A NORTH CAROLINA CASE STUDY

DISTRIBUTED ENERGY STORAGE

The Missing Piece in North Carolina's Decarbonization Efforts

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Applied Economics Clinic

Clean Energy Group

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Distributed Energy Storage

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About this Report

This report, prepared by the Applied Economics Clinic (AEC) on behalf of Clean Energy Group (CEG), presents the case for the inclusion of distributed energy resources, and specifically distributed energy storage, also called behind-the-meter (BTM) battery storage, as a tool that should be used to help meet the goals of North Carolina's Carbon Plan. This report also looks at energy burden (defined as the percentage of gross household income spent on energy costs) in North Carolina and considers the role that distributed battery storage with well-designed incentives could play in reducing energy burden. Currently, there are no state-level policies in North Carolina that require or incentivize distributed battery storage, but these resources have been used successfully to meet carbon goals and to reduce energy burden in many other states. Learn more about CEG's work on energy storage policy at https://www.cleanegroup.org/initiatives/energy-storage-policy-and-regulation.

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Forward

In the rapidly evolving realm of renewable and clean energy adoption, state policy drives the pace and magnitude of investment. In 2007, implementation of the North Carolina Renewable Energy Portfolio Standard launched growth in utility-scale solar infrastructure in the state, and this was bolstered in 2017 with the passage of House Bill 589 and the implementation of the competitive procurement of renewable energy (CPRE) program. After these pieces of legislation passed, North Carolina became a national leader in utility-scale solar investment, growing the solar fleet from 3,785 megawatts in 2016[1] to 8,459 megawatts[2] in just seven years to become fourth in the nation for installed solar. North Carolina now generates almost 10 percent of its electricity from utility-scale solar.

The state has no corresponding policies of magnitude to promote the development of distributed clean energy resources, such as residential rooftop solar or behind-the-meter battery storage, which are located close to load and can be aggregated to provide grid services. But the North Carolina Carbon Plan and the passage of House Bill 951—both establishing carbon reduction targets for the state—offer an opportunity and a framework to create policies that value and support the deployment of dispatchable, aggregated, distributed energy storage, as has been successfully done in many other states.[3]

State programs supporting distributed battery deployment are no longer a new idea. Distributed, aggregated, behind-the-meter resources are already providing megawatts of capacity in wholesale power markets across the country. These resources are providing carbon-free electrons to the grid, helping states meet carbon reduction targets. They are reducing regional peak demand, allowing polluting peaker power plants to be shut down and reducing the need to build new ones. Distributed clean energy resources can also reduce customer energy burden through well-designed, equity-based installation and performance incentives. And distributed battery storage programs can provide backup power to homes and neighborhoods, saving lives during grid outages by maintaining critical loads and emergency services.

There are numerous successful state energy storage programs that North Carolina can learn from and emulate. For example, California is an early adopter of energy storage at scale. With roughly four times the population of North Carolina, California has 843 megawatts of strictly residential battery storage capacity spread across 119,483 residences as of this writing[4], and this figure is expected to continue to grow with various policy changes and increasing climate change-related natural disasters. Based on population, a proportional amount of residential battery storage for North Carolina would be 210

[1] Wayback Machine access for Solar Energy Industries Association North Carolina Fact Sheet (2016) Available at: https://web.archive.org/web/20171231110847/https://www.seia.org/state-solar-policy/north-carolina-solar (accessed November 17, 2023).

[2] Solar Energy Industries Association North Carolina Fact Sheet (Q2 2023) Available at: https://www.seia.org/state-solar-policy/north-carolina-solar (accessed November 17, 2023).

[3] State distributed battery storage programs are outlined in this report and in the Appendix.

[4] California Energy Storage System Survey Available at: https://tableau.cnra.ca.gov/t/CNRA_CEC_PUBLIC/views/EnergyStorageDashboard/CaliforniaEnergyStorageSystemSurvey?%3Aembed=y&%3AisGuestRedirectFromVizportal=y&%3Adisplay_count=n&%3AshowAppBanner=false&%3Aorigin=viz_share_link&%3AshowVizHome=n (accessed November 17, 2023).

megawatts. Energy Information Agency data for 2022 indicates only 1.4 megawatts of residential storage is grid-connected in North Carolina, all in electric cooperative territories[5].

Vermont provides another example. Utility Green Mountain Power (GMP) harnesses a fleet of 4,800 residential batteries. GMP has 237,776 residential customers in total, so the current deployment is .02 batteries per residential customer. If Duke Energy Carolinas and Duke Energy Progress had an equivalent battery program in place, there would be a fleet of 62,114 residential batteries in North Carolina, or almost 435 megawatts of capacity that could be called on for carbon-free grid services and resilience.[6] Of note, the Vermont Public Utilities Commission (PUC) has recently lifted a cap on GMP's existing battery programs, which have long waiting lists; and GMP has filed a request to significantly expand its battery storage programs in remote and outage-prone areas as part of its "Zero Outages Initiative."[7] If approved, the new program would provide free customer batteries in areas where they constitute a lower-cost solution than undergrounding power lines and hardening infrastructure.

There are good reasons for North Carolina to take note of successful distributed energy storage programs in other states. Applied Economics Clinic states in this report that Duke Energy's coal fleet emitted 25.4 million short tons of CO_2 in 2021. Retiring this fleet should clearly be a priority if the state is to meet its decarbonization goals. But in its Carbon Plan Integrated Resource Plan (CPIRP) filing in September of 2023, Duke has proposed adding more natural gas capacity, including 900 megawatts of near-term peaker plants. For a sense of what the CO_2 emissions for those plants might look like, we can consider the four 250-megawatt combustion turbine peakers that Dominion Energy is proposing for Chesterfield, Virginia. In the air permit application for these four turbines, totaling 1,000 megawatts of capacity, the CO_2 emissions are estimated to be between 2,008,033 and 2,194,773 tons per year.[8]

Adding this level of new emissions simply isn't necessary. In June of 2023, The Brattle Group released a study that demonstrates that aggregated distributed resources are far more cost effective than new fossil-gas combustion turbine peakers.[9] Considering the cost of new peakers compared to a robust distributed storage program, and the localized pollutants that peakers emit, choosing to add new fossil generation instead of distributed solar and storage is neither cost effective nor equitable.

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[5] U.S. Energy Information Agency Annual Electric Power Industry Report Form EIA-861 detailed data files Available at: https://www.eia.gov/electricity/data/eia861/ (accessed November 17, 2023).

[6] In 2021, Duke Energy Carolinas and Duke Energy Progress has a combined 3,076,924 residential customers in North Carolina. This figure, multiplied by .02 is 62,114. This figure, multiplied by an average system size of 7 kW, is 434,798 kilowatts, or almost 435 megawatts.

[7] Vermont Public Utility Commission Docket 23-3501-PET GMP/request for approval of zero outages; Available at: https://epuc.vermont.gov/?q=node/64/193438/FV-PFEXAFF-PTL (accessed November 17, 2023).

[8] Virginia Department of Environmental Quality, Dominion Chesterfield Energy Reliability Center Project Available at: https://www.deq.virginia.gov/topics-of-interest/dominion-chesterfield-energy-reliability-center-project (accessed November 17, 2023).

[9] The Brattle Group "Virtual Power Plants (VPPs) Could Save US Utilities $15-$35 Billion in Capacity Investment Over 10 Years" Available at: https://www.brattle.com/insights-events/publications/real-reliability-the-value-of-virtual-power (accessed November 17, 2023).

Given the policy landscape, the dominance of Duke Energy in the North Carolina market, the full deployment of advanced meters in their territories[10], and Duke Energy's commitment to distribution investments that will expand the connection of distributed energy resources[11], DEP and DEC and the regulatory policies that impact them are a logical focus for the discussion and recommendations regarding residential distributed energy storage in this report. Additionally, we hope that the information herein will inform and support distributed battery storage policies for the municipalities and electric cooperatives that serve the 1.8 million residential electric customers outside of DEC and DEP territory.

New policies and programs that allow North Carolina to catch up to leading states in the deployment of aggregated distributed resources, and specifically battery storage, would fill a void in the North Carolina Carbon Plan and in Duke Energy's CPIRP. This missing piece would address energy burden, carbon emissions, localized pollution, and resilience, all in a cost-effective manner. North Carolina has an opportunity to establish dispatchable distributed battery storage programs that can help the state meet the targets established by the Carbon Plan, while also addressing the significant energy burden issues outlined herein.

With this report, Clean Energy Group hopes to give North Carolina policymakers and advocates the information they need to take advantage of the unique opportunity for distributed storage policy offered by the Carbon Plan and by Duke Energy's Carbon Plan Integrated Resource Plan.

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[10] U.S. Energy Information Agency Annual Electric Power Industry Report Form EIA-861 detailed data files Available at: https://www.eia.gov/electricity/data/eia861 (accessed November 17, 2023).
[11] See Duke Energy's 2022 DEP Multi-Year Rate Plan Transmission and Distribution Technical Conference presentation: https://starw1.ncuc.gov/NCUC/ViewFile.aspx?Id=2e034889-07ea-4a6c-ae84-f5bbf60a0354 p. 15 (accessed December 4, 2023).

Executive Summary

Many states have established policies and programs to incentivize the adoption of residential energy storage systems (home batteries), also called distributed energy storage systems. Residential energy storage can provide load management to help meet peak electric demand, reducing the need for costly and polluting fossil fuel peaker plants. When paired with solar PV, batteries can provide clean backup power to improve energy resilience while reducing home energy bills. These are all needed benefits in North Carolina, but they require state policy leadership to achieve. Without equitable policy—including financial incentives—for distributed energy storage deployment, North Carolina's ratepayers will continue to miss out on benefits that residents of other states already enjoy. Fortunately, North Carolina now has an excellent opportunity to secure the missing piece in the state's decarbonization efforts.

The passage of North Carolina House Bill 951 (HB951) in 2021 set the State on a path to net-zero carbon emissions by 2050. Duke Energy Carolinas (DEC) and Duke Energy Progress (DEP), the state's largest investor-owned utilities, collectively referred to as "Duke NC" throughout this report, combined serve more than 3 million of the state's 4.8 million residential electric utility customers. North Carolina policymakers have set several climate goals to reduce greenhouse gas emissions across the state and reduce electricity demand through energy efficiency measures, but the state does not currently have legislative policies in place to specifically incentivize distributed residential solar and energy storage.

In August 2023, DEC and DEP filed their proposed 2023-2024 Carbon Plan and Integrated Resource Plan (CPIRP) with the North Carolina Utilities Commission (NCUC) in compliance with HB951. The CPIRP lays out the utility's coal retirement plans and electric capacity expansion plans over the next 15 years to meet North Carolina's climate goals. According to the CPIRP, Duke NC proposes to achieve the State's required climate target for electric public utilities—a 70 percent reduction in carbon emissions by the year 2030 and net-zero carbon emissions by the year 2050—through the retirement of coal resources and through renewable and fossil gas capacity expansion. The CPIRP includes no mention of distributed energy storage playing a role in the utility's road to decarbonizing its electric supply, although utility-scale storage is planned.

More specifically, by 2035 Duke NC plans to install 6,000 megawatts (MW) of solar photovoltaic (PV) and 2,700 MW of energy storage—1,650 MW of which will be composed of stand-alone battery storage and 1,050 MW of which will be battery storage combined with solar PV—1,200 MW of onshore wind, 5,780 MW of fossil gas-fired resources, and 1,700 MW of new pumped hydro storage capacity. These new resources are all proposed to be utility-scale investments (i.e., not distributed or behind-the-meter resources), and several of the fossil gas resources, including a 1,360 MW combined cycle plant and 900 MW of combustion turbines, are in the near-term planning stages.

Behind-the-meter energy storage programs are already in place in many other states, and they provide capacity and grid services as well as resilience services that have added significant value to state and utility energy resource plans. The omission of residential, behind-the-meter energy storage policies in North Carolina legislation and planned resources in Duke NC's CPIRP constitutes a "missing piece" that—if addressed—would be a valuable tool to the state and the utility as they work to shift away from fossil fuels. When paired with solar PV and supported through incentives that address barriers to deployment, especially for low- to moderate-income customers, behind-the-meter battery storage is able to achieve the following:

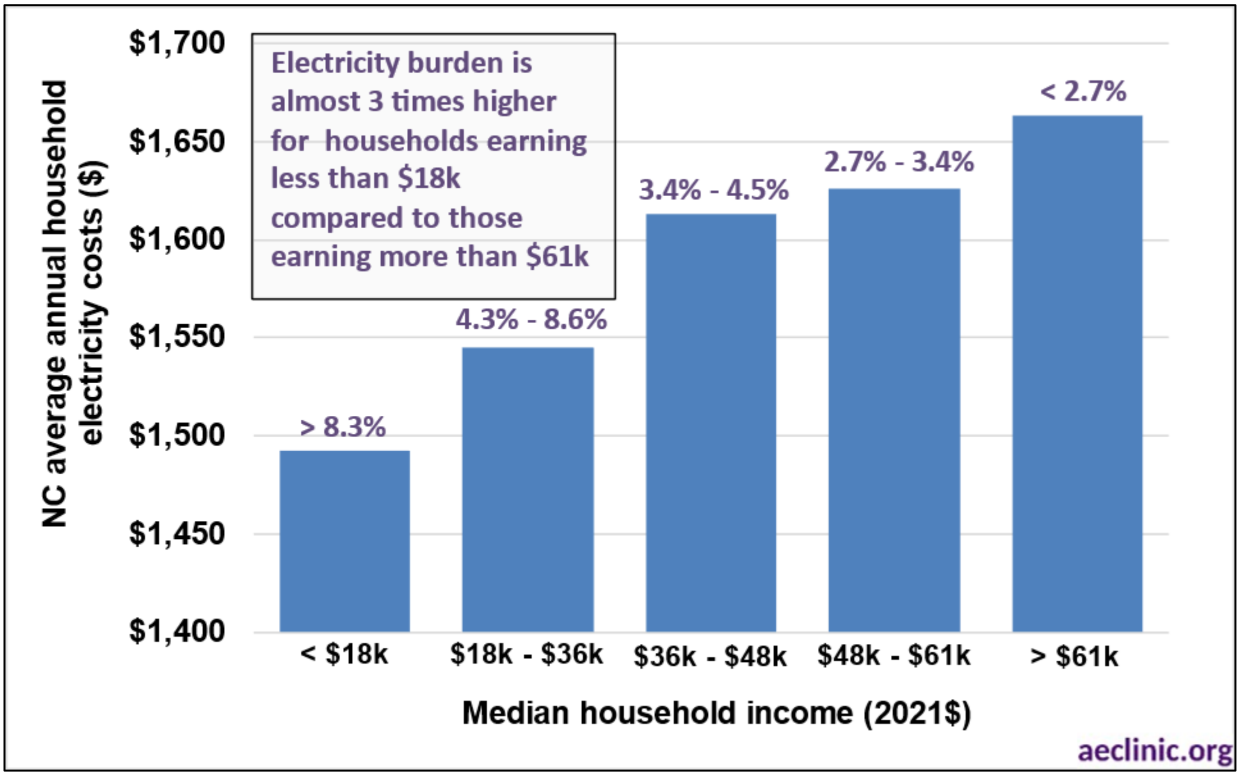
- Lower costs for utilities and customers
- Peak demand reduction
- Improved reliability and resiliency of the electric grid
- Improved residential energy resilience
- More control by communities and individuals over their energy supply
- Decreased electricity energy cost burden and improved energy equity outcomes.

The need to reduce electricity cost burdens (the share of household income spent on electricity costs) for low- to moderate-income customers is significant, and a well-designed distributed storage program can help. In North Carolina, households with median incomes lower than $18,000 are paying almost $1,500 per year in household electricity costs, an electricity cost burden of more than 8.3 percent. These lowest income households pay just $159 less per year in electricity costs than households earning more than $61,000 per year, meaning the electricity cost burden for low-income households in North Carolina is nearly three times that of wealthier households (see ES-Figure 1).

To support North Carolina's decarbonization efforts and equity goals, this report makes three key policy recommendations for increasing incentives and lowering barriers to distributed energy storage deployment:

1. **Approve and expand utility deployment of equitable distributed solar and distributed energy storage pilot programs.** Distributed energy storage resources would help North Carolina meet its decarbonization targets by supporting renewable distributed resources like rooftop solar, reducing the state's need for fossil-fuel fired electric capacity. Distributed energy storage resources can also reduce electric system load and/or export power during peak demand times, reducing the need for fossil fuel-fired peaker plants.
2. **Create statewide financial incentives for residential and community-based distributed solar and behind-the-meter battery installations.** Financial incentives would lower the barriers to program participation by helping with the upfront costs associated with installing distributed storage systems, particularly for low-income customers.
3. **Establish equity, climate, and energy performance-based metrics and targets for electric utilities.** Established benchmarks and tracking systems would help to facilitate program assessment and ensure electric utilities are held accountable for achieving program goals and equitably distributing program benefits.

ES-Figure 1. North Carolina average household electricity costs by median household income



Implementing the above recommendations would support North Carolina's equitable and just transit-ion away from fossil-fuel fired electric capacity, allowing both consumers and utilities to benefit from increased demand for distributed solar by pairing it with dispatchable distributed energy storage. A shift toward increased deployment of distributed solar and storage would facilitate a reduction in greenhouse gas emissions while simultaneously alleviating electric energy burdens for residential customers, and in particular, low- and moderate-income customers.

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Introduction

In North Carolina, Duke Energy Carolinas (DEC) and Duke Energy Progress (DEP)—the state's largest investor-owned utilities, together referred to as "Duke NC" throughout this report[12]—recently developed a proposed combined DEC/DEP 2023–2024 Carbon Plan and Integrated Resource Plan (CPIRP)[13] to meet the state's required climate target for electric public utilities: a 70 percent reduction in carbon emissions by the year 2030 (from 2005 levels) and net-zero carbon emissions by the year 2050.[14]

Air pollutants from fossil fuel-fired electric generators not only exacerbate climate change impacts, but they also increase the risk of adverse health outcomes, including heart attacks, stroke, respiratory illness, Alzheimer's disease, and premature death,[15] in neighboring communities. Across the United States, exposure to air pollutants—and their associated negative health impacts—is greater for low-income communities and communities with higher shares of residents that identify as Black, Indigenous, and/or People of Color (BIPOC).[16] These same communities—that often live in closer proximity to polluting facilities—are also disproportionately impacted by the effects of climate change,[17] exacerbating preexisting inequities (such as a greater incidence of negative health outcomes), and making these communities more vulnerable to future crises.

Residential rooftop solar combined with behind-the-meter batteries can be a helpful tool in reducing electricity demand, shifting demand away from peak demand hours, and reducing the need for fossil fuel generators such as coal-fired, fossil gas-fired,[18] and oil-fired electric generating plants. North

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[12] Duke Energy is the parent company of five regulated electric utilities that supply electricity to six states—North and South Carolina, Florida, Indiana, and Ohio-Kentucky. DEC and DEP are the regulated electric utilities managed by Duke Energy in the areas of North and South Carolina. See: Duke Energy. 2023. "Regulated Utilities." Available at: https://www.duke-energy.com/our-company/about-us/businesses/regulated-utilities.

[13] The DEC and DEP systems span both North Carolina and South Carolina. Thus, the CPIRP current and proposed generating and energy storage assets cover both states but must be approved separately by the South Carolina Public Service Commission and the North Carolina Utilities Commission.

[14] General Assembly of North Carolina, Session 2021, Session Law 2021-165. *House Bill 951*. Available at: https://www.ncleg.gov/Sessions/2021/Bills/House/PDF/H951v6.pdf.

[15] Vohra, K., Vodonos, A., Schwartz, J., Marais, E. A., Sulprizio, M. P., Mickley, L. J. April 2021. "Global mortality from outdoor fine particle pollution generated by fossil fuel combustion: Results from GEOS-Chem." *Environmental Research, 195, 110754.* Available at: https://doi.org/10.1016/j.envres.2021.110754.

[16] (1) U.S. EPA. 2021. "Study Finds Exposure to Air Pollution Higher for People of Color Regardless of Region or Income." Available at: https://www.epa.gov/sciencematters/study-finds-exposure-air-pollution-higher-people-color-regardless-region-or-income; (2) U.S. EPA. 2022. "EPA Research: Environmental Justice and Air Pollution." Available at: https://www.epa.gov/ej-research/epa-research-environmental-justice-and-air-pollution.

[17] Patnaik, A., Son, J., Feng, A., Ade, C. August 2020. "Racial Disparities and Climate Change." Princeton University. Available at: https://psci.princeton.edu/tips/2020/8/15/racial-disparities-and-climate-change.

[18] Throughout this report, the term fossil gas-fired is used to refer to generators fueled by utility-supplied methane gas or so-called "natural gas."

Carolina's policy landscape to meet its climate and clean energy goals includes legislative policies and utility programs to meet energy savings targets and to incentivize energy efficiency measures. However, it currently lacks incentives for distributed solar and distributed energy storage program investment by local utilities like Duke NC. If supported by effective compensation and incentive programs, equitable distributed energy storage system deployment can eliminate the need for new fossil fuel-fired combustion turbines used to meet peak demand, reduce the amount that existing plants run, reduce utility energy costs, and increase customer choice while lowering household energy bills and reducing greenhouse gas emissions and localized pollutants.[19]

The remainder of this Applied Economics Clinic (AEC) report, prepared on behalf of Clean Energy Group (CEG), provides an overview of the existing energy policy landscape in North Carolina, and it identifies opportunities to equitably decarbonize the electric sector through utility-driven distributed solar and distributed energy storage programs. Primary focus is on behind-the-meter battery storage because of its dispatchability. Section 1 describes North Carolina's existing electric generation mix and presents the results of a distributional equity analysis of the state's counties. Section 2 describes the North Carolina energy policy landscape and draws attention to missing legislative incentives for distributed energy storage deployment. Section 3 explains Duke NC's resource planning and customer base, and how energy efficiency and demand-side management measures can benefit the customers most impacted by energy decisions. Section 4 presents the results of a distributional equity analysis of counties within the Duke NC service area. Section 5 explores distributed energy storage systems, new findings regarding their cost impact compared to fossil gas-fired peakers, and how energy storage programs have been introduced in other states. Section 6 offers recommendations to Duke NC and state policymakers regarding successful deployment and incentivization of distributed energy storage for all residential electric customers. Lastly, the Appendix includes a table with links and summaries of battery storage programs that can serve as a resource.

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[19] National Governors Association. 2023. *State Approaches to Equitable Distributed Energy Resource Deployment*. Available at: https://www.nga.org/wp-content/uploads/2023/03/NGA-Equitable-DER-Deployment_Mar2023.pdf.

SECTION 1

North Carolina Electric Capacity and Generation, Emissions, and Energy Burden

This section looks at electric generating **capacity**—the maximum amount of electricity a power generator can produce in a given moment, measured in megawatts (MW)[20]—and actual **generation**—the amount of electricity actually produced and dispatched, measured in gigawatt-hours (GWh)—for the State of North Carolina. (Capacity and generation specific to Duke NC will follow in a later section). The state's electric generating capacity is dominated by fossil fuel-fired resources. In 2022, fossil gas-fired resources made up 49 percent (18,958 MW) of the state's installed electric capacity, and coal-fired resources made up 13 percent (4,816 MW, see Figure 1, p.14). Nuclear resources made up 14 percent (5,395 MW) of the state's installed electric capacity. Renewable solar resources comprised 16 percent of the state's installed electric capacity (5,967 MW). Hydroelectric, oil, other (which includes wood and waste biomass and landfill gas), and wind resources each accounted for between 1 and 5 percent of the total electric capacity. Energy storage resources accounted for less than 1 percent of capacity (36 MW).

Also in 2022, North Carolina's electric generators produced almost 134 GWh of energy. Coal and fossil gas-fired resources (combined) provided 54 percent of statewide annual electric generation (see Figure 1).[21] Nuclear resources provided 32 percent of total generation. Renewable wind and solar generation produced 8 percent (12 GWh) of total generation. Remaining resource types, including hydroelectric, oil and other, each produced 4 percent or less of total generation.

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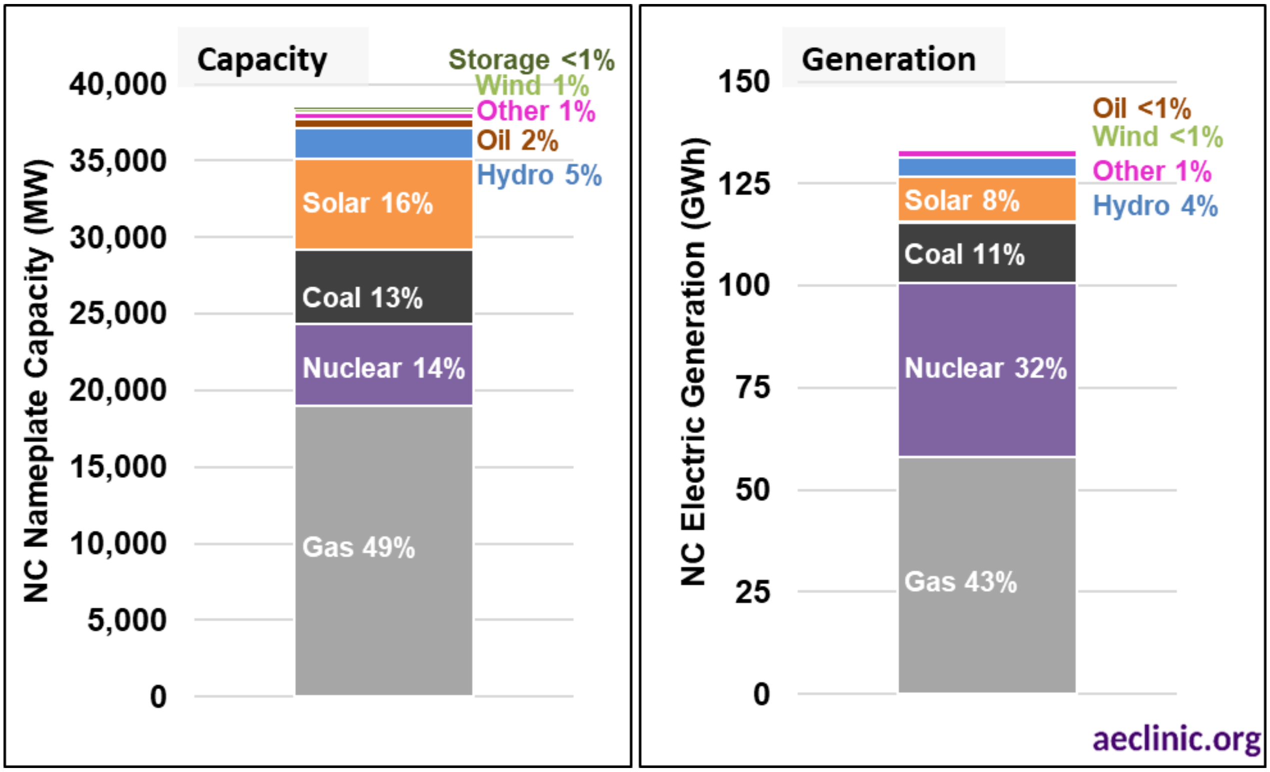
[20] Department of Energy. N.d. "What is Generation Capacity?" Available at: https://www.energy.gov/ne/articles/what-generation-capacity#:~:text=Capacity%20%3D%20Maximum%20Power%20Output&text=When%20it%20comes%20to%20generation,it's%20running%20at%20full%20blast.

[21] U.S. Energy Information Administration. "Frequently Asked Questions (FAQs)." Available at: https://www.eia.gov/tools/faqs/faq.php?id=101&t=3.

Figure 1. North Carolina 2022 nameplate capacity and electric generation by resource



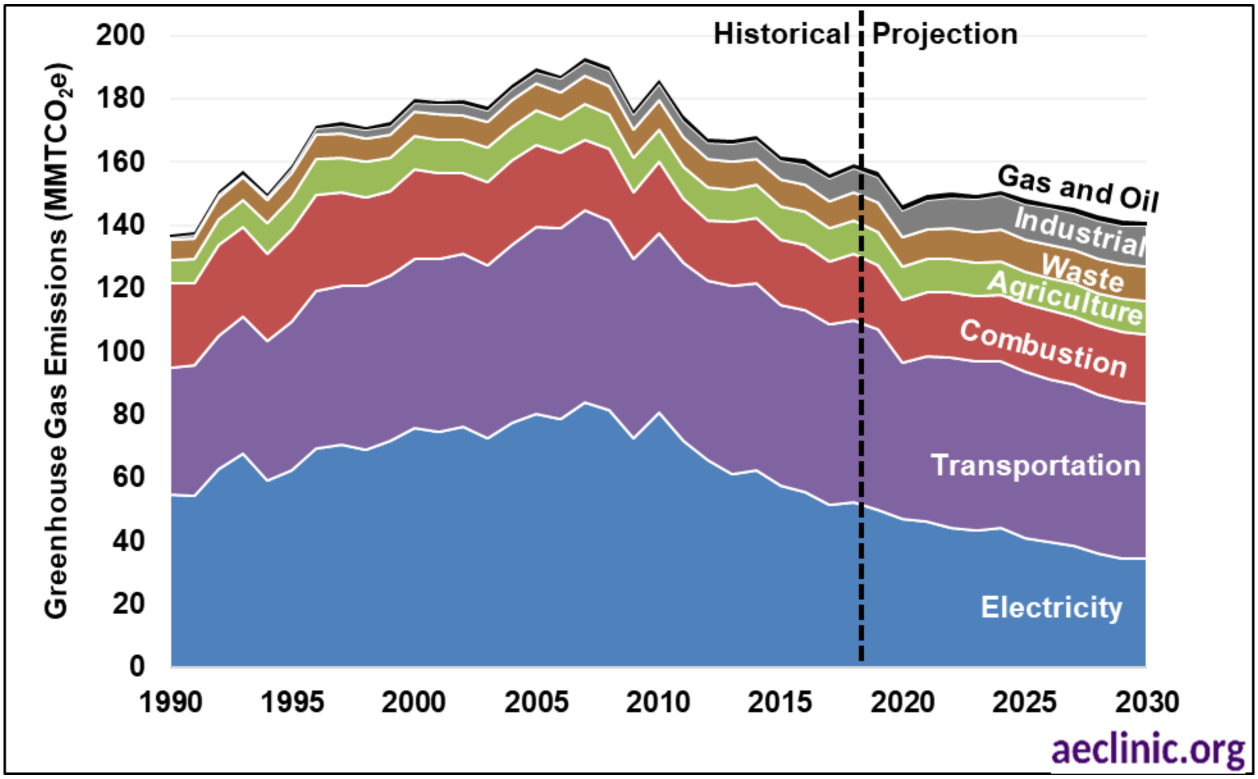
Note: While energy storage capacity is reported in Form EIA-860, energy storage does not generate energy and therefore is not included as a part of generation. Although energy storage does not generate energy, it helps meet electric demand by charging during times of lower energy demand and discharging during times of peak demand. Data source: U.S. Energy Information Administration (EIA). 2022. Form EIA-860. Available at: *https://www.eia.gov/electricity/data/eia860*.

North Carolina's electric sector emissions have declined steadily since 2010

The North Carolina Department of Environmental Quality's 2022 *Greenhouse Gas Inventory*[22] reports that the transportation and electric sectors produce the highest share of statewide greenhouse gas emissions (36 and 33 percent of total emissions in 2018, respectively, see Figure 2, p.15). Since 2010, North Carolina's greenhouse gas emissions have declined both in the electric sector and in total. Between 2010 and 2018, electric sector emissions fell by about 35.2 percent, from 81 million metric tons of carbon dioxide equivalent (MMT CO_2e) in 2010 to 52 MMT CO_2e in 2018.[23]

[22] North Carolina Department of Environmental Quality. 2022. "Greenhouse Gas Inventory." Available at: https://deq.nc.gov/energy-climate/climate-change/greenhouse-gas-inventory.
[23] North Carolina Department of Environmental Quality. 2022. North Carolina Greenhouse Gas Inventory (2010-2018) [Table A1-A4]. Available at: https://www.deq.nc.gov/air-quality/ghg-inventory-report-2022/download?attachment.

Figure 2. North Carolina historical and projected greenhouse gas emissions by sector



Data source: North Carolina Department of Environmental Quality. 2022. North Carolina Greenhouse Gas Inventory (2010-2018) [Table A1-A4]. Available at: https://www.deq.nc.gov/air-quality/ghg-inventory-report-2022/download?attachment.

Affordability and energy burden

Affordability is a critical consideration in energy planning. North Carolina families pay approximately $1,500 to $1,650 for electricity per year, based on data from the U.S. Department of Energy Low-Income Affordability (LEAD) Tool.[24] Households with a median income lower than $18,000 are paying almost $1,500 per year in household electricity costs, an electricity cost burden[25] (the share of household income spent on electricity costs) of over 8.3 percent. The lowest income households pay only $159 less per year in electricity costs than the highest income households (those earning more than $61,000 per year, which have an electricity cost burden of less than 2.7 percent). Overall, annual electricity costs vary little with income (see Figure 3, p.16).[26]

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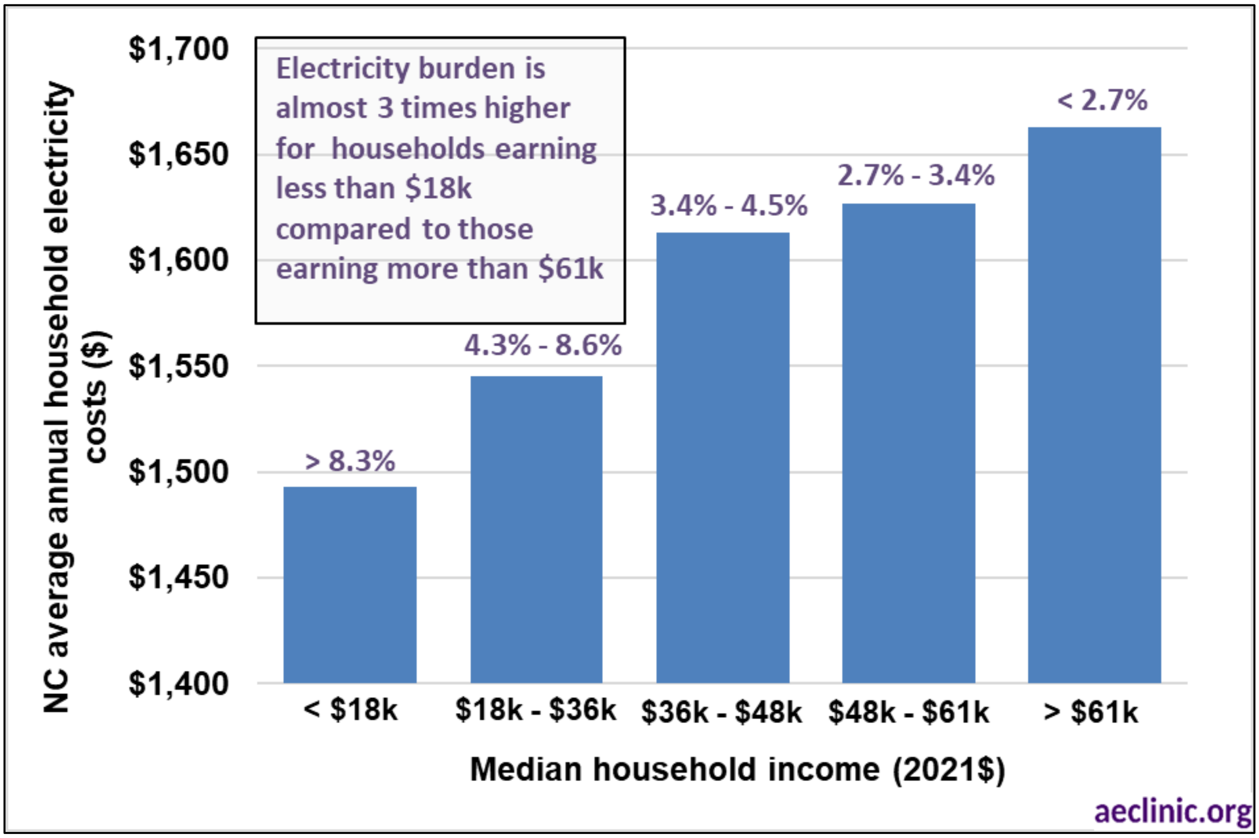
[24] U.S. DOE. 2018. "Low-Income Energy Affordability Data – LEAD Tool – 2018 Update."

[25] Electric burden by median household income is calculated using average annual electricity cost data organized by household income as a share of the state median income from the U.S. DOE LEAD Tool and median household income data from the 2021 U.S. Census ACS data.

[26] (1) U.S. Department of Energy. 2018. "Low-Income Energy Affordability Data - LEAD Tool - 2018 Update;" (2) U.S. Census. 2021 ACS 5-Year Detailed Estimates [Table: S1903].

Figure 3. North Carolina average household electricity costs by median household income



Data source: (1) U.S. DOE. 2018. "Low-Income Energy Affordability Data – LEAD Tool – 2018 Update;" (2) U.S. Census. 2021 ACS 5-Year Detailed Estimates [Table: S1903].

North Carolina's low-income households pay a disproportionate share of income on electric bills, meaning that they experience greater electricity cost burdens than higher income households. The 2022 North Carolina Low-Income Affordability Collaborative (LIAC) Quarterly Progress Report[27] found that low-income households also use more energy per square foot to heat and cool their homes than higher-income households. This is often attributable to low energy efficiency within the home,[28] suggesting that inefficient appliances and inadequate insulation and duct and envelope sealing are contributing to disparate energy burdens in the state.[29] Research by the American Council for an Energy Efficient Economy (ACEEE) also found that across the nation, low-income households lack access to energy efficiency resources and tend to live in more inefficient homes compared to their wealthier

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[27] Duke NC. August 2022. *Joint North Carolina Low-Income Affordability Collaborative Quarterly Progress Report.* Available at: https://starw1.ncuc.gov/NCUC/ViewFile.aspx?Id=9113a9ae-3d9d-424c-b93d-446e1168c97c.

[28] Duke NC. August 2022. *Joint North Carolina Low-Income Affordability Collaborative Quarterly Progress Report.* North Carolina Utilities Commission Docket Nos. E-7, Subs 1213, 1214 and 1187 and E-2, Subs 1219 and 1193. P. 6.

[29] Ibid.

counterparts.[30] Low-income customers with inefficient appliances and un-weatherized homes who struggle to pay high energy bills are also twice as likely, compared to higher income customers, to be disconnected from electric service if they are unable to pay the bill.[31]

North Carolina's median household income is $61,000—half of all households in the state earn less than $61,000 and half earn more—compared to a median income of $70,800 for the United States as a whole.[32] Across North Carolina's 100 counties, median household income varies from a low of $33,000 in Washington County to a high of $88,500 in Union and Wake Counties (see Figure 4, p.18, top map). The share of households living below the federal poverty line in North Carolina ranges from 7 percent in Union and Camden Counties up to 55 percent of households in Hyde County (see Figure 4, middle map).[33] For reference, in 2021, the U.S federal poverty level for a family of four was $26,500.[34]

North Carolina's counties with median household incomes below $45,000 in 2021 (Figure 4, top map) also had the highest energy burdens in the state (Figure 4, bottom map). Energy burden is the share of household costs spent on energy bills, including electricity and any additional energy bills such as fossil gas or oil heating fuel bills. Among the 21 North Carolina counties with median household incomes below $45,000, 11 of those counties also have average energy burdens of 6 percent or higher.[35] (ACEEE classified energy burden of 6 percent or higher as "high" levels of burden.[36]) According to data from the U.S. DOE LEAD Tool, households in counties with median household incomes less than $45,000, such as Washington, Robeson, and Bladen Counties, have average annual household energy burdens greater than 5 percent, compared to just 2 percent in higher-income counties such as Union and Wake Counties.[37]

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[30] ACEEE. 2020. *How High are Household Energy Burdens?* Available at: https://www.aceee.org/sites/default/files/pdfs/u2006.pdf, P. 3.

[31] Duke NC. August 2022. *Joint North Carolina Low-Income Affordability Collaborative Quarterly Progress Report.* North Carolina Utilities Commission Docket Nos. E-7, Subs 1213, 1214 and 1187 and E-2, Subs 1219 and 1193. P. 6.

[32] (1) U.S. Census. 2021 ACS 5-Year Detailed Estimates [Table: S1903]. Available at: https://data.census.gov/table?q=median+household+income&g=040XX00US37&tid=ACSST5Y2021.S190 (2) U.S. Census. 2021. "Income in the United States." Available at: https://www.census.gov/library/publications/2022/demo/p60-276.html.

[33] U.S. Census. 2021 ACS 5-Year Detailed Estimates [Table: S1903].

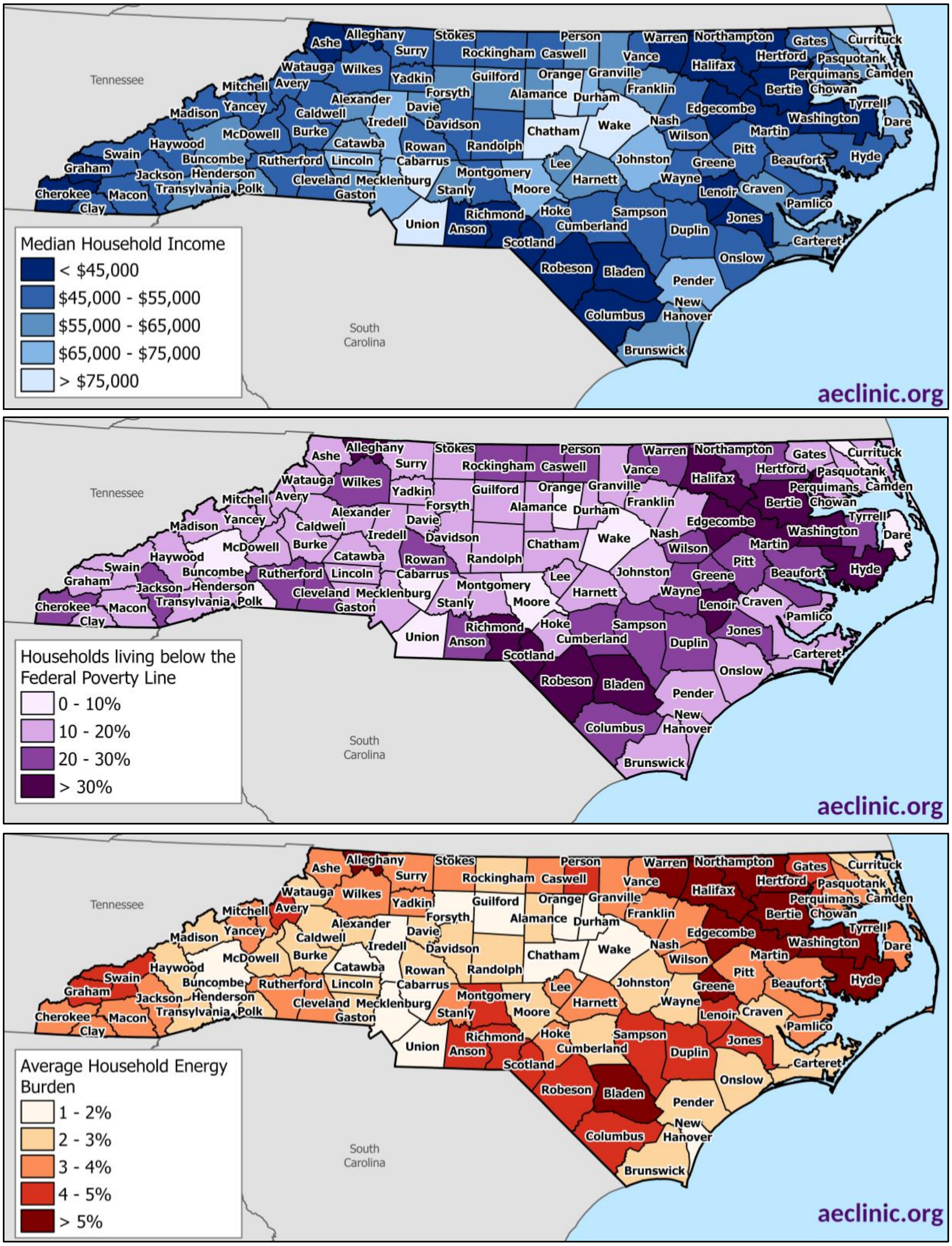
[34] Office of the Assistant Secretary for Planning and Evaluation. 2021. Poverty Guidelines. Available at: https://aspe.hhs.gov/2021-poverty-guidelines.

[35] These counties include Alleghany, Bertie, Bladen, Edgecombe, Halifax, Hertford, Martin, Northampton, Tyrrell, Warren, and Washington.

[36] ACEEE. N.d. "Understanding Energy Affordability." Available at: https://www.aceee.org/sites/default/files/energy-affordability.pdf.

[37] U.S. Department of Energy. 2018. "Low-Income Energy Affordability Data - LEAD Tool - 2018 Update." Available at: https://data.openei.org/submissions/573.

Figure 4. North Carolina 2021 household median income, poverty, and energy burden



Data source: (1) U.S. Census. 2021 ACS 5-Year Detailed Estimates [Table: S1903, S1702_C01_002E]; (2) U.S. DOE. 2018. "Low-Income Energy Affordability Data - LEAD Tool - 2018 Update."

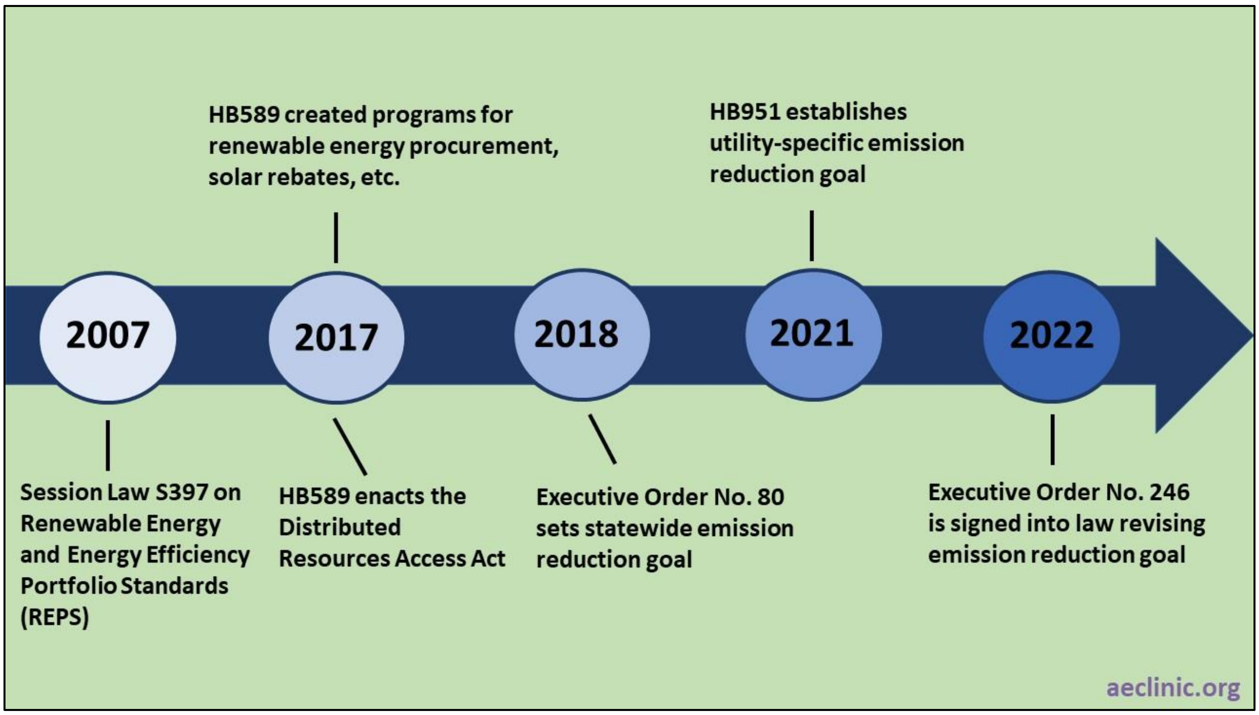
Hyde County has the highest county-level energy burden—9 percent—in North Carolina (see Figure 4, bottom map). Hyde County has a median household income of $48,600, and the average energy burden is 9 percent, so the average household spends $4,374 on energy costs annually ($48,600 x 9 percent). More than half, 55 percent, of Hyde County households live below the federal poverty line, the highest percentage of households across North Carolina's counties. Washington County has the second highest county-level average energy burden—7 percent—and a median household income of $39,900. It also has the second highest percentage of households living below the federal poverty line, at 38 percent. Bertie County, Martin County, Northampton County, and Tyrell County also have an average county-level energy burden of 7 percent. Halifax County has the third highest county-level average energy burden—6 percent—and the median household income is $37,800. Just over 37 percent of households live below the federal poverty line. Alleghany County, Bladen County, Edgecombe County, Greene County, Hertford County, and Warren County also have an average county-level energy burden of 6 percent.

SECTION 2

North Carolina Clean Energy and Emissions Policy Landscape

Over the past two decades, North Carolina has enacted regulations to reduce greenhouse gas emissions from the electric sector (and statewide) and increase the share of electricity generated with renewable energy (see Figure 5). However, North Carolina does not currently have legislative policies that specifically incentivize or mandate small-scale or residential battery storage, which, if properly incentivized, can help to achieve both goals.

Figure 5. North Carolina clean energy and climate regulations



Renewable Energy and Energy Efficiency Portfolio Standard

In 2007, North Carolina Session Law 2007-397 (SL397 or SB3) established the Renewable Energy and Energy Efficiency Portfolio Standard (REPS)[38] that requires investor-owned utilities to provide an increasing combined share of renewable energy-derived electricity sales or energy efficiency savings:

- 3 percent of electric retail sales by 2012

[38](1) North Carolina Utilities Commission. N.d. "Renewable Energy and Energy Efficiency Portfolio Standard (REPS)." Available at: https://www.ncuc.gov/Reps/reps.html; (2) North Carolina General Statutes Chapter 62, Section 133.8. N.d. *Renewable Energy and Energy Efficiency Portfolio Standard (REPS).* Available at: https://www.ncleg.net/enactedlegislation/statutes/html/bysection/chapter_62/gs_62-133.8.html.

- 6 percent of electric retail sales in 2014
- 10 percent of electric retail sales in 2017
- 12.5 percent of 2020 retail sales from 2021 onward.[39]

According to the North Carolina Energy Policy Council, a legislative advisory group for state lawmakers, renewable energy certificates awarded to renewable electric generators through the REPS accounted for just 6 percent of 2020 statewide electric sales (130,400 GWh),[40] or 7,600 GWh of renewable electric generation—less than half of what is required to meet the 2021 REPS mandate.[41] Renewable energy certificates awarded for energy efficiency measures through the REPS accounted for about 5 percent of 2020 statewide electric sales, or 6,500 GWh of energy savings.[42] If North Carolina is to meet its REPs goals, it will need to advance programs that support the deployment of distributed renewables and energy storage, which can be installed quickly, require no new land to develop, and can provide direct benefits to their host facilities and communities, in addition to grid benefits such as decarbonization.

In 2017, a decade after North Carolina's REPS was established, House Bill 589 (HB589) was passed as Session Law 2017-192 creating the Competitive Procurement of Renewable Energy (CPRE) program, a competitive bidding process designed to increase renewable energy generation within North Carolina.[43] HB589 limits the ability of the state's electric public utilities to meet renewable energy generation targets through utility-owned renewable developments to no more than 30 percent of their required target.[44] HB589 also enabled community solar as well as third-party leasing of distributed energy, but it capped both of those programs (at 20 MW per utility for community solar and at total installed capacity not to exceed 1 percent of the previous five-year average of the North Carolina retail contribution to the offering utility's coincident retail peak demand).[45] HB589 also mandated large utilities, serving more than 150,000 customers, to design and implement a 600 MW renewable energy procurement program that reserves 100 MW for major military installations and 250 MW for the University of North Carolina (at least through February 2020, after which time the utility would no longer be required to maintain this reserve).[46]

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[39] General Assembly of North Carolina, Session 2007, Session Law 2007-397. *Senate Bill 3*. Available at: https://www.ncleg.net/Sessions/2007/Bills/Senate/PDF/S3v6.pdf. p. 3.
[40] U.S. EIA. 2020. "North Carolina Electricity Profile 2020." Available at: https://www.eia.gov/electricity/state/archive/2020/northcarolina.
[41](1) Energy Policy Council. 2022. *2022 DRAFT Biennial Report*. Available at: https://deq.nc.gov/media/31550/download?attachment. Pg. 43.
[42] Ibid.
[43] General Assembly of North Carolina, Session 2017, Session Law 2017-192. *House Bill 589*. Available at: https://dms.psc.sc.gov/Attachments/Matter/f2b699a1-394d-4ff5-a4e6-56c8775b1cc2.
[44] Ibid.
[45] DSIRE. 2022. "North Carolina Community Solar." Available at: https://programs.dsireusa.org/system/program/detail/22467/north-carolina-community-solar.
[46] General Assembly of North Carolina, Session 2017, Session Law 2017-192. *House Bill 589*.

Greenhouse gas emissions targets

In October 2018, North Carolina Governor Roy Cooper issued Executive Order No. 80,[47] *North Carolina's Commitment to Address Climate Change and Transition to a Clean Energy Economy* that sets the following emission reduction targets for 2025, based on 2005 levels:

- Reduce statewide greenhouse gas emissions 40 percent
- Increase the number of state-registered zero emission vehicles (ZEVs) by at least 80,000
- Reduce energy consumption in state-owned buildings by at least 40 percent.[48]

In 2021, House Bill 951 (HB951) was passed as Session Law 2021-165 and established a utility-level goal[49] of a 70 percent reduction in carbon emissions by the year 2030 (from 2005 levels) and net-zero carbon emissions by the year 2050.[50]

In 2022, Governor Cooper issued Executive Order No. 246 (E.O. 246), *Climate and Equity*, which establishes additional statewide greenhouse gas emissions targets including a statewide reduction of 50 percent from 2005 levels by 2030 and net-zero statewide emissions by 2050.[51] Moreover, E.O. 246 expands the ZEV adoption goal to 1,250,000 registered ZEVs by 2030, and it establishes a new goal that 50 percent of new light-duty vehicle sales be ZEVs by 2030. Finally, E.O. 246 requires all cabinet-level agencies to have public participation plans for soliciting input on environmental justice (EJ) concerns as it pertains to decarbonization policies.

Distributed energy storage: the missing piece from North Carolina's policy landscape

As indicated above, North Carolina policymakers have set goals to reduce greenhouse gas emissions across the state and to reduce electricity demand through energy efficiency measures, but the State does not currently have legislative policies in place to specifically incentivize residential distributed solar and distributed energy storage, which could help to meet these goals as they have in other states. The only movement in this direction occurred in March 2023 when the North Carolina Utilities

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[47] Office of Governor Roy Cooper. 2018. Executive Order No. 80. *North Carolinas Commitment to Address Climate Change and Transition to a Clean Energy Economy*. Available at: https://files.nc.gov/ncdeq/climate-change/EO80--NC-s-Commitment-to-Address-Climate-Change---Transition-to-a-Clean-Energy-Economy.pdf.

[48] (1) Office of Governor Roy Cooper. 2018. Executive Order No. 80. *North Carolinas Commitment to Address Climate Change and Transition to a Clean Energy Economy*.; (2) North Carolina Department of Health and Human Services. N.d. "Climate Change and Clean Energy: Plans and Progress." Available at: https://www.ncdhhs.gov/about/department-initiatives/climate-change-and-clean-energy-plans-and-progress#:~:text=In%20Executive%20Order%2080%3A%20North,40%20percent%20below%202005%20levels.

[49] According to HB 951 "electric public utility" means any electric public utility serving at least 150,000 North Carolina retail customers in 2021. See: General Assembly of North Carolina, Session 2021, Session Law 2021-165. *House Bill 951*. Available at: https://www.ncleg.gov/Sessions/2021/Bills/House/PDF/H951v6.pdf.

[50] General Assembly of North Carolina, Session 2021, Session Law 2021-165. *House Bill 951*.

[51] Office of Governor Roy Cooper. 2022. Executive Order No. 246. *Climate and Equity*. Available at: https://governor.nc.gov/executive-order-no-246.

Commission (NCUC) denied Duke NC's proposed Smart $aver Solar Energy Efficiency Program and ordered Duke NC to develop a pilot program that creates incentives for residential solar and battery storage installations. NCUC requires the pilot solar-plus-storage program to incentivize distributed solar up to 10 kW per program participant.[52] In compliance with this order, in June 2023, Duke NC submitted an application to the Commission for approval of the PowerPair℠ Solar and Battery Installation Pilot Program (called the "PowerPair℠ Program"), which provides financial incentives to residential customers installing new solar plus storage systems.[53] As of November 2023, the pilot has not yet been approved by the NCUC.

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[52] NCUC. Docket No.'s E-2, SUB 1287 and E-7, SUB 1261. *In the Matter of Application by Duke Energy Progress, LLC, for Approval of Smart $aver Solar Energy Efficiency Program*. Available at: https://starw1.ncuc.gov/NCUC/ViewFile.aspx?Id=6175ed18-d5fc-4ef0-bd40-5114f10ee67c.

[53] NCUC. Docket No.'s E-2, SUB 1287 and E-7, SUB 1261. *In the Matter of Application by Duke Energy Progress, LLC, for Approval of its PowerPair Solar and Battery Installation Pilot Program Pursuant to the North Carolina Utilities Commission's March 23, 2023, Order in Docket Nos. E-2, Sub 1287 and E-7, Sub 1261*. Available at: https://starw1.ncuc.gov/NCUC/page/docket-docs/PSC/DocketDetails.aspx?DocketId=7e9e79b5-342a-4324-810d-77dccd03e343.

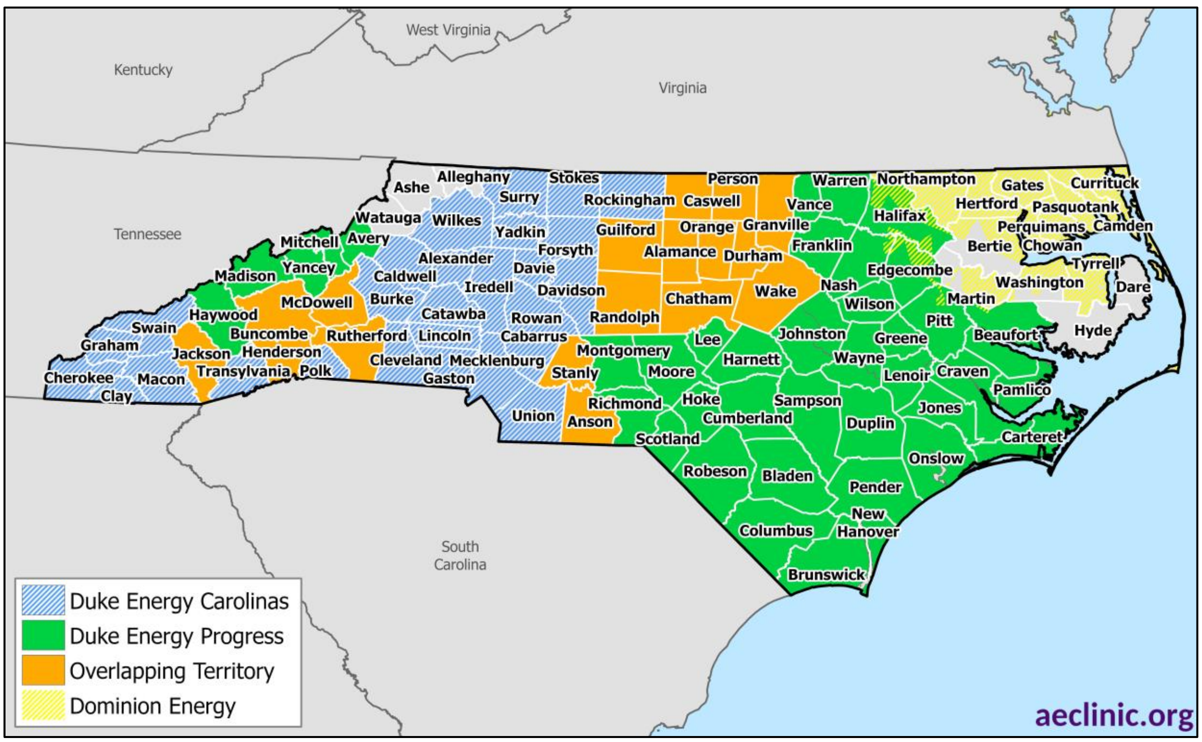
SECTION 3

Duke NC resource planning

Electric utilities can reduce their greenhouse gas emissions by retiring fossil fuel plants and replacing them with renewable resources or by reducing the amount of electricity needed to serve their customers through energy efficiency and demand-side management programs. Pairing distributed energy storage with distributed solar helps support the expansion of renewable resources by improving the reliability and electric generating potential of solar resources. In North Carolina, investor-owned utilities regularly submit planning documents to the NCUC that outline the utility's proposed capacity expansion plans, decarbonization strategies, and energy efficiency and demand response measures.

In 2021, North Carolina's two largest investor-owned utilities (IOUs) (DEC and DEP, see Figure 6) served over 3.1 million (64 percent) of the state's 4.8 million residential electric customers.[54]

Figure 6. Duke Energy Carolina and Duke Energy Progress service territories



Note: This map's legend includes investor-owned utilities only. Electric member co-operatives and municipal light plants are shown in grey.

Data source: U.S. EIA. 2022. "U.S. Energy Atlas" [Shapefile: Electric Retail Service Territories]. Available at: https://atlas.eia.gov/datasets/geoplatform::electric-retail-service-territories-2/explore

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[54] (1) U.S. EIA. 2022. "Electric Sales, Revenue, and Average Price." Available at: https://www.eia.gov/electricity/sales_revenue_price. [Tables: T1, T6]; (2) North Carolina Utilities Commission. N.d. "North Carolina Major Utility Companies. *NC Public Staff*. Available at: https://publicstaff.nc.gov/north-carolina-major-utility-companies.

Duke NC (DEC and DEP combined) serves about 44 percent of parent company Duke Energy's total customer count across the companies' five regulated electric utilities that supply electricity to six states (Duke Energy Florida, Duke Energy Indiana, Duke Energy Ohio, DEC, and DEP).[55]

DEC's service area covers the western part of North Carolina while DEP's service area covers the eastern part of the state and five mountain counties along the western border. In 17 counties,[56] both DEP and DEC supply electricity to different customers living in the same county (see Figure 6).

According to U.S. Energy Information Administration (EIA) data (last updated in 2022), DEC serves 1.8 million residential customers in North Carolina and DEP serves almost 1.3 million residential customers in North Carolina (see Table 1).[57]

Table 1. Duke NC 2021 electric customers, revenue, and sales

Customer Type	Utility	Number of Customers	Revenue ($ thousands)	Sales (MWh)
Residential	Duke Energy Carolinas	1,837,991	$2,403,249	23,015,861
	Duke Energy Progress	1,292,259	$2,057,449	16,894,870
	Duke NC Total	**3,130,250**	**$4,460,698**	**39,910,731**
Commercial and Industrial	Duke Energy Carolinas	309,129	$2,592,531	36,978,243
	Duke Energy Progress	220,563	$1,857,660	21,745,560
	Duke NC Total	**529,692**	**$4,450,191**	**58,723,803**
Total		**3,659,942**	**8,910,889**	**98,634,534**

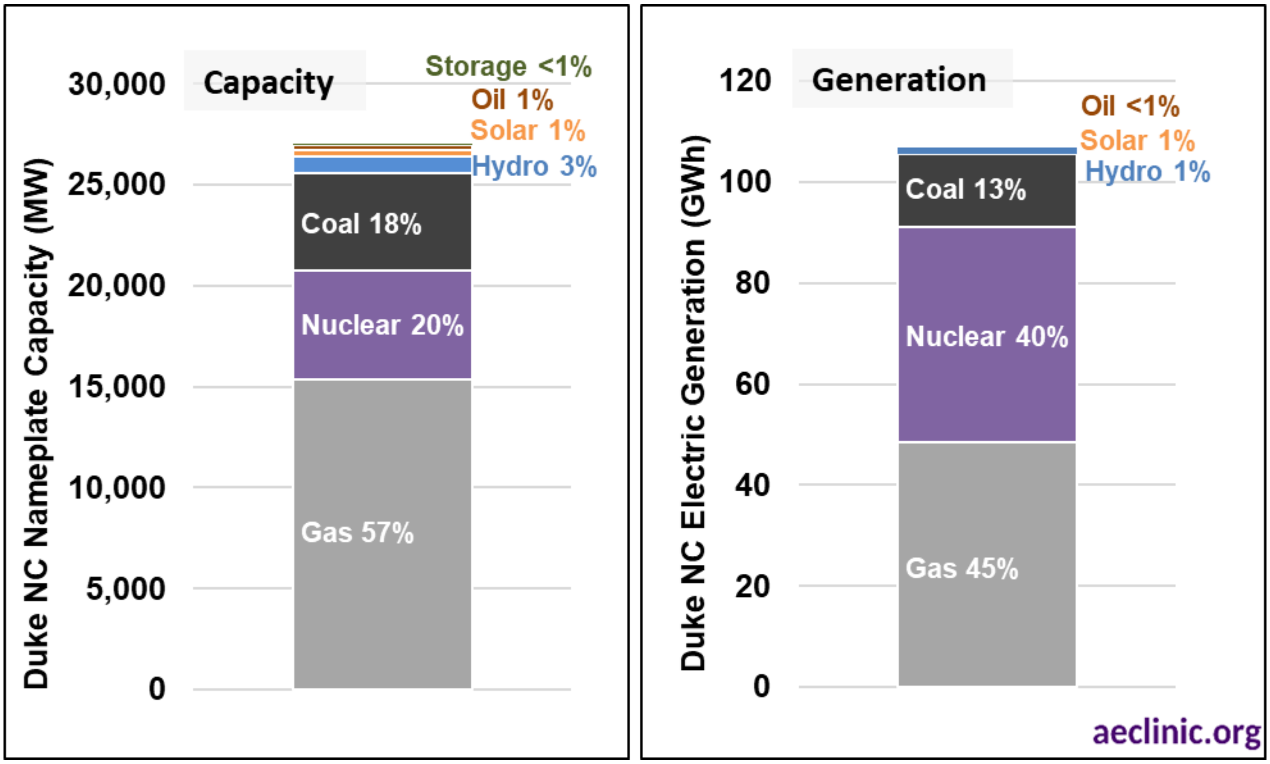
Data source: U.S. EIA. 2022. Form EIA-861.

Three-quarters of Duke NC's installed electric capacity is composed of fossil fuel infrastructure (i.e., coal-fired, fossil gas-fired, and oil-fired generators) equal to about 20,400 MW of combined nameplate capacity and 59 percent of 2022 electric generation (see Figure 7, p.26). Less than 5 percent (1,200 MW) of Duke NC's total nameplate capacity (and 2 percent of total electric generation) is renewable solar, hydroelectric, wind, or energy storage resources. Nuclear

[55] (1) U.S. EIA. 2021. Form EIA-861. Available at: https://www.eia.gov/electricity/data/eia861/; (2) Duke Energy. 2023. "Fast Facts." Available at: https://p-cd.duke-energy.com/-/media/pdfs/our-company/duke-energy-fast-facts.pdf?rev=77d14a34d96f449493f89595285d4d57.
[56] These counties include Wake, Chatham, Randolph, Durham, Orange, Alamance, Guilford, Granville, Caswell, Person, Anson, Stanly, Rutherford, Henderson, Jackson, Buncombe, and McDowell.
[57] (1) U.S. EIA. 2022. Form EIA-861; (2) Duke Energy. 2023. "Fast Facts."

generators account for 20 percent of Duke NC's total capacity and supply 40 percent of Duke NC's total electric generation.[58]

Figure 7. Duke NC 2022 nameplate capacity and electric generation by resource



Data source: U.S. EIA. 2022. Form EIA-923.

Despite comprising almost a fifth of the utility's generating capacity and 13 percent of electric generation in 2022, Duke NC coal units had capacity factors[59] comparable to the utility's solar and hydroelectric resources, suggesting declining utilization of its existing coal resources (see Figure 8, p.27).

In 2022, Duke NC's coal generating units had an average capacity factor of 34 percent,[60] 5 percentage points lower than the United States coal generation average in the same year.[61] It is important to note that while Duke NC's generating assets are located in both North and South Carolina, its remaining coal fleet, with related emissions, is located exclusively in North Carolina.

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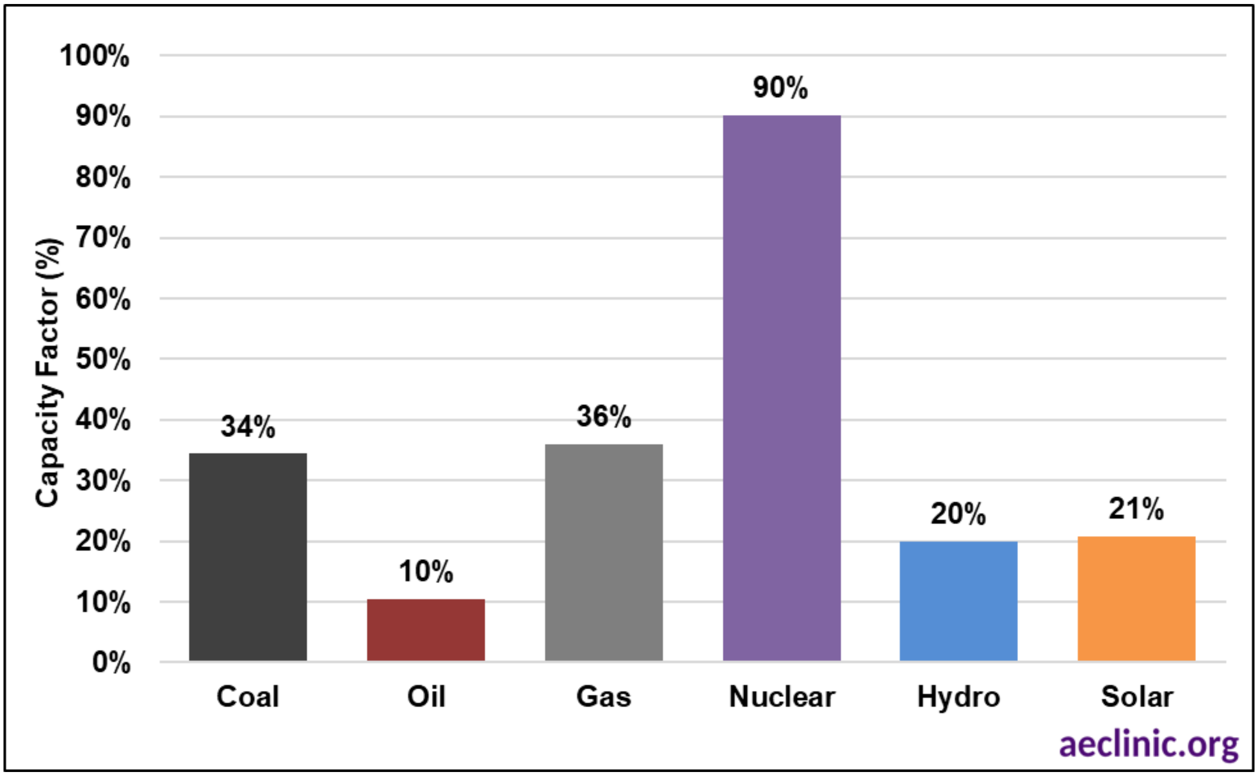
[58] (1) U.S. EIA. 2022. Form EIA-861; (2) U.S. EIA. 2022. Form EIA-923. Available at: https://www.eia.gov/electricity/data/eia923/

[59] Capacity factor is a measure of how often generating units are running compared maximum utilization for a year. Capacity factor is calculated by dividing electric generation in MWh by generating capacity in MW multiplied by the number of hours in a year (8,760).

[60] U.S. Energy Information Administration (EIA). 2021. Form EIA-923.

[61] U.S. EIA. 2022. "Capacity Factors for Utility Scale Generators Primarily Using Fossil Fuels" [Table 6.07A]. Electric Power Monthly. Available at: https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_6_07_a

Figure 8. Duke NC 2022 capacity factor by resource



Data source: U.S. EIA. 2022. Form EIA-923.

Resource planning

Duke NC is required by the NCUC to submit biennial Integrated Resource Plans (IRPs) for public comment describing the utility's expectations for the future, including customer demand and planned resource additions or retirements.[62] Duke NC's most recently approved IRP was released in 2020 (note: the CPIRP discussed below is still proposed, not approved) and forecasts electric demand and required resource capacity for the 2020 to 2035 time period. Duke NC plans to retire 15 coal-fired generating units with a combined summer capacity of 3,700 MW by 2035—37 percent of its total coal capacity[63]—as well as eight fossil gas-fired and/or oil generators with a combined summer capacity of 180 MW by December 2025.[64] To meet the resource gap created by fossil fuel retirements, Duke NC plans to add utility-scale solar and solar plus storage resources (see Figure 9, p.28).[65]

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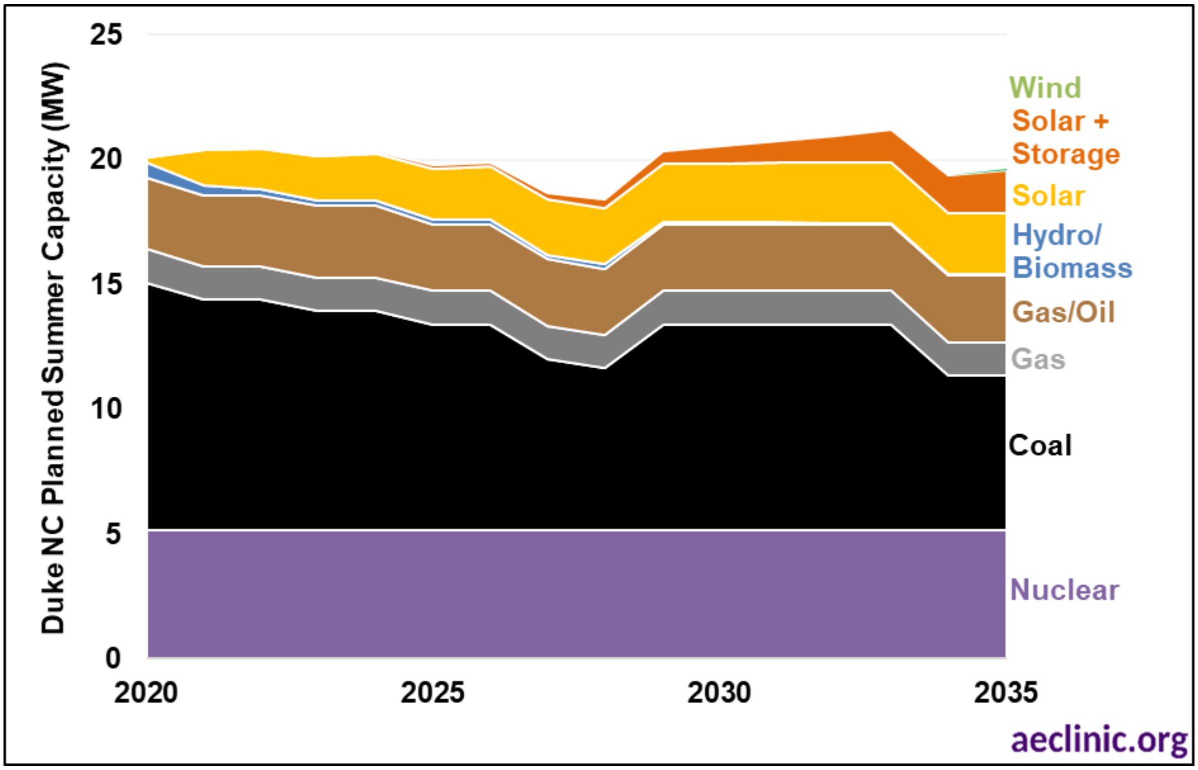
[62] NCUC. Docket No. E-100, Sub 165. 2021. *Order Scheduling Public Hearing on 2020 Biennial IRP Reports and Related 2020 REPS Compliance Plans*. Available at: https://starw1.ncuc.gov/ncuc/ViewFile.aspx?NET2022&Id=ed6a47e6-45db-4389-9402-230b843931e6

[63] NCUC. 2020. Duke Energy Progress 2020 IRP. [Table 5-A, APPENDIX B]; (2) NCUC. 2020. Duke Energy Carolinas 2020 IRP. [Table 5-A, APPENDIX B]

[64] Ibid.

[65] "Existing generating resources, designated and expected resource additions and EE/DSM resources do not meet

Figure 9. Duke NC 2020 IRP planned additions



Data sources: (1) NCUC. 2020. Duke Energy Progress 2020 IRP. Available at: https://starw1.ncuc.gov/ncuc/ViewFile.aspx?NET2022&Id=6cd0dac3-d077-496b-a20d-19b46662471a. [Table 5-A, APPENDIX B]; (2) NCUC. 2020. Duke Energy Carolinas 2020 IRP. Available at: https://starw1.ncuc.gov/NCUC/ViewFile.aspx?Id=9752b166-f870-4b0c-8469-8f791405d95c.

In August 2023, Duke NC submitted its 2023 – 2024 CPIRP, which includes three pathways to achieving the goals of the Carbon Plan, to the NCUC for public comment.[66] According to the CPIRP, Duke NC's preferred pathway (Pathway 3) proposes to meet the emission reduction targets by retiring all coal resources by 2035 and procuring the following resources:

- 6,000 MW of utility-scale solar by 2031
- 2,700 MW of utility-scale storage by 2031 (*1,650 MW of stand-alone battery storage and 1,050 MW battery storage combined with solar*)
- 1,200 MW of onshore wind by 2033
- 5,780 MW of fossil gas-fired resources by 2032 (of which 1,700 MW is combustion turbines for peaking capacity), and

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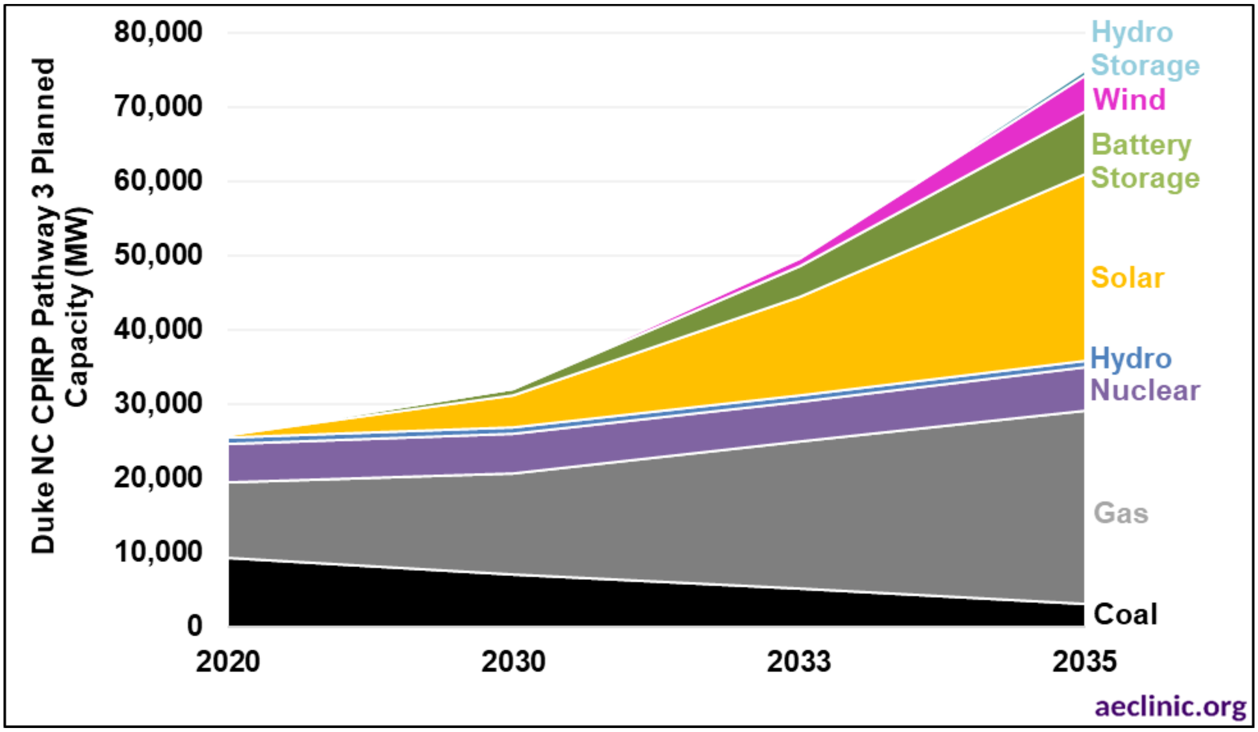
the required load and reserve margin beginning in 2026. As a result, the Base Case with Carbon Policy plan is presented to meet the resource gap." Duke Energy. 2023. "Integrated Resource Planning in the Carolinas." Available at: https://www.duke-energy.com/our-company/about-us/irp-carolinas, P. 100

[66] Duke NC. 2023. *Chapter NC: 2023-2024 CPIRP Update*. Available at: https://starw1.ncuc.gov/NCUC/PSC/PSCDocumentDetailsPageNCUC.aspx?DocumentId=70c6dc5c-502d-4a62-9743-2e3bcec044cc&Class=Filing.

- 1,700 MW of new pumped hydro storage by 2034 (see Figure 10).[67]

Figure 10. Duke NC CPIRP Pathway 3 capacity forecast



Data source: (1) Resource retirements and additions: NCUC Docket No. E-100, Sub 190. October 13, 2023. Technical Conference Presentation [PowerPoint]. Available at: https://starw1.ncuc.gov/NCUC/ViewFile.aspx?Id=3f9c58f8-2c69-46b6-bb7a-a07c3aab5932; (2) Existing resources: Duke NC. 2023. 2023-2024 CPIRP Proposal [Appendix B].

Carbon planning

Duke NC is required by HB951 to submit a biennial Carbon Plan outlining measures necessary to achieve the state-mandated greenhouse gas emissions reduction target for the electric sector of 70 percent below 2005 levels by 2030.[68] The resulting document is the Carbon Plan Integrated Resource Plan (CPIRP) described above.

As of 2021, Duke NC had reduced its greenhouse gas emissions 64 percent from 2005 levels.[69] Duke NC must reduce its emissions by another 6 percentage points to reach its HB951[70] target by 2030. [71] DEP

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[67] Duke NC. 2023. *Chapter NC: 2023-2024 CPIRP Update*. [Table NC-1].

[68] General Assembly of North Carolina, Session 2021, Session Law 2021-165. House Bill 951.

[69] 2005 emission levels are based on the U.S. Environmental Protection Agency's eGrid data. Data source: U.S. Environmental Protection Agency (EPA). 2021. "Historical eGRID Data." Available at: https://www.epa.gov/egrid/historical-egrid-data.

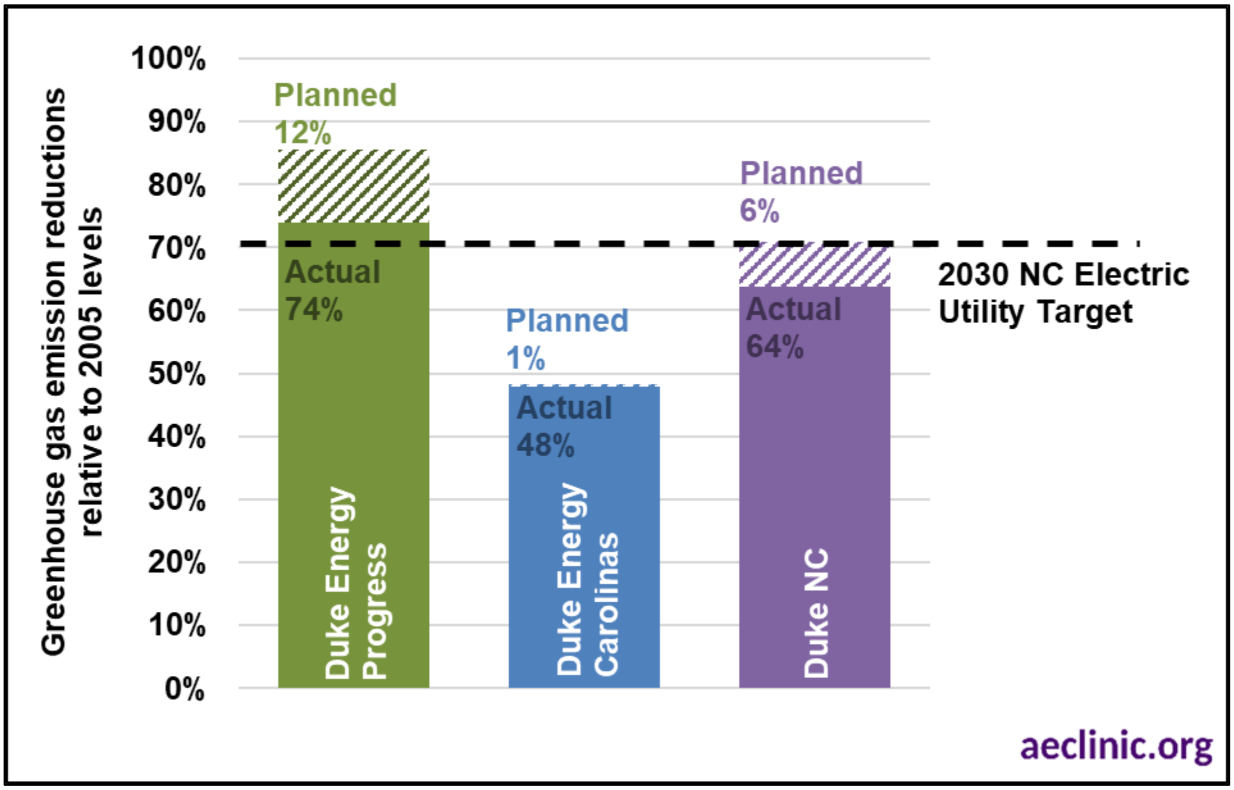
[70] General Assembly of North Carolina, Session 2021, Session Law 2021-165. House Bill 951.

[71] (1) NCUC. 2020. Duke Energy Progress 2020 IRP; (2) NCUC. 2020. Duke Energy Carolinas 2020 IRP.

has already surpassed the state's target by 4 percentage points, while DEC is currently short of the state-mandated reduction requirement by 22 percentage points (or 7,600 short tons of CO_2 emissions, see Figure 11 where the hatched portion of the bar represents estimated emissions reductions, from 2005 levels, that would result from planned retirements described in DEP/DEC's approved 2020 IRP).

Duke NC's 2020 IRP plans for the retirement of the Mayo, Roxboro, and Allen coal plants, as well as the Blewett and Weatherspoon oil-fired plants[72] before the year 2030. This would further reduce total greenhouse gas emissions to achieve a 71 percent reduction from 2005 levels,[73] meeting the requirements set forth in HB951.[74] If DEC and DEP carry out the plans set forth in their proposed CPIRP, both utilities are on track to comply with the HB951 mandated requirement of a 70 percent reduction[75] by 2030.[76]

Figure 11. 2021 Duke NC greenhouse gas emissions reductions from 2005 levels



Data source: (1) U.S. EPA. 2005-2021. "Historical eGRID Data.; (2) NCUC. 2020. Duke Energy Progress 2020 IRP; (3) NCUC. 2020. Duke Energy Carolinas 2020 IRP.

[72] As of 2021, the Blewett plant houses four oil-fired generators and six hydro generators and the Weatherspoon plant houses four oil-fired generators. See: U.S. EIA. 2021. Form EIA-860.

[73] AEC calculation based on 2021 greenhouse gas emissions and Duke NC 2020 IRP planned retirements.

[74] General Assembly of North Carolina, Session 2021, Session Law 2021-165. House Bill 951.

[75] Ibid.

[76] Duke NC. 2023. *Chapter NC: 2023-2024 CPIRP Update*.

Energy efficiency and demand-side measures

Electric utilities can reduce their greenhouse gas emissions by retiring fossil fuel plants and replacing them with renewable resources, as outlined above, but also by reducing the amount of electricity needed to serve their customers through energy efficiency and demand-side management programs.

Duke NC provides home energy audits (e.g., "Duke Energy Neighborhood Energy Saver"[77] for low-income customers and "Home Energy House Call"[78] for all other residential customers), energy efficiency products and financing (e.g., "Energy Efficiency Kit"[79] and the "Smart $aver"[80] rebate program), and energy efficiency education to their residential customers (see participation rates and energy savings in Table 2, p.32).[81]

U.S. EIA reports Duke NC's annual incremental energy savings from energy efficiency totaled 571 GWh of residential energy savings, or 1.5 percent of Duke NC's total electric sales in 2021,[82] which, because of poor performance by other utilities, is higher than the 0.6 percent annual incremental statewide energy efficiency savings in the same year.[83] According to Duke NC, in 2019, the majority of energy savings were achieved by DEC. DEC's cumulative energy savings totaled 3,250 GWh from energy efficiency programs offered to residential customers, while DEP achieved cumulative energy savings of 277 GWh (see Table 2).[84]

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[77] Duke Energy Progress. n.d. "Neighborhood Energy Saver." Available at: https://www.duke-energy.com/home/products/income%20qualified/neighborhood%20energy%20saver?jur=NC02.
[78] Duke Energy Carolinas. n.d. "Home Energy House Call." Available at: https://www.duke-energy.com/home/products/home-energy-house-call.
[79] Duke Energy Progress. n.d. "Energy Efficiency Kit." Available at: https://www.duke-energy.com/energy-education/energy-centers-and-programs/energy-revolution-energy-efficiency-in-schools/energy-efficiency-kit.
[80] Duke Energy Progress. n.d. "Smart $aver." Available at: https://www.duke-energy.com/home/products/smart-saver.
[81] (1) NCUC. 2020. Duke Energy Progress 2020 IRP; (2) NCUC. 2020. Duke Energy Carolinas 2020 IRP.
[82] (1) U.S. EIA. 2021. Form EIA-861; (2) NCUC. 2020. Duke Energy Progress 2020 IRP; (3) NCUC. 2020. Duke Energy Carolinas 2020 IRP.
[83] Subramanian, S., Berg, W., Cooper, E., Waite, M., Jennings, B., Hoffmeister, A., Fadie, B. 2022. *2022 State Energy Efficiency Scorecard.* Available at: https://www.aceee.org/research-report/u2206.
[84] (1) NCUC. 2020. Duke Energy Progress 2020 IRP; (2) NCUC. 2020. Duke Energy Carolinas 2020 IRP.

Table 2. Duke NC energy efficiency and demand-side management programs

Duke NC Residential Energy Efficiency and Demand-Side Management Programs	Number of Participants	Energy Savings (GWh)	Peak Summer Capacity Saved (MW)
Duke Energy Carolinas			
Energy Efficient Appliances And Devices	63,803,127	2,476	323,988
Energy Efficiency Education Program For Schools	234,148	58	10,307
Multi-Family Energy Efficiency	2,854,090	144	15,397
My Home Energy Report	1,339,152	328	91,387
Low Income Energy Effiency And Weatherization Assistance Program	75,441	41	5,821
Residential Energy Assessments	197,969	81	11,941
Personalized Energy Report	86,333	25	2,790
Online Home Energy Comparison Report	12,902	4	387
Smart Saver Energy Efficiency	171,758	94	28,016
Subtotal	**68,774,920**	**3,250**	**490,034**
Duke Energy Progress			
Appliances And Devices	1,311,635	79	25,278
Energy Efficiency Education	46,842	26	3,626
Residential Energy Assessments	144,853	31	3,787
Residential New Construction	39,880,246	61	23,231
Residential Service – Smart $Aver	201,592	81	43,398
Subtotal	**41,585,168**	**277**	**99,320**
Total	**110,360,088**	**3,528**	**589,354**

Data sources: (1) NCUC. 2020. Duke Energy Progress 2020 IRP; (2) NCUC. 2020. Duke Energy Carolinas 2020 IRP.

According to the *2020 Annual Report Regarding REPS in North Carolina*,[85] Duke NC complied with its REPS requirements in 2019 through renewable energy generation and energy efficiency programs. Duke NC's *2020 REPS Compliance Plan*[86] forecasts a small decrease in residential energy efficiency savings from 2020 through 2022, with 619 GWh of forecasted energy savings in 2020 decreasing to 608 GWh of forecasted cumulative energy savings in 2022.[87]

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[85] NCUC. 2020. *Annual Report Regarding REPS in North Carolina*. Available at: https://www.ncuc.gov/reports/repsreport2020.pdf.

[86] (1) Duke Energy Progress. *Integrated Resource Plan Attachment I NC Renewable Energy and Energy Efficiency Portfolio Standard (NC REPS) Compliance Plan.* Available at: https://starw1.ncuc.gov/NCUC/ViewFile.aspx?Id=a2e6e35c-9358-4f76-82b3-bef40c52d1f2; (2) Duke Energy Carolinas. *Integrated Resource Plan Attachment I NC Renewable Energy and Energy Efficiency Portfolio Standard (NC REPS) Compliance Plan.* Available at: https://starw1.ncuc.gov/NCUC/ViewFile.aspx?Id=05017b06-1787-4b7d-8742-bf04f1bd2bf2.

[87] Ibid. [EXHIBIT B] p. 27.

The *Duke NC Energy Efficiency and Demand-side Management Market Potential Study*[88] notes that Duke NC offers all energy efficiency measures that are cost-effective as determined by the Total Resource Cost (TRC) test, meaning that all measures that provide more benefits than costs (where costs to both customers and the utility are considered) are offered to customers.[89] However, due to concerns with the underlying assumptions for the TRC test,[90] evaluation of the cost-effectiveness of new and ongoing programs is performed using the Utility Cost Test (UCT) based on costs to the utility, rather than the TRC which evaluates measures based on both the cost to the utility and to participants.[91]

U.S. EIA data report that 427,401 residential customers are enrolled in Duke NC's demand-side management programs, which provide financial incentives to reduce energy consumption at times of peak demand.[92] For example, the "EnergyWise Home" program provides DEP residential customers with up to $100 per year to reduce energy consumption during times of peak electric demand by installing load control switches that allow DEP to assume remote control of home heating or cooling systems during times of especially high energy demand.[93] In 2021, Duke NC residential demand-side management programs reported achieving no actual peak demand savings, despite having previously reported 900 MW of potential peak demand savings.[94] It is unlikely that the Duke NC programs achieved no actual demand savings, but if savings were minimal, this may be due to lack of utilization in that period by the utility.

In June 2023, Duke NC filed a proposed demand response program, the PowerPair^SM Program, and at the same time filed revisions to their energy efficiency and demand-side management programs that would allow Duke NC to incorporate optional Battery Control for customers with battery storage systems.[95] Duke NC proposes to provide $6.50 per kW per month to customers choosing to participate

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[88] Duke NC. June 2020. *Duke Energy North Carolina EE and DSM Market Potential Study,* available at: https://dms.psc.sc.gov/Attachments/Matter/5dd1b614-dd18-48ca-a7e9-f16b0809e273.

[89] Ibid.

[90] For example, in response to the Duke NC 2020 IRP, several local governments including towns, cities, and counties within North Carolina requested that the NCUC review the assumptions of the TRC to ensure the potential benefits of energy efficiency programs are fully captured. See: NCUC Docket No. E-100, Sub 165. February 24, 2021. *RE: Duke Energy Progress and Duke Energy Carolinas jointly submitted 2020 Biennial Integrated Resource Plan.* Available at: https://starw1.ncuc.gov/ncuc/ViewFile.aspx?NET2022&Id=bf1e6203-0b2b-410d-9917-132ffbda49a6.

[91] NCUC, Docket No. No. E-2, Sub 931. 2020. *Order Approving Revisions to the Demand-Side Management and Energy Efficiency Cost Recovery Mechanisms*. Available at: https://starw1.ncuc.gov/NCUC/ViewFile.aspx?Id=5aaea5ce-6458-41fe-ab2d-14d86881092d.

[92] U.S. EIA. 2022. Form EIA-861.

[93] Duke Energy Progress. n.d. "EnergyWise Home." Available at: https://www.duke-energy.com/home/products/energywise-home.

[94] (1) Data retrieved from Form EIA-861 is based on reporting from utilities and may contain errors, see: U.S. EIA. 2023. "Annual Electric Power Industry Report, Form EIA-861 detailed data files." Available at: https://www.eia.gov/electricity/data/eia861/; (2) U.S. EIA. 2022. Form EIA-861.

[95] NCUC Docket No. E-2, Sub 927. 2023. Order Granting Extension of Time for Comments, Interventions and Reply Comments. Available at: https://starw1.ncuc.gov/NCUC/ViewFile.aspx?Id=ee61b292-166c-4882-b16e-6d5e9a7929e8.

in the Battery Control option.[96] (As of publication, the PowerPair℠ Program and related changes to the Battery Control program have not been approved by the Commission.)

Beyond energy efficiency and demand response efforts that reduce customer demand for energy, Duke NC, and North Carolina more broadly, lack incentives for grid modernization technologies like distributed solar and storage systems or advanced meters to support North Carolina's decarbonization targets.[97] As discussed in Section VI below, utility programs that incentivize the deployment of residential distributed solar and storage systems have been used in other states to reduce energy demand and energy costs for ratepayers.

[96] NCUC Docket No. E-2, Sub 927. 2023. Proposed Modifications to the Existing Commission-Approved Residential Service Load Control Rider LC-9 ("EnergyWise"). Available at: https://starw1.ncuc.gov/NCUC/ViewFile.aspx?Id=e51801c0-952c-4e84-badf-1a42039afd47.

[97] NC Department of Environmental Quality. n.d. Clean Energy Plan Utility System Planning and Investment Memo. Available at: https://www.deq.nc.gov/environmental-assistance-and-customer-service/climate-change/clean-energy-plan/group-5-utility-system-planning-memo-final/download.

SECTION 4

Affordability and energy burden in Duke NC counties

In Duke NC's service territory, which includes 83 of North Carolina's 100 counties, median household income ranges from a low of $36,700 in Robeson County, located in the Southeastern area of the state, to a high of $88,500 in Wake County, located in the center of the state (see Figure 12, p.36, top map). Counties in which the median household income is below $45,000 are clustered along the southern and northern borders of Duke NC's service territory and include: Warren, Northampton, Halifax, Edgecombe, Anson, Richmond, Scotland, Robeson, Bladen, Columbus, Graham, and Cherokee Counties (see Figure 12, top map).[98]

In 2021, 9 percent of North Carolina families lived below the federal poverty level, which was $26,500 for a family of four.[99] Like counties with median household incomes below $45,000, the counties with the highest poverty levels are clustered along the southern and northern border of Duke NC's service territory (see Figure 12, middle map). In Duke NC's territory, Halifax County has the largest share of households living below the federal poverty line, at 37 percent. The counties with the lowest percentage of house-holds living below the federal poverty line are in the center and western part of the Duke NC service area and include Wake County, Orange County, Moore County, Cabarrus County, Polk County, and Buncombe County, all at 10 percent or lower.

The U.S. DOE LEAD Tool shows five counties within the Duke NC service territory[100] in which households have average annual energy burdens greater than 5 percent (see Figure 12, bottom map). Among the 11 North Carolina counties with median household incomes below $45,000, four counties also have an average energy burden of over 5 percent: Warren, Bladen, Halifax, and Edgecombe. The counties with the lowest average energy burden—just 2 percent—include Durham County, Chatham County, Forsyth County, Guilford County, Buncombe County, Henderson County.[101]

DEC and DEP's 2022 *Low- and Moderate-Income Penetration Study* reports that 43 percent of Duke NC's residential customers are low- to moderate-income (LMI), defined as those living within Census block groups and tracts with greater than 20 percent of households earning less than 80 percent of the area median income.[102] According to the 2022 *Low- and Moderate-Income Penetration Study,* Duke NC runs three low-income energy efficiency programs: a Neighborhood Energy Saver program offered since 2013; a low-income weatherization program offered since 2015, and a Weatherization Pay per kWh Pilot program offered since 2018.[103]

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[98] U.S. Census. 2021 ACS 5-Year Detailed Estimates [Table: S1702].

[99] Assistant Secretary for Planning and Evaluation. 2021. "U.S. Federal Poverty Guidelines Used to Determine Financial Eligibility for Certain Federal Programs." U.S. Department of Health and Human Services. Available at: https://aspe.hhs.gov/2021-poverty-guidelines.

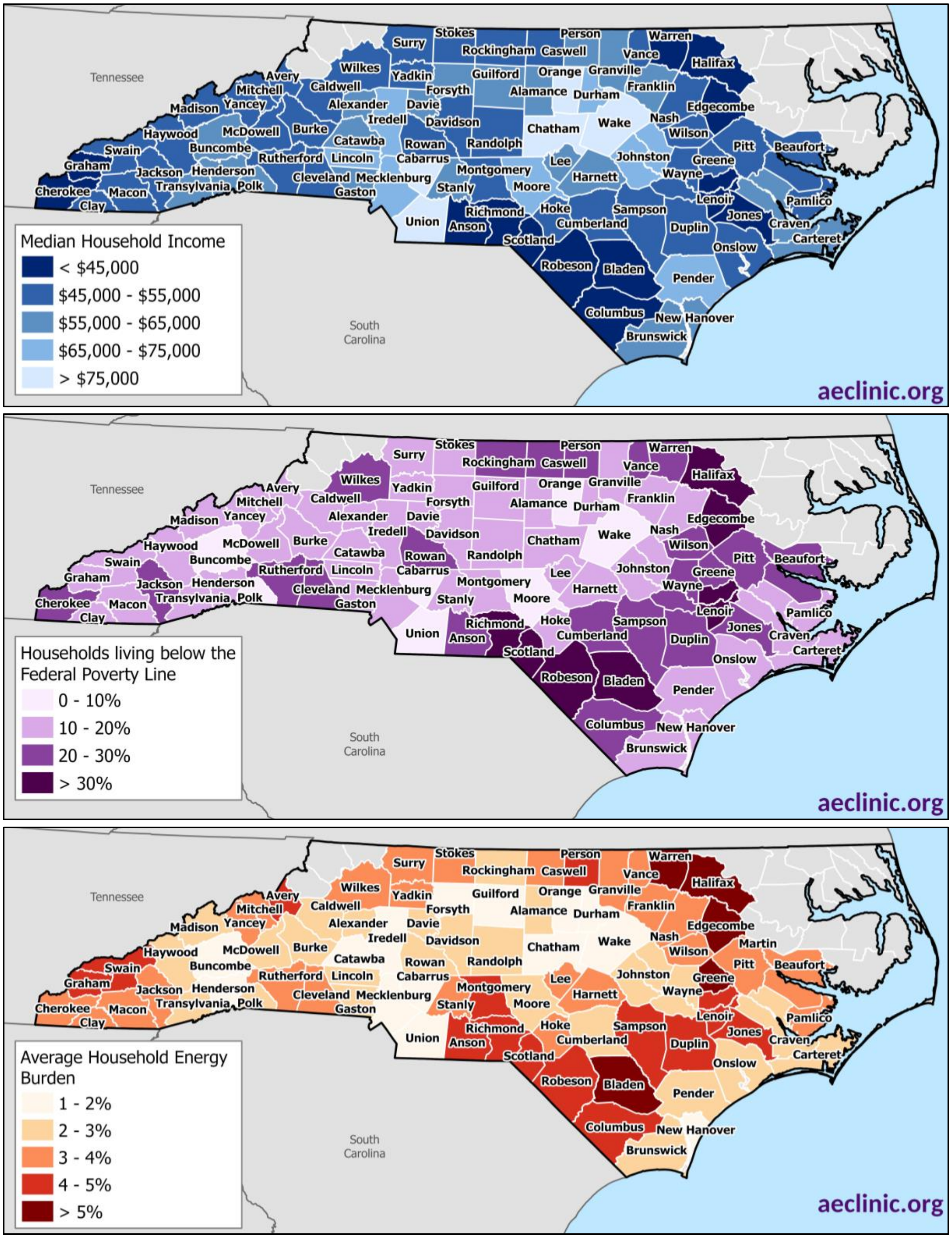
[100] The counties include Bladen, Warren, Halifax, Edgecombe, and Green

[101] U.S. Department of Energy. 2018. "Low-Income Energy Affordability Data - LEAD Tool - 2018 Update."

[102] Opinion Dynamics. December 2022. *Low- and Moderate-Income Penetration Study*. p. 7 and p. 13

[103] Ibid. p. 12.

Figure 12. Duke NC 2021 median household income



Data source: (1) U.S. Census. 2021 ACS 5-Year Detailed Estimates [Tables: S1903, S1702_C01_002E]; (2) U.S. Department of Energy. 2018. "Low-Income Energy Affordability Data – LEAD Tool – 2018 Update." Available at: https://data.openei.org/submissions/573.

Low-income household participation rates in Duke NC's energy efficiency programs ranged from less than 0.5 percent in the Weatherization Pay per kWh Pilot program, to 20 percent in the Neighborhood Energy Saver program.[104] Only 21 percent of LMI households participated in more than one of Duke NC's energy efficiency programs, compared to 31 percent of non-LMI households.[105]

The utilities' *2022 Low- and Moderate-Income Penetration Study* reports that LMI customers' main barriers to program participation were cost and the challenges faced by renters who lack bargaining power with landlords.[106] Additional barriers to participation included a lack of internet access or awareness of program offerings, limited English language ability, or moving frequently due to living in rental properties.[107] According to its 2022 Carbon Plan, Duke NC will seek approval from NCUC to expand its income-eligible energy efficiency programs to include median household incomes that are less than 300 percent of the federal poverty level.[108]

According to the ACEEE, distributed energy resources, including distributed energy storage systems, can reduce costs for utilities and customers, improve reliability and resiliency of the electric grid, and give communities and individuals more control over their energy supply.[109] In addition, the integration of distributed energy storage systems allows electricity generated from solar or wind resources to be stored and used when it is most needed, improving the performance of renewable resources and reducing the need for fossil fuel resources such as peaker plants,[110] which are costly, highly polluting, and often sited in lower-income neighborhoods.

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[104] Ibid. p. 26.
[105] Ibid. p. 23.
[106] Ibid. p. 47.
[107] Ibid. p. 17.
[108] Duke Energy. 2022. *The Execution*. Available at: https://p-cd.duke-energy.com/-/media/pdfs/our-company/carolinas-carbon-plan/supplemental/chapter-04.pdf. p. 30.
[109] ACEEE. n.d. "Distributed Energy Resources." Available at: https://www.aceee.org/topic/distributed-energy-resources#:~:text=The%20Benefits%20of%20DERs,equity%20in%20the%20power%20sector.
[110] Long Duration Energy Storage Council. November 2023. *Driving to Net Zero Industry Through Long Duration Energy Storage*. Available at: https://www.ldescouncil.com/assets/pdf/LDES_Net_Zero_Industry_Report.pdf.

SECTION 5

Distributed Solar and Distributed Energy Storage

Distributed solar resources are small-scale solar panels that are located in close proximity to the home, business, school, or community (e.g., rooftop solar). Distributed energy storage, or behind-the-meter storage, such as home battery storage or other small scale storage systems, store energy to be used at a later time and typically can be charged from the grid or from distributed solar with which they are co-located.[111]

A 2023 study by Brattle Group found that behind-the-meter battery dispatch could contribute to grid reliability at a lower cost than a fossil gas-fired peaker plant.[112] The analysis assumed a utility with 1.75 million residential customers, of whom 1 percent, or 17,500 are eligible for a behind-the-meter dispatch program, and 20 percent of whom (or 3,500) actually participate.[113] The report modeled the dispatch capability and cost of this configuration and compared it to a 400 MW gas-fired combustion turbine, or peaker plant.[114] They found that the aggregated dispatch of the behind-the-meter batteries had a net cost—inclusive of both system costs and societal costs—of $2.2 million, which is $41.1 million less than the net cost for the gas peaker.[115] A September 2023 report published by the U.S. Department of Energy found that the large scale deployment of distributed solar and distributed energy storage resources, and the aggregation of these resources as virtual power plants, could help serve growing electric demand as utilities move away from fossil fuel-fired capacity.[116]

Duke NC's not-yet-approved CPIRP calls for 1,700 MW (across four units) of additional combustion turbine peaking capacity in their preferred scenario (or roughly 425 to 450 MW per peaking unit), starting with 900 MW in near-term planning in 2024 at the Marshall Steam Station near the town of Catawba.[117] Duke NC's residential customer base is not dissimilar from the Brattle 2023 study presented above (Duke NC serves 3.1 million residential customers and the Brattle study assumes a utility serving 1.7 million customers). The $41 million net cost difference between the two Brattle scenarios—3,500 aggregated behind-the-meter batteries versus a 400 MW gas peaker—indicates that Duke NC should explore alternative resource expansion models that expand behind-the-meter battery storage instead of building additional fossil-gas fired units, saving ratepayers on their energy bills, and reducing Duke NC's greenhouse gas emissions.

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[111] Microgrid Knowledge and NRG Energy. 2019. *The Evolution of Distributed Energy Resources.* Available at: https://www.microgridknowledge.com/home/whitepaper/11434780/nrg-energy-the-evolution-of-distributed-energy-resources.

[112] Brattle Group. 2023. *Real Reliability: The Value of Virtual Power*. Available at: https://www.brattle.com/wp-content/uploads/2023/04/Real-Reliability-The-Value-of-Virtual-Power-Technical-Appendix_5.3.2023.pdf.

[113] Ibid, p. 3, 9.

[114] Ibid, p. 2, 13.

[115] Ibid, p. 19.

[116] U.S. Department of Energy. September 2023. *Pathways to Commercial Liftoff: Virtual Power Plants*. Available at: https://liftoff.energy.gov/wp-content/uploads/2023/09/20230911-Pathways-to-Commercial-Liftoff-Virtual-Power-Plants_update.pdf.

[117] Duke Energy. 2023. *Execution Plan*. Available at: https://www.duke-energy.com/-/media/pdfs/our-company/carolinas-resource-plan/chapter-4-execution-plan.pdf?rev=ccb35fc247e54eefbdcda2499a56764b.

Net metering

Residential net metering systems are distributed energy resources, typically rooftop solar panels, which are installed on a customer's property and connected to the utility grid, allowing customers to power their homes with renewable energy and transfer any surplus energy generated to the utility grid. Net metering systems typically receive special rates for power dispatched to the grid. Distributed energy storage systems can be paired with solar net metering systems to store any excess energy generated for use when home energy demand is high. This pairing is especially helpful when home energy demand is high at the same time total demand on the grid is high (known as "peak demand" on the grid).

As of January 2023, according to Duke NC's proposed CPIRP, there were almost 35,000 residential customers enrolled in Duke NC residential net metering programs with 481 GWh of forecasted 2023 behind-the-meter generation, which is less than 1 percent of Duke NC total residential electric sales in 2022.[118] By 2030, Duke NC aims to have over 100,000 residential customers enrolled in net metering rates with a forecasted behind-the-meter generation of 920 GWh, equal to 1 percent of Duke NC total residential electric sales in 2022.[119]

From 2018 to 2022, Duke NC offered rebates to residential customers with rooftop solar installations on a net metering rate, but the program was limited by North Carolina General Statute §62-155[120] that set a 10-kW limit on residential solar installations participating in utility net metering programs. According to the proposed CPIRP*,* about 9,500 customers participated in the Solar Rebate Program, but the program is no longer accepting applications as of January 2023.[121]

According to the NCUC, the current residential net metering rider is closed to new customers and the revised net metering riders, Residential Solar Choice and Net Metering Bridge, went into effect in October 2023, at which time new residential customers could enroll.[122] The Residential Solar Choice rate requires customers to participate in the Time-Of-Use (TOU) with Critical Peak Pricing rate schedule (where rates differ depending on the hour of the day and are determined by the utility based on peak electricity demand),[123] whereas the Net Metering Bridge rider, available to a limited number of customers each year, allows customers to participate in the net metering rider without participating in the TOU rate schedule.[124] TOU rates provide the opportunity for lower utility bills if customers shift their electricity demand to off-peak hours (6 am to 11am and 8pm to 6am in the summer and 12pm to

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[118] (1) Duke Energy. 2023. *Appendix H: Grid Edge and Customer Programs*. 2023-2024 CPIRP. Available at: https://www.duke-energy.com/-/media/pdfs/our-company/carolinas-resource-plan/appendix-h-grid-edge-and-customer-programs.pdf?rev=f825f35f6e7b41db82f66c6696f4e397. p. 47; (2) U.S. EIA. 2022. "Form EIA-861."

[119] Duke Energy. 2023. *Appendix H: Grid Edge and Customer Programs*. 2023-2024 CPIRP. p. 47

[120] NC G.S. §62-155. *Electric power rates to promote conservation*. Available at: https://www.ncleg.gov/Laws/GeneralStatuteSections/Chapter62.

[121] Duke Energy. 2023. *Appendix H: Grid Edge and Customer Programs*. 2023-2024 CPIRP. p. 48

[122] NCUC. 2023. "Net Metering." Available at: https://publicstaff.nc.gov/electric/net-metering.

[123] Duke Energy. n.d. "How it works." Available at: https://www.duke-energy.com/business/billing/time-of-use-rate/how-it-works#:~:text=Under%20the%20Duke%20Energy%20Time,demand%20for%20electricity%20is%20lower.

[124] NCUC. 2023. "Net Metering."

4pm and 8pm to 6am in the winter),[125] however, customers on TOU rates pay higher rates during on-peak hours compared to those not enrolled in TOU rates. There is currently no approved incentive to add behind-the-meter battery storage to help optimize the use and dispatch of these distributed solar systems.

Distributed energy storage programs and policies in other states

Beyond distributed energy storage incentives embedded within existing net metering policy, programs to incentivize battery storage have been increasingly used in other states to meet demand-side management goals, reduce energy costs for low-to-moderate income residential customers, and reduce the costs of peak energy supply for all ratepayers. Examples of state programs include (but are not limited to) the following:

- California Self-Generation Incentive Program (SGIP)[126]
- Connecticut Energy Storage Solutions[127]
- Connecticut ConnectedSolutions[128]
- Hawaii Battery Bonus[129]
- Massachusetts ConnectedSolutions[130]
- Massachusetts Low-Income Battery Pilot[131]
- Massachusetts SMART Solar Incentive[132]

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[125] Duke Energy. n.d. "How it works."
[126] CPUC. N.d. *Participating in Self-Generation Incentive Program (SGIP).* Ca.gov. Available at: https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/demand-side-management/self-generation-incentive-program/participating-in-self-generation-incentive-program-sgip.
[127] Energy Storage Solutions. N.d. "Introducing Energy Storage Solutions." Available at: https://energystoragect.com.
[128] Eversource. n.d. "Connecticut Home Battery Storage Options." Available at: https://www.eversource.com/content/residential/save-money-energy/clean-energy-options/home-battery-storage.
[129] Hawaiian Electric. n.d. "Battery Bonus." Available at: https://www.hawaiianelectric.com/products-and-services/customer-renewable-programs/rooftop-solar/battery-bonus.
[130] MassSave. n.d. "Use your Battery Storage Device to Make the Grid More Sustainable." Available at: https://www.masssave.com/residential/rebates-and-incentives/connectedsolutions-batteries.
[131] Paul, T. and Epstein, G. March 2023. "Innovation Massachusetts Low-Income Battery Pilot Finally Wins Approval (For Now…)." Clean Energy Group. Available at: https://www.cleanegroup.org/innovative-massachusetts-low-income-battery-pilot-finally-wins-approval-for-now/?utm_source=rss&utm_medium=rss&utm_campaign=innovative-massachusetts-low-income-battery-pilot-finally-wins-approval-for-now.
[132] Commonwealth of Massachusetts. N.d. "Solar Massachusetts Renewable Target (SMART) Program." Available at: https://www.mass.gov/info-details/solar-massachusetts-renewable-target-smart-program.

- New York Long Island Dynamic Load Management[133]

Of these programs, several have moved beyond the proposal phase and are actively accepting residential customers, for example:

- **Connecticut:** Connecticut's Public Utilities Regulatory Authority (PURA) has introduced the Energy Storage Solutions program, aiming to enhance the reliability and resilience of the electric distribution system, particularly for vulnerable communities. The program, administered by the Connecticut Green Bank in collaboration with utilities Eversource and United Illuminating, offers upfront incentives and ongoing performance incentives for residential, commercial, and industrial customers, with additional incentives for low-income customers, underserved communities, and those affected by frequent and prolonged storm-related outages.[134]
- **Massachusetts:** Cape Light Compact's Low-Income Battery Pilot offers free or reduced cost solar PV and heat pumps to 100 income-eligible households in Cape Cod, Martha's Vineyard, and Duke County, with 25 of these households also receiving free or reduced cost battery storage. To qualify, households must earn at or below 80 percent Area Median Income (AMI), with low-income defined as at or below 60 percent AMI.[135]
- **New Hampshire:** Liberty Utilities in New Hampshire has a residential Battery Storage pilot program that allows customers to charge their batteries during times when peak electric usage and electric rates are low, and to use that stored energy when peak electric usage and electric rates are high. In turn, Liberty Utilities can utilize excess stored energy from customers when peak is particularly high, and the customers are compensated on their monthly energy bill.[136] New Hampshire's utility regulator has instructed Liberty to expand the residential storage program.[137] In addition, New Hampshire customers have the option to enroll in a ConnectedSolutions program similar to programs of the same name in Massachusetts, Rhode Island and Connecticut.[138]

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[133] NYSERDA. N.d. "Incentives for long Island Residents." Available at: https://www.nyserda.ny.gov/All-Programs/Energy-Storage-Program/Solar-Plus-Energy-Storage/Incentives-for-Long-Island-Residents#:~:text=LIPA%E2%80%99s%20Dynamic%20Load%20Program%20Energy%20storage%20can%20earn,times%2C%20which%20occur%20a%20few%20times%20a%20year.

[134] PURA. January 2022. *Connecticut Launches Statewide Battery Storage Program with Green Bank and Utilities to Jointly Administer Incentives to Improve Resilience and Benefit Ratepayers.* CT.gov. Available at: https://portal.ct.gov/PURA/Press-Releases/2022/Connecticut-Launches-Statewide-Battery-Storage-Program.

[135] Paul, T. and Epstein, G. March 2023. "Innovation Massachusetts Low-Income Battery Pilot Finally Wins Approval (For Now…)." Clean Energy Group.

[136] Liberty. N.d. "Battery Storage."

[137] Energy News Network. March 24, 2023. "A New Hampshire in-home energy storage program saved money and helped the grid." Available at: https://www.power-grid.com/der-grid-edge/a-new-hampshire-in-home-energy-storage-program-saved-money-and-helped-the-grid/#gref.

[138] Energysage. n.d. "New Hampshire energy storage rebates and incentives." Available at:

- **Vermont:** Green Mountain Power (GMP) in Vermont has two behind-the-meter programs – one in which customers may enroll their own battery and GMP pays the customer for the services the battery provides,[139] and one in which GMP provides the battery and controls its dispatch and the customer pays the utility $55 per month for the resilience services the battery provides to the customer.[140] GMP has 2,900 customers (and more than 4,800 batteries) enrolled in the two programs.[141] Of note is that the program was originally capped by the Vermont Public Utilities Commission, but that cap was recently removed in response to the flooding events in the state earlier this year, allowing an additional 1,000 customers currently on a waiting list to enroll.[142] And as part of its proposed "Zero Outages Initiative," GMP is now proposing to provide free batteries to residential customers in remote and outage-prone areas, where BTM batteries offer a more cost-effective solution than upgrading distribution grid infrastructure. GMP has 225,059 residential customers.[143]

Many similar programs are currently in active development across the country, including Duke NC's PowerPair[SM] Program discussed above. (See Table 3 in the Appendix for more examples.)

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https://www.energysage.com/local-data/storage-rebates-incentives/nh/#:~:text=The%20ConnectedSolutions%20Program%2C%20available%20to,times%20of%20peak%20energy%20demand.

139 Green Mountain Power. N.d. "Bring Your Own Device." Available at: https://greenmountainpower.com/rebates-programs/home-energy-storage/bring-your-own-device/

140 Green Mountain Power. N.d. "Tesla Powerwall." Available at: https://greenmountainpower.com/rebates-programs/home-energy-storage/powerwall/

141 Green Mountain Power. 2023. "GMP's Request to Expand Customer Access to Cost-Effective Home Energy Storage Through Popular Powerwall and BYOD Battery Programs is Approved." Available at: https://greenmountainpower.com/news/gmps-request-to-expand-customer-access-to-cost-effective-home-energy-storage-is-approved/

142 Vermont Public Utility Commission Case No. 23-1335-TF. August 2023. Final Order Approving Tariff Revisions. Available at: https://s3.documentcloud.org/documents/23930878/135809408571174onbase-unity_41297038454399479854063 49.pdf

143 U.S. EIA. 2022. Form EIA-861.

SECTION 6

Recommendations

Through the years, North Carolina policymakers have set several climate goals to reduce greenhouse gas emissions and reduce energy demand through demand response and energy efficiency measures, but the State currently has no legislative policies in place to specifically target or incentivize residential rooftop solar and behind-the-meter battery storage. Duke NC's proposed 2023-2024 CPIRP includes 1,050 MW of battery storage combined with solar, none of which is identified as distributed resources for customer use.

However, Duke NC has proposed a PowerPair℠ Solar and Battery Installation Pilot Program that aims to provide financial incentives to residential customers installing new solar plus storage systems. The proposed program is the result of the North Carolina Utilities Commission's March 2023 filing (Docket No.'s E-2 Sub 1287 and E-7 Sub 1261), which ordered Duke NC to develop the 60 MW pilot for the purpose of studying the potential impact of distributed resources on decarbonization and on the Duke NC system.

In other states, distributed solar and distributed energy storage deployment is used as a tool to lower utility energy costs, reduce household energy burden, improve community energy resilience, and achieve state decarbonization targets.[144] Yet, North Carolina's largest utility, Duke NC, has no announced or approved plans to develop equitable distributed energy storage as a tool for decarbonization, nor does the state have any legislative policies that incentivize distributed solar or distributed energy storage to help reach its energy reduction and greenhouse gas emission reduction goals.

To support North Carolina's broader decarbonization efforts and equity goals, this report makes three key policy recommendations for increasing incentives and lowering barriers for distributed energy storage deployment:

1. **Approve and expand utility deployment of equitable distributed solar and distributed energy storage pilot programs.** Offering statewide solar and distributed energy storage programs, based on Duke's PowerPair℠ model, could be widely beneficial to the State of North Carolina, the environment, and ratepayers. For example, Duke NC had 9,925 MW of coal generating capacity in 2021.[145] If Duke NC had retired all coal capacity, as the utility plans to do according to the proposed CPIRP, and deployed 9,925 MW of distributed solar and distributed energy storage resources (a little less than 1 million 10 kW solar plus storage units, or one 10 kW distributed solar and distributed energy storage unit installed at a third of Duke NC customer homes[146]), Duke NC's 2021 CO_2 emissions would have been 64 percent lower.[147]

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[144] National Governors Association. 2023. *State Approaches to Equitable Distributed Energy Resource Deployment*.
[145] U.S. EIA. 2021. Form EIA-861.
[146] As of 2021, there are 3,076,924 Duke NC residential customers. See: U.S. EIA. 2021. Form EIA-861.
[147] According to EPA eGrid data, Duke NC coal units emit 25.4 million short tons CO_2 emissions in 2021, 64 percent of Duke NC's total annual CO_2 emissions. See: U.S. EPA. 2021. "Historical eGrid data."

2. **Create statewide financial incentives for residential and community-based distributed solar and distributed energy storage installations.** The creation of financial incentives to spur customer participation in distributed solar and distributed energy storage utility programs, particularly for LMI households, could improve program participation rates, reduce household energy costs, and ensure a more equitable distribution of program benefits. For example, the *Low- and Moderate-Income Penetration Study* suggests that developing stronger incentives can aid in reducing the barriers associated with participating in energy efficiency programs.[148] This is being done in other states like Massachusetts, where the Massachusetts Department of Energy Resources offers the Solar Massachusetts Renewable Target (SMART) program that offers a tariff-based incentive paid to distributed solar owners with adders for storage, low-income customers, and those living in low-income communities or nearby brownfields.[149]

3. **Establish equity, climate, and energy performance-based metrics and targets for electric utilities.** Clear and specific equity, climate, and energy performance-based metrics and targets are essential to assess the success of distributed solar and distributed energy storage utility programs in achieving state policy goals, such as reducing energy burdens for LMI customers and lowering utility-level CO_2 emissions. For example, in 2019, the North Carolina Department of Environmental Quality identified Potential Underserved Communities in the state based on racial/ethnic composition and poverty rates.[150] Mandated annual targets for distributed solar and distributed energy storage installations, distributed solar and distributed energy storage capacity, energy savings, bill savings, and avoided CO_2 emissions in Potentially Underserved Communities would ensure that deployment efforts provide for the participation of LMI customers.

These three recommendations are critical to achieving North Carolina's broader decarbonization efforts and equity goals by increasing the deployment of distributed solar and distributed energy storage, particularly for LMI households. Increasing equitable deployment of distributed energy storage helps North Carolina meet its decarbonization targets through (1) supporting distributed solar resources by providing electric customers with the infrastructure necessary to store excess renewable energy generated on-site, and (2) lowering customer demand during peak demand periods, which reduces the need for fossil-fuel fired electric capacity. It can also lower LMI customers' energy burden and increase community energy resilience. Financial incentives for LMI households lower barriers to distributed energy storage program participation and facilitate higher participation rates. Statewide utility-level tracking of established deployment targets, including installation and capacity targets for LMI house-hold participation, and performance metrics to facilitate program assessment, would hold electric utilities accountable for ensuring program benefits are realized and are equitably distributed.

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[148] Opinion Dynamics. December 2022. *Low- and Moderate-Income Penetration Study,* p. 18.

[149] Massachusetts Department of Energy Resources. n.d. "Solar Massachusetts Renewable Target (SMART) program." Available at: https://www.mass.gov/info-details/solar-massachusetts-renewable-target-smart-program.

[150] North Carolina Department of Environmental Quality. 2022. "NC DEQ's Potentially Underserved Block Groups 2019." Available at: https://ncdenr.maps.arcgis.com/home/item.html?id=13a1aace03134969b8181c1f9f026960.

Appendix – Distributed Energy Storage Programs in Other States

Table 3. Distributed Energy Storage Programs in Other States

Program	Launch Year	Link
California Self-Generation Incentive Program (SGIP)	2001	(1) https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/demand-side-management/self-generation-incentive-program/participating-in-self-generation-incentive-program-sgip; (2) https://sgipsd.org/background#:~:text=In%202001%2C%20SGIP%20was%20established,renewable%20and%20nonrenewable%20DG%20technologies
Connecticut Energy Storage Solutions	2022	(1) https://energystoragect.com/; (2) https://www.energy-storage.news/connecticut-utilities-launch-580mw-aggregated-energy-storage-solutions-incentives-programme/
Connecticut ConnectedSolutions	2021	(1) https://www.eversource.com/content/residential/save-money-energy/clean-energy-options/home-battery-storage; (2) https://www.masssave.com/-/media/Files/PDFs/Save/Residential/connectedsolution-batteries/MA-Resi-Battery-Program-Materials-August-2021.pdf
Hawaii Battery Bonus	2021	(1) https://www.hawaiianelectric.com/products-and-services/customer-renewable-programs/rooftop-solar/battery-bonus; (2) https://www.hawaiianelectric.com/documents/products_and_services/customer_renewable_programs/battery_bonus_stakeholder_presentation.pdf
Massachusetts ConnectedSolutions	2019	(1) https://www.masssave.com/residential/rebates-and-incentives/connectedsolutions-batteries; (2) https://www.cleanegroup.org/wp-content/uploads/connected-solutions-affordable-housing.pdf
Massachusetts Low-Income Battery Pilot	2023	https://www.cleanegroup.org/innovative-massachusetts-low-income-battery-pilot-finally-wins-approval-for-now/?utm_source=rss&utm_medium=rss&utm_campaign=innovative-massachusetts-low-income-battery-pilot-finally-wins-approval-for-now

Table 3. Distributed Energy Storage Programs in Other States (continued)

Program	Launch Year	Link
Massachusetts SMART Solar Incentive	2018	(1) https://www.mass.gov/info-details/solar-massachusetts-renewable-target-smart-program; (2) https://www.mass.gov/doc/smart-launch-and-program-overview/download
Maryland Elk Neck Battery Storage Pilot Program	2022	(1) https://www.delmarva.com/SmartEnergy/InnovationTechnology/Pages/BatteryStorage.aspx; (2) https://azure-na-assets.contentstack.com/v3/assets/blt47b6e332b18fb457/blt602317e67ac20b77/64a52ce18cff651c3efcdbd3/DPL_ElkNeck_FAQ_FactSheet_2021-ADA.pdf
New Hampshire Liberty Battery Storage Program	2020	(1) https://new-hampshire.libertyutilities.com/acworth/residential/smart-energy-use/electric/battery-storage.html; (2) https://www.puc.nh.gov/Regulatory/Docketbk/2017/17-189/LETTERS-MEMOS-TARIFFS/17-189_2022-11-29_GSEC_INTERIM-EVALUATION-REPORT.PDF
New York Long Island Dynamic Load Management	2020	(1) https://www.nyserda.ny.gov/All-Programs/Energy-Storage-Program/Solar-Plus-Energy-Storage/Incentives-for-Long-Island-Residents#:~:text=LIPA%E2%80%99s%20Dynamic%20Load%20Program%20Energy%20storage%20can%20earn,times%2C%20which%20occur%20a%20few%20times%20a%20year; (2) https://www.prnewswire.com/news-releases/con-edison-and-national-grid-select-cpower-for-dynamic-load-management-program-in-new-york-301273202.html
Rhode Island ConnectedSolutions	2019	(1) https://www.rienergy.com/RI-Home/ConnectedSolutions/; (2) https://www.cleanegroup.org/wp-content/uploads/connected-solutions-policy.pdf
Vermont Bring Your Own Device (GreenMountain Power)	2018	(1) https://greenmountainpower.com/rebates-programs/home-energy-storage/bring-your-own-device/; (2) https://www.solarreviews.com/blog/green-mountain-power-bring-your-own-device-program-explained
Vermont Powerwall Program (Green Mountain Power)	2017	(1) https://greenmountainpower.com/rebates-programs/home-energy-storage/powerwall/; (2) https://greenmountainpower.com/news/network-of-powerwall-batteries-delivers-first-in-new-england-benefit-for-customers/

DISTRIBUTED ENERGY STORAGE

The Missing Piece in North Carolina's Decarbonization Efforts

A NORTH CAROLINA CASE STUDY

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