

The Science of Climate Change and Its Importance and Opportunities for Florida

Executive Order 07-128 created the Governor’s Action Team on Energy and Climate Change in the summer of 2007. The Action Team was tasked to develop a series of recommendations for addressing climate change in Florida. A brief description of the science of climate change and the potential impacts to Florida is provided here to assist the reader in understanding the nature of these recommendations and the importance of taking action. There are numerous benefits, both environmental and economic, which accrue to the State of Florida and the private sector due to pursuing energy efficiency and investing in alternative energy technologies.

Natural Warming

The sun’s energy drives the Earth’s weather and climate and heats its surface. Some of this energy radiates back into space, but some is trapped by naturally occurring greenhouse gases (GHGs) such as carbon dioxide (CO₂), water vapor, and other gases. GHGs are necessary to life as we know it, because they keep the planet’s surface warmer than it otherwise would be. However, as the concentrations of these gases continue to increase in the atmosphere, the Earth’s temperature is rising above traditional levels. According to the U.S. National Oceanic and Atmospheric Administration (NOAA) and the U.S. National Aeronautics and Space Administration (NASA) data, the Earth’s average surface temperature has increased by about 1.2 to 1.4° Fahrenheit in the past 100 years. The eight warmest years on record (since 1850) have all occurred in the past 10 years since 1998, with the warmest year being 2005.

Human Activities are Changing the Earth’s Climate

In May 2001, The White House asked the National Academy of Sciences (NAS) to assess the current understanding of climate change by answering key questions related to both causes of climate change and projections of future change. The NAS released a report, *Climate Change Science: An Analysis of Some Key Questions (2001)*, and a second report, *Understanding and Responding to Climate Change (2008)*, the latter of which stated, “... [C]limate changes observed over the last several decades are likely mostly due to human activities” and “... additional evidence collected over the past several years has increased confidence in this conclusion.”

The accumulation of some GHGs in the atmosphere is a natural part of the Earth’s climate system and has been beneficial to our living environment. However, due to the extensive combustion of fossil fuel and land use changes over the past several hundred years, concentrations of GHGs in the Earth’s atmosphere now exceed pre-industrial era amounts. Between 1970 and 2004, global emissions increased by 70%, with a full 24% increase occurring in the 14 years between 1990 and 2004. During that time, GHGs increased from 28.7 to 49

gigatons (GT). Of those, emissions of CO₂ grew by about 80% between 1970 and 2004, with the largest increase of 28% occurring during the 14 years between 1990 and 2004.¹

The largest growth in global GHG emissions occurring between 1970 and 2004 came from the energy supply sector, with a 170% increase. The next-largest growth in emissions came from the transportation sector with 120%, then the industrial sector with 65%, and finally land use and forestry with 40%. Between 1970 and 1990, direct emissions from agriculture grew by 27%. Without specific action, by 2030, global emissions of CO₂ from energy use are projected to grow from 45% to 110% more than emissions measured in the year 2000.²

Fossil fuel consumption in automobiles and electric power plants worldwide results in the emission of approximately 5.5 billion metric tons of CO₂ each year, and deforestation contributes an estimated additional 1.6 billion metric tons annually.³ GHG increases of methane and nitrous oxide are due primarily to agricultural activities.

If GHGs continue to increase, climate models predict that the average temperature at the Earth's surface could increase from 2.5 to 10.4°F by 2100.⁴ Members of the NAS and the scientific members of the Intergovernmental Panel on Climate Change (IPCC) are certain that human activities are changing the composition of the atmosphere, and that increasing the concentration of GHGs will change the planet's climate.⁵ At this point in time, scientists do not know with certainty how much it will change, at what rate it will change, or what the exact effects will be.

Florida's Emissions of Greenhouse Gases

Florida's net GHG emissions increased from 230.9 million metric tons in 1990 to 309.4 million metric tons in 2005 as shown in Figure 1.

Figure 1. Actual and projected greenhouse gas emissions in Florida, 1990–2025

[PLACE GRAPHIC FIGURE 1]

¹ Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report, Working Group III, May 2007, available at: http://news.bbc.co.uk/1/shared/bsp/hi/pdfs/04_05_07_ipcc_report.pdf

² Ibid.

³ U.S. National Aeronautics and Space Administration. "Earth Observatory: The Carbon Cycle," available at: http://earthobservatory.nasa.gov/Library/Carboncycle/carbon_cycle.html

⁴ IPCC. 2007. "Climate Change 2007: the Physical Science Basis," Solomon, S., D. Qin, M. Manning, eds. Contribution of Working Group I to the Fourth Assessment Report of the IPCC, available at: http://news.bbc.co.uk/1/shared/bsp/hi/pdfs/02_02_07_climate_report.pdf

⁵ U.S. Environmental Protection Agency. "Climate Change: Basic Information," available at: <http://www.epa.gov/climatechange/basicinfo.html>

Florida's GHGs come primarily from fossil fuel combustion attributable to the utility and transportation sectors. The utility sector accounts for 42% of GHGs and the transportation sector accounts for 36% of GHGs. This means that Florida's GHGs are largely attributable to supplying consumer demand for electricity and transportation. Future GHG growth in Florida is anticipated to come from these same sectors as seen in Figure 2.

Figure 2. Actual and projected greenhouse gas emissions in Florida by source, 1990–2025

[PLACE GRAPHIC FIGURE 2]

While climate science is complex and evolving, the scientific community has reached a strong consensus regarding the science of global climate change. The world is undoubtedly warming. This warming is largely the result of emissions of carbon dioxide and other GHGs from human activities, including fossil fuel combustion, industrial processes, and changes in land use, such as deforestation. Although legitimate differences of opinion exist regarding the most effective mix of policies to address this problem, mitigation of GHGs is the essential component.

The Effects of Global Climate Change on Florida

With the release of each new report by the IPCC and the NAS, the consequences of global climate change are becoming better understood. By virtue of Florida's geography, changes in climate and sea level are of particular concern.

The impacts of climate change on Florida will result directly from an increase in air and water temperature, sea level rise, and a change in precipitation levels.

- **Air Temperature Rise**—The IPCC predicts that the average temperature at the Earth's surface could increase from 2.5 to 10.4°F by 2100.⁶
- **Sea Level Rise**—Higher temperatures are expected to raise sea level by expanding ocean water, melting mountain glaciers and small ice caps, and causing portions of the coastal section of the Greenland and Antarctic ice sheets to melt or “slide” into the ocean. The IPCC estimates that the global average sea level will rise between 4 and 35 inches, depending on the magnitude of warming.
- **Future Precipitation and Storm Changes**—Tropical storms and hurricanes are likely to become more intense, produce stronger peak winds, and produce increased rainfall over some areas due to warming sea surface temperatures (which can strengthen these storms).⁷

⁶ IPCC. 2007. “Climate Change 2007: the Physical Science Basis,” Solomon, S., D. Qin, M. Manning, eds. Contribution of Working Group I to the Fourth Assessment Report of the IPCC, available at: http://news.bbc.co.uk/1/shared/bsp/hi/pdfs/02_02_07_climatereport.pdf.

Each of these changes will impact the various sectors of Florida's economy, such as health, agriculture, forestry, water resources, coastal areas, and animal and sea-life species.

- **Health**—Human health can be affected directly and indirectly by climate change in part through extreme periods of heat and cold, storms, and diseases spread by mosquitoes in warm climates.⁸ Florida's population of senior citizens, particularly those living alone, would be most adversely affected by heat waves and heat-related illnesses.⁹ Further, sea surface warming could increase health threats from marine-borne illnesses, shellfish poisoning, and harmful algal blooms.¹⁰
- **Agriculture**—Citrus crop yields could decrease with warmer temperatures in the southernmost part of Florida because of the lack of a sufficient dormant period. Changes in cotton and sorghum production are unclear because increasing CO₂ levels and rainfall would likely increase yields. However, the shorter growing season brought on by increasing temperatures could result in plants producing fewer or smaller seeds and fruit.¹¹ In the short-term, it appears there may be benefits in the agricultural section from global warming; however, the effects in the long-term are unknown.
- **Forestry**—Changes in tree species, geographic extent, and the health and productivity of forests can be expected with a warmer climate. The mixed conifer/hardwood forests found in the northern and Panhandle sections of Florida are likely to retreat northward. These forests eventually would give way to wet tropical forests such as tropical evergreen broadleaf forests and dry tropical savanna. If conditions become drier, the current range of forests could be reduced and replaced by grasslands and pasture.¹²
- **Water Resources**—Evaporation is likely to increase with a warmer climate, and that could result in lower river flow and lower lake levels during drier periods. If stream flow and lake levels drop, groundwater could also be reduced. Saltwater intrusion from sea level rise could threaten aquifers used for urban water supplies. These changes could further stress south Florida's water resources. In contrast, more intense rain could increase flooding in some areas.¹³
- **Oceans** – High water temperatures lead to the bleaching of coral, which is the expulsion of the symbiotic algae that corals need for survival, growth, and reproduction. While some

⁷ Ibid.

⁸ U.S. Environmental Protection Agency. "Climate Change: Basic Information," available at: <http://www.epa.gov/climatechange/basicinfo.html>

⁹ U.S. Environmental Protection Agency. "Climate Change and Florida." EPA 230-F-97-008i, September 1997. [http://yosemite.epa.gov/OAR/globalwarming_nsf/UniqueKeyLookup/SHSU5BUKSV/\\$File/fl_impct.pdf](http://yosemite.epa.gov/OAR/globalwarming_nsf/UniqueKeyLookup/SHSU5BUKSV/$File/fl_impct.pdf)

¹⁰ Ibid.

¹¹ Ibid.

¹² Ibid.

¹³ Ibid.

corals can recover from bleaching other corals will be eliminated which will reduce local and regional coral diversity. Ocean acidification is another impact of climate change on oceans is caused by the increases in atmospheric concentration of CO₂. Higher CO₂ concentration in the air increases the amount of CO₂ dissolved ocean waters. Increased ocean acidity and lowers the concentration of carbonate which corals and other marine organisms need to build their skeletons.¹⁴

- **Coastal Areas**—As sea level rises, Florida’s wetlands and lowlands along the Gulf and Atlantic coasts could be inundated. Adverse impacts in these areas could include loss of land and structures, loss of wildlife habitat, accelerated coastal erosion, exacerbated flooding and increased vulnerability to storm damage, and increased salinity of rivers, bays, and aquifers, which would threaten supplies of fresh water.¹⁵
- **Land Plants and Animals**—Scientists are seeing spring events occurring earlier each year. In North America, a northern shift is occurring in plant and animal ranges. Scientists are seeing shifts in ranges and changes in algal, plankton, and fish abundance in Florida associated with rising water temperatures, as well as related changes in salinity, oxygen levels, and circulation.¹⁶

If Florida and other states and nations act now to reduce GHG emissions, many of these effects can be avoided, minimized, or mitigated. The actions necessary to reduce GHG emissions are available to every household, every community, and every state in the nation. There is a cost associated with some of these actions, but there is also a direct cost for failing to act.

Addressing Climate Change through a Market-Based Solution

There is more than one method for encouraging the reduction in GHGs within the Florida economy. Options range from taxing to mandatory cuts to seeking market-based solutions. The U.S. Environmental Protection Agency had success in the 1980s with reducing acid rain through the use of market-based solutions, and many in the world believe the same can be accomplished with GHGs. The market-based solution being pursued by the European Union, as well as the Regional Greenhouse Gas Initiative and the Western Climate Initiative here in the United States, are using a cap-and-trade program to reduce emissions. This initiative is discussed at greater length in Chapter 4. By seeking a market-based solution to Florida’s climate change concerns, the resulting economic stimulus will provide multiple benefits to the state. Not only will Florida benefit by slowing climate change through reducing GHGs but it will stimulate the economy through the creation of new energy technologies, new business opportunities, new green jobs, and a reduction in the state’s dependence on foreign sources of fuel, which translates to better energy security.

¹⁴ The Pew Center on Global Climate Change, [Coral Reefs & Global Climate Change](http://www.pewclimate.org/docUploads/Coral_Reefs.pdf), February 2004
http://www.pewclimate.org/docUploads/Coral_Reefs.pdf

¹⁵ U.S. Environmental Protection Agency. “Climate Change and Florida.” EPA 230-F-97-008i, September 1997.
[http://yosemite.epa.gov/OAR/globalwarming.nsf/UniqueKeyLookup/SHSU5BUKSV/\\$File/fl_impct.pdf](http://yosemite.epa.gov/OAR/globalwarming.nsf/UniqueKeyLookup/SHSU5BUKSV/$File/fl_impct.pdf)

¹⁶ Ibid.

Market mechanisms are an efficient means to address GHG reductions because these mechanisms use price signals to provide incentives to individuals. To enhance the effectiveness of market mechanisms, consumer outreach programs can educate citizens on the critical role that everyday choices play in reducing GHG. By making conscious choices to conserve energy and to use energy more efficiently, Floridians can make a measureable difference in reducing GHG emissions.

Stimulating Economic Development

In order to address Florida's energy future, the public and the private sector must invest in new fuel sources, new technologies, new infrastructure, and more efficient homes, buildings, appliances, and transportation. These investments also represent real business opportunities in the private sector.

Governor Crist has pointed out repeatedly that there are many commercial opportunities that can be created by new economic ventures in Florida, specifically that "there is gold in green" for Florida in alternative energy technologies. If Florida is successful in expanding hydrogen, biomass, solar, wind, and ocean energy programs, it will be poised to provide other states and nations with the technologies, expertise, and manufactured parts to take advantage of Florida's renewables industry. Entrepreneurs and businesses have the opportunity to invest in new technologies and build an alternative energy market while strengthening Florida's energy future.

Efforts to address energy security and global climate change are creating new markets for products and services that did not exist 20 years ago. One particular sector of Florida's economy that is already seeing new investments is agriculture. In order to reduce national reliance on foreign sources of petroleum, the transportation sector is investing in biofuels. Evidence of the economic opportunities in Florida for alternative fuels is offered by the success of the past three Farm-to-Fuel programs sponsored by the Florida Department of Agriculture and Consumer Services (DACS) and with the movement of biofuel companies into the state and start-ups created within the state.

Businesses and investors are keenly interested in the new opportunities offered by alternative fuels and emerging technologies. During both of Governor Crist's "Serve to Preserve" Summits on Global Climate Change in 2007 and 2008, attendees listened to both emerging and established technology companies capitalizing on the commitment to develop alternative forms of energy. At the state, national, and global levels, venture capitalists are investing in the advanced energy technology sector. In 2006, venture capitalists invested \$740 million into biofuel firms, compared with \$111 million invested in 2005.¹⁷ The broader advanced energy

¹⁷ Cleantech Venture Network. "Envy with Green(tech)," TeleSoft Partners. 2007.

technology sector attracted \$2.9 billion in venture capital in 2006, outstripping even the FY2008 federal appropriations of \$2.7 billion.¹⁸

Achieving Energy Security

Approximately 58% of the oil consumed by the United States is imported. Of total imports, 49% originates in the Western Hemisphere, 21% from Africa, 16% from the Persian Gulf, and 14% from others sources.¹⁹ Projected trends by the U.S. Department of Energy show dependence on oil imports continuing to increase. In May 2001, the National Energy Policy Development Group concluded that this imbalance, "...if allowed to continue, will inevitably undermine our economy, our standard of living and our national security." Geopolitical challenges are driving the United States to focus on energy security by increasing the domestic production of energy rather than depending on foreign nations.

The achievement of energy security in the United States has focused on five main objectives:

1. Increase the energy efficiency of transportation, appliances, buildings, power plants, and transmission lines;
2. Modernize energy infrastructure by adding new transmission facilities, retiring old generators that release high emissions, and investing in public transportation;
3. Diversify the fuels used in the electric and transportation sectors;
4. Develop cleaner domestic fuels; and
5. Invest in and encourage alternative and new technologies.

Florida is looking to achieve those same objectives on a state level. Increasing energy efficiency and conservation in our homes, offices, buildings and industry can have the largest impact on increasing energy security. In addition to every citizen taking personal responsibility to pursue energy efficiency and conservation, the state must upgrade and modernize its energy infrastructure. These upgrades need to come in the form of investments in cleaner electric generators, new transmission facilities that can accommodate renewable energy sources, and public transportation systems.

The fuel that drives Florida's electric generators comes from out-of-state and out of the country. For example, coal is delivered to Florida by rail or barge, natural gas is delivered through pipelines, oil is delivered by tanker, and nuclear fuel is delivered by rail and truck. Florida receives 98% of its transportation fuel by sea via barge and tanker ship into seven ports. Any

¹⁸ IBID

¹⁹ United States Energy Information Administration.

one of these transport systems that fuel Florida’s electricity and transportation sectors could be, and has been, disrupted by a disaster or severe weather.

In an effort to diversify the state’s fuel supply and attempt to keep consumer costs affordable, a number of Florida-based utilities are looking at nuclear facilities for the first time in decades. Because nuclear plants have zero GHGs in the production phase of their plant life cycle, nuclear energy has taken on increased importance in strategies for meeting future energy demand. Two Florida utilities have expressed interest and intent to expand current nuclear capacity or construct new nuclear generating facilities. Through the Energy Policy Act of 2005, the federal government offers tax incentives, loan guarantees, and other subsidies for nuclear power generation. Florida also enacted statutory provisions in 2006 and 2008 to allow for “advanced cost recovery” for nuclear power and its associated transmission system. Ongoing concerns regarding nuclear waste disposal remain a key issue that needs to be addressed.

Florida’s utilities are also increasing investments in energy efficiency and in renewable sources of electricity generation. Important changes to Florida law enacted by the 2008 Florida Legislature expanded the range of energy efficiency program coverage and provided added incentives to utilities to achieve additional efficiency gains. Further, investments in renewable sources of energy are increasing in Florida due to increased fossil fuel prices as well as a range of policy actions that have removed market barriers, offset capital costs, and provided guidance for the establishment of a renewable portfolio standard for Florida utilities.

In the transportation sector, national energy security issues focus on U.S. refineries. Currently, domestic oil refineries are running at near-maximum capacity and represent a bottleneck in the oil supply chain. Due to environmental, safety, and aesthetic reasons, adding oil refinery capacity is difficult. Biofuels may help stabilize near-term oil prices by serving as fuel extenders, allowing fuel companies to sell more gallons than their petroleum refineries are capable of producing. Since biofuel plants do not pose as many of the same concerns as oil refineries, they are viewed as a solution to the refinery capacity dilemma. As the demand for transportation fuels increases, Florida’s infrastructure for producing, storing, and transporting that fuel or biofuel to market will need to expand, including new storage capacity in Florida’s ports.

Conclusion

Few single elements have as much economic impact and are as critical to the economic health of the state as energy. Whether it is the electricity to run homes or businesses or the petroleum to power transportation systems, energy is the lifeblood of the economy. Due to its economic importance, one of the primary goals of Florida’s energy policy must be to ensure a clean, reliable, fair, and affordable energy supply. This goal is consistent with reducing GHGs because, by encouraging investment in energy efficiency and the use of clean renewable energy sources, Florida will be reducing its demand for imported fuel and securing better sources of energy for the future.

To position the state to take economic advantage of the emerging technology industry, Florida must act now to reduce GHG emissions. Hand-in-hand with pursuing energy efficiency measures that build on the 2008 Legislature's work, Florida should encourage the development of alternative energies to achieve the goals of:

- Mitigating the potential impacts to Florida from climate change,
- Further stimulating economic development in our state associated with the existing and emerging alternative energy industries, and
- Achieving energy security by reducing our dependence on foreign fuels.

Acronyms and Abbreviations

CO ₂	carbon dioxide
DACS	[Florida] Department of Agriculture and Consumer Services
GHG	greenhouse gas
IPCC	Intergovernmental Panel on Climate Change
NAS	National Academy of Sciences
NASA	National Aeronautics and Space Administration
NOAA	National Oceanic and Atmospheric Administration
OPEC	Organization of the Petroleum Exporting Countries

Units of Measure

GT	gigatons
MMtCO _{2e}	million metric tons of CO ₂ equivalent