CAROLINAS ENERGY
PLANNING FOR THE FUTURE

In December 2014, the South Carolina Energy Office, in collaboration with the North Carolina State Energy Program, Advanced Energy, and UNC Charlotte's Energy Production and Infrastructure Center (EPIC), received a State Energy Program Competitive Award from the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy to develop a bi-state coordinated vision for energy planning that can help meet state policy goals, support electric reliability, and comply with environmental standards.

As part of the two-year project, EPIC led the creation of a working document that examines North Carolina's and South Carolina's energy capacities, infrastructure, regulations, emerging technologies, and energy projections. To summarize the main findings from the working document, this condensed version has been written. This summary document is divided into three sections: Baseline, Projections, and Challenges and Opportunities. The Baseline section describes the region and its demographics, energy consumption, and utility landscape. The Projections section summarizes energy resource trends and forecasts from utility providers. The Challenges and Opportunities section covers the energy challenges facing both states along with opportunities for the future. Overall, this document aims to develop bi-state communication around commonalities in energy production and consumption in the Carolinas.

The information presented here is only current as of the dates mentioned throughout the report. For the most current information, please visit the websites listed in the resources section.

**Photography Credit: Duke Energy*

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BASELINE 3

PROJECTIONS 12

CHALLENGES AND OPPORTUNITIES 19

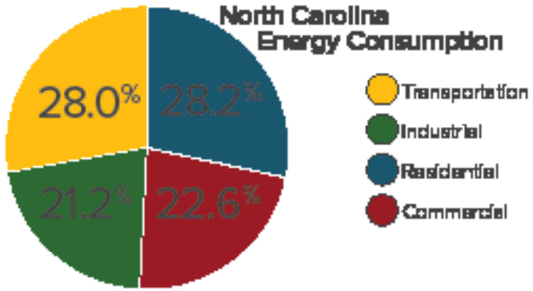
Regional Population

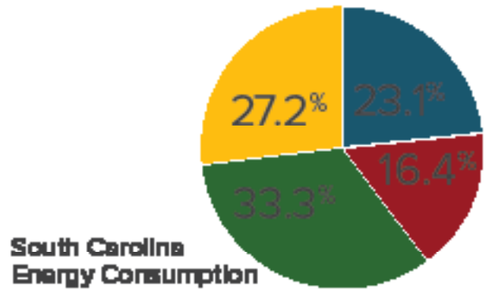
Population is growing in the Carolinas. As in many areas of the country, rural populations in the region are moving to cities in search of jobs. With their diverse mountains-to-sea landscape, the Carolinas have many natural attractions that draw both tourists and retirees. These changes in population dynamics will affect the demand for electricity in certain areas. The future population distribution and economic productivity will cause high energy demand, especially in larger cities. Energy must be produced in sufficient quantities and transmitted safely through dense areas, which may pose a challenge for production capacity and competition for land use. The space left for production facilities and transmission systems, as well as other infrastructure, may be limited in some areas of the Carolinas.

Energy Consumption

According to the U.S. Energy Information Administration (EIA) 2014 data, North Carolina has a total annual energy consumption per capita in the bottom one-third of all states in the nation, at 257 million Btu. The residential sector is the largest consumer of energy in the state.

In South Carolina, industry is the largest energy-consuming sector, accounting for nearly one-third of the state's total energy consumption of 1,591 trillion Btu (338 million Btu per capita). The residential sector also accounts for a large amount of retail sales. Per capita retail electricity sales in the state are among the highest in the nation, partly because of the high demand for air conditioning during the hot and humid summer months. Electricity consumption is also high because more than two-thirds of South Carolina households use electricity as

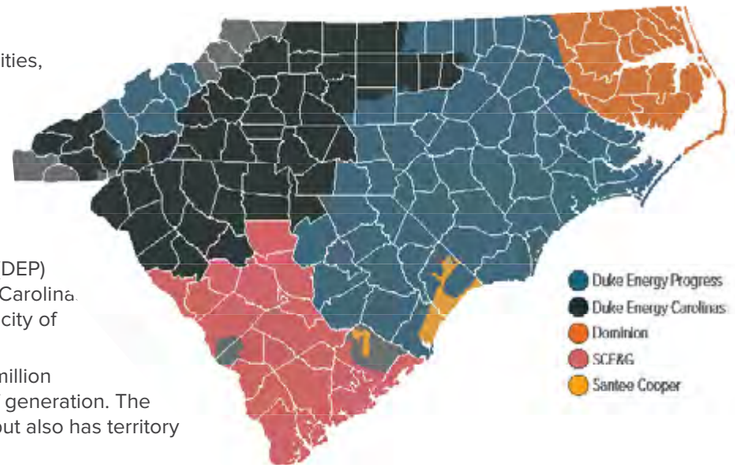




Utility Landscape

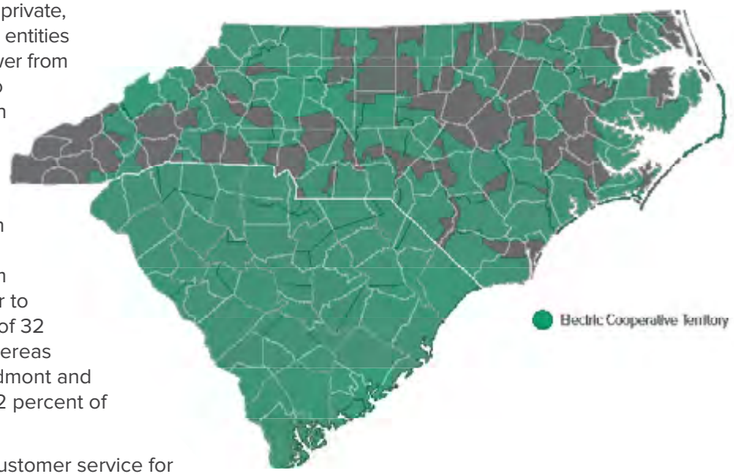
Electric Utilities

The Carolinas have a diverse array of electric utilities, including investor-owned utilities, electric cooperatives, and electric municipalities.



- Duke Energy is the largest electric power holding company in the United States, supplying and delivering energy to 3.3 million customers in North Carolina and 730,000 in South Carolina. Duke Energy Carolinas (DEC) and Duke Energy Progress (DEP) employ approximately 16,000 people in the Carolina and have a total nameplate generation capacity of 32,500 megawatts (MW).
- Dominion Resources (Dominion) serves 2.5 million customers with approximately 25,700 MW of generation. The utility primarily distributes power in Virginia but also has territory in northeastern North Carolina.
- South Carolina Electric & Gas Company (SCE&G) provides electric service to roughly 698,000 customers in a service area covering more than 17,000 square miles in 24 counties in the central, southern, and southwestern portions of South Carolina. Major metropolitan areas served by SCE&G are Columbia, Charleston, and Aiken.
- Santee Cooper is a public-power provider and the primary source of electricity for approximately 2 million people in all 46 counties of South Carolina. The utility serves more than 174,000 residential and commercial customers directly in Berkeley, Georgetown, and Horry counties. It also supplies electricity to the state's 20 electric distribution cooperatives, the cities of Bamberg and Georgetown, and 27 large industrial customers.

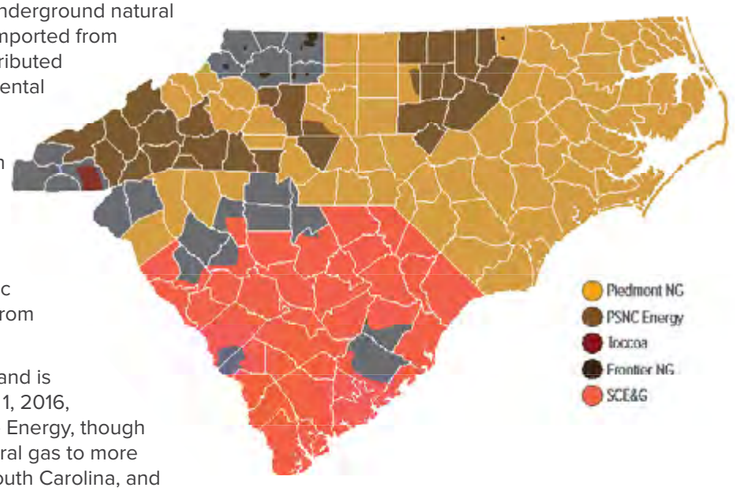
- North Carolina's Electric Cooperatives bring 26 private, independent, and not-for-profit member-owned entities together. They purchase wholesale electric power from generating utilities and then resell that power to serve more than 2.5 million people across North Carolina in 93 of the state's 100 counties.
- North Carolina Eastern Municipal Power Agency (NCEMPA) and North Carolina Municipal Power Agency 1 (NCMPA1) are North Carolina's two municipal power agencies. Each purchases wholesale electric power from generating utilities and then resells that power to their served municipalities. NCEMPA consists of 32 cities and towns in eastern North Carolina, whereas NCMPA1 serves 19 cities and towns in the Piedmont and western North Carolina. NCMPA1 also owns 62 percent of the Catawba Nuclear Reactor 1.



- ElectriCities is an organization that provides customer service for municipal power agencies. It offers safety training, emergency and technical assistance, legal services, and oversight of operations.
- Electric Cooperatives of South Carolina Inc. (ECSC) represents 20 consumer-owned electric cooperatives, one wholesale power supply cooperative, and one materials supply cooperative covering all 46 counties of South Carolina. It is the largest electric distribution system in the state, with more than 1.5 million customers, most of whom live in small towns, suburbs, and rural areas. The consumer-owned business passes on its savings from operations to the consumer.
- South Carolina Association of Municipal Power Systems (SCAMPS) is an organization that connects all of the state's 21 municipal electric utilities. The group started as a cluster of 14 cities in 1972, called Piedmont Municipal Power Systems, and grew over time.
- Piedmont Municipal Power Agency (PMPA) is an agency formed by 10 of South Carolina's municipal electric utilities, all in the northwest section of the state.

Natural Gas Utilities

Currently, there is no natural gas production or underground natural gas storage within the Carolinas. Natural gas is imported from other states through interstate pipelines and distributed through local pipelines. The Williams Transcontinental (Transco) pipeline system is the primary transporter, bringing natural gas from the Gulf Coast region into the Carolinas. Upon completion of the Atlantic Sunrise project – expected by late 2017 – Transco will also begin bringing natural gas from northern Pennsylvania into the Carolinas. Additionally, in 2019, North Carolina is expected to be served by the proposed Atlantic Coast Pipeline that will connect it to natural gas from the Marcellus Shale region in West Virginia.



- Piedmont Natural Gas has 1,800 employees and is headquartered in Charlotte, NC. On October 1, 2016, Piedmont Natural Gas was acquired by Duke Energy, though it will keep its name. Piedmont provides natural gas to more than 1 million customers in North Carolina, South Carolina, and Tennessee with a service area that covers northwestern South Carolina, and central and coastal North Carolina. The customer base is 28 percent residential, 21 percent commercial, 23 percent firm industrial, and 27 percent interruptible. Piedmont's non-interruptible sales demand for the current 2016 fiscal year is 1.4 million dekatherms (Dt).
- South Carolina Electric & Gas Company (SCE&G) is the largest provider of natural gas in South Carolina. SCE&G distributes gas to about 338,000 customers in a service area that covers approximately 23,000 square miles and 36 counties. The gas is delivered by Southern Natural, Transco, and DCGT and comes through Gulf Coast pipelines.
- Frontier National Gas Company (Frontier) provides service to 3,000 customers in eight cities in six counties in northern North Carolina: Surry, Wilkes, Yadkin, Watauga, Ashe, and Warren. Its main office is in Elkin, NC.
- PSNC Energy, the Public Service Company of North Carolina, is a subsidiary of SCANA that is headquartered in Gastonia, NC. More than 600 employees work on the purchase, transport, and sale of natural gas. PSNC serves roughly 482,000 customers in parts of western and central North Carolina. The service area encompasses 12,000 square miles in 28 counties. PSNC's year-round contract capacity for the current 2016 fiscal year is 398,000 Dt per day, with 98 percent supplied by Transco.
- Toccoa Natural Gas is a regional natural gas utility located in Toccoa, GA. Its service area stretches to Macon County, NC. Overall, Toccoa serves 7,000 residential and commercial customers, and in North Carolina, provides fuel to more than 670 customers.
- Municipal gas systems are also present in both states. The eight municipal gas systems in North Carolina are located in Bessemer City, Kings Mountain, Lexington, Monroe, Rocky Mount, Shelby, Wilson, and Greenville. South Carolina has 14 publicly-owned gas distributors: Clinton-Newberry, Fountain Inn, Lancaster County, Lauren, Winnsboro, Bamberg, Bennettsville, Chester County, Union, Fort Hill, Greenwood, Greer, Orangeburg, and York.

Regulatory Environment

Investor-owned utilities in the Carolinas are regulated by public utility commissions. The main functions of the commissions are to regulate rates and services of the utilities in their jurisdictions. The purpose of regulating public utilities is to protect the interest of the public so that service is provided at reasonable rates that are fair for both the utilities and their customers.

South Carolina Public Service Commission

The South Carolina Public Service Commission (PSC) regulates utilities as defined in Title 58 of the South Carolina Code. One commissioner from each of the seven congressional districts is elected by the general assembly for a term of four years.

In 2005, the PSC was restructured as a quasi-judicial body as a result of Act 175. This act brought major changes to the agency's operations and made PSC's principal duty to hear cases involving the state's regulated utilities. The PSC has jurisdiction to establish fair and reasonable rates for services of the utilities, which include investor-owned electric, gas, water and wastewater companies, and more.

Act 175 also created the South Carolina Office of Regulatory Staff (ORS). The ORS represents the public interest in utility regulation for all major utilities before the PSC, the court system, the South Carolina General Assembly, and federal regulatory bodies. Therefore, the ORS must balance the concerns of the using and consuming public, the financial integrity of public utilities, and the economic development of South Carolina. The ORS is responsible for many of the non-adjudicative functions associated with utility regulation that formerly fell under the PSC. In 2015, state reorganization resulted in the state Energy Office being moved to the ORS, thereby adding a planning mandate to the agency's responsibilities.

North Carolina Utilities Commission

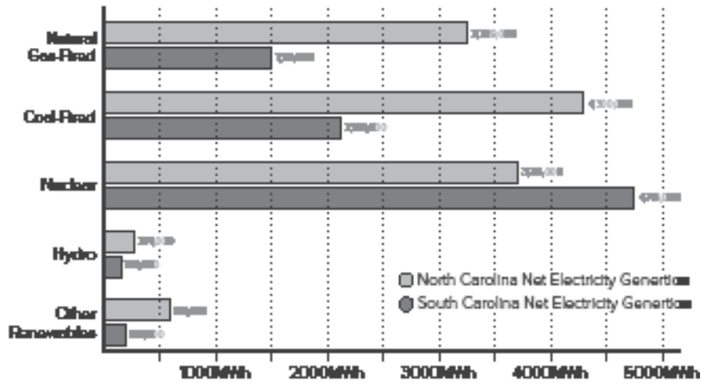
The North Carolina Utilities Commission (NCUC) is an agency created by the North Carolina General Assembly to regulate the rates and services of all public utilities in North Carolina. The commission staff is composed of three divisions: legal and administration, operations, and fiscal management. The NCUC is authorized to promulgate rules and regulations and to fix utility rates in accordance with the Public Utilities Act. The NCUC is accountable to the General Assembly and is subject to legislative oversight by the Joint Legislative Utility Review Committee.

The NCUC is required to publish annual reports to the Governor regarding its activities, including copies of general orders and regulations, comparative statistical data on the operation of various public utilities in the state, comparisons of rates in North Carolina with rates elsewhere, and more. The NCUC also publishes a separate annual volume with its final decisions made on the merits during formal proceedings, including significant procedural orders and decisions.

The law defining the NCUC's responsibilities is specific in that utility companies must be fairly compensated for their services, but the law also enables the NCUC to go beyond rate setting and service and into such matters as the planning of new generation facilities, reviewing management efficiencies, and requiring least cost power generation and power generation planning by electric utilities. With respect to the fixing of rates, the NCUC is required to conduct hearings in general rate cases and other rate making proceedings. Participation in these hearings includes the utility, the Public Staff, and the Attorney General, as well as other parties and members of the public who are interested in the formation of the rate.

Electric Generation and Transmission Infrastructure

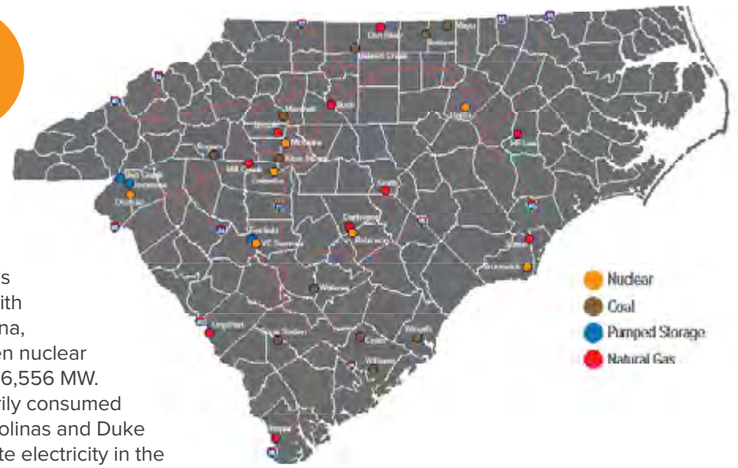
Electricity in the Carolinas is mainly generated by natural gas, coal-fired, and nuclear power plants. Investor-owned utilities, electric cooperatives, and electric municipalities all provide electricity in North Carolina and South Carolina. As most electric municipalities and cooperatives have no generation of their own, transmission and distribution systems are crucial for serving the regions covered by these entities. In 2015, North Carolina's total utility scale electric net generation amounted to 124.9 terawatt-hours (TWh) and South Carolina's electric net generation amounted to 94.9 TWh.



The Carolinas have adopted an "all of the above" strategy to ensure a balanced portfolio to guard against fuel price volatility and strengthen energy assurance. Because of the high cost of meeting environmental regulations, recent years have seen an increased focus on nuclear energy and natural gas-fired power generation facilities and an associated decrease in coal-fired plants, especially those with smaller capacities. Further, the increased discovery of shale gas, and the resulting production increase and price decrease, has triggered a large switch in facilities from coal to natural gas. This trend is reflected in nearly all states that have many coal plants.

Nuclear

Nuclear power plants are the largest generators of electricity in the Carolinas, accounting for more than 40 percent of the net electric power production and more than 90 percent of the zero-emissions electricity consumed. In 2015, the 12 reactors in the Carolinas operated at 93.3 percent capacity on average, producing a total of 95.2 TWh of net electricity. One-third of North Carolina's in-state electric power generation is produced by five nuclear facilities at three plants, with a combined capacity of 5,077 MW. For South Carolina, more than half of its electricity is generated by seven nuclear facilities at four plants, with a combined capacity of 6,556 MW. It is important to note that electricity is not necessarily consumed in the state where it is generated. Duke Energy Carolinas and Duke Energy Progress are multi-state utilities that generate electricity in the Carolinas for their North Carolina and South Carolina customers.



Although the most recent nuclear power plant was commissioned in 1987 (Harris Unit 1), the Carolinas have increased electricity production from their nuclear fleet more than 20 percent in the past two decades due in large part to less operation downtime. Nationally, South Carolina ranks third in nuclear power generation, and North Carolina ranks fifth, a clear indication of the states' continuing reliance on nuclear energy. Seven factors indicate a high potential for continued reliance on nuclear energy within the Carolinas' energy portfolio:

1. Local sources of fabricated nuclear fuel assemblies
2. Capacity for additional spent fuel storage at each site
3. Extended licenses at all nuclear facilities
4. Improvements, approved by the U.S. Nuclear Regulatory Commission (NRC), in risk management and security measures
5. Relatively low energy production costs
6. Projections for continued reliance on nuclear power at the national level, and U.S. Environmental Protection Agency (EPA) predictions for nuclear power to be approximately 20 percent of the United States energy portfolio in 2030
7. A national emphasis on "clean" energy that includes nuclear

The United States imports most of its uranium (U_3O_8) for nuclear fuel production. Of the 57 million pounds of uranium purchased by United States nuclear power reactor owners and operators during 2015, 17 million pounds originated from Canada and 3.6 million pounds came from domestic sources. The U.S. Energy Information Administration (EIA) reports that uranium inventories at United States power reactor sites, which totaled 121 million pounds at the end of 2015, could provide more than two years of uranium loadings.

The uranium is converted, enriched, and fabricated into nuclear fuel for power reactors at six facilities in the country. Five of those fabrication facilities are located in the Carolinas or in neighboring states: one in Wilmington, NC, one in Columbia, SC, one in Erwin, TN, and two in Lynchburg, VA.

There is currently no permanent disposal facility in the United States for high-level nuclear waste. Spent nuclear reactor fuel (i.e., fuel that is no longer useful for producing electricity) is securely stored on-site in contained air-tight steel dry casks or steel-lined concrete pools filled with water, which cools the fuel and acts as a radiation shield. Diverse and redundant barriers and safety systems prevent radioactive material from being released. The NRC requires that all containment vessels be designed to withstand extreme weather events and earthquakes.

Coal

A decade ago, coal-fired power plants produced more than three-fifths of the electricity generated in North Carolina, but today they produce only about a third. In recent years, there has been a substantial shift from aging coal-fired units to cleaner and more efficient power generation. One driver of this shift in North Carolina was the Clean Smokestacks Act. To comply with emissions regulations, North Carolina has retired many coal-fired units or upgraded them with 21st century emissions control technology. These changes have improved air quality.

In 2015, 31.4 percent of North Carolina's electricity and 23.5 percent of South Carolina's electricity was generated by the remaining coal fleet: 13 coal-fired power plants in North Carolina and 10 in South Carolina. In North Carolina, these plants include seven electric utility facilities, three electric combined heat and power (CHP) facilities, two industrial facilities, and one commercial facility. In South Carolina, the plants include eight electric utilities and two industrial facilities.

In 2013, more than 95 percent of the coal consumed in the Carolinas was used for electricity generation, with close to 20 million short tons of coal consumed in North Carolina and approximately 12 million in South Carolina. Both states rely on the coal supplied from other states. West Virginia, Kentucky, Pennsylvania, Illinois, Virginia, and Tennessee have historically supplied the bulk of the coal used. Kentucky and West Virginia are still high-volume suppliers, but supplies from Virginia have almost been eliminated. Because consumption has decreased, orders for rail companies to transport coal have decreased as well, and thus transportation costs may rise in the future.

Natural Gas

In 2015, 28.3 percent of North Carolina's electricity and 16.9 percent of South Carolina's electricity was generated by natural gas facilities. A total of 52 electric utilities, industrial plants, independent power production sites, and CHP plants in the Carolinas are fueled by natural gas and served by nine gas distribution companies. Most of the gas power plants are located near the main gas transmission lines to secure natural gas supply. Exceptions can be found, mainly in North Carolina, where plants are fed by gas distribution lines instead. Natural gas combined cycle units generally receive priority above industrial customers during times when gas demand could potentially exceed pipeline capacity supply. However, electric generation with combustion turbines that utilize interruptible pipeline capacity and have alternative fuel capability are subject to curtailment by margin with no elevated priority.

The Carolinas have a combined gas transmission pipeline length of about 6,967 miles (North Carolina has 4,193 miles and South Carolina has 2,774 miles). This number does not include gas distribution lines. A network of distribution pipelines carries natural gas from transmission pipelines to residential, commercial, and industrial customers and to power plants where it is burned to generate electricity. North Carolina has four liquefied natural gas (LNG) facilities in North Carolina to support peak demand, including Pine Needles (Transco), Bentonville LNG and Huntersville LNG (Piedmont), and a LNG facility supporting PSNC. Furthermore, North Carolina has one and South Carolina has two liquefied propane gas (LPG) facilities to supply LPG via trucks to customers regionally.

Natural gas consumption within the Carolinas has been increasing steadily due to its growing use in electric power generation. This development is expected to continue in the coming years. Three gas pipeline extension projects are planned in the next three years that will significantly increase gas supply to the Carolinas.

1. The Atlantic Sunrise Project by Williams Co. will enable bi-directional gas flow on the existing Transco pipeline system that currently flows only to the north, transporting up to 1.7 million Dt per day of natural gas from northern Pennsylvania to markets in the Mid-Atlantic and Southeast regions. It is scheduled to begin operating in late 2017 and has 15-year shipper commitments from producers, local distribution companies, and power generators for 100 percent of its firm transportation capacity.
2. The Atlantic Coast Pipeline LLC (ACP), a joint venture by Dominion Resources, Duke Energy, Piedmont Natural Gas, and AGL Resources, plans to move 1.5 million Dt/day of natural gas through approximately 600 miles of pipeline from West Virginia into Virginia and terminating in Robeson, NC. ACP has entered into 20-year precedent agreements for approximately 96 percent of the project's total capacity.
3. The Mountain Valley Pipeline LLC (MVP), a joint venture of EQT Midstream Partners, NextEra U.S. Gas Assets, WGL Midstream, and Vega Midstream Partners, will be 301 miles of 42-inch diameter pipeline bringing 2 million Dt of natural gas from West Virginia to the Transco pipeline station 165 in Virginia. It will create a second supply source for Transco from the north and is targeted for full in-service by the end of 2018. The project has five shippers and is fully subscribed.

Hydroelectric

In 2015, approximately 3.8 percent of North Carolina's electricity and 2 percent of South Carolina's electricity was generated by conventional hydroelectric power. Electric utilities produced approximately 7.9 TWh, and independent power producers produced approximately 0.14 TWh. The capacity of hydroelectric power plants in the Carolinas has remained almost constant since 2005 (approximately 2,000 MW for North Carolina and 1,300 MW for South Carolina), but production rates vary depending on annual rainfall. In addition, there are three pumped storage hydroelectric plants in South Carolina that have a combined capacity of 2,351 MW. The largest hydroelectric station is the 1,066 MW Bad Creek pumped storage facility located in Oconee County, SC. It is a four-unit station that utilizes an upper and lower reservoir (lake) to generate electricity.

Many of the hydroelectric power plants are old and in need of upgrades. NC Senate Bill 1004, passed in 2010, placed all dams used for power generation cooling lakes, processing ponds, and hydropower reservoirs under the jurisdiction of the NC Dam Safety Program to standardize the assessment process and comprehensively improve quality. Even though utilities in South Carolina own a small percentage of the dams (2 percent), some of the local, federal, and private-owned dams are also used to generate electricity. The condition of dams in South Carolina is managed by the SC Department of Health and Environmental Control through the Dams and Reservoirs Safety Program of 1977. However, the Federal Energy Regulatory Commission (FERC) is in charge of issuing licenses for hydroelectric dams.

The U.S. Department of Energy (DOE) recently released a report, titled Hydro Vision, supporting maintenance, upgrades, and added pumped storage to the United States hydroelectric fleet to help with the intermittency issues posed by more solar and wind energy being integrated into the grid. Duke Energy plans to complete upgrades to each of the four units at its Bad Creek pumped storage facility in the 2020 to 2023 time frame. Each upgrade is expected to provide 46 MW of added energy storage capacity to help meet peak demand and support integration of intermittent sources of energy.

Renewable Energy Resources

Both North Carolina and South Carolina have renewable energy mandates passed by their respective legislatures. Created in 2007 with the passage of SB3, the Renewable Energy and Energy Efficiency Portfolio Standard (REPS) in North Carolina requires graduated increases in renewable energy and energy efficiency through 2021. Beginning in 2021, 12.5 percent of electric power generated by investor-owned utilities must be provided by renewable resources and energy efficiency measures. Electric cooperatives and municipal utilities have to meet 10 percent of their electricity sales with renewable energy and energy efficiency measures by 2018 and face slightly different requirements. Eligible renewable energy resources include wind, hydropower up to 10 MW, solar-electric, solar-thermal, wave energy, biomass, landfill gas, hydrogen, and CHP produced from renewable energy resources. The REPS also sets minimum requirements for three renewable resources:

- Solar Energy – 0.2 percent of electric sales by 2018
- Swine Waste – 0.2 percent of electric sales by 2018
- Poultry Litter – 900,000 megawatt-hours (MWh) by 2018

South Carolina's General Assembly passed Act 236, which allowed large investor-owned utilities to establish distributed energy resource programs that would result in an aggregated amount of installed nameplate generation capacity equal to at least two percent of the previous five-year average of retail peak demand. It also allows investor-owned utilities to recover costs incurred through meeting the target, and creates a program to allow for third-party leasing with certification by the ORS.

Wind

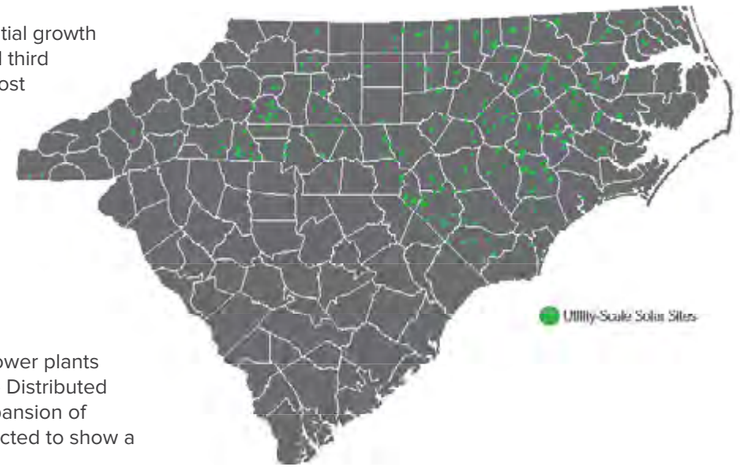
The construction of Southeast's largest wind energy project, the Amazon Wind Farm U.S. East, is underway in Perquimans and Pasquotank counties. The 208 MW nameplate capacity wind energy facility includes 104 turbines and is expected to generate approximately 0.67 TWh of electric power annually. When completed, it will be the first utility-scale wind farm in the Carolinas.

Biomass

Biomass, such as forest wastes, landscape trimmings, landfill and swine waste gas, and sawmill residues, can be used to generate electricity. The plants that burn biomass face a variety of challenges due to the physical properties of the items burned. Many of the plants are co-firing, which means that they use biomass as a partial fuel. The Carolinas have abundant waste wood resources, making biomass energy a logical choice for renewable power. Landfill gas is also used to generate electricity or to displace natural gas in plant operations. In South Carolina, BMW was a pioneer in using landfill gas in its paint drying operations, saving millions of dollars per year. Other major industries, such as Kimberly Clark and Fuji, have followed suit. There are seven utility-owned biomass facilities in South Carolina and nine merchant biomass plants providing power to utilities or directly to industrial customers.

Solar

North Carolina has recently experienced exponential growth in solar electric generation and is currently ranked third in the country for utility-scale solar installations. Most utility-scale solar projects are owned by non-utility third parties and are 1 MW or greater in size. The growth is attributed to renewable portfolio standards, federal, state, and local tax incentives, declines in solar panel and installation costs, and improvements in system performance. Almost 1,000 MW alternative-current of solar energy nameplate capacity was interconnected to North Carolina's electric grid in 2015.



In South Carolina, there are currently two solar power plants with a capacity greater than 1 MW. Passage of the Distributed Energy Resource Program Act ushered in the expansion of solar in South Carolina, and updated data is expected to show a significant increase in solar capacity in the state.

Energy Efficiency and Demand Response Programs

Energy efficiency (EE) and demand response (DR) programs play an important role in the Carolinas energy portfolio. Both states have a lead-by-example program to reduce energy consumption in state-owned or -operated facilities. EE and DR are the only resources that can reduce electric bills by decreasing overall consumption. EE acts to manage and restrain the growth in energy consumption, whereas DR focuses on harmonizing electricity supply and consumption by leveling electric load, peak shaving, or coincident peak shaving.

Utility Programs

Electricity providers in the Carolinas have developed a portfolio of programs to involve their customers in EE and DR. The most popular programs are those for upgrades, such as light bulbs, which are easy to implement. Duke Energy's programs, which are similar across the Carolinas, have generally reduced the most energy. Specifically, the EE program that has saved the most energy is Duke Energy Progress's (DEP) Residential Home Energy Improvement Program, which provided 32,145 MWh in energy savings in 2014. Educational programs, such as the Energy Efficiency Education Program (21,299 MWh savings in 2014) from Duke Energy Carolinas (DEC), and benchmarking programs, such as the Residential Energy Efficient Benchmarking Program (11,945 MWh savings in 2014) from DEP, also had high participation.

Company	2014 Electricity Sales in MWh	2014 Energy Savings in MWh	Percentage of 2014 Total	Customers 2014 Total
DEC	83,859,000	2,021,123	2.410%	2,500,000
DEP	56,447,000	1,136,258	2.013%	1,500,000
SCE&G	22,648,000	125,000	0.552%	688,000
Santee Cooper	5,591,000	23,337	0.417%	171,000

Demand response is a strategy by which customers can opt into a utility program and agree to curtail their energy use during high-demand periods. In return, the utility will compensate the customer at an agreed-upon rate. DEC has established programs called "PowerManager" for residential and "PowerShare" for non-residential customers. An additional demand response program is EnergyWise, which allows utilities to cycle customers' air conditioners during peak events.

Even before the introduction of REPS, DEP offered demand response programs. Its time-of-use (TOU) programs for residential, commercial, and industrial customers are the most popular, each having more than 29,000 participants. Instead of a single electric rate for energy use, TOU rates are higher when electric demand is higher. When there is less demand during off-peak times, TOU rates are lower. The TOU rate was designed to keep the electric grid reliable by attracting customers to shift their energy use to time periods with less demand. Most utilities distinguish between a summer (June until October) and a non-summer (November until May) schedule. Within those seasons, different peak times apply: on-peak, off-peak, and shoulder rates.

Depending on how much load customers are able to shift from on-peak hours to off-peak or shoulder hours, energy bills can be significantly reduced. Utilities also benefit from a lower energy demand during on-peak hours and have less need to provide additional capacity. On the other hand, if more customers shift energy usage to off-peak hours, the demand may exceed the capacities due to a large amount of appliances, such as air conditioners, electric vehicles, and televisions, being used shortly after an on-peak period ends. These scenarios are very much dependent on human behavior, and it is unlikely that there will be mass migration to using significant house loads during off-peak times.

Specifically in South Carolina, SCE&G has two demand response programs. An interruptible program for large customers and a standby generator program. According to the 2016 integrated resource plan (IRP), these programs represent over 250 MW on their system. Santee Cooper also offers a TOU rate or seasonal rate for its customers.

Five of South Carolina's electric cooperatives have on-bill financing programs that use the common brand, "Help My House." The programs us the "whole-house" approach to evaluate the house as a system. Efficiency improvements include air sealing the home and ductwork, upgrading the HVAC system, and installing insulation. As of May 2015, 548 homes had been retrofitted through the program, saving approximately 4,140 MWh of electricity per year.

State Programs

The Carolinas establish their own legislative plans to individually achieve energy efficiency goals. Many states currently have renewable portfolio standards (RPS). The North Carolina standard expands the RPS to a REPS (Renewable Energy and Energy Efficiency Portfolio Standard) by requiring a minimum amount of electricity to be generated by renewable energy or energy efficiency measures.

Also in North Carolina, the NC Utility Savings Initiative (USI) aims to make public buildings more energy efficient by supervising the cost and use of energy and water in the state's facilities. The USI achieved a 32 percent reduction in energy use intensity in 2015 from the 2002-2003 baseline, resulting in a cumulative savings in excess of $1 billion.

In South Carolina, the SC Government Energy Conservation and Efficiency Act requires that state agencies, public school districts, and all public entities reduce energy use by 20 percent by 2020, using 2000 as a baseline. The requirements are defined as total site energy consumption per gross square foot. The South Carolina Energy Office has also enacted loan, grant, and incentive programs to support energy-efficient investments. Two energy efficiency loan programs, the ConserFund Loan and the ConserFund Loan Plus, assist government and non-profit entities in carrying out energy efficiency projects. Both offer a minimum loan amount of $25,000 and a maximum of $500,000 per fiscal year. Unlike ConserFund, ConserFund Plus consists of 70 percent as loan and 30 percent as grant and is only available to state agencies, public K-12 schools, and state-supported colleges and universities.

An additional loan program is the Energy Efficiency Revolving Loan (EERL), which is funded by the DOE to stimulate investments into energy measures and improvements. South Carolina and Alaska are the only states offering this kind of loan. The funds are meant for business and industry; however, utilities, non-profits, and governmental facilities can be eligible under certain circumstances.

Other Programs

The Carolinas also have numerous companies and local organizations focused on achieving a more sustainable and energy-efficient future.

The SystemVision program by Advanced Energy provides training and technical support to encourage high standards of energy efficiency in the construction of affordable housing in North Carolina. Advanced Energy issues a two-year heating and cooling bill guarantee to all homes under the program. SystemVision states that the average heating and cooling costs for a certified home rarely exceed $30 per month. Annual heating and cooling costs that exceed the guarantee are reimbursed by Advanced Energy, and further investigation is done to remediate the issue. Funding for this program is provided by the North Carolina Housing Finance Agency.

Envision Charlotte is a non-profit organization whose objective is to help Charlotte, NC, become one of the most sustainable urban cores in the country. It partners with public and private entities, property managers, universities, and utilities to implement technologies and strategies to reduce energy and water consumption, waste, air pollution, and the cost of doing business. Envision Charlotte has an ambitious goal to reduce energy use in Uptown Charlotte by 20 percent in five years.

New home partners have built more than 80,000 ENERGY STAR certified homes to date in the Carolinas. Fifteen percent of all new homes built in North Carolina in 2015 received the ENERGY STAR certification. North Carolina ranks sixth nationally in terms of states with the highest market share of ENERGY STAR homes and conserves 10,000 MWh each year through this initiative. Additionally, it has 23.7 million square feet of ENERGY STAR certified buildings and plants. The private sector has also been implementing EE measures. For example, energy conservation efforts by Food Lion, based in Salisbury, NC, saved 71,250 MWh in 2015 at its 1,100 stores in the Southeast and Mid-Atlantic. It would take about 700 million cubic feet of natural gas or 200 acres of solar panels to produce the amount of energy that Food Lion saved in one year through its conservation measures.

The City of Greenville, SC, formed the Greenville Green Ribbon Advisory Committee, which is similar to Envision Charlotte. It is a local voluntary program that aims to improve the quality of life within the city. The committee is composed of seven members who advise the city council on topics regarding sustainability and environmental issues. Its goal is to construct and maintain a greener city.

Federal Programs

Programs and initiatives affecting EE and DR on a nationwide scale are mainly established by the Office of Energy Efficiency and Renewable Energy (EERE) within the DOE. The EERE consists of several offices supporting the DOE's mission of strengthening energy efficiency and renewable power.

Energy Conservation Subsidy Exclusion is a program that provides non-taxable energy conservation subsidies to customers through public utilities. The program is available to personal and corporate entities, and it includes installations and modifications designed to reduce electricity or natural gas consumption and make energy demand more manageable. Electricity-generating systems registered as "qualifying facilities" under the Public Utility Regulatory Policies Act of 1978 (PURPA) are excluded from this tax exemption.

To finance EE improvement of existing homes or to increase buying power for new energy-efficient homes, residential homeowners and homebuyers can make use of Energy Efficient Mortgages (EEM). This support from the U.S. government is insured through the Federal Housing Authority (FHA) or Veterans Affairs (VA) programs. EEM receives support from the ENERGY STAR program, which allows lenders of EEM to promote themselves as ENERGY STAR partners.

State, local, and tribal governments can apply for Qualified Energy Conservation Bonds (QECBs). QECBs are tax credit bonds for qualified energy conservation projects. The definition of "qualified energy conservation projects" includes energy efficiency capital expenditures in public buildings that reduce energy consumption by at least 20 percent, as well as green community programs and renewable energy production projects, and campaigns of public energy efficiency education. Established in 2008, the loan program was expanded by the American Recovery and Reinvestment Act to the bond volume of $3.2 billion.

The Tribal Energy Program Grant provides financial help and training to tribal communities. The funding aims to accelerate the implementation of renewable energy and energy efficiency technologies on tribal lands and is awarded each year through a competitive process. The incentive amount varies by solicitation.

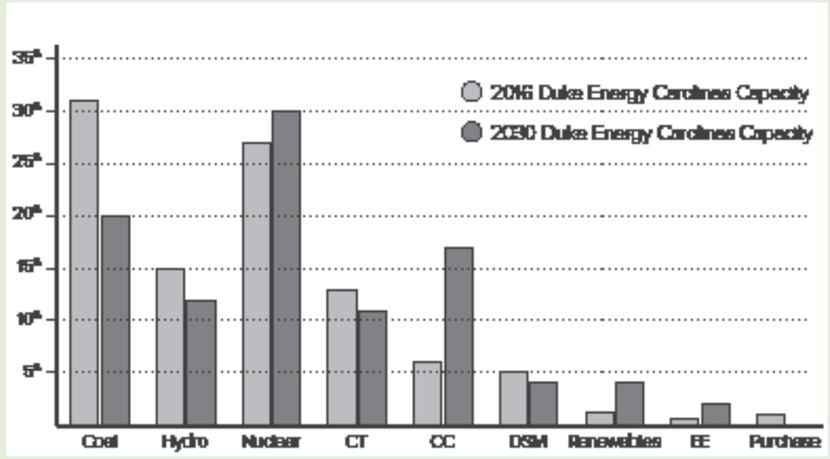
A similar program for agricultural producers and rural small businesses is offered by the Rural Energy for America Program (REAP) established by the U.S. Department of Agriculture. It provides guaranteed loan financing and grant funding to allow EE improvements. The loan ranges between $5,000 and $25 million. The maximum grant is $250,000. The program seeks to increase energy-efficient installations in rural areas and to reduce long-term energy costs.

For utility systems that are responsible for providing retail electric service to rural areas, the U.S. Department of Agriculture Rural Utilities Service offers the Energy Efficiency and Conservation Loan Program (EECLP). Businesses can borrow money to develop new energy service products within their service territories. For example, the money could be used for customers to install energy efficiency measures and repay the loan to the utility through their electricity bill.

Additional federal programs include the Residential Energy Efficiency Tax Credit, Business Energy Investment Tax Credit, Energy Efficient New Homes Tax Credit for Home Builders, Fannie Mae Green Initiative Loan Program, FHA PowerSaver Loan Program, Low Income Home Energy Assistance Program (LIHEAP), Modified Accelerated Cost-Recovery System (MACRS), Renewable Electricity Production Tax Credit (PTC), Sales Tax Exemption for Hydrogen Fuel Cells, U.S. Department of Energy Loan Guarantee Program, USDA – High Energy Cost Grant Program, USDA – Repowering Assistance Biorefinery Program, and Weatherization Assistance Program (WAP).

PROJECTIONS

Affordability, environmental impacts, fuel availability, reliability, resiliency, safety, and security are all major considerations in energy resource planning by electric utility providers and energy policy makers in North Carolina and South Carolina. These objectives are best achieved with a diverse portfolio of cost-effective, zero-emissions energy resources, clean burning natural gas-fired generation, and energy demand reduction measures (including energy efficiency and demand-side management).



Nuclear power has been, and will likely continue to be, the primary source of base load clean energy in the Carolinas, currently providing more than 90 percent of its emissions-free electricity. The Carolinas' highly acclaimed nuclear energy cluster, comprised of about 150 companies concentrated around the Charlotte area, sets the region apart as a global leader in nuclear energy and positions it to favorably advance nuclear energy in a cost competitive manner. Over the next 15-year planning horizon, the Carolinas are expected to strengthen their nuclear leadership, with the V.C. Summer Units 2 and 3 coming online by 2020 and potentially two Duke Energy nuclear units in 2026 and 2028. By 2030, the Carolinas could have sufficient nuclear generation capacity to produce enough electricity to meet half of the two states' projected energy needs. The four new units are expected to generate emissions-free electric power for 80 years or more.

Future renewable energy growth, required to meet REPS mandates, is expected to be dominated by solar energy facilities due to the Carolinas' lack of cost-effective and unrestricted wind energy resources. The capacity of solar energy facilities interconnected to the Duke Energy grid in the Carolinas may quadruple within the next 15 years.

In the coming decades, coal-fired power will likely continue to be displaced with lower-emitting natural gas-fired generating facilities. In recent years, Duke Energy has retired about 3,650 MW of its coal generation capacity in North Carolina and South Carolina and plans to shut down another 1,545 MW of coal-fired units by 2030. To offset the loss of these resources and meet growing energy demands, Duke Energy projects, in its 2016 IRP, to build almost 6,000 MW of natural gas generation capacity, bringing the total to more than 15,000 MW by the end of the next decade.

Natural gas generation is the current market choice for new electric power generation. It emits much less pollution than other fossil-fueled sources, has low capital investment, and has low operating costs thanks to the abundant supply of affordable natural gas in the United States brought about by the recent shale gas revolution. However, because a natural gas power plant requires on-demand fuel with limited storage options, and the bulk of its generation cost is the cost of natural gas, it can be highly impacted by supply disruptions and price volatility, and also requires more supply infrastructure. The nationwide ongoing shift from coal to natural gas may affect supply and demand for natural gas, possibly leading to price instability and pressures on supply. Future development of potential shale gas and coalbed methane resources in North Carolina could help minimize these impacts.

Energy conservation measures and demand supply management will play an important role in slowing the growth of energy consumption and winter and summer peaks. For example, Duke Energy anticipates that by 2031 its EE measures can achieve an annual energy savings of 5.8 TWh and a winter peak reduction of 951 MW, and its demand-side management (DSM) programs can reduce winter peak by 1,207 MW.

Integrated Resource Planning

Each year, regulated investor-owned electric utilities in North Carolina and South Carolina submit integrated resource plans (IRPs) to project how they will meet future peak load and energy consumption growth.

Expected load growth and projected generation capacity mix

Utility	State(s)	Annual Growth Rate			Projected 2031 Generation Capacity Percentages					
		Energy	Winter Peak	Summer Peak	Nuclear	Gas	Coal/Oil	Hydro	RE/EE/ DSM	Purchases
Dominion	NC	1.5%	1.5%	1.5%	14%	54%	18%	9%	4%	1%*
DEC	NC, SC	1.1%	1.3%	1.2%	30%	25%	21%	12%	12%	0.3%
DEP	NC, SC	1.1%	1.3%	1.1%	13%	49%	15%	1%	19%	3%
Santee Cooper	SC	--	--	--	20%	19%	59%	2%	1%	--
SCE&G#	SC	1.3%	1.7%	1.2%	30%	30%	25%	12%	3%	0%

** Does not include EE and DSM*

 # From 2015 IRP with the percentages of 2030 generation capacity

Santee Cooper is not an IOU but does submit an IRP to the SC Energy Office

Duke Energy Projections

The 2016 IRPs for Duke Energy Carolinas (DEC) and Duke Energy Progress (DEP) are Duke Energy's best projections of how its portfolio will look over the next 15 years based on current data assumptions. These projections may change, however, as projected load forecasts, fuel prices, new environmental regulations, and other variables shift. Over the planning period, Duke Energy expects to require more than 8,000 MW of generating resources in addition to its incremental renewable resources, EE, and DSM to meet its customers' needs in the Carolinas.

The annual growth rate of energy consumption for all customers is forecasted to be 1.1 percent. The growth in winter peak demand is expected to outpace the increase in overall consumption and summer peak demand, with an average projected growth of 1.3 percent. Projected electricity consumption annual growth rates by customer class are as follows:

- The commercial class is the fastest growing class, with a 1.3 percent annual projected growth rate.
- The industrial class has a projected annual growth rate of 0.8 to 0.9 percent.
- The residential class has a projected growth rate of 1.1 to 1.2 percent.

In addition to customer growth, plant retirements and expiring purchased power contracts require additional incremental resources to allow Duke Energy to reliably meet future demand. Over the last several years, aging coal plants have been replaced with efficient natural gas-fired combined cycle (CC) units. Approximately 3,650 MW of coal generation capacity have been retired, while about 10,450 MW of coal units, each equipped with emissions control technology, continue to provide electric power to customers in the Carolinas. DEC and DEP have also retired a total of 650 MW less-efficient combustion turbine (CT) units.

Natural Gas

Duke Energy recognizes the need for new natural gas plants that are economic, highly efficient, and reliable. In the near future, it plans to make the following additions to its natural gas fleet:

- Complete construction of the 683 MW/653 MW (winter/summer) natural gas CC plant at Lee Steam Station, Anderson County, SC, in 2017
- Complete a 100 MW/84 MW (winter/summer) Sutton fast start/black start CT in 2017
- Complete 560 MW/495 MW (winter/summer) natural gas CC at Asheville, NC, in late 2019

Nuclear Power

The 2016 IRP continues to support new nuclear generation as an emissions-free, cost-effective, and reliable baseload option within Duke Energy's resource portfolio. The current base plan calls for the following:

- Uprates at existing nuclear power facilities totaling 135 MW in generation capacity
- Commercial operation of the first unit at the Lee Nuclear Station by November 2026
- Study the possibility of a license extension from the current 60 years to 80 years at the Oconee Nuclear Station, extending its operations until the 2053-2054 time frame, and the potential for license renewals for its other nuclear reactors
- Review the potential need for additional new nuclear capacity so that it is available in advance of the Oconee license expiration

Renewable Energy Resources
In response to the signing of the South Carolina Distributed Energy Resource Program, in 2015 DEC was approved of a portfolio of initiatives that would increase the capacity of renewable generation to approximately 84,000 kilowatts (kW) by January 2021, with an option to invest in an additional 44,000 kW. Most of this capacity is expected to be solar photovoltaics (PV). Likewise, solar PV will play a big role in complying with NC REPS.

Renewable mandates, substantial tax subsidies, and declining costs make solar energy Duke Energy's primary renewable energy resource within the 2016 IRP. Most of the new solar energy capacity will be owned by third-party, non-utility investors and be available to Duke Energy through power purchase agreements (PPAs), renewable energy credit (REC) purchases, and utility-owned solar generation. By 2031, Duke Energy expects to have almost 5,000 MW of nameplate solar energy capacity connected to its power grid in the Carolinas.

In its latest IRP, Duke Energy recognizes and plans for the operational limitations of intermittent energy resources. Solar energy cannot be dispatched to meet changing demand from customers during all hours of the day and through all types of weather. However, solar energy in combination with traditional resources can help diversify the energy resource portfolio.

Energy Efficiency and Demand-Side Management
EE and DSM programs are supporting efforts to reduce the annual forecasted demand growth over the next 15 years. Duke Energy manages approximately 20 EE and DSM programs that span both residential and non-residential classes, and predicts continued energy and capacity savings from them through the planning period. DSM programs avoid the need for 885 MW of winter peak generation capacity in 2017 and 1,207 MW of winter peak generation capacity by 2030.

Dominion Resources Projections
Dominion's 2016 IRP focuses on continuing development to meet customer needs. Similar to other utility projections, Dominion will shift generation slightly away from coal and toward low- and zero-carbon forms of energy generation, such as natural gas, nuclear energy, and renewable energy. Currently, fossil-fueled power stations relying primarily on coal generate more than 40 percent of the power provided to Dominion customers. However, the IRP projects that nearly 49 percent of capacity additions during the next 10 years will be gas fired, with natural gas making up 43 percent of projected on-peak resource mix by 2025. Over the next 15 years, Dominion plans to shut down 750 MW of coal generation capacity and add 5,250 MW of gas generation and 745 MW of solar energy.

Renewable energy continues to grow in Dominion's generating portfolio. To comply with North Carolina REPS requirements, Dominion will generate and purchase additional renewable energy and use approved energy efficiency programs. According to its IRP, Dominion plans to add 600 MW of solar generation from non-utility generators in its North Carolina service area by 2017. This number includes 308 MW of PPAs that have been signed as of May 2015.

At its Kitty Hawk District Office, Dominion constructed its microgrid demonstration project in July 2014. This project includes innovative renewable generation and energy storage technologies. It uses four different types of micro-wind turbines producing up to 14 kW of power, a 6 kW solar PV array, and a lithium-ion battery integrated with the existing on-site diesel generator and utility feed. A year later, Dominion added two residential-sized fuel cells to study how they interact with the current renewable energy technologies. This project will allow Dominion to better understand how to integrate large amounts of intermittent generation into the grid.

Demand-side resource programs are also a critical part of Dominion's portfolio. Approved or pending DSM programs in North Carolina include the Small Business Improvement Program, the Income and Age Qualifying Home Improvement Program, and the Air Conditioner Cycling Program.

South Carolina Electric & Gas Projections
South Carolina Electric & Gas Company (SCE&G) is committed to generating more of its power from clean energy sources. Currently, it generates clean energy from hydro, nuclear, solar, and biomass sources, which produce approximately 25 percent of its total generation. By 2021, SCE&G expects to produce 60 percent of generation from clean energy, including nuclear, while 20 percent will come from coal, and 18 percent from natural gas. Total territorial energy sales on SCE&G's system are expected to grow by an average rate of 1.3 percent per year over the next 15 years, while firm territorial summer and winter peak demands will increase at 1.7 percent and 1.2 percent per year. The energy sales forecast for SCE&G is made for over 30 individual categories, which are subgroups of SCE&G's seven classes of customers. The three primary customer classes of residential, commercial, and industrial comprise slightly over 93 percent of sales.

SCE&G's forecasting process is divided into two parts: development of the baseline forecast and adjustments for energy efficiency impacts. Short-range forecasting is defined as the next two years, and long-range is defined as beyond two years. Adjustments were made to the baseline forecast to incorporate factors not reflected in historical experience. These adjustments included more stringent air conditioning, heat pump, and water heater efficiency standards, plus improved lighting efficiencies and the addition of SCE&G's energy efficiency programs.

DSM Impact on Forecast
SCE&G expects its EE programs to reduce retail sales in 2016 by approximately 71 gigawatt-hours (GWh). Retail sales after this EE impact are expected to be 22,166 GWh, for a reduction of about 0.32 percent. In 2015, SCE&G had seven residential DSM programs and two non-residential programs. To assess how its EE programs have fared, SCE&G analyzed the reported EE impacts of several other companies from the Southeast. The median EE impact of these companies was 0.18 percent, indicating that SCE&G's programs compare favorably.

Potential for Renewable Generation
SCE&G has been actively signing up new customers for solar rooftop systems. Furthermore, in late 2016, SCE&G will allow customers to purchase individual panels of utility-managed solar farms, and they will receive a share of the total system's output on their bills. This arrangement is useful for customers that may not have access to or interest in rooftop solar.

Currently, SCE&G has about 6 MW of solar generation on the system, and by the end of 2016, it will include renewable energy from six new solar electric generating facilities totaling approximately 36 MW. By 2021, SCE&G plans to add up to 100 MW of renewable energy.

Nuclear Power, Coal, and Natural Gas
In 2015, SCE&G reported that Unit 1 at the Summer Nuclear Station produced 20 percent of customers' needs, which amounted to 4,744 GWh. Through August 2042, this unit should produce another 134,665 GWh for SCE&G.

For Summer Units 2 and 3, SCE&G and Westinghouse agreed to amend the engineering, procurement, and construction. The guaranteed substantial completion dates for these units are August 2019 (Unit 2) and 2020 (Unit 3). By the end of 2021, SCE&G expects to own 60 percent of both units – about 670 MW each – while Santee Cooper will own 40 percent.

SCE&G had six small coal-fired units totaling 730 MW that did not meet emission standards. Over the past few years, SCE&G retired Canadys' Units 1, 2, and 3, and dismantled the coal handling facilities at Urquhart Unit 3 and converted it to be fired with natural gas. The two remaining coal-fired units, McMeekin Units 1 and 2, have a capacity of 250 MW and are required to maintain system reliability until new nuclear capacity is available. SCE&G expects to convert these to natural gas as well.

Santee Cooper Projections

Santee Cooper is South Carolina's state-owned electric and water utility and is one of the nation's largest public power providers. Its systems serve approximately 2 million customers in all 46 counties of South Carolina. Santee Cooper's direct customers currently include 27 large industrial customers, Central Electric Power Cooperative Inc. (Central), and two municipal electric systems, the City of Georgetown and the City of Bamberg. New service agreements were executed in 2013 with Georgetown and Bamberg for 10 years and 20 years, respectively. Central is an association of 20 electric distribution cooperatives that primarily serves residential, commercial, and small industrial customers. In 2013, Santee Cooper's total energy needs were met primarily by coal, at 53 percent, while nuclear energy supplied 11 percent, natural gas supplied 16 percent, and purchases supplied 17 percent. Santee Cooper's generation expansion plans include the following:

- Continue the remainder of the work required to supply, construct, test, and start up two AP1000 nuclear power plant units as is consistent with the AP1000 certified design
- Sell to SCE&G an additional 5 percent ownership interest in Summer Nuclear Units 2 and 3; under the terms of the agreement, SCE&G will own 60 percent of the new nuclear units and Santee Cooper will own 40 percent
- Retire six electric-generating units
- Monitor existing and potential regulation and permitting requirements affecting Santee Cooper's current and future generation facilities
- Periodically evaluate the generation expansion plan to determine the impacts of potential environmental legislation or regulation, changes in load forecast, updated cost information, and more

Santee Cooper is projecting 104 MW of purchased renewable capacity and energy to be under contract by 2020, of which nearly 79 MW are currently in commercial operation.

Renewable Resources and Programs

Hydroelectric: Santee Cooper's largest source of renewable energy is from hydroelectric facilities. As Santee Cooper has grown, these hydroelectric units have gradually shifted from the sole source of electric generation to mainly peaking capacity.

Biomass: In 2001, Santee Cooper became the first utility in South Carolina to produce electric power using methane gas from landfills as a fuel source. It now has six sites totaling 28 MW of generating capacity. Bioenergy Technologies' facility is located in Berkeley County and delivers power to Santee Cooper through Berkeley Electric Cooperative. It began producing power in mid-2013. The anaerobic digestion process utilizes pre-consumer food waste, grease, food processing waste, and wastewater sludge to generate 1.6 MW of renewable electricity. Green Energy Solutions (GES) continues to pursue the first agricultural waste-fueled facility, which uses poultry waste in an anaerobic digestion process. Santee Cooper's contract with GES is for production of up to 25 MW of biogas-fueled renewable energy from multiple facilities around the state. EDF Renewable Energy completed the construction of two 17.8 MW facilities in Allendale and Dorchester counties. These facilities operate using wood chips and waste wood for fuel and were declared commercial in fall 2013.

Solar: Santee Cooper has developed a Green Power Solar Schools (GPSS) program for middle schools around the state. At participating schools, Santee Cooper and the local electric cooperative install a 2 kW PV solar panel and provide a science curriculum that meets state standards. To train the teachers who will use the curriculum, a similar 2 kW PV panel has also been installed at Santee Cooper's Wampee Conference Center. Currently there are 26 solar school installations across the state with a total capacity of more than 57 kW.

Santee Cooper continues to investigate and utilize solar technology. In addition to the GPSS installations, Santee Cooper built a 16 kW solar pavilion at Coastal Carolina University, a 20 kW installation at the Center for Hydrogen Research in Aiken, and a second 20 kW installation in December 2009 at the Technical College of the Lowcountry in Bluffton. With partial funding from the American Recovery and Reinvestment Act, Santee Cooper completed the 311 kW Grand Strand Solar Station in Myrtle Beach in early 2011. The installation of an 8 kW solar project in Rock Hill was also completed in early 2014.

Wind: In 2005, Santee Cooper began investigating the wind generating potential in South Carolina. Santee Cooper partnered with the DOE and the South Carolina Energy Office to contract with AWS Truepower to provide wind mapping. Since the completion of the mapping, Santee Cooper has joined several partnerships to further study the potential of wind generation.

Santee Cooper helped install and maintain anemometer towers at Waites Island in Horry County and the Baruch Institute in Georgetown. To complete these projects, Santee Cooper worked with Coastal Carolina University, Clemson University, Savannah River National Laboratory, Secondwind, and the Baruch Foundation. The towers proved that inland wind resources were not strong enough to sustain utility-scale wind turbines; however, they also partially validated the estimates produced by AWS Truepower in 2005 that predicted that a large wind resource exists in South Carolina's offshore waters. In addition, the Baruch Tower was used to validate an emerging wind-measuring technology that was developed by Secondwind.

A 2.4 kW Skystream wind turbine was installed at Oceanfront Park in North Myrtle Beach in November 2010 and has since been in continuous operation. Santee Cooper continues to investigate the possible installation of additional small wind turbines at public locations where wind is determined to be adequate.

Electric Cooperatives Projections

Electric cooperatives are private, independent, and not-for-profit electric utility businesses. They are owned by the consumers they serve and are incorporated under the laws of the state in which they operate. Their membership elects a board of directors to set policies and procedures that are implemented by cooperative personnel. The majority of electric cooperatives are distribution cooperatives, meaning that they deliver at-cost electricity to their members. Some cooperatives, however, are generation and transmission cooperatives that both generate and deliver electricity to their members. Because cooperatives are owned by their members, the net margin above expenses and reserves belongs to the members. Any margin is usually used to improve operations or is redistributed to the cooperative's members. In addition to providing electricity, many electric cooperatives are involved in local revitalization projects and community development.

North Carolina's 26 electric cooperatives provide electricity to more than 2.5 million people across 93 of the state's 100 counties. They project an annual average growth of 1.2 percent from 2013 through 2022. North Carolina's cooperatives also comply with NC REPS. South Carolina has 22 electric cooperatives, of which two are generation and transmission cooperatives that serve as wholesale power providers to other electric cooperatives and do not serve retail customers. South Carolina's electric cooperatives serve over 1.5 million people in all 46 counties.

Electric cooperatives seek to serve their members and offer advanced solutions to meet their needs. These solutions have included new energy efficiency programs, renewable energy investments, bill payment options, and technology upgrades. They also maintain and update generation and transmission equipment. For example, North Carolina's electric cooperatives recently began commercial operation of two peaking plants to replace the power supplied by expiring power supply contracts and to meet the growing electric needs of members. In South Carolina, the electric cooperatives recently partnered with Santee Cooper to build the state's largest solar farm, which generated 4,687 MWh in its first year.

Each individual cooperative also manages programs to benefit the members in its territory. These programs include community solar, electric vehicle charging station installations, appliance rebates, smart meters, time-of-use rates, on-bill financing, and more. The North Carolina and South Carolina cooperatives are in a unique position to be able to offer innovative programs for their members and plan for future changes based on their members' needs and wants.

Electric Municipalities Projections

North Carolina Public Power represents municipally-owned and -operated electric service, which makes up approximately 10 percent of total residential electric sales in the state. In all, public power serves more than 500,000 customers in more than 70 communities. Fifty-one of these communities are part of two municipal power agencies: North Carolina Municipal Power Agency 1 (NCMPA1) and North Carolina Eastern Municipal Power Agency (NCEMPA). Public power customers and the two municipal power agencies receive support from ElectriCities, which is an organization providing a variety of customer service programs and distribution assistance endeavors.

NCMPA1 consists of 19 municipal electric systems in central and western North Carolina. In 2015, it supplied almost 5.3 TWh of electricity to its customers. NCMPA1's energy portfolio is comprised of 95 percent nuclear power, making it among the smallest emissions profiles nationally. It owns 75 percent of the Catawba Nuclear Station Unit 2, which is operated by Duke Energy. In addition, NCMPA1 owns and operates 34 diesel peaking generators and has wholesale power purchase agreements with Duke Energy, Southeastern Power Administration, and Southern Power Company.

NCEMPA consists of 32 municipal electric systems in central and eastern North Carolina. In 2015, NCEMPA supplied 7.5 TWh of electricity to its customers. Up until its asset sale, effective August 1, 2015, NCEMPA owned 700 MW of power generation, including a portion of two nuclear energy facilities and two coal power plants operated by Duke Energy. NCEMPA is now dependent on purchased power, but its members are allowed to receive unlimited capacity and unlimited energy from Duke Energy during the contract period (30 years) as part of the asset sales agreement.

Under NC REPS, municipal power providers must reach up to 10 percent of their energy through renewable or energy-efficient resources by 2018. To meet these mandates in a least cost manner, NCMPA1 and NCEMPA offer energy efficiency programs to encourage energy conservation and efficient energy use. They also have purchase agreements for RECs generated from in-state and out-of-state solar photovoltaic, biomass power plants, poultry and swine waste and out-of-state wind energy. NCMPA1 also receives renewable energy from a solar photovoltaic generation plant in Shelby, NC.

South Carolina municipal electric utilities are organized by the South Carolina Municipal Power Systems (SCAMPS). This association connects the 21 publicly-owned utilities in the state. SCAMPS provides aid in times of dire need and offers a number of services to its members, including legislative initiatives, public relations programs, and training for electrical personnel.

Ten of the communities, all in the northwest part of South Carolina, form the Piedmont Municipal Power Agency (PMPA). This agency provides wholesale electric service to more than 100,000 residential, commercial, and industrial customers. It supplies electricity primarily through a 25 percent ownership interest in Catawba Nuclear Station Unit 2, which provides 277 MW of capacity output. Additional power supply requirements come from Santee Cooper.

PMPA provides a variety of services to its customers, including community outreach, energy safety and conservation tips, assistance attaining RP3 designation, and load forecasts. It also offers access to Energy Depot, which is a suite of online tools and resources to help customers learn more about their energy use. In its most recent strategic plan, PMPA outlined rates, load management, reliability, and financial stability as the most important initiatives to examine in the coming years.

CHALLENGES AND OPPORTUNITIES

North Carolina and South Carolina are linked in many ways: they border the Atlantic Ocean in the east and mountains in the west, three of South Carolina's four major rivers flow out of North Carolina, and weather patterns and storm damage issues are similar. The two states also share major highways, rail lines, and electric, petroleum, and gas transmission lines. Their energy futures are inextricably linked by the fact that the majority of citizens in both states are served by a single utility, Duke Energy, and many are served by a SCANA subsidiary.

The region's electric utilities have historically pursued the least cost generation that would ensure reliable service and comply with all applicable environmental regulations. This approach favored the operation of large nuclear and coal plants for baseload generation, hydroelectric and small coal units for intermediate load, and natural gas/oil peaking and hydroelectric plants to meet high demand. The setup has been successful, as average electric rates across all market sectors are lower than the national average (9.91 cents/kilowatt-hour [kWh] vs 10.83 cents/kWh), and the states have an excellent record of reliable power dispatch (over 99.99 percent).

Coal

Although coal plants have provided low cost and reliable electric power in the Carolinas for decades, there is little public support for building new plants. Furthermore, coal appears to no longer be a least cost option for new generation when the expense of carbon capture and other externalities are considered. The costs and resulting emissions increase of ramping a coal-fired unit up and down to integrate renewable energy are generally higher than that of a more efficient natural gas-fired unit.

None of the electric utilities serving the Carolinas plan to add coal to their portfolio during the next 15-year planning horizon, but all plan to continue to operate most of their current coal fleet as a least cost option. As other generation sources are added to meet energy consumption and peak demand growth, coal's contribution will likely continue to decline and may be only a fourth of the total generation capacity in the Carolinas by 2030. This "flipping" of coal for gas will have obvious and significant benefits to the Carolinas' air quality. However, the challenge will be to recognize that coal's contribution to ensuring electric power is available on demand and to add the right balance of new generation growth. It will be important to add new dispatchable energy resources with local fuel storage to maintain reliability and minimize fuel volatility risks.

Coal Ash

Coal ash is an unavoidable byproduct of the combustion of coal. It consists of fine particles that are driven out of the boiler with the flue gases (fly ash) and ash that falls in the bottom of the boiler (bottom ash). The chemical composition of coal ash is determined primarily by the chemistry of the source coal and the combustion process.

Coal ash is reused in various ways. The most common reuse is substituting cement and sand in concrete and using it in embankments and other structural fills. Other uses include mine reclamation, loose application for ice control, or even cosmetics, toothpaste, and kitchen counter tops.

The remaining coal ash is placed in landfills and impoundments. In North Carolina, this amounts to an estimated 102 million tons of ash. About 60 percent of disposed fly ash is managed dry in landfills, and 40 percent is managed wet in impoundments, with a long-term trend toward increased use of dry management practices. Wet storage in ponds has been found to cause a number of problems. Wet storage of coal ash can lead to slow leakage of contaminants and led to the failure of a stormwater pipe below a pond that allowed 39,000 cubic yards of ash to spill into the Dan River. The North Carolina Department of Environmental Quality and Duke Energy also entered into a settlement regarding Duke's role in the Dan River spill. While North Carolina has taken great strides to deal with the coal ash problem and mandate that every coal ash pond in the state be permanently closed, coal ash has been a controversial topic in recent years.

North Carolina's coal ash laws require the closure and remediation of all coal ash sites. High priority sites must be closed by 2019, intermediate sites by 2024, and low priority sites by 2029. The North Carolina Department of Environmental Quality classified all 33 coal ash sites in North Carolina as intermediate or high risk. Under state law, some of these sites may be reclassified as low priority only if the owner/operator takes action to lower risks to public health and the environment, such as strengthening coal ash pond dam integrity and providing alternative water supply. All of South Carolina's storage sites that have been evaluated are classified as low or intermediate risk.

Natural Gas

Natural gas demand has been rising in the Carolinas, and is expected to continue to rise, mostly due to increasing reliance on natural gas for electricity generation. Large declines in the cost of natural gas power generation have occurred in the last seven years as technological advancements have made gas combined cycle plants more efficient and access to United States shale gas more economical. As natural gas burns cleaner than other fossil fuels, air quality in the Carolinas should continue to improve.

North Carolina may be susceptible to potential supply constraints. One interstate pipeline system (Transco) transports the vast majority of its natural gas supply from predominantly one region (the Gulf Coast). South Carolina is served by Transco and by the Southern Natural Gas Company interstate pipeline, which transports natural gas supplies from Southwestern production areas.

Adequacy of local gas storage could also be an issue. The Carolinas have no in-state underground gas reservoirs. Both states have liquefied natural gas (LNG) storage facilities, but their LNG storage capacity has not risen in proportion to the increasing demand.

Companies have recognized the need for more pipeline capacity and diversity in supply. The Williams Co.'s five-year plan, beginning in 2013, is to increase the Transco pipeline capacity by 50 percent and tap into shale gas supplies in Pennsylvania and West Virginia. Additionally, Dominion Transmission, in partnership with Duke Energy, Piedmont Natural Gas, and AGL Resources, proposes to bring 1 million Dt/day of natural gas into eastern North Carolina from West Virginia with the planned ACP project. Within the next two to three years, North Carolina should have a redundancy of gas supply and delivery, closer access to gas fields, and the pipeline capacity to supply its increasing gas needs. Proposed pipeline projects, which will shorten the amount of time it takes to move natural gas into the Carolinas from supply markets, may offset some of the local gas storage needed. The enhanced gas infrastructure should also bring economic development opportunities, particularly in eastern North Carolina.

Hydropower

Hydropower is a dispatchable resource that generates emissions-free electric power. Existing conventional plants are relatively inexpensive to operate. The majority of hydropower plants were built before World War II and some before World War I. The primary hydropower fleet in the Carolinas consists of 40 plants in North Carolina and 37 in South Carolina, including three pumped storage plants. The Bad Creek and Jocassee pumped storage facilities operated by Duke Energy and the Fairfield pumped storage plant operated by SCE&G provide the vast majority of energy storage capacity for the Carolinas. Several hydro dams will come up for relicensing before 2030. The licensing process will need to address issues including safety, wildlife habitat preservation, and water demand.

Nuclear

Nuclear energy is an integral part of the North Carolina and South Carolina clean energy future. Reliance on nuclear power in these two states is projected to increase moderately between now and 2030. Policy certainty will be key in continuing nuclear energy growth beyond the V.C. Summer Units 2 and 3 coming online. Long-term energy policies that recognize the value of generation diversity, on-site fuel, the ability to dispatch electricity on demand, energy availability during critical peak demand, and low emissions could successfully advance nuclear energy development.

Helping the public and policy makers become better informed about the safety of nuclear power will be important. A common concern is with the radiation associated with nuclear power generation. While high-level radiation is known to cause serious health problems, there is little direct evidence to show that low-level radiation is harmful.

The NRC oversees the construction and operation of nuclear facilities. The comprehensive design standards and site operation procedures that are required have been effective at preventing radiation releases, but add significant costs to plant construction. The NRC calls for multiple layers of defense, including specifying that nuclear plants be fabricated with the highest quality of materials and equipment, undergo rigorous inspections, be equipped with early leak detection systems, have emergency cooling systems capable of preventing a meltdown, and have secure containment designed to hold all potentially released radioactivity in the unlikely event of a meltdown.

Each plant must be capable of withstanding hurricanes, floods, tornadoes, tsunamis, and earthquakes and have effective security strategies in place to defend against physical attacks, insider threats, and cyber-attacks. The NRC continually monitors the potential for new or heightened risks and establishes safeguards against these risks as needed. All of the nuclear power plants operating in the Carolinas are equipped with the highest level of protection.

Since 1977, United States policy has forbid reprocessing of used nuclear fuel. DOE was directed to establish a national high-level nuclear waste repository for spent fuel and other high-level radioactive waste, but has yet to do so. In the interim, spent fuel is securely stored at nuclear plant sites in wet storage (steel-lined, water-filled concrete pools) and dry cask storage (concrete and steel containers). While there is still ample spent fuel storage capacity remaining at each of the Carolina nuclear plants, it is imperative that the federal government provide a permanent solution for the long-term management of high-level nuclear waste to advance nuclear power projects.

Most statistics indicate that the turnover and retirement rates in the energy industry, especially nuclear, are greater than the rate of new hires. The nuclear power industry requires highly competent workers. It has formed partnerships with universities, community colleges, and other institutions to educate and train the future nuclear energy workforce and retrain the current one. The U.S. Department of Labor predicts as much as half of the nation's utility workforce will retire by 2024.

Well in advance of new construction, the Carolinas will need to establish new programs in community colleges and state universities that will provide students the technical skills and STEM (science, technology, engineering, and math) education they need to work in the nuclear energy field. The Carolinas already have substantive energy research and a curriculum base at nine universities (Appalachian State, Clemson University, Duke University, N.C. State University, N.C. Agricultural & Technical State College, University of North Carolina-Chapel Hill, University of South Carolina, University of North Carolina Charlotte, and Wake Forest University). By committing to a new nuclear power plant by 2020, the Carolinas will be well positioned to take advantage of the V.C. Summer and Georgia Power – Plant Vogtle workforce supply chain.

All 12 of the nuclear power reactors currently operating in the Carolinas were built between 1970 (Robinson 2) and 1987 (Shearon Harris). These plants were originally licensed to operate for 40 years but have each received a 20-year operating license extension. It is likely that utilities will seek another extension; however, to date no United States nuclear plant has been licensed to operate for 80 years. Renewals require long-lead planning of 10 years or more and could include extensive plant upgrades. The NRC is considering if new rules should apply to nuclear power facilities operating beyond 60 years. Presently, there are few prohibitions against another 20-year extension. Assessment models developed by DOE and the Electric Power Research Institute (EPRI) indicate nuclear plants can operate safely out to 80 years.

Renewable Energy

Renewable energy resources offer the promise of improved air quality and reduced environmental impacts but are currently more expensive than conventional energy sources. A major challenge facing the expansion of renewables is that solar and wind energy are intermittent resources that cannot be dispatched to meet changing customer demand during all hours of the day and night or through all types of weather. The existing grid is limited in its capability to integrate large amounts of renewable energy sources. Keeping the grid running reliably is a balancing act, where the amount of power put into the grid must equal the amount taken out. A utility's control systems continuously ramp generating units up or down to meet the electric demand of its customers. With the variability of renewable energy sources, this balance becomes increasingly difficult to maintain. A modernization and hardening of the existing infrastructure will allow the integration of new technologies, such as battery storage and microgrids. To participate in the innovation coming to fruition in the electric sector (e.g., solar panels, wind turbines, electric vehicles, battery storage, and microgrids), the Carolinas will require an advanced, integrated grid to manage and optimize the increasingly dynamic flow of electricity.

Wind

Although both North Carolina and South Carolina have significant wind resources, only one utility-scale wind development is underway (Amazon Wind Farm U.S. East in northeastern North Carolina), which will be generating electricity by the end of 2016. Viewshed issues are significant in both states, not only along the coastlines but in the mountains as well (North Carolina has the Ridge Law that effectively prohibits wind power in its mountains). Planning processes are underway in both states that may lead to offshore development. The Bureau of Ocean Energy Management recently announced the release of the Atlantic Wind Lease Sale 7 Proposed Sale Notice and Request for Interest for 122,405 acres offshore North Carolina. The bidding process should take place in early 2017. Development will not be within 24 nautical miles of the North Carolina coastline.

Solar

As solar penetration continues to rise in the Carolinas, the management of this intermittent power generation within the existing transmission and distribution infrastructure is becoming more challenging. The power frequency and load must be balanced with other resources to compensate for the highly intermittent availability of solar energy. A sudden shutdown in solar energy production when clouds roll by requires the prompt ramping up of a complementary dispatchable energy resource to maintain grid stability. Frequent ramping affects a power plant much like a gasoline car driving in stop-and-go traffic – it lowers fuel efficiency, increases emissions per unit of power generated, and adds significant wear and tear that causes the plant to operate less efficiently.

Another concern of solar generation is the "afternoon ramp" or "duck curve." Solar generation is available during the day, but conventional power sources ramp up as solar production falls. The steep ramp forces utilities to run plants as back up and/or at less than optimal efficiency to meet the rapidly rising demand.

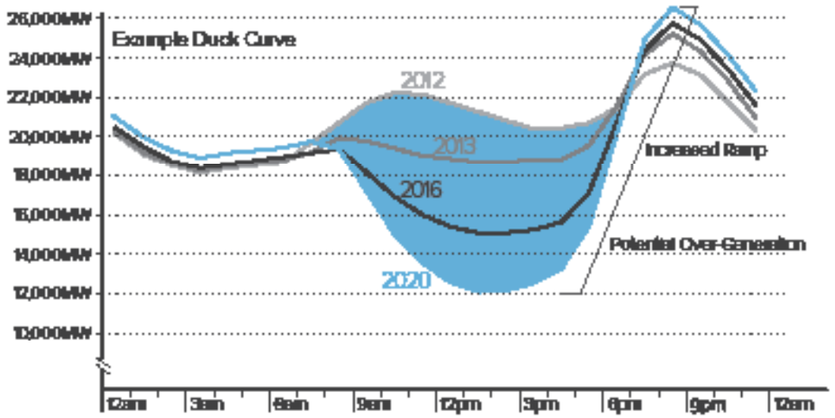
At some point, the inundation of solar energy could significantly impact the electric grid. To avoid negative outcomes, it will be important to follow a Pairing Environmentally Protective Generation (PEP-G) approach, where intermittent resources (e.g., solar and wind energy) are brought online together with non-intermittent clean generation (e.g., nuclear, pump storage, and demand response) to maintain system performance, minimize costs, and avoid creating localized air quality issues. The system flexibility inherent with PEP-G should reduce the need for less efficient and higher emitting peaking sources required to offset the sudden drop off in solar energy from late afternoon to the evening during summer peak demand. Two Carolina utilities are studying how to best implement a PEP-G-like approach.

- Dominion has a microgrid demonstration project at its Kitty Hawk District Office in North Carolina to evaluate how to integrate intermittent power into the grid. This project includes a 6 kW solar array, four types of micro-wind turbines totaling 14 kW, two residential sized fuel cells, and a lithium-ion battery integrated with the existing on-site diesel generator and utility feed.
- Duke Energy plans to add 5 MW of energy storage capacity when it builds a 15 MW solar energy project in western North Carolina to support the retirement of two coal units at its Asheville plant. With operation control of the facility and paired energy storage, Duke Energy expects it can effectively integrate the variable solar power with the rest of its generation, transmission, and distribution systems.

The Carolinas Energy Planning for the Future Summit on May 2, 2016, identified the need for installation standards for solar PV as a major issue. As with any new technology, installation skills and standards are still developing. The queue for approvals is currently so long (in North Carolina) that sometimes the equipment a developer specifies in an application is no longer available when approval is received, meaning that the system that is built does not match the application. Local inspection departments lack staff and expertise to conduct inspections beyond the basic electrical code, and the conclusion from the summit was that, at least for now, a system of third-party inspections (paid for by the developer) needs to be developed, particularly in North Carolina, where utility-scale solar is growing quickly. Developers and utilities are working collaboratively to establish appropriate standards and inspection protocols, and efforts to educate appropriate public officials are underway.

Most solar facilities have been built in rural areas where land is available for lease at a reasonable price. Thousands of acres of prime farmland in North Carolina have been displaced by solar panels, and there are plans for many more solar energy projects, some of which cover hundreds of acres. As more PV facilities and the first wind energy complex are developed in North Carolina, concerns over decommissioning are growing, particularly among those in the agricultural community. Some fear that the landowner will be left with disposal and site restoration costs.

Many developers, however, claim that the salvage value of the solar panels, support structures, and electrical wiring is greater than the removal and site restoration costs – making it a poor financial decision for a developer to abandon a site at the end of the lease. However, there may be logistical issues or environmental restrictions arising from hazardous compounds used in the panel that limit recycling. United States recycling centers are not presently equipped to process the volume of panels that will be discarded in 25 years. North Carolina requires all wind energy facility permit applicants to have a bond that covers the cost of decommissioning and site restoration. A similar requirement for solar energy would protect the land owner from bearing the decommissioning costs.



The Grid

The transmission and distribution grid system currently in place serves the region well but will face considerable challenges in the planning horizon. Shifts in population patterns in the region, coupled with the decentralization of electric generation and the need for a reversed flow of electrons in some portions of the system, pose significant engineering challenges for utilities. Another challenge will be around funding for upgrades and expansion projects, and fairly distributing the costs for these changes.

Widespread use of sensing, communicating, and computing smart grid technologies could help the grid integrate distributed energy resources more efficiently and increase reliability and resiliency. Microgrids, storage systems, and other distributed energy resources can also be integrated to improve system reliability and resiliency. The term "microgrid" refers to a collection of all components of an electric grid (electricity generation, energy storage, and loads) that can be operated both while connected to the traditional grid and while in isolation (islanding). Microgrids present numerous engineering challenges but offer opportunities for significant demand management as well as increased resiliency for the area being served.

Emerging Technologies

Energy Storage

The concept of energy storage is not new (the first large-scale energy storage system was built in 1932), but the need for new storage technology is being accentuated by trends such as the growth in intermittent resources (such as solar PV) and increased interest in resiliency, due both to natural and man-made causes. Storage is also expected to play a crucial role in the transition of the power system toward a smarter grid.

The major sources of energy storage currently available in the Carolinas are the three pumped hydro facilities operated by Duke Energy. While there are facilities that use other storage technologies, such as flywheels, the focus of new storage development is on batteries. Utility-scale storage systems using batteries of various types are in operation in Duke Energy territory, providing buffering to solar generation and back-up to a microgrid.

Currently, there are major challenges with batteries in terms of their performance and cost, but cost-effective solutions may be developed in the near future thanks to the work that Duke Energy is doing and the Swiss company Alevo's announcement of a start-up for the production of grid-level-scale lithium-ion electrolyte batteries in Concord, NC.

Electric Vehicles

Although electric vehicles currently constitute only a small fraction of the total number of vehicles sold, their unique characteristics warrant discussion. As a load for electric utilities, they are a small but welcome new source of revenue. One challenge as a load is the possibility of on-peak charging. The summertime dinner hour is of particular concern: system-wide usage is still high, any solar production available is sagging, and people are getting home from work and plugging in their vehicles. Demand controls on in-home chargers (or circuits used for charging) may be needed.

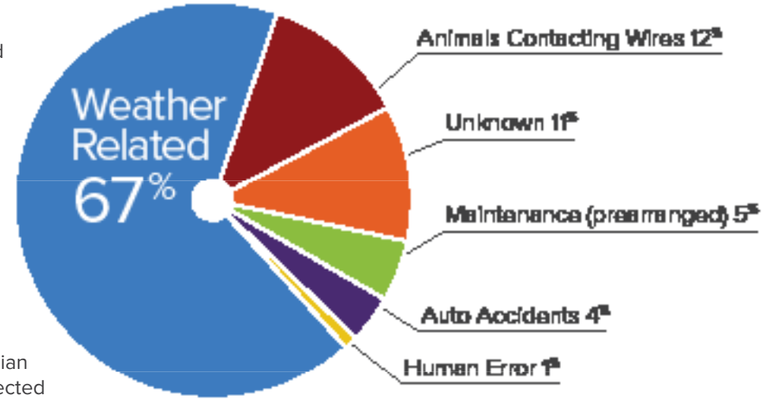
The vehicles' energy storage capacity, though, conceivably represents an opportunity. If the vehicles' batteries can be charged when system usage is low (such as in the middle of the day and at night) and then discharged when system usage is high (dinner time again), then the batteries can be used to flatten out the load over an entire 24-hour period. The potential also exists to use vehicle batteries to buffer the use of renewables in a household or on a larger scale, or for use during power outages. These strategies require further research and significant consumer education.

Threats to Energy Assurance

Weather

Most electrical outages are weather-related disturbances to the electric grid.

- Hurricanes and tropical storms have long been the leading cause of energy disruptions in the Carolinas, affecting the coast and, more recently, inland areas. From 2003 to 2013, the median time to restore power to customers affected by a hurricane was 30 hours.
- Winter storms are responsible for the second most electricity outages in the Carolinas. From 2003 to 2013, the median time to restore power to customers affected by a winter storm was 43 hours.
- Thunderstorms produce lightning, strong winds (including tornadoes), hail, and flash flooding. Time to restore power after thunderstorm damage tends to be only a few hours.



Cyber and Terrorist Attacks

The increasing risk of terrorist attacks in the United States is a threat to the generation, transmission, and distribution of electricity, natural gas, and refined petroleum products. Electric system operators increasingly rely on networks of internet-connected sensors and controllers to monitor and manage their systems. The same technology that allows operators to manage their infrastructure from a central location also introduces new points of vulnerability. Cyber-attacks could directly disrupt utilities and pipeline operation or could require reversion to labor-intensive manual control, which may reduce supply to end-users.

Electromagnetic Disturbances

A geomagnetic storm (also known as a geomagnetic disturbance, or GMD) is a temporary disturbance of the earth's magnetosphere caused by coronal mass ejections and solar flares. These disruptions can be substantial, as in the case of one that brought down the power grid in Quebec for nine hours in 1989. These disturbances generally take several days from the time they are generated to the time they reach the earth, giving power grid and pipeline operators time to prepare for their impact.

Electromagnetic pulses (EMPs) can be generated by both natural events (such as a lightning strike and GMDs) and man-made events, including a nuclear weapon. EMPs are disruptive to electronic equipment and (unlike GMDs) occur with little warning. Theoretically, a massive EMP could severely damage the power grid over a large area, but little objective data is available.

Emergency Management

Emergency management in the case of a long-term, region-wide power outage is a critical issue. Such an outage could be the result of natural forces such as a mega-storm or a physical attack on the grid. The issues would be significantly exacerbated if an electromagnetic event of some type is the cause.

Robust emergency planning infrastructures exist in both North Carolina and South Carolina. Electric utilities devote extensive resources to emergency planning, which increasingly includes issues such as cyber-security, physical attacks, and electromagnetic events. North Carolina Emergency Management has taken the initial steps in being prepared for an EMP or GMD event. In August 2016, it coordinated with the North Carolina Department of Environmental Quality to lead a tabletop exercise simulating a coronal mass ejection. Currently, North Carolina Emergency Management is preparing an EMP annex to add to the state's Emergency Operations Plan, and has received a United States Homeland Security grant to study the impacts of a nuclear detonated EMP on the state's ability to provide emergency response and the private sector's medical service capabilities.

Solutions

Energy planning across state boundaries is a challenge. The Carolinas Energy Planning for the Future project developed a committee of stakeholders from both states to make sure all ideas and viewpoints were considered. The group included local governments interested in maintaining air quality, state regulators engaged in utility oversight or environmental regulation, utility representatives, regional planners, advocates, and more. Over the course of two bi-state stakeholder meetings, practical ideas were shared and relevant problems that were appropriate for state cooperation were identified. These next steps fell into two main categories: public education and bi-state planning.

Public Education

Public education is an extremely important component to ensure upcoming energy changes are well understood and that the right balance of energy resources is supported. There is a lack of knowledge around the challenges that the electric utility industry is currently facing, the wide variety of changes that are coming, the way the utility system functions, emerging technologies, and the need for a diverse generation portfolio.

The participants at the May 2016 bi-state summit discussed the need to educate the public, starting with local elected officials. Many of these local officials, especially in North Carolina, are already having to confront some of the issues, such as siting PV facilities and coal ash impoundments. A well-educated body of local officials will help our two states work through these challenges and opportunities with less disruption and confusion.

The education can be conducted through multiple avenues, including utilities, colleges, state agencies, and nonprofits. It is very important, however, that all entities share the same message. The North Carolina Department of Environmental Quality is starting to work with educators across the state to integrate the DOE National Energy Education Development Program (NEED) into current curriculums. Also, there is a goal to have North Carolina facilities participate in educational outreach opportunities.

Carolinas Bi-State Planning

The fact that one electric utility, Duke Energy, serves most of the residents of both North Carolina and South Carolina inextricably ties the energy futures of our two states together. The states are further linked by geographical features, such as mountains, rivers, and coastlines, as well as by weather patterns. Because of these links, it is beneficial to develop a planning process for areas where the states can share best practices and lessons learned. Specific bi-state planning areas may include the following:

- Duke Energy has committed to offering consistent energy efficiency programs in both states, but bi-state planning is needed to reduce the impact these programs face from having to be approved by separate regulatory structures.
- The grid that serves the Carolinas is already largely interlinked, but bi-state planning is needed to repair the grid and communicate with the affected customers in case of a major long-term outage.
- The resource mix cited in this report is much more robust when both states are considered together. Bi-state planning is needed to ensure that the costs and benefits of the resource mix are appropriately shared by all customers moving forward.
- Bi-state planning and coordination are needed to educate the region's public and elected officials to ensure that the Carolinas have the right energy infrastructure in place to meet its energy demands and continue to grow the economy. The electric utility industry is already complex, and the changes that are coming will make it even more so. Differences of opinion are a part of the public discourse, but a lack of information, or one-sided information, will only lead to decisions that are not in the best interest of the public.
- There has clearly been a commitment to low-cost electricity in both states, and this is not expected to change. However, renewables and other developments are providing challenges to how costs are passed on in the rate structure. Bi-state planning is needed to touch on several issues related to the low- (and fixed-) income ratepayers in both states, such as how to protect these ratepayers from increases in their electric bills.
- There is also a bi-state planning need around air quality. The winds that flow down our mountains into the Midlands and Piedmont and the ocean winds that wash our coastlines from Hilton Head to Corolla pay no heed to the state line. Bi-state planning and coordination are necessary now to prevent conditions that might lead to future declarations of air quality non-attainment and provide cleaner air for our citizens, particularly in major metropolitan areas along the state boarders and in heavily trafficked areas. These planning efforts must pay attention to everything from macro issues, such as the electric generation resource mix, to energy efficiency programs to the promotion of clean and efficient transportation.

The Carolinas Energy Planning for the Future project provided North Carolina and South Carolina an opportunity to step back, look at the current energy industry within the states, and begin to have conversations about shared issues and opportunities. For many topics, this undertaking was the first time that the states had come together to discuss their ideas around solving an energy issue.

As a result of the project, two bi-state stakeholder summits occurred, an air quality-focused toolkit for local governments was created, engagement was increased between the states' regulatory staffs, and cooperation between the states with regard to emergency planning increased. As this bi-state planning effort moved forward, related efforts specific to each state were also unfolding. North Carolina-specific recommendations will be presented to the North Carolina Energy Policy Council. In South Carolina, a large group of stakeholders, divided into 12 subcommittees, met over a period of a year to develop a state-specific energy plan with a total of 80 recommendations and extensive baseline data. Information about the South Carolina plan can be found at http://www.energy.sc.gov/energyplan.

Through this two-year project, a stronger relationship was created between the North Carolina and South Carolina energy industries, and moving forward, there is now a platform for the states to collaborate around energy topics. With shared geography, issues, and utilities, having a more combined approach will greatly benefit both states.

ABBREVIATIONS GUIDE

ACP – Atlantic Coast Pipeline LLC
Btu – British thermal unit
CC – Combined cycle
CHP – Combined heat and power
CT – Combustion turbine
DEC – Duke Energy Carolinas
DEP – Duke Energy Progress
DER – Distributed Energy Resource
DOE – U.S. Department of Energy
Dominion – Dominion Resources
DR – Demand response
DSM – Demand-side management
Dt – Dekatherms
ECSC – Electric Cooperatives of South Carolina Inc.
EE – Energy efficiency
EECLP – Energy Efficiency and Conservation Loan Program
EEM – Energy Efficient Mortgages
EERE – Office of Energy Efficiency and Renewable Energy
EERL – Energy Efficiency Revolving Loan
EIA – U.S. Energy Information Administration
EMP – Electromagnetic pulse
EPA – U.S. Environmental Protection Agency
EPIC – UNC Charlotte's Energy Production and Infrastructure Center
EPRI – Electric Power Research Institute
FERC – Federal Energy Regulatory Commission
FHA – Federal Housing Authority
Frontier – Frontier National Gas Company
GES – Green Energy Solutions
GMD – Geomagnetic disturbance
GPSS – Green Power Solar Schools
GWh – Gigawatt-hour
HVAC – Heating, ventilation, and air conditioning
IOU – Investor-owned utility
IRP – Integrated resource plan
kW – Kilowatts
kWh – Kilowatt-hour
LIHEAP – Low Income Home Energy Assistance Program
LNG – Liquefied natural gas
LPG – Liquefied propane gas
MACRS – Modified Accelerated Cost-Recovery System
MVP – Mountain Valley Pipeline LLC
MW – Megawatts
MWh – Megawatt-hour
NCEMPA – North Carolina Eastern Municipal Power Agency
NCMPA1 – North Carolina Municipal Power Agency 1
NCUC – North Carolina Utilities Commission
NEED – National Energy Education Development Program
NRC – U.S. Nuclear Regulatory Commission
ORS – South Carolina Office of Regulatory Staff
PEP-G – Pairing Environmentally Protective Generation
PMPA – Piedmont Municipal Power Agency
PPA – Power purchase agreement
PSC – South Carolina Public Service Commission
PSNC – Public Service Company of North Carolina
PTC – Renewable Energy Production Tax Credit
PURPA – Public Utility Regulatory Policies Act of 1978
PV – Photovoltaics
QECBs – Qualified Energy Conservation Bonds
RE – Renewable energy
REAP – Rural Energy for America Program
REC – Renewable energy credit
REPS – Renewable Energy and Energy Efficiency Portfolio Standard
RPS – Renewable portfolio standards
RP3 – Reliable Public Power Provider
SCAMPS – South Carolina Association of Municipal Power Systems
SCE&G – South Carolina Electric & Gas Company
STEM – Science, technology, engineering, and math
TOU – Time-of-use
Transco – Williams Transcontinental pipeline system
TWh – Terawatt-hours
USDA – U.S. Department of Agriculture
USI – North Carolina Utility Savings Initiative
VA – Veterans Affairs
WAP – Weatherization Assistance Program

RESOURCES

U.S. Energy Information Administration
www.eia.gov

Solar Energy Industries Association
www.seia.org

Duke Energy
www.duke-energy.com

Duke Energy Progress
www.progress-energy.com

Dominion North Carolina Power
www.dom.com

Santee Cooper
www.santeecooper.com

South Carolina Electric & Gas
www.sceg.com

North Carolina Electric Cooperatives
www.ncemc.com

The Electric Cooperatives of South Carolina
www.ecsc.org

North Carolina Public Power
www.ncpublicpower.com

Electricities
www.electricities.com

Municipal Association of South Carolina
www.masc.sc

PROJECT PARTNERS

ENERGY OFFICE
www.energy.sc.gov

NC Nothing Compares
www.deq.nc.gov

advanced energy
www.advancedenergy.org

UNC CHARLOTTE
Energy Production and Infrastructure Center
www.epic.uncc.edu

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