4 Energy Production, Use, and Vulnerability to Climate Change in the Southeast USA

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The southeastern USA is home to large and varied, though unevenly concentrated, energy resource reserves, including coal, gas, and oil as well as renewable energy sources such as solar, biomass, and wind. In addition to being one of the most important domestic producers of energy in the United States, it is also one of the biggest users.

Key Findings

- At approximately 27% of the USA total, the Southeast (SE) consumes more energy as a region and per person than any other NCA region.
- Energy consumption in the SE in 2009 was dominated by the industrial sector (31%) and transportation (28%), both of which are higher than the national average.
- Residential use accounted for 23% of SE energy consumption while commercial activity consumed 18%, both of which are lower than the national average.
- As the climate changes, concerns exist for energy services in the SE due to the potential for changing patterns of demand, such as increased demand for air conditioning, as well as the potential impacts on electricity generating capacity and energy distribution infrastructure.
- An improved ability to project climate change and its impacts at a more local level, a better understanding of changing regional patterns of energy use, and enhanced strategies to improve the resiliency of energy supply systems are just a few of the areas that will be needed to ensure energy supplies in the SE.

4.1 Status and Outlook for Energy Production and Use in the Southeast

For purposes of this chapter, the Southeast is comprised of Louisiana, Alabama, Mississippi, Florida, Georgia, South Carolina, North Carolina, Virginia, Tennessee, Kentucky, Arkansas, Puerto Rico, and the US Virgin Islands. Unless otherwise noted, the statistics presented are focused on the 11 continental states. In 2010, states in the SE produced 15% of the coal and approximately one-quarter of the nation's domestic crude oil (EIA 2012a and b). In 2009, three SE states ranked in the top ten nationally in renewable energy installed or cumulative capacity in millions of watts (MW) in one or more resource types: Alabama (fifth in biopower), Florida (fourth in biopower and fifth in solar photovoltaic or PV), Louisiana (second in biopower), and North Carolina (tenth in annual solar PV capacity additions) (NREL 2009). However, no southeastern state ranked in the top ten in wind or geothermal development. In addition to being a major supplier of energy, the region is also a large consumer of electricity and other fuels. Of the 11 states in the SE, six import more electricity than they generate; two with greater than 20% deficit and four between 20% and 0% deficit. Puerto Rico and the US Virgin Islands have few conventional energy sources and generate most of their electricity from imported fossil fuels (EIA 2012c).

This chapter explores the status of the SE as a source and user of energy. It also looks at how a changing climate may impact the region's ability to supply energy into the future and identifies key uncertainties in the understanding of these issues.

4.1.2 Existing Energy Resources in the Southeast

The SE is home to large and varied, though unevenly concentrated, energy resource reserves. Approximately 10% to 11% of national hydroelectric power comes from the SE, with more than half of that from Alabama and Tennessee; some additional future potential still available (Kosnick 2008). Coal deposits are distributed throughout Appalachia and beyond. Natural gas and oil reserves exist both onshore and offshore. Insolation is above average for the eastern part of the nation. Significant amounts of biomass energy are available. In specific locations, wind and geothermal resources are also potential sources of energy (EIA 2012d; NREL 2012). In the ongoing development of these various energy resources, a number of issues will have to be considered, including permitting requirements, costs, transmission distance, environmental impacts, and the number of projects needed to reach generation goals.

Coal. In 2011, recoverable coal reserves in the SE were estimated at 2,081 million short tons (approximately 10.8 of the USA total) (EIA 2012e). Southeastern coal reserves are primarily located in two key states, including Kentucky with 1,419 million tons and Virginia with 348 million tons. About 71 percent of coal mined in the US is transported by train for at least part of its trip to market. Coal can also be transported by barge, ship, truck, and even pipeline (EIA 2012f).

There are also lignite resources available in Arkansas, Mississippi, and Louisiana that could play a role in future electric generation. Mississippi Power Company's 582 MW Integrated Gasification Combined Cycle (IGCC) power plant in Kemper County, for example, is set to burn lignite as its fuel supply beginning in 2014, and will also include carbon capture and sequestration technology (Southern Company 2012).

Oil and Natural Gas. Figure 4.1 shows natural gas production in the USA from 1990 through 2009 with forecasts through 2035. While onshore and offshore conventional supplies make up a significant portion of historical production, shale gas is forecast to play a key role in future supply due to improved exploration and production technologies (EIA 2011a). Key shale finds include the Fayetteville shale in Arkansas and the Haynesville/Bossier in Louisiana. Of the 97 trillion cubic feet (Tcf) of shale play reserves in the USA, 27 Tcf are found in the Haynesville/Bossier and Fayetteville plays (EIA 2012g).

Insert Figure 4.1

The distribution of natural gas occurs in a major pipeline network (Figure 4.2) with significant pipeline capacity in the SE. Several liquefied natural gas (LNG) terminals are in Louisiana and Georgia (EIA 2012h).

Insert Figure 4.2

Biomass. One estimate of the biomass resource in the SE is 106,710 thousand tons of material per year, which is 25% of the USA total (Brown et al. 2010). Wood pellet mills are among the most successful group of new woody biomass consumers, with pellet mills currently consuming 6.2 million tons of wood per year and producing 3.1 million tons of export quality wood pellets (Forisk Consulting 2011). This is largely due to demand for biomass co-firing in European countries that have opted to use wood pellets because of increasing fossil fuel prices and environmental concerns (Force Technology 2012).

Nuclear. Of the 104 nuclear reactors in the USA, 37 are located in the SE and account for more than 36,400 MW of electrical power. In 2010, these units generated some 285 billion Kwh, operating at a capacity factor slightly less than 90% (Nuclear Energy Institute 2011).

Hydro and Marine Hydrokinetic. Every SE state except Mississippi generates some electricity via hydroelectric power. In 2010, the SE produced 14% of the total USA hydroelectric (EIA 2012i). Tennessee, Arkansas, and Mississippi each have approximately 4 gigawatts (GW) of developable hydroelectric resources remaining. North Carolina, Georgia, Alabama, and Louisiana have between 2 and 4 GW of developable hydroelectric resources remaining. South Carolina, Kentucky, and Florida have about 1 GW of hydroelectric potential each (NREL 2004). These resources are mostly available from retrofitting and upgrading existing hydroelectric dams, or installing small or microscale hydroelectric systems.

The US Department of the Interior estimates that 0.1% of the Florida Straits Current could supply 35% of Florida's electrical demand via marine hydrokinetic electric generation (MMS 2006). Some energy generation potential also exists for Georgia (Hunt et al. 2010) and North

Carolina (Seim et al. 2010) and likely in similar fashion for South Carolina from wave, tidal, and currents using marine hydrokinetic technology.

Solar. Solar resources in the 11 states of the SE are not as robust as those found in the western USA, but resources near or in excess of 5 watts per square meter are significantly better than in much of the country east of the Mississippi River. Among SE states, Florida has the best solar resources as measured in $kWh/m^2/d$ (NREL 2008a). Puerto Rico and the US Virgin Islands also have high solar resource potential (Lantz et al. 2011, Irizarry-Rivera et al. 2008).

Wind. In the SE wind energy resources are less robust than resources in the Plains states; however, wind resources exist in specific mountainous, coastal, and offshore areas. A scenario outlined by the National Renewable Energy Laboratory estimated that as part of a national strategy to generate 20% of the nation's electricity from wind energy by 2030, the SE could provide between 17 and 32 GW of wind energy capacity, including onshore and offshore resources (NREL 2008b). North Carolina, for example, has among the best potential offshore wind resources in the country (Schwartz et al. 2010).

Geothermal. The SE has few viable opportunities for geothermal power generation sites. However, co-produced fluids, such as water from oil and gas production, could provide up to 771 MW of geothermal energy using existing wells in Alabama, Arkansas, Florida, Louisiana, and Mississippi (Green et al. 2006).

Insert Case Study: Louisiana

Energy Efficiency. Energy efficiency initiatives in the SE are a powerful way to reduce per capita energy consumption, conserve fuels, and reduce the need for new generating capacity into the future. Additional energy efficiency resources and initiatives are discussed in chapters 5 and 12.

4.1.3 Landscape of Energy Production, Delivery, and Use in the Southeast

Electricity Production. Peak demand for electricity in the SE, which was more than 238 GW in 2010, represents about 32% of the total national demand. Likewise, generating capacity in the SE is approximately 32% of the total nationwide. Nationally, fossil fuel-based capacity represents some 71% of the total generating capacity while nuclear, hydro, and other renewables make up around 25%. In the SE, traditional fossil-based generating capacity is some 235 GW or 78% of the total generating capacity of 300 GW. In addition to fossil fuels, nuclear power in 2009 provided 36 GW, and renewables and pumped storage 28 GW of generating capacity (Table 4.1).

Insert Table 4.1

Insert Case Study: DeSoto

The SE has a balanced portfolio of resources from an operational perspective. Traditional base load resources such as nuclear and coal provide power around the clock. Pumped storage and gas turbine units provide energy during peak load conditions. The generation of electricity on an hourly basis, measured in kilowatt-hours, provides a different picture. In 2009 nuclear power provided around 292 billion Kwh of electricity, some 25% of the electrical needs of the SE. In contrast, coal generation in 2009 delivered 491 billion Kwh, while natural gas combined cycle units produced some 277 billion Kwh of electricity. From 2005 to 2009, coal fired generation dropped from 50% to 43% of the total generation, while natural gas picked up the majority of that difference (EIA 2011b).

With regard to growth in the electric power sector, a 2004 study by the Department of Energy projected a 63% to 79% increase in thermoelectric capacity by year 2025 for much of the Southeast (Figure 4.3) (Hoffmann et al. 2004). Updated estimates for growth in the electric power sector (all fuel types) indicates more modest growth in electric generating capacity between 2010 and 2035 of 23% for Florida and 15% for the rest of the region. The 15% increase noted represents the combined increase in capacity for the SERC Reliability Corporation Delta (SRDA), Southeastern (SRSE), Central (SRCE), and Virginia-Carolina (SRVC) regions (EIA 2012j).

Insert Figure 4.3

With regard to renewables, including conventional hydropower, the SE produced 67 billion Kwh in 2009 (EIA 2011b) with this value expected to grow over time. For example, 29 MW of generation capacity from wind turbines currently exist at the Tennessee Valley Authority's (a) Buffalo Mountain site (TVA 2012a), and at least five utility-scale wind farms have recently been proposed in the following locations: Invenergy, NC, 80 MW; Iberdrola, NC, 300 MW; Invenergy, NC, 300 MW; Next Era, KY, 100 MW; and Wind Capital Group, FL, 150 MW (News & Observer of Raleigh 2011, Iberdrola 2011, Beamon 2011, Toncray 2011, Wind Capital 2011).

As another example, TVA has 300 kW of solar photovoltaic capacity installed, an additional 16 MW under contract, and 34 MW approved under the *Generation Partners* program (TVA 2012b). Duke Energy owns, purchases, or has installed up to 24 MW of solar capacity in North Carolina and South Carolina (Duke Energy 2012). Georgia Power is soliciting 50 MW of large-scale solar capacity to be added to the Georgia system by 2015 (Platts 2011), and National Solar Power LLC has announced its plans to develop a 400 MW solar power plant in Florida (Heller 2011). Florida Power and Light's existing three solar power plants generate 110 MW of clean energy for 4.5 million customers throughout the state, preventing the emission of more than 3.5 million tons of greenhouse gas-equivalent to removing 25,000 cars from the road every year (FPL 2012).

The Caribbean also has significant renewable energy resources. For example, a recent study estimated available resources for electricity production on the island of Puerto Rico (Table 4.2) (Irizarry-Rivera 2008). In 2010, the US Virgin Islands signed a memorandum of understanding with both the US Department of Energy (DOE) and US Department of the Interior (DOI) to establish a deployment strategy for the islands' significant renewable energy resources. The plan includes transportation, electricity generation and transmission, energy efficiency, tourism and industry, and public education (NREL 2010). As of March 2012, several utility-scale wind and solar projects were under construction in Puerto Rico, according to information provided by the Puerto Rico Energy Affairs Administration (PREAA 2012).

Insert Table 4.2 here

Electrical Transmission System. The electrical transmission system in the SE is widely interconnected throughout the Eastern Interconnection. The Eastern Interconnection links states east of the Rocky Mountains, except Texas, with more than 280,000 miles of transmission lines of more than 100 kilovolts (kV). The SE grid consists of almost 110,000 miles of transmission lines above 10 kV and primarily includes the SERC Reliability Corporation and the Florida Reliability Coordinating Council, (regional entities that operate and insure reliability of the electrical grid (Figure 4.4) (SERC 2012). As of 2009, this represented 35% of the transmission found in the Eastern Interconnection and 26% of the entire USA transmission of 372,340 miles. In 2009, approximately 8,800 circuit miles of new transmission were added to the North American bulk power system with some 2,600 miles greater than 200 kV. More than 5,000 miles of that new transmission was added in the SE, particularly in Florida. The bulk transmission system has more than 100 kV and is forecast to consist of over 115,000 miles by 2018 with the Eastern Interconnection totaling 296,000 miles within a national system of 407,000 miles of power lines (NERC 2010).

Insert Figure 4.4

Some energy sources have special transmission considerations. For example, DOE has noted that the rapid development of wind power requires substantial additions to the national transmission infrastructure in certain locations due to the geographically-dependent nature of wind resources. The relatively low capacity of wind plants and the short time it typically takes to build a new wind project versus the longer time required to develop new transmission infrastructure add to the challenge (Mills et al. 2009). That said, wind energy-related projects are moving forward to provide electricity for the SE. TVA contracted in 2010 for more than 1,300 MW of wind energy from projects throughout the Midwest (TVA 2012c); and Alabama Power has signed a power purchase agreement for 202 MW of wind energy from Oklahoma (Platts 2011). Pattern Energy has proposed its Southern Cross long-distance transmission project that would connect up to 3,000 MW of Texas wind farm energy to an offloading location in Northeastern Mississippi by 2016 (Southern Cross 2012) and Clean Line Energy has proposed its Plains & Eastern project that would provide up to 7,000 MW of wind energy capacity from farms in Kansas, Oklahoma, and Texas to an offloading point in Memphis, TN, which is TVA territory (Clean Line 2012).

Electricity Assets in the Southeast. The nation's current inventory of electric power generators has a wide range of sizes and ages. Of the nation's 1,266 coal steam electric generating units, for example, the largest (250 MW and up) represents 36% of the generators and have been in service an average of 34 years. The smallest units (0 to 25 MW), which make up 15% of the generators have been in service an average age of 45 years (US EPA 2011). In the SE, there have been numerous coal plant retirement announcements, including 269 MW at 4 units by Dominion Power; 800 MW at four Cliffside units in North Carolina by Duke Power; 1,481 MW at 14 units, also by Duke, each of which was built between 1941 and 1958. Progress Energy is retiring 11 units of 1951 to 1972 vintage in North Carolina totaling 1,513 MW; Southern Company is retiring over 1,094 MW units built in the 1960s. TVA has announced plans to retire 21 coal-fired generating units in Tennessee and Alabama, totaling 3,231 MW at plants built between 1952 and 1959. In total, this represents around 8,388 MW of electrical generating capacity that will eventually be replaced with more efficient, cleaner electrical supply options (EEI 2011).

In the American Society of Civil Engineers (ASCE) *Report Card for America's Infrastructure 2009*, the energy sector received a grade of D+, which is consistent with other segments of USA infrastructure, such as water, roads, bridges, and transit. ASCE has noted that "while progress has been made in grid reinforcement since 2005 and substantial investment in generation, transmission and distribution is expected over the next two decades, demand for electricity continues to grow (25% since 1990) and permitting for much needed modernization of production facilities has been difficult. Projected electric utility investment needs could be as much as $1.5 trillion by 2030 (ASCE 2009)."

Energy Use in the Southeast. At approximately 27% of the USA total, the SE consumes more energy as a region and per person than any other NCA Region (Figure 4.5). That consumption in 2009 was dominated by the industrial sector (31%) and transportation (28%), both of which are higher than the national average. Among industrial energy consumption, Louisiana is substantially higher than other southeastern states. Residential use accounted for 23% of SE energy consumption while commercial activity consumed 18%, both of which are lower than the national average. Of the southeastern states, Florida dominates in terms of consumption (Figure 4.6). It is noteworthy that among residential users, the per capita consumption of energy in the SE has risen steadily since the 1960s (Figure 4.7) (EIA 2012k).

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With regard to petroleum, the SE is the largest consumer of petroleum products in the USA, with one quarter of all petroleum consumed by the region's eleven states (Table 4.3) (EIA 2012l). For example, about 28% of all automotive gasoline consumed in the USA was purchased in the SE in 2009, reflecting both the high population and the number of vehicle miles traveled (VMT) in this region (including Puerto Rico). It is also noteworthy that in addition to having the highest VMT among all NCA regions (Figure 4.8), the per capita VMT in the SE is also the highest (FHA 2009).

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4.2 Impact of Climate Change on energy Supply and Demand in the Southeast
Climate change is of concern for energy services in the SE due to the potential for changing patterns of demand, such as increased demand for air conditioning, as well as the potential impacts on electricity generating capacity and energy distribution infrastructure. The US Climate Change Science Program has summarized this issue as follows (Wilbanks et al. 2008):

> ***How might climate change affect energy consumption in the United States?*** *The research evidence is relatively clear that climate warming will mean reductions in total U.S. heating requirements and increases in total cooling requirements for buildings. These changes will vary by region and by season, but they will affect household and business energy costs and their demands on energy supply institutions. In general, the changes imply increased demands for electricity, which supplies virtually all cooling energy services but only some heating services. Other effects on energy consumption are less clear.*
>
> ***How might climate change affect energy production and supply in the United States?*** *The research evidence about effects is not as strong as for energy consumption, but climate change could affect energy production and supply (a) if extreme weather events become more intense, (b) where regions dependent on water supplies for hydropower and/or thermal power plant cooling face reductions in water supplies, (c) where temperature increases decrease overall thermoelectric power generation efficiencies, and (d) where changed conditions affect facility siting decisions. Most effects are likely to be modest except for possible regional effects of extreme weather events and water shortages.*
>
> ***How might climate change have other effects that indirectly shape energy production and consumption in the United States?*** *The research evidence about indirect effects ranges from abundant information about possible effects of climate change policies on energy technology choices to extremely limited information about such issues as effects on energy security. Based on this mixed evidence, it appears that climate change is likely to affect risk management in the investment behavior of some energy institutions, and it is very likely to have some effects on energy technology R&D investments and energy resource and technology choices. In addition, climate change can be expected to affect other countries in ways that in turn affect U.S. energy conditions through their participation in global and hemispheric energy markets, and climate change concerns could interact with some driving forces behind policies focused on U.S. energy security.*
>
> *In most cases, the availability of peer-reviewed published literature on these issues is limited, including at the regional level, although there is a broad consensus about the general vulnerabilities and risks based partly on reputable expert group assessments.*

The remainder of this section provides brief examples of some of the potential climate risks and vulnerabilities to SE energy production and use. As noted previously, chapter 3 of this report provides additional detail about historical climate trends in the SE and projections of future climate (along with citations for this information).

4.2.1 Climate Impacts on Energy Demand

The SE already experiences high heat and humidity, resulting in elevated heat indices in summer months with higher temperatures projected for the future. Higher temperatures raise warm season demands for electricity to cool homes, work places, commercial spaces, and indoor recreational spaces. Urban heat island effects may further increase demands for cooling. In cooler seasons, energy demands for space warming will likely decrease, possibly reducing net annual demands for non-electricity fuels for interior heating. Overall, the net change for energy demand (cooling and heating) in the SE is expected to be an increase, which is of particular concern for lower income households that may not be able to weatherize their homes and install and operate air conditioning systems or to improve the efficiency of existing systems (Hadley et al. 2006, US EPA 2012).

For example, a 2006 analysis looked at heating energy, cooling energy, and net changes, by Region, under two climate projections. The study estimated that cooling demands in the SE would increase by 2025 for either a high or a low temperature-change scenario (Figure 4.9) (Hadley et al. 2006).

Insert Figure 4.9

Other climate effects on energy demand are less clear, such as lower fuel mileage from increased vehicle air conditioning use or more use of lawn irrigation systems in response to high temperatures or droughts (Wilbanks et al. 2008). While some of these changes may not be large, they may contribute to increases in regional energy demands overall.

Climate-related demographic shifts are another consideration for energy needs in the SE. For example, the American Planning Association has noted that shifts in migration in the SE may occur in response to climate-related risks in coastal areas and rising heat indexes (APA 2011). Such shifts in population and economic activities would change patterns of energy demand within the region.

4.2.2 Climate Impacts on Energy Production and Distribution

Critical SE regional infrastructure, such as energy, transportation, and hospitals, already experience the effects of extreme events such as floods, hurricanes, high ambient temperatures, and tornados. Damage to these assets can disrupt services from days to months.

Of these risks, one has received substantial attention in recent years—coastal infrastructure exposure to hurricanes, sea-level rise, and land subsidence along the Gulf Coast. For example, sea level rise and storm surge has the potential to affect coastal highways, ports, and rail (Savonis et al. 2008). Climate change poses risks of major temporary disruptions in energy supply, including both coastal and offshore facilities for extracting and processing oil and gas as well as electricity production systems. Climate change could also increase capital expenditures to harden existing facilities, to build more robust new facilities, or to move facilities and activities to less vulnerable locations.

The impact of current climate extremes on oil and gas production and refining was demonstrated in 2005 when hurricanes Katrina and Rita hit the Gulf. Figure 4.10 shows the large magnitude of impact and slow recovery of production following the two storms (Dismukes et al. 2011). To put these numbers into a national perspective, Katrina alone resulted in the shut-in of more than 95% of offshore Gulf crude oil production and approximately 27% of total US crude production. This local domestic production could not be rapidly replaced by imports since major oil import terminals were also interrupted, resulting in an estimated 32% reduction of total USA crude oil import capacity. In addition, Katrina and Rita forced the shutdown of about 32 refineries representing a loss of up to 26% of USA refining capacity. According to the Federal Trade Commission, these interruptions were largely responsible for gasoline price increases of about 17%, which did not disappear until several months after the storms (FTC 2006).

Insert Browns Case Study

Insert Figure 4.10

Based on climate projections discussed in chapter 2, other potentially important considerations for certain areas of the SE may include (a) increased droughts that reduce the availability of water for power generation; (b) higher temperatures, particularly during summer months, that cause electricity demands to rise over periods that are long enough to exceed supply and that could jeopardize electricity availability; (c) reductions in thermal power plant capacities due, for example, to higher water temperatures (see the Browns Ferry case study); and (d) possible effects on renewable energy sources such as biopower which are generally thought to be more sensitive to climate variability than fossil or nuclear energy systems(Wilbanks et al. 2008).

4.2.3 Indirect Effects of Climate Change on Energy Production and Use: Possible Cascading Impacts

Climate change may have important indirect implications for energy supply and use. Indirect effects could affect other economic sectors that, in turn, could have implications for energy supply and demand. Other areas of potential indirect effects include energy technology development and choice, energy prices, and energy security (Wilbanks et al. 2008). The following discussion illustrates this concept using southeastern agricultural and tourism energy needs as examples.

All agricultural crops have an optimum range of environmental conditions relative to maximum yield. Most crops cultivated in the SE are at, or near, their optimal growing temperatures for the CO_2 and water conditions that currently prevail. A rise in temperature and CO_2

concentration in the SE is expected to have a direct effect on the agricultural yield and may, consequently, affect related energy needs, such as for irrigation pumps.

Specifically, warmer temperatures will speed annual crops through their developmental phases but at a cost of possible increased daily water requirements and resulting lower grain number, size, and quality (Fraisse et al. 2009). Increased water requirements result in greater water pumping and transportation needs, all at a significant energy cost. Periods of drought may necessitate additional irrigation further increasing electric and diesel pump loads.

Overall, the southern tier of the SE is expected to increase its need for irrigation water and result in a corresponding energy demand. In contrast, the northern tier is expected to decrease its relative need for irrigation, with a corresponding decreased energy demand (Burkett et al. 2000).

Similar to crops, the effects of climate change on livestock are likely to be variable, based on the magnitude of the temperature increase, animal feed prices, and the cost of electricity for cooling. Dairy cows, for example, produce milk at an optimum temperature between 40°F and 75°F. Areas with increasing temperatures will consequently pose a cooling issue for livestock owners (Fraisse et al. 2009).

Another SE economic sector that has an important link to energy is tourism, a complex and multifaceted industry that includes a variety of operating sectors such as transportation, accommodations, food service, attractions and events, and outdoor recreation. Within the 11 state NCA SE region, tourism spending exceeds $181 billion, including $28.6 billion in tax receipts, and over two million jobs with a payroll of $48 billion (Long et al. 2011. US Travel Association 2010).

The important connection of tourism to energy is illustrated by vacation rentals where in 2007 in the USA they represented a $24.3 billion market, equaling more than 22% of the USA hotel market and 8% of the entire travel and tourism market. The vacation rental market is particularly strong in the south Atlantic region where fully one-third of the nation's vacation accommodations were rented in just three states: 22% in Florida, 7% in North Carolina and 5% in South Carolina (Connolly et al. 2009).

Each year, the average energy expenditure on American hotel rooms is $2,196, representing about 6% of all operating costs (Energy Star Program 2011). This relatively high level of energy consumption, along with water consumption, waste levels, and the use of potentially hazardous chemicals, has made this industry a focus of pollution prevention efforts. As such, the availability, type, and cost of energy, and its associated greenhouse emissions, are important considerations for climate change issues and the tourism sector in the SE.

4.3 Key Issues and Uncertainties

The US Climate Change Science Program has articulated a core set of research priorities to better understand the relationship between energy and climate change (Wilbanks et al. 2008).

In general, the areas of research articulated at the national level are equally relevant to the SE USA. An improved ability to project climate change and its impacts at a more local level, a better understanding of changing regional patterns of energy use, and enhanced strategies to improve the resiliency of energy supply systems are just a few of the areas that will be needed to ensure energy supplies in the SE.

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