Energy Policy Council

Biennial Report

May 2018

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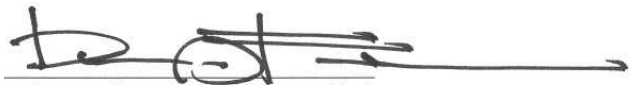
Transmittal Page

Pursuant to N.C.G.S. §113B-12, this comprehensive report providing a general overview of the energy conditions of the State of North Carolina is hereby transmitted to the Governor, the Speaker of the North Carolina House of Representatives, the President Pro Tempore of the North Carolina Senate, the Environmental Review Commission, the Joint Legislative Commission on Energy Policy, and the Chairman of the Utilities Commission.

Respectfully submitted,



Dan Forest, Lieutenant Governor Chair,
Energy Policy Council

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List of Abbreviations

ACEEE	American Council for an Energy Efficient Economy
ACP	Atlantic Coast Pipeline
ASCE	American Society of Civil Engineers
BOEM	Bureau of Ocean Energy Management
Btu	British thermal units
CAFE	Corporate Average Fuel Economy
CHP	Combined Heat and Power
CME	Coronal Mass Ejection
CNG	Compressed Natural Gas
CO_2	Carbon Dioxide
CPRE	Competitive Procurement of Renewable Energy
DEC & DEP	Duke Energy Carolinas and Duke Energy Progress
DEM	North Carolina Division of Emergency Management
DEQ	North Carolina Department of Environmental Quality
DPP	Draft Proposed Plan
DSM	Demand-Side Management
EA	Energy Assurance
EE	Energy Efficiency
EI	Energy Infrastructure
EIA	Energy Information Agency
EMC	Electric MembershipCooperative
EMP	Electromagnetic Pulse
EOP	Emergency Operations Plan
EPC	North Carolina Energy PolicyCouncil
EPRI	Electric Power Research Institute
EV	Electric Vehicle
FERC	Federal Energy RegulatoryCommission
GDP	Gross Domestic Product
GHG	Greenhouse Gases
HERS	Home Energy Rating System
IED	Intelligent Energy Devices
ICE	Internal Combustion Engine
IOU	Investor-Owned Utility
IRP	Integrated Resource Plan
KW	Kilowatt
KWh	Kilowatt-hour
LFG	Landfill gas
M&V	Measurement and Verification
MVP	Mountain Valley Pipeline
MW	Megawatt

NAAQS	National Ambient Air Quality Standards
NCUC	North Carolina Utilities Commission
NERC	North American Electric Reliability Corporation
NGV	Natural Gas Vehicle
NO_X	Oxides of Nitrogen
O_3	Ozone
OCS	Outer Continental Shelf
PC	Performance Contracting
PURPA	Federal Public Utilities Regulatory Policy Act of1978
PV	Photovoltaic
REPS	Renewable Energy Portfolio Standard
RFI	Request for Information
SCADA	Supervisor Control and Data Acquisition
SMR	Small Modular Reactors
SO_2	Sulfur Dioxide
T&D	Transmission and Distribution
USDA	United States Department ofAgriculture
USDOE	United States Department of Energy
USDOI	United States Department of theInterior
USEPA	United States Environmental Protection Agency
USI	North Carolina Utility Savings Initiative
VOCs	Volatile Organic Compounds
WAP	North Carolina Weatherization Assistance Program
WEA	Wind Energy Area
WEF	Wind Energy Facility
WWTF	Wastewater Treatment Facility

Executive Summary

The Energy Policy Council advises the Governor and the General Assembly about legislation and regulations to protect the environment, advance domestic energy exploration and development, and that encourage economic development in North Carolina. The Council's responsibilities include the preparation of comprehensive energy policy that addresses present and future energy needs while positioning North Carolina and the nation towards achieving energy independence.

Members of the Council possess expertise in areas such as: research and policy; the utility industry; environmental management; and a diverse suite of energy resources and delivery practices. The Energy Policy Council also develops contingency and emergency plans to address possible energy shortages in order to protect the public's health, safety, and welfare, and makes recommendations about energy efficiency and conservation programs. The Council is an independent body that is supported by staff in the North Carolina Department of Environmental Quality.

Pursuant to Chapter 113B of the North Carolina General Statutes, the Council's responsibilities include:

- Developing a comprehensive State Energy Policy for the Governor and the General Assembly that addresses energy requirements in the short- (10 years), mid- (25 years), and long-term (50 years) in order to achieve maximum effective management and use of present and future sources of energy.
- Conducting an ongoing assessment of the opportunities and constraints presented by various uses of all forms of energy to facilitate the expansion of domestic energy supplies and to encourage the efficient use of energy.
- Reviewing and coordinating energy-related research, education, and management programs that inform the public, and actively engage in discussions with the federal government to identify opportunities to increase domestic energy supply within North Carolina and its adjacent offshore water.
- Recommending to the Governor and the General Assembly, legislation, rulemaking, and any necessary modifications to energy policy, plans, and programs.
- Recommending and energy efficiency program that is designed to protect the public health and safety of the citizens of North Carolina, and considering the conservation of energy through reducing wasteful, inefficient, or uneconomical use of energy resources.
- Developing contingency and emergency plans to protect the public from possible shortages of energy, to be compiled into an emergency energy program.[1]

In order to fulfill its statutory directives, the full Council meets quarterly, which the Energy Assurance, Energy Efficiency, and Energy Infrastructure committees of the Council meet more

[1] North Carolina Energy Office. (2013) *North Carolina Energy Assurance Plan*. Retrieved from https://files.nc.gov/ncdeq/Energy%20Mineral%20and%20Land%20Resources/Energy/Energy%20Assurance%20Plan%202013.pdf

frequently to receive information pertinent to their charge and to develop recommendation for the full Council's consideration.

Since the Energy Policy Council convened again in 2017, three full Council meetings were held on August 16, 2017, November 9, 2017, and on February 21, 2018. The agendas, minutes, and associated presentations and materials from these meetings are available on the Council's Web Page.

Energy Policy Council
Members and Committees

The Energy Policy Council works to identify and utilize all domestic energy resources in order to ensure a secure, stable, and predictable energy supply and to protect the economy of the State, promote job creation, and expand business and industry opportunities while ensuring the protection and preservation of the State's natural resources, cultural heritage, and quality of life. The Council anticipates that much of the work it will perform going forward will be completed by the committees as described below:

1. The Energy Assurance (EA) Committee which focuses on: energy supply networks and disruptions; system security (both physical and cyber vulnerabilities); microgrid deployment; distributed generation (small-scale renewable, combined heat and power); alternative fuels; and resiliency in building codes. The members of the EA Committee are:
    - Dr. Herb Eckerlin
    - Walt Coleman (Chair)
    - Michael Van Wingerden
    - Secretary Tony Copeland
    - Lieutenant Governor Dan Forest (tie-breaker, as needed)
2. The Energy Efficiency (EE) Committee which focuses on: life-cycle cost analyses for new and existing development; performance contracting; expansion of existing programs to all sectors; transportation applications; energy efficiency building code adoption; and synergies across State and other programs. The members of the EE Committee are:
    - Paolo Carollo
    - Rick Feathers
    - Scott Tew (Chair)
    - Secretary Michael Regan
    - Lieutenant Governor Dan Forest (tie-breaker, as needed)
3. The Energy Infrastructure (EI) Committee, which focuses on: utility-scale generation, transmission, and distribution; exploration for and penetration of traditional and renewable energy resources; identifying new energy resources; smart grid technology deployment;and grid modernization. The members of the EI Committee are:
    - Gus Simmons
    - Bruce Barkley
    - Carl Wilkins (Chair)
    - Robert Caldwell
    - Lieutenant Governor Dan Forest (tie-breaker, as needed)

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List of Committee Meetings

Energy Assurance Committee

October 26, 2017: Review of EA Committee content in 2016 report; plan for subsequent meetings.
November 9, 2017: Select Committee Chair; request update on natural gas pipeline projects mentioned in the 2016 Report; suggestion to incorporate the findings from the coronal mass ejection (CME) and electromagnetic pulse (EMP) tabletop exercises (TTXs) into the EPC Report (along with any other EA recommendations) prior to next full Council meeting; and identify initiatives for future Committee work.
January 29, 2018: Review and assignment of work responsibilities for 2018 report.
February 6, 2018: Draft documents were circulated and topics for EA content were discussed.
February 14, 2018: Final Committee meeting to discuss EA report content.

Energy Efficiency Committee

October 24, 2017: Select Committee Chair; review topics; schedule subsequent meeting.
November 16, 2017: Staff overview of past recommendations and create 2018 priorities.
December 18, 2017: Presentations on residential, commercial, and public buildings; continued discussion of past recommendations; and priorities for future information items.
January 19, 2018: Presentations on building codes, industrial energy efficiency, and residential weatherization programs.
February 12, 2018: Discuss report structure and content edits by sectors.
February 21, 2018: Discuss materials and compilation of all speaker recommendations to date; review and prioritize proposed recommendations.
March 15, 2018: Presentations on beneficial electrification and EV air quality impacts.
March 26, 2018 (webinar): Discuss Committee draft report content.

Energy Infrastructure Committee

November 9, 2017: Select Committee Chair; overview of EI focus areas; review of 2016 Council report.
December 5, 2017: Continue review of the 2016 report; identify items for new business and subsequent meeting dates.
January 30, 2018: Restate the focus of the EI Committee as "utility-scale electric generation, transmission, and distribution; exploration for traditional and renewable energy resources; and grid modernization;" continued discussion and review of 2016 with a focus on above topics.
April 6, 2018: Progress update on EI Committee report content; develop outline and assignment of work responsibilities.

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Energy Infrastructure

I. Overview

North Carolina is nationally recognized for its quality of life, business-friendly tax climate, and skilled workforce. According to the United States Energy Information Administration (EIA), North Carolina's average residential electric rate is 10.84¢ per kilowatt-hour (kWh), average commercial electric rate is 8.74¢/kWh, and average industrial electric rate is 6.14¢/kWh as of March 2018.[2] Compared with the year-to-date national average residential electric rate of 12.57¢/kWh, national average commercial electric rate of 10.51¢/kWh, and national average industrial electric rate of 6.79¢/kWh, North Carolina is quite favorable across rate classes[3,4] (as depicted in Figure 1 below).

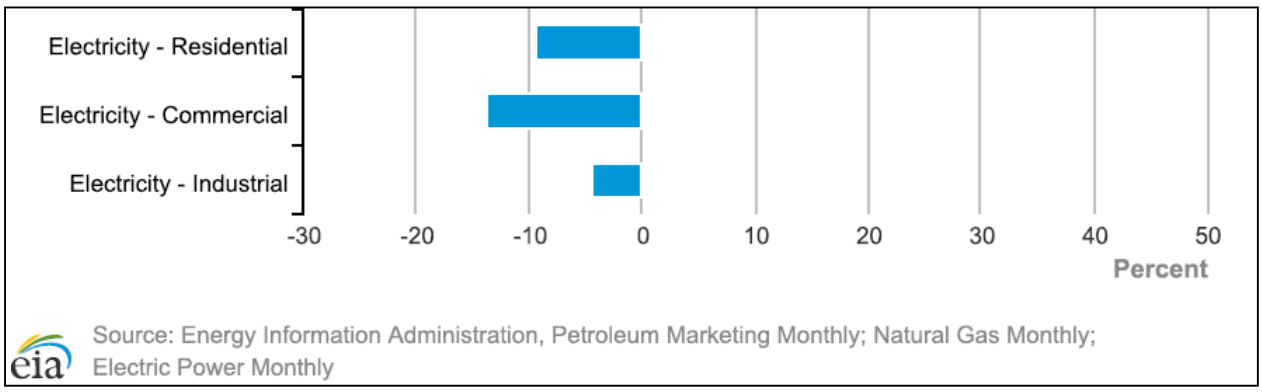

Figure 1. North Carolina Electricity Price Differential from the National Average

Reliable and reasonably priced electricity is vital to sustain the State's growing economy and workforce. Continued exploration and utilization of North Carolina's native energy resources, including renewable resources, is important for assuring the State's energy security and its ability to meet long-term energy demands. The Energy Policy Council's plans have been and continue to address an *all-of-the-above* energy strategy for North Carolina.

Generation, transmission, and distribution infrastructure are necessary for maintaining electric reliability, affordability, and to deliver services that meet customer needs and expectations. As new technology allows for bi-directional grid communication, the opportunities and service expectations evolve for both customers and for utilities. Application of these new technologies is broadly termed *grid modernization* and includes smart meters, automated switchgear, load control devices, grid diagnostic devices, and data derived from these management devices. The North Carolina Utilities Commission (NCUC or Commission) licenses all electric generation,

[2] United States Energy Information Administration, *Average Price of Electricity to Ultimate Customers by End-Use Sector, By State:* https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_5_06_b

[3] U.S. EIA, *Average Price of Electricity to Ultimate Customer,* Retrieved from: https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_5_03

[4] U.S. EIA , *North Carolina Price Differences from United States Average:* https://www.eia.gov/state/?sid=NC#tabs-5

including utility-scale renewable energy facilities, and transmission facilities.[5] In 2018, the Commission approved a rate increase for Duke Energy Progress, LLC, which primarily allowed the company to recover costs for coal ash remediation, storm recovery, natural gas power plant investments, and transmission and distribution investments.[6] As of the time of the publication of this report, the rate increase requested by Duke Energy Carolinas, LLC, remained under consideration by the Commission.[7]

Electric generation in North Carolina is evolving to address carbon emission reductions, employ greater efficiency, and include more distributed energy generation resources. North Carolina's electric utilities continue to manage their nuclear fleets as a necessary carbon-free resource for baseload generation. Focusing on carbon emissions to help mitigate climate change, North Carolina utilities have decommissioned coal-fired plants and replaced much of that capacity with cheaper and cleaner natural gas electric generation plants. In many cases, environmental compliance and cost impacts were inseparable. The retrofits associated with current environmental compliance associated with 1940s and 1950s vintage plants was often not the least-cost option for utilities. The heavy capital cost associated with making these older coals plants compliant coupled with low cost, abundant natural gas both contributed to the trend to retire coal and build gas. North Carolina's electric utilities have exceeded the *Clean Smokestacks Act* emissions requirements for oxides of nitrogen (NO_X) and sulfur dioxide (SO_2) emissions and are on track to comply with the 2021 renewable energy and energy efficiency mandates established in 2007, with exception of the swine and poultry waste-to-energy set asides.

[5] North Carolina Utilities Commission. (2017, November 21). *Annual Report Regarding Long Range Needs for Expansion of Electric Generation Facilities for Service in North Carolina.* p.4. Retrieved from http://starw1.ncuc.net/NCUC/ViewFile.aspx?Id=2292ba92-d5a1-4b05-b2b7-b158c915655d

[6] North Carolina Utilities Commission (2018, February 23) *North Carolina Utilities Commission Issues Rate Case Decision, Cuts Duke Energy Progress's Rate Request by More than Half*, Retrieved From http://starw1.ncuc.net/NCUC/ViewFile.aspx?Id=5681acfe-ce7b-4c30-81ac-7093bc4c9417

[7] North Carolina Utilities Commission. *Docket E-2 Sub 1142.* Retrieved from http://starw1.ncuc.net/NCUC/page/docket-docs/PSC/DocketDetails.aspx?DocketId=6ea9dcdc-5417-4c84-b6a0-90fa464d8995

In 2016, the contribution of natural gas electric generation surpassed that of coal for the first time in North Carolina.[8] Further opportunities for the use of net-positive carbon emissions energy resources, such as repurposing and converting organic waste streams, can yield greater than one- to-one emissions reductions.[9]

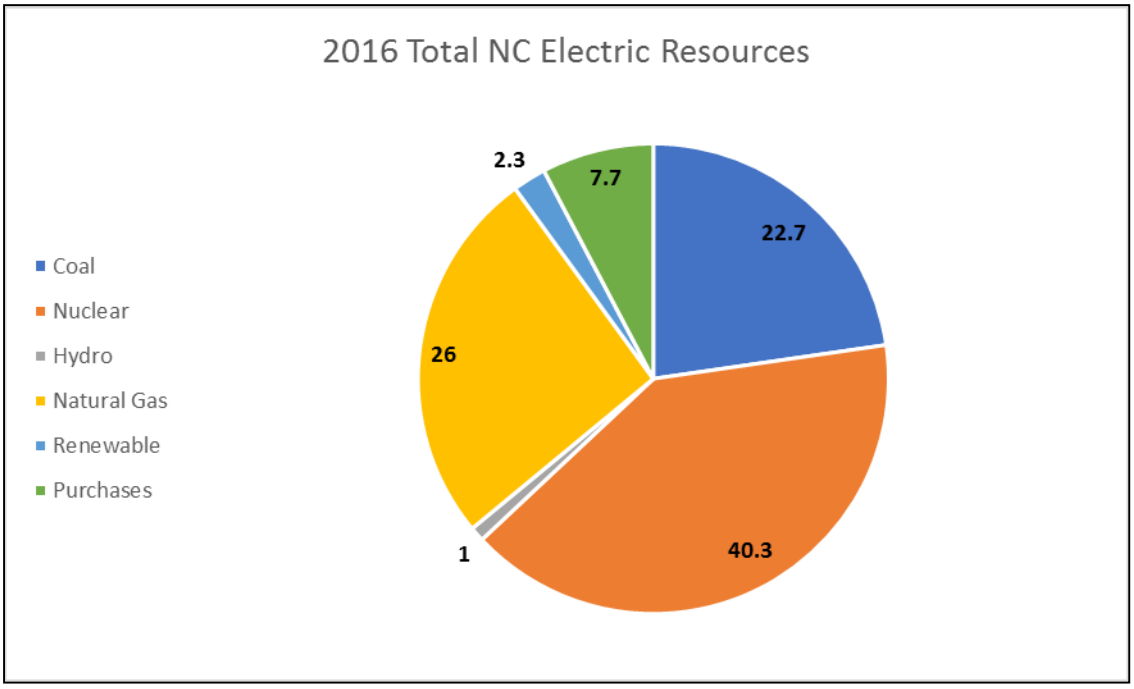

Chart 1. Resource Percentage: Electric Capacity Portfolio[10]

Those items identified as "purchases" in Chart 1 reflect purchases to comply with the State's Renewable Energy Portfolio Standard (REPS) which can include the use of renewable fuels in existing electric generating facilities, the generation of power at new renewable energy facilities, the purchase of power from renewable energy facilities, the purchase of renewable energy certificates (RECs), and the implementation of energy efficiency measures.[11]

Electric utilities require adequate and diverse generating capacity to provide electricity every second of every day, whether during periods of low- or peak demand. Public utilities are required by law to adequately plan for customers' long-range needs and in the most economical manner possible. The utility planning process is challenging due to the evolving changing demands for energy, increased distributed energy generation, storage, microgrid deployment, electric vehicle penetration, demand-side management, and dynamic pricing. Since intermittent

[8] United State Energy Information Administration. (2017, August 17). *Profile Analysis (North Carolina).* Retrieved from https://www.eia.gov/state/analysis.php?sid=NC

[9] Uncontrolled methane emissions from organic wastes can provide methane emissions reduction benefits as well as the 'fuel switch' reduction by use of a lower carbon emission fuel, like renewable natural gas.

[10] North Carolina Utilities Commission. (2017, November 21). *Annual Report Regarding Long Range Needs for Expansion of Electric Generation Facilities for Service in North Carolina.* Retrieved from http://starw1.ncuc.net/NCUC/ViewFile.aspx?Id=2292ba92-d5a1-4b05-b2b7-b158c915655d

[11] North Carolina Utilities Commission. (2007). *Renewable Energy and Efficiency Portfolio Standard.* Retrieved from http://www.ncuc.commerce.state.nc.us/reps/reps.htm

renewable generation, such as from wind and solar, is not considered "dispatchable" by utility planners, it must be off-set with traditional generation sources and more continuous renewable resources that can be more reliably planned for and dispatched to meet the demands of customers. Grid modernization, reliable demand-side management programs, voltage controls, and other technical applications may assist utility operators with balancing the grid when the output from non-dispatchable energy sources fluctuates. Furthermore, electric customers are starting to expect more data, information, and control over their electric use. As such, utilities and customers are looking to grid modernization as a tool for efficient energy management.

North Carolina is ranked 2nd in the country for installed capacity of solar photovoltaic (PV) generation. In 2007, North Carolina enacted the Southeast's first renewable energy and energy efficiency portfolio standard (S.L. 2007-323, SB3). Under the REPS law, codified at § N.C.G.S. 62-133.8, investor-owned electric utilities must increase their use of renewable energy resources and/or energy efficiency such that those sources meet 12.5% of their North Carolina retail sales in 2021.[12] Due to the REPS, a State tax incentive,[13] property tax abatements, and broad support of renewable energy, North Carolina has emerged second only to California in installed solar capacity. North Carolina is recognized as having the third-richest bioenergy resources in the country. Utilizing this in-State bioenergy resource can reduce emissions resulting from combusting conventional geologic energy fuels. The policy mechanisms that propelled the success of solar in North Carolina could be applied to this nascent industry.

Offshore energy resource potential, including renewable wind and traditional fossil fuel resources, have received attention and have gained momentum due in large part to recent actions taken by the Bureau of Ocean Energy Management (BOEM) in the Department of the Interior. Any resources located in offshore waters in excess of three nautical miles from the coast are subject to federal jurisdiction. A more detailed discussion of the offshore energy including the status of both renewable and fossil fuel programs is provided later in this section.

Electric utilities in North Carolina plan for major storms and other threats to critical infrastructure with system resiliency and contingency plans for outage response and recovery. Automated switch gear and other grid modernization technologies improve the response and recovery times from outage events both large and small. Additionally, utilities subject to the Federal Energy Regulatory Commission (FERC) and the North American Electric Reliability Corporation (NERC) jurisdiction study and plan for *high impact/low probability* events such as geomagnetic disturbances (GMD) and electromagnetic pulse (EMP) events. More details on North Carolina's utilities work to protect and maintain grid resilience are discussed later in the section on Energy Assurance.

II. Energy Resources

A. Renewable Energy Resources

Renewable energy resources, including solar, wind, bioenergy, and hydroelectric present opportunity for the State. As previously stated, North Carolina has the 2nd highest solar

[12] North Carolina Utilities Commission. (2017, November 21). *Annual Report Regarding Long Range Needs for Expansion of Electric Generation Facilities for Service in North Carolina.* Retrieved from http://starw1.ncuc.net/NCUC/ViewFile.aspx?Id=2292ba92-d5a1-4b05-b2b7-b158c915655d

[13] North Carolina General Statutes. Business and Energy Tax Credits. N.C. Gen. Stat. § 105-129.15 and 129.16A. Retrieved from https://www.ncleg.net/enactedlegislation/statutes/html/byarticle/chapter_105/article_3b.html

generation capacity in the United States, except for California. In 2017, the North Carolina Sustainable Energy Association reported that North Carolina possessed 3,641 megawatts (MW) of solar capacity.[14] Duke Energy alone reported that it had connected an aggregate of 2,689 MW of solar generation. Renewable energy resources in North Carolina accounted for 10.4% of the generation mix in 2017, up from 3.6% in 2007.[15]

Approximately 74% of the 3,641 MW of renewable energy capacity is in Duke Energy Progress and Duke Energy Carolinas, approximately 21% in Dominion Energy North Carolina (including 208 MW of wind capacity) and about 5% installed by municipal electric utilities and electric cooperatives.

Currently Duke Energy has requests for interconnection of 10,000 MW of renewable energy resources across the Carolinas. Table 1 provides the total connected solar in megawatts located in the Duke Energy service areas in both North Carolina and South Carolina. Utility means that a Duke utility owns the facility output, NEM means that the equipment is owned by a retail customer under a Net Energy Metering Tariff and PPA means that the output is sold to the utility under a Purchase Power Agreement by a third party.

	NC				SC				Total
	Utility	NEM	PPA	Total NC	Utility	NEM	PPA	Total SC	Connected
2015	0	36	1,410	1,446	0	4	6	9	1,455
2016	242	49	1,716	2,006	0	18	12	30	2,036
2017	225	56	2,395	2,676	0	56	18	74	2,750
2018	225	59	2,405	2,689	0	62	18	80	2,769

Table 1. Total Connected Solar Capacity in Duke Energy Service Areas, 2015-2017

As illustrated by the information presented in Table 2, during the same three-year period, the interconnection queue grew at a proportionate rate, generally maintaining a level of approximately four times the amount of connected generation.

	Interconnection Requests		
	NC	SC	Total Queue
2015	3,027	1,294	4,320
2016	5,164	1,580	6,744
2017	6,139	3,888	10,027

Table 2. Number of Interconnection Requests in the Carolinas, 2015-2017

As of the date of this report, one wind energy facility (WEF), or utility-scale wind facility, is in operation in the State. Located in Perquimans and Pasquotank counties near Elizabeth City, Avangrid's Amazon Wind Farm, US East,[16] boasts 104 2MW wind turbines that can generate 208 MW of electricity when operating at full capacity. According to Avangrid, the facility generates enough electricity to power 61,000 homes annually. The facility spans 22,000 acres and is leased from approximately 60 local land owners. The facility's total permanent footprint

[14] North Carolina Sustainable Energy Association. (2018). *North Carolina's Energy Generation Mix.* Retrieved from https://energync.org/ncs-energy-mix/#

[15] Ibid

[16] Avangrid Renewables. (2017). *Amazon Wind Farm US East.* Retrieved from http://www.avangridrenewables.us/cs_amazon-wind-farm-us-east.html

is less than 200 acres and local land owners continue to farm corn, soybeans, and wheat on lands under lease. Amazon Wind went into operation in 2017, and Avangrid became the largest single taxpayer in both Perquimans and Pasquotank counties, with payments of over $381,000 and $260,000 made respectively.

Article 21C of Chapter 143 of the General Statutes governs permitting for WEFs in the State.[17] The WEF permitting law was enacted in 2013, and included a grandfather clause that provided relief to Amazon Wind, allowing the project to proceed without being subject to the requirements under the new law. The Department of Environmental Quality is authorized to permit WEFs under the law, however, DEQ may not issue permits during the 18-month permitting moratorium established pursuant to Section 13 of S.L. 2017-192 (H589).[18] According to the legislation, the purpose of the moratorium is to allow the General Assembly time to study military operations in the State and to consider the impact of future WEFs and energy infrastructure on military operations, training, and readiness. The findings and recommendations from the study are expected in late May 2018, and the moratorium, pending further legislative intervention, will lift on December 31, 2018.

In addition to distributed solar and wind power resources, nuclear power holds a significant share of North Carolina's carbon-free energy generation portfolio. Without it, achieving a carbon-free electricity supply may be insurmountable, and if it can be accomplished, it may be at a much higher cost for customers. As discussed more fully later in this section of this report, nuclear generation represents a significant portion of the nation's and North Carolina's carbon free electricity.[19] Other opportunities for reduced carbon emissions stem from the incorporation of renewable biogas, which is also discussed in greater detail later in this section of the report.

North Carolina's utilities have reduced carbon dioxide (CO_2) emissions by 31% since 2005, and have goals to achieve further reductions. In 2017, the utilities established a goal to reduce CO_2 emissions by 40% from 2005 levels by 2030. Beyond 2030, the long-term strategy will continue to drive carbon out of the system. This will be achieved by expanding renewable energy as a part of the resource portfolio, expanding the deployment of battery storage to flatten the daily demand curve, and increasing overall efficiency and, where necessary, utilize high-efficiency low-cost gas technologies to backstop the system.

As part of its analysis, Duke Energy evaluated a *two-degree policy* where CO_2 emissions are sharply reduced in order to limit global temperature increase to no more than 2º Celsius above pre-industrial levels. This analysis provides high-level insights on one possible pathway consistent with a carbon-constrained future, including potential long-term impacts on the generation mix associated with a *two-degree policy* scenario.[20] The current plan to achieve a 40% reduction across Duke's entire fleet by 2030 is consistent with a pathway to achieve a science-based 2º Celsius target. Since 2005, Duke Energy has reduced CO_2 emissions in the

[17] North Carolina General Statutes. Permitting of Wind Energy Facilities. N.C. Gen. Stat. § 21C-115-126. Retrieved from https://www.ncleg.net/EnactedLegislation/Statutes/PDF/ByArticle/Chapter_143/Article_21C.pdf

[18] North Carolina General Assembly. (2017, July 27). House Bill 589. Retrieved from https://www.ncleg.net/Sessions/2017/Bills/House/PDF/H589v6.pdf.

[19] McNelis, D. N. (2016, August 2). *The High Cost of Ignoring Nuclear Energy in North Carolina.* Retrieved from http://www.newsobserver.com/opinion/op-ed/article93321897.html

[20] Duke Energy. (2017). *2017 Climate Report to Shareholders*. Retrieved from https://www.duke-energy.com/_/media/pdfs/our-company/shareholder-climate-report.pdf

Carolinas by 37%. The scenario analyzed would require all sectors of the global economy to reduce CO_2 emissions equally. Under this scenario, Duke would achieve a 72% reduction in CO_2 emissions by 2050, compared to 2010 levels. This would be accomplished by: phasing out existing coal generation; increasing energy efficiency; expanding the use of renewable resources, natural gas, and energy storage; and deploying innovative technologies.[21]

Looking beyond 2030, Duke's pathway to further reduce CO_2 emissions will adjust to ever-evolving and innovative technologies that balance the reliability and affordability that customers expect and that regulators require. The long-term energy strategy should include planned investments in additional renewable energy sources coupled with storage, grid modernization, and improved energy efficiency and demand response programs. The Council supports advancing policies that sustain a balanced energy portfolio mix, support research and development of low-carbon technologies, and ensure it remains affordable for all utility customers. Specific system investments will be addressed in utility integrated resource plans, which are filed on a regular basis with the Commission.

B. Natural Gas

North Carolina's demand for natural gas, as illustrated in Chart 2, has increased due primarily to its increasing use for electricity generation. New natural gas generating facilities will continue to play a vital role in meeting consumer demand for electricity over the next decade. As many of North Carolinas older, less efficient coal plants lacking advanced emissions control technology have been retired, much of the generating capacity has been replaced by natural gas. This trend will continue with an additional 7 coal units with winter capacity of 1,514 MW planned for retirement by 2028.[22]

The availability, cost, and environmental benefits of natural gas contribute to the majority of electric generation capacity additions forecast by Duke Energy in its Carolinas generating fleet over the next 15-year planning horizon will be fueled by natural gas.[23] Advanced drilling technology has led to the discovery of abundant natural gas supplies, with ample natural gas reserves to meet America's needs for the next 100 years. The United States EIA projects annual growth in the price of natural gas delivered to customers from the date of this report and 2050 at less than 1%. Environmental benefits of natural gas versus coal or oil-fired generation include

[21] Ibid

[22] North Carolina Utilities Commission. (2016). *2016 Biennial Integrated Resource Plans and Related 2016 REPS Compliance Plans*. Docket E-100, Sub 147. Retrieved from http://starw1.ncuc.net/NCUC/PSC/DocketDetails.aspx?DocketId=1f016c40-5ad5-4915-a74b-96c230626875 NCUC filing.

[23] Ibid.

virtually zero emissions of sulfur dioxide (SO_2) and lower emission levels of carbon and nitrogen oxide (NO_x).

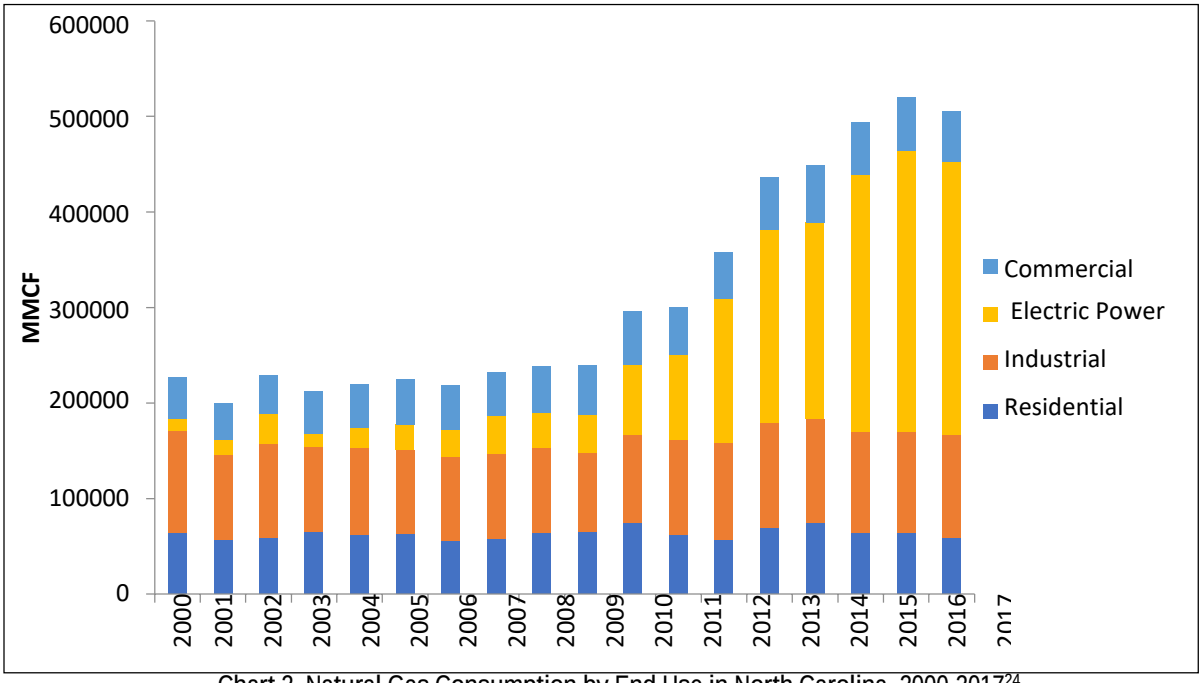

Chart 2. Natural Gas Consumption by End Use in North Carolina, 2000-2017[24]

Technological advances in new natural gas generation facilities continue to improve unit efficiencies and performance characteristics. This enhanced efficiency and flexibility lowers the operating cost of new units, provides, additional operational flexibility to the existing generation fleet, and thereby assists the utility in the integration of incremental renewable generation.

This incremental natural gas consumption in North Carolina will be supported by additional pipeline capacity provided by various interstate initiatives that are discussed in more detail in the Energy Assurance section of this report.

C. Bioenergy

The term *bioenergy* describes sustainable energy fuels derived from natural, organic, or biological resources through processes that extract combustible materials that can be used in lieu of conventional fossil fuels. Examples of such organic resources include food waste, food processing wastes, animal manures, crop residues, and biogas generated from conventional landfill operations used to manage municipal solid waste. Using bioenergy resources to satisfy energy demands decreases carbon emissions and improves the environment. Most organic waste resources are currently managed such that uncontrolled methane emissions are released to the atmosphere. Methane is the larger energy constituent of natural gas, which currently fuels most of North Carolina's energy demand. Capturing and repurposing the methane naturally emitted from these organic waste resources for energy use provides reductions in: (i) the existing carbon emissions from the natural decomposition of these wastes and (ii) carbon emissions from the use of conventional fossil fuels, like coal, when used as a replacement fuel. The use of bioenergy as

[24] United States Energy Information Administration. (2018, April 30). *Natural Gas Consumption by End Use (North Carolina).* Retrieved from https://www.eia.gov/dnav/ng/ng_cons_sum_dcu_SNC_a.htm

a drop-in replacement for conventional fossil fuels, such as coal, liquid petroleum, or natural gas can reduce atmospheric emissions of carbon dioxide and other greenhouse gases.

Bioenergy resources are considered to be infinitely renewable, as they stem from the human need for food and everyday use of organic products. The interest in, and use of, bioenergy in the United States has grown in recent years, as it both provides opportunities to address environmental concerns associated with combustion of geologic fossil fuels and addresses environmental concerns associated with the management and disposal of waste organics, namely food waste, animal manures, and crop residues.

North Carolina has abundant bioenergy resources, much of which is from the State's robust agricultural sector. According to the United States Department of Agriculture (USDA), North Carolina ranks 8th in the country in total value of agricultural products sold, ranks 1st in the production of poultry and eggs, and 2nd in both the production of pigs and Christmas trees.[25] In fact, North Carolina is a top 10 producer in 19 agricultural commodities.[26] Agricultural production yields unused organic materials, such as stovers, residues, and manures. Estimates have been developed by the USDA, the United States Environmental Protection Agency (USEPA), and non-governmental organizations in an effort to quantify North Carolina's bioenergy resources; however, these estimates have not been aggregated into a single, comprehensive summary of the opportunity for North Carolina, especially as pertains to the opportunities to generate renewable natural gas, nor validated by North Carolina resource managers and scientists. Capitalizing on these abundant resources creates opportunity for multi- faceted environmental improvements, increased domestic energy independence, continued economic development, and sustained job growth.

Bioenergy project development can serve as a catalyst for new investment in North Carolina's agriculture sector, which contributes the largest value-added portion to the North Carolina Gross Domestic Product[27] ($76 billion, with $15 billion in gross cash income) and accounts for 17% of all jobs in the State. Harvesting waste or underutilized organics from this sector, such as for use as bioenergy resources provides a means for North Carolina to take advantage of an existing, State-derived energy resource while leveraging one of its strongest economic engines – agriculture. Doing so provides investments and creates jobs in often struggling rural and agricultural communities and provides access to other new and emerging energy fuel markets, both in-state and as an export. For these reasons, it is imperative that the State's short- and long- term energy planning efforts address bioenergy resources in the overall energy portfolio. The estimated economic impacts from developing North Carolina's bioenergy resources, biogas in particular, need to be improved and updated such that the energy planning and policies set forth by the State and this Council are reformed such that they derive the greatest economic benefit, environmental quality, and sustainable attributes from our abundant bioenergy resources.

[25] United States Department of Agriculture. (2017). *2017 State Agriculture Overview (North Carolina).* Retrieved from https://www.nass.usda.gov/Quick_Stats/Ag_Overview/stateOverview.php?state=NORTH%20CAROLINA

[26] United States Department of Agriculture. (2014). *National Agricultural Statistics Service - Agriculture Statistics 2014.* Retrieved from https://www.nass.usda.gov/Publications/Ag_Statistics/2014/Ag%20Stats%202014_Complete%20Publication.pdf

[27] Walden, M. (2013). Agriculture and Agribusiness: North Carolina's Number One Industry. *North Carolina State University College of Agriculture andLifeSciences*.

Policies should also reflect the need for further innovation in the use of bioenergy with an eye toward reducing the cost to produce energy from bioresources.

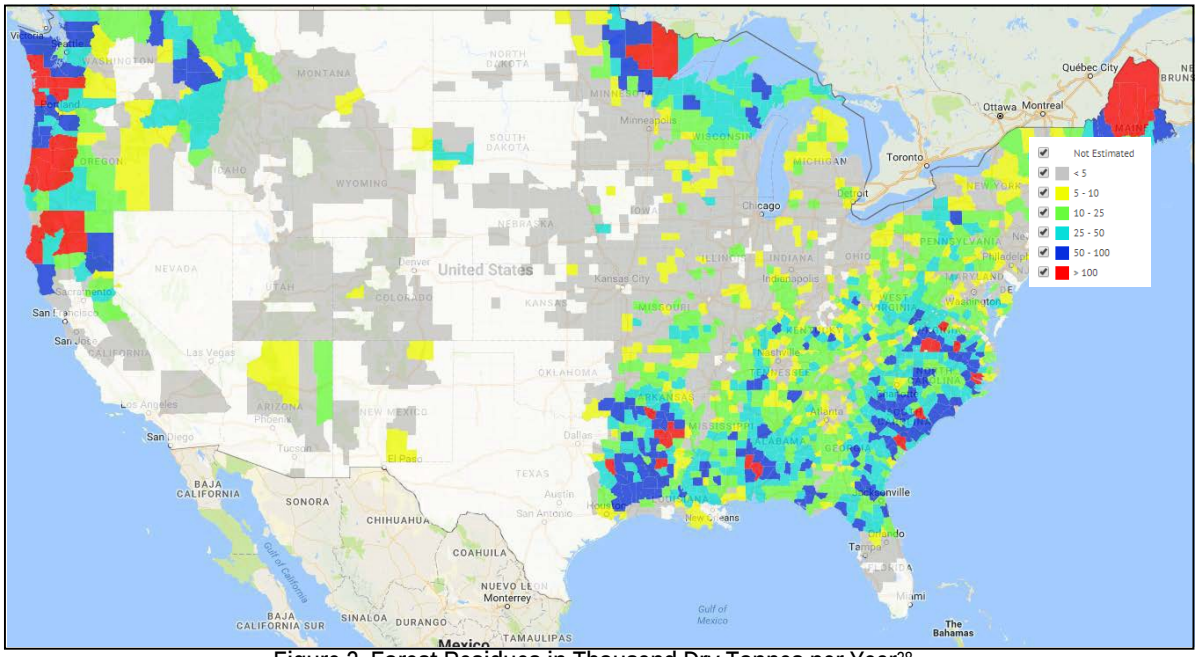

Figure 2. Forest Residues in Thousand Dry Tonnes per Year[28]

1. Fuel Types

There are three primary forms of bioenergy: (i) solid fuels are typically referred to as biomass; (ii) liquid biofuels; and (iii) gaseous fuels which are typically referred to as biogas.

i. *Biomass* – Biomass describes energy fuels that are managed and used in a solid, dry form,and includes stoker boilers that use pelletized wood, biomass gasification and fluidized bed boilers, and other methods of biomass combustion that create heat and steam that is used in turbines to generate electricity. Examples of biomass resources in North Carolina are: forest products (including wood, wood products, and forestry harvesting residues); energy crops; poultry litter; biochar; and other dry organic wastes. The use of poultry litter, was carved out in the 2007 REPS legislation and signals interest in incentivizing more beneficial use of this abundant resource.

North Carolina has a robust forestry industry, and is an international exporter of biomass in the form of wood pellets for energy fuel. According to the most recent data released by North Carolina State University Extension Forestry, the forest products industry continues to be the State's top manufacturing industry; employing 145,000 people; and contributing $29.4 billion to the State's economy.[29] As described above, in addition to the use of harvested wood products in the manufacture of wood pellets intended for use as an energy fuel, the forestry harvesting

[28] National Renewable Energy Laboratory. Biopower Atlas Map. Retrieved from https://maps.nrel.gov/biopower-atlas/

[29] McConnell, T. E. (2016). North Carolina's Forests and Forest Products Industry by the Numbers, 2013. *North Carolina Cooperative Extension Service*. Retrieved from https://www.ncforestry.org/wp-content/uploads/2016/05/NC-Forest-Bulletin_Published.pdf

process creates residues and woody waste that too can be used as an energy fuel. A 1993 Research Triangle Institutes study conducted for the North Carolina Division of Forest Resources estimated the wood energy potential in North Carolina to be 1,017 MW, including captive generation operated by the large paper mills in the State. The current capacity of wood waste power plants in North Carolina is 330 MW, meaning there is significant opportunity to expand use of this energy resource.[30]

Grasses such as switchgrass, giant Miscanthus, and biomass crops such as sorghum and energy tobacco can produce high yields, can be harvested annually without replanting, and have the added benefit of improved crop fertility and reduced soil erosion when used as a cover crop grown between cash crops or in the fallow season. The production, harvest, and use of these energy crops are an area of intensive and ongoing research in North Carolina, in both the academic setting and in the private sector, given North Carolina's propensity for efficient agricultural production and conducive climate. In 2013, the North Carolina General Assembly allocated funds to support the development of energy production from North Carolina agricultural and forest-based products, which is administered by the Bioenergy Research Initiative of the North Carolina Department of Agriculture and Consumer Services.

Biomass fuels are typically used in a combustion process to create heat and electricity, in a similar manner as coal. While emissions from the combustion of these materials must be considered, the use of existing organic waste products – such as poultry litter, forestry harvesting residues, and crop residues – that naturally decompose into greenhouse gases may still provide net positive environmental benefits.

ii. *Liquid Biofuels* – Liquid biofuels, such as ethanol and biodiesel, can substitute for liquid petroleum fuels. The two most common biofuels in the United States are biodiesel and ethanol, though in North Carolina, biodiesel production is the most represented. Biodiesel is made primarily from various oilseed crops such as soybeans and secondarily from waste vegetable oil, which is essentially used restaurant cooking oil. Biodiesel can be used in any existing diesel engine with no modifications, and its use eliminates the emission of sulfur dioxins. It also reduces particulate matter, carbon monoxide, and unburned hydrocarbon tailpipe emissions. North Carolina currently has 5 biodiesel plants that are each able to produce between 1 and 5 million gallons of fuel annually from waste cooking oil, and the State boasts approximately 115 public and private biodiesel fueling stations. Since biodiesel is produced in North Carolina primarily through the use of waste cooking oils, its manufacture and use support environmental improvement while also providing the only in-State source of liquid transportation fuels.

[30] North Carolina Solar Center. *Biomass Energy Sources for North Carolina.* Retrieved from https://nccleantech.ncsu.edu/wp-content/uploads/BiomassFactSheet_2002.pdf

iii. *Biogas* – North Carolina is a biogas opportunity-rich state and recognized as the third greatest in the country.[31] As the process is illustrated in Figure 3, biogas is derived from the biological, chemical, or physical processing of organic waste materials resulting in the extraction of carbon compounds in a gaseous form, such as methane. At present, there are 75 operational biogas systems in North Carolina. Examples include solid waste landfills, where the organic portion of the wastes is converted to landfill gas (LFG), and anaerobic digesters, like those used at municipal wastewater treatment plants and in farming applications. It is estimated that North Carolina has the potential for 900 additional biogas projects, creating $2.7 billion in capital investment and supporting nearly 1,800 long-term jobs, many of which would be located in rural and economically-challenged areas of the State.[32]

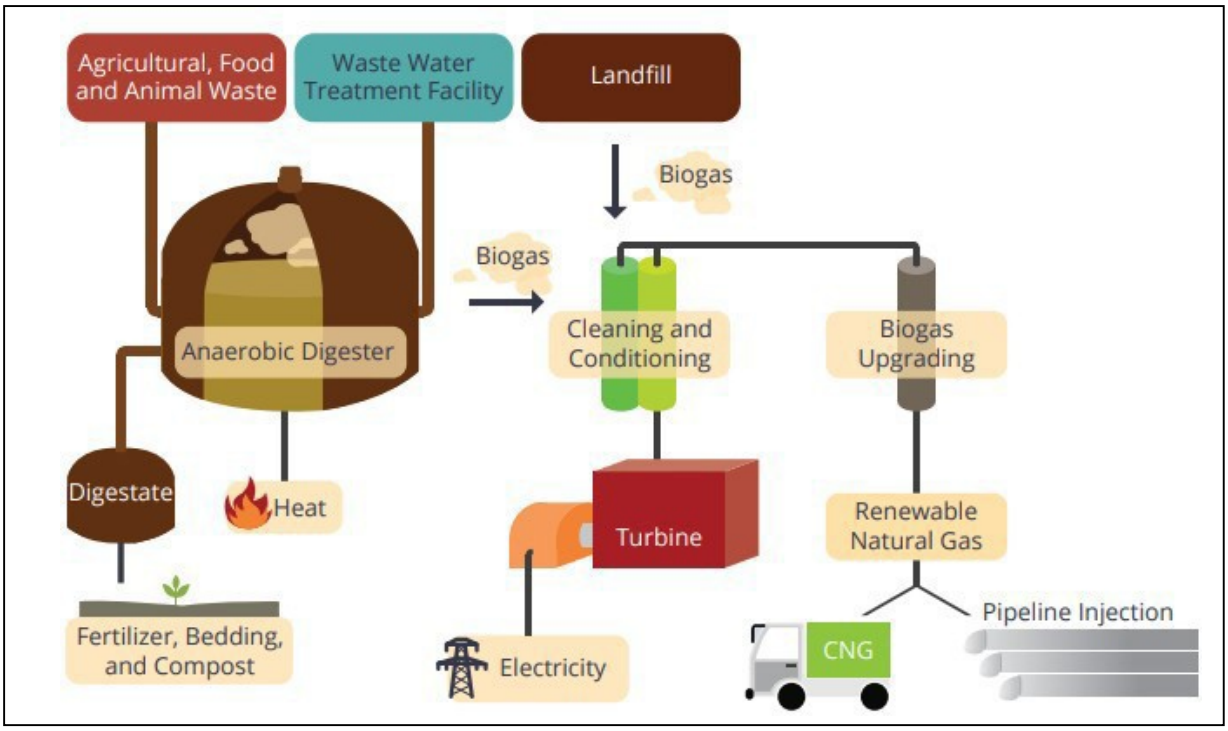

Figure 3. Biogas Technology Diagram

As depicted in the national biogas resource map in Figure 2, every county in North Carolina has documented biogas resources, meaning it is one of the most widespread in-state energy resources availed to North Carolina at an estimated one half million tonnes of methane emission per year.[33] Not only does this mean that North Carolina has the third richest bioenergy resources in the Country, it means the greatest bioenergy resource cache east of the Mississippi. North Carolina is particularly well-suited to lead the nation, if not the world, in the production of biogas resources.

[31] American Biogas Council. (2015, August 7). *Biogas State Profile: North Carolina.* Retrieved from https://www.americanbiogascouncil.org/State%20Profiles/ABCBiogasStateProfile_NC.pdf

[32] Ibid

[33] National Renewable Energy Laboratory. *Biopower Atlas*. Retrieved from https://maps.nrel.gov/bioenergyatlas/

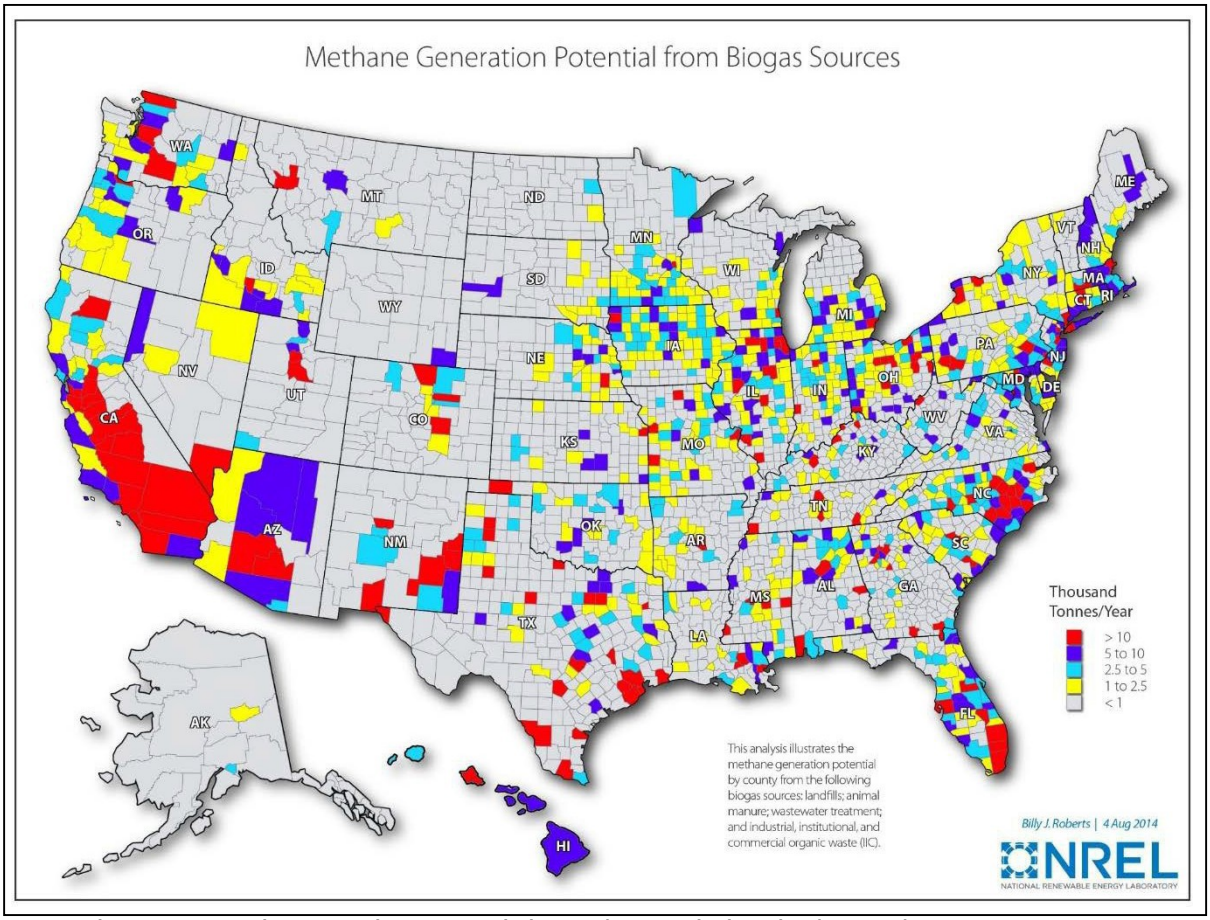

Figure 4. NREL Biopower Atlas Map Depicting Methane Emissions in Thousand Tonnes per Year

The continued development of LFG harvesting projects presents opportunity for North Carolina. The EPA Landfill Methane Outreach Program (LMOP) lists 125 active landfills serving North Carolina, with 33 active LFG systems and 14 candidate landfills,[34] with an estimated 80 MW of energy potential being utilized from landfills in North Carolina.[35] Of the candidates identified, and all other landfills without a current or planned LFG utilization project, the opportunity for the harvested LFG for the generation of renewable electricity or renewable natural gas represents an untapped opportunity for North Carolina. When using LFG in a stationary internal combustion engine to produce electricity, formaldehyde emissions are created due to incomplete combustion process and those emissions must be considered with these projects.[36]

As all these landfills generate methane, the collection and use of the LFG for the beneficial purpose of energy generation creates environmental improvement and emissions reduction – especially for those landfills not currently utilizing a LFG bioenergy system and are emitting LFG to the atmosphere, or simply flaring the LFG – in sum, a wasted opportunity.

[34] Candidate Landfills are currently accepting waste or have been closed for five years or less, have at least one million tons of waste, and do not have an operational, under-construction, or planned project

[35] United States Environmental Protection Agency. (2018). *State-Level Project and Landfill Totals from the LMOP Database.* Retrieved from https://www.epa.gov/sites/production/files/2018-02/lmopdatanc.xlsx

[36] Lisa L. Damiano, Lisa L. and Stephen G. Zemba. (March 2017). What's the Best Way to Manage Landfill Gas? From an Environmental Perspective. Retrieved from: http://pubs.awma.org/flip/EM-Mar-2017/damiano.pdf

In addition to harvesting LFG that is produced from these landfills, systems and programs can be implemented that segregate organic waste from the other solid waste materials prior to landfilling. The USEPA estimates, on average, that removing organic wastes and recycling them through energy harvesting systems, like anaerobic digesters, can reduce the amount of landfilled waste each year by 20% to 40%. Removing organic wastes can extend the life of existing landfills, leverage existing assets in our State and defer the costly process of siting, permitting, and constructing new landfills – all while supplying renewable and reliable energy fuels for use in the State.

Anaerobic digestion is described as a collection of processes by which microorganisms break down biodegradable material in the absence of oxygen. The process is used for industrial or domestic purposes to manage waste or to produce fuels. Organic waste is infinitely available, and does not directly depend on sun, wind, or climate, so it is thought of as an unlimited resource for producing energy. Anaerobic digestion is a process that has been around for thousands of years, but has only recently been recognized as a way to economically harvest energy and power from organic waste. Anaerobic digestion can make renewable energy fuels from sources such as wastewater treatment facilities, agriculture, and industrial or manufacturing industries that produce or process organic goods.

Across the nation, most major wastewater treatment facilities (WWTF) typically use anaerobic digestion for primary treatment of the waste.[37] North Carolina has over 940 permitted municipal WWTF, 35 of which are considered major facilities, with a design daily influent flow of greater than 10 million gallons per day. According to the Division of Environmental Assistance and Customer Service in DEQ, 42 WWTFs in North Carolina utilize anaerobic digestion in their treatment works. Currently, only about 20 WWTFs in North Carolina have biogas harvesting systems coupled with anaerobic digesters. Incorporating biogas harvesting systems at these WWTFs can generate new revenue streams for the facility, thereby assisting municipalities in maintaining those facilities at lesser or less frequent rate increases to the customers they serve.

Of the tremendous biogas potential for North Carolina, the anaerobic digestion of agricultural wastes, from swine farming manure and poultry farming litter, represents the greatest opportunity. North Carolina is home to approximately 2,300 permitted swine farms, 160 dairy farms, and an estimated 5,700 poultry farms. These farming operations produce a significant volume of food for our planet's growing population, and as a result, produce a sizeable resource of manure and organic waste. This resource can be converted to biogas and renewable natural gas to fuel North Carolina's growing energy needs.

[37] Clean Watersheds Needs Survey – 2012 Report and Data. Retrieved from: https://www.epa.gov/cwns/clean-watersheds-needs-survey-cwns-2012-report-and-data

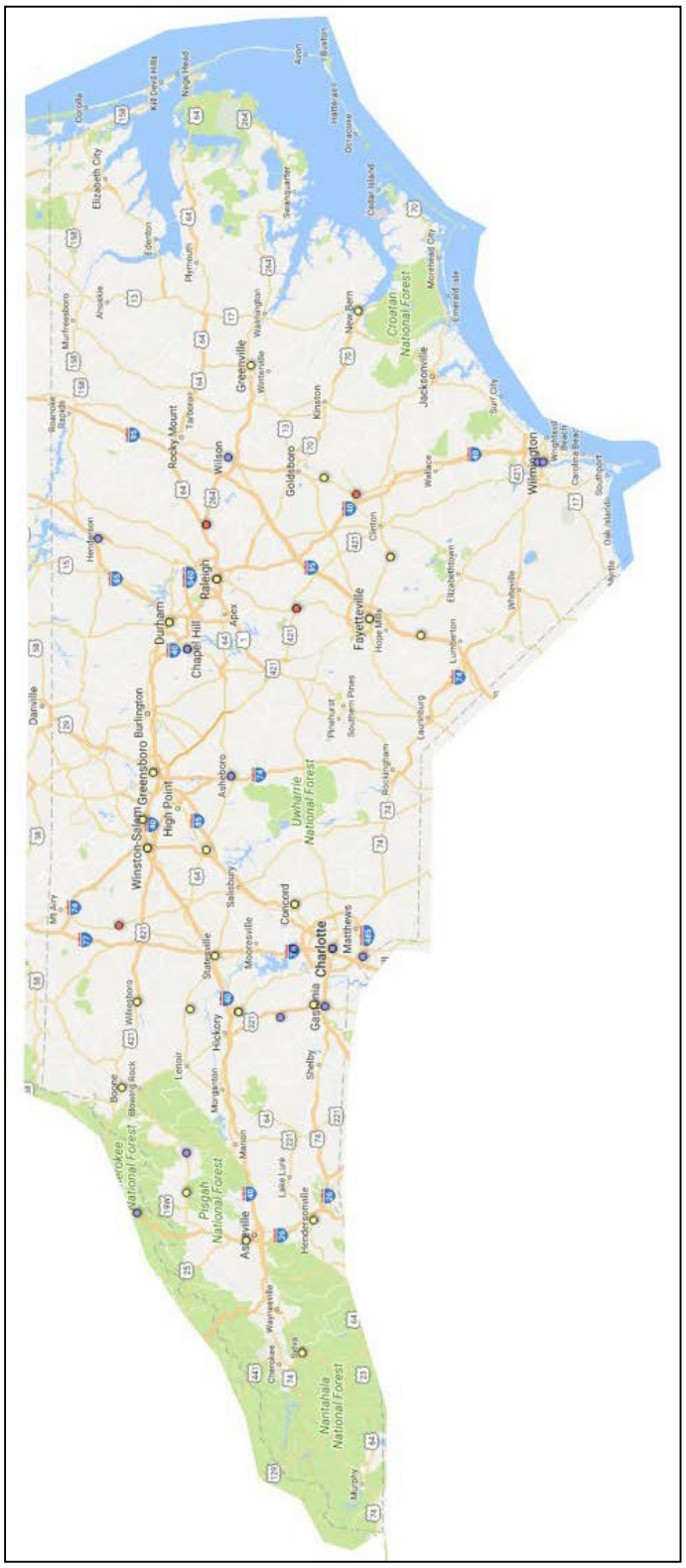

Figure 5. Operational Biogas Systems in North Carolina[38]

Significant economic benefit and job creation have been lauded for advancement of North Carolina's biogas resource utilization. The American Jobs Project estimates the Sates's biogas resources can lead to more than 26,000 full-time equivalent (FTE) jobs, many of which would be located in rural and agricultural areas of our State, where good paying secure employment is less available to residents.

[38] American Biogas Council. *Biogas Data.* Retrieved from http://www.biogasdata.org;

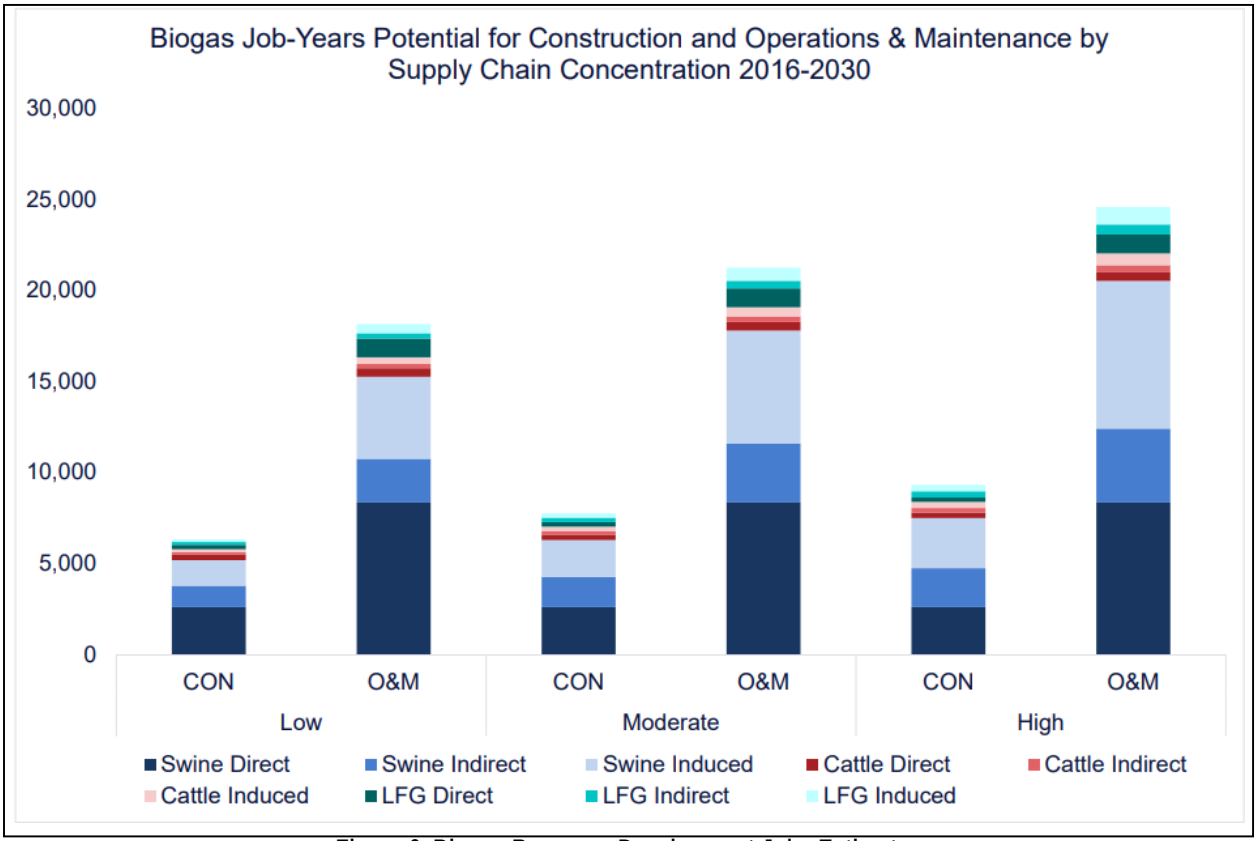

Figure 6. Biogas Resource Development Jobs Estimate.

In summary, North Carolina has an incredible opportunity to advance the use of its bioenergy resources, and stands to become a national leader in the use of biogas and bioenergy resources to produce low-emissions and net-negative-emission electricity and power. Previously in this report, the point was made that policies that propelled the success of solar power generation in North Carolina may similarly advance bioenergy opportunities for our State. However, such a comparison has not yet been formally accomplished nor have any such lessons learned been incorporated in prior State Energy Plans. In establishing the REPS, the State set goals and requirements for the provision of renewable electricity, inclusive, specifically, of bioenergy resources such as swine manure and poultry manure. However, no such goals have been established for the development of renewable natural gas from bioenergy resources. While, as described herein, conventional geologic fossil natural gas resources are abundant in the United States, previous efforts to quantify and support the exploitation of natural gas deposits in North Carolina have identified only limited amounts of natural gas, confined to a small geographic area, and no resultant applications[39] or installations for natural gas well drilling in the State have

United States Environmental Protection Agency. *Landfill Methane Outreach Program*. Retrieved from https://www.epa.gov/lmop; United States Environmental Protection Agency. (2018) *AgSTAR Program-Livestock Anaerobic Digester Database*. Retrieved from https://www.epa.gov/agstar/livestock-anaerobic-digester-database

[39] North Carolina Department of Environmental Quality. (2018). *Oil and Gas Program*. Retrieved from https://deq.nc.gov/about/divisions/energy-mineral-land-resources/energy-group/oil-gas-program

been made to-date. The abundance and prevalence of biogas resources should compel similar, more productive policy directives.

D. Offshore Energy Resources

Energy exploration, development, and production in North Carolina's offshore waters beyond the State's jurisdiction (3 or more nautical miles) is subject to review and approval by the Bureau of Ocean Energy Management (BOEM) in the U.S. Department of the Interior (DOI). As of the date of this report, there has been no commercial-scale energy-generating activity off North Carolina's coast, in either State or federal waters. However, recent actions taken by BOEM with regard to both renewable and traditional energy resources have garnered corporate and political attention and response.

1. Wind and Other Renewable Energy Resources

In 2009, DOI implemented final rules for the Outer Continental Shelf (OCS) Renewable Energy Program, authorized by the Energy Policy Act of 2005. These regulations provide a framework for issuing leases, easements, and rights-of-way for OCS activities that support production and transmission of energy from sources other than oil and natural gas.[40] The three types of potential offshore energy generation include: (i) ocean wave energy – which utilizes wave power devices to extract energy directly from the surface motion of ocean waves; (ii) ocean current energy – which utilizes submerged water turbines to capture and convert ocean current energy; and (iii) wind energy – which utilizes turbines to harness the energy of the moving air over the oceans. Of these three energy resources, only offshore wind energy has been deployed with broad – albeit international – commercial success and utility-scale generating capacity.

To date, there are no offshore Wind Energy Facilities (WEF) located within either North Carolina's 3-mile offshore jurisdiction or the 200-mile exclusive economic zone of the OCS under federal jurisdiction. Furthermore, at present there are no WEFs in operation in the mid- Atlantic planning area of the OCS (comprising Delaware, Maryland, Virginia, and North Carolina). The first, and only offshore WEF in the United States, the Block Island Wind Farm,[41] is located off the coast of Rhode Island, and went into operation in December 2016.

Federal Regulatory Process – Offshore wind energy development proposed in areas 3 to 200 miles off the coast is subject to federal jurisdiction under BOEM. BOEM's wind energy responsibilities are phased,[42] as follows:

1) *Planning and Analysis Phase:* (i) suitable areas for wind energy leasing (wind energy areas or WEAs) are identified through processes that engage stakeholders, tribes, and state and federal government agencies and (ii) BOEM conducts environmental compliance reviews and consultations with tribes, states, and natural resource agencies.
2) *Leasing Phase:* results in the issuance of a commercial wind energy lease, either through a competitive or noncompetitive process. A commercial lease gives the lessee the exclusive right to subsequently seek BOEM approval for the development of the leasehold, however

[40] Bureau of Ocean Energy Management, United States Department of the Interior. *Renewable Energy Programs*, Retrieved April 3, 2018, from https://www.boem.gov/Renewable-Energy/

[41] Deepwater Wind. (2018). *Block Island Wind Farm: America's First Offshore Wind Farm.* Retrieved April 4, 2018, from http://dwwind.com/project/block-island-wind-farm/

[42] Bureau of Ocean Energy Management, United States Department of the Interior. *Wind Energy Commercial Leasing Process*, Retrieved April 2, 2018, from https://www.boem.gov/Commercial-Leasing-Process-Fact-Sheet/

does not grant the lessee the right to construct any facilities. Rather, the lease grants the lessee the right to use the lease area to develop its plans, which BOEM must approve before the lessee can proceed to the Site Assessment Phase.

3) *Site Assessment Phase:* includes the submission of a Site Assessment Plan (SAP), that contains the lessee's detailed proposal for the construction of a meteorological tower and/or the installation of meteorological buoys on the leasehold. The SAP must be approved by BOEM before activities may proceed on the leasehold. During this phase, the leasee conducts site characterization surveys and studies (e.g., avian, marine mammal, archeological, etc.).
4) *Construction and Operations Phase:* consists of the submission of a Construction and Operations Plan (COP), a detailed plan for the construction and operation of a wind energy project on the lease. BOEM conducts environmental and technical reviews of the COP and decides whether to approve, approve with modification, or disapprove the COP. Prior to the end of the lease term, the developer must submit a plan to decommission facilities. Construction and operations are authorized for up to 25 years.

Intergovernmental Task Forces are engaged throughout the whole of BOEM's phased process and are directed to collect and share relevant information useful to BOEM in its decision- making. North Carolina's Task Force was reengaged in December 2017, during which BOEM convened a joint North Carolina-Virginia Renewable Energy Task Force meeting in Virginia Beach, Virginia, to provide updates and technical presentations on the activities underway off both states' shores.

Presently, detailed assessment of one WEA is underway off the coast of Kitty Hawk, North Carolina. Avangrid Renewables, LLC won the lease auction for the 122K+ acre Kitty Hawk WEA in March 2017[43] (the Kitty Hawk Call Area is indicated by the red arrow in *Figure 7*). The lease was executed on November 1, 2017, and Avangrid is developing its SAP, which must be submitted to BOEM by November 1, 2018. Upon approval of the SAP, Avangrid will have 4½ years to submit its COP for the WEF.

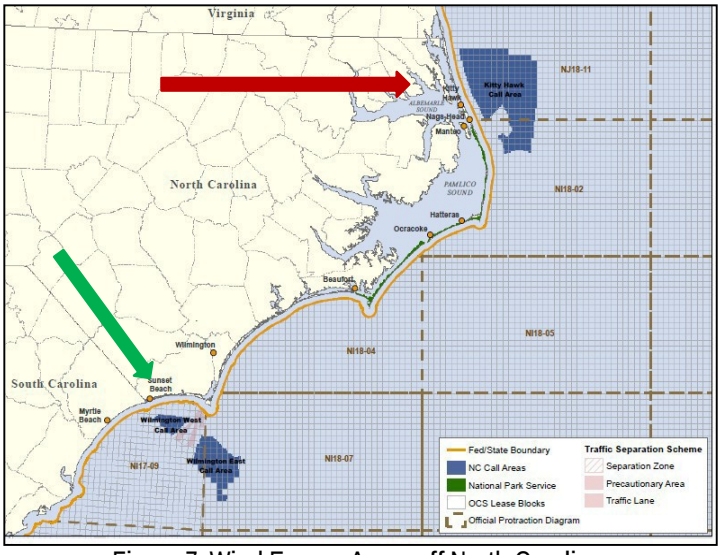

Figure 7. Wind Energy Areas off North Carolina

At 133,000 and 51,000 acres respectively, progress on leasing the Wilmington East and West WEAs is on hold while BOEM continues to evaluate and address local concerns that development and operation of wind near-shore will negatively impact tourism (the Wilmington East and West Call Areas are indicated by the green arrow in *Figure 7*). Based on these concerns, communities requested a 27-mile buffer to insure the structures remain invisible from the shore. A 27-mile buffer would eliminate the Wilmington West WEA, significantly reduce the

[43] Bureau of Ocean Energy Management, United States Department of the Interior. (2012). *NC Call Area Names.* Retrieved April 2, 2018, from https://www.boem.gov/uploadedFiles/BOEM/Renewable_Energy_Program/State_Activities/NC_Call_Area_Names.pdf

size of the Wilmington East WEA, and due to the locational proximity to South Carolina's coast, would significantly impact the Grand Strand WEA as well.[44]

In an attempt to resolve these concerns, BOEM, with the support of Consensus Builders Institute (CBI), created a steering committee of North and South Carolina representatives to help guide CBI's efforts to explore, detail, and capture state and local stakeholders' perspectives on offshore wind energy development. Interviews with stakeholders were held in early February 2018, and a preliminary report describing the findings was completed in April 2018.

On April 6, 2018, BOEM issued a Request for Feedback (RFF)[45] regarding its *Proposed Path Forward for Future Offshore Renewable Energy Leasing on the OCS,* wherein the Bureau proposes to conduct a high-level assessment of all waters offshore the Atlantic Coast for potential additional lease locations. The assessment would rely on various factors to assess which areas along the Atlantic are the most likely to have the highest potential for offshore wind development in the next 3 to 5 years. The period for public comments on the RFF ends on July 6, 2018.

2. Oil and Gas Resources

According to BOEM, the estimated oil and gas resources in North Carolina's OCS lands are small as compared to the estimated resources in other OCS planning areas across the country. According to the 2016 BOEM report *Inventory of Technically and Economically Recoverable Hydrocarbon Resources of the Atlantic Outer Continental Shelf as of January 1, 2014,*[46] the average estimated amount of Undiscovered Technically Recoverable Resources (UTRR), in the Atlantic OCS is significantly smaller than that estimated in the Alaska, Pacific, and Gulf of Mexico planning areas.

In recent years, the United States has emerged as a leading exporter of energy resources. According to John Jessup, Executive Director of the North Carolina Propane Gas Association, more domestically-produced propane gas is exported for foreign consumption than that which is used to meet national demand.[47,48] The EIA reports that in 2016, the U.S. imported approximately 10.1 million barrels per day (MMb/d) of petroleum and exported about 5.2 MMb/d to over 100 countries, resulting in a net import of about 4.9 MMb/d of

[44] Bureau of Ocean Energy Management, United States Department of the Interior. (2015). *South Carolina Activities.* Retrieved April 3, 2018, from https://www.boem.gov/South-Carolina/

[45] Bureau of Ocean Energy Management, United States Department of the Interior. (2018, April 6). *Request for Feedback on BOEM's roposed Path Forward for Future Offshore Renewable Energy Leasing on the Atlantic OCS*. 83 Federal Register 67, pp. 14881-14884. Retrieved from https://www.gpo.gov/fdsys/pkg/FR-2018-04-06/pdf/2018-07106.pdf

[46] Bureau of Ocean Energy Management, United States Department of the Interior. (2014). *Inventory of Technically and Economically Recoverable Hydrocarbon Resources of the Atlantic Outer Continental Shelf as of January 1, 2014.* Retrieved February 21, 2018, from https://www.boem.gov/BOEM-OCS-Report-2016-071/

[47] Jessup, J. (2018, February 21). *Financing Opportunities; Volkswagen Settlement Agreement: Propane as an Alternative Fuel.* Presentation at the meeting of the North Carolina Energy Policy Council, Raleigh, NC.

[48] United States Energy Information Administration. (2018, February 28). *U.S. Propane Prices and Crude Oil Prices Re-Link as Exports Increase.* Retrieved March 1, 2018, from https://www.eia.gov/petroleum/weekly/archive/2018/180228/includes/analysis_print.php

petroleum that year.[49] For natural gas, EIA reports that the United States' natural gas production in 2016 was the second-highest level recorded, and in 2016, national dry natural gas production accounted for approximately 97% of domestic natural gas consumption.[50] This increased domestic energy production has resulted in shrinking net imports of natural gas over the last 10 years.[51]

Similar to the progress on offshore wind energy, to date, there is no oil or gas exploration, development, or production located within either the State's 3-mile offshore jurisdiction or the 200-mile exclusive economic zone of the OCS under federal jurisdiction. Like offshore wind energy, actions taken to explore or develop OCS areas beyond the State's 3-nautical mile jurisdiction for oil and gas resources are subject to BOEM review and approval. The process is years-long and follows the schedule demonstrated in Figure 8.[52]

[49] United States Energy Information Administration. (2018, February 28). *How Much Petroleum Does the US Import and Export?* Retrieved March 1, 2018, from https://www.eia.gov/tools/faqs/faq.php?id=727&t=6

[50] United States Energy Information Administration. (2018, February 28). *Where Does our Natural Gas Come from?* Retrieved March 1, 2018, from https://www.eia.gov/energyexplained/index.php?page=natural_gas_where

[51] United States Energy Information Administration. (2018, February 28). *U.S. Natural Gas Consumption, Dry Consumption, Dry Production, and Net Imports, 1950-2016.* Retrieved March 1, 2018, from https://www.eia.gov/energyexplained/images/charts/natural_gas_consumption_production_net_imports-large.jpg

[52] Bureau of Ocean Energy Management, United States Department of the Interior. *National OCS Oil and Gas Leasing Program.* Retrieved April 3, 2018, from https://www.boem.gov/BOEM-OCS-Oil-Gas-Leasing-Process/

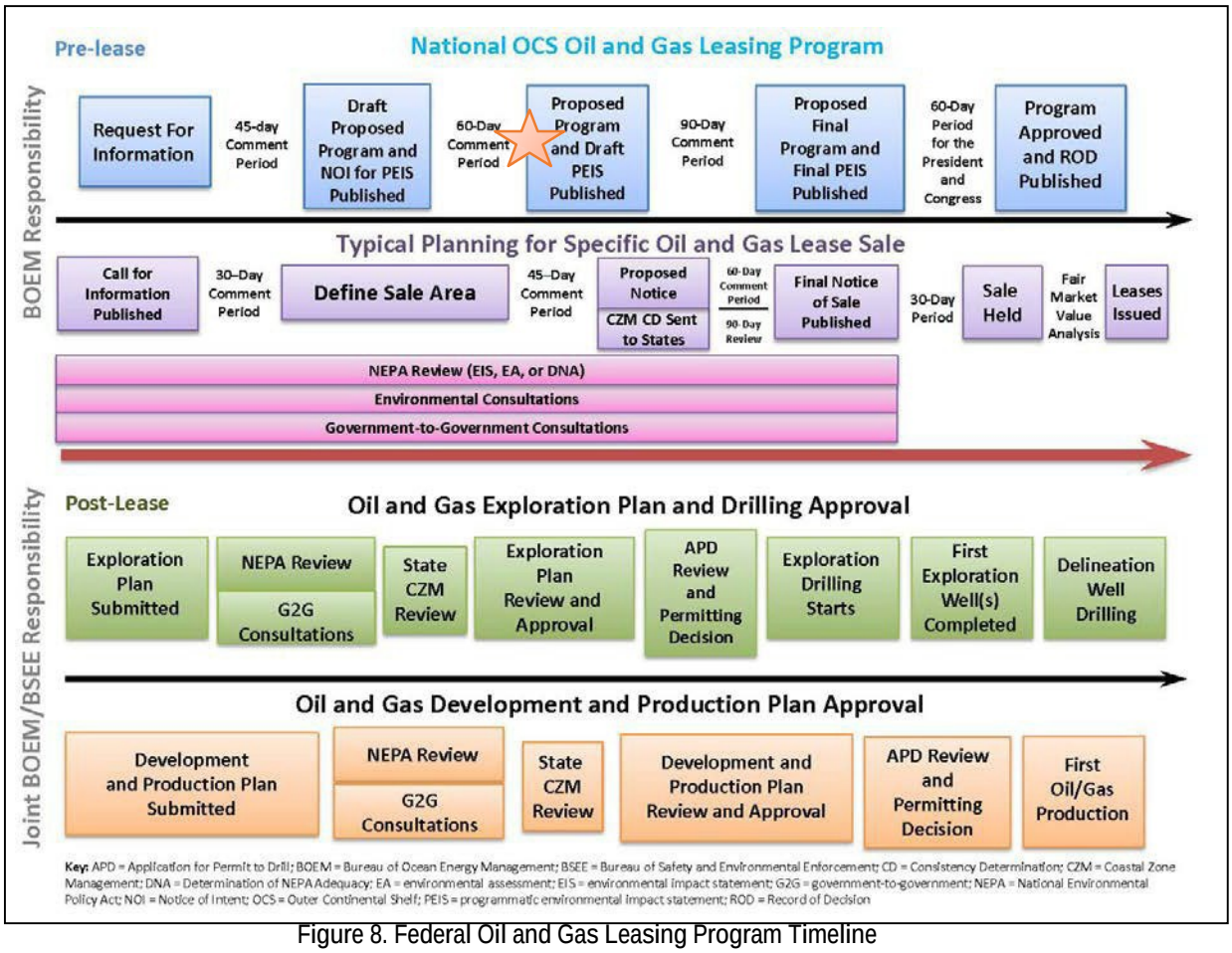

Figure 8. Federal Oil and Gas Leasing Program Timeline

On July 3, 2017, BOEM announced its Request for Information (RFI)[53] for a new National OCS Program for 2019-2024 (also known as a *Five Year Plan*) in the Federal Register, with a 45-day comment period that ended on August 17, 2017. The purpose of the RFI is for BOEM to solicit comments and information "on other uses of the sea, marine productivity, and environmental sensitivity…[and] invites and provides an opportunity for Governors of affected States, local government, industry, [f]ederal agencies, and the general public to provide suggestions and any other information they believe BOEM should evaluate for purposes of the 2019-2024 Program."[54] Information received by BOEM in the RFI solicitation is then considered in light of the factors specified in Section 18 of the OCS Lands Act, then the Secretary of the Interior prepares a Draft Proposed Program (DPP) within which areas to include or remove from the Program are identified. Any areas that are included in the DPP are subject to further analysis in the Program. Both Governor Cooper and Lieutenant Governor Forest submitted comments in response to the RFI.

[53] Bureau of Ocean Energy Management, United States Department of the Interior. (2017, July 3). *Request for Information and Comments on the Preparation of the 2019–2024 National Outer Continental Shelf Oil and Gas Leasing Program*. 82 Federal Register 126, pp. 30886-30892. Retrieved from https://www.boem.gov/82-FR-30886/

[54] Ibid

On January 4, 2018, BOEM issued the DPP[55,56] which proposed to open more than 98% percent – including the whole of the Mid-Atlantic planning area – (Figure 9) of the national OCS lands for oil and gas leasing during the 2019-2024 period. Specifically, the DPP proposed 47 lease sales in all of the OCS regions, 3 of which would be offered in the Mid-Atlantic region in 2020, 2022, and 2024, respectively. The notice in the Federal Register provided a 60-day comment period for interested parties to submit written comments on the DPP, the scope of the Programmatic Environmental Impact Statement (EIS), significant issues that should be addressed, and the types of oil and gas activities of interest in OCS planning areas included in the DPP.

BOEM received more than 1.67 million comments on the DPP, including comments from Governor Cooper.[57] The placement of the star on Figure 8 indicates the current status of the Program in the timeline. BOEM will review the comments received and make determinations as to which planning areas will remain for further program consideration in the 2019-2024 Five Year Plan.

[55] Bureau of Ocean Energy Management, United States Department of the Interior. (2018, January 8). *Notice of Availability of the 2019–2024 Draft Proposed Outer Continental Shelf Oil and Gas Leasing Program and Notice of Intent to Prepare a Programmatic Environmental Impact Statement.* 83 Federal Register 5 (January 8, 2018), pp. 829-834. Retrieved from https://www.boem.gov/83-FR-829/

[56] Bureau of Ocean Energy Management. (2018). *2019-2024 National Outer Continental Shelf Oil and Gas Leasing Draft Proposed Program*. Retrieved from https://www.boem.gov/NP-Draft-Proposed-Program-2019-2024/

[57] Governor Roy Cooper. (2018, March 9). *Comment on the Notice: Environmental Impact Statements; Availability, etc.: 2019-2024 Draft Proposed Outer Continental Shelf Oil and Gas Leasing Program.* Retrieved from https://files.nc.gov/governor/documents/files/North%20Carolina%202019-2024%20DPP%20Comments.pdf

Figure 9. Atlantic Planning Areas

E. Nuclear Energy

Nuclear power is an essential component of North Carolina's strategy to maintain a diverse generation portfolio; provide homes and businesses with clean, reliable, and affordable energy; and move the United States toward energy security. It is the source of more than 56% of the electricity consumed by Duke Energy customers in the Carolinas and is generated by carbon-

free, zero emissions power facilities.[58] As depicted in Chart 3, approximately 80% of North Carolina's emissions-free electricity was generated by 11 nuclear reactors in the Carolinas during the year ending October 31, 2017.[59]

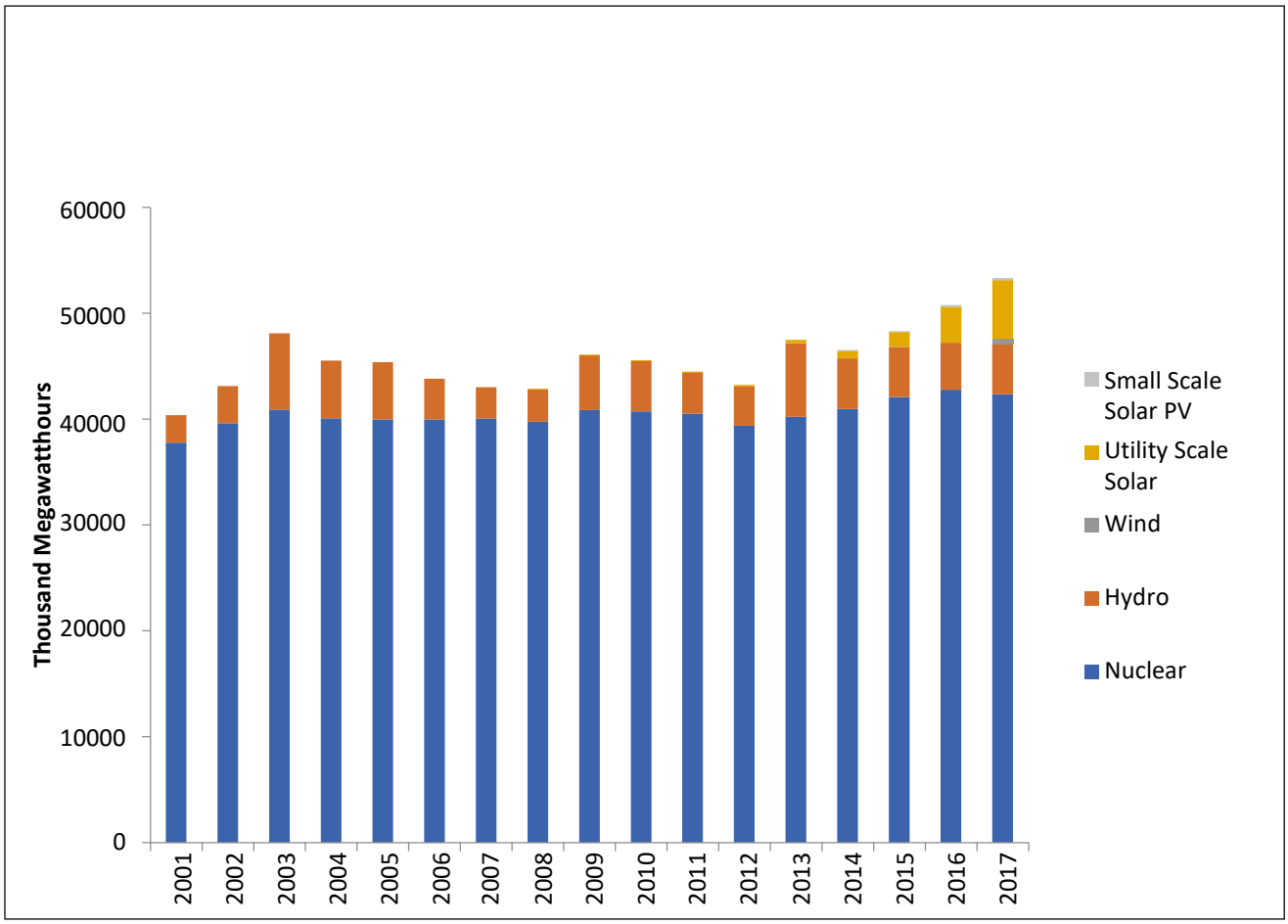

Chart 3. Emissions-Free Electricity Generation in North Carolina, 2001-2017.[60]

Another advantage of nuclear power is its extraordinary availability – nearly 100% – during both summer and winter peak as refueling and routine maintenance outages are performed in the spring and the fall. During the 12-month period ending on December 31, 2017, the 5 reactors in North Carolina operated at a capacity factor of 95.6%, meaning that on average, each reactor operated 95.6% of the time. In contrast to electric power generating sources whose dispatch readiness is intermittent, nuclear power plants are highly reliable baseload resources that decrease the need for high-capacity reserve margins. Nuclear plants typically operate around- the- clock and generally without interruption for 18 or 24 months before being shut down for refueling, thereby making them ideal sources for baseload electricity generation. Nuclear power

[58] Duke Energy. (2018, February 14). Duke Energy Carolinas Nuclear Plants Deliver Strong Performance in 2017. Retrieved from https://news.duke-energy.com/releases/duke-energy-carolinas-nuclear-plants-deliver-strong-performance-in-2017

[59] United States Energy Information Administration. (2017). *Profile Analysis (North Carolina)*. Retrieved from https://www.eia.gov/state/analysis.php?sid=NC

[60] Ibid

generation does not emit greenhouse gases (GHG) during operations. The fuel cost of nuclear plants is lower than that for fossil fuels, as a result, nuclear is often the first to be dispatched by system operators.

As demand for electricity grows during peak loads, less clean, less-efficient, and more expensive sources of power generation are dispatched. Few peaking generators have advanced pollution control devices or heat recovery systems. With dependable nuclear power, fewer of these units are operated, which keeps the air cleaner and operating costs lower.

As previously state, existing nuclear power plants are one of the lowest-cost producers of electricity in the United States. In 2016, the total generating cost at an average site (including capital, fuel, and operating expenses) was $33.93/MWh. The generation cost at multi-unit sites like McGuire (Huntersville) and Brunswick (Southport) Nuclear Stations are lower, with an average of $31.63/MWh. The Nuclear Energy Institute reports that nuclear energy facilities contribute to the State's economy by employing more than 2,600 skilled workers with an annual payroll of $203 million, resulting in more than $14 million in State and local taxes.

2016 Cost Summary ($/MWh)

Category	Number of Plants / Sites	Fuel	Capital	Operating	Total Operating (Fuel + Operating)	Total Generating (Fuel + Capital + Operating)
All U.S.	60*	6.76	6.74	20.43	27.19	33.93
Plant Size						
Single-Unit	25	6.77	8.67	25.95	32.72	41.39
Multi-Unit	35	6.75	6.15	18.73	25.48	31.63
Operator						
Single	12	7.18	8.19	21.20	28.38	36.57
Fleet	48	6.63	6.32	20.21	26.84	33.16

**Costs exclude shutdown plants.*
Source: Electric Utility Cost Group (EUCG)

Table 3. Cost Summary of U.S. Nuclear Fleet, 2016.

1. New Construction and License Renewals

Duke Energy currently has no plan to construct new nuclear plants as the company has filed its notice of cancellation for the Lee Nuclear facility. Duke Energy's decision to cancel this project stems from events associated with the 2017 departure of Westinghouse and its parent, Toshiba Corporation, from the nuclear construction business. Westinghouse was the owner, designer, and engineer for the technology that would have been utilized at the Lee Nuclear facility.

Southern Company began construction of two new Westinghouse AP1000 reactors at the Vogtle

site in Georgia in 2012, and SCANA did likewise shortly thereafter at the Summer site in South Carolina. The projects experienced schedule delays and cost overruns, and Westinghouse entered bankruptcy protection proceedings in March 2017. Southern Company removed Westinghouse from the lead role in the project and continued work at its site; startup of the two units is now projected for 2020 and 2021. SCANA and its co-owner, Santee Cooper, elected to discontinue construction on Summer Units 2 and 3. While the Nuclear Regulatory Commission (NRC) issued a number of combined construction and operating licenses for new reactors over the past five years, no additional construction of large nuclear power reactors is expected in the United States in the near future.

Assuming an operating period of 60 years, many of the nation's nuclear power plants will be required to shut down by 2040. However, the 60-year operating period for a nuclear reactor is an arbitrary value, and many, if not all, nuclear plants should be capable of operating for at least an additional 20 years. Several years ago, the NRC established a process for extending operating licenses for an additional period, referred to as subsequent or second license renewal. The process will be very similar to the initial license renewal process and involves demonstrating by analysis, combined with ongoing monitoring and surveillance, that plant safety is preserved. The operating licenses for all of Duke Energy's nuclear plants in the Carolinas extend through at least 2030. Duke Energy is evaluating the feasibility of relicensing its existing nuclear resources for an additional 20-year period. Dominion Energy has also filed to relicense its North Anna and Surry facilities in its IRP.

Energy production has experienced many innovations over the past couple of decades, and nuclear technology is no exception. Significant interest has developed in small modular reactors (SMRs), a concept involving small reactors that are constructed in a manufacturing facility and shipped to the site of a power plant. Existing nuclear power plants were constructed with a goal of economy of scale, generating as much power as possible from each unit in order to spread nuclear power's large capital cost over as many megawatts as possible. With SMRs, electricity generators could add reactor modules to reach a desired level of power generation. Due to factory production, SMRs present advantages with respect to cost, schedule, and quality control. One SMR developer, NuScale, submitted a design certification application for its light water SMR design to the NRC in 2016. The regulatory review is on schedule and is expected to be complete by 2020. While the economic feasibility of SMRs has not yet been demonstrated, they may be better suited to the 21st century power generation market than large reactors.

Another technology, advanced reactors, represents a significant departure from current nuclear reactor technology than SMRs. Advanced reactors (some of which would also be small and modular) employ radically different coolants and operating characteristics than current large light water reactors. The design concepts include: helium-cooled, graphite-moderated power plants; liquid metal-cooled reactors; and reactors cooled using molten salt – all of which have been used in the past, at least on a small scale. Currently operating light water reactors must operate at high-coolant pressure and employ active cooling systems. In contrast, advanced reactors with different coolants can operate at lower pressure, and typically incorporate passive safety features that enable simpler designs overall. Higher operating temperatures than light water reactors provide for better thermal efficiency and potential non-power applications, such as process heat. In many cases, innovative fuel designs also contribute to greater safety margins and reduced operational cost. Advanced reactor designs vary in terms of technical maturity, but in general, are not expected to be commercially available until at least 2030, following technical demonstration and regulatory approval. Dozens of companies are developing advanced reactor

designs, ranging from traditional reactor vendors to startups funded by venture capital. DOE actively supports advanced reactor research and development, and the nuclear industry is working with the NRC to establish a licensing framework for innovative nuclear designs that will enable deployment at reasonable costs and schedules.

III. GRID INFRASTRUCTURE

A. Transmission and Distribution Infrastructure in North Carolina

North Carolina has approximately 13,600 miles of transmission infrastructure, 68,100 miles of overhead distribution pole miles, and 20,600 miles of distribution underground lines.[61,62] Transmission and distribution systems in North Carolina have been designed, built, and have been operating safely and efficiently by local electric utilities for decades. By adhering to good design standards, maintenance practices, and inter-cooperation, the electric utilities in North Carolina have a good reputation for providing highly reliable, low-cost electricity. Most of North Carolina is not located within a regional transmission operator (RTO) or independent system operator (ISO) area, except for Dominion Energy, which means that all utilities plan for and manage their respective transmission systems.

Transmission owners in North Carolina participate in the voluntary planning organization called the North Carolina Transmission Planning Collaborative (NCTPC or Collaborative) which was established in 2005. Members include the investor-owned utilities (IOUs), Duke Energy Carolinas, Duke Energy Progress, the North Carolina Electric Membership Cooperatives (NCEMC) and municipal power systems (ElectriCities). Dominion Energy, a Virginia-based utility with service territory in the northeastern part of North Carolina has less than 150,000 customers, participates in the PJM RTO, and coordinates its transmission facilities accordingly.

The NCTPC conducts studies for the future needs of transmission infrastructure in North Carolina and in its 2016, report asserted that the State will need 7 new major transmission projects totaling $144 million by 2025. The NCTPC coordinates joint transmission planning with its members in order to "preserve the integrity of the current reliability and least-cost planning processes" for all the State's stakeholders.

All transmission owners in North Carolina are subject to federal and State oversight and regulation. The North Carolina Utilities Commission (NCUC) requires utilities to file long- range plans for future electricity capacity "as part of the Least Cost Integrated Resource Planning process, commonly called integrated resource planning (IRP). IRP takes into account conservation, energy efficiency, load management, and other demand-side options along with new utility-owned generating plants, non-utility generation, renewable energy, and other supply-side options."[63]

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[61] United States Department of Energy. (2015). *State of North Carolina Energy Sector Risk Profile.* Retrieved from https://www.energy.gov/sites/prod/files/2015/05/f22/NC-Energy%20Sector%20Risk%20Profile.pdf

[62] North Carolina Utilities Commission. (2003, November). *Feasibility of Placing Electric Distribution Facilities Underground.* Retrieved from http://www.ncuc.commerce.state.nc.us/reports/undergroundreport.pdf

[63] North Carolina Utilities Commission. (2017, November 21). *Annual Report Regarding Long Range Needs for Expansion of Electric Generation Facilities for Service in North Carolina*. Retrieved from http://starw1.ncuc.net/NCUC/ViewFile.aspx?Id=2292ba92-d5a1-4b05-b2b7-b158c915655d

In addition to future energy generation, utilities must plan for future transmission infrastructure in order to transport the electric energy from the generation plants to the end users. As such, transmission is an integral part of the bulk electric power supply system. Since the utilities are subject to regulation by the NCUC, the Commission evaluates the IRPs to determine if they are reasonable for planning purposes.

There are opportunities for North Carolina transmission owners and operators to add technology and system improvements to increase reliability and resiliency. Also, as the location and production of the new generation sources change, the need for and use of transmission, and especially distribution systems, must change. Accordingly, there may be opportunities for transmission owners to integrate grid modernization into future plans.

In 2007, the North General Assembly directed the NCUC to adopt and implement rules that "establish standards for interconnection of renewable energy facilities."[64] In 2008, the Commission adopted federal standards for interconnections. According to the Annual Report for Long Range Needs, there was 3,217 MW of renewable generation in Duke Energy's interconnection queue, of which 3,177 MW was solar photovoltaics.[65] In contrast to traditional central station generating plants, a majority of the new renewable generation is being interconnected on the distribution grid. This is a notable departure from historical practice and creates the need for a more flexible electricity grid.

The Commission does not regulate the retail rates of either municipally-owned electric systems or EMCs. However, as previously stated, the Commission does have oversight over EMC and municipal construction of generation and transmission facilities, pursuant to its jurisdiction over the licensing of all new electric generating plants and large-scale transmission facilities built in North Carolina. EMCs are independent, not-for-profit corporations and 31 EMCs serve metered customers in North Carolina, comprising approximately 25% of the State's population. Of those, 26 are headquartered in the State, and served 1,039,557 metered customers in 2016.

Although distribution systems across North Carolina are built to the individual standards of each utility, in aggregate they are considered reliable and resilient. Using a combination of poles (wood, concrete, and steel) and underground cable, North Carolina utility distribution systems generally withstand major weather events and experience few major outages.

The distribution system is considered by some to be the *grid edge*. In other words, the distribution grid is where utility facilities touch most customers, and has the ability to gather data at the point of interconnection to customers. According to GreenTech Media, "the grid edge comprises technologies, solutions and business models advancing the transition toward a decentralized, distributed and transactive electric grid."[66]

In addition to grid infrastructure, grid modernization includes customer energy management, transactive energy and electricity market design. As a result, the modern distribution system will

[64] North Carolina General Assembly. (2007). Senate Bill 3. Retrieved from https://www.ncleg.net/Sessions/2007/Bills/Senate/PDF/S3v6.pdf

[65] North Carolina Utilities Commission. (2017, November 21). *Annual Report Regarding Long Range Needs for Expansion of Electric Generation Facilities for Service in North Carolina*. Retrieved from http://starw1.ncuc.net/NCUC/ViewFile.aspx?Id=2292ba92-d5a1-4b05-b2b7-b158c915655d

[66] Chen, O. (2017, January 1). What is Grid Edge? *GreenTech Media.* Retrieved from https://www.greentechmedia.com/articles/read/what-is-the-grid-edge

employ advanced metering infrastructure (AMI), advanced distribution management systems (ADMS), and distributed energy management systems.

B. Grid Modernization in North Carolina

As the electric grid in North Carolina ages, it must keep pace with emerging technologies and customer expectations. The electric grid in North Carolina was designed, constructed and operated based on the traditional concept of central generation. In this paradigm, power from centralized power stations is sent via high-voltage transmission lines to distribution substations, which is then sent to distribution systems that serve end-use customers. The introduction of distributed generation changes the traditional flow of electricity and may require a rethinking about the traditional approach to planning. In a digital economy where consumers have greater access to more information and an increased reliance on electric service, utilities must modernize the grid to accommodate these changing requirements and expectations. This entails more intelligence, two-way communications to smart devices, and more flexibility and resiliency from the electric grid. Together, these improvements are broadly categorized as *grid modernization*.

In order to keep pace with the State's growing population and economy, North Carolina must have adequate electric grid infrastructure. Moreover, the State's utilities have plans and programs to modernize the electric grid to maintain the level of service and reliability our citizens have come to expect. To do so requires significant investment and commitment from the utilities to meet customers' short- and long-term expectations.

The State's IOUs, namely Duke Energy Progress, Duke Energy Carolinas and Dominion Energy recently announced grid modernization programs that commit billions of dollars to future transmission and distribution investment.[67]

Duke Energy's key objectives for grid modernization are ensuring a more reliable system and creating a smarter grid. Three components of the proposed more reliable system are storm hardening; targeted undergrounding; and resiliency. Three components of creating a smarter grid are advanced metering; advanced systems and communications; and self-optimizing grid.

Duke Energy hopes to create system benefits by reducing the frequency and duration of system outages by 50% over the next 10 years. In addition, Duke Energy plans to create customer benefits by decreasing power interruptions, enabling faster, more automated power restoration; providing new data and information to its customers, and enabling higher penetration of distributed energy resources like solar PV and wind.

Of the $25 billion of grid modernization investment Duke Energy announced in 2017, at least 60% of it will be spent in the Carolinas. Duke Energy plans to invest $5 billion on the grid in the next 5 years.

Dominion Power, which serves the northeast corner of North Carolina, recently received approval from the Virginia legislature to proceed with its plans for grid modernization. Dominion plans to invest nearly $4 billion in 8 areas: smart meters; intelligent grid devices;

[67] Duke Energy. (2017, April 12). Duke Energy Embarks on 10-year initiative to strengthen North Carolina's Energy Grid. *Duke Energy News Center.* Retrieved from https://news.duke-energy.com/releases/duke-energy-embarks-on-a-10-year-initiative-to-strengthen-north-carolina-s-energy-grid; and Dominion Energy. (2018, January 17). *The Smart Grid—What's Next: Transforming the Energy Grid.* Retrieved from https://www.dominionenergy.com/about-us/electric-projects/grid-transformation

communications infrastructure; grid resilience; automated control systems; customer information platform; big data analytics; and innovation. It is expected that these investments will result in a more reliable electric grid that improves customer experience and accommodates more distributed energy resources.

The State's electric membership cooperatives (EMC)and municipal power companies have kept pace with emerging technologies and customer expectations by engaging in various modernization initiatives over the past decade.

For example, the State's EMCs were early adopters of so-called *smart metering*, deploying AMI to address low customer density along wide expanses of distribution lines, and to facilitate communication and exchange of telemetry and data. The EMCs implement conservation voltage reduction capabilities; developed and brought online 18 community solar facilities; operate 2 microgrids (located on Ocracoke Island and on Butler Farm in Harnett County); and partner with members to implement DSM/EE programs, including one for Wi-Fi-enabled thermostats with more than 1,000 member-owner thermostats enrolled.

Similarly, more than half of the municipal public power communities in North Carolina are in various stages of smart meter deployment, ranging from pilots to full deployment and budgeting for projects. Public power utilities, which serve 1.2 million customers in North Carolina – more than the populations of Charlotte and Raleigh combined – use AMI functions (including remote meter connection and disconnection, leak detection, and power theft notification) to better serve customers and protect the safety and reliability of the grid. Other smart grid technologies employed in North Carolina public power communities include: outage management systems; electric vehicle and renewable integration; load management equipment and distributed energy resources; and various distribution automation and grid sensing technologies. North Carolina public power communities have deployed more than 3,000 smart load management switches, and 10 public power communities have deployed smart thermostats. In total, North Carolina public power communities can reduce demand by more than 300 MW through implementation of smart residential load management program.

The 2016 Energy Policy Council Report provided that utilities require diverse generation resources in order to reliably and economically meet baseload and peak power demands. With the recent announcements of closing electric generating units, it appears that the State’s utilities are transitioning from traditional fossil fuel resources, such as coal and oil, to natural gas and renewable generation. Contributing to the resource diversity, the State’s utilities have large investments in nuclear and hydroelectric energy generation. Despite this resource diversity, 90% of the North Carolina’s electricity is presently generated by nuclear, coal, and natural gas.

As previously mentioned in this section, North Carolina ranks second in the nation in the growth and adoption of distributed solar PV generation and boasts the Southeast’s first commercial-scale wind farm with a nameplate capacity of 208 MW.[68] Renewable generation continues to grow which places an increasing demand on the utilities to build and maintain a modern electric grid that serves both the distributed generators and consumers. As of the date of this report, North Carolina has a total installed capacity of 3,288 MW of distributed solar generation connected to the grid. The Amazon Wind, U.S. East windfarm has 104 wind turbines in commercial operation

[68] United States Energy Information Administration. (2017). *Profile Analysis (North Carolina).* Retrieved from https://www.eia.gov/state/analysis.php?sid=NC

and all of the power generated is dedicated to its namesake in the PJM territory. However, transmission facilities in North Carolina within the Dominion Energy service area are used to wheel the power to its destination.

Both solar PV and wind are considered intermittent generation sources, meaning output is dependent on availability of the sun and wind, respectively. As a result, the electric grid must be able to accommodate and adjust instantaneously to the variable output from these resources. This adaptability requires additional layers of planning and technology deployment by the utilities and their electric grids.

Utility grid modernization is a solution to address the increased complexity and demands from operating a changing electric grid. Selective use of technology can reduce outage and speed restoration times, especially after a major storm event. New grid technology can also help integrate emerging technologies such as electric vehicles and battery storage, both of which are receiving new attention and application in today's environment. Due to the transient nature and potential imbalances of intermittent distributed renewable generation, modernizing the grid can address these issues more effectively than legacy devices in substations and distribution feeders today.

Figure 10 illustrates this point: traditional power flow in distribution systems starts in the substation and flows to distribution feeders or circuits to end-use consumers for the length of the feeder. The introduction of distributed generation on the distribution grid power flow is bi-directional, and varies depending on the distributed generator output, local loads, and the time of day. There are also legacy devices, depending the utility's standards, on the distribution feeder including capacitor banks, voltage regulators, and reclosers. There may be devices in the substation such as a transformer load tap changer and protection devices. The advent of power flow back to the substation, and even up to the transmission system through the station transformer requires a new operations philosophy and information technology. Furthermore, some utilities have implemented conservation voltage reduction as a demand-side management strategy, again based on traditional power flow on radial feeders.

Utility grid modernization efforts should anticipate and incorporate emerging technologies such as distributed generation, battery energy storage, and electric vehicles without causing disruptive effects on customers. As customers add their own generation (i.e. rooftop solar PV), operational challenges will be compounded. Grid modernization should include advanced data analytics as the number of intelligent devices producing data increases exponentially, requiring some intelligence on the part of the utilities to track trends and predict how the distribution grid operates and responds

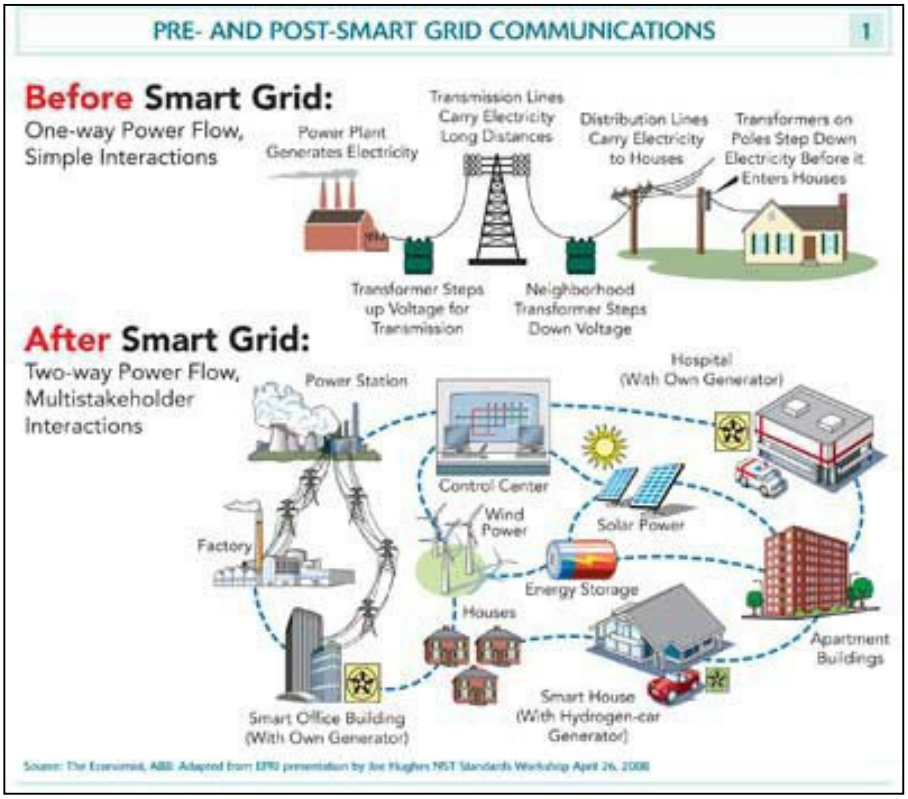

Figure 10. Illustration of Smart Grid Communications[69]

Investing in grid modernization provides a strong foundation for the future of North Carolina energy generation and provides the flexibility needed to adapt to an ever-changing technology landscape. Grid modernization also requires investment in innovation and pilot programs to ground truth and test proof of concept, as certain technologies may not prove beneficial or efficient to North Carolina utilities or their customers.

Examples of the grid modernization include: distribution automation, which is the addition of smart switches that enable fault location, isolation, and restoration; new distribution monitoring and data gathering systems (e.g., Supervisor Control and Data Acquisition) (SCADA)); and two-way communications to intelligent energy devices (IED) on the distribution grid. Each new system generates orders of magnitudes of new data that can be analyzed and interpreted.

Grid modernization may also include battery energy storage systems (BESS), and may be utility- or customer-owned. Energy storage benefits include the ability to store excess energy, frequency regulation, and the ability to smooth ramp rates associated with intermittent solar and wind generation. There are benefits of BESS that must be weighed against its cost and ability to fit into the distribution system requirements.

A more robust discussion of electric vehicles follows in the section on Energy Efficiency, however EVs play a role in grid modernization. Duke Energy has committed to electric vehicle charging infrastructure. The impact of high penetration of electric vehicles has been studied and

[69] Krachenfels, J. (2012, November 1). The Role of Communications in the Smart Grid. *Electric Light & Power*. Retrieved from http://www.elp.com/articles/powergrid_international/print/volume-17/issue-11/features/the-role-communications-smart-grid.html

utilities view EV as another consumer load. The greatest impact of increased EV adoption will be on the distribution system, so whether there is high or low penetration, a modern grid will be required to support it.

IV. Legislative and Regulatory Role

With a population of more than 10 million, North Carolina is the 9th most populous state in the country. The State Gross Domestic Product (GDP) is approximately $500 billion. The distribution of the State's GDP is: about 20% manufacturing; 16% agriculture; 18% finance, insurance, and real estate, 8% education, and 10% retail and wholesale. Approximately, 43% of all State jobs are in manufacturing, with the remaining in retail, farming, and wholesale.[70]

A. Current Policy

From the policy perspective, economic development can be defined as those efforts that seek to improve the economic well-being and quality of life for a community by creating and retaining jobs and supporting and growing incomes and the tax base. Economic growth is achieved by attracting large companies that employ sizable numbers of people and purchase significant volumes of materials and natural resources native within the state. This is accomplished by, among other things, matching indigenous raw materials from within the state with more reliable and lower cost energy needed to transform materials into finished products and services. As today's companies consider siting for new assets and commercial locations, they evaluate the aforementioned criteria and the availability of reliable, low-cost energy. Some companies seek to obtain their energy from clean, renewable resources and the enactment of H589 in 2017, has helped to lay the foundation for increased renewable energy procurement in North Carolina.

One of the primary policy drivers of renewable energy was the Federal Public Utilities Regulatory Policy Act (PURPA) established by Congress in 1978. PURPA provided that utilities must buy energy from renewable energy and cogeneration facilities owned by third parties in response to the oil shortages of the 1970's.

Today, North Carolina is the largest PURPA state in the country, with 60% of the nation's PURPA supply. Most states, including California found that deploying renewable energy under PURPA was more expensive than through a competitive procurement process. Basically, PURPA violates a primary principle of economics; PURPA is absent any finite demand component and without it, suppliers are not price responsive to changes in their costs.

Economic theory provides that all products and services possess a finite demand and a finite supply and, in theory the intersection of these demand/supply structures that determines the value or price for that product and service.

In addition to what appears to be a lack of economic discipline, most of the solar construction in North Carolina was occurring in the eastern part of the State. As new solar facilities came online, the utilities began to identify reliability concerns and actual power quality excursions.

While utility-scale solar reached a frenetic pace in North Carolina, rooftop and customer-owned and sited solar facilities have dropped significantly, due in large part to the sunset of the State

[70] North Carolina Department of Commerce, Labor and Economic Analysis Division. North Carolina's Gross DomesticProduct.

solar tax credit in 2015.[71] The rooftop industry actually was subject to the basic principles of economics. What happened to the rooftop solar industry and growth is an example of free market-driven consumer choice; because the cost of rooftop solar increased after the expiration of the tax credit, customer demand fell. This resulted in lost jobs in the small scale solar industry and a rapid migration of resources from the rooftop industry to the consolidated utility-scale solar industry.

Furthermore, some utility customers sought alternative choices for the types of energy they used and wanted more control over the type of energy resources by which they are served.

Together, this experience revealed that: (i) cost savings; (ii) locational siting and reliability; (iii) erosion of the nascent small-scale solar industry; and (iv) consumer demand for greater options and choices needed to be addressed and yielded a broad stakeholder process to find compromise and support for a comprehensive energy solution.

B. Recent Shift in Policy / H589

In sum, what H589 highlighted and in many ways remedied, was that implementation of PURPA in North Carolina failed to accomplish the natural economic balance of supply and demand for utility-scale solar and addressed all renewable energy resources, generally. When supply of a product or commodity increases without a reciprocal increase in demand, the price for that product normally goes down. North Carolina has been experiencing flat to modest growth in electricity demand over the last several years but the supply of solar resources has increased around 50% every year for the past 3 years. Until recently, North Carolina did not experience a corresponding decrease in the cost of solar, while the cost to produce solar was noticeably going down. The avoided cost rates used in the purchase of solar continued to remain reasonably constant. H589 helped resolve this by establishing an efficient mechanism to balance supply and demand, which will ensure just and reasonable pricing for solar, while allowing developers to continue to earn a reasonable return on their investments.

At present, the peak demand for electricity in North Carolina is approximately 40,000 MW. Duke Energy alone now has in excess of 10,000 MW of solar in its interconnection queue. This exceeds the immediate need for new generation in the State.

H589 established a transition to a new economic reality where there is capped demand for new renewable energy and where only the least-cost, most efficient producers are selected to supply the energy needed in the State. Under H589, incentives were shifted from the economically- challenged PURPA program, to a competitive process which could guarantee that the North Carolina remains at the forefront of renewable energy. To follow is a brief description of the programmatic shift from PURPA to competitive markets in the State:

1. Competitive Procurement of Renewable Energy (CPRE) ensured that the price for solar would be competitively determined, creating downward price pressure on suppliers. This ultimately saves customers money while providing a reasonable return on investment for suppliers. The CPRE process also provided the utilities with some discretion to ensure

[71] North Carolina General Assembly. (2015). House Bill 97. Retrieved from https://www.ncleg.net/Sessions/2015/Bills/House/PDF/H97v9.pdf; and Dewitt, D. (2015, September 15). Budget Ends Renewable Energy Tax Credit, Among Other Environmental Changes. *WUNC*. Retrieved from http://wunc.org/post/budget-ends-renewable-energy-tax-credit-among-other-environmental-changes#stream/0

that optimal locations are selected to site facilities, which will also enhance reliability. From an economic perspective for solar developers, contracts were extended from 15 to 20 years, and reduced, from 5MW to 1MW, the standard contract under PURPA to instead permit and encourage developers to take advantage of scale and build facilities as large as 80MW. The CPRE requires utilities with more than 150,000 customers to issue a request for proposals (RFP). The RFP must be issued over a 45-month term for a total procurement of 2,660 MW of capacity from renewable energy facilities provided the total amount of energy in the competitive procurement is adjusted up or down by any amount in which the public utility's renewable energy procurement outside of the competitive procurement and the green source rider program is more or less than 3500 MW. The competitive bidding process will be overseen by an independent administrator that is required to publish the methodology used to choose the projects. The costs to procure energy in the competitive procurement are eligible to be recovered through an annual rider. The annual costs recoverable, however, are not allowed to exceed one percent of total revenues of the utility in the State for the prior calendar year.

2. Under CPRE, the Duke Energy has discretion in where solar facilities are located and will be able to locate more of what is to be procured in the western part of the State rather than isolating it in the east, as has been the practice. This will enhance reliability, help manage excess energy in low load periods, and more easily enable western utilities meet REPS compliance obligations.

3. The new statutes under H589 allow solar leasing contracts with performance and or availability guarantees in designated areas where the utility has more than 150,000 customers. This will allow customers that wish to utilize solar on their property to do so with very low upfront costs. The law also allows nonprofit customers to capture some benefit from the Federal Investment Tax Credit to the extent the lessor can monetize the tax credit and chooses to share those benefits with the customer.

4. Finally, customer programs in H589 provide incentives and added opportunities for customers to utilize solar as well as to influence the amount of solar that is deployed in the State (only applicable in designated areas where the utility has more than 150,000 customers).
    a. The Solar Rebate Program, that was approved by the NCUC in 2018, provides residential customers with $0.60 per watt to install new solar on their property for up to 10kW of panels. This means that the residential rebate could total as much as $6,000, and possibly offset as much as 25% of the total upfront costs to own solar. Non-residential customers may receive a rebate of $0.50 per watt for up to 100kW installed. This means that a non-residential could receive a rebate for as much as $50,000, and a non-profit customer could receive a rebate of $0.75 per watt for up to 100kW which means it could receive as much as $75,000 for installing a solar facility on their property.
    b. Shared Solar Program, if approved as filed with the Commission, will allow customers to buy subscriptions of a solar facility and receive a credit, based on the energy generated, on their electric bill for the 20 years that follow.
    c. A Large Customer Program provides large customers with either up to 1 MW of load or 5 MW aggregated to participate in a program where they can buy

renewable energy for up to 20 years and monetize that energy in the North Carolina market, while being permitted to retain the renewable attributes on that energy. Furthermore, since only new generation can supply this program, a program participant can also claim responsibility for the addition of renewable generation that is developed and constructed.

If done successfully, this legislation will result in as much as 8,500 MW of solar in the State by 2025. A major goal of H589 was to establish efficiency, meaning that the electric providers must manage costs, provide reliable service and supply quality; all while providing increasingly cleaner energy supply choices to customers. Under H589, solar will continue to expand at a sustainable pace with competitive pricing.

The outcome of H589 and its implementation is that this new energy reality will yield lower cost, more reliable, cleaner energy platform for all citizens of our state. Incentive systems such as those created by H589 should foster the development of other new technologies, lower costs for those new technologies, and enhance reliability when deploying them. Ultimately, this should result in volumetric proliferation of new advanced methods for managing energy and may also ultimately render them the technologies of choice selected economically by all electric suppliers in the future.

On this journey electric providers must also continue to invest in the grid, because the need to deliver energy of all types does not diminish – it is still essential to ensure a robust growing economy.

Energy Assurance

I. Overview[72]

North Carolina's highly regarded energy infrastructure, with its diversified generating plants, robust transmission and distribution infrastructure, and growing pipeline systems and renewable resources, is nonetheless susceptible to both natural and man-made incidences that may result in local or statewide energy emergency events. The Energy Assurance (EA) Committee focus is on recognizing potential energy emergency threats, how to prepare for those threats, and how to mitigate their impacts. For example, in the past two years since the last biennial report, members and staff of the EA Committee participated in tabletop exercises for both a coronal mass ejection (CME) and electromagnetic pulse (EMP) event affecting the electric power grid in North Carolina. These two exercises involved utilities, military, businesses, and State, local and federal agencies in determining how North Carolina can prepare for and respond to widespread power disruption events such as these. In addition to addressing energy assurance in the electric sector, the EA Committee considers threats that disrupt the natural gas, petroleum, and propane pipelines that serve our State, and any other incidences or events that may threaten North Carolina's energy assurance.

II. Update on Energy Assurance of Delivery Systems[73]

In its *2017 Infrastructure Report Card*, the American Society of Civil Engineers (ASCE) graded North Carolina's overall energy infrastructure, with a good (B+) score.[74] ASCE cited energy source affordability, diversity and reliability as North Carolina's strengths and noted that our foundational energy infrastructure can support both current and long-range (20-year) planning needs.

A. Natural Gas Infrastructure

The *2017 ASCE Report Card* provides that North Carolina "is almost entirely dependent on [the] Transco Gas Pipeline for its natural gas requirements." This heavy reliance on Transco Pipeline for natural gas availability presents vulnerabilities. This vulnerability may be mitigated by the addition of addition of three proposed interstate pipelines described in more detail below.

1. Atlantic Coast Pipeline (ACP)[75,76]

The ACP is a new 600-mile underground natural gas transmission pipeline that will transport supplies of natural gas from West Virginia, through Virginia (with a lateral extending to the City

[72] Energy Policy Council. (2016, March). *Energy Policy Council Report*, pp. 4. Retrieved from https://ncdenr.s3.amazonaws.com/s3fs-public/documents/files/Energy%20Policy%20Council%20Report%20March%202016.pdf
[73] Ibid. Pages 31-38.
[74] American Society of Civil Engineers. (2017). *North Carolina Infrastructure Report Card*. Retrieved from https://www.infrastructurereportcard.org/state-item/north-carolina/
[75] Atlantic Coast Pipeline, LLC. (2018). *Atlantic Coast Pipeline*. Retrieved from https://atlanticcoastpipeline.com/default.aspx
[76] Federal Energy Regulatory Commission. (2017, October 13). *Order Issuing Certificates for the Atlantic Coast Pipeline*. Retrieved from https://www.ferc.gov/CalendarFiles/20171013192035-CP15-554-000.pdf

of Chesapeake), and then continue with a 36-inch diameter pipeline into eastern North Carolina, before terminating in Robeson County. The ACP is being developed by four leading domestic energy companies: Dominion Energy; Duke Energy; Piedmont Natural Gas; and Southern Company Gas. Combined, these companies have centuries of experience in providing reliable electric and natural gas service to millions of customers in the Southeast. As the leading percentage owner of the ACP, Dominion Energy will be responsible for constructing and operating the pipeline.

Customers receiving gas from the ACP will include Duke Energy Carolinas, Duke Energy Progress, Piedmont Natural Gas, and PSNC Energy. The project was approved by the FERC in October 2017, and will be able to transport as much as 1.5 million dekatherms of natural gas per day. Approximately 96% of the gas is subscribed to the four developers.[77] FERC estimates that about 79% of the natural gas subscriptions will support electric power generation, 9% will support the residential sector; 9% percent will support the industrial sector, and 3% will serve other uses (e.g., vehicle fueling). As of the date of this report, some additional State permits are pending, although several were obtained, and tree felling commenced during the first quarter of 2018. The planned in-service date for the ACP is the fourth quarter of 2019.

2. Mountain Valley Pipeline (MVP)[78]

The Mountain Valley Pipeline received FERC order granting a Certificate of Public Convenience and Necessity in 2017, and as of the date of this report has begun tree felling in order to begin construction on the project.[79] MVP is a 303-mile pipeline expansion project that extends the Equitrans pipeline transmission system from Wetzel County, West Virginia, to interconnect with Transco Gas Pipeline's Zone 5 compressor station 165 in Pittsylvania County, Virginia.

In April 2018, MVP announced its plans for the Mountain Valley Southgate project, extending from Pittsylvania County, Virginia for 70 miles into North Carolina. The proposed route runs through Rockingham County and terminates in Alamance County. Southgate is anchored by a firm capacity commitment from PSNC Energy. The Southgate Project, is a joint venture between EQT Midstream Partners, NextEra US Gas Assets, Con Edison Transmission, WGL Midstream, and RGC Midstream, and will be built and owned by MVP. Southgate will be operated by EQT Midstream Partners, who own a substantial interest in the Project.

3. Southeastern Trail Expansion[80]

Williams Partners LP announced its proposed Southeastern Trail expansion project. Williams requested FERC approval for the project which would provide an additional 296,275 dekatherms per day of additional firm capacity to markets in the Mid-Atlantic and Southeastern United States. Williams held an open season for the project in the summer of 2017, and executed long-

[77] Atlantic Coast Pipeline, LLC. (2017). FERC Approves Certificate of Public Convenience and Necessity for the ACP. *Atlantic Coast Pipeline Releases.* Retrieved from https://atlanticcoastpipeline.com/news/2017/10/13/ferc-approves-certificate-of-public-convenience-and-necessity-for-the-acp.aspx

[78] Mountain Valley Pipeline, LLC. (2018). *Mountain Valley Pipeline.* Retrieved from https://www.mountainvalleypipeline.info/current-news

[79] Federal Energy Regulatory Commission. (2017, October 13). *Order Issuing Certificates for the Mountain Valley Pipeline.* Retrieved from https://www.ferc.gov/CalendarFiles/20171013192058-CP16-10-000.pdf

[80] Williams Companies. (2018). *Southeastern Trail Expansion Project*. Retrieved from http://co.williams.com/expansionprojects/southeastern-trail-expansion-project/

term binding precedent agreements with 5natural gas shippers for 100% of the firm transportation capacity. Customers served by the project are PSNC Energy, South Carolina Electric & Gas, Virginia Natural Gas, and the cities of Buford and LaGrange, Georgia. The Southeastern Trail Expansion project will consist of approximately 7.7 miles of 42-inch pipeline looping facilities in Virginia, horsepower additions at existing compressor stations in Virginia, and piping and valve modifications on other existing facilities in South Carolina, Georgia, and Louisiana to allow for bi-directional flow. The certificate application reflects an expected capital cost of $404.8 million and a target in-service commitment of November 1, 2020.

4. Atlantic Sunrise Project[81]

The Atlantic Sunrise Project, is slated for a mid-2018 completion and involves looping and compression on Pennsylvania's Leidy Line, and flow-reversal on portions of Transco's main line. According to members of the NCUC's Public Staff; "[n]one of [North Carolina's] utilities – gas or electric – are subscribers," to the Atlantic Sunrise Project.

Much of the capacity from both Mountain Valley and Atlantic Sunrise is subscribed to by marketers and may impact availability of and price for natural gas in North Carolina.

B. Electric Power Grid Infrastructure

According to the January 16, 2018, *Report on the North Carolina Transmission Planning Collaborative (NCTPC or Collaborative) 2017-2027 Collaborative Transmission Plan,* Duke Energy Carolinas (DEC) and Duke Energy Progress (DEP) have projects already planned to address reliability concerns for the near-term (5 year) and long-term (10 year) planning horizons. There were no unforeseen problems identified in the reliability studies performed on the base cases.[82]

The NCTPC was established to provide the Participants (DEC, DEP, North Carolina Electric Membership Corporation, and ElectriCities of North Carolina) and other stakeholders an opportunity to participate in the electric transmission planning process for areas of the Carolinas that the Participants serve. The Collaborative is directed to preserve the integrity of the current reliability and least-cost planning processes and to expand the transmission planning process to include analysis of increasing transmission access to supply resources inside and outside the Balancing Authority Areas of DEC and DEP. The NCTPC was also directed to develop a single coordinated transmission plan for the Participants that includes reliability and local economic study transmission planning while appropriately balancing costs, benefits, and risks associated with the use of transmission and generation resources. This Process is performed annually and includes the reliability planning and local economic study planning processes, which are intended to be concurrent and iterative in nature. The NCTPC Process is designed such that considerable feedback and iteration takes place between the two processes; the two efforts solution alternatives affect one another.

C. Challenges and Opportunities in Energy Assurance

[81] Williams Companies. (2018). *Atlantic Sunrise Pipeline Project*. Retrieved from http://atlanticsunriseexpansion.com/

[82] North Carolina Transmission Planning Collaborative. (2017, January 13). *Report on the NCTPC 2016-2026 Collaborative Transmission Plan*. Retrieved from http://www.nctpc.org/nctpc/document/REF/2017-01-13/2016-2026_NCTPC_Report %2001_13_2017_FINAL.pdf

1. Gas Pipelines

Though shielded from most natural hazards, underground gas pipeline disruptions may be weather-related or caused by human errors during excavation. North Carolina had 7 incidents reported since the publication of the last biennial report in 2016.[83] North Carolina's low incident rate may be attributed partially to the State's continuing promotion of the *811 Call Before You Dig* program.[84] This federally-designated phone number has raised and continues to provide awareness of underground utility line (including both gas and electric) locations to prevent accidents and utility disruptions.

2. Electric Power

Electric power generation in North Carolina has been the largest natural gas-consuming sector since 2012. In 2016, the sector used 32.5% of nuclear energy for generation, 30% of natural gas- fired generation and 28.6% of coal-fired generation and it continues to drive-up NC's demand for natural gas.[85]

Although many of North Carolina's electric power outages are weather-related, the threat of human-induced physical (e.g., a high altitude electromagnetic pulse (EMP)) or cyber-attack disruptions is expected to increase substantially. To address to the growing threat of cyber-attack, the North American Electric Reliability Corporation (NERC) designed *GridEx*, a biennial exercise that simulates a cyber or physical attack on the electric grid and other critical infrastructure across North America. On November 15 and 16, 2017, *GridEx IV* which involved electric utilities, regional and federal government agencies in law enforcement, first response, and intelligence community functions, critical infrastructure partners, and supply chain stakeholder organizations) was successfully executed.[86] Representatives from North Carolina's Division of Emergency Management and the Department of Environmental Quality participated in the Exercise.

The *February* 2017 Electric Power Research Institute (EPRI) HEMP report**:** *Magnetohydrodynamic Electromagnetic Pulse Assessment of the Continental U.S. Electric Grid: Geomagnetically Induced Current and Transformer Thermal Analysis* found that "a limited number of bulk-power transformers would be at potential risk of thermal damage due to a single high-altitude electromagnetic pulse (HEMP) attack." The report stated that "additional work is needed to fully investigate the impact to the entire bulk-power system."[87] EPRI's Vice President of Transmission and Distribution, Rob Manning, was quoted in the January 2018 *Public Utilities*

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[83] United States Department of Transportation. (2017). *Pipeline Incident 20-Year Trends*. Pipeline and Hazardous Materials Safety Administration Retrieved from https://www.phmsa.dot.gov/data-and-statistics/pipeline/pipeline-incident-20-year-trends

[84] Call 811. (2018). *811 In Your State*. Retrieved from http://call811.com

[85] United States Energy Information Administration. (2017). *Profile Analysis (North Carolina).* Retrieved from https://www.eia.gov/state/analysis.php?sid=NC

[86] North American Electric Reliability Corporation. (2017). *GridEx*. Retrieved from http://www.nerc.com/pa/CI/CIPOutreach/Pages/GridEX.aspx

[87] Electric Power Research Institute. (2017). *Magnetohydrodynamic Electromagnetic Pulse Assessment of the Continental U.S. Electric Grid: Geomagnetically Induced Current and Transformer Thermal Analysis.* Retrieved from http://www2.epri.com/Press-Releases/Pages/EPRI-Research-Finds-Limited-Impact-to-Transformers-from-E3-Electromagnetic-Pulse.aspx

Fortnightly magazine, that the February 2017, EPRI report was based on impacts of the E3 wave of an HEMP. As a follow up, Mr. Manning stated that EPRI is now working on a HEMP report that investigates the impacts of the E1 wave on the electric power grid.[88] The Council notes that William Graham and Peter Pry of the Congressional EMP Commission dispute the findings of this report.

D. Committee Activities and Findings

1. Coronal Mass Ejection
Orientation Tabletop Exercise and Follow-on Evaluated Tabletop Exercise

On August 2, 2016, the North Carolina Department of Public Safety's Division of Emergency Management (DEM) and the North Carolina Department of Environmental Quality's (DEQ) Energy Group conducted a joint pair of tabletop exercises for 69 attendees; including 31 participants, 29 observers, 7 exercise team members, and 2 administrative support personnel. The participants and observers including elected and appointed officials, representatives from State agencies, electric utility companies, private industry and trade associations, federal agency representatives, military, and utility regulators. The tabletop exercise modeled a space weather phenomenon – Coronal Mass Ejection (CME). The orientation exercise took about 25 minutes and was followed by the evaluated exercise which took about two and one-half hours to complete.

The primary outcomes from conducting these exercises were: (i) the education of participants on the risk of space weather; (ii) the potential impacts; (iii) mitigation measures; and (iv) the public information that should be shared during such an event. The most common issue raised in the after-action Hot Wash (or review), was the need to add a *Space Weather Annex* to the North Carolina Emergency Operations Plan (NCEOP). Such an annex would address this type of phenomenon that could impact Earth. The Earthquake Annex already in the SEOP has many of the attributes that a proposed *Space Weather Annex* would include, such as impact without warning, need for impact assessment (power outages and physical damage to facilities and infrastructure), communication restoration, and public information sharing.

In the Orientation Tabletop exercise, there was a list of Essential Elements of Information (EEI) which is not included in the Draft EMP Annex. Consideration should be given to include the EEI exercise list, like one in the Earthquake Annex, to the State Emergency Operations Plan's EMP Annex.

2. Electromagnetic Pulse
Orientation Tabletop Exercise and Follow-on Evaluated Tabletop Exercise

On August 29, 2017, DEM and the DEQ Energy Group conducted a pair of orientation tabletop exercises and a second pair of evaluated tabletop exercises to a group of 45 attendees including, 30 participants, 10 observers, and 5 exercise team members. The participants and observers included appointed officials and representatives from State agencies, electric utility companies, the United States Department of Energy, the United States Marine Corps, utility regulators, and

[88] Mitnick, S., and R. Manning. (2018). Grid Impact from High-Altitude Nuclear Attack. *Public Utilities Fortnightly*. Retrieved from https://www.fortnightly.com/fortnightly/2018/01-0/grid-impact-high-altitude-nuclear-attack

private industry. Participation in the 2017 Exercise was significantly reduced due to then ongoing State and federal emergency management responses to hurricanes Gert, Harvey, and Irma.

The exercise in-brief addressed an Electromagnetic Pulse (EMP) as an act of war. Lessons learned were: (i) determining impacted area with the Voice Interoperability Plan for Emergency Responders (VIPER) radio system; (ii) establishing and using alternative communications within the State; (iii) increasing communications with the Federal Emergency Management Association (FEMA); and (iv) preparing a needs assessment document to plan for an EMP scenario. In the unlikely event of a nuclear EMP attack, assess the ability of critical communication systems, emergency response centers, and state-owned electrical generators to function.

Following both Tabletop Exercises, discussions about VIPER communications system resiliency across the State ensued; DEM developed an *EMP Annex* for the NCEOP; North Carolina received a *National Governor's Association (NGA) Lead-by-Example* grant award to review the State's Joint Force Headquarters, the State Emergency Operations Center, and regional EOCs for resiliency or microgrid applications. Following the work completed pursuant to the *NGA Lead- by-Example* award, a State Energy Program/Department of Energy grant for an energy resiliency assessment at the Eastern Regional EOC in Kinston was awarded to DEM.

The Tabletop Exercises also reveal that it is important that electric utilities to engage in research to determine practical strategies to protect their critical infrastructure from damaging effects of a nuclear EMP. One such example was Duke Energy's participation in the 2017 EPRI Grid Study which found that "a small number of geographically dispersed transformers were found to be at potential risk of thermal damage from MHD-EMP (E3) generated by a single high-altitude burst over the [continental United States]."[89]

[89] Perry, C. (2017). EPRI Research Finds Limited Impact to Transformers from E3 Electromagnetic Pulse. *West.* Retrieved from https://globenewswire.com/news-release/2017/02/21/925846/10166280/en/EPRI-Research-Finds-Limited-Impact-to-Transformers-from-E3-Electromagnetic-Pulse.html

Energy Efficiency

I. Overview

By continuing to promote energy efficiency, North Carolina will reduce energy demand without sacrificing economic output or consumer services, which is key to keeping energy costs affordable while reducing the State's carbon footprint. In the near term, improving energy efficiency lowers utility bills, allowing investment in other areas, while reducing greenhouse gas emissions the result of fossil fuel energy generation. In the long term, reducing peak demand will improve grid reliability and optimization, which will keep energy affordable and accessible. As illustrated in Chart 4, since 2014, energy costs, as a percentage of total U.S. household expenditures, have fallen every year, and is now below 4%.[90] This trend will continue as energy efficiency improves, energy costs remain stable, and the economy grows.

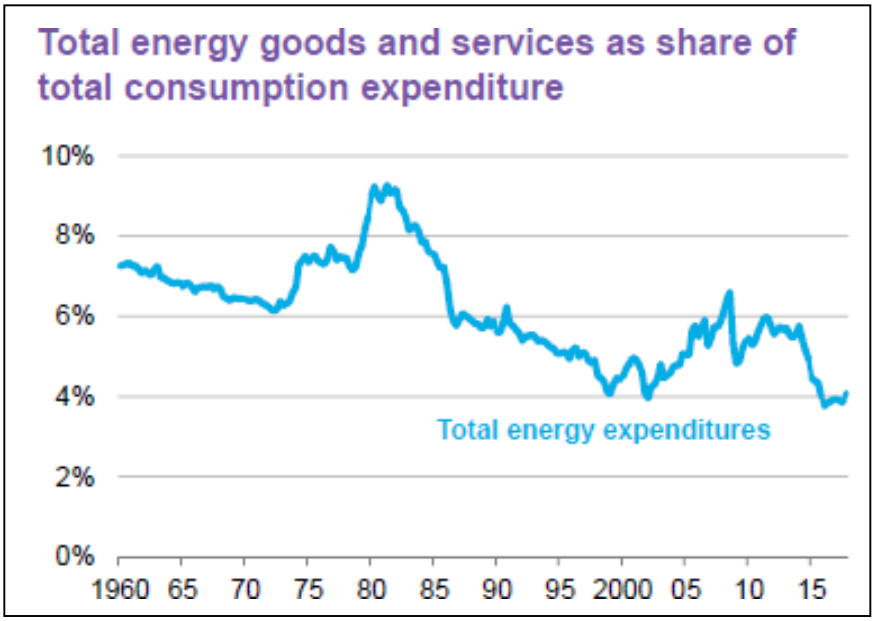

Chart 4. U.S. Energy Expenditures as a Share of Consumption 1960-2015

The American Council for an Energy Efficient Economy (ACEEE) promotes the adoption of policies that support energy efficiency (EE) including: building codes; energy efficiency resource standards (EERS); and transportation efficiency measures. In its *2017 State Energy Efficiency Scorecard* that ranks state EE initiatives, ACEEE recognized North Carolina as one of the best in the region, behind Florida and Virginia, and 31st nationally (see Figure 11).[91] In this assessment, North Carolina scored its highest 4 out of 6 points on State government-led initiatives, and matched the national average for this category, along with Transportation and Codes. As of April 2014, 23 states enacted mandatory EE requirements and two states, including North Carolina, allow for EE to meet a portion of the REPS requirements. The EE portion of

[90] Business Council for Sustainable Energy (2018). *2018 Sustainable Energy in America Factbook, Understanding the U.S. Energy Transformation*. Retrieved from http://www.bcse.org/sustainableenergyfactbook/

[91] American Council for an Energy-Efficient Economy. (2017). *State and Local Policy Database*. Retrieved from http://database.aceee.org/state/north-carolina

North Carolina's REPS is currently limited to 2.5% of 2017 retail sales and in 2021, will increase to 5% of the prior-year retail sales.

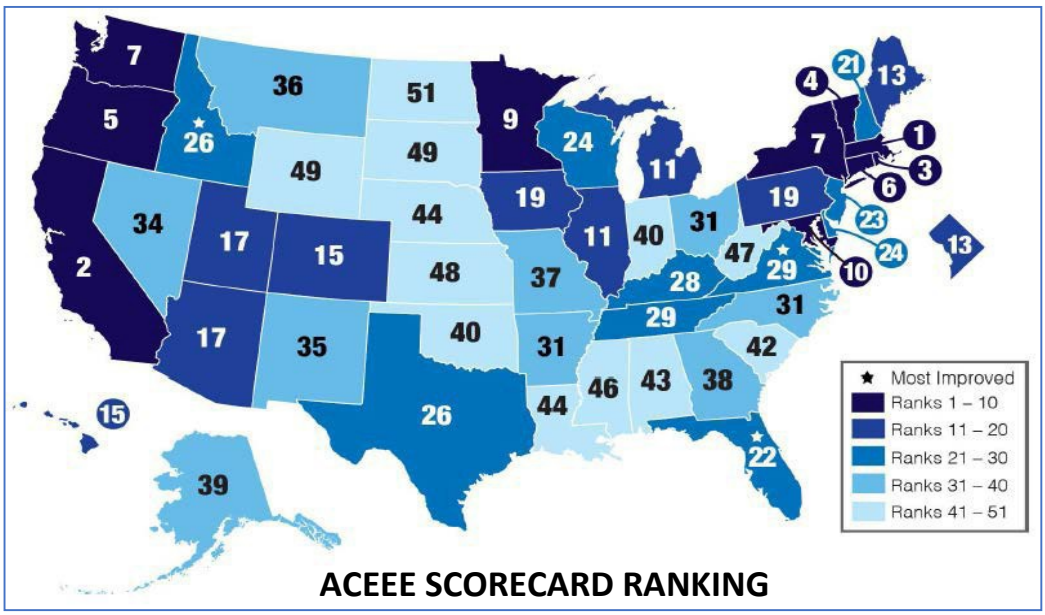

Figure 11. ACEEE 2017 National Scorecard

Following the ACEEE State Scorecard methodology, the states that consistently earn top ratings have clear requirements for statewide energy savings met through utility programs. In the 2017 Scorecard, the top states achieved incremental electricity savings as a percentage of sales of roughly 1% to 3%, spent roughly 2% to 7% of statewide electricity revenues on energy efficiency programs, and had a mandatory annual EERS target of 1% to 3%. North Carolina, by comparison, received marks of 0.57%, 1.17%, and 0.4%, respectively – a leader in the southeast, but below the national average in all three metrics. In 2018, North Carolina residential customers within the Duke Energy Carolinas service territory pay 0.5472¢ per kWh to cover the cost of residential energy efficiency and demand-side management programs, while commercial and industrial customers pay 0.6181¢ per kWh to cover those program costs.[92] Pursuant to G.S. 62- 133.9, commercial and industrial customers may opt out of the DSM and EE fees if they chose.

Average Sales Price	North Carolina	U.S. Average
Natural Gas		
City Gate	$3.54 /thousand cu ft	$3.98 /thousand cu ft
Residential	$12.04 /thousand cu ft	$10.26 /thousand cu ft
Electricity		
Residential	11.02 ¢/kWh	13.01 ¢/kWh
Commercial	8.30 ¢/kWh	10.55 ¢/kWh
Industrial	5.54 ¢/kWh	6.79 ¢/kWh

Table 4. National and North Carolina Average Sales Price of Natural Gas and Electricity

[92] Duke Energy Carolinas, LLC. (2017). *Summary of Rider Adjustments, North Carolina Thirty First Revised Leaf No. 99.* Retrieved from https://www.duke-energy.com/_/media/pdfs/for-your-home/rates/electric-nc/ncridersummary.pdf?la=en

Energy Consumption	North Carolina 2015	U.S. Rank
Total Consumption	2,524 trillion Btu	12
Total Consumption per Capita	251.5 million Btu	38
Total Expenditures	$ 30,841 million	11
Total Expenditures per Capita	$3,073	45
EIA 2015 Data		

Table 5. North Carolina Energy Consumption and National Ranking[93]

Seven of the 13 lower-48 states with the highest energy prices consume less than half the energy per GDP produced than the national average.[94] As of 2015, North Carolina's energy intensity was 5,600 Btus per dollar of GDP and was 30% below the national average.

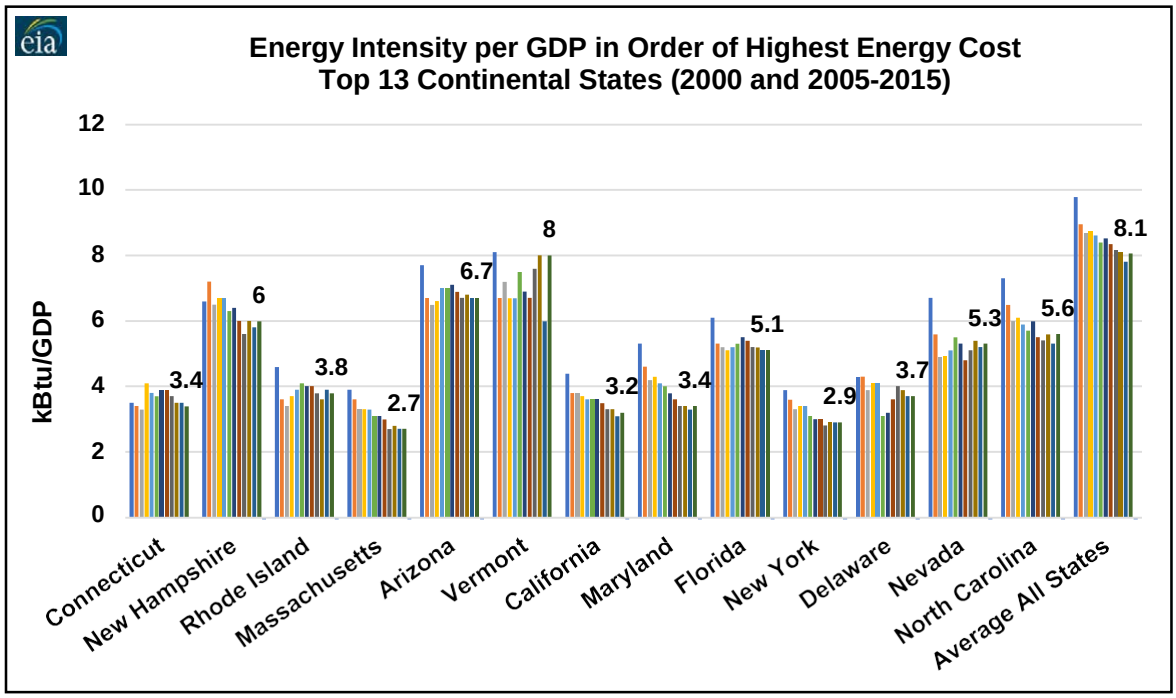

Chart 5. Energy Intensity per GDP: Top Continental States[95]

[93] United States Energy Information Administration. (2017, November). *Electric Power Monthly Electricity Data*. Retrieved from https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_5_6_a ; and United States Energy Information Administration. (2017, November). *Natural Gas Price Data*. Retrieved from https://www.eia.gov/dnav/ng/ng_pri_sum_dcu_nus_m.htm

[94] United States Energy Information Administration. (2015). *Energy Consumption Estimates by End-Use Sector, Ranked by State, 2015*. Retrieved from https://www.eia.gov/state/seds/data.php?incfile=/state/seds/sep_sum/html/rank_use.html&sid=US ; and United States Energy Information Administration. (2015). *Energy Consumption Estimates per Capita by End-Use Sector, Ranked by State, 2015*. Retrieved from https://www.eia.gov/state/seds/data.php?incfile=/state/seds/sep_sum/html/rank_use_capita.html&sid=US

[95] United States Energy Information Administration. (2015). *Energy Consumption Estimates per Real Dollar of GDP, Ranked by State, 2015.* Retrieved from https://www.eia.gov/state/seds/data.php?incfile=/state/seds/sep_sum/html/rank_use_gdp.html&sid=US

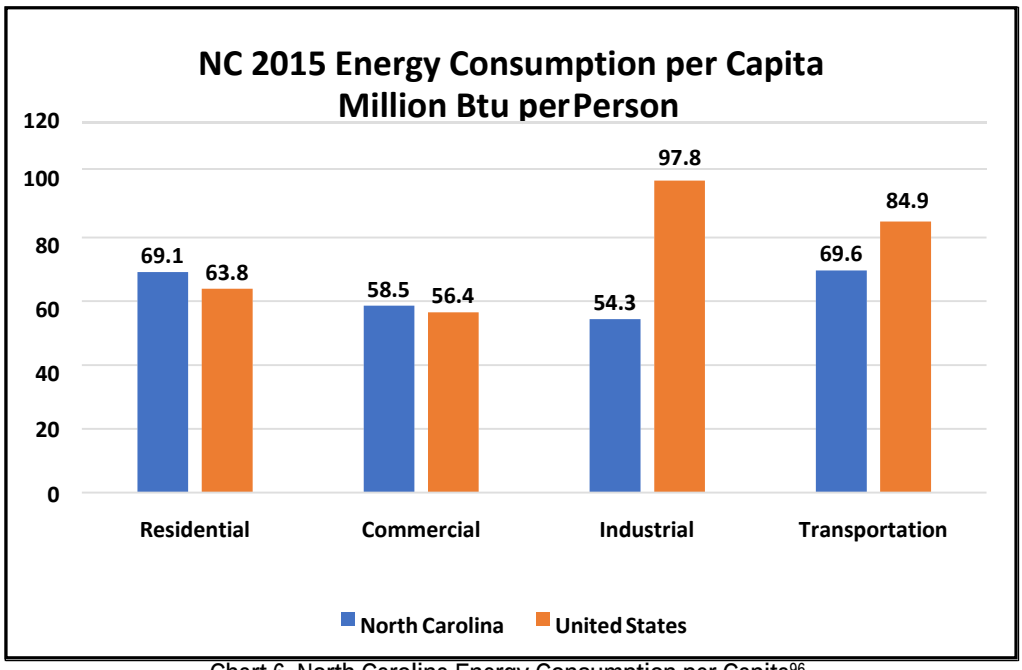

Chart 6. North Carolina Energy Consumption per Capita[96]

Based on 2015 data compiled by the EIA, North Carolina ranks 8th lowest in transportation energy use per capita and 15th lowest industrial energy use per capita (residential ranked 23rd lowest and commercial ranked 25th energy consumption per capita). In 2015, North Carolinians consumed 251.5 million Btus of energy per capita, which was 17% below the national average of 303 million Btus per capita.

2005 vs. 2015 State Energy Consumption by Sector Trillion Btu			
Sector	**2005**	**2015**	**% Change**
Transportation	749.3	698.3	-7%
Residential	712.7	693.5	-3%
Commercial	563.3	587.0	4%
Industrial	653.5	545.0	-20%
Total	**2,678.8**	**2,523.8**	**-6%**

Table 6. North Carolina Energy Consumption by Sector 2005 v. 2015[97]

[96] United States Energy Information Administration. (2015). *Energy Consumption Estimates per Capita by End-Use Sector, Ranked by State, 2015.* Retrieved from https://www.eia.gov/state/seds/data.php?incfile=/state/seds/sep_sum/html/rank_use_capita.html&sid=US

[97] United States Energy Information Administration. (2017). *State Energy Data System (SEDS): 1960-2015 (complete).* Retrieved from https://www.eia.gov/state/seds/seds-data-complete.php?sid=US

II. Status of Energy Efficiency by Sector

A. Industrial Sector

Improving economic output per energy input, or energy productivity, is a major driver for growth in the industrial sector. Because energy expenditures often account for a large portion of overall costs for this sector, energy efficiency can play an important role in improving economic growth. Optimization of existing facility subsystems, as well as identifying areas for equipment improvement, creates opportunity for energy savings in the industrial sector.

In 2015, North Carolina's industrial energy use per capita was 45% lower than the national average and about half of what industries in South Carolina consumed per capita that same year. Louisiana, Wyoming, Alaska, and North Dakota have the highest industrial energy use per capita. In 2015, the average energy price for these states, excluding Alaska, was $12.89/million Btu and 33% below the average price North Carolinians paid at $19.23/million Btu. The average industrial energy price comparison for the same states was $8.43/million Btu, which was 26% below the average industrial North Carolina price of $11.34/million Btu.

B. Commercial Sector

Similar to the industrial sector, commercial buildings are ripe for energy efficiency improvements through optimization, opportunities for which can be identified by benchmarking energy performance, and system commissioning. Especially in the small commercial (<50,000 ft^2) sector, buildings underperform due to a lack of expertise and resources to effectively monitor energy performance. Tremendous energy savings can be achieved by identifying the lowest hanging fruit in commercial buildings, and making improvements accordingly.

C. Public Buildings

Article 3B of Chapter 143 of the General Statutes provide that it is the policy of the State of North Carolina to ensure that energy conservation practices are employed in the design, construction, operation, maintenance and renovation of State-owned buildings and facilities at institutions of higher learning. The State promotes investment in energy conservation through its Utility Savings Initiative (USI) program. USI is a lead-by-example initiative housed within the DEQ. USI assists North Carolina governmental units manage the use and cost of energy, water, and other utilities in their facilities. In addition to State agencies, universities, and community colleges, the program serves public schools, county and municipal governments, but does not track utilities cost and usage for schools and local governments.

According to the 2017 USI annual report, a total of $1.3 billion in avoided utility costs for North Carolina's State agencies and universities have been realized since the program's implementation in the 2002-2003 fiscal year. Beginning in FY 2007, utility savings at the State's community colleges were reported. To date, more than $36 million in avoided utility costs have been realized by North Carolina community colleges. Currently, the State (agencies, institutions of higher learning, and community colleges) pays more than $988,000 in utility costs per day. The USI efforts ensure continued awareness and compliance in reducing utility consumption. Over the past two fiscal years, $374 million was saved the result of avoided utility bills at State agencies, institutions of higher learning, and community colleges.

Performance Contracting (PC), also commonly referred to as Guaranteed Energy Savings Contracts, is one of the tools USI employs to provide funding for improvements to public sector

buildings, thereby encouraging reduction in energy and water use. Performance contracting is a method of financing, designing, and building major projects that yield a return-on-investment in avoided utility costs and provides a way to replace obsolete and inefficient equipment using guaranteed utility savings to pay for the project. Since the program's beginning in in 2003, 76 contracts have been completed with total project costs of over $471 million with an estimated total savings of more than $605 million.

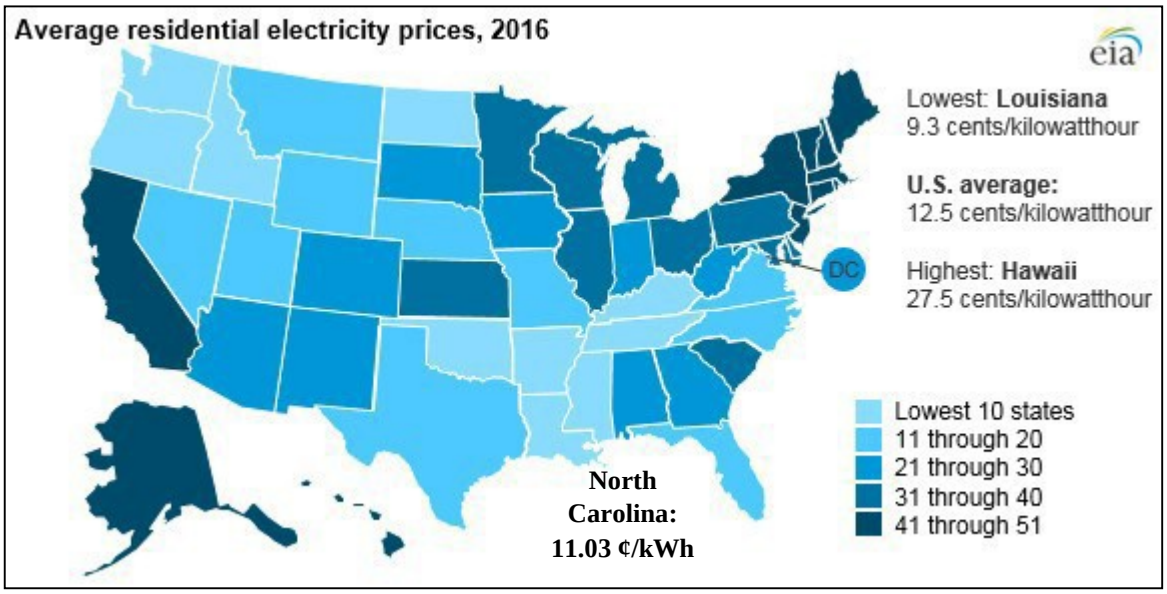

Figure 12. Average Residential Retail Price of Electricity[98]

D. Residential Sector

In the residential buildings sector, integrating energy efficiency best practices are more cost-effective at the time of initial construction rather than during subsequent renovation. The best way to achieve these savings is through improved building codes, which have continued to evolve as building technologies have advanced. North Carolina's most recent code updates are scheduled to be adopted by July 1, 2018, commencing a six-month overlap timeframe during which both the 2018 and the immediate prior versions of the code are acceptable. On January 1, 2019, the 2018 Code provisions become effective and mandatory.

From an energy efficiency perspective, the development and promulgation of new building code provisions requires careful balance, striving for the highest degree of conservation attainable while simultaneously ensuring that residential construction is not unduly costly and new homes remain affordable to a wide range of potential owners. Striking this balance need not pit conservationists against homebuilders, and the Committee resolves to explore policies or practices that reconcile these interests. Among other ideas under consideration, the Committee seeks to learn what policies or practices incentivize home buyers to place greater value on energy efficient homes, including consumer and realtor education, market valuation, and utility incentives. The Committee will also examine the extent to which EE metrics for residential

[98] United States Energy Information Administration. (2018) *Today in Energy.* Retrieved from: https://www.eia.gov/todayinenergy/detail.php?id=34932

properties, such as HERS ratings, might provide energy efficient homes with a competitive advantage in the residential real estate market.

While there is understandable focus on new construction, many North Carolina residential owners benefit from home upgrades that facilitate energy conservation. The North Carolina Weatherization Assistance Program (NCWAP), a program housed within DEQ with a mission to provide assistance to low-income citizens in saving energy and reducing expenses through installation of conservation materials and implementation of energy efficiency. NCWAP proposes to enhance its existing program by adding two new components for greater energy reduction through: (i) improved priority scoring and (ii) measurement and verification (M&V) practices.

The first proposed program enhancement is to add *energy intensity* to NCWAP's Weatherization Priority Score. Current program scoring includes consideration of the following criteria for a residence: no functioning heat; whether any elderly or disabled people reside there, the presence of children five years of age or under, the energy burden (energy usage versus income); the use of combustion appliances; and the poverty level. Adding energy intensity, or the amount of energy used per square foot, is critical in identifying potential energy reduction of a home. Homes with the greatest potential for energy reduction will score higher than homes with lower potential. The program prioritizes service based on the highest score, and this new scoring would continue NCWAP's mission of reducing energy costs for low-income families.

For example, consider two homes that *consume the same amount of energy*; one is 800 ft² and the other 2,400 ft². While additional factors play a role in evaluating the two homes, one can assume that the same amount of money spent to weatherize the smaller residence would result in a greater reduction in energy use; thus creating greater energy reduction and financial return on investment.

The second proposed program enhancement to introduce M&V, which includes post-weatherization utility data analysis to determine actual energy savings from weatherization retrofits. Applying this enhancement to the program will assist in calculating weather-normalized energy savings in kWh, carbon offsets, annual dollars saved, estimated time for savings to exceed retrofit investment, crew effectiveness, best practices, and training needs. With this analysis, NCWAP will be able to evaluate program efficacy, implement program improvement strategies, and provide North Carolina Weatherization energy reduction data, thereby enhancing the overall effectiveness of the Program. The Committee expects to explore a wide variety of pre- and post-construction EE initiatives, ranging from measures intended to encourage greater efficiency in manufactured housing to funding opportunities(?) to encourage additional residential energy rehabilitation. Speakers from advocacy and industry groups will be invited to share their perspective on these and other EE programs.

E. Transportation Sector

According to the most recent data published by the U.S. EIA, North Carolina's transportation sector is the largest end-use energy-consuming sector in the State, followed closely by the residential sector.[99] The Transportation and Material Moving occupational sector employs over

[99] United States Energy Information Administration. (2017). *Profile Analysis (North Carolina).* Retrieved from https://www.eia.gov/state/analysis.php?sid=NC

308,000 people in North Carolina.[100] The 2015 EIA data provides that the State's transportation sector consumes 698.3 trillion Btu of energy generated from fossil fuel resources, an amount that ranks our State's transportation sector 11th in the nation.

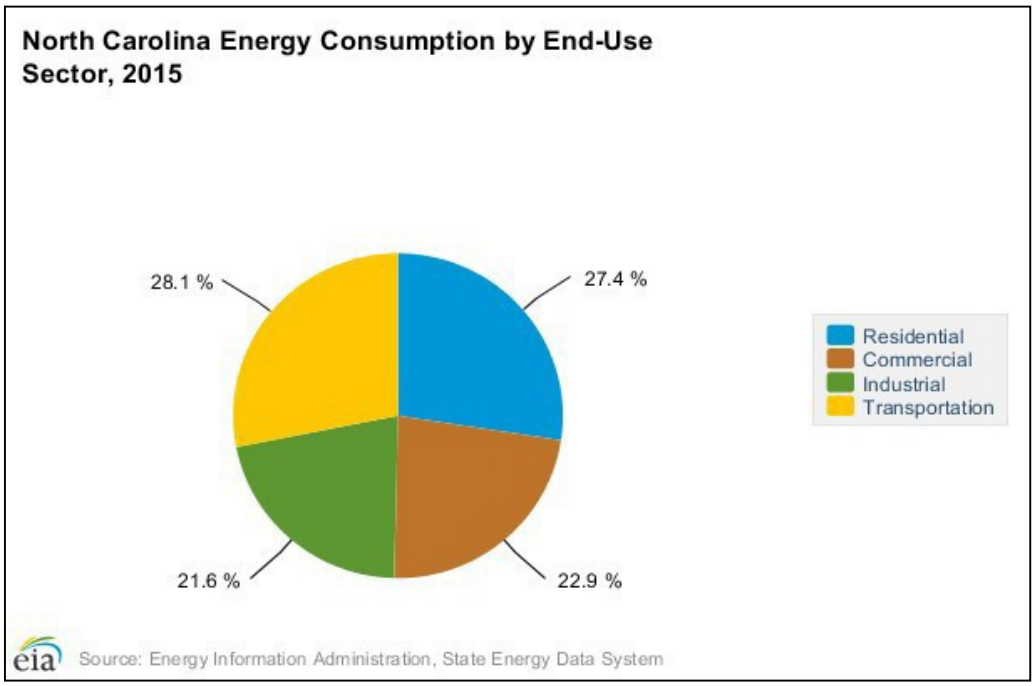

Chart 7. North Carolina Energy Consumption by End-Use, 2015[101]

The State's transportation sector will gain energy efficiency improvements from implementation of the federal Phase 2 CAFE standards for model year 2017-2025 internal combustion engine (ICE) vehicles that yield new fleet averages of approximately 54.5 miles per gallon (mpg)[102] and the adoption of USEPA's Tier 3 emission standards for engines.[103] Additional energy reductions can be obtained with the implementation of other efficiency programs and adoption of new technologies in this sector. The Energy Efficiency (EE) Committee and the full Council initiated its work to learn more about and evaluate alternatives to set North Carolina's course towards achieving greater energy efficiency in the transportation sector.

[100] Labor and Economic Analysis Division, North Carolina Department of Commerce. (2017). *AccessNC: Current Employment Statistics*. Retrieved from https://accessnc.opendatasoft.com/pages/home/

[101] United States Energy Information Administration. (2017). *Profile Analysis (North Carolina).* Retrieved from https://www.eia.gov/state/analysis.php?sid=NC

[102] United States Environmental Protection Agency. (2012). Final Rule for Model Year 2017 and Later Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards. Retrieved from https://www.epa.gov/regulations-emissions-vehicles-and-engines/final-rule-model-year-2017-and-later-light-duty-vehicle. On April 2, 2018, U.S. EPA announced the completion of the Midterm Evaluation of Light-Duty Vehicle Greenhous Gas Emissions Standards for Model Years 2022-2025, and found current standards are too stringent and should be revised as appropriate. The current standards will remain in effect until the final Agency. As of the date of the publication of this report, EPA was circulating a proposal in Washington to freeze the 2020 fuel economy standards through 2026.

[103] United States Environmental Protection Agency. (1998). *USEPA Emission Standards for Tier 1-3 Engines.* Retrieved from https://www.ourair.org/wp-content/uploads/epatierstnds.pdf

1. Electric Vehicles

At its meeting on February 21, 2018[104], the Council heard several presentations on electric vehicles (EV), including necessary infrastructure improvements and financing, outlook and projected EV penetration in the State, and impacts on rural and disproportionally affected communities. The EE Committee heard more additional detailed presentations on EVs at its meeting on March 15, 2018, covering beneficial electrification and the environmental co-benefits of EV adoption.

The investor-owned utilities have enough power built into their systems to support all the increased demand from projected EV adoption in North Carolina. In fact, because of its flexible load profile, additional EV adoption in the State could help smooth utility load curves and drive down overall rates because the electric utility system overall would operate more efficiently. While this may appear contradictory in nature, because the utilities are designed to service peak demand that occurs infrequently in the average year, outside of those peak hours, there exists power supply that goes either unused or underused.

In terms of EV adoption in the State, according to Marcy Bauer (representing EVgo), there are presently 8,500 EVs on the road and accounts for a 42% increase in adoption year-over-year. Projections for future EV adoption vary: Navigant projects 10x 2017 sales by 2026; National Renewable Energy Labs predict 475,000 by 2030; and the EIA predicts increases from 4% to 10% in market share from 2030 to 2040, respectively. The cost of EVs have dropped approximately 80%, which has been a significant driver in consumer accessibility. It is estimated that by 2025, EVs will be cost-competitive with ICE vehicles.

While these future adoption figures do vary, they all trend upward and the current pace of publicly-available charging infrastructure deployment will not keep up with the projected demand. For example, nationwide there are presently 16,000 public EV charging stations compared to over 115,000 gas stations. The United States DOE anticipates a total of 200,000 EV charging stations by 2030. Several challenges impede EV charging deployment including: design constraints; permitting and utility-driven timelines; operating costs; and grant/operating and cost-recovery structures.

EVs represent great opportunity for North Carolina's transportation sector and provide additional co-benefits. According to Kristie Aldridge, who represents the North Carolina Electric Membership Cooperatives (EMC), in areas of the State served by EMCs, EV adoption can: reduce air emissions as the electric grid becomes cleaner; promotes rural economic development; and propel tourism by supporting EVs at popular attractions.

[104] Energy Policy Council. (2018, February 21). *Energy Policy Council Meeting, February 21.* Retrieved from https://deq.nc.gov/about/divisions/energy-mineral-land-resources/energy-policy-council/epc-meetings

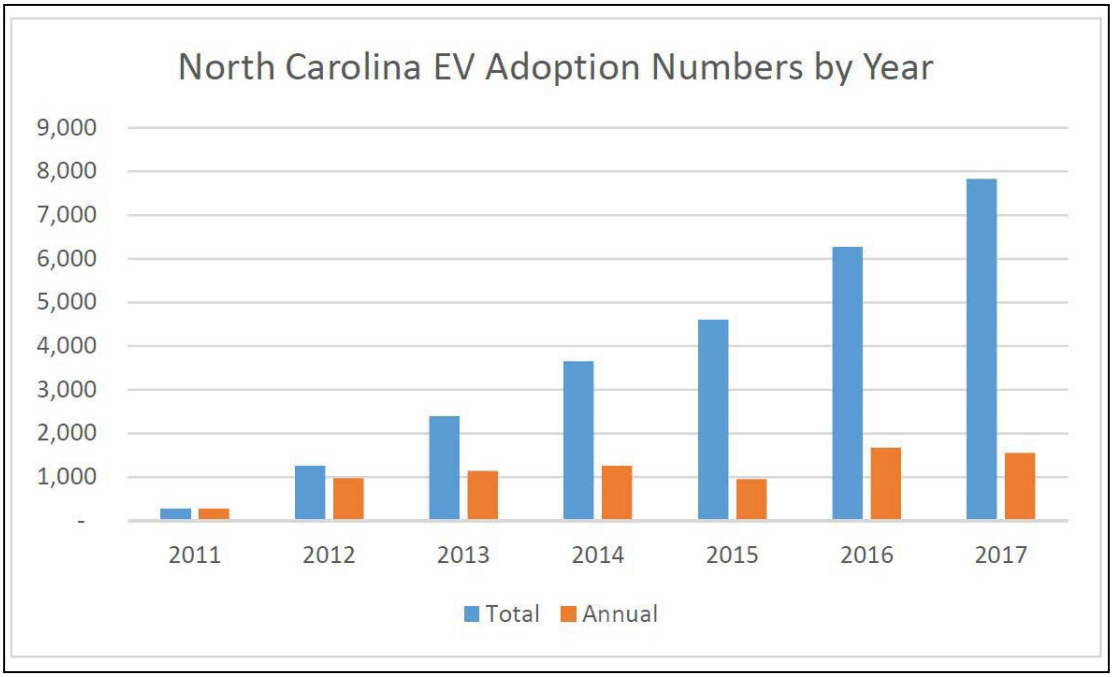

Chart 8. EV Adoption in North Carolina, 2011-2017.

To that end, as electric power becomes *cleaner*, so too do the environmental co-benefits increase. According to a pending publication by MJ Bradley, annual North Carolina emissions of CO_2 in the transportation sector could be reduced by 30% to 70% by 2050 under moderate or high EV penetration scenarios, respectively. Furthermore, additional air quality benefits of reduced NO_X, volatile organic compounds (VOCs), and particulate matter emissions would be realized and would disproportionally benefit disadvantaged communities and vulnerable populations.

A preliminary study of the air quality impacts of EVs in the Charlotte Ozone Maintenance Area was conducted by Sushma Masemore, PlanningSection Chief, and her colleagues in the Division of Air Quality. This initial modeling revealed that while the impacts of EV penetration in this region may seem relatively minor, the incremental reductions in NO_X, VOCs, and other NAAQS pollutants provide the region greater flexibility within which to meet the federal 70 parts per billion ozone (O_3) standard. A reduction of over 4.7% in CO_2 equivalents is projected with the modeled EV penetration in the Charlotte region. Additional research into the impacts of indirect emissions from power plants to supply increased EV penetration will be conducted.

2. Propane Vehicles

Until beneficial electrification becomes the standard in the transportation sector, bridge fuels, such as propane, liquid natural gas (LNG), and others will be used to meet fueling demand. North Carolina ranks first in the nation in total retail locations and bulk plants for propane gas. School buses and other heavy-duty equipment can undergo an engine repower which results in significantly reduced emissions while allowing for the original vehicle body and chassis to be maintained. Agility Fuel Solutions proposes to replace Navistar engines in Type C school buses with liquid propane gas engine packages. ROUSH Clean Tech has partnered with BlueBird to deploy over 12,000 propane school buses in the United States. that exceed the current federal NO_X standard emissions by 75%.

3. Compressed Natural Gas Vehicles

The use of Compressed Natural Gas (CNG) has been a viable transportation option for several decades. CNG is a proven, reliable technology and around the world there are over 25 million natural gas vehicles (NGV) with over 160,000 in the United States.[105] CNG is used in light-, medium-, and heavy-duty applications, the majority in the United States serves the medium- and heavy-duty markets as follows:[106]

Long-haul Freight Trucks – These heavy-duty high-mileage trucks consume significant amounts of fuel and benefit from the lower cost of natural gas.
Refuse – More than 17,000 natural gas refuse trucks operate across the country and about 60% of new trucks on order are NGVs.
Transit –Transit agencies across the country are moving to NGVs, in fact, over 11,000 natural gas buses are presently on the road.
School Buses – More than 150 school districts operate 5,500 NGVs.

North Carolina stands to benefit from cleaner mass transit, refuse, and regional and short-haul trucking. Alternative fuel vehicle technology advancements have make drastic reductions in emissions possible. The newest natural gas engines with Near-Zero, or *Zero Emissions Equivalent*, technology produce 90% fewer NO_X emissions than the current standard. The new Cummins Westport natural gas engines have received emission certifications from both the U.S. EPA and the California Air Resources Board. These ultra-low emission engines are both 90% lower than the current federal NO_X limit and meet the 2017 EPA greenhouse gas emission requirements.[107] These advancements in natural gas engine technology provide fleets with reliable performance and a near-zero emissions solution for all their transportation needs. Fleets are able to continue to diversify their fuel portfolio while enhancing their own sustainability goals and initiatives through the utilization of near-zero engines.

With 26 public CNG stations, North Carolina's current natural gas fueling infrastructure ranks 10th in the nation. In fact, there are more than 1,650 public and private CNG stations in the United States, 42 of which are in North Carolina.[108] This infrastructure allows fleets to travel to most areas of the State with access to CNG fueling stations. North Carolina offers fleets unprecedented access to support with NGV manufacturing facilities located within the State including Freightliner, Thomas Built Bus, Cummins Westport, and Agility.

Natural gas is an abundant, domestic natural resource and NGV usage allows for a relatively stable cost which is an important factor for fleet operators. Overall, CNG is a proven

[105] Natural Gas Vehicle Knowledge Base. (2018). *Current Natural Gas Vehicle Statistics*. Retrieved from http://www.iangv.org/current-ngv-stats/
[106] Natural Gas Vehicles for America. (2018). *Natural Gas Vehicles for America*. Retrieved from https://www.ngvamerica.org/vehicles/
[107] Cummins Westport. (2018, January 4). Cummins Westport Receives 2018 Emissions Certifications for ISX12N Natural Gas Engine. *Cummins Westport Newsroom.* Retrieved from http://www.cumminswestport.com/press-releases/2018/cummins-westport-receives-2018-emissions-certifications-for-isx12n-natural-gas-engine
[108] United States Department of Energy, Energy Efficiency and Renewable Energy. (2018). *Alternative Fueling Station Locator.* Retrieved from https://www.afdc.energy.gov/stations/#/analyze?region=NC&fuel=CNGhttps://www.afdc.energy.gov/stations/#/analyze

transportation solution that can help North Carolina continue to be a leader in improving air quality and the adoption of innovative energy technologies.

III. Beneficial Electrification

As defined by the Energy Collective and Ken Colburn, *Beneficial Electrification* refers to electrifying energy end-uses usually powered by fossil fuels – secures a variety of positive outcomes and represents a major opportunity within power sector transformation. [109] Examples of beneficial electrification include electric water heating, space heating, and electric vehicle charging. Benefits of electrification include pollution reduction, improved management and flexibility of the electricity grid, and savings to ratepayers. Beneficial electrification is currently driven by advancements in technology and increases in efficiency and control.

The penetration of EVs and plug-in hybrid EVs provides a significant near-term electrification opportunity by offsetting petroleum use by cars and light trucks. Heavy duty trucks can benefit from battery improvements for long-haul trucking. Public and other transit systems can be electrified and reduce the need for petroleum-based resources to power buses, rail, and other forms of transit.

[109] The Energy Collective, and the Regulatory Assistance Project. (2017, January 25). *Beneficial Electrification: A Key to Better Grid Management.* Retrieved from http://www.theenergycollective.com/raponline/2397065/beneficial-electrification-a-key-to-better-grid-management

Council Findings and Recommendations

Adopted May 16, 2018

Energy Infrastructure Committee

1) Recommendation: All electric utilities in North Carolina should continue to invest in their respective transmission and distribution infrastructure in order to support future load and economic growth in the State, all while providing the highest levels of reliability and services in a safe, cost effective manner. North Carolina's legislative and regulatory bodies should continue to provide legislation and policies where utilities have the flexibility to invest in it fully integrated T&D infrastructure and modern technology and recover all reasonable and customary costs through their rate structure. The statewide transmission planning collaborative and long-range planning process utilized by the NC Utilities Commission should continue to provide a framework for the future T&D needs of North Carolina.
2) Recommendation: Promote and develop North Carolina's bioenergy resources and deployment by:
    a. Developing a bioenergy resource inventory and economic impact analysis; establish goals for the capture and refining of biogas into renewable natural gas for distribution; and goals for incorporation of biogas-derived natural gas into the State's transportation fuels program for State fleets and public transportation.
    b. Conducting economic impact analysis including analyses of environmental and community benefits and impacts, for the beneficial and optimum utilization of the State's bioenergy resources.
    c. Creating a bioenergy resource inventory for North Carolina based on input from industry, regulatory, and academic sources that are current and specific to North Carolina.
    d. Completing and summarizing the results of this work in the 2020 Biennial report of this Council.
3) Recommendation: Analyze the programs, policies, and approaches to the development of solar energy in our State – such as property tax abatement for bioenergy production systems – and make policy recommendations to the Joint Legislative Energy Policy Committee for consideration during the 2019 Regular Session of the General Assembly.
4) House Bill 589 has done much to continue the advancement of renewable energy while also establishing an approach managing reliability, power quality and costs for electric consumers. The Energy Policy Council recommends that the state monitor the progression of energy policy through the implementation of House Bill 589 structures and programs. The House Bill 589 structures and programs were established as a 4 – 7-year program. Four to five years of resource commitments through CPRE, GSA,Shared Solar and rooftop programs and an additional 3 – 4 years to construct and connect systems. The Energy Policy Council recommends evaluating the implementation of House Bill 589.
5) The Energy Policy Council recommends that looking to the future, utilities in the state should continue to further reduce CO_2 emissions and adjust to evolving and innovative technologies in a way that balances the reliability and affordability that customers expect,

while including planned investments in additional renewable energy sources coupled with storage, grid modernization and improved energy efficiency and demand response programs. The state should also retain public policies that sustain a balanced portfolio mix, and not become too dependent on any one type of technology while managing costs for customers. Specific system investments should also be addressed in utility integrated resource plans.

Energy Assurance Committee

1) The Council recommends that North Carolina confer with natural gas organizations about adequate natural gas storage/reserves being readily available for its residential, commercial and industrial customers during high demand and/or usage periods.
2) The Council recommends further evaluation of flexibility in natural gas "curtailable rates" to assure that their impacts, pricing, and prioritization do not adversely affect existing customers."

The Council recommends consideration of the following (from 2016 EPC Report) as a possible (EMP) Annex to the 2018 EPC Report

A nuclear EMP is a multi-pulse consisting of three components – E1, E2, and E3. When atypical nuclear device is detonated, a small amount of its energy is released as gamma radiation. If the nuclear burst is at high altitude, that gamma radiation will interact with atoms in the upper atmosphere and the Earth's magnetic field to create an electric field that is known as the E1 pulse. E1 pulses, though very brief (lasting approximately one millionth of a second), are capable of producing momentary high voltages in electric transmission lines within the affected area. As a result, the electric field generated by an E1 pulse would be expected to burn out small transformers, damage electronic control systems and electronics that are plugged in, and possibly disable a fraction of vehicles within its range. The size of the affected area is dependent on the altitude at which the detonation occurs, with higher altitude nuclear explosions causing more widespread effects.

E2 pulses bear a resemblance to the type of electric field created by a lightning strike. Due to this similarity, most of the current infrastructure is already capable of withstanding an E2 pulse. There is still concern that E2 pulses could cause further harm to components previously damaged by the E1 pulse, but otherwise the E2 pulse is largely irrelevant when considering current susceptibilities.

The E3 component is the third aspect of a high altitude nuclear EMP. The E3 pulse is caused by the distortion of Earth's magnetic field around the detonation of the nuclear device. This distortion creates a long-lasting (generally several minutes) electric field that produces a less intense current surge in affected transmission lines that could damage large transformers. Unlike E1 pulses, the size and severity of the E3 pulse is dependent on the blast yield of the detonated nuclear bomb.

EMPs also occur naturally from geomagnetic disturbances (GMDs) generated from the sun's output. An extreme GMD could damage transformers and cause voltage instability or collapse of the bulk power grid. The geological characteristics of the Piedmont and Coastal Plain provide natural resistance to GMDs and lower the state's risk. The most recent extreme GMD storm

occurred in March 1989 and led to a 12-hour blackout in Quebec, Canada. There were more than 200 power grid issues in the U.S. but they had no impact on North Carolina. However, it is expected that a 150 – 500 year GMD storm, like the massive solar storm of 1859 known as the Carrington Event, would cause major power disruptions in our state (National Aeronautics and Space Administration, 2014). Measures to safeguard the bulk power grid from nuclear EMPs also protect it against intense GMDs.

Energy Efficiency Committee

Membership in the Council's Energy Efficiency committee was reshuffled as 2017 drew to a close. The newly-constituted Committee is now chaired by Scott Tew of Ingersoll Rand and its members are: Paolo Carollo of Beta Renewables, Richard Feathers with North Carolina's Electric Cooperatives, and Michael Regan, Secretary of the Department of Environmental Quality. While Committee membership has changed, its focus on reducing wasteful and inefficient uses of energy resources through State policy and practice has continued. Meetings have been scheduled or are planned with experts from the private sector, State government, the university system, and non-profits to learn more about EE opportunities and strategies to encourage implementation. As in the past, the Committee will seek guidance from the state government entities such as the Building Code Council, the Department of Transportation (NCDOT), as well as experts in emerging technologies targeted for efficiency improvements. This effort will assist the Committee as it prepares its policy recommendations for the full EPC's consideration to advance energy efficiency in State-owned buildings, minimize fuel consumption by motor vehicles, or to otherwise maximize efficient use of energy resources in the State. As its starting point, the Committee utilized its initial meetings to consider the extent to which prior Committee recommendations, previously approved by the EPC and "inherited" by the current Committee members, had been implemented by either legislative or executive action. One of the first goals of the Committee was to determine the disposition of these past recommendations – whether they remain in place, are refined, or jettisoned.

Past Recommendations for Reapproval in 2018 *[initially approved 11/19/2014]*

1) Recommend increasing the State buildings energy use reduction goal from 30% to 40% by 2025, thereby potentially saving an additional $2 billion in reduced utility costs
   In 2015, North Carolina agencies and universities achieved the 30% energy use reduction goal established in G.S. § 143-64.12. The proposed increase to 40% percent energy use reduction from the 2002–2003 baseline year will enhance the State's competitiveness for federal grant funding opportunities and encourage further energy savings.
2) Strengthen and support the State's USI for public facilities by providing a 1% pass-through of the annual avoided utility costs realized by the USI program.
   USI has supported State agencies and universities in avoiding $700 million in utility expenses since the 2002 – 2003 baseline year. To assist State facilities in meeting the proposed 40% percent energy use reduction goal from the 2002 – 2003 baseline year, USI will use the proposed 1% pass-through budget (approximately $1.14 million) to support training, engineering and technical assistance, outreach, and incentives for energy project investments.
3) Establish a program with State governmental entities to allow utility savings to be reinvested in short duration, rapid payback, energy conservation measures. Reinvesting

energy cost reductions incentivizes State agencies and universities to re-commission buildings, optimize building automation systems, and upgrade equipment.

4) Pursue a system of electronic data transfer from utility providers tocustomer's/owner's data collection and analysis systems with a focus on deploying a system such as the USEPA Portfolio Manager. Accessing electronic utility data will assist State agencies and universities better manage energy and water use and costs and identify the best opportunities for energy savings.
5) Establish a policy that provides for initial and ongoing staff training, resources, and retention to institutionalize the skills needed to maintain State buildings in an energy-efficient manner.
6) Commissioning of New State Buildings Require building commissioning for all new State buildings to ensure they are brought online in optimal performance, thereby saving taxpayers on long-term costs of building operations. Commissioning a new building adds roughly 0.6% to the total construction cost. With the energy savings (typically 13% according to a Lawrence Berkeley Laboratory report) the payback period is less than 5 years.

2018 Recommendations by Sector

Public Buildings

1) Revert to a one-year annual energy reporting period for public buildings and institutions under the Utility Savings Initiative (USI) program.
2) Strengthen the USI Public Buildings programs by:
    a. Funding the Energy Management Diploma training.
    b. Requiring commissioning for North Carolina Connect Bond projects per S.L. 2015-280.
    c. Providing commissioning training using a State commissioning (CX) working group.
    d. Exploring expansion of annually reporting utility data to K-12 schools.

Commercial Energy Efficiency

1) Examine the costs and benefits associated with adopting a minimum requirement for commercial buildings to require third-party commissioning, and/or promote training, awareness, and incentives related to improving energy efficiency in the commercial energy sector.
2) Investigate state-level support for consumer financing programs such as on-bill financing and
   C-PACE Financing for both commercial and residential sectors.

Residential Energy Efficiency

1) Support NCWAP proposals to integrate two new components for greater energy reduction through: (i) Improved Priority Scoring; and (ii) Measurement & Verification practices.
2) Research new programs and incentives for improving the energy efficiency of manufactured housing.
3) Assess the costs and benefits of measures intended to encourage builders or owners to exceed code standards, including programs such as Duke Energy Progress' incentive for new construction built to or above the Energy Conservation Code's High Efficiency Residential Option ("HERO"), or programs offered by electric and natural gas utilities that provide

discounts for Energy Star rated homes. Examine whether the analysis supports expansion or enhancement of such programs.

4) Consider the value of initiatives designed to promote the competitive advantage of energy efficient homes, including educating consumers and realtors about metrics to assess residential EE, such as the Home Energy Rating System ("HERS") Index, for example.

Energy Codes

1) Monitor developments at the General Assembly, particularly those legislative proposals that support or discourage energy efficiency requirements for buildings.
2) Monitor developments at the Building Code Council, particularly those that consider balancing issues of cost and policy in advancing energy efficient residential construction.
3) Explore whether a return to a code cycle of 3 years, instead of recently-adopted change to a 6-year cycle, would be unduly burdensome from a regulatory perspective in light of the potential benefits to more frequent consideration of code provisions.

Codes: Electric Vehicles

1) The Council supports the burgeoning electric vehicle (EV) industry in the transportation sector of the North Carolina economy. To that end, the Council encourages the State to adopt measures and implement programs that (i) promote electric vehicle adoption, (ii) increase the availability and public's knowledge of electric vehicles, and (iii) ease the transition to an electrified transportation economy for all North Carolinians. The Council recommends consideration, by elected officials and regulatory agencies, of measures intended to address perceived barriers to EV deployment, including examples such as:
    a. Residential building codes for the feasibility of required or recommended pre-wiring for Level 2 EV charging.
    b. Commercial building codes for the feasibility of requiring or recommending that parking lot construction is EV Ready, and identification of what constitutes "EV Ready."
    c. Americans with Disabilities Act guidelines for EV charging stations.
    d. A standardized and streamlined processing for permitting new construction that incorporates EV Ready infrastructure.
    e. Local government authorization to establish codes that encourage EV ready construction.

Industrial Energy Efficiency

1) The Council recommends consideration of measures intended to encourage adoption of prevailing energy efficiency technology in industrial settings. Possible areas to consider would include the following:
    a. Lighting upgrades from less efficient technology to more efficient Light Emitting Diodes
    b. Use of occupancy sensors in lightly used areas to automate efficiency
    c. Transition to air compression technologies with variable frequency drives (VFD)and use of the correct size compressor for the right application (i.e., small units at night during lower demand).
    d. Lower compressor pressure settings, use of metered storage for high intermittent use applications

e. Ensure industrial boilers are properly maintained and served including proper insulation of steam/hot water lines

2) The Council supports efforts to identify and create opportunities to engage industrial firms to design energy efficiency programs for industrial application that would improve the number of industrial customers' participation in the electric utility programs adopted pursuant to the State REPS legislation.
3) The Council supports the further evaluation of opportunities that would expand Combined Heat and Power deployment for both Industrial and Large Commercial/Public Buildings.

Transportation Efficiency

1) Investigate potential for improved traffic flow strategies and best practices implemented in other states, such as traffic circles.
    a. Support NCDOT and other stakeholders to provide knowledge and training for community planners who must plan for increasing population in both large urban areas and small rural communities. In many areas, the lack of planning to address population demands impedes efficient traffic infrastructure.
    b. Focus efforts on education, performance assessment, and the provision of knowledge and global benchmarking tools available to local and regional planners and leaders to better inform their decision-making. Investigate and evaluate tools and policies at the State level that allow city planners to assess and improve the efficiency of traffic systems, and more importantly, to gain knowledge of possible options with high return for investment that can be used to fund future projects.
2) Evaluate options for establishing targets for transitioning public transit, private and fleet transportation, and other modes of transport to higher utilization of alternative fuels, including conversion of and engine rebuild for school buses and other vehicles.
3) Recommend standardized highway and wayfinding language for alternative fuel stations, chargers, and associated infrastructure.
4) Evaluate the feasibility of on-road alternative fuel vehicles incentives, such as utilization of high-occupancy vehicle (HOV) lanes.
5) The Council also recognizes that EV adoption in the State will not happen in a vacuum and the impacts of such a paradigm shift are far-reaching. Opportunities to shape EV adoption in North Carolina will hinge on:
    a. How EV corridors of the State are publicized, marketed, and managed.
    b. Whether the State establishes an EV adoption / EV charging infrastructure goal.
    c. How the State leads-by-example in terms of its motor fleet EV purchases.
    d. The State's position on allowing private power supply for EV charging at public facilities.

The Council is aware of stakeholdering directed by the Commission (that includes utilities, members of the Public Staff, and other interested parties) to consider the subject of electronic data transfer and customer access to data usage. The Council intends to monitor the progress of these discussions, and the extent to which measures adopted by the Commission support increased energy efficiency achievable by utility customers.