and actions recommended under TLU-4 (Improve Development Patterns) and TLU-5 (Transit & Bike-Pedestrian).

TLU-12. Low-GHG Fuel Standard

This policy seeks to reduce GHG emissions by decreasing the carbon intensity of all passenger vehicle fuels sold in the state. To this end, South Carolina should observe the California plan to reduce GHG fuel emissions as it is put into practice and note the real-world successes and failures of that template. Low-carbon fuels include biodiesel, cellulosic ethanol, hydrogen, compressed natural gas, liquefied petroleum gas, and electricity.

The California standard measures fuels' carbon impacts on a life-cycle basis, in order to include all emissions from fuel production to consumption. Fuel providers (defined as refiners, importers, and blenders of on-road vehicle fuels) will demonstrate annually that their fuel mixtures provided to the market meet the low-carbon standard. Options for compliance may include blending or selling increasing amounts of lower-carbon fuels, using previously banked credits, and purchasing credits from fuel providers who earned credits by exceeding the standard. Penalties for noncompliance will be determined during the implementation process.

A low-GHG fuel standard in South Carolina must take into consideration the state's dependence on Gulf Coast refineries and on the existing transportation system via two major pipelines originating in the Gulf and terminating in New York Harbor. Incentivizing the production, development, and marketing of low-GHG fuels should continue and will promote their availability and use. With respect to the state's dependence on Gulf Coast refineries and on existing transportation systems, producing alternative fuels within the state and encouraging further in-state production of these fuels as much as possible has multiple economic benefits (e.g. job creation).

There is also a need to acknowledge regional assets in the development of specific fuels and to use the state's resources to stimulate technological innovation to further develop these fuels.

TLU-14. Plan for Enhanced Rail

Rail transport is one of the most energy-efficient means to move people and freight over commonly traveled routes on land. Improved freight rail service and new passenger rail services have the potential to reduce overall GHG emissions, compared to movement by highway. Technology improvements, such as anti-idle devices and more efficient engines, can reduce direct emissions from locomotives operating on the rail network. A robust and efficient rail network can play a key role in sustaining South Carolina's economy under future carbon emission constraints, while providing many social, economic, and environmental benefits.

Because a detailed and comprehensive analysis of South Carolina's rail system and its role in the movement of people and goods does not currently exist, the CECAC does not have sufficient information to develop specific policy recommendations for the rail system. Therefore, the CECAC recommends that South Carolina immediately undertake a detailed and comprehensive analysis of the state's rail system.

This policy is not quantified, as its goal is to determine the potential for expanding rail.

Chapter 7
Agriculture, Forestry, and Waste Management Sectors

Overview of Greenhouse Gas Emissions

The agriculture, forestry, and waste management (AFW) sectors are directly responsible for moderate amounts of South Carolina's current greenhouse gas (GHG) emissions. However, it is important to note that emissions from fossil fuel combustion in the AFW sectors are included in the industrial fossil fuel combustion and transportation sectors; hence, the emissions included here are *primarily* noncombustion GHG emissions (with the exception of some combustion in the waste management sector).

The total agriculture sector contribution to carbon dioxide-equivalent (CO_2e) gross emissions in 2005 was 3.0 million metric tons (MMt), or about 3% of the state's total. Agricultural emissions include methane (CH_4) and nitrous oxide (N_2O) emissions from enteric fermentation, manure management, agriculture soils, and agriculture residue burning. As shown in Figure 7-1, CH_4 emissions from manure management and enteric fermentation both make significant contributions to the sector totals. Agriculture sector emissions shown in the chart also include N_2O emissions resulting from activities that increase nitrogen in the soil, including fertilizer (synthetic, organic, and livestock) application, crop residues, and production of nitrogen-fixing crops (legumes). Not shown in the chart are CO_2 emissions from oxidized soil carbon (0.18 $MMtCO_2$ for all years based on a single 1997 estimate).

There is a very small amount of agricultural burning activity in South Carolina; however, the emissions are too small to be seen in Figure 6-1. Overall, emissions from the agriculture sector have declined slightly through the inventory period, and are estimated to remain fairly constant through the 2020 forecast period.

Forestland emissions refer primarily to the net CO_2 flux[1] from forested lands and urban forests in South Carolina (forests account for about 66% of the state's land area). As shown in Table 7-1, data suggest that South Carolina forests are net sinks of CO_2 and sequestered an average of over 30 $MMtCO_2e$ per year from 1990 to 2005. Hence, during this period in the forested landscape, carbon losses due to forest conversion, wildfire, and disease were estimated to be smaller than the CO_2 sequestered in forest carbon pools, such as live trees, debris on the forest floor, and forest soils, as well as in harvested wood products (e.g., furniture and lumber) and the landfilling of forest products.

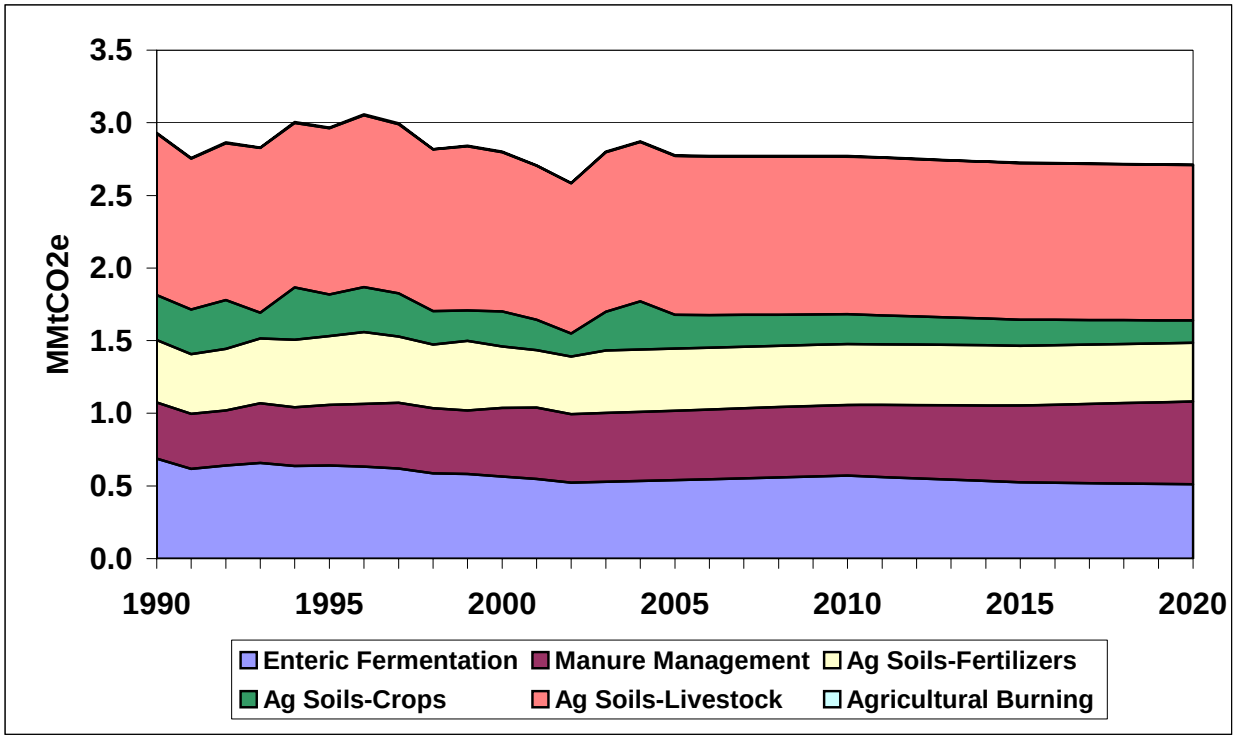
Note that, in keeping with U.S. Environmental Protection Agency (EPA) methods and international reporting conventions, the South Carolina inventory and forecast (I&F) report covers anthropogenic sources of GHGs.[2] There could be some natural sources of GHGs that are not represented in the I&F; however, these are not addressed in the Climate, Energy, and

[1] "Flux" refers to both emissions of CO_2 to the atmosphere and removal (sinks) of CO_2 from the atmosphere.

[2] Center for Climate Strategies. *Final South Carolina Greenhouse Gas Inventory and Reference Case Projections: 1990–2020*. Prepared for the Climate, Energy, and Commerce Advisory Committee of the Office of the Governor of South Carolina. June 2008. Available at: http://www.scclimatechange.us/Inventory_Forecast_Report.cfm.

Commerce Advisory Committee (CECAC) process. In the forestry sector, all emissions are treated as anthropogenic, since all of the state's forests are managed in some way (GHG reporting conventions are to treat all managed forests as anthropogenic sources). Such sources as CO_2 from forest fires and decomposing biomass are captured within the I&F (as part of the carbon stock modeling performed by the U.S. Forest Service [USFS]). However, CH_4 emissions from anaerobic decomposition of biomass in forests are not currently captured due to a lack of data. Emissions of CH_4 and N_2O from fires are estimated separately from CO_2 emissions. As noted in the I&F report, these emissions were not estimated for South Carolina; however, they are expected to be small relative to the estimated carbon sequestration rates.

Figure 7-1. Historical and projected emissions from the Agriculture Sector, 1990–2020



$MMtCO_2e$ = million metric tons of carbon dioxide equivalent; LF = landfill; WW = wastewater; LFGTE = landfill gas to energy.

Source: Calculations based on the approach described in *Final South Carolina Greenhouse Gas Inventory and Reference Case Projections: 1990–2020*. This chart does not show an additional 0.18 $MMtCO_2e$ in emissions due to soil carbon losses for each year based on available data.

Notes: Ag Soils–Crops category includes: incorporation of crop residues and nitrogen-fixing crops; Ag Soils–Fertilizers category includes emissions from commercial fertilizer application; Ag Soils–Livestock category includes emissions from manure application. Emissions for agricultural residue burning are too small to be seen in this chart.

Table 7-1. GHG emissions (sinks) from the forestry sector

Subsector	1990	1995	2000	2005	2010	2020
Forested landscape (excluding soil carbon)	–28.8	–28.8	–28.8	–28.8	–28.8	–28.8
Urban forestry and land use	–4.38	–2.88	–2.24	–2.46	–2.46	–2.46
Sector total	–33.2	–31.7	–31.0	–31.2	–31.2	–31.2

Note: Negative numbers indicate net sequestration. Based on USFS input, emissions from soil organic carbon are left out of the forestry sector summary due to a high level of uncertainty.

Carbon is also estimated to be sequestered in South Carolina's urban forests. For the urban forestry and land-use sector, these include the net CO_2e emissions from carbon stored in urban trees, carbon stored in landfilled yard and food wastes, and N_2O emissions from fertilizer application. These rates of sequestration in the forestry sector (both urban and forested landscape) are assumed to remain constant through 2020. By including forestry sector sequestration in the inventory, total South Carolina gross GHG emissions in 2005 of 93.5 $MMtCO_2e$ are lowered to 62.3 $MMtCO_2e$ on a net basis.

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_4 emitted from landfills, while emissions from wastewater treatment include both CH_4 and N_2O. Smaller amounts of GHGs are also emitted during the combustion of solid waste. As shown in Figure 7-2, the largest contributions in the waste management sector come from uncontrolled landfills (about 64% in 2005), although these sites are projected to contribute lower levels in the future as more of the state's wastes are directed to controlled sites. Overall, the waste management sector accounts for about 3% of South Carolina's total gross emissions per year from 1990 through 2020.

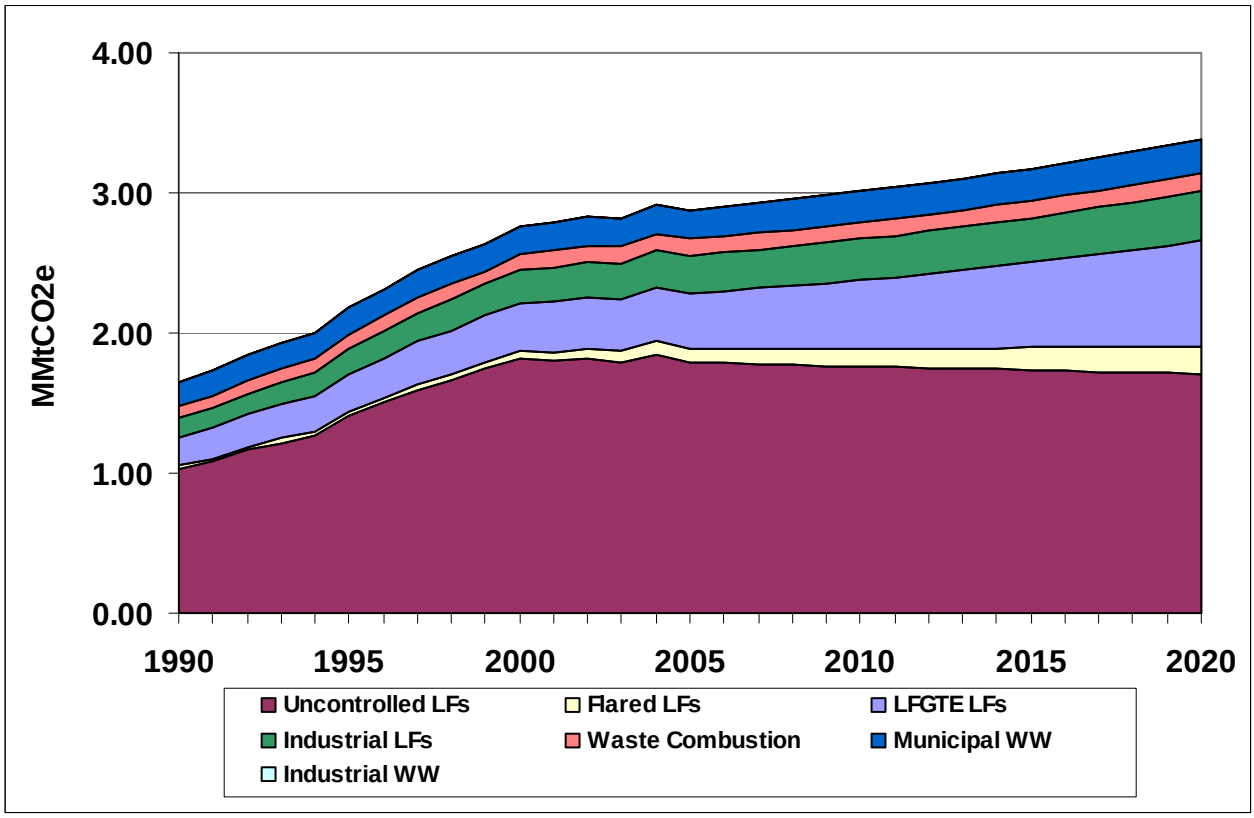
The CECAC acknowledges that there are higher levels of uncertainty in the GHG emissions and forecasts in the AFW sectors compared to those in other GHG sectors (e.g., those where emissions are tied directly to energy consumption). There is a need for continued investment in research and measurement to refine the AFW I&F (details on key uncertainties are presented in the appendices of the I&F report).

Opportunities for GHG mitigation in the AFW sectors involve measures that can reduce emissions within the sector or reduce emissions in other sectors. For example, within the agriculture sector, changes in crop management practices can reduce GHG emissions by building soil carbon (indirectly sequestering carbon from the atmosphere). Similarly, additional collection and control of landfill methane can reduce emissions from the waste management sector, and reforestation projects can achieve GHG reductions by increasing the carbon sequestration capacity of the state's forests.

For GHG reductions outside of the AFW sector, actions taken within the sector, such as production of liquid biofuels, can offset fossil fuel emissions in the transportation sector, while biomass energy can reduce fossil fuel emissions in the energy supply (ES) or residential, commercial, and industrial (RCI) sectors. Similarly, actions that promote solid waste reduction or recycling can reduce emissions within the sector (future landfill CH_4), as well as emissions

associated with the production of recycled products (recycled products often require less energy to produce than similar products from virgin materials). Finally, urban forestry projects can reduce energy consumption within buildings through shading and wind protection. Many of the mitigation actions in the AFW sectors can achieve reductions both within and outside of both the AFW sector and state boundaries.

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



$MMtCO_2e$ = million metric tons of carbon dioxide equivalent; LF = landfill; WW = wastewater; LFGTE = landfill gas to energy.

Following are primary opportunities for GHG mitigation identified by the CECAC.

- **Agricultural crop cultivation:** Implement programs that incentivize growers to utilize cultivation practices that build soil carbon and indirectly sequester CO_2 from the atmosphere. These practices, such as no-till cultivation, also often offer opportunities to reduce fossil fuel consumption.
- **Production of liquid biofuels:** Production of renewable fuels, such as ethanol from 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 on a life-cycle basis.

Production incentives could position the state's future biofuels industry to supply states with low-carbon fuel standards, including potentially South Carolina (see TLU-12).

- **Expanded use of forest and agricultural biomass:** Expanded use of biomass energy from residue removed from forested areas during treatments to reduce fire risk, crop residues, or purpose-grown crops 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 of ES-1.
- **Enhancement/protection of forest carbon sinks:** Through a variety of programs, enhanced levels of CO_2 sequestration can be achieved and carbon can be stored in the state's forest biomass. These include reforestation programs, management programs directed at increased sequestration and forest carbon protection, and urban tree programs. Programs aimed at reducing the conversion of forested lands to nonforest cover will also be important to maintain the sequestration capacity of these lands.
- **Changes in municipal solid waste management practices and wastewater treatment efficiency programs:** By concentrating on enhancing the recycling and composting practices in the state, significant GHG emission reductions can be achieved. Also, for waste remaining after full implementation of these "front-end" practices, additional projects are needed to collect and capture methane from biodegradable wastes that are still to be emplaced within the state's landfills. Beneficial use of this methane could achieve additional benefits by offsetting fossil fuel sources. Since wastewater treatment is an energy-intensive process, efficiency programs at wastewater treatment plants can achieve significant GHG reductions by lowering electricity consumption at these sites.

Key Challenges and Opportunities

In the agriculture sector, the CECAC found significant opportunity in promoting biofuel production using feedstocks and production methods with superior GHG benefits (e.g., current conventional corn-based ethanol). When biofuels are used to displace fossil fuels with higher life-cycle carbon contents, net GHG benefits can be achieved. The combined benefits of AFW-4a (ethanol production) and 4b (biodiesel production) are cumulative reductions of more than 1.6 $MMtCO_2e$ annually by 2020.

It should be noted that the estimated GHG benefits did not include any indirect impacts associated with emissions resulting from land-use change.[3] For ethanol production, the recommendations include incentives only for cellulosic ethanol from biomass, not for starch-based ethanol production. Hence, the indirect impacts associated with potential land-use change don't appear to be an issue. For biodiesel production, some of the feedstocks are likely to come from crop oils that also serve as food (e.g., soybean oil, other vegetable oils), especially during

[3] Recent research has indicated that incorporating land conversion impacts into GHG analysis may remove any GHG benefits from biofuels production from crops (e.g., corn to ethanol in the United States leading to land conversion for planting crops in developing countries to make up for the loss of available export food crops). See: T. Searchinger et al. "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.

the early years of implementation. To limit these potential impacts, incentives for research and development, pilot plants, and commercial-scale production will be needed to establish in-state production capacity from new and emerging technologies (cellulosic ethanol, algal biodiesel, gasification, etc.). For the purposes of estimating GHG benefits, it was assumed that these technologies are commercially viable during the policy period.

Future work on the biofuels recommendations should assess the potential for significant impacts on the availability of land, biomass, and water, as well as the consequences for food production, economic feasibility, and changes in overall fuel costs. These issues should be studied in coordination with the recommendations under TLU-12 on the low-GHG fuel standard.

It should be noted that there is significant overlap in benefits of AFW-4a and 4b with the TLU-12 low-GHG fuel standard. However, the CECAC recognizes the need for programs to promote in-state biofuels production (TLU-12 focuses more on the demand side of biofuels).[4] Examples of biofuels that could be produced with much better GHG impacts include ethanol from cellulosic hydrolysis of biomass. Feedstocks for the fiber needed for this recommendation could come from crop residue, energy crops, forestry residue, municipal solid waste biomass, or other sources. A major challenge for the success of AFW-3 is the production of a viable commercial-scale cellulosic ethanol and biodiesel industry by 2015.

CECAC recommendation AFW-5 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 almost 5 $MMtCO_2e$ annually by 2020. The CECAC conducted a limited assessment of the available biomass resources in the state, which indicated that sufficient resources were available through 2020 to achieve the goals for both the liquid biofuels recommendation above and this biomass for energy recommendation. Research on sustainable harvest standards is also needed with resulting yields potentially affecting the estimated available quantities. Although the initial assessments show sufficient resources to meet the CECAC's biomass policies, a number of variables are not taken into consideration, including the assumption that all land currently available for biomass production will still be available in 2012 and 2020, the assumption that all available biomass can actually collected feasibly, and the impact of future climate conditions. It will also be necessary to analyze the impact of biomass harvest on plant nutrient removal in both agricultural and forest systems.

Within both the agriculture and forestry sectors, the CECAC also recommends programs to promote terrestrial carbon sequestration (AFW-6). These recommendations cover soil carbon management programs in agriculture to increase soil carbon levels, thereby indirectly sequestering carbon from the atmosphere. Within the forestry sector, there are three separate recommendations covering forest management programs for carbon sequestration, afforestation/reforestation programs, and urban forestry. Combined with the agriculture soil carbon recommendation, these three forestry sector recommendations are estimated to deliver over 4.8 $MMtCO_2e$ in GHG reductions annually by 2020.

[4] The overlap in GHG benefits between AFW recommendations and recommendations in other sectors has been removed in the sector-level totals used to estimate the overall reductions for the CECAC process.

The forest management recommendation to promote terrestrial carbon sequestration seeks to increase the rates of carbon sequestration in the state's forests through a variety of management approaches. These could include increased stocking of poorly stocked lands, age extension of managed stands, thinning and density management, fertilization and waste recycling, expanded short-rotation woody crops (for fiber and energy), expanded use of genetically preferred species, modified biomass removal practices, fire management and risk reduction, and pest and disease management. The afforestation/reforestation recommendation targets establishing forests on 1.4 million acres of land suitable for these projects. The key challenge with this recommendation is the identification of land both suitable and available for these projects. This recommendation along with the urban forestry recommendation will expand the state's forest base, leading to higher levels of future carbon sequestration. The urban forestry component also has the potential to reduce fossil fuel consumption through shading and wind protection of homes and commercial buildings.

Land use management approaches to carbon management in the agriculture and forestry sectors are also recommended to protect existing above- and below-ground carbon stocks (AFW-7a and b). By preserving agricultural and forested lands, the CECAC estimates GHG savings in 2020 of 3.3 $MMtCO_2e$. To achieve these reductions, the state will need to work closely with local planning agencies, land owners, and nongovernmental organizations to identify lands suitable for acquisition/conservation easements and funding mechanisms. Another benefit from these policies, which was not quantified, is the reduction in vehicle miles traveled (VMT) due to more efficient development patterns that should result as the lands around the urban fringe are protected (see TLU-4).

AFW-8 and AFW-9 provide an integrated set of recommendations for future management of municipal solid waste in South Carolina. AFW-8 focuses on "front-end" waste management technologies: recycling and composting. AFW-8 focuses on reducing landfill methane emissions. The recommendations for AFW-8 represent a significant change from business-as-usual (BAU) waste management in the state: for recycling, a 35% recycling rate should be achieved by 2020, compared to current levels of about 25%; and for composting, a rate of 10% by 2020, compared to current levels of about 6%. The recycling and composting elements of AFW-7 are estimated to reduce GHGs by 3.0 $MMtCO_2e$ annually by 2020. These reductions include avoided landfill GHG emissions, as well as avoided product and packaging life-cycle GHG emissions from the use of recycled products and packaging versus those created from virgin materials. The landfill gas recommendations under AFW-8 are estimated to reduce GHGs by 1.0 $MMtCO_2e$ by 2020.

Although AFW-8 is estimated to achieve a net cost savings, successful implementation will require waste management infrastructure investment by communities in the form of material recovery facilities and composting operations. Cost savings result from avoided landfill fees and the addition of the value of recycled or composted materials. New markets for recycled commodities will need to be established.

Additional CECAC recommendations cover energy efficiency programs covering on-farm operations and wastewater treatment plants (AFW-1 and AFW-10). These recommendations will require sources of up-front capital for implementation, but are also estimated to result in a net cost savings, once energy reductions are taken into account. Combined GHG reductions for these energy efficiency options are estimated to be over 0.3 $MMtCO_2e$ annually by 2020. A final set of

recommendations covers energy recovery projects on swine, dairy, and poultry operations (AFW-2a and b). These recommendations are estimated to produce GHG reductions of 0.05 $MMtCO_2e$, with low to negative societal costs.

Overview of Policy Recommendations and Estimated Impacts

As noted above, the 10 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 7-2.

Table 7-2. Summary list of policy recommendations

No.	Policy Recommendation	GHG Reductions ($MMtCO_2e$)			Net Present Value 2008–2020 (Million $)	Cost-Effectiveness ($/tCO_2e$)	Level of Support
		2012	2020	Total 2008–2020			
AFW-1*	On-Farm Energy Efficiency	0.052	0.16	1.0	–$43	–$41	Unanimous
AFW-2a	On-Farm Waste Energy Recovery—Swine/Dairy	0.006	0.019	0.13	$0.58	$5	Unanimous
AFW-2b†	On-Farm Waste Energy Recovery—Poultry Litter	0.010	0.031	0.20	–$3.2	–$16	Unanimous
AFW-3	Expanded Use of Local Agricultural Products	0.012	0.030	0.21	Not Quantified	Not Quantified	Unanimous
AFW-4a†,‡	In-State Liquid Biofuels Production—Biodiesel	0.12	0.13	1.5	$26	$17	Unanimous
AFW-4b†	In-State Liquid Biofuels Production—Ethanol	0.86	1.5	13	$281	$22	Unanimous
AFW-5‖	Expanded Use of Biomass Feedstocks for Electricity, Heat, or Steam Production	2.7	4.9	41	$156	$4	Unanimous
AFW-6a	Terrestrial Carbon Sequestration—Agriculture	0.21	0.39	3.1	–$191	–$62	Unanimous
AFW-6bi	Terrestrial Carbon Sequestration—Forestry: Forest Management	0.33	0.85	5.8	$53	$9	Unanimous
AFW-6bii	Terrestrial Carbon Sequestration—Forestry: Afforestation/Reforestation	0.81	2.4	16	$158	$10	Unanimous
AFW-6biii¶	Terrestrial Carbon Sequestration—Forestry: Urban Forestry	0.37	1.2	7.5	$456	$60	Unanimous
AFW-7a	Conservation and Restoration of Agriculture Lands for Enhanced Carbon Sequestration	0.080	0.21	1.5	$54	$37	Unanimous
AFW-7b	Conservation and Restoration of Forestlands for Enhanced Carbon Sequestration	0.42	3.1	16	$117	$7	Unanimous
AFW-8	Advanced Recycling and Composting	1.18	3.0	20	–$44	–$2	Unanimous
AFW-9‖	Waste-to-Energy Reclamation	0.41	1.0	7.2	$0.23	$0.03	Unanimous
AFW-10*	Water and Wastewater Energy Efficiency Improvements	0.16	0.18	1.6	–$33	–$21	Unanimous
	Sector Total After Adjusting for Overlaps**	**7.8**	**19.2**	**135**	**$987**	**$7**	
	Reductions From Recent Actions	**—**	**—**	**—**	**—**	**—**	
	Sector Total Plus Recent Actions**	**7.8**	**19.2**	**135**	**$987**	**$7**	

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent.

All costs are reported in 2005 U.S. dollars, net present value as of January 1, 2009. 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 numbering used to denote the above policy recommendations is for reference purposes only; it does not reflect prioritization among these policy recommendations.

* AFW-1 and AFW-10 may overlap with RCI-6 (Residential, Commercial, and Industrial). However, for reasons stated in the documentation of AFW-1 and AFW-10, no overlap will be counted.

† AFW-4 overlaps with TLU-12 (Transportation and Land Use). This overlap will be accounted for in the cumulative analysis of the TLU options.

‡ AFW-4 biodiesel targets were unachievable with in-state feedstock supplies. These reductions and costs refer to modified goals based on in-state feedstock. See text under AFW-4.

|| AFW-2, AFW-5, and AFW-9 overlap with ES-1 (Energy Supply). These overlaps will be accounted for in the cumulative analysis of the ES options.

¶ AFW-6biii represents the combined costs and benefits of two elements of urban forestry: tree planting and avoided deforestation. The net cost of avoided deforestation was not quantified because of insufficient information regarding the costs of such programs.

** The totals may not equal the sum of rows because of independent rounding. The cost-effectiveness totals represent the total net present value divided by the cumulative (2008–2020) GHG reductions for those options for which quantitative cost analyses were performed (i.e., excludes AFW-3).

Agriculture, Forestry, and Waste Management Sector Policy Descriptions

The agriculture, forestry, and waste management sectors include emission mitigation opportunities related to the use of biomass energy, protection and enhancement of forest and agricultural carbon sinks, production of renewable liquid fuels, production of additional biomass energy, forestation on nonforested lands, and an increase in municipal solid waste recycling, composting, and landfill gas collection.

AFW-1. On-Farm Energy Efficiency

Renewable energy may be produced and used on site at individual agricultural operations or regionally through farm cooperatives to achieve better economies of scale. For example, on-farm production and use of solar heating and biofuels will reduce CO_2 emissions by displacing the use of fossil-based fuels.

Energy conservation for agricultural operations will result in increased efficiency. For example, improved irrigation systems save both water and energy, and expanded use of precision-agriculture systems will also reduce fossil fuel use.

GHG benefits can also be achieved indirectly through better use of organic fertilizers (manure) to offset commercial fertilizers, which require intensive energy inputs for production, transportation, and application. These indirect (life-cycle) benefits are covered within recommendation AFW-6a (Soil Carbon Management—Agriculture).

Note: This AFW policy recommendation is related to RCI-6 (Incentives and Policies for Improving Building Efficiency, Including Building Energy Codes). However, as the AFW-1 mechanism is not prescriptive as to where the electricity reductions must come from, no overlap between these two options is counted.

AFW-2. Farm By-Products Energy Recovery

This policy would reduce both methane emissions from livestock manure by installing manure digesters on livestock operations, and the amount of excess nitrogen applied to crops from poultry litter by promoting gasification, pyrolysis, and other thermochemical conversion methods for energy recovery.

Energy from manure digesters is used to create heat or power, which offsets fossil fuel-based energy production and the associated GHG emissions. Thermochemical conversion and other methods of waste-to-energy conversion may be more advantageous than anaerobic digestion. Energy from these processes will also reduce GHG emissions and may be used to produce synthesis gas and hydrocarbon fuels. As with AFW-1, these energy-recovery projects can be implemented at individual livestock operations or collectively at groups of operations to achieve better economies of scale.

Note: This policy is related to ES-1 (Efficiency and Renewable Portfolio Standard and Statement of Support for New Nuclear Energy). Any overlap with the ES policy is addressed in the ES cumulative analysis. No GHG benefits have been subtracted from the AFW cumulative analysis.

AFW-3. Expanded Use of Local Farm Products

This policy promotes the production and consumption of locally produced agricultural commodities, which displace the consumption of commodities transported from other states or countries. GHG reductions occur from reduced transportation-related emissions and from local farms that utilize GHG reduction practices that may not be instituted in other states or countries.

AFW-4. In-State Liquid Biofuels Production

The ultimate goal of South Carolina is to take full advantage of resources available in the state through agriculture, forestry, or other biomass feedstocks to displace the use of fossil fuels. South Carolina is in an excellent position to develop an in-state alternative fuels industry that will provide economic opportunities for rural communities looking for alternatives to fading tobacco and cotton industries. Policies must be developed in South Carolina that will attract farmers, investors, retailers, and purchasers to produce and use the fuels in the state. The focus of this policy should be in-state biofuels production based on in-state feedstocks.

Efforts on the part of farmers in growing and processing biocrops into biodiesel fuel for on-farm use should be encouraged, and the farmers and/or those who make biodiesel on their behalf should qualify for available state fuel-making incentives.

In 2006 and 2007, South Carolina passed attractive incentives to promote and expand this industry. To date, the incentives have been effective, and have generated a great deal of interest within the alternative-fuels industry. Other potential incentives for alternative-fuel producers include expanding existing tax credits for biodiesel and ethanol to include other low-GHG future fuels, such as butanol and hydrogen.

Note: This policy is related to TLU-12 (Low-GHG Fuel Standard) and TLU-6 (Alternative-Fuel Infrastructure), which promote public consumption of alternative fuels. This policy seeks to achieve incremental GHG benefits beyond the TLU policies by promoting in-state production of biofuels using feedstocks with greater GHG benefits than the likely BAU national production methods. Any overlap with the TLU policies is addressed in the TLU cumulative analysis. No GHG benefits have been subtracted from the AFW cumulative analysis for AFW-4.

AFW-5. Expanded Production of In-State Biomass for Electricity, Heat, or Steam Production

This policy proposes to offset fossil fuel use with production of electricity, steam, and heat from biomass resources, and to provide incentives for the development of new biomass production and collection infrastructure, as well as incentives for energy end users that are equitable throughout the economy. Local electricity, heat, or steam production yields the greatest net energy payoff. According to a recent study for the Central Electric Power Cooperative, South Carolina currently

has 360 MW of installed capacity for woody biomass.[5] Based on available wood and agriculture residue inventories, as well as energy crop production potential, South Carolina has the ability to more than double its current level of biomass production.

The focus of this policy is on programs needed to increase the availability of biomass feedstocks for in-state use. Policies to encourage use of this resource are addressed within the ES recommendations.

Note: This policy is related to ES-1 (Study the Energy Options for Portfolio Standards). Any overlap with the ES recommendation is addressed in the ES cumulative analysis. No GHG benefits have been subtracted from the AFW cumulative analysis.

AFW-6. Terrestrial Carbon Sequestration

AFW-6a. Terrestrial Carbon Sequestration—Agriculture

This policy considers four components of improved soil carbon management: alternative cultivation practices, manure management practices, crop conversion to increase sequestration potential, and rotational grazing.

The amount of carbon stored in the soil can be increased by adopting such practices as conservation-till and no-till cultivation, cover cropping, and application of biochar (i.e., charcoal) and compost. Reducing summer fallow and increasing winter cover crops are complementary practices that reduce the need for conventional tillage. The application of biochar and compost increases soil carbon content, stabilizes soil carbon, enhances drought resistance, and may improve production by boosting soil dynamics. By reducing mechanical soil disturbance, these practices reduce the oxidation of soil carbon compounds and allow more stable aggregates to form. Other benefits include reduced wind and water erosion, reduced fuel consumption, and improved wildlife habitat.

Additionally, manure management practices may reduce GHG emissions associated with manure handling and storage. Potential practices may include composting of manure (to reduce methane emissions) and improved methods of field application (for reduced nitrous oxide emissions). Application improvements include incorporating manure into the soil, instead of surface spraying or spreading it, spreader calibration, and manure management planning.

Another management practice involves converting marginal agricultural land used for annual crops to permanent cover, such as grassland/rangeland, orchard, perennial biocrops, or forest, where the soil carbon and/or carbon in biomass is higher under the new land use. This policy includes opportunities to keep U.S. Department of Agriculture Conservation Reserve Program lands covered in perpetuity. Increased demand for corn-based ethanol and biodiesel feedstocks can act as an incentive for converting grassland to cropland. Incentives could be offered to reduce returning acreage to conventionally tilled production or to suburban/urban development.

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[5] GDS Associates, Inc., and La Capra Associates, Inc. "Analysis of Renewable Energy Potential in South Carolina: Renewable Resource Potential—Final Report." Prepared for Central Electric Power Cooperative, Inc. September 12, 2007. Available at: http://www.ecsc.org/newsroom/RenewablesStudy.ppt.

Heavy grazing can cause significant soil disturbance and result in carbon losses from soils. Practicing rotational grazing, where animals are regularly moved from field to field, reduces soil disturbance, improves soil carbon levels, and can improve plant vigor.

AFW 6b. Terrestrial Carbon Sequestration—Forestry

This policy establishes forests on land that has not historically been forested (e.g., agricultural land) ("afforestation"). It also promotes forest cover and associated carbon stocks by regenerating or establishing forests in areas with little or no present forest cover ("reforestation").

Forest management has significant potential to sequester CO_2. Southern forests are capable of sequestering more than 1 tCO_2/acre/year, and there are 12.9 million acres of forestland in South Carolina. Since 73% of South Carolina forestland is privately owned, the management decisions made by private landowners will ultimately determine carbon impacts.

Promoting forest management for carbon sequestration also has many additional benefits, such as wildlife habitat, clean air and water, recreational opportunities, and scenic beauty. Timber is South Carolina's highest-valued agricultural crop, and the forest industry leads the manufacturing sector in South Carolina with regard to employment and wages paid. Forest-based jobs, payroll, and capital investment are an important part of the state's economy.

This policy includes a range of forest management activities that promote productivity and increase the rate of CO_2 sequestration in biomass, soils, and harvested wood products. Practices may include soil preparation, erosion control, increased stocking of poorly stocked lands, age extension of managed stands, thinning and density management, fertilization and waste recycling, expanded short-rotation woody crops (for fiber and energy), expanded use of genetically preferred species, modified biomass removal practices, fire management and risk reduction, pest and disease management, and urban forestry, including urban tree planting and enhanced maintenance programs.

AFW-7. Conservation and Restoration of Forest and Agricultural Lands for Enhanced Carbon Sequestration

AFW-7a. Conservation and Restoration of Agricultural Lands for Enhanced Carbon Sequestration

In agricultural lands, soil carbon levels can be higher than those converted to developed use. By conserving agricultural lands, GHG emissions can also be reduced indirectly by influencing more efficient development patterns (leading to lower VMT). Therefore, a suitable policy for carbon sequestration is to incorporate methodologies that reduce the rate at which the existing base of South Carolina agricultural acreages is cleared and converted to developed uses.

AFW-7b. Conservation and Restoration of Forestlands for Enhanced Carbon Sequestration

Forests can play a substantial role in climate change by sequestering (or storing) carbon (by absorbing CO_2) as trees grow and releasing it as they decay. Trees are powerful, relatively low-cost concentrators of carbon. Young forests sequester carbon at a high rate, roughly proportional

to forest growth in biomass. Old-growth forests have a large balance of carbon stored over time in wood and soil.

Forests set aside to promote old growth result in long-term carbon storage balance due to a negligible rate of additional carbon sequestration because of natural loss and decay at about the same rate as they are growing. Land-use changes resulting in forest conversion to other uses are generally believed to be a secondary source of net carbon release. Much of the carbon stored in forest biomass and soils can be released as a result of such land-use conversion in addition to the loss in future carbon sequestration. Therefore, a suitable policy for carbon sequestration is to incorporate methodologies that promote long-term maintenance of the existing base of South Carolina forest acreages and support public policies that encourage and enhance carbon sequestration on those lands. Another appropriate policy to sequester carbon is to encourage the manufacture and use of durable wood products sequestering carbon over the life of the products.

Conversion of cropland acreage to forest acreage can produce GHG benefits by adding above- and below-ground biomass (sequestering carbon) to the converted area. The converted area is also likely to sequester more carbon annually as forested area than as cropland. This option also covers programs aimed at protecting forested areas that were previously converted (e.g., returned to active cultivation).

AFW-8. Advanced Recycling and Composting

This policy would increase the use of recycling and composting as waste diversion methods in order to limit GHG emissions associated with landfill methane generation and to increase production efficiencies of raw materials and new products. To achieve the goals of this policy, it will be necessary to increase awareness of the value of recycling, develop consistent recycling programs across counties, promote “best practices” comparisons across counties and between other states, increase and create new recycling programs, provide incentives for the recycling of construction and demolition waste, develop markets for recycled materials and compost, and increase average participation/recovery rates for all existing recycling and composting programs.

AFW-9. Waste-to-Energy Reclamation

This policy promotes the use of anaerobic digesters and energy recapture for organic waste materials (e.g., food processing waste, yard waste, other organics). (Note the linkage to AFW-2, whereby some organics from this waste stream could be co-managed with livestock wastes, and to the AFW-8 composting goals.) For waste that is landfilled, this policy promotes the use of landfill gas-to-energy projects.

Anaerobic digesters make a two-fold contribution to climate protection: the usual unchecked discharge of methane into the atmosphere is prevented, and the burning of fossil fuels is replaced with clean, renewable energy (biogas). Under this policy, the clean, renewable energy created at landfills by anaerobic digesters is used to make electric power, space/process heat, and liquefied/compressed natural gas. Note that this policy is not promoting waste combustion-to-energy projects.

Note: This AFW policy is related to ES-1 (Efficiency and Renewable Portfolio Standard and Statement of Support for New Nuclear Energy). Any overlap with ES-1 is addressed in the ES cumulative analysis. No GHG benefits have been subtracted from the AFW cumulative analysis.

AFW-10. Water and Wastewater Energy Efficiency Improvements

The collection and treatment of wastewater and the treatment and delivery of drinking water cost around $4 billion per year and make up 3% of the nation's energy use. Achieving the goal of a 10%–25% improvement in energy efficiency would produce a savings of $400 million to $1 billion, which translates into energy savings of 5–12.5 billion kilowatt-hours. The improved energy efficiency would also help to reduce GHG emissions.

Most facilities that carry out these operations were designed during periods of lower energy costs and/or did not adequately consider the release of GHG emissions to the environment. Simple improvements, such as replacing older equipment, can produce savings. Organizations like the American Water Works Association (AWWA) Research Foundation and EPA have launched initiatives to improve energy efficiency. The AWWA Research Foundation launched the National Municipal Water and Wastewater Facility Initiative in December 2004, and EPA launched the ENERGY STAR wastewater program in 2007.

Note: This policy is related to RCI-6 (Incentives and Policies for Improving Building Efficiency, Including Building Energy Codes). However, as the AFW-1 mechanism is not prescriptive as to where the electricity reductions must come from, no overlap between these two policies is counted.