FLORIDA'S GLOBAL WARMING SOLUTIONS

A Study for:
World Wildlife Fund

Tellus Institute
Resource and Environmental Strategies

November 1999

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Summary

The threat of global climate change and the challenge of averting it have important implications throughout the world. Scientists have shown that there is a serious risk of dangerous climate disruption if we do not dramatically reduce greenhouse gas emissions, especially carbon dioxide from fossil fuel combustion. Global warming is caused by the continued buildup of these gases in the atmosphere, which traps excessive amounts of incoming solar radiation, thus increasing the Earth's temperature. Such climate change could unleash ecological, economic and social disruptions throughout the world, many irreversible or lasting for generations. The impacts would be especially severe in Florida, where sea-level rise, severe storms and higher temperatures would threaten sensitive marine and terrestrial ecosystems, human health and the State's economy.

Fortunately, there are promising resources, technologies and practices that can be mobilized to meet the challenge of climate change by implementing effective policies and measures. Florida has unique opportunities to contribute to and benefit from policies that avert climate change, owing to its geographic location and the character of its economy. Efforts to curb climate change, through development and implementation of technologies that reduce carbon dioxide emissions, would have ecological, economic health and social benefits throughout the State. This paper discusses the benefits that Florida would derive from national policies and measures that combat global warming. Many of these policies and measures, appropriately tailored to local conditions and institutions, could be pursued on the state level to achieve similar results and benefits to Florida's citizens.

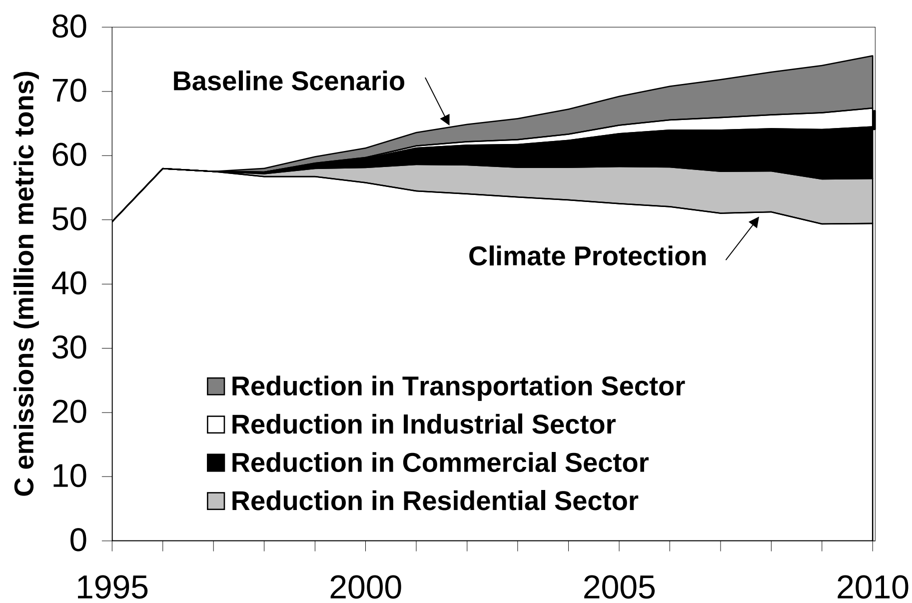
A recent national policy study, *America's Global Warming Solutions* (Bernow *et al* 1999), outlined and evaluated a plan through which the United States could reduce its annual carbon-dioxide emissions by about 654 million metric tons of carbon (MtC) by 2010, 36 percent below business-as-usual (baseline) projections for that year. This brings 2010 emissions to 14 percent below 1990 emissions, thereby exceeding the reductions required under the Kyoto Protocol of the United Nations Framework Convention on Climate Change (UNFCCC). The study found that these reductions could be obtained with net economic savings, almost 900,000 net additional jobs, and significant decreases in pollutant emissions that damage the environment, and are harmful to human health, especially of children and elderly.

This report assesses how the set of national actions presented in *America's Global Warming Solutions* would affect Florida's energy systems, carbon emissions and economy. This study finds that by 2010, the set of national actions to reduce global warming would decrease Florida's primary energy use by 26 percent and its carbon emissions by 36 percent. They would also provide increasing annual savings reaching about $300 per-capita in 2010 and averaging about $110 per-capita per year between now and 2010. Thus, the State would cumulatively save about $17 billion over that period. The set of national actions would also create approximately 39,000 net additional jobs in Florida by 2010. They would reduce emissions of other pollutants and begin to shift the basis of the State's economy towards more advanced, energy-efficient technologies and cleaner resources. The table below summarizes these results.

Table S.1: Summary of Policy Impacts			
	1990	**2010 Base Case**	**2010 Policy Case**
End-use Energy (Quads)	2.1	3.0	2.4
Primary Energy (Quads)	2.9	4.2	3.1
Renewable Energy (Quads)	0.1	0.2	0.4
Carbon Emissions (MtC)	51.9	79.7	51.4
Other Emissions (thousand tons)			
Sulfur Dioxide		445	190
Nitrogen Oxides		715	510
Fine Particulates (PM-10)		57	37
Net Savings ($ billion)			
In the year	--	--	$ 4.9
Cumulative (discounted)	--	--	$17.3

The graph below shows how the upward baseline trend in Florida's carbon emissions, which contributes to climate change and local environmental and health problems, would be reversed by the proposed national policies and measures. It shows the contributions to the overall emissions reductions, from changes in emissions from energy use, by each energy end-use sector – transportation, industrial, commercial and residential (reductions in the emissions from electricity supply are allocated to the end-use sectors based on their use of electricity).

Figure S.1: Carbon Emission Reductions in Florida Sectors due to the Climate Protection Scenario



These changes in Florida's energy system would help the U.S. reduce its global warming emissions, meet its Kyoto Protocol targets in the near term, and establish momentum for the deeper reductions needed for climate protection in subsequent decades. At the same time, they would contribute to the economic vitality, environmental integrity and quality of life in the State.

1. Introduction

1.1. Global Climate Change

The international community of climate scientists has moved toward the consensus, expressed by the Intergovernmental Panel on Climate Change, that "…human activities are having a discernible impact on global climate" (IPCC 1996). Concentrations of CO_2 in the atmosphere are now approximately 360 parts-per-million (ppm), about 30 percent above the natural, pre-industrial levels. This is unprecedented in many tens of millennia.

Annual global CO_2 emissions (measured as carbon) are about 6 billion metric tons from fossil fuel combustion and 1 billion from land-use changes (mainly burning and decomposition of forest biomass). Under a business-as-usual future, annual global emissions of carbon are expected to increase about threefold by the end of the next century, and atmospheric concentrations would approach three times pre-industrial levels (IPCC 1996). Climate models, recent empirical evidence and the paleo-climatological record indicate that this would cause global average temperature to rise between 1.4 to 2.9 degrees Centigrade (2.5 to 5.2 degrees Fahrenheit), with even greater increases in some regions (IPCC 1995; 1996).

The potential consequences of such change are myriad and far-reaching. Sea level rise could approach one meter (IPCC 1995; 1996), with severe implications for coastal and island ecosystems and human communities. Shifts in regional climates, and more frequent and prolonged extreme weather events (droughts, hurricanes and floods), could cause severe geophysical, ecological, economic, health, social, and political disruptions.

While the precise timing, magnitude and character of such impacts remains uncertain, our climate and ecological systems could undergo very large irreversible changes. The probabilities of extremely adverse outcomes in such complex and sensitive systems may not be extremely small, as is normally the case in simpler systems (Shlyakhter *et al.* 1995). Global warming itself would increase the rate of greenhouse gas accumulation, thus accelerating global warming and its impacts. For example, runaway warming could be precipitated by the release of methane from a thawing of the arctic tundra and decreased uptake of carbon by a warming of the oceans. Moreover, large changes could occur very rapidly once a threshold is reached, perhaps on the time-scale of a single decade (Schneider 1998; Severinghaus *et al.* 1998). Rapid change could cause additional ecological and social disruptions, further limiting the abilities of natural and social systems to adapt. Florida's ecosystems, economy and citizens would be particularly sensitive to such changes (Markham 1999). The rapid onset of climate disruption and its impacts could render belated attempts to mitigate climate change more hurried, more costly, less effective, or too late.

Recently, the Miami-Dade County Clerk was one of a group of six prominent municipal officials who initiated a statement on global warming that was signed by 567 mayors and local officials throughout the country. The statement expressed concern about the dangers of climate change and urged federal action to reduce domestic sources of greenhouse gases. They also noted the important role of local government in promoting energy efficient technology and renewable resources, which would strengthen their economies and increase the livability of their communities.

1.2. Regional Variation

The potential damages from climate change will not likely be distributed evenly around the world; they will vary depending on geophysical, ecological and socio-economic factors (IPCC 1998). For example, the combination of sea-level rise and increased frequency and severity of storms would be especially problematic for regions with low-lying coastal communities, economies and ecosystems. Well-known examples include the vulnerable small island states, such as the Maldives in the Indian Ocean, and economically weak coastal communities such as in Bangladesh. In many other regions, the uncertain fates of agriculture and forests, and the ecological and economic and social stability that depends upon their viability, are invoked as consequences of climate change.

Florida is uniquely vulnerable to climate change. It has a relatively large and demographically and economically important coastline, whose human and ecological communities would be at great risk with the temperature and precipitation changes, severe storms and sea level rise that would occur with climate change. Scientists have identified the potential for global warming to induce the spread of disease in marine ecosystems (Harvell *et al* 1999), which are important to Florida. The State's beautiful and valuable reefs would be threatened, as increases in sea temperatures cause coral bleaching and loss of species. Scientists have also predicted that warming seas will lead to more frequent El Niño events, causing extreme weather such as hurricanes; these storms inflict severe property damage and result in high insurance premiums. Florida would be on the front lines as sea level rises, resulting in beach erosion; this will cause losses of habitat, species, property and tourism revenue. The Everglades ecosystem would be endangered, affecting the hydrology of South Florida, the health of fisheries in Florida Bay, and endangered species such as the Florida Panther and Key Deer. Global warming could cause a greater incidence of wildfires, resulting in property damage and respiratory problems for Florida residents. Public health could be affected, as the ranges of vector-borne diseases such as dengue and malaria spread further north (Epstein 1999; Patz *et al* 1996), residents suffer from heat-related illnesses and deaths, and dangerous red tides become more common.

The economic viability of many tourist destinations depends upon the well-being of their natural environments; these include coastal resorts, alpine ski reports, and unique ecosystems such as rainforests, coral reefs, and wildlife habitats. A recent WWF report (Viner *et al* 1999) indicates that Florida stands to lose a great deal of tourism income due to the impacts of climate change. Tourism is Florida's biggest industry; visitors to the State's reefs contribute $1.6 billion annually to the economy. Travelers from around the U.S., Europe and beyond come to Florida to experience its beaches, the Keys, the Everglades and the Ten Thousand Islands. Florida's coastal resorts and its already compromised Everglades and coastal waters could become severely undermined from the impacts of global warming, such as beach erosion, coral bleaching, and saltwater incursion into freshwater systems (Frederick and Gleick 1999; Markham 1999.) The State's drinking water supplies would also be threatened by sea-level rise and severe storms. Other resources in the state, including its agricultural sector, would face an uncertain future from these changes, while vegetation, fauna and humans could face new risks from changes in the incidence of disease-carrying pests.

1.3. Climate Protection

Notwithstanding marked regional variation in its destructive potential, climate change is a global problem that requires solutions at all levels -- global, regional, national and local. The demographic, economic and political interconnection of peoples within nations and around the world could produce serious secondary impacts that would reverberate within and across national boundaries. Among such impacts could be decreased production, decline of markets for locally and internationally traded goods, increases in the number of environmental refugees, and exacerbated political instability and conflict. Moreover, both the scope of the problem and the moral interconnectedness of peoples demand cooperative action to curb climate change, based on the principles of adequacy, equity and capability embodied in the Climate Convention.

Reducing the ultimate magnitude of human-induced climate change and slowing down the rate of such change would help to protect vital ecosystems, economies and communities. To avert dangerous climate disruption, the current global emissions of about 6 billion tons carbon equivalent, now projected to increase to about 20 billion tons by the end off the next century, would have to decrease to less than three billion tons by that time. Even then, the carbon equivalent in the atmosphere would reach about 450 parts per million, about 60 percent above pre-industrial levels, which would still entail some climate change, sea-level rise and ecological impact.

Already, the industrialized world contributes 4 billion tons per year, two-thirds of global emissions, with almost 1.5 billion or about one quarter of annual global emissions from the U.S. alone. Thus, for stabilization at 450 ppm the world would have to decrease from about 1 ton per capita to less than 0.3 tons per-capita by the end of the twenty-first century. To match this global average per-capita target, the U.S. would have to reduce its emissions intensity more than 15-fold from more than 5 tons per-capita current level.

Arguably, as the limited carbon carrying capacity of the atmosphere has been nearly exhausted by the U.S. and other industrialized nations in amassing their economic power and wealth, both the responsibility and the capability for addressing climate change fall largely on their shoulders. As developing country economies will need to grow in the near term, early global carbon emissions reductions will have to come from the industrialized countries; this would both slow the rate of carbon accumulation in the atmosphere and inaugurate the technological and institutional transition to a low-carbon economies. At the same time, the industrialized countries could provide technological and financial assistance to the developing countries to help ensure that their economic growth is along a path of low-carbon intensity. The developing countries could thus advance in a manner that does not recapitulate the North's history of energy-inefficient, fossil fuel based economic growth; and there is already evidence that many have begun to pursue such a path. But with these responsibilities come opportunities -- for pollution reduction and improved public health and environmental quality, for technological innovation and productivity improvement, and for the institutional and human capacity building that can help to ensure sustainable development in the coming century.

In December 1997, the United Nations Framework Convention on Climate Change (UN FCCC) adopted the Kyoto Protocol, as a first step towards stabilizing concentrations of greenhouse gases in the atmosphere to reduce the risk of dangerous climate change. The Kyoto Protocol requires that emissions during the period 2008 to 2012 be reduced below 1990 levels by 7 percent for the U.S., 6 percent for Japan, 0 percent for Russia, and an average of 8 percent for the European Union.

The Protocol affords the U.S. and other industrialized nations considerable flexibility in meeting these reduction targets. These options include offsets amongst different greenhouse gases, offsets from biomass carbon sinks, the Clean Development Mechanism (CDM) that could create offsets from actions in developing countries, Joint Implementation projects, and industrialized nation (Annex I) trading of emissions allocations. Exploiting such options could allow the U.S. to undertake correspondingly lower reductions in carbon emissions from its energy sector while still meeting its 7 percent net reduction commitment, at lower near-term costs. However, these flexibility mechanisms have problems that need to be resolved before implemented on a large scale. Otherwise they could seriously threaten climate protection and environmental integrity (GACGC 1998), socio-economic development, and the credibility of the Kyoto Protocol.

Moreover, given the rather modest reduction targets of the Protocol relative to the much deeper long-term reductions needed for climate protection, use of the flexibility mechanisms may permit too slow a start and too weak a signal for the necessary technological transition in energy production and use (WWF 1998). The focus of our climate protection activities must thus be on where the heart of the problem and its solution lies – beginning a sustained process to achieve deep reductions in domestic energy-related carbon-dioxide emissions. In rising to that challenge, we could spur technological modernization and innovation, pollution reduction, increased productivity and economic benefits.

1.4. U.S. Policies and Measures

America's Global Warming Solutions showed that the U.S. could reduce its carbon emissions by 14 percent below its 1990 levels with solely domestic energy policies and measures, and enjoy net economic savings, increased employment and pollution reductions. Thus, the U.S. could significantly reduce its greenhouse gas emissions and go beyond its target under the Kyoto Protocol with no use of the flexibility mechanisms, through policies and measures that would affect energy choices, resources, technologies and systems throughout the country. The economic and environmental benefits of these policies and measures would be widespread across the country. While there would be many common impacts in each region or state, there would be some variation that would reflect differences in current and projected energy and economic conditions.

This report provides analyses of the impact that these national policies and measures would have on Florida. The impacts that we estimate include changes in energy demands, energy supply technologies and fuel mix, carbon emissions, costs, savings and employment.

2. Energy Use and Carbon Emissions in Florida

Florida's energy system and carbon emissions reflect its unique geographic, climatic and economic conditions. Thus, Florida's relative contributions to national carbon-dioxide emissions and to national emissions mitigation will also reflect these conditions. So too will the opportunities for and impacts of emissions mitigation policies.

2.1. Current Energy and Emissions

In 1996 Florida's citizens and economy consumed about 2.4 quadrillion Btu's (Quads) of fuels and electricity to meet its end-use energy demands in residential and commercial buildings, industry and transportation, about 3.3 percent of national consumption. Since Florida's population is about 5.5 percent of the national population, its per-capita end-use energy intensity of about 165 Million Btu (MMBtu) per person is only about 60 percent of the national energy intensity.

A comparison of Florida and U.S. energy use is given in the figures below. The top pair of pie charts, in which emissions from electricity generation is allocated to the sectors in proportion to their demands, shows Florida's larger shares of carbon emissions from buildings and transportation and its smaller share from industry. The lower pair, in which emissions are ascribed at the points of fuels combustion, shows Florida's larger shares from electricity generation and transportation and its smaller shares from buildings and industry.

Figure 1.A: 1996 Carbon Emissions – Electricity Allocated to Other Sectors

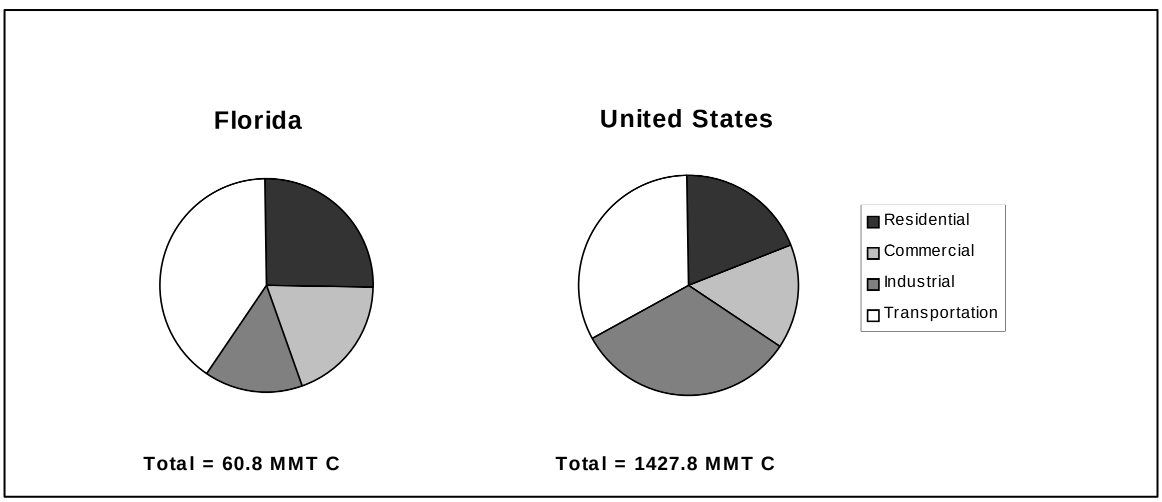
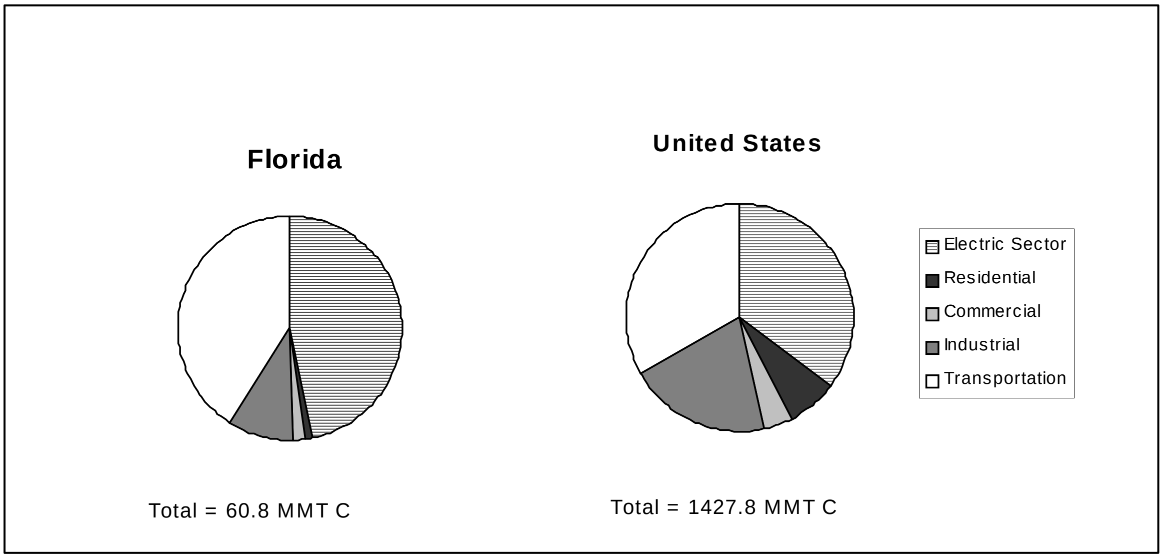


Figure 1.B: 1996 Carbon Emissions from Primary Energy Use by Sector



The figures show that Florida has a very different sectoral energy use mix than that of the country as a whole. While its residential and commercial energy use comprise a little over one-fourth of the total for both Florida and the nation, the contributions of transport and industry exhibit a quite divergent pattern. Florida's industrial energy use is about 1.6 percent of national energy use, far lower than the population ratio, thus reflecting the more residential, commercial, agricultural and high-tech character of the state's economy. Its transportation energy use is about 5.5 percent of national energy use, the same as population ratio. Industry in Florida contributes about 20 percent of total end-use energy consumption, while in the U.S. it contributes about 40 percent. On the other hand, transportation contributes about one-half of the total in Florida and about one-third in the country as a whole. On a per-capita basis, building energy consumption in Florida is about two-thirds that of the U.S. as a whole, while transportation is about 10 percent less, and industry is less than one-third.

The end-use fuel mix is also very different for the State than for the nation as a whole. About one-quarter of the total in Florida comes from electricity, 60 percent from oil, and 10 percent from natural gas. For the U.S. these fractions are 15 percent, 50 percent and 28 percent respectively. These differences reflect the different sectoral mix discussed above, and the relative importance of air conditioning, and limited access to natural gas in the State.

Florida's electricity generation was more than 80 percent fossil (predominantly coal) and almost 20 percent nuclear in 1996, while generation in the U.S. was about two-thirds fossil (predominantly coal) more than 20 percent nuclear. While hydro-electricity contributed about 11 percent nationally, it is virtually absent in Florida.

Adding the fuels used for electricity to the fuels directly consumed at the end-use gives total primary energy consumption. Florida's primary energy consumption of 3.6 Quads in 1996 was about 3.8 percent of national consumption. Owing to its higher electricity share, and the higher proportion of fossil fuel for electricity generation, its per-capita primary energy consumption was about 70 percent that of the U.S., higher than its 60 percent relative per-capita end-use consumption.

Florida's carbon-dioxide emissions reflect its overall energy use and fuel mix, about 61 million tons carbon in 1996, which was about 4.3 percent of total national emissions of 1428 million tons. Thus, Florida emitted about 4.2 tons per-capita, about 78 percent of the nation's approximately 5.4 tons per-capita.

2.2. Future Emissions and Mitigation Options

From 1996 to 2010, under business-as-usual conditions, Florida's carbon emissions would grow by about one-third to about 80 million tons, while the U.S. carbon emissions would grow by one-fourth to almost 1800 million tons. Thus Florida's share would grow from 3.8 to 4.4 percent of the national total, still below its share of national population.

National and state policies could help to stimulate investments in energy efficiency and renewable resources to reverse this trend in Florida's energy system of increasing carbon and other pollutant emissions. Recent reports from Florida agencies and organizations (GCSSS 1997; PEEF 1996) have surveyed the potential in Florida for cleaner, more efficient energy supply and use, and have identified policies that could help to realize this potential. There are many companies in the State that deliver energy-efficiency and renewable energy equipment and services, including efficient motors, chillers, and lamps, conventional and solar heating and cooling, and industrial process, and many more companies and households stand to benefit from the energy bill reductions from improved energy efficiency. Studies undertaken by the Florida Energy Office have identified opportunities for cost-effective end-use efficiency improvements (SRC 1992, 1993) and fuel switching from electricity to gas for heating and cooling in the residential and commercial sectors, under effective policy regimes (Tellus 1995). Other studies have shown that energy efficiency investments in the State have been shown to yield economic benefits (Goodman et al 1993,1995)

The potential for highly efficient co-generation, or combined-heat-and-power (CHP), in Florida is strong, mainly in the Chemicals, Stone Clay and Glass, Paper and Pulp and Food Processing industries, to meet heating, cooling and electricity needs. Florida's important high-tech semiconductor manufacturing industry, for which reliability is very important and cooling loads are high, could also benefit from on-site CHP and design for whole system efficiency (Robertson 1999).

Florida's strong residential and commercial building energy codes, which take account of the specific conditions of the state's climate, are based on legislation that requires they be updated at least triennially to incorporate available cost-effective energy saving equipment and techniques. The latest revision, providing minimum requirements for building envelopes, lighting, electrical distribution, space heating, air conditioning and water heating, went into effect in 1997. An updated statewide uniform code will be sent to the legislature in 2000.

Florida has excellent potential for renewable energy in end-use (e.g., solar heating) and electricity supply (solar and biomass). Florida is a partner in the federal government's million solar roofs initiative, with 350 installations currently listed as part of this project. The goal is to have 20,000 photovoltaic systems to produce on-site solar electricity and 140,000 solar thermal systems for on-site heating in place by 2010. Maintaining state funding and federal support is a key to reaching these goals.

The State has ample biomass resource potential in forest residues, mill residues, urban wood waste, and short rotation woody crops (Walsh *et al* 1999). Biomass could be co-fired in coal power plants, used in dedicated biomass power plants, or converted to cellulosic (wood based) ethanol to replace or blend with gasoline. With its high level of construction activity and the desirability of limiting inputs to landfill near its sensitive ecosystems, the use of wood wastes for energy could have multiple benefits in the State.

Some agencies and industrial firms in Florida are participating in the Climate Wise program jointly sponsored by the U.S. Department of Energy and Environmental Protection Agency. Though this program firms can obtain access to technical and financial information and technical assistance on a wide range of energy saving and emissions reducing opportunities, including process changes, materials substitution, and fuel switching. The Miami-Dade County Department of Environmental Protection is a Climate Wise Government Ally in the State that has brought companies from industry into this program.

Transportation emissions reductions in the State could be effected through actions by its various state, regional and municipal agencies. Among options that being pursued are transportation demand management, mode switching, and alternative fuel vehicles such as the Miami Beach electric shuttle bus system. Other opportunities could be pursued in fuel-efficiency and emissions standards, incentives and procurement, public education, pricing, land-use, and infrastructure and mode alternatives.

Restructuring of the electric utility industry, which is leading to de-regulation and increased retail competition in some states, has caused concern about lost momentum and opportunity for end-use energy efficiency, renewable power supply and reduced pollutant emissions. At the national level it has stimulated initiatives to adopt complementary policies, such as a renewable portfolio standard and generation (emissions) performance standards. De-regulation is not moving quickly in Florida, but this need not preclude strong renewables, efficiency and emissions reduction policies by the State. Currently, some utilities are exploring "green pricing" for customers interested in photovoltaics. As the State utilities' demand-side management programs have been focused on load shifting, rather than efficiency improvements for electrical appliances and equipment, there is room for their expansion as a carbon and pollution reduction strategy.

3. The National Policies and Measures

America's Global Warming Solutions presented analysis of national policies and measures within each sector, which would stimulate faster adoption of more energy-efficient technologies and low-carbon energy resources, and induce innovation, learning and further diffusion. These included a robust mix of complementary approaches, including incentives, market creation and transformation, regulatory modernization, technical assistance, efficiency and performance standards, research and development, and tax reform. Specifically they were:

For transportation:

- A vehicle efficiency initiative, including: progressively stronger fuel economy standards for cars and sports utility vehicles; an efficiency and emissions based rebate system for vehicle purchases; R&D for improved design, materials and technologies; public sector market creation programs for cleaner and more efficient vehicles; and standards and incentives for freight trucks and other commercial modes.
- Urban/regional transportation demand management and related incentives; pricing reforms, including congestion and emissions-based pricing; land-use and infrastructure planning for improved access to alternative and complementary travel modes, including transit, walking and biking; facilitation of high speed intercity rail development; pricing, planning and informational initiatives to promote intermodal freight movement.
- A progressively stronger cap on the carbon intensity of motor fuels, reaching a 10 percent reduction by 2010; R&D for cellulosic ethanol, other renewable fuels and associated vehicle technologies; renewable fuels commercialization programs in various market segments, including public sector procurement programs.

For industry:

- Tax incentives to stimulate more investment in new more efficient energy-using manufacturing equipment, and RD&D to bring down the costs and speed the availability of more efficient equipment;
- Regulatory refinement and technical assistance to remove disincentives for industrial combined heat and power (CHP), whereby electricity is generated on-site, rather than imported from the grid, by using the same fuels that produce heat for manufacturing processes.

For electricity generation:

- A progressively increased renewable portfolio standard, that would require suppliers to collectively provide 10 percent of generation by 2010 with renewable resources, with a credit trade system to ensure that the national target is met with a regional distribution that results in lowest cost.
- A tightening of the 1990 Clean Air Act Amendment SO_2 cap, which now halves the sector's emissions from 1990 levels to 9 million tons by 2000, to reduce them further to about 3.5 million tons by 2010. Also, a cap and trade systems for NOx and fine particulates to bring their levels down. These pollution restrictions would reduce coal use and, thereby, carbon emissions.
- A requirement for co-firing of biomass in coal plants, with credit trading, which is progressively increased to 10 percent by 2010, providing near-term carbon reductions and stimulating development of that resource.
- A cap and trade (or tax) for carbon emissions to reduce the carbon intensity of the sector between 1990 and 2010 by about 40 percent.

For commercial and residential buildings:

- Appliance and building standards that would establish norms for equipment, design and performance which, through purchases and practices, would reduce energy used to provide services in homes and offices.
- Market transformation incentives including technology demonstrations, manufacturer incentives, and consumer education to reduce barriers to energy savings and renewables.
- Initiatives to expand the use of combined heat and power for district energy systems.

4. Energy, Carbon and Cost Impacts

The national policies and measures were estimated to achieve a 22 percent reduction in primary energy use and a 36 percent reduction in carbon emissions by 2010 relative to baseline projections for the U.S. that year, about 14 percent below 1990 emissions. These carbon emission reductions are realized entirely through energy-related policies and measures, with net economic savings. Overall national savings in energy bills exceeded net incremental investments through 2010 by an average of about $150 per capita per year.

In Florida, these policies would also reduce carbon emissions by about 36 percent below baseline projections for 2010. These reductions reflect a 25 percent reduction in primary energy use owing to increased investment more energy efficient equipment, as well as a shift to less carbon-intensive fuels for electricity, transportation and industry. Net annualized savings were estimated to average about $110 per-capita through 2010, reaching about $300 per-capita in that year.

This section presents a summary of the methods and assumptions for the national and Florida studies and a more detailed energy, carbon and cost/benefit results.

4.1. Analyses and Results for Energy and Carbon

The analyses of the national policies and measures, whose impacts on Florida are presented here, are described in *America's Global Warming Solutions* (Bernow et al 1999) and its predecessor study *Policies and Measure to Reduce CO_2 Emissions in the U.S.* They were undertaken using several models, taking the projections and assumptions of the U.S. Department of Energy *Annual Energy Outlook* (EIA 1998) for the baseline or Base Case. The models used included the U.S. Department of Energy, Energy Information Administration (DOE/EIA) National Energy Modeling System: NEMS (EIA 1995; 1999) and the Argonne National Laboratory Long-Run Industrial Energy Forecasting (LIEF) model (Ross et al. 1993). More detailed discussion of the assumptions and analyses upon which this study was based can be found in *Energy Innovations* (EI 1997), the *Energy Policy* Special Issue on Climate Strategy for the United States (1998) and Bernow et al. (1998). Other recent studies with similar approaches and results include Brown et al. (1998), Koomey et al. (1998b) and Geller et al. (1998).

NEMS is a computer model that projects future U.S. energy consumption and supply based on energy technology and fuel choice for each sector and end-use, deriving from fuel prices, technology costs and characteristics, equipment turnover rates, and financial and behavioral parameters. The data and assumptions used were from EIA (1998). The Base Case, which served as the point of departure for computing the impacts of the policies investigated in this study, was the NEMS computer run consistent with the EIA (1998) projections. NEMS was used for modeling of the Base Case and policy scenarios for the Residential and Commercial buildings sectors, Electricity Supply, and the integration of demand and supply. Its Base Case was also used for benchmarking all other models used in this analysis, in particular for Transportation and Industry. LIEF is comprised of curves that reflect empirically based energy efficiency investments affecting fossil fuels and electricity use in eighteen industrial sectors in the U.S. These curves show the energy savings that could be achieved as a function of the energy price and capital recovery factor (reflecting the cost of money and factors contributing to a "hurdle" discount rate as well as amortization period).

National and regional energy demand, supply and cost data for the both the Base Case and Policy Scenario were taken from the models used, and were benchmarked to recent energy demand, supply and price data for Florida. For example, NEMS provides detailed information and policy impacts for electric power supply by region, including the SERC/Florida region, and it provides building sector results for the Southeastern U.S. census region. Relative demographic and economic growth rates were used to map national and regional projections onto Florida. The LIEF model was run for the Base and Policy cases using Florida's fossil and electricity prices. For transport modes we used regional data from NEMS projections for various modes and vehicle types, combined with state data on the mode and vehicle mix and energy use, and applied the policy variables in the models reflecting transport demand, stock turnover, fuel-efficiency and costs.

4.1.1. Transportation

Analyses of the policy impacts in the transportation sector took account of vehicle stock turnover, fuel-efficiencies and travel indices, and were benchmarked to the structure, data and baseline projections of the EIA (1998). The analyses were further benchmarked to transportation data for Florida. For light duty vehicles (LDVs), we assumed a progressively improving national fuel efficiency standard, increasing by 1.5 miles per gallon (mpg) per year from 1998 through 2010. This results in new cars at an average of 45 mpg and new light trucks at 37 mpg in 2010. For the entire fleet in operation, the average would be about 25 mpg, about 19 percent below baseline projections for that year. For heavy-duty freight trucks fuel efficiency improvements would be about 8 percent by 2010 relative to baseline projections. The demand management and mode shift policies would reduce LDV energy use by another 8 percent.

We assumed that the carbon content and renewable fuel policies would result in a progressive increase to a 10 percent contribution of cellulosic ethanol as a blend with gasoline in cars by 2010. In Florida, this would require about 70 trillion Btu. This amount could be provided by one-half of the State's biomass resource potential at less than $50 per dry ton (about $3 per MMBtu, from urban wood wastes, forest and mill residues, and short rotation woody crops, and about two thirds of its potential at less than $40 per dry ton.

The graphs below summarize the impacts of the national policies on energy use in Florida's transportation sector.

Figure 2.A: Total Transport Energy Use – Base Case vs. Policy Case

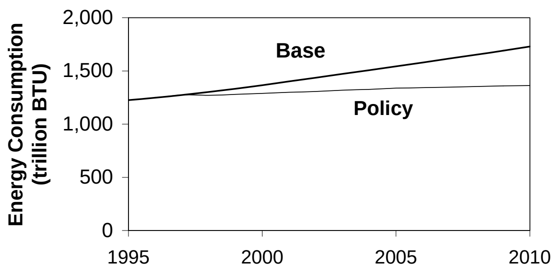
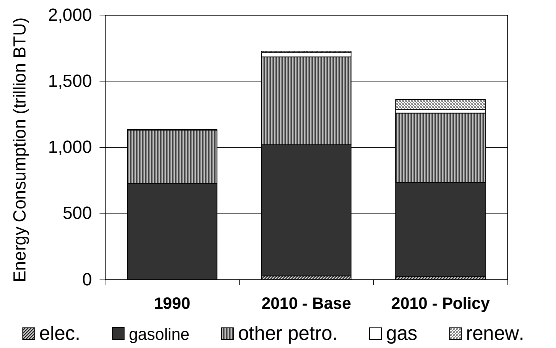


Figure 2.B: Transport Energy Use by Fuel Type – Base Case vs. Policy Case



The fuel use reductions from the efficiency and demand management policies would reduce carbon emissions from the sector by about 6.7 MtC or 20 percent in 2010. The carbon content/ethanol policy would reduce emissions by bout 1.9 MtC or 5.6 percent by 2010 (1.5 MtC from gasoline displacement and 0.4 MtC from electricity generated in the ethanol production. An additional 1.3 MtC would be saved at refineries owing to reduced throughput, but as a very small fraction of U.S. refinery capacity is in Florida, we did not credit this effect to Florida's carbon reductions.

4.1.2. Industry

For industrial energy efficiency policies, we used the empirically based LIEF model, benchmarked to the AEO 1998 baseline energy price and consumption projections. A high effective discount rate of 27.8 percent, owing to market and institutional barriers, was used in the Base Case in order to match observed energy demands with LIEF. We assumed that this would be reduced to 12.3 percent by the policies of technical assistance, information, tax credits and R&D. We found that national industrial energy consumption could be decreased by more than 10 percent by 2010, relative to the Base Case, through investments in cost-effective energy efficiency induced by the policies. For analysis of the impacts of these policies on Florida, we benchmarked LIEF to recent data on the industrial mix, energy use and energy prices in the State. We found that overall end-use energy consumption in the State would decrease by about 16 percent by 2010 owing to the energy efficiency policies, with electricity consumption reduced by about 14 percent.

For industrial combined-heat-and-power (CHP) with advanced micro-turbines, we assumed that by 2010 twenty percent of existing manufacturing steam demand would shift to cost-effective gas-fired co-generation and fifty percent of existing co-generation in the paper and pulp industry would retrofit to advanced turbines. This results in about 38 GW new CHP capacity and 236 TWh electricity generated on site by 2010. For Florida, it results in about 1 GW and about 5 TWh (about 2 percent of the national CHP achieved).

The reduction in demand for grid electricity is about 28 percent by 2010. CHP does not appreciably affect overall end-use energy consumption in industry, since the on-site electricity generated requires additional fuel. But the additional fuel is far less than that needed for the grid electricity generation that it displaces, and its natural gas fuel is cleaner than the high-carbon avoided fuel.

The graphs below summarize the impacts of the national policies on energy use in Florida's industrial sector.

Figure 3.A: Total Industrial Energy Use – Base Case vs. Policy Case

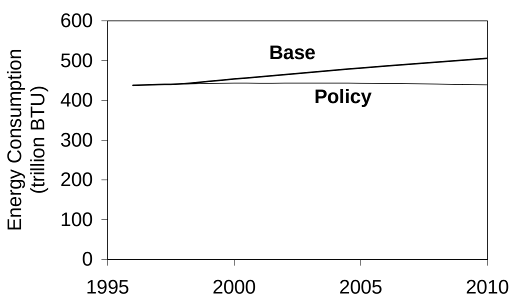
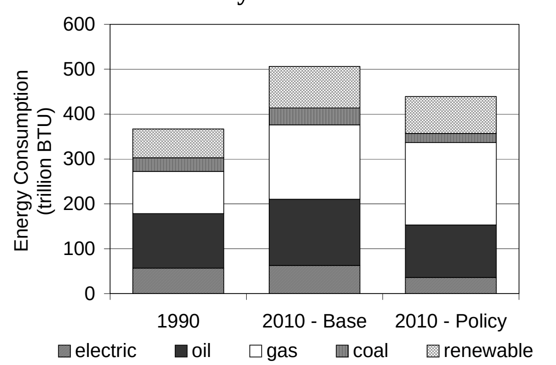


Figure 3.B: Industrial Energy Use by Fuel Type – Base Case vs. Policy Case



The fuel use reductions from the national energy efficiency policies for industry would reduce carbon emissions from the sector by about 2.5 MtC in 2010. This is about 27 percent of the total emissions caused by industrial sector's energy demand, both from on-site fossil combustion and from grid based electricity generation. The CHP policy would reduce the emissions caused by the sector's energy demand about 1.0 MtC or 10.6 percent by 2010.

4.1.3. Buildings

For residential and commercial building policies we used the NEMS model, which represents energy technologies and demand for each major fuel type and end-use, including air conditioning, space and water heating, and various types of equipment and appliances, based on building and technology characteristics and costs. The policies were modeled though changes in the availability of new more efficient technologies and of the "hurdle" discount rates that reflect non-financial influences (e.g., information) on consumer choice.

Overall national energy use in buildings was reduced about 16 percent in buildings in 2010. For Florida the reduction was found to be about 26 percent overall, about 23 percent for residential and 29 percent for commercial buildings. For the U.S., we assumed that an initiative to promote district energy systems (DES) using CHP for high-density commercial buildings, but we assumed no DES impacts for Florida in this analysis. Nonetheless, while space-heating demand is relatively low in the State, its high cooling demand in high-density commercial and residential buildings could warrant selected deployment of DES, which is worthy of further study.

The graphs below summarize the impacts of the national policies on Florida's residential and commercial buildings sectors.

Figure 4.A: Total Residential Energy Use – Base Case vs. Policy Case

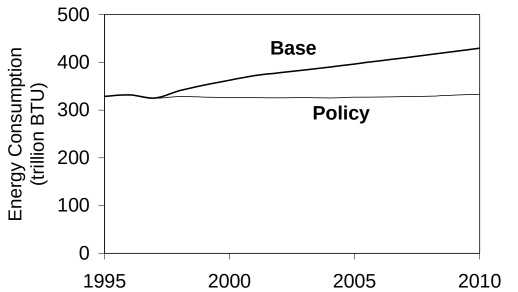


Figure 4.B: Residential Energy Use by Fuel Type – Base Case vs. Policy Case

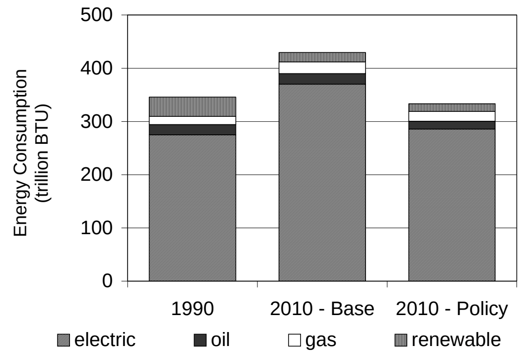


Figure 5.A: Total Commercial Energy Use – Base Case vs. Policy Case

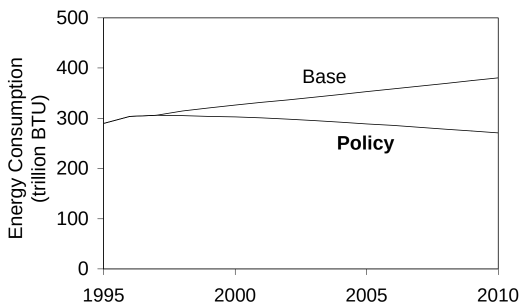
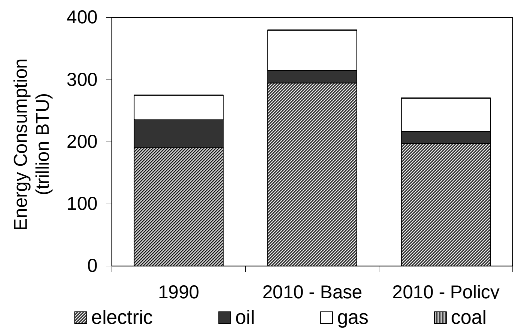


Figure 5.B: Commercial Energy Use by Fuel Type – Base Case vs. Policy Case



The fuel use reductions from the national energy efficiency policies for residential and commercial buildings would reduce carbon emissions by about 10.4 MtC or 29 percent in 2010. The very high electricity demand in Florida, owing in part to high cooling loads and historically limited access to natural gas, makes energy efficiency and fuel switching in the State's building sector and important component of a national carbon reduction strategy.

4.1.4. Electricity Supply

The electric sector policies were modeled using NEMS. NEMS includes data for existing power plants in the thirteen Electric Reliability Council regions of the U.S. and neighboring Canadian regions. It simulates dispatch of these plants and new plants needed to meet the growing electricity demand in each region, taking account of regional exchanges and the characteristics of existing and new electricity supply options. NEMS was used to analyze a national renewable portfolio standard (RPS) set to ramp up to 10 percent of electricity generation in 2010 from solar, wind, biomass and geothermal power plants. It was also used to model the generation performance standards, through a tighter cap on sulfur-dioxide emissions, and externality adders for particulates, oxides of nitrogen and carbon. Analysis of a national standard for biomass co-firing in coal power plants, to displace ten percent of existing coal generation by 2010, was performed off-line, based on the results of the NEMS analyses.

In Florida, the national RPS was found to increase total renewable generation by about 7.7 TWh by 2010, primarily biomass (4.2 TWh) and solar (2.5Twh). Thus, the 10 percent national RPS policy would be realized in Florida via 6 percent with its own renewable resources plus renewable credit purchases from outside the State. This occurs since the use of relatively low cost wind power in other regions would go a long way towards satisfying the national requirement. Nonetheless, the policy stimulates use of Florida's indigenous renewable resources. Further development of these resources could be encouraged by complementing the national RPS with State renewables policies.

Together with existing MSW generation of 4.2 TWh this would provide about 9 percent of electricity generated in the State in the Policy Case. Another 4.6 TWh is provided by the biomass co-firing requirement, bringing the renewable total to about 12 percent of in-state generation by 2010.

The availability and cost of biomass, for cellulosic ethanol and co-firing in coal fired electric power plants, was developed from Walsh *et al*. (1997; 1999) and Walsh (1999). The total biomass requirement for these three uses, about 160 trillion Btu or 10 million dry tons, could be met entirely by in-state resources – primarily urban wood wastes, forest and mill residues, and short rotation woody crops – at less than $50 per ton. About two-thirds could be met with in-state resources at less than $40 per ton or about $2.60 per MMBtu, the assumption made here. Much of the resource could come from agricultural residues, supplemented by wood wastes and dedicated energy crops. This resource could be developed in Florida.

The graphs below summarize the impacts of the national electricity supply policies on electricity generation and fuels mix for generation in Florida.

Figure 6.A: Impact of National Electricity Supply Policies on Electricity Generation – Base Case vs. Policy Case

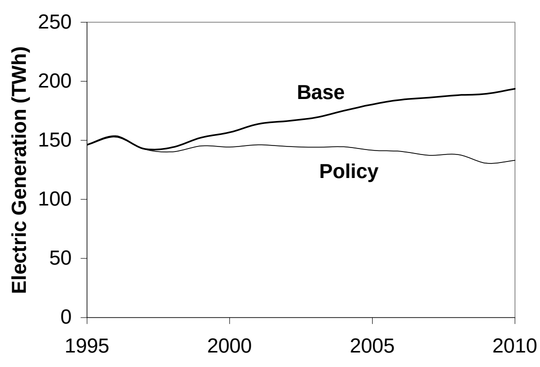
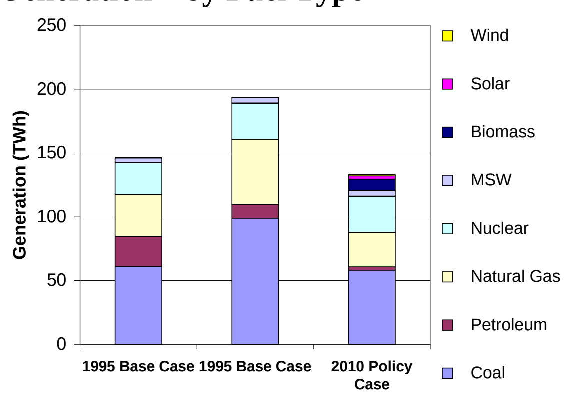


Figure 6.B: Impact of National Electricity Supply Policies on Electricity Generation – by Fuel Type



The shifts in power plant fuels from the national electric sector policies would reduce carbon emissions by about 5.9 MtC or 15 percent of the total from electricity supply in 2010. RPS and biomass co-firing would contribute about 3.0 MtC while the generation performance standards would contribute about 2.9 MtC.

4.2. Summary of Carbon and Pollutant Emissions Impacts

The two graphs below summarize the impacts of the national policies and measures on carbon emissions from energy use and supply in Florida. The first shows the emissions reductions in the sectors of their origin, that is, in which the combustion of fossil fuels occurs. Thus, it shows emission from on-site fossil fuel combustion in buildings, industry, transportation and electricity production. It is noteworthy that the largest reductions arise in the electric sector, owing to the end-use energy efficiency policies that reduce demand, plus the emissions and renewables

Figure 7.A: Carbon Emission Reductions in all Florida Sectors

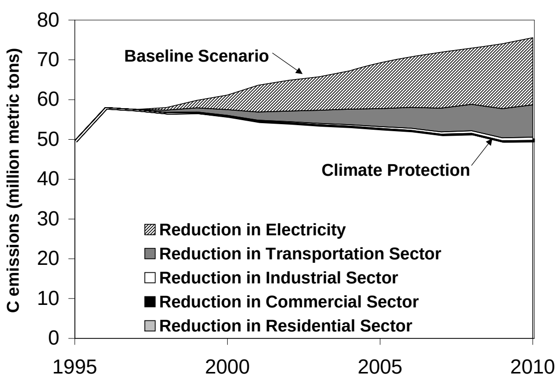
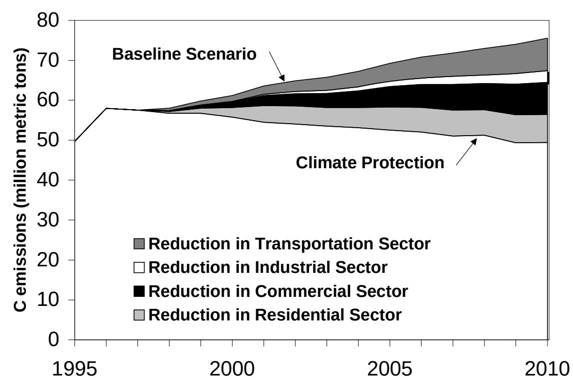


Figure 7.B: Carbon Emission Reductions in Florida End-use Sectors



policies for power supply that shift the fuels for electricity generation. The second graph shows the reductions across the end-use sectors only, that is, from which the demands for fossil fuel combustion on-site or at power plants arise. In this graph electric sector emissions are allocated to the end-use sectors proportional to their demands.

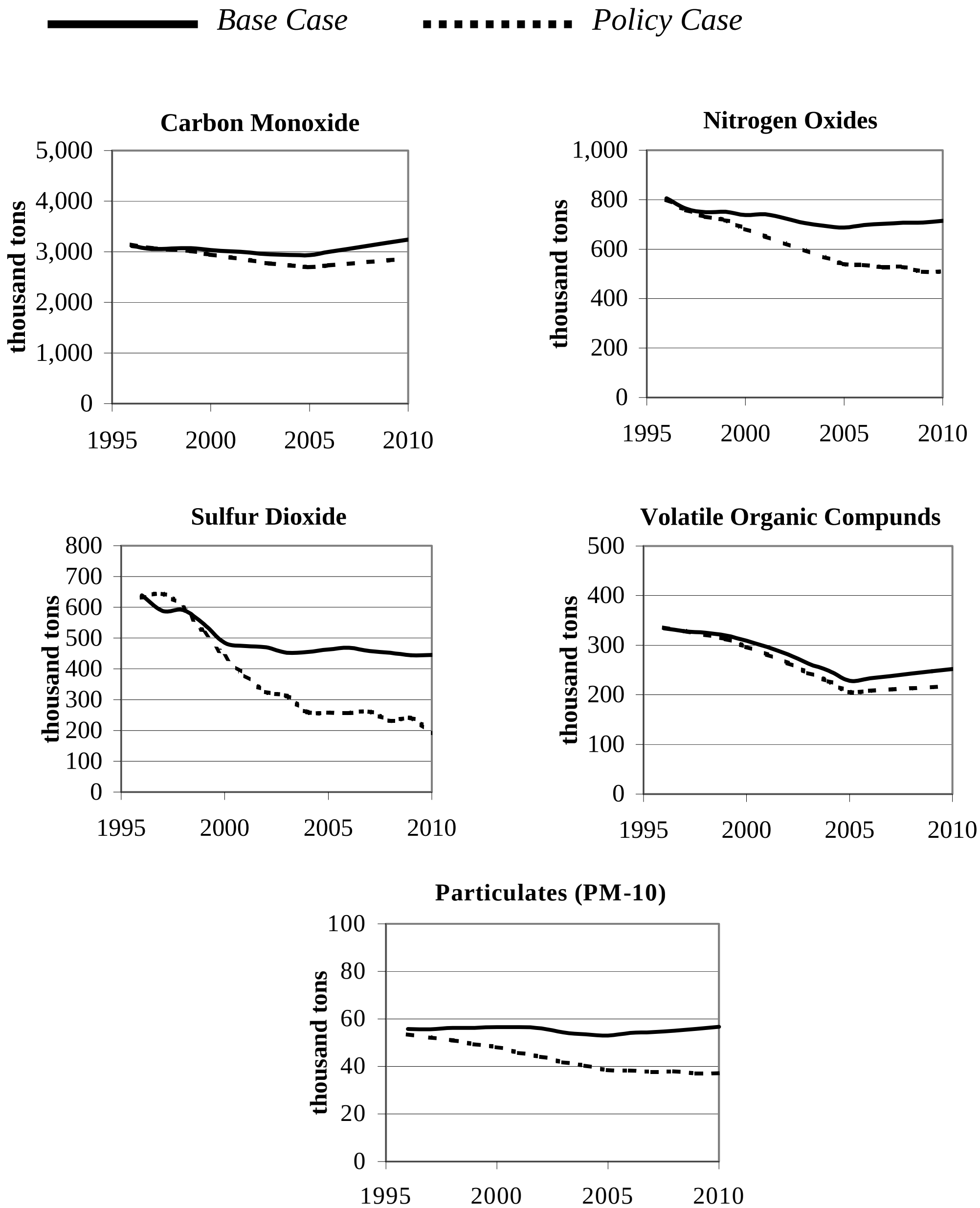
The carbon emissions reductions could also be reported by policy or by the sectors to which the policies are directed. Table 1 on the following page provides these results and compares them with the national carbon reductions realized by the policies and measures. It should be noted that in the U.S. analyses we took account of reductions at refineries owing to decreases in oil consumption, but in Florida we did not do so. In the national case this comprises about 17 percent of the reductions from policies in the U.S. transportation sector, since for every unit of gasoline produced, an additional 0.2 units are consumed at the refinery.

Table 1: Carbon Reductions by Sector and Policy, Florida and U.S. (MMT C in 2010)

Year	Florida	U.S.	% U.S.
TOTAL BASE CASE EMISSIONS	80	1,806	4.4%
Transport Sector			
Vehicle Efficiency	4.1	105	3.9%
Transport demand	2.7	65	4.2%
Ethanol	1.9	31	6.1%
Total Transport Sector	8.6	201	4.3%
Industrial Sector			
Industry Efficiency	2.5	77	3.2%
Industry CHP	1	34	2.9%
Total Industrial Sector	3.5	111	3.2%
Residential and Commercial Sectors			
Building Efficiency	10.4	98	10.6%
District Energy	----	12	----
Total Residential and Commercial Sector	10.4	110	9.5%
Electric Supply Sector			
Renewable Portfolio Standard	1.7	34	5.0%
Biomass Co-firing	1.3	22	5.9%
Generation Performance Standards	2.9	178	1.6%
Total Electric Supply Sector	5.9	234	2.5%
Total Reductions	**28.3**	**656**	**4.3%**
TOTAL POLICY CASE EMISSIONS	51	1,150	4.5%

In addition to carbon emission reductions, the set of policies also yields reductions of criteria air pollutant emissions. Air pollutants such as fine particulates, carbon monoxide, sulfur dioxide, and ozone (formed by a mix of volatile organic compounds and nitrogen oxides in the presence of sunlight) can cause or exacerbate health problems that include premature mortality and morbidity effects. Research shows that small children and the elderly are particularly at risk from these emissions (Dockery et al., 1993; Schwartz and Dockery, 1992). These emissions also account for damages to the environment such as poor air quality and acid rain. Figure 8 below illustrates the impacts of the policies and measures on combustion-related emissions of criteria air pollutants in Florida.

Figure 8: Emission of major air pollutants: 1995-2010, Base Case and Policy Case



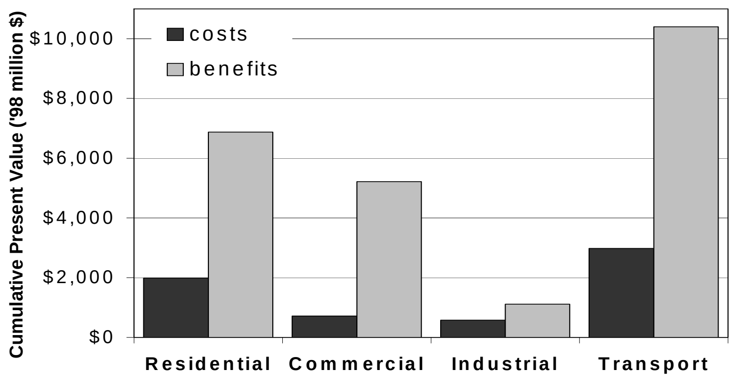
4.3. Analysis and Results for Costs and Savings

The national climate change policies and measures cause shifts in energy related expenditures in Florida. These shifts entail both costs and savings. The costs are the incremental investments in more efficient energy using equipment, power supply technologies and renewable energy resources, and the savings are the net reductions in the energy bills of households and businesses.

For this analysis, the costs and fuel prices used were obtained from the NEMS model for residential, commercial and electric power sectors, the LIEF model for the industrial sector, and

DeCicco and Lynd (1997) and Lynd (1997) for the transportation sector. In 2010 the net savings on household and business energy bills in Florida would exceed the net incremental investments by about $5 billion or about $300 per capita. Cumulative present value ($1998) of the net savings would reach about $17 billion by 2010, and the average annual (levelized) net savings over that timeframe would be about 2 billion per year, about $120 per capita per year.

Figure 9: Costs and Benefits of Climate Change Policies



The breakdown by sector of the cumulative discounted costs and benefits are presented in Figure 9. In 2010 the net savings on household and business energy bills in Florida would exceed cumulative discounted costs and benefits are presented in the figure to the left. In that breakdown, the net costs of the changes in the electric power supply sector owing to the fossil reduction policies are embodied in the net savings in each end-use sector, based on its consumption of electricity.

5. Impacts on Florida's Economy

The set of national policies and measures that affect Florida's energy system and carbon emissions would also affect its economy. Many analyses of state-level policies that induce more efficient energy technologies and renewable resources show that the net economic impact is positive. Thus, one would expect that a similar set of national policies would have similarly positive state-level impacts, particularly in states that are not energy suppliers.

Three indicators of the economic impact in Florida of the national policies and measures were developed—net incremental jobs, wages and salaries and Gross State Product for the years 2005 and 2010. These impacts were estimated using IMPLAN (Impact Analysis for Planning), an input-output (I-O) model that represents interactions between different sectors of the economy. Changes in each sector's spending patterns, owing to changes in fuel consumption and energy technology investments (energy using equipment and power supply facilities), induce changes in other sectors level of output (and inputs), and these are reflected in appropriate sectoral multipliers (jobs per dollar spent). The analytical approach used here is similar to that in Geller, DeCicco and Laitner (1992), Laitner, Bernow and DeCicco (1998), and Goldberg *et al.* (1998).

The analysis tracks changes in expenditures on more efficient lighting, residential appliances, commercial equipment, heating and cooling, building shells, motors, automobiles and trucks, industrial processes and other technologies, that reduce combustion of high carbon fossil fuels. It also tracks the savings in energy bills to households, offices and manufacturing owing to these investments. As the energy bill savings exceed the incremental investments, greater portions of incomes are available to be re-spent, not on fuels but on the myriad goods and services that households and businesses typically purchase. Some sectors, primarily those supplying conventional energy and high carbon resources could decline in the near term Overall, both the changes in investments and the re-spending of savings stimulate the state's entire economy, as each sector must purchase materials and products from other sectors to be able to produce to satisfy the increased demand for goods and services.

Table 2: Macroeconomic Impacts of the Policy Scenario

Year	Net Change in Jobs (Actual)	Net Change in Wage and Salary Compensation (Millions of 1996$)	Net Change in GSP (Millions of 1996$)
2005	17,400	$560	$540
2010	38,600	$1,250	$1,140

Table 2 provides the net economic benefits in Florida of the set of national policies and measures that would accelerate the use of energy efficient equipment and renewable technologies and resources throughout the country, including Florida. By the year 2010, Florida's wage and salary earnings would increase by just over $1 billion and employment would increase by just under 39,000, relative to the reference case for that year. At the same time, Gross State Product is projected to increase by over $1 billion in 2010.

Table 3 provides detailed results for the 23 sectors analyzed in this study, for the year 2010. The table shows how each of the major economic sectors are affected in the year 2010 in the Policy Scenario. It should be noted that the results in this table are not intended to be precise forecasts of what will occur, but rather approximate estimates of overall impact. The two sectors that benefit most are the service sectors and the construction industry.

As might be expected, the energy supply industries incur overall losses. But these results must be tempered somewhat as the energy industries themselves are undergoing internal restructuring. For example, as restructuring takes place and the electric utilities engage in more energy efficiency services and other alternative energy investment activities, they will undoubtedly employ more people from the business services and engineering sectors. Hence, the negative employment impacts in these sectors should not necessarily be seen as job losses, rather they might be more appropriately seen as a redistribution of jobs in the overall economy and future occupational tradeoffs.

These analyses are approximate and indicative. They assume that labor, plant and materials would not otherwise be fully employed under baseline conditions and would be available with the policy-induced investments. They do not account for a variety of feedbacks, e.g. from price changes and inflation. The results of the analysis do not include other productivity benefits that are likely to stem from the efficiency investments, which could be substantial, especially in the industrial sector. They do not reflect the potential for policy-induced innovation and scale economies across all sectors. Finally, the analysis does not reflect the full benefit of the efficiency investments, since the energy bill savings beyond 2010 are not incorporated in the analysis.

While these increases are significant, the impacts are relatively small in comparison to overall economic activity. For instance, increasing the State's GSP by $1.14 billion in 2010 represents only 0.2 percent of the $484 billion (1996$) projected GSP in that year. Nonetheless, the analysis indicates that in helping to achieve the national and international goals of climate protection, Florida would not compromise its economic vitality. At the same time, the State would shift its energy supply and use to a more advanced, efficient and productive basis, and would reduce its combustion of fossil fuels, thereby enhancing its environmental quality and public health.

Table 3: Macroeconomic Impacts of the Policy Scenario by Sector in 2010			
Sector	**Net Change in Jobs (Actual)**	**Net Change in Wage and Salary Compensation (Millions of 1996$)**	**Net Change in GSP (Millions of 1996$)**
Agriculture	900	$20	$30
Other Mining	0	$0	$0
Coal Mining	0	$0	$0
Oil/Gas Mining	(1,000)	($10)	($50)
Construction	7,700	$250	$260
Food Processing	100	$10	$10
Other Manufacturing	1,600	$90	$120
Pulp and Paper Mills	0	$0	$10
Oil Refining	0	$0	$0
Stone, Glass, and Clay	400	$20	$30
Primary Metals	200	$10	$20
Metal Durables	600	$40	$60
Motor Vehicles	1,200	$70	$80
Transportation, Communication, and Other Utilities	2,100	$120	$200
Electric Utilities	(2,000)	($200)	($790)
Natural Gas Utilities	0	$0	$10
Wholesale Trade	(300)	($10)	($20)
Retail Trade	3,300	$70	$110
Finance	2,200	$100	$190
Insurance/Real Estate	400	$20	$110
Services	15,400	$420	$490
Education	1,800	$60	$60
Government	4,000	$170	$210
Total	**38,600**	**$1,250**	**$1,140**

6. Conclusions

Analysis and experience have shown that there are ample technological and policy opportunities for the U.S. to significantly reduce its greenhouse gas emissions at a net economic benefit. National policies and measures would overcome market, institutional and other barriers to the more rapid and widespread diffusion of advanced and more efficient energy technologies and cleaner energy resources. America's Global Warming Solutions showed that the U.S. could reduce its emissions 36 percent below projected levels for 2010, 14 percent below 1990 levels, with net economic savings to households, almost 900,000 net additional jobs, and significant reductions of pollutants that harm human health and the environment. These improvements in technology, environment and economy would be widespread across the country.

This study has analyzed the impacts of this national strategy on Florida, which has significant vulnerabilities to climate change owing to its location and the character id its economy. It finds that the set of national policies and measures of America's Global Warming Solutions would reduce carbon emissions in Florida by about 36 percent in 2010, bringing it back to the 1990 level. This would be achieved with increasing annual savings, which would reach about $300 per household in 2010. Thus, over the period through 2010 about $17 billion cumulative net savings to Florida's households and businesses, from energy bill reductions well in excess of their incremental investments in the new and more efficient energy technologies and cleaner resources. About 39,000 additional jobs would be created in the State by 2010.

The risks of climate disruption to future generations throughout world, the U.S. and Florida are too great to delay early and sustained reductions of greenhouse gas emissions. The U.S. can fulfill its historic responsibility to meet the challenge of climate change, by taking actions that fulfill its Kyoto obligations while establishing momentum to achieve the deeper long-term reductions in greenhouse gas emissions that are required for climate stabilization. The citizens and economy of Florida can support and participate in these actions and changes, and would derive economic and environmental benefits in the near-term and well into the future.

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