HOW ENERGY EFFICIENCY CAN HELP REBUILD NORTH CAROLINA'S ECONOMY:

ANALYSIS OF ENERGY, COST, AND GREENHOUSE GAS IMPACTS

BY RACHEL GOLD, CHARLOTTE COHN, ANDREW HOFFMEISTER, AND MAGGIE MOLINA

ACEEE RESEARCH REPORT
SEPTEMBER 2020

ACEEE
American Council for an Energy-Efficient Economy

Contents

About the Authors

Rachel Gold leads ACEEE's Utilities Program. Her research focuses on energy efficiency programs and policy and on utility regulation and ratemaking. She also provides technical assistance to utilities, state regulators, and efficiency program administrators. Rachel was previously in the electricity practice at Rocky Mountain Institute and on the regulatory affairs and market development team at Opower. She holds a master of public policy from the University of California, Berkeley, and a bachelor of science in biology and environmental studies from Brandeis University.

Charlotte Cohn conducts research and analysis on utility energy efficiency policy. Prior to joining ACEEE, she worked with the Vermont Law School Institute for Energy and the Environment on building community solar projects for low-moderate income communities in New Hampshire. She holds a master's degree in energy regulation and law from the Vermont Law School and a bachelor's degree from the University of Vermont.

Andrew Hoffmeister is a program analyst on ACEEE's industrial team. His work focuses primarily on decarbonization policy research, messaging, and outreach. Prior to joining ACEEE, Andrew volunteered with the Tennessee Department of Environment and Conservation on its watershed project in the Cumberland River Basin and conducted research on decarbonization planning. He holds a bachelor's degree in earth and environmental science from Vanderbilt University.

Maggie Molina is senior director for policy at ACEEE. She oversees work on federal, state, and local policy as well as utility regulation. She conducts energy efficiency program and policy research and provides technical assistance to policymakers and others. She has authored numerous reports on state policy and utility sector energy efficiency topics, including the first editions of the *State Energy Efficiency Scorecard*, efficiency potential studies, utility business models, the cost of saved energy, and efficiency programs. Maggie holds a master of engineering and public policy (MEPP) from the University of Maryland and a bachelor of arts from Colgate University.

Acknowledgments

This report was made possible through the generous support of The Energy Foundation, the North Carolina Department of Environmental Quality, and other ACEEE funders. Additional funding is pending. The authors gratefully acknowledge the external reviewers, internal reviewers, colleagues, and sponsors who supported this report. External expert reviewers included Rory McIlmoil from Appalachian Voices; Kevin Martin from Carolina Utility Customers Association, Inc.; Abraham Wapner from the Coalition for Green Capital; Lynda Shafer from Duke Energy; Jennifer Weiss from the Duke University Nicholas Institute for Environmental Policy Solutions; Ryan Hodum from the Energy Foundation; Ryan Miller from the North Carolina Building Performance Association; Terry Albrecht, Reid Conway, Paula Hemmer, and Sushma Masemore from the North Carolina Department of Environmental Quality; and Ivan Urlaub and Laura Langham from the North Carolina Sustainable Energy Association. Internal reviewers included Neal Elliott, Jennifer Amann, Steve Nadel, Lauren Ross, and Mary Shoemaker. The authors also gratefully acknowledge the assistance of Stefen Samarripas and Sara Hayes on particular report sections. External review and support do not imply affiliation or endorsement. Last, we would like to thank

Mariel Wolfson for developmental editing, Mary Robert Carter for managing the editorial process and for graphics design, Keri Schreiner for copy editing, Roxanna Usher for proofreading, and Ben Somberg, Maxine Chikumbo and Wendy Koch for their help in launching this report.

Suggested Citation

Gold, R., C. Cohn, A. Hoffmeister, and M. Molina. 2020. *How Energy Efficiency Can Help Rebuild North Carolina's Economy: Analysis of Energy, Cost, and Greenhouse Gas Impacts.* Washington, DC: American Council for an Energy-Efficient Economy.

Executive Summary

KEY FINDINGS

- Energy efficiency (EE) is one of the most promising economic tools available to North Carolina communities as they manage the COVID-19 pandemic and plan their recoveries. On average, every dollar invested in the efficiency policies and programs recommended in this report produces $2.30 in benefits to North Carolina residents and businesses. These programs can support recovery of the state's 16,600 EE jobs lost to COVID-19 in the spring of 2020, and they can support new jobs as well. Efficiency policies also provide critical support for low-income households, helping them lower their energy bills.
- Continuing and further expanding on North Carolina's EE programs and policies could achieve 11% of the electric power sector greenhouse gas (GHG) reductions needed to meet the state's 2030 goals (a reduction of 70% relative to 2005). These efforts, established based on local stakeholder recommendations, can avoid 3 million metric tons of CO_2 emissions each year, the equivalent of making one out of every five vehicles in the state carbon-free.
- North Carolina's policy choices now will define its economic health and energy future for decades. Investments from 2022–2040 in a suite of achievable policies and programs would reduce electricity costs in the state by $5.9 billion, net of costs, over the life of the measures. These savings, which would flow to all residents and businesses in the state, are equivalent to $565 per capita.
- North Carolina's existing efficiency policies and programs, if continued in their current form, would contribute 4% toward North Carolina's 2030 climate goal of reducing 2005 emissions by 70% in the electric power sector. They provide a strong foundation for the additional efforts needed to achieve North Carolina's GHG reduction targets.
- New policies and expanded EE programs targeted at the building and industrial sectors can cost effectively reduce North Carolina's power needs by 12% in 2030 and 19% in 2040.
- The most promising policies include EE targets for utilities, residential and commercial building codes, and financing tools such as commercial Property-Assessed Clean Energy (C-PACE). Establishment of a statewide, nonprofit clean energy fund would serve as an important enabler to scale up efficiency investments for underserved sectors. Building performance standards and zero-energy codes provide additional GHG reduction opportunities, but these were not included in our study.
- In addition, these policies can avoid air pollution that contributes to heart attacks, respiratory illnesses and symptoms, premature deaths, and emergency room visits to treat asthma. We estimate $300–700 million in cumulative avoided health harms from pollution if North Carolina were to implement the EE policy and program recommendations detailed in this report.

North Carolina faces a crossroads in its clean energy future. As states around the country confront economic recession and a continued public health crisis due to COVID-19, many policymakers are looking into strategies that can bring back vital, well-paying jobs and support local economic recovery. North Carolina also faces the impacts of climate change on its shorelines and in its most vulnerable communities. To address the climate crisis, North Carolina seeks to reduce its GHG emissions from the electric power sector by 70% in 2030 relative to 2005 levels; beyond that, it aims to reach carbon neutrality in the sector by 2050. In developing a strategy to achieve these goals, the state is building on the steps it took in the last decade to build its clean energy economy, and it is doing so based on a strong foundation of EE. Our analysis finds that North Carolina has ample opportunities to invest in EE as a tool to support economic recovery while building a robust and sustainable clean energy economy for the long term.

This report presents a suite of policies and programs that can cost effectively reduce North Carolina's annual energy demand. These policies can potentially save more than 28,700 GWh in 2040, which is equivalent to meeting 18.5% of North Carolina's electricity needs in that year. By making these investments in energy-efficient technologies, the state can accelerate progress toward its climate goals and avoid more than $300 million in health costs from the air pollution that leads to respiratory illnesses, heart attacks, and asthma. Efficiency also helps improve the resilience of buildings and can lower energy bills, which are disproportionately high for the state's low-income, African American, Latino, and renting households.

North Carolina Should Build on Progress from the Last Decade

North Carolina has already taken a number of important steps to improve EE for businesses and households, and it is a regional leader on efficiency in the Southeast. Utilities, especially Duke Energy Carolinas and Duke Energy Progress, have preserved and expanded programs for their customers, meeting a portion of their renewable portfolio standard goals with EE. Several of North Carolina's 32 electric cooperative utilities (co-ops) and 72 municipally owned utilities also offer efficiency programs, including energy audits, appliance replacements, demand-response programs, and financing or on-bill tariff programs. The state's Department of Environmental Quality has continued and expanded weatherization, industrial programs, business and institutional assessments, and performance contracting for public buildings.

We project that if continued at current levels, existing EE programs and policies will save North Carolinians more than 9,400 GWh per year in 2040, avoiding less than 4% of total projected GHG emissions in 2040. These levels will not be sufficient to meet the state's vital climate and economic goals. North Carolina still ranks well below national leaders on key indicators of efficiency achievement. Compared to leading states, North Carolina's annual energy savings in its utility sector are less than one-third of those realized by high-performing states. Though it is the highest-performing state in the Southeast region, North Carolina ranks 26th in the *2019 ACEEE State Scorecard*. Given its status as a regional leader with substantial room for improvement on the national level, North Carolina has a unique opportunity to proactively adopt energy savings programs and policies that can benefit not just its own citizens but the entire Southeast region.

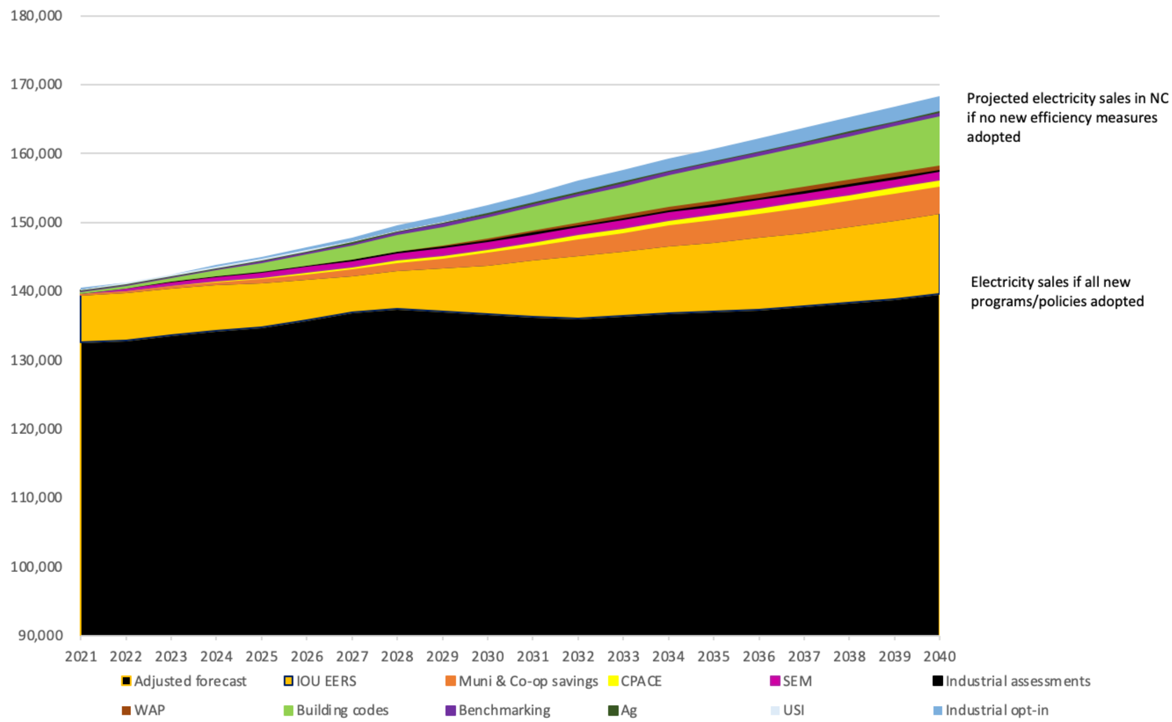
PURSUE ENERGY EFFICIENCY OPPORTUNITIES

North Carolina has strong potential to accelerate its EE policies. In this analysis, we capture existing efficiency efforts and model a suite of new or expanded electricity efficiency policy options based on the recommendations from the state's stakeholders and successful models implemented in other states. EE targets for utilities, in the form of Energy Efficiency Resource Standards (EERS), underpin savings opportunities across the buildings and industrial sectors. Co-ops and municipal utility targets can help extend savings to all customers. Further, establishing a statewide clean energy fund could support the agriculture sector as well as efficiency projects for low-income and affordable housing. This would ensure access to financing for underserved sectors, where utility programs are currently unavailable or insufficient. The legislature could address barriers to C-PACE, expand on-bill financing and bill tariff programs, strengthen building codes, and expand energy savings targets for public buildings. Multiple actors could support expanded programs for industrial customers, including industrial assessments and expansion of voluntary strategic energy management (SEM) programs. Cities could benefit from state and utility programs, and they could support code enforcement and building benchmarking.

These opportunities would create jobs and reduce household and business energy costs, directly supporting the communities hardest hit by crises like COVID-19 and addressing the growing gap in economic opportunity between the state's rural counties and large urban centers. These programs and policies include enhanced offerings for low-income, agricultural, and low-to-moderate income (LMI) multifamily customers, as well as for the businesses in the communities in which those customers live.

RESULTS

Figure ES-1 shows the contribution of the individual policies and programs we recommend in our EE Policy and Program Case (EE case). Implementing this suite of policies would contribute savings of more than 28,700 GWh, meeting 18.5% of North Carolina's projected electricity needs in the year 2040. This is more than three times the savings from continuing existing policies.



ES-1. Share of electricity from EE policies and programs in the EE case. ***Note:*** **The scale is truncated at 90,000 GWh to enable view of individual recommendations. The adjusted forecast represents the projected electricity sector demand if all recommended EE policies and program expansions are adopted.**

The cost–benefit analysis of these programs and policies shows that their benefits exceed their costs; specifically, investing in this suite of achievable policies and programs would result in estimated net benefits of $5.9 billion in avoided electricity costs to the state. Additional societal benefits, in the form of avoided CO_2 equivalent (CO_2e) emissions, range from $1.6 billion to $3.3 billion through 2040 alone (the lower end of the range assumes a cost of carbon starting at $5/ton and ramping up to $50/ton, while the upper end assumes a cost of carbon starting at $5/ton and ramping up to $110/ton).

Investments in EE could also create new clean energy jobs in North Carolina, increasing both wages and gross state product. Before the COVID-19 pandemic, North Carolina was sixth in the country in EE jobs, with 86,559 EE workers (E4TheFuture and E2 2019). Reinvesting in this sector could help the state's clean energy industry recover from the devastation of COVID-19.

Based on the current statewide forecast, if North Carolina continues with existing policies and programs, it is projected to produce 42.46 million metric tons of CO_2e ($MMTCO_2e$) in 2030. The EE policies outlined in this report would bring statewide electric sector emissions an additional 13% closer to the 2030 target of 23.81 $MMTCO_2e$. By improving local air quality, such reductions would also deliver $300–700 million in avoided health harms in North Carolina communities.

RECOMMENDATIONS AND CONCLUSIONS

North Carolina has parallel opportunities to recover sustainably from the COVID-19 crisis while simultaneously building its clean energy economy and mitigating the effects of climate change. North Carolina lost more than 16,600 EE jobs from March to June of 2020, despite gains of more than 4,400 jobs as the state got back to work in June. Investment in this critical sector could help to regain those local jobs, create new job opportunities, and address the affordability crisis by reducing bills and targeting savings where they are needed most.

The state has taken important steps forward in the past decade, most recently in its work to develop a Clean Energy Plan in response to Governor Cooper's Executive Order 80. That plan aims to: 1) reduce GHG emissions by 70% from 2005 levels by 2030 and reach carbon neutrality by 2050, 2) foster long-term energy affordability and price stability, and 3) create economic opportunities for both rural and urban areas of the state. Based on our analysis, we offer six recommendations for North Carolina to deliver on its potential as an EE powerhouse:

- *Build on the Existing Foundation of Policies.* The state is a regional leader in EE, with savings coming from utility programs, weatherization, building codes, and voluntary industrial efforts. If maintained at present levels, these programs will save more than 9,400 GWh in 2040 and contribute 4% toward North Carolina's 2030 climate goals in the electric power sector.
- *Leverage EE as a Tool for Job Growth*. EE is a driver of job growth and economic revitalization. COVID-19 has hit the state's EE sector hard, with losses of more than 16,600 jobs this spring. Driving investment in EE can help get those North Carolinians back to work.
- *Establish Minimum Efficiency Targets to Drive Utility Sector Progress*. Shift EE targets for investor-owned utilities from being an optional element of the renewable portfolio standard to being a stand-alone minimum target that creates a sustainable, long-term signal for EE. Ensure that a portion (one-fifth) of those savings comes from offerings for low- and moderate-income customers, and that co-ops and municipal utilities also set their own ambitious savings targets.
- *Reform Policies that Prevent Utilities from Contributing to GHG Reductions*. Remove two key barriers: 1) barriers to participation in utility programs for industrial customers, and 2) barriers to adoption of high-efficiency heat pumps through efficient fuel switching for heating, water heating, and other uses in buildings and industry.
- *Focus Efforts on Underserved or Newly Vulnerable Populations*. Increase policy emphasis on communities traditionally underserved by program offerings, including rural, low-income, and renter families, and agricultural and small businesses.
- *Futureproof North Carolina's Policy Environment with Advances in Financing and Buildings*. Enact and implement the codes, benchmarking, and financing tools needed to support a robust private market for EE.

With a commitment to EE from policymakers, utilities, households, and businesses, North Carolina can seize the opportunity to address both immediate economic recovery and the effects of climate change. A strong set of EE policies and programs can help to make up

COVID-19-related job losses in the efficiency sector, reduce energy insecurity for customers, and support fresh economic development in the state.

Introduction

Clean energy is a growing and vital part of North Carolina's economy and a key solution to meeting the state's climate goals. With 3,375 miles of coastline, an economy largely driven by agriculture, and increasingly severe weather events such as hurricanes and flooding due to the effects of climate change, North Carolina needs a comprehensive climate solution to protect the economic, environmental, and physical well-being of its residents.

In 2018, Governor Roy Cooper's Executive Order 80 (EO 80) committed to reducing the impacts of climate change while capturing opportunities from the clean energy economy to address long-term energy affordability and economic development across rural and urban parts of the state. In 2019, the North Carolina Department of Environmental Quality (DEQ) went through an extensive 10-month stakeholder process to craft a holistic vision for the state's clean energy future, ultimately presented in its Clean Energy Plan (North Carolina DEQ 2019b). As the state shifted toward implementing that effort in early 2020, policymakers rightly shifted their focus toward response to and relief from COVID-19's health and economic impacts.

While the impacts of both climate change and COVID-19 are already affecting—and will continue to affect—all North Carolinians, the state's disadvantaged groups and communities will be disproportionately impacted by these challenges. Even before COVID-19, the past few decades have revealed a growing divide in population growth, employment, and income between the state's rural counties and large urban centers. For example, although 15 of North Carolina's 100 counties grew 10% or more in population between 2010 and 2018, 43 counties saw a net loss of people; these changes mirror divides in household income and employment trends (Henderson and Chemtob 2019).

Energy efficiency (EE) offers an important solution both challenges. EE supports economic development, creating jobs that cannot be exported out of state. North Carolina had 86,559 EE jobs in 2019, accounting for 16% of all construction jobs and 41% of all energy sector jobs (E4TheFuture and E2 2019). Unfortunately, COVID-19's impact has disproportionately affected jobs in the efficiency sector, resulting in a loss of 16,600 of North Carolina's EE jobs in the spring of 2020, representing 19% of the state's total EE workforce (Jordan 2020). Bringing back these jobs will be critical to the state's economic recovery. EE workers are important to helping implement public health recommendations, such as improved building ventilation systems, and their work can address underlying respiratory health issues through preventative measures as a part of home heating retrofits and weatherization (Nadel 2020). Because the income and economic benefits of efficiency jobs are all local, prioritizing employment in EE is an ideal way to stimulate the economy as it reopens.

EE also directly benefits utility customers; unlike centralized generation resources, it can target savings where and when they are needed most, directly reducing customer utility bills and making homes and buildings more comfortable, safe, healthy, and productive. As of July 15, more than 1.3 million residential accounts were eligible for disconnection (but have not been disconnected) and 84,685 nonresidential accounts were also at risk of being disconnected (Mission:data Coalition 2020). Policymakers and utilities can take critical short-term measures to support families and businesses directly, such as providing bill payment assistance, removing punitive fees for nonpayment, and declaring disconnection moratoria. In addition to these measures, providing no-cost EE programs targeted at at-risk customers can reduce the risk of arrearage and lower customers' energy burdens over the long term.[1]

EE is also a crucial tool for mitigating the impacts of climate change, and it is less expensive than most other electricity resource options (Hoffman et al. 2018; Lazard 2017). ACEEE research finds that EE can slash U.S. energy use and greenhouse gas (GHG) emissions by approximately 50% by 2050, getting us halfway to our national climate goals (Nadel and Ungar 2019). Further, EE remains the cheapest energy resource on average, and investments in EE can mitigate reliance on more expensive utility investments. EE reduces costs for all customers in the system by reducing fuel costs and market purchases (Baatz 2015). In the 2015 program year, EE programs cost utilities, on average, about 3.1 cents per kilowatt-hour (kWh) levelized nationally, including program costs and performance incentives (Molina and Relf 2018). Data from North Carolina investor-owned utilities (IOUs) have shown a similar levelized cost of saved energy. For example, in 2018, average efficiency portfolio costs ranged from 2.3 to 3.5 cents per kWh based on spending and savings data reported in ACEEE's *Utility Energy Efficiency Scorecard* (Relf et al. 2020).

The emission reductions from EE can also lead to significant gains in public health by avoiding the burning of fossil fuels, consequently reducing pollution from fine particulate matter ($PM_{2.5}$), nitrogen oxides (NO_x), and sulfur dioxide (SO_2), which lead to respiratory illnesses, heart attacks, and asthma. ACEEE's research found that reducing electricity use by 15% nationwide would save Americans up to $20 billion through avoided health harms annually. North Carolina ranked among the top 10 states that would see the largest avoided health harms—which include reductions in heart attacks, respiratory illnesses and symptoms, premature deaths, and emergency room visits for asthma treatment—from investments in EE and subsequent emissions reductions in the electric power sector (Hayes and Kubes 2018). EE also delivers a host of other benefits, such as improving grid reliability and increasing resilience in the face of increasing storm frequency (Relf, York, and Kushler 2018).

North Carolina, like many other U.S. states, is at an inflection point for climate change and for its response to the ongoing COVID-19 health and economic crisis. The policy choices that the state makes now will define the vibrancy of its clean energy economy for years to come. While EE offers the potential for myriad near-term economic benefits to support economic recovery, it will also be crucial in defining North Carolina's decarbonized future.

The State of Play: North Carolina's Energy Landscape in 2020

A decade ago, ACEEE conducted a statewide analysis of EE potential in North Carolina. At the time, the state was continuing to experience a resurgence of interest in clean energy that began in the years before the Great Recession. In the decade since ACEEE's last analysis, the state's energy landscape has shifted dramatically due to the ongoing transition away from a

[1] *Energy burden* is defined as the percentage of household income spent on home energy bills. ACEEE has found that high energy burdens most often affect low-income, Black, Latino, low-income multifamily, and renter households in cities such as Charlotte, North Carolina. Please see ACEEE's 2020 Energy Burden report: www.aceee.org/energy-burden

coal-dominated power grid and an unprecedented boom in the clean energy economy (see figure 1). State energy policies such as the Renewable Energy and Energy Efficiency Portfolio Standard (REPS), along with environmental policy actions such as the Clean Smokestacks Act and market forces—including favorable Public Utility Regulatory Policies Act (PURPA) conditions, state and federal tax credits, and low natural gas prices—have created a demand for affordable, cost-effective, cleaner energy sources. North Carolina is now a leader in total installed solar capacity, not just in the Southeast but nationwide, second only to California (EIA 2019). The REPS policy has accelerated clean energy and EE deployment throughout the state, with new program offerings from large utilities, such as Duke Energy, as well as smaller co-ops and municipal utilities. Established in 2008, REPS requires that, by 2021, 12.5% of retail electricity sales (and 10% of sales for non-IOUs) come from renewable energy and efficiency, with up to 40% of that goal allowed to be met with EE savings (NC SB 2007-397).[2] In 2017, the state passed the Competitive Energy Solutions for NC bill (HB589), which created new programs for competitive renewable energy procurement, solar rebates and leasing, and community solar. If all of the bill's requirements are fulfilled, it will lead to a doubling of current capacity to 4,000 megawatts (MW) by 2025.

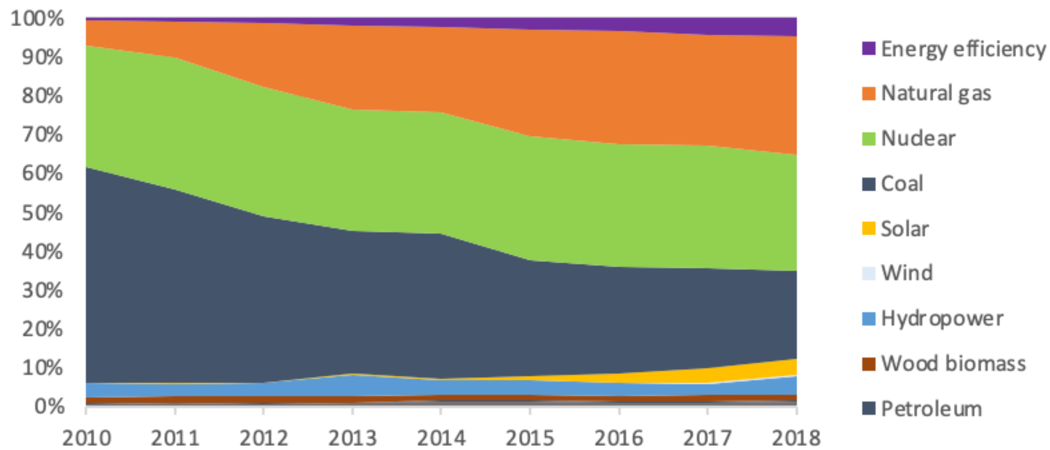


Figure 1. North Carolina's electricity generation by source, 2010–2018. *Sources:* EIA 2019 and ACEEE *State Scorecards* 2010–2019.[3]

Despite the dramatic shift in energy generation toward a less carbon-intensive grid, North Carolina has ample opportunities to build on its momentum and status as a regional leader in clean energy and EE. The state faces legislative and procedural barriers, however, that hinder it from achieving its full EE potential. Although some utilities are maximizing contributions to the REPS from EE, the combined RPS/EERS policy has not been successful

[2] Cooperative and municipal utilities have no limit on the amount of EE they can use toward REPS. Until 2020, the ceiling for IOUs was 25%.

[3] We estimated North Carolina's cumulative MWh savings from EE compared to other electricity generation resources (see figure 7). We assumed that savings from investments made from 2010–2018 would persist at the end of the period in 2018, based on the average portfolio measure life of 11.25 years across utilities in the *Utility Scorecard* (Relf et al. 2020). EE program savings equivalent to less than 1% of total sales in MWh per year starting in 2010 resulted in cumulative energy savings equivalent to 4.87% of total electric industry demand by 2018.

at promoting high levels of energy savings, resulting in average statewide electricity savings of 0.67% in 2018, which is less than the nationwide average of 0.73% (Berg et al. 2019).

Further, certain policies also limit EE for particular end-use sectors. For example, there is a clause that allows large commercial and industrial (C&I) users of more than 1,000,000 kWh per year to opt out of utility-run efficiency programs (NCUC R8-69 (d) 2007). While voluntary activity is an important part of North Carolina's landscape, this policy limits the transparency of energy data and may frustrate opportunities for deep energy and cost savings in the large C&I sector beyond the confines of capital budgets and company planning cycles. Additionally, state residential and commercial building energy codes lag the national standard, with the most recent codes equivalent to the 2009 International Energy Conservation Code (IECC) (DOE 2020b). EE experts are not represented on North Carolina's Building Code Council (NCBCC), which develops and evaluates future code changes. Because of this, the council oversaw rollbacks of modest and cost-effective changes to the state's minimum energy code requirements, locking in decades of wasted energy for thousands of buildings throughout the state (Weiss 2019). These barriers run contrary to the governor's stated goal of reducing GHG emissions statewide, as well as fostering long-term energy affordability and price stability for all ratepayers.

Since the passing of the REPS, the state has not enacted substantive legislation expanding EE. However, EE and renewable policies were preserved due to bipartisan defense of these policies in 2010, and clean energy bills have been introduced by legislative sponsors on both sides of the aisle (I. Urlaub, chief, strategy and innovation, NCSEA, pers. comm., July 22, 2020). In 2017, Governor Cooper announced that North Carolina would join the U.S. Climate Alliance, a bipartisan coalition of 24 governors committed to reducing GHG emissions consistent with the goals of the Paris Agreement. In accordance with those commitments, Cooper's administration issued EO 80 in 2018, and in 2019 DEQ released its Clean Energy Plan. This leadership has fostered a newfound interest in climate-focused energy policy in North Carolina. A broad coalition of stakeholders, along with regulators and policymakers, are working together to transition the state into a new energy economy.

Governor Cooper's EO 80 recognizes the need for North Carolina to reduce its GHG emissions to 40% of 2005 levels by 2025 (North Carolina Office of the Governor 2018). The Clean Energy Plan sets longer-term goals for the electric power sector of 70% reduction by 2030 and carbon neutrality by 2050, among the most ambitious targets in the country (North Carolina DEQ 2019b). Two additional goals established in the Clean Energy Plan were 1) to foster long-term energy affordability and price stability for North Carolina's residents and businesses, and 2) to accelerate clean energy innovation, development, and deployment in order to create economic opportunities for both rural and urban areas. The Clean Energy Plan also contains short- to medium-term recommendations (1–5 years) related to EE, equitable access, just transition, and beneficial electrification.

EE can, and should, be an integral part of this solution. In 2019, the Duke University Nicholas Institute led a stakeholder process to develop the North Carolina Energy Efficiency Roadmap (hereafter, *EE Roadmap*), a list of policy, program, and procedural recommendations, many of which were incorporated into the state's Clean Energy Plan (Weiss 2019; North Carolina DEQ 2019b). Here we analyze some of the recommendations in the *EE Roadmap* and Clean Energy Plan, including establishing an Energy Efficiency Resource Standard (EERS); updating statewide residential and commercial building energy codes to the latest 2021 IECC standard; creating a clean energy investment fund such as a green bank; and expanding programs targeted at hard-to-reach sectors such as multifamily and agriculture. Appendix B provides detailed information about the source of each recommendation that we analyze.

Several other studies have identified EE as a potential clean energy resource in North Carolina. A recent potential study for Duke Energy indicates annual achievable savings of up to 8,845 GWh by 2044 in the Duke Energy Carolinas (DEC) territory and 6,220 GWh by 2044 in Duke Energy Progress (DEP) territory (Nexant S&P Group 2020). In the multifamily sector, a 2015 study by the National Resources Defense Council (NRDC) and Energy Efficiency for All (EEFA) identified 629 GWh of achievable energy savings for affordable multifamily homes in North Carolina (Mosenthal and Reed 2015). Finally, in its 2018 report, the North Carolina Building Performance Association projects a total of $13.9 billion in energy savings with a 16.8% increase in investment for North Carolina homes and businesses (NCBPA 2018).

PROJECT AND METHODOLOGY OVERVIEW

Our study is a state-level analysis of the potential for policies and programs to increase EE to levels needed to achieve the majority of the building and industrial sectors' goals—namely, reducing the GHG emissions of the electric power sector by 70% below 2005 levels by 2030 and reaching carbon neutrality by 2050. Electricity generation is a major source of North Carolina's GHG emissions, contributing to 35% of emissions in 2017 (North Carolina DEQ 2019c). Our study aims to support local stakeholders in understanding the electricity savings potential, costs, and benefits of implementing the EE ideas included as a part of the 2019 EE Roadmap and the Clean Energy Plan. The state has substantial opportunities for EE savings, and its executive branch has signaled willingness and interest in action on climate change.

Responding to that opportunity, this study aims to inform policymakers and stakeholders of the opportunities for EE in electricity end uses and to suggest specific policies and program enhancements that they could implement in service of climate and economic development goals.

Study Scope and Limitations

This project focuses on policy and program opportunities for end-use electricity efficiency savings from buildings and industry. We chose this focus because generating electricity to serve buildings and industries accounts for 45% of the total GHG emissions in the state (North Carolina DEQ 2019c). In 2017, the residential sector accounted for 44% of total GHG emissions from electricity use, while the commercial sector represented 37%, and the industrial sector contributed an additional 19%, according to the state's GHG inventory report (North Carolina DEQ 2019c). End-use efficiency offers considerable opportunity to reduce electricity usage and emissions in these sectors. Throughout this report, we highlight additional opportunities for energy savings in buildings from natural gas, propane, and other fossil fuels from these policies and programs, but time and funding did not allow us to include a comprehensive analysis of those savings. In 2017, direct fossil fuel use in buildings accounted for 18% of the state's emissions, and it remains an important opportunity for savings. Similarly, it was beyond the scope of this study to examine opportunities for combined heat and power (CHP) as an economic and emissions reduction strategy for the state.

We examined peak demand trends for the reference case because EE offers significant potential to cost effectively reduce peak demand (Mims Frick et al. 2019). However, a detailed analysis of potential impacts was beyond the scope of our study.

Further, our study does not examine opportunities to reduce transportation sector emissions, which account for approximately one-third of the state's GHG emissions. Opportunities in that sector include vehicle efficiency improvements, land use planning and other location efficiency strategies, and electrification. While those were outside the scope of this analysis, our 2010 study did provide an overview of key opportunities for the state to improve vehicle and transportation system efficiency.

In 2009–2010, North Carolina experienced a water crisis due to drought. Our 2010 *North Carolina Energy Future* report therefore included an analysis of water efficiency along with an analysis of transportation efficiency. Water and transportation both remain important opportunities for North Carolina.

This study is not a traditional EE potential study, which provides granular, measure-level assessments of technical, economic, and achievable potential for utility planners. Rather, our analysis is designed to complement existing potential studies by contextualizing the specific and achievable program and policy opportunities that already exist in the region and across the country. For example, key assumptions related to program participation and ramp-rates are based on actual data from other regional and national jurisdictions. We focus on statewide opportunities, but in many cases, we separate potential savings by actor—including IOUs, co-ops and municipal utilities, state agencies, and local governments. Our goal is to show different stakeholders the GHG reduction opportunities that EE offers.

Stakeholder Engagement

We aim to reflect the priorities of key stakeholders in the state, as expressed in the Clean Energy Plan, the EE Roadmap, and in our stakeholder engagement throughout the project (North Carolina DEQ 2019b; Weiss 2019). In addition, we reviewed the energy landscape for cities, utilities, and the state from ACEEE's series of *Scorecards,* identifying promising policies that could be developed but do not yet exist in North Carolina. We vetted these policies with stakeholders to collect feedback on their economic and political feasibility.

Analysis Methodology and Report Outline

We organized this report into several sections as follows, briefly describing the methodology in each section; the appendices include further details on the methodologies and related resources.

- **The State of Play: Energy Efficiency in North Carolina Today**. This section provides background on the state's progress on EE since ACEEE's 2010 study, *North Carolina's Energy Future: Electricity, Water, and Transportation Efficiency.* It highlights those policies and programs that support North Carolina's role as an EE leader in the region, and it details the drivers of future EE performance.

- **Reference Case**. The first step in our analysis was to characterize the state's current and expected patterns of electricity consumption and peak demand over the study's time period (2018–2040). As part of this first step, we provide a reference case for utility avoided costs in North Carolina and a forecast for retail electricity prices in the state. We vetted this reference case for electricity with stakeholders.
- **Continue Existing Efforts (CEE Case)**. In this section, we assess the potential electricity savings and GHG emissions reduction from North Carolina's existing policies and programs—assuming no policy changes are made—projected forward over the study's duration (2018–2040). We highlight the state's expected progress absent changes to policy, as well as the state's achievements to date.
- **Energy Efficiency Policy and Program Opportunities (EE Case)**. For this analysis, we developed and analyzed a suite of new or expanded policies and programs based on successful models implemented in other states and in consultation with North Carolina stakeholders. The case in this section assumes reasonable program and policy penetration rates to capture the cost-effective and achievable resource potential informed by recent potential studies, a meta-review of EE potential studies discussed in Appendix C, and actual program and policy experience from other states. The EE case captures savings from the CEE case in addition to these new savings to represent the total opportunity for EE to meet electricity demand.
- **Results of the Energy Efficiency Program and Policy Case.** This section presents the electricity impacts attributable to the implementation of EE measures as a result of the policies and programs in the EE case. The results include the savings from the CEE case. We also analyze the programs' associated costs and benefits to the state and to participants. Finally, we detail potential CO_2 emissions reductions—and the resulting health impacts—in North Carolina from improved efficiency in the electricity sector.
- **Recommendations**. This section presents a set of recommendations for policymakers and stakeholders who want to implement the programs and policies analyzed in the EE case. We discuss potential timelines and options for packaging actions together and for prioritizing actions based on current priorities.

Reference Case

We collected data to characterize North Carolina's current and expected patterns of electricity consumption and peak demand for 2020–2040. Our analysis uses a reference case vetted with stakeholders and leverages data from the Energy Information Administration (EIA), utility docket filings, and other publicly available sources. We did not account for the COVID-19 pandemic's potential impacts on near-term energy consumption because those impacts are uncertain and are not yet modeled in the integrated resource plans (IRPs) of North Carolina's major utilities. Our focus is on long-term energy savings and emissions reductions opportunities for 2022–2040. Electricity consumption trends are not expected to be materially impacted by COVID-19 in 2030 or beyond (Mahajan 2020).[4] The reference case excludes estimates about the continuation of existing utility EE policies and programs included in Duke's IRPs as these savings are captured in the CEE analysis. Appendix A includes detailed assumptions.

In 2018, IOUs in North Carolina accounted for 73.7% of the state's electricity sales, while municipal utilities composed 12.1% and customer-owned electric co-ops made up the remaining 14.2%. DEP, DEC, and Dominion Energy are the three IOUs in North Carolina; they were responsible for 28%, 43%, and 3% of statewide sales, respectively. Of the total IOU electricity sales, 44% were from the residential sector, 36% from the commercial sector, and 20% the industrial sector (EIA 2020c).

For electric co-ops, which primarily serve the state's more rural and small-town areas, we forecast an average annual decline of 0.37% per year in total energy sales due to population shifting to more urban areas. While some load growth due to increased transportation electrification is expected, it is not expected to significantly change the overall decline in sales for co-ops serving rural areas (Schurhoff et al. 2020).[5] We expect municipal utilities to see an average annual increase of 0.16% per year in overall load; this is less than expected load growth for the Duke Energy utilities, which provide electricity to some of the fastest-growing areas of the state, including major metropolitan areas, and which are projected to increase sales by 12% across all sectors by 2040. Toward 2040, we anticipate increases in the commercial, residential, and industrial loads for Duke. To project this demand growth, DEC used average annual growth rates of 1.1% for the residential load, 1.1% for commercial, and 0.4% for industrial. DEP used 1.3% for residential, 0.8% for commercial, and 0.5% for the industrial sector (DEC 2019; DEP 2019b). Overall statewide electricity usage will increase steadily—approximately 0.36% annually—over the intervening 20 years, especially in areas served by IOUs. Appendix A includes further sector-specific projections.

[4] In the GHG analysis below, we remove the utility EE (UEE) savings from the EE case savings because the NC DEQ GHG inventory relies on estimates of needed generation from Duke's IRPs that most likely account for UEE.

[5] Our analysis was completed before the announcement that the Atlantic Coast Pipeline was cancelled. It is unclear how planned new natural gas generating capacity will be affected by this cancellation and how it will shift the landscape for beneficial electrification.

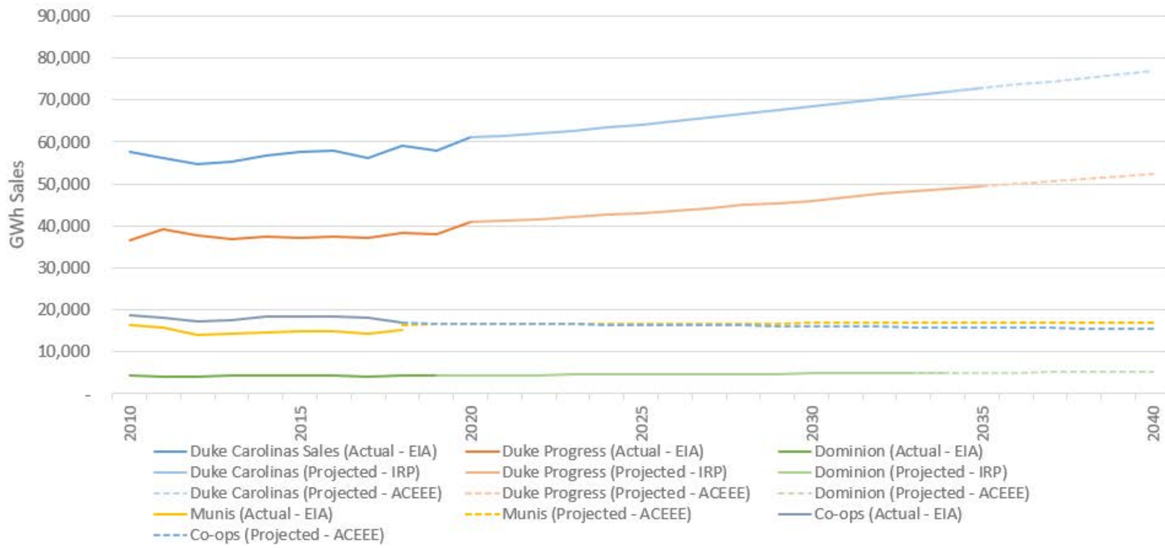


Figure 2. Electricity sales forecasts in North Carolina. *Sources:* EIA 861 and 861s, DEP IRP 2019, DEC IRP 2019, Dominion IRP 2019, EPRI 2017.

Figure 2 shows the reference case for electricity sales growth in North Carolina, which forms the foundation for our quantitative analysis of efficiency programs and policies. The base year for electricity sales is 2018, which is the most recent year for which the EIA provides comprehensive electric sales data. Historical sales are based on data from EIA 861 (EIA 2020a). We predict statewide sales growth from 138,000 GWh in 2018 to 148,000 GWh in 2040.[6] Figure 2 projects electricity sales, with the utility EE programs included in IRPs.[7]

[6] Note that our reference case data for electricity represent electricity sales "at the meter" rather than electricity "at generation." Electricity sales "at the meter" are lower than "at generation" because of some line losses in the transmission and distribution (T&D) system from the point of generation to the customer meter. Energy efficiency avoids electricity at the customer meter and avoids line losses. However, to be consistent with the reference case data being at the meter, our EE case also represents electricity savings at the meter. We did not capture additional electricity savings of avoided line losses in our EE case.

[7] Note that because these values are accounted for in our Continue Existing Efforts (CEE) case, to avoid double counting these savings, we subtracted Duke UEE's total GWh savings from the anticipated savings in the CEE and EE cases.

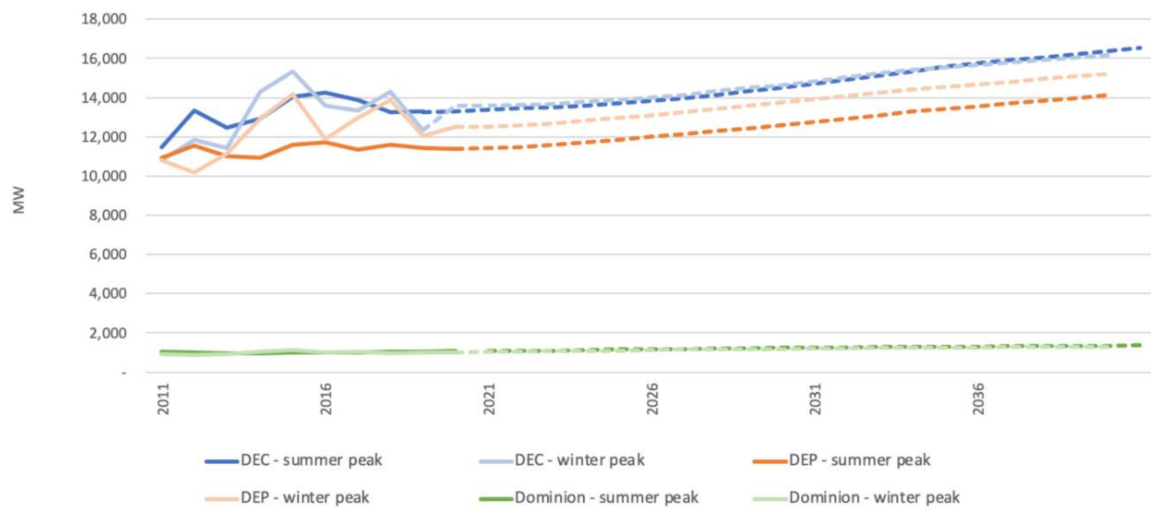


Figure 3. Peak demand forecast in North Carolina. *Sources:* DEC IRP 2019, DEP IRP 2019, Dominion IRP 2019, NCUC DSM Filings for DEC and DEP 2019.

Figure 3 shows our peak demand forecast, which we developed from the IRPs filed by two of the three state IOUs (DEP 2019b, DEC 2019). Peak demand forecasts were not available for municipal utilities and co-ops; however, we used this forecast statewide because co-ops and ElectriCities, the association for municipal utilities, buy most of their power from Duke Energy. The load forecast data for both Duke Energy IOUs show that one has already shifted to a winter peak, and the other is expected to shift from a summer to a winter peak by 2025. In the Southern Alliance for Clean Energy's (SACE) 2018 report, *Seasonal Electricity Demand in the Southeast*, it was determined that the Southeast region is dual peaking, and that peak electric load is declining overall. Additionally, winter peaks vary more than summer peaks, which tend to be less than five hours on average and have similar load shapes. For most utilities, winter peaks are shorter than summer peaks, though some strong winter peaking systems have longer peaks of up to 12 hours (Wilson and Shober 2020). We examine peak demand trends here because EE can offer significant potential to reduce peak demand. However, a detailed analysis of potential impacts was beyond our study's scope.

To estimate EE's system benefits, we created an avoided cost forecast, including avoided energy, avoided capacity, and avoided transmission and distribution (T&D) projections from 2021–2040 to calculate total avoided costs (in $/MWh) for summer and winter for the IOUs. We used Federal Energy Regulatory Commission (FERC) Form 714 load factor data to translate avoided capacity and T&D values into average annual values relative to energy expressed in $/MWh (FERC 2019). We used these values to determine simple averages and weighted avoided costs based on the proportion of statewide load from each utility.

Figure 4 shows the estimated changes in average retail price (cents/kWh, nominal value) for each sector based on historical trend data from 2010–2018, and applied to a base year of 2018; we removed outliers from consideration beyond two standard deviations. Residential retail price forecasts were based on EIA data from AEO 2020 for SERC-East (EIA 2020b). Overall, across all sectors, we calculated an average price decline of –0.32% annually. Despite this average decline, our projections actually indicate an increase in residential prices, from a state average of 11.09 cents/kWh in 2018 to 12.21 cents/kWh in 2040. The overall average decline can be attributed to commercial prices, which we anticipate decreasing from 8.58 cents/kWh in 2018 to 8.25 cents/kWh in 2040. Further, we expect the already low industrial rates to decrease further, from 6.33 cents/kWh in 2018 to 5.60 cents kWh in 2040. While retail electricity prices are not a direct input to the program administrator cost test (PACT) or the utility cost test (UCT) cost–benefit analyses, they are a factor for understanding participant drivers for investing in efficiency; we therefore use them as an input for the participant cost test (PCT) analysis.

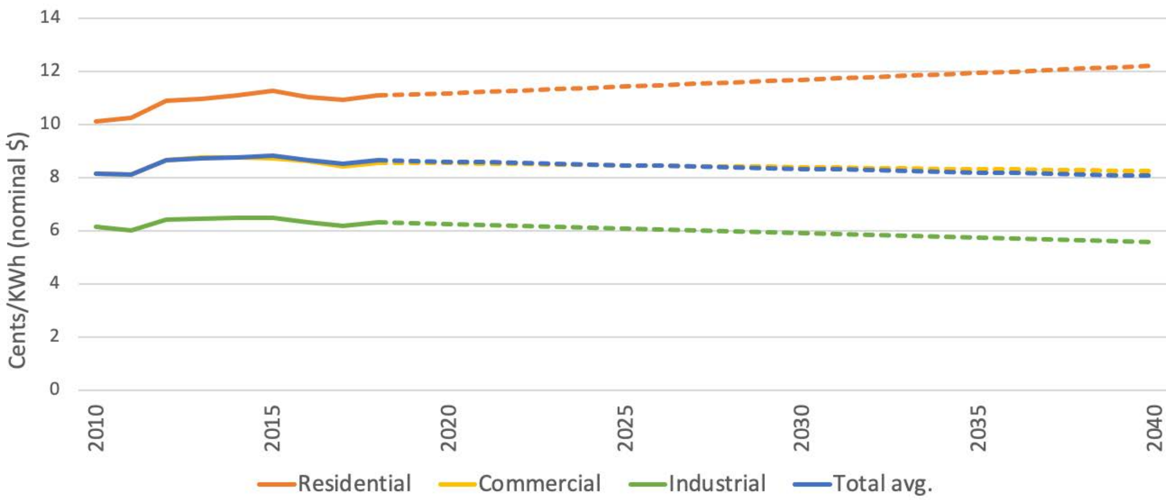


Figure 4. Electricity retail prices in North Carolina 2010–2040. *Source:* EIA 2019.

Continue Existing Efforts Case

As noted above, North Carolina has already made considerable progress on EE over the past decade, solidifying its status as a regional leader in climate and energy policies and programs. Following efforts in the legislature to dismantle or repeal many of the preexisting efficiency programs, utilities—including Duke Energy—took action to preserve and expand existing programs within their service areas. This has resulted in moderate gains in efficiency throughout the state over the past decade and brought efficiency programs to neighboring states such as South Carolina. Leadership has come from several state agencies, including DEQ; nonprofit groups such as the North Carolina Sustainable Energy Association (NCSEA), the Southern Alliance for Clean Energy (SACE), the North Carolina Building Performance Association, and the Environmental Defense Fund (EDF); academic institutions such as Duke University and North Carolina State University; technical assistance and ratepayer education organizations such as Advanced Energy; and electric utilities, including co-ops and municipal utilities, as well as Duke Energy. Here, we discuss the gains made so far with existing EE programs, which have brought energy, cost, and GHG savings to millions of North Carolinians.

It is not certain, however, that these recent EE gains will survive without continued initiative and investment on behalf of the state government, utility program managers, and advocates. In recent years, the largest source of efficiency spending has been the state's two largest utilities, DEP and DEC. Recent filings demonstrate a projected decline in savings from 1.24% of sales in 2016 to 0.74% in 2020 for DEP, and from 1.2% in 2019 to 0.94% in 2021 for DEC, according to each utility's demand-side management (DSM) cost recovery filing with the North Carolina Utilities Commission (NCUC; see figure 5). Dominion's EE contributions to the REPS grew 31% from 2015–2017, but it is unclear from current filings whether that growth has continued in filed and approved programs in North Carolina (NC-RETS 2020; Dominion Energy North Carolina 2018a, 2019b).[8]

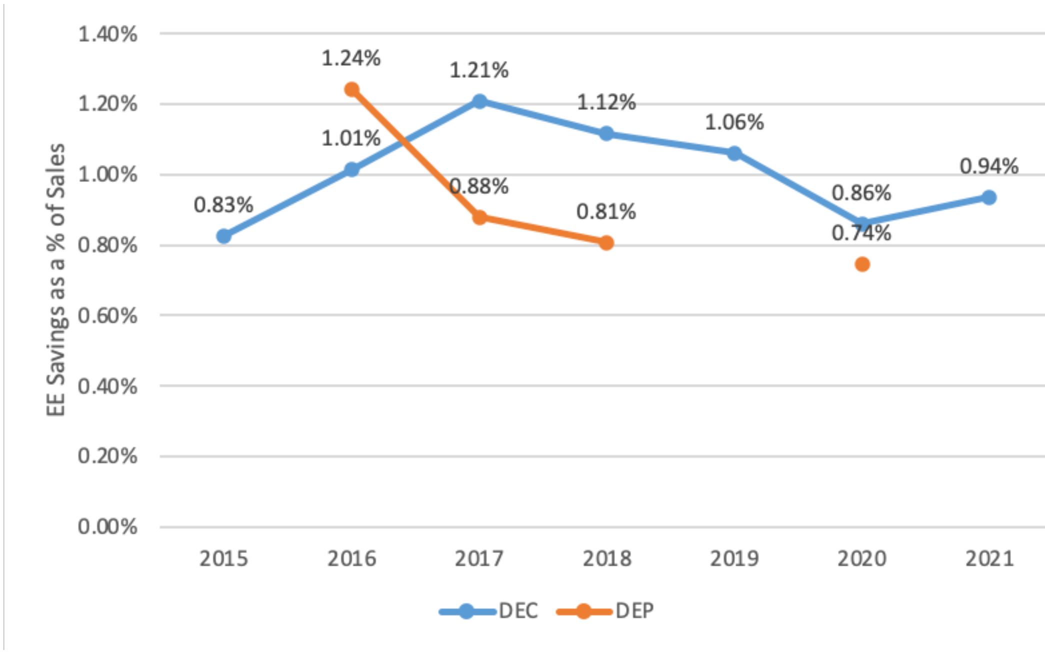


Figure 5. EE savings as a percentage of sales for Duke utilities. The 2020–2021 data indicate future year savings forecasts. *Source:* DSM cost recovery filings (DEC 2020b; DEP 2019a).

Our analysis of the Continue Existing Efforts (CEE) case serves to recognize the work already being done by state and local governments, utilities, and nonprofits in North Carolina. While much opportunity remains for greater savings through new and expanded programs, the existing EE portfolio serves as an important base of savings. By analyzing this case, we aim to understand the energy savings we would expect to see under a continuation of existing efforts in North Carolina.

Statewide Energy Efficiency Programs

The following statewide programs are implemented by state agencies or community groups. For each program listed below, we estimate savings that would likely be realized for the CEE case.

NCDEQ SEO UTILITY SAVINGS INITIATIVE

The North Carolina State Energy Office administers the Utility Savings Initiative (USI), a public sector program to coordinate and support energy and water management and

[8] Dominion's DSM cost recovery filings report savings of 10,420 MWh in 2018 and 124,394 MWh in 2019. Such a large increase may be attributable to Dominion's growing investment in Virginia in 2018 in response to the Grid Transformation and Security Act of 2018; it is not clear from the filings how those savings are allocated to Dominion's North Carolina service territory.

conservation programs among the state's publicly owned buildings (North Carolina DEQ 2019a). Since its establishment in 2002, USI has overseen energy and water conservation projects in state agency buildings and the University of North Carolina (UNC) system. In collaboration with U.S. Department of Energy (DOE) Better Buildings project, the USI program's initial goal was to reduce state-owned building energy consumption per gross square foot by 30% by 2015 (relative to a 2002–2003 baseline). As of 2019, this program's efficiency improvements have saved taxpayers approximately $1.3 billion in avoided utility costs, as well as avoided GHG emissions equal to 3.64 million metric tons of CO_2 equivalent ($MMTCO_2e$). Based on this success, the 2018 EO 80 extended this commitment to a 40% reduction by 2025 for cabinet agencies. The House passed legislation (H 330) to enter this target into law and also extend the savings target to non-cabinet agencies and UNC system buildings, but the bill has yet to pass the Senate (Ouzts 2020).

In addition to overseeing energy savings projects, USI also benchmarks energy use in public buildings. Buildings participating in USI report energy consumption and price data to DOE's Better Buildings center, where energy savings progress is monitored relative to a baseline (DOE 2020a). Currently, the benchmarking initiative collects energy data from state agencies, UNC system buildings, and community colleges. As of 2020, this benchmarking does not cover primary and secondary K-12 schools. EE Roadmap recommendation #2 calls for USI to expand to encompass this additional public building stock.

Participating institutions can access affordable financing for EE upgrades via the USI-run Performance Contracting program. This program enables financing of large upgrades via Guaranteed Energy Savings Contracts, which allow for taxpayers to see these savings immediately. USI staff provides technical assistance, project review, and guidance to agencies and other state governmental units engaging in performance contracts. A state or local institution that wishes to participate in the Performance Contracting process issues a request for proposals (RFP) process to select the most qualified contractor based on level of savings, overall project cost, and speed of delivery. For projects on the local level, such as K-12 schools or town government buildings, the Local Government Commission must approve all performance contracts chosen by the local institution.

OTHER STATEWIDE PROGRAMS

- **Building Codes**. North Carolina last updated its building codes in 2018, with the new codes going into effect on January 1, 2019. These energy codes are based on the 2015 IECC standards but contain amendments that largely reduce stringency. Due to these loopholes, DOE has determined that the current building code is equivalent to the 2009 IECC for residential and ASHRAE 90.1-2010 for commercial (DOE 2020b). Because North Carolina is a Dillon's Rule state,[9] these codes are developed on a statewide level and enforced locally. A 2017 DOE field study found that 88% of residential homes surveyed in North Carolina were compliant with codes (Bartlett et al. 2017)

[9] In Dillon's Rule states, as opposed to Home Rule states, local governments have only the powers specifically delegated to them by statute. For more information, see canons.sog.unc.edu/is-north-carolina-a-dillons-rule-state/ .

- **Waste Reduction Partners (WRP).** Under the DEQ umbrella, WRP consists of an organized network of efficiency professionals throughout the state. It provides audits and technical assistance targeted at nonresidential sectors, particularly industry and agriculture. This program is funded through grants from DOE, the U.S. Department of Agriculture (USDA), and other federal and state agencies. While WRP also offers water conservation and solid waste management support, EE accounts for more than half of the program's savings. Since 2012, WRP projects have saved approximately 9 GWh annually for a total cumulative savings of 594 GWh. If current levels of funding are maintained, we expect WRP to deliver 100 GWH of savings in the year 2030 for commercial, industrial, and agricultural energy users.
- **Weatherization**. North Carolina's Weatherization Assistance Program (WAP) is funded through a combination of federal grants and state and utility contributions, which are directed to local community action agencies (CAAs) to install energy-saving and weatherization measures on income-qualified homes. To be eligible for weatherization, household income must be at or below 200% of the federal poverty level. Some of the federal Low Income Home Energy Assistance Program (LIHEAP) funds also contribute to residential weatherization.
- **Housing Trust Fund (HTF)**. The North Carolina HTF, funded by the General Assembly and administered by the Housing Finance Authority (HFA), has been a flexible resource for affordable housing in the state since its founding in 1973 (NCHFA 2020). In addition to providing affordable mortgages, low-cost loans for new construction, and services for existing home retrofits, the HTF requires that units meet a minimum EE standard. EE Roadmap recommendation #17 recognizes the importance of continuing to fund the HTF in order to provide affordable housing, jobs, and energy-efficient living to thousands of North Carolinians each year (Weiss 2019).

SECTOR-SPECIFIC AND VOLUNTARY PROGRAMS

- **Co-ops and Municipal Utility Programs**. A number of North Carolina's 32 electric co-ops and 72 municipally owned utilities offer efficiency programs including energy audits, appliance replacements, and demand-response programs. For example, Roanoke Electric Cooperative offers Upgrade To $ave, which is an example of an on-bill tariff program for EE upgrades (SELC 2015). We reviewed reported savings values for these utilities from both EIA and North Carolina RETS to inform the CEE case.
- **Industrial Programs.** DEQ operates an Environmental Stewardship Initiative (ESI) through which members commit to self-imposed energy-saving goals. This voluntary program captures some of the savings that fall within the scope of a statewide strategic energy management (SEM) program. We projected the self-reported savings enabled by the ESI program forward and excluded them from the SEM program's potential savings. We used an average of historical yearly savings from the ESI program and an average measure life of six years to project savings to 2040. Some existing savings are enabled by Superior Energy Performance (SEP) and other federal programs, but none are large enough to be considered in the CEE case. The same is true for agricultural audits, Industrial Assessment Center (IAC)-, and

WRP-implemented recommendations, for which savings are supplemented in projections through additional funding and/or infrastructure.

Duke Utilities Energy Efficiency Portfolio

The majority of North Carolina's EE investment is carried out by Duke Energy, the larger of the state's two IOUs, through its operating companies DEP and DEC. Although the DEP and DEC service territory covers portions of both North Carolina and South Carolina, most of their retail kWh sales are in North Carolina—as is most of their EE program spending and savings (Duke Energy Collaborative 2020).

Following is a brief overview of Duke's EE programs, which comprise various measure types and are typically targeted to specific customer segments.[10] Duke's existing IRP filings continue expected savings from Utility Energy Efficiency (UEE) through 2034, and the recently published potential study for DEC and DEP indicates continued opportunity through 2044.

RESIDENTIAL PROGRAMS

- **Income-Qualified Programs.** The Neighborhood Energy Saver program targets low-income neighborhoods for home energy audits and direct-install measures at no cost to the resident. These programs served more than 9,000 homes in North Carolina, resulting in energy savings of more than 12,000 MWh in 2019. In addition, DEC offers incentives in partnership with the income-qualified weatherization program, financing appliance replacements and home energy retrofits that are implemented through local CAAs.
- **Energy Efficiency Education Programs.** Duke offers an educational program for middle and high school students that lets them take home a home energy kit containing efficient measures to install in their homes.
- **Home Energy Assessments.** This in-home program has a certified energy specialist inspect home energy use, diagnosing behavioral and equipment opportunities for energy savings. Participants receive an EE "starter kit" with a variety of measures that can be directly installed by the energy specialist.
- **Behavioral Programs.** "My Home Energy Report" (MyHER) compares home energy use to similar homes in the area and allows customers to access an online portal to track their usage and view opportunities for energy savings.
- **Appliance Programs.** Duke provides a variety of incentives for customers to get free or reduced-cost energy-efficient appliances, including LED lighting, low-flow showerheads, and rebates for certain ENERGY STAR™ certified appliances such as heat pump water heaters (HPWH), high-efficiency pool pumps, and smart thermostats.
- **Residential Smart $aver.** This midstream program provides incentives for customers to install high-efficiency HVAC, HPWH, and Wi-Fi-enabled smart thermostats.

[10] For a more complete account of Duke's program offerings, see the most recent cost-recovery filings (as of Spring 2020), which are available at Duke Progress and Duke Carolinas.

- **Multifamily Energy Efficiency.** This direct-install program partners with property owners of multifamily apartment complexes to provide LED lighting and water-saving measures at no cost to residents.
- **Residential New Construction.** This program is targeted at builders and developers to incentivize them to adopt optional High Efficiency Residential Option (HERO) standards in new builds.

NONRESIDENTIAL PROGRAMS

Due to the opt-out clause in NCUC Rule 8.69, C&I customers with an annual load of 1,000,000 kWh may choose to opt out of receiving utility incentives and paying the EE rider. This renders them ineligible to participate in ratepayer-funded EE and DSM programs. Currently, approximately 31,865 GWh of C&I load in the state is opted out of EE programs. This amount accounts for about 53% of statewide IOU C&I sales in 2020. This both reduces enrollment in nonresidential programs and limits their budgets. Therefore, many of Duke's nonresidential programs are targeted at small businesses rather than large industrial users.

- **Small Business Energy Saver.** This direct-install program provides energy audits for small businesses, combined with recommended measures for customers to install. Duke provides an upfront incentive to cover up to 80% of the material and installation cost to the consumer depending on the measure.
- **Nonresidential Smart $aver Programs.** Several programs exist under this label. Through paper and online delivery channels, nonresidential customers can purchase discounted energy-efficient equipment targeted at specific sectors (such as manufacturing, food service, commercial real estate, and industrial lighting).
- **EnergyWise Business.** A demand-response program that lets business customers participate in air conditioner cycling during peak hours in exchange for a credit on their utility bill. Although the program does not produce MWh savings, it reduces peak demand on the grid during summer.

Dominion Energy Efficiency Programs

The other IOU, Dominion Energy, serves 4% of retail kWh sales in the state and delivers its own EE portfolio. Programs are offered according to a phase schedule, rotating in new programs on a two-year cycle. The 2020 program offerings include a residential income-qualified home weatherization, a midstream energy-efficient appliance marketing program, and several small business efficiency programs. In its 2019 DSM cost recovery filing, Dominion projects that savings from its EE portfolio will decline from 5,189 MWh/year in 2023 to 2,304 MWh/year in 2028 (Dominion Energy North Carolina 2019b).

Summary of Continue Existing Efforts Case

We project savings from six groups of existing programs (see table 1). This CEE case quantifies and recognizes the current efforts by North Carolina's advocates and stakeholders to advance efficiency. These existing programs are an essential foundation for the state's economy, climate, and clean energy goals. Efforts to expand efficiency must start by first recognizing these savings achievements and taking steps to ensure that they persist through continued funding, legislative, and regulatory support.

Table 1. Summary of electricity savings by policy or program in the CEE case

Total annual electricity savings by policy/program	GWh savings 2030	GWh savings 2040	Total savings in 2040 (% of overall load)
IOU EERS	5,259	5,573	3.6%
Co-ops and municipal utilities	950	1,030	0.66%
Building code stringency and compliance	1,071	2,027	1.30%
Weatherization	43	46	0.03%
Agricultural energy audits	21	23	0.01%
Industrial assessments	79	108	0.07%
Strategic energy management	616	666	0.43%
Total savings	8,043	9,473	6.09%
Remaining electricity needs (GWh)	135,177	146,031	

We present total savings in 2040 as a percentage of forecasted electricity sales in 2040 from the reference case. We do not include savings from USI because our measure life assumptions resulted in savings that do not extend to 2030.

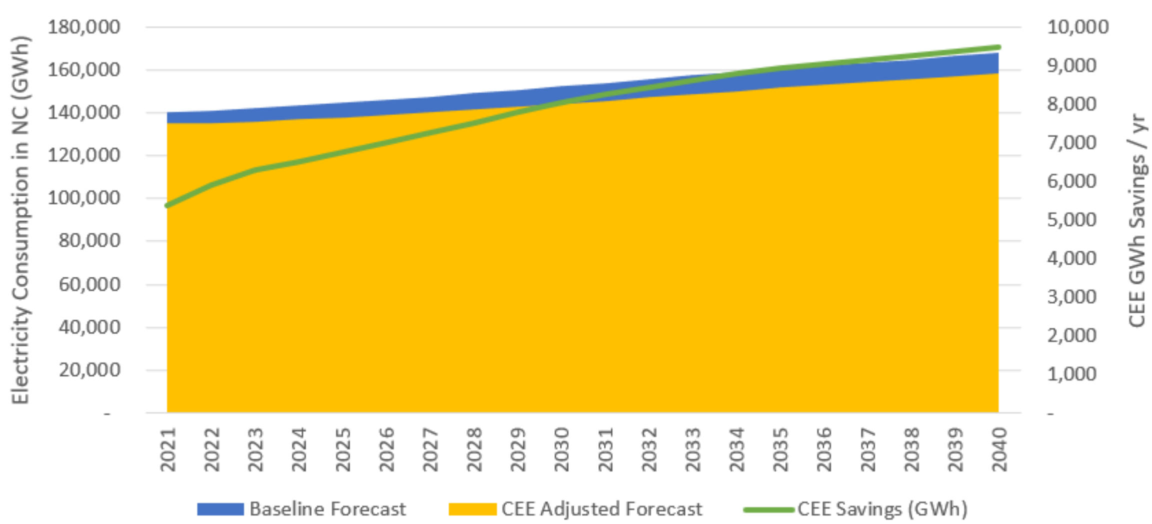


Figure 6. The CEE case energy consumption forecast compared with the state's baseline forecast, and total annual CEE savings in GWh

Assuming they continue at consistent levels, current EE programs are expected to save North Carolinians almost 10,000 GWh per year in 2040 (figure 6). Aside from utility efficiency targets, a large contribution to these savings comes from maintaining North Carolina's current (2018) building energy codes. This ensures that each new or renovated structure is constructed in a way that reduces utility costs and energy waste. While the CEE case represents significant progress in the state, these contributions to addressing the states' GHG emissions and supporting local economic development are projected to decline over time. North Carolina policymakers and stakeholders should consider dramatic changes to maximize EE, as continuing existing policies is not sufficient to scale up to the levels needed to meet the state's climate goals. We outline those opportunities in the following.

Energy Efficiency Policy and Program Opportunities

Here, we present a suite of policy options North Carolina can implement to enhance EE in the state beyond the existing CEE case policies. Table 2 outlines each program and policy area in the EE case, organized by sector or intervention type. Italicized items are policies and programs whose savings would contribute to one or more of the numbered item policies, but we estimated their savings as critical programmatic or policy design recommendations from the EE Roadmap or Clean Energy Plan.

Table 2. Matrix of electricity efficiency policies in the EE case

#	Category	EE case
Utilities		
1	EERS	Separate the REPS and enact a stand-alone EERS requiring 10% cumulative electric energy savings from IOUs by 2030, below a baseline of each utility's total gross electric sales in 2020. Savings ramp to 1.2% of sales per year by 2032, and continue through 2040.
2	Co-ops and municipal utilities	Enact a stand-alone EERS or spending goal for co-ops and municipal utilities, with savings equivalent to 5% total annual electric energy savings and 5% demand reduction by 2030, below a baseline of each utility's total gross electric sales in 2020. Incremental annual savings ramp to 1.2% of sales by 2032, and continue through 2040. Programs deploy a range of strategies including financial incentives to customers and on-bill financing or on-bill tariff programs.
Buildings		
3	Residential and commercial building codes	Close loopholes in amended building codes and facilitate a transition to adopting the upcoming 2021 IECC code standards over two building code cycles, with greater emphasis on code stringency and compliance.
4	Commercial and multifamily building benchmarking	Establish a building energy use benchmarking and disclosure policy for privately owned buildings greater than 50,000 sq. ft. in Raleigh and Charlotte.
5	Utility savings initiative	Expand existing energy savings targets for state-owned buildings under the USI, targeting a 40% reduction in energy intensity per square foot for non-cabinet agency and UNC system buildings.
Financing		
	Clean energy fund	*Establish a clean energy fund to catalyze the development of clean energy and EE investment by issuing direct loans, providing credit enhancements, and providing technical assistance. Initial capitalization of $50 million through ratepayer funds or bonds issued by the state or local governments.*
6	Financing—C-PACE	Implement Commercial Property Assessed Clean Energy (C-PACE) through local or state programs; assumes that C-PACE projects provide additional savings to utility programs.
Low income		
	Minimum savings goal	*Include a low-income carve-out for electric energy savings of 2% by 2030 for IOUs and 1% by 2030 for co-ops and municipal utilities.*
7	Weatherization	Expand WAP through coordination with other funding sources.
	Affordable multifamily buildings	*Increase funding to all preexisting programs to broaden participation and eligibility.*

#	Category	EE case
Industry		
8	Large customer savings beyond SEM	Capture industrial savings opportunities through legislative action or a stakeholder process initiated by the executive branch. Options include: expanded utility offerings, adoption of a self-direct program, minor changes to the thresholds of who can opt out, or a wholesale change to industrial opt out.
9	Industrial assessments	Supplement the North Carolina State IAC and WRP with additional state or federal funding over their existing DOE funding to allow for additional energy use assessments of eligible industrials.
10	Strategic energy management (SEM)	Launch a standalone statewide SEM program to target medium and large C&I customers that have opted out of IOU EE programs.
11	Agricultural audit and implementation program	Create a statewide energy audit and implementation program that would engage the existing network of agricultural stakeholders as well as available federal programs to better reach the underserved agricultural sector.

RESULTS: ENERGY EFFICIENCY POLICY CASE

Here, we describe results from our analysis of the recommended policies listed in table 2. We also discuss the savings from the CEE case for policies we recommend extending or expanding.

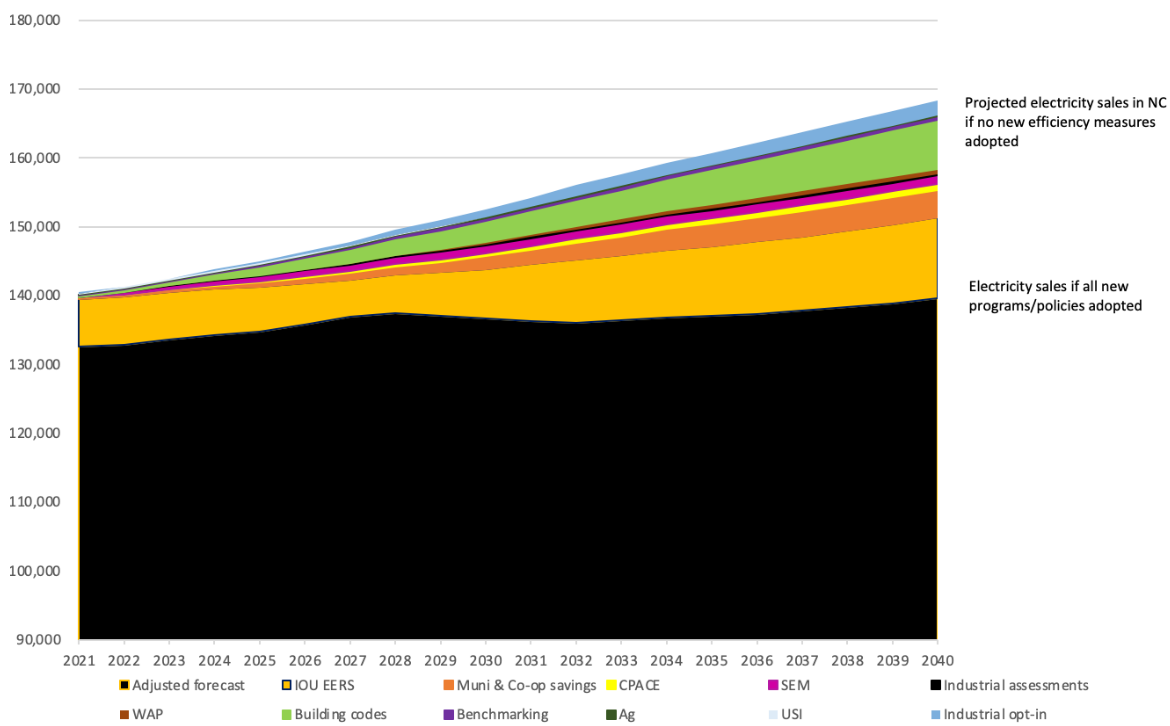
In the EE case, North Carolina sets a separate electricity savings target, or EERS, for IOUs, toward which residential, commercial, and opted-in industrial programs contribute. In addition, co-ops and municipal utilities deliver savings through different goals, either in an EERS policy or spending target. The state expands performance contracting for public buildings and programs for industrial customers, including industrial assessments and expansion of voluntary SEM programs. The legislature also addresses barriers to C-PACE and the state establishes a statewide clean energy fund, which is used to support low-income and affordable housing efficiency projects, and agricultural efficiency programs. Additional policies include building code enhancement and enforcement, building benchmarking adoption in large cities, low-income efficiency programs, and industrial programs. Combined, this suite of policies achieves additional savings and greater participation for underserved customer groups.

Table 3 lists the estimates of total annual electricity savings from EE in 2030 and 2040 by policy or program. Under these conditions, we estimate that North Carolina can meet 18.5% of forecasted needs in 2040, as figure 7 shows. Appendix A includes detailed results, assumptions, and analysis of costs and benefits.

Table 3. Summary of electricity savings by policy or program in the EE case

#	Total annual electricity savings by policy/program (GWh)	2030	2040	Total savings in 2040 (% of forecasted sales in 2040)
1	IOU EERS	7,226	11,755	7.6%
2	Co-ops and municipal utilities	1,833	4,001	2.6%
3	Building code stringency and compliance	3,062	7,115	4.6%

#	Total annual electricity savings by policy/program (GWh)	2030	2040	Total savings in 2040 (% of forecasted sales in 2040)
4	Building benchmarking	445	513	0.3%
5	Utility savings initiative	38	N/A	N/A
6	C-PACE	447	829	0.5%
7	Weatherization	317	776	0.5%
8	Large customer savings beyond SEM	1,111	2,125	1.4%
9	Industrial assessments	176	208	0.1%
10	Strategic energy management	1,116	1,257	0.8%
11	Agricultural audits and implementation	65	122	0.1%
	Total savings	16,678	28,702	18.5%
12	Remaining electricity needs (GWh)	126,542	126,801	



Total savings in 2040 as a percentage of forecasted 2040 electricity sales from the reference case

Figure 7. Share of electricity from EE policies and programs in the EE case. The scale is truncated at 90,000 GWh to enable view of individual recommendations.

In the following, we analyze several specific program areas that contribute to the policies outlined above. Expanding existing heat pump and HPWH programs, multifamily programs, and agricultural programs would contribute to both the IOU and co-op/municipal utilities energy savings targets.

Discussion of Energy Efficiency Policy and Program Recommendations

We now discuss each policy and program recommendation, then describe the potential benefits from their implementation. Appendix A presents detailed results, assumptions, and cost–benefit analysis.

UTILITY PROGRAMS

North Carolina's utilities have been one of the primary drivers of EE in the state. Their programs, funded by utility customers through utility rates, encourage customers to reduce their energy waste through efficient technologies and practices. For utility resource planners, helping customers save electricity is generally cheaper than building new generation resources; figure 8 shows the levelized cost of saving energy compared to the cost of building new resource options. In 2018, North Carolina's utilities ranked 26th among U.S. states for electricity savings, saving 0.67% of electricity sales statewide on average (Berg et al. 2019).

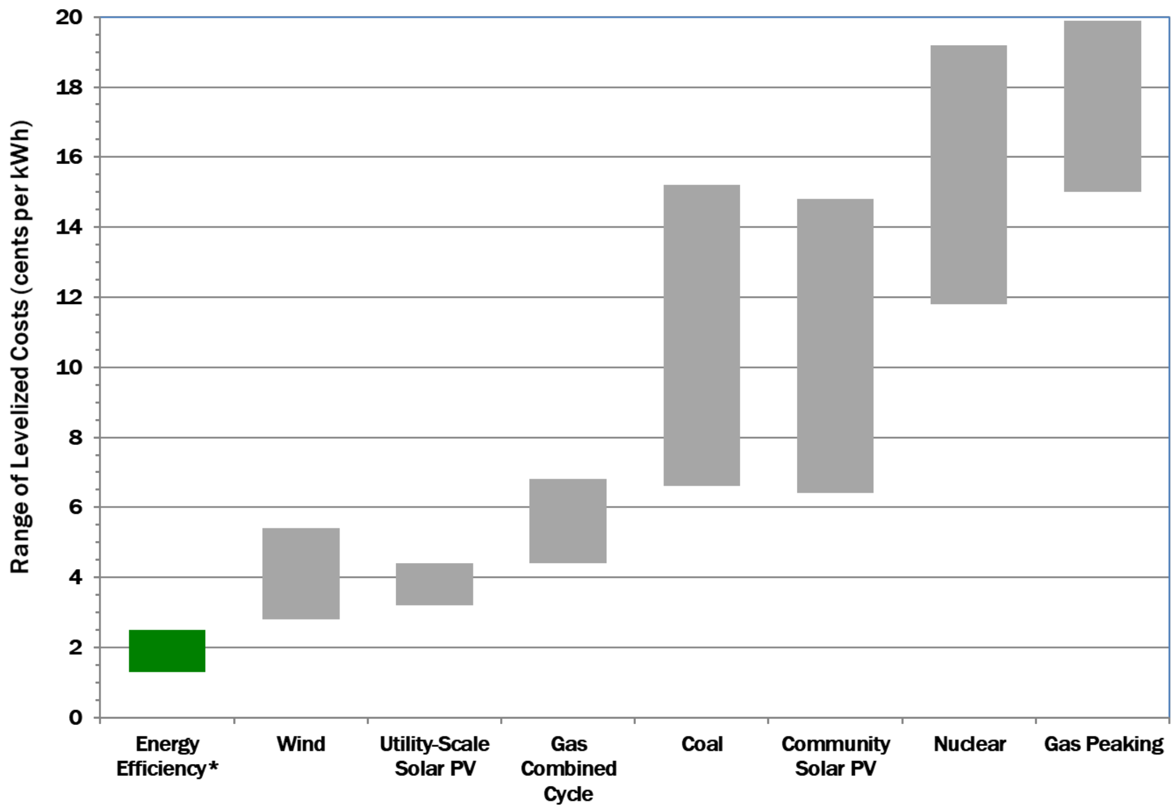


Figure 8. Levelized cost of new electricity resource options. *Notes and sources:* All data in the gray bars are national estimates from Lazard 2017 and represent that study's *Levelized Cost of Energy Comparison–Unsubsidized Analysis*. *EE data represent portfolio average costs in 2018 to the North Carolina IOUs as reported in ACEEE's *Utility Energy Efficiency Scorecard* (Relf et al. 2020). Energy savings data are net savings at the generator level and represent total program costs (not including participant costs).

Below, we highlight opportunities for investor-owned, municipal, and cooperative utilities to expand their offerings for customers through dedicated EE savings targets.

EERS

EERSs are policies that require utilities or statewide administrators to hit long-term (three or more years) energy savings targets by ramping up EE programs for homes and businesses. These policies are typically set independent of specific programs, technologies, or market targets, giving obligated utilities the flexibility to find the least-cost path to meeting the targets. Typically, only IOUs are required to meet EERS targets. Currently, 27 states have enacted mandatory energy savings goals through legislation or order, and they include sufficient funding to fully implement the programs needed to meet targets.

EERS are effective policy tools. Savings from states with EERS policies in place accounted for approximately 80% of all reported U.S. utility savings in 2016 and 2017 (Gold, Gilleo, and Berg 2019). In 2018, states with an EERS achieved incremental electricity savings of 1.22% of retail sales on average, compared with 0.35% in states without an EERS.[11] All of the major leading states have electric EERS: in 2018, 19 of the top 20 electricity-saving states had an EERS policy in place (Berg et al. 2019).[12]

Most states with an EERS also include utility business model reforms that allow utilities to recover program costs, earn performance-based incentives if they meet or exceed savings targets, and/or have full or partial revenue decoupling mechanisms, which help to remove a utility's disincentive to invest in efficiency. A combination of an EERS and a comprehensive set of utility business model changes is most closely associated with high levels of energy savings (Molina and Kushler 2015; Sergici and Irwin 2019). The Clean Energy Plan included the overarching recommendation to "develop and implement policies and tools such as performance-based mechanisms, multi-year rate planning, and revenue decoupling, that better align utility incentives with public interest, grid needs, and state policy" (DEQ 2019). While recent progress better aligns shareholder incentives with EE performance for the Duke utilities,[13] North Carolina utilities lack a full revenue decoupling mechanism that fully addresses their business model's disincentive to pursue EE, which could be explored as a part of the "B-1" Clean Energy Plan stakeholder process.

In 2011, DEP reached a South Carolina Public Service Commission-approved settlement agreement with clean energy groups that set an annual EE savings aspirational target of 1% of retail sales starting in 2015 and a 7% cumulative target from 2011to 2018 (Duke Energy and NCUC 2012). However, this was not mandatory or enforced as an EE resource standard and was not renewed after 2018.[14] North Carolina has also had a REPS in place since 2007

[11] Data from Berg et al. 2019. Note that the presence of an EERS holds as a driver of savings in states with high and low usage (Arizona, Arkansas, Massachusetts, and Vermont), and in states with high and low prices (e.g., Connecticut, Hawaii, Oregon, and Arkansas).

[12] Ohio and Iowa had EERSs in place as of 2018, although recent legislative changes have since gutted the policies.

[13] A recent settlement agreement includes cost recovery, lost revenue recovery, and a shared savings incentive as before, but it provides an additional incentive for achieving savings of 1% of retail sales, and a penalty for falling below 0.5%, as well as a separate incentive for low-income programs with UCT <1.0, which would normally be ineligible for the shared savings incentive (DEC and DEP 2020).

[14] Although not formally enforced, that goal is an organizing principle for conversations in North Carolina. For example, DEC, public staff, and intervenor parties came to an agreement in the pending proposed revisions to

(NC SB 2007-397) that requires IOUs to supply 12.5% of 2020 retail electricity sales with renewable energy sources. EE is an eligible resource and can contribute up to 25% of the requirement for IOUs before 2020 and up to 40% after 2021; municipal utilities have no limitation on EE's contribution to the goals (N.C. Gen. Stat. § 62-133.8). To date, EE has contributed the maximum 25% of REPS goals in 2012–2017 for DEP and DEC, but only 3-7% of the goals in 2015–2017 for Dominion (NC-RETS 2020; J. Weiss, senior associate, Nicholas Institute, pers. comm., May 21, 2020). In addition, some utilities are banking extra EE certificates (EECs) for later compliance, which suggests that efficiency is a cost-effective means of compliance.

North Carolina is the only remaining U.S. state with a combined RPS/EERS. While these policies have delivered some EE, they have not led to particularly high levels of energy savings. Several states that previously had such a combined policy in place, including Pennsylvania, Connecticut, and Hawaii, have since separated their targets (Eldridge et al. 2010). Lack of clear guidance and policy motivation on EE led these states to separate EE and renewable energy targets. Further, combining efficiency and renewable energy is no longer necessary to reduce the cost of deployment of renewable energy, as efficiency and renewable energy are low-cost resources (as figure 8 shows), and each can be considered on its own merits to ensure maximum deployment of cost-effective and low-carbon resources. In North Carolina, stand-alone EE targets for the IOUs that serve 73.7% of the state's load (2018) would strengthen the state's commitment to least-cost energy planning and the climate goals articulated in EO 80.

STAKEHOLDER-PROPOSED EERS

The DEQ Clean Energy Plan and EE Roadmap recognize the importance of clear guidance, recommending an EERS by establishing minimum EE goals within the current allowable 25-40% of REPS beginning in 2021, subject to cost-effectiveness screens. The EE Roadmap includes a stand-alone mandatory EERS for all utilities to achieve efficiency goals in EO 80. The working group recommends a target of achieving 10% electric energy savings for IOUs by 2030, below a baseline of each utility's total gross electric sales in 2020. This would include a 2% electricity savings requirement for low-income programs, representing 20% of the 10% target. We modeled this target through 2030, with 1% savings per year for DEP and DEC, then ramping up 0.1% per year to 1.2% savings per year in 2032, with annual savings at 1.2% until 2040. We modeled one-third of that target for Dominion in 2021, consistent with its use of EE for approximately one-third of its REPS compliance in 2015–2017, ramping up more steeply to 1% by 2030, and then assuming the same savings rates as Duke Energy utilities from 2030–2040. We modeled the EERS as incremental to savings from building codes; those savings are captured in the Buildings section below.

This EERS of 1–1.2% savings per year would help North Carolina continue its leadership position in the region but would not bring the state into the ranks of leaders around the country, which aim for savings of 2% to nearly 3% savings per year. An EERS of 1.2% per year matches the goals of utilities in Arkansas, the current regional leader, and is consistent with the achievable savings from similar utilities in our meta-analysis of potential studies in

the DSM/EE cost recovery mechanisms (Docket No. E-7, Sub 1032), which includes revising and expanding a bonus incentive payment for attaining 1% annual savings.

Appendix C, so we modeled this slightly more ambitious goal for the 2032–2040 time period. Many utilities with such targets are already achieving and sustaining savings results above and beyond 1%. Indeed, 25 utilities achieved more than 1% net incremental annual savings in the 2018 program year and, of those, 13 achieved greater than 1.5% (according to the 2020 *Utility Energy Efficiency Scorecard*) and 2 achieved greater than 3% savings (Relf et al. 2020).[15] These states and utilities show that it is possible to meet aggressive EE targets in a cost-effective manner, including in states with low or moderate retail energy prices, such as Colorado, Oregon, and Arkansas.

We modeled the 1–1.2% target as a percentage of eligible load, assuming that the savings requirement is placed on all residential and commercial sales under 1,000,000 kWh, as well as any sales for large customers that do not opt out. When adjusting to exclude the usage of nonresidential opt outs from total annual sales, DEC's total portfolio savings as a percentage of sales in 2019 were 1.56%, but only 0.98% when the sales from opted-out customers were included (Bradley-Wright 2020). As a result, savings as a percentage of total load are only 0.7–1% as modeled.

The proposed ramp rate of 0.07% for Dominion from 2020–2022 and 0.1% per year for Duke and Dominion utilities from 2023–2032 is consistent with previous ACEEE research, which found that significant year-over-year growth in savings is achievable. *Ramp rate* is defined as the actual change in savings as a percentage of retail sales from one year to another. In a sample of 93 program years for leading utilities saving more than 1.5% of retail sales, researchers found an average ramp rate of 0.19% (Baatz, Gilleo, and Barigye 2016). Nearly one-fifth of the observations were more than 0.5%, demonstrating the ability of some utilities to rapidly ramp up savings.

AVAILABLE POTENTIAL TO MEET EERS

The EERS values are slightly greater than those in Duke's efficiency potential study, which found average annual achievable potential of 0.78–0.82% over 25 years for DEC and 0.87–0.90% for DEP, depending on the scenario (see table 4). We were unable to find a potential study for Dominion's North Carolina territory.

Table 4. Aggregated results of achievable program potential for DEC and DEP

	DEC		DEP	
Scenario milestones	Energy (GWh)	Average annual % of base sales*	Energy (GWh)	Average annual % of base sales*
Base scenario—includes existing DEC and DEP programs and measures				
5-yr sum of annuals (2024)	1,730	0.88%	1,176	0.94%
10-yr sum of annuals (2029)	3,321	0.84%	2,289	0.91%
25-yr sum of annuals (2044)	8,257	0.78%	5,910	0.87%

[15] *Net savings impacts* are "changes in energy use attributable to a particular energy efficiency program. These changes may implicitly or explicitly include the effects of factors such as free-ridership, participant and nonparticipant spillover, and induced market effects" (DOE's Uniform Methods Project, NREL 2017, Chapter 17). *Gross savings impacts* are "changes in energy consumption that result directly from program-related actions taken by participants in an energy efficiency program, regardless of why they participated."

	DEC		DEP	
Scenario milestones	Energy (GWh)	Average annual % of base sales*	Energy (GWh)	Average annual % of base sales*
Enhanced scenario—increased incentives up to 75% maximum				
5-yr sum of annuals	1,878	0.95%	1.250	1.00%
10-yr sum of annuals	3,563	0.90%	2,409	0.96%
25-yr sum of annuals	8,663	0.82%	6,107	0.90%
Energy cost sensitivity scenario—increased the avoided energy cost by 50%				
5-yr sum of annuals	1,754	0.89%	1,197	0.96%
10-yr sum of annuals	3,363	0.85%	2,325	0.92%
25-yr sum of annuals	8,336	0.79%	5,972	0.88%

Average annual energy savings as a percentage of annual base sales per period. *Source:* Duke Energy North Carolina 2020.

The Nexant market potential study's approach has significant limitations that keep savings below the 1–1.2% included in the EERS policy. First, the study uses an asymmetrical total resource cost (TRC) test, which counts various categories of costs (e.g., the full incremental measure cost to customers) without their attendant benefits (e.g., other fuel or water savings, or health benefits). While TRC is the state's current cost-effectiveness test, a proposal is pending before the NCUC that would shift the primary cost-effectiveness test from TRC to UCT. A sensitivity analysis for the economic potential analysis that used UCT found that it increased potential by 37% for the residential sector, 46% for the commercial sector, and 15% for the industrial sector (Duke Energy North Carolina 2020). As a rough comparison, if achievable savings similarly increased by about 40% under the UCT sensitivity analysis, the study's achievable results would increase from about 0.8% to 1.12% per year for DEC and from 0.9% to 1.26% per year for DEP.

Second, the study relies on past program performance to train the Bass diffusion model, which determines customer participation levels and projects the market response to program offers. This limits the estimated potential to Duke's current suite of program delivery and customer acquisition methods and may miss critical tools such as financing, enhanced marketing, and program targeting using AMI data. Financing could increase program uptake by 3–5% (Kramer et al. 2015), and program targeting using AMI data can improve cost effectiveness by targeting marketing to customers most likely to save energy if they participate (Scheer et al. 2018). Finally, the study focuses on measure-level cost effectiveness, and may miss opportunities to sequence strategically or bundle measures together and make marginal measures cost effective.

For these reasons, the Nexant study likely underestimates average annual and achievable energy savings potential. However, our study is based on kWh savings across the whole year, while Duke's uses a more granular analysis of cost effectiveness for each hour of the year. As a result, our analysis of average annual savings may under- or overstate potential given the variability of costs and value to the system during different seasons and times of day.[16]

However, as Appendix C describes, our meta-analysis of various potential studies from around the country in states or with utilities similar to Dominion, DEP, and DEC in their retail prices found achievable average annual savings as a percentage of baseline of 1.2% (with achievable maximum annual savings of 1.6%). Several are also vertically integrated utilities, such as Entergy New Orleans, Puget Sound Energy, NV Energy, and Minnesota utilities. Further, the sample includes large utilities (similar to Duke), such as ComEd, Ameren Illinois, and Entergy Louisiana, and smaller utilities (similar to Dominion), such as Idaho Power and some Minnesota utilities.

In reviewing Dominion and Duke's existing portfolios, and the list of measures in the Nexant economic potential study for Duke utilities, we identified a number of program approaches or delivery options that were not included in the potential study. Many are opportunities brought forward by stakeholders in a summary report from the Duke Energy Collaborative, suggesting that many may be currently under consideration by the Duke companies (Duke Energy Collaborative 2019). These may provide additional opportunities for energy savings beyond those utilities' current portfolios. Table 5 describes those programs or delivery options. Some, such as low-income weatherization and agricultural programs, are addressed elsewhere in this report (and marked with an asterisk in the table).

Dominion's filings suggest a thinner portfolio of offerings in North Carolina; in addition to the opportunities in table 5, we recommend that Dominion develop additional offerings including behavioral programs; whole-home retrofit programs; HVAC equipment programs; HPWH programs for residential customers; multifamily and affordable multifamily programs; and custom offerings, including efficient motor programs, retrocommissioning, and upstream programs for nonresidential customers (Relf et al. 2020).

Table 5. Additional program area, design, and delivery channel opportunities for investor-owned utilities in North Carolina

Program opportunity	Description
Residential offerings	
HP and HPWH program expansion (see text box below)	Expand incentives and offer instant rebates and midstream delivery channels that favor high-efficiency HVAC and water heating equipment (Bradley-Wright 2020); pilot lease options for low-income customers (Weiss 2019).
New construction	Extend the Residential Construction program offered at DEP to DEC. A filing for this program was submitted in September 2017 but was rescinded after DEC and local natural gas utilities were unable to come to an agreement on its design; DEC must file modifications (DEC 2020b).

[16] While energy efficiency can provide important short-term benefits at system peak, it also can affect long-term decision making and investment decisions, enabling replacement or avoidance of more expensive energy, capacity, and T&D resources, as well as other systemwide benefits such as avoiding ancillary services, environmental compliance costs, and renewable portfolio standards costs (Baatz 2015).

Program opportunity	Description
Code implementation support	Incorporate code compliance training into EE programs.[17]
*Income-qualified weatherization	Extend DEP program to DEC. Weatherization across the state has the opportunity to grow to 458 GWh of savings by 2040; coordinated support with utility programs is critical to scale offerings to the state's needs.
Nonresidential offerings	
*Strategic energy management	Expand SEM program adoption (currently in the Smart $aver Customer program) to help medium or large businesses manage energy through continual improvement and a systematic approach to energy performance. (We analyze the potential for opted-out utilities to save by adopting SEM below.)
*Agricultural programs expansion	Duke currently offers a Smart $aver Prescriptive program that includes rebates for some agricultural equipment. Enhance diversity of agricultural offerings, and target incentives at those customers alongside proposed statewide agricultural audit and incentive program.
Energy Efficiency as a Service (EEaaS)	Offer program models where the service provider (usually a third party) maintains ownership of installed equipment while the customer pays for the energy services provided, shifting the burden of financing, owning, installing, and managing the performance of energy assets away from the customer to the service provider (ACEEE 2019).
Metered EE Transaction Structure (MEETS) for commercial buildings	Pilot MEETS, a financing arrangement in which the yield from metered EE (i.e., the difference between a dynamic baseline and actual consumption) is delivered to the utility, enabling EE to be treated like a long-term power purchase agreement (if investor/customer-driven) or like a utility-owned generation or leased property (if utility-driven) (MEETS Accelerator Coalition 2020).
Nonresidential energy efficiency in LMI communities	Target small business and public building offerings to nonresidential community serving institutions in low-to-moderate income areas, such as nonprofits, schools, local government buildings, medical facilities, shelters, and community centers (Drehobl and Tanabe 2019).
Delivery channel and program design	
Expanded midstream and upstream offerings	Offer programs (beyond lighting) that transform the market for EE products by targeting upstream manufacturers or midstream retailers to improve choices and reduce costs for customers.
Expanded retail products platforms	Minimize barriers to participation during and after COVID-19, by bringing more products and even services online in marketplace offerings for energy-efficient products.
Leveraging Advanced Metering Infrastructure (AMI) data to improve cost effectiveness and participation	Use granular customer energy usage data (AMI) to improve program effectiveness by targeting programs to customers who: 1) can participate (e.g., have relevant end uses), 2) are likely to participate, or 3) are likely to save more energy when they do participate. Such techniques may increase savings by over 50% (Scheer et al. 2018).

[17] We note that this would likely require a review of NCUC rules to ensure that utilities can receive appropriate credit for advancing adoption, implementation, and/or compliance verification of building energy codes (Misuriello et al. 2012). Further, these savings are currently captured in the Building Codes section of this paper and would be incremental to the proposed EERS.

Program opportunity	Description
On-bill financing and tariffs	Offer on-bill financing, enabling customers to pay down the cost of EE investments through monthly electric bill payments, either through loans (utility or third party) or on-bill tariffs.
Geotargeted programs/EE for nonwires alternatives	Target businesses in specific geographic locations that will yield high savings and value for the grid.
Braiding health funding	Modify residential programs to include measures that promote better health outcomes for residents (asthma, falls, extreme temperature exposure) and identify complementary funding sources (e.g., insurance, Medicaid, philanthropic grants, government programs) for the preventative health care services provided (Hayes and Gerbode 2020).

* Programs described in separate sections later in this report.

In addition, two areas could offer significant savings potential but would require policy changes to capture those savings: industrial EE for currently opted-out customers and beneficial electrification. As noted above, 63–90% of C&I customers with an annual load of at least 1,000,000 kWh have opted out of the EE rider at each of the IOUs, rendering them ineligible to participate in ratepayer-funded EE and DSM programs. Further, programs that support efficient fuel-switching options that lower total energy use across electricity and other fuels are limited by rules that require a higher level of NCUC scrutiny.[18] Recently, this had the effect of delaying opportunities for a new construction program (DEC 2020b).

RESULTS

Given the potential of similar utilities and our analysis of the recent Nexant *Market Potential Study* for DEP and DEC, we anticipate that IOUs in North Carolina will be able to meet the EE Roadmap proposed goals (Duke Energy North Carolina 2020). Separating the REPS and creating a stand-alone EERS for IOUs could save nearly 11,755 GWh across residential, commercial, and industrial sectors in 2040, which could meet 7.6% of forecasted needs in 2040.

[18] NCUC R8-68 requires utilities to apply for commission approval before implementing a measure or program that either "directly or indirectly alters or influences the decision to use the electric public utility's or electric membership corporation's service for a particular end use or that directly or indirectly encourages the installation of equipment that uses the electric public utility's or electric membership corporation's service." The factors the commission considers include whether the proposed measure/programs are in the public interest and benefit the utility's overall customer body, the impact of the proposed measure/programs on peak loads, and whether they encourage energy efficiency (Berg, Cooper, and Cortez 2020).

Residential Heat Pump and Heat Pump Water Heater Program Expansion

Space conditioning and water heating are the two largest end uses in homes, representing 50.2% and 18.5% of average residential load in the South Atlantic region, respectively (EIA 2018). They also represent the largest source of residential efficiency potential in North Carolina. As figure 9 shows, replacing electric furnaces with heat pumps is the top source of economic potential in North Carolina; this is consistent with ACEEE research showing particular opportunities for such conversions in the South (Nadel and Kallukuri 2016).

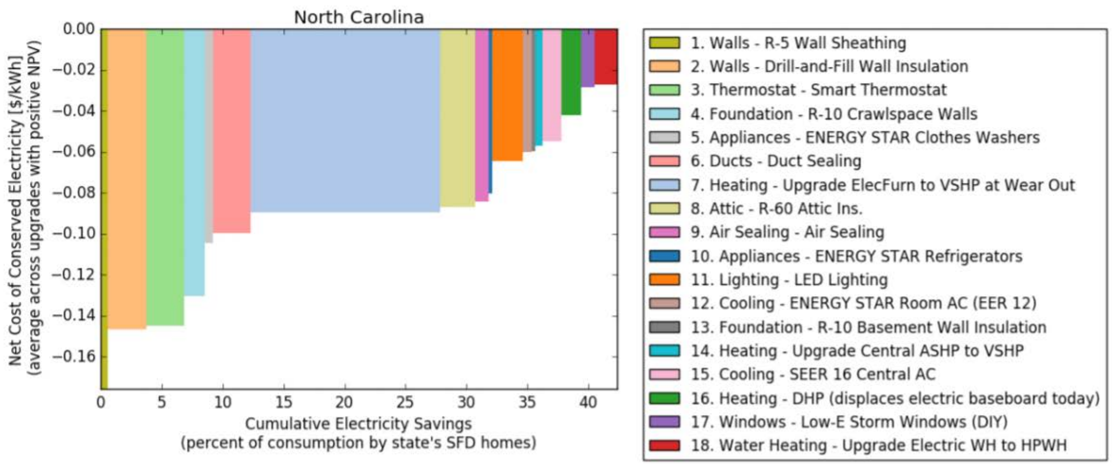


Figure 9. Electricity EE supply curve for single-family detached housing stock in North Carolina. *Source:* Wilson et al. 2017.

DEP and DEC currently offer programs targeted at these ends uses in the Residential $mart Saver program, including ENERGY-STAR-qualified HPWH and high-efficiency air and ground source heat pumps. In 2018, 24,562 DEP customers and 25,852 DEC customers participated in the Residential Smart $aver program; an evaluation of that DEC program found that 34% of verified savings came from air source heat pumps, and 1% from HPWH (Nexant S&P Group 2019; DEP 2019a; DEC 2020). Dominion does not offer these measures, but it did offer Heat Pump Tune Up and Upgrade programs in 2014–2017, upgrading 1,349 units in North Carolina over that time period (Dominion Energy North Carolina 2019a).

The EE Roadmap calls for deployment of "smart" equipped HPWH as an EE and demand-side management (DSM) tool targeted in low- to moderate-income communities through a utility-sponsored equipment rental program (Weiss 2019). This recommendation highlights two areas missing from IOU portfolios in North Carolina: lease options, which can reduce first-cost barriers, especially for low-income customers; and more robust offerings for heat pumps and HPWH, two of the highest potential efficiency opportunities in the state.

The draft *Market Potential Study* for DEP and DEC does not find cost-effective savings available for HVAC measures; this may be due to the use of an asymmetrical TRC and past program participation as key inputs to the adoption curve (Duke Energy North Carolina 2020). With a UCT cost-effectiveness test, new mechanisms to support customer adoption through financing or lease structures, and integration with DSM measures to capture the value from demand flexibility, we anticipate that these measures would be a highly cost-effective cornerstone of the utilities' programs.

Cooperatives and Municipal Utilities: Energy Efficiency Programs and Statewide Technical Assistance

In North Carolina, rural co-ops and municipal utilities together provide about 26% of statewide electricity sales. The North Carolina Electric Cooperatives serve 2.5 million residents through 26 individual co-ops. Additionally, ElectriCities of North Carolina is a nonprofit membership organization that serves dozens of municipal utilities. In this section, we refer to both groups of utilities as *public power utilities*. These utilities offer some EE programs for their customers, but they have varying degrees of impact. Scaling up these programs along with electrification efforts would tap into additional savings potential and carbon reductions for the state. Because some of the smaller utilities may have a harder time establishing efficiency programs, expanding services to these utilities through a statewide or multi-utility technical assistance provider could leverage economies of scale in program administration and evaluation support.

Across the country, utility efficiency policies generally do not emphasize serving public power customers because public utilities are not regulated by utility commissions. Public utilities typically have different policy drivers than IOUs. For example, most rural utilities are not subject to EERS. However, they can still provide exemplary EE portfolios as a resource to their customers. A study of efficiency performance by electric co-ops in six states found that leading utilities saved about 1.0–1.2% relative to their retail energy sales (Bickford and Geller 2016). The study found that effective statewide legislation was an indicator of high performance, along with program implementation infrastructure and regulatory support, where applicable. For municipal utilities, a 2015 ACEEE study profiled nine successful examples of municipal utility efficiency programs and found that they achieved average annual electricity savings of 1.4% of sales, with average spending of 3.1% of revenues (Kushler et al. 2015).

In North Carolina, current state policy requires all electricity providers (including public power utilities) to meet specified percentages of their retail sales using renewable energy and EE, and they demonstrate compliance by the number of renewable energy certificates (RECs) and EECs.[19] However, the state does not require its co-ops and municipal utilities to meet minimum levels of EE. Still, several individual co-ops and municipal utilities offer some EE programs to earn EECs as a compliance pathway (NCUC 2020).

For this analysis, we assume that statewide policy requires municipal utilities and co-ops to achieve 5% total annual electricity savings by 2030, as recommended in the EE Roadmap. To achieve this goal, utilities should establish incremental annual savings targets of 0.2% in 2022 and 2023, increasing by 0.2% every two years until they reach 1% incremental annual electricity savings by 2030 and 1.1% annual electricity savings in 2032 and annually thereafter. Regulatory or legislative policies related to economic development and to climate change can drive these opportunities for increased EE deployment. See Appendix B for more details.

Regulated utilities typically levy a charge, or *rider*, on customer bills to pay for efficiency, while other utilities collect funds through rates just as they would collect funds for investments in power plants or distribution assets. Co-ops and municipal utilities could also collect funds through a small charge on customer bills, which would provide dedicated funding to a suite of program offerings, ranging from incentives and financing for whole-

[19] N.C. Gen. Stat. § 62-133.8. A REC represents one MWh of electricity supply and an EEC represents one MWh of electricity saved from efficiency programs.

house and whole-building retrofits, to appliance and equipment replacement incentives, behavioral strategies, and engineering support for businesses and facilities. These utilities could establish programs such as on-bill tariffs[20] without a rider, which could provide significant savings for those who participate in the on-bill offering. However, on-bill tariffs are not sufficient to achieve savings at the scale of the available potential. Program impacts on the order of 1–1.2% savings per year would require more significant investments.

Not all co-ops and municipal utilities have the capacity to administer their own programs. In such cases, membership organizations such as North Carolina Electric Membership Corporation (NCEMC) and ElectriCities can play an important role. Another option is to establish a statewide non-utility entity that serves as a technical assistance provider or direct administrator of programs on behalf of these utilities. One possible model here is the Southern Minnesota Municipal Power Authority, where a local nonprofit joint-action agency collaborates with a regional EE entity (Slipstream) and the University of Minnesota Clean Energy Network Teams to provide EE programs to residential, commercial, and industrial customers in the region.[21]

Although its program structure could draw on lessons learned from other states, the unique demographics of North Carolina's co-ops and municipal utilities mean that their efficiency program offerings will vary and should be tailored to customer needs.

RESULTS

Expanded co-op and municipal utility efficiency programs could save nearly 4,002 GWh across residential, commercial, and industrial sectors by 2040 and 2.6% savings relative to the reference case.

[20] We discuss these below in the "Financing" section.

[21] For a case study of the program, see Appendix A of www.michigan.gov/documents/energy/BaselineReportFinal_668264_7.pdf.

Energy Efficiency Program Responses to COVID-19

The COVID-19 crisis has greatly affected customer EE programs and the workforce that delivers them. Ensuring that these programs are not permanently set back by the pandemic will require adapting them to reduce direct human contact, focusing resources on the most affected communities, and closely reexamining program services and driving demand. Here, we highlight steps that efficiency program administrators for North Carolina utilities could take to ensure the continuity of their programs in this time (York 2020).

Continue virtually

Many programs have expanded or established virtual means to provide services, including virtual energy assessments, EE "treasure hunts," and promotion of online energy marketplaces for purchasing energy-efficient products. Designed well, moves to virtual services can ensure continued availability of EE for customers, while building communications touch points to engage customers more effectively when it is safe to return to work. Responsive utilities are also providing administrative flexibility, streamlining processing of incentive payments to keep money flowing, and allowing partial payment for work in progress.

Train program staff and contractors

Program administrators can use this time to train program staff and contractors who are unable to work. Such training might include typical professional development, as well as training on new guidelines and practices to ensure health and safety. Program administrators in New York, for example, are responding to the pandemic by coordinating free online training opportunities for clean energy contractors (NYSERDA 2020).

Help energy efficiency businesses obtain crisis relief dollars

Several utilities and efficiency program administrators helped their contractors apply to the U.S. Small Business Administration's (SBA) Paycheck Protection Program (PPP) as part of federal COVID-19 stimulus efforts. Through the PPP, the SBA provided small businesses with loans that can be forgiven if businesses keep employees on the payroll (SBA 2020). Considering that COVID-19 has most adversely affected communities of color—and especially Black communities—crisis relief efforts are a key tool for helping to keep workers employed and businesses afloat. As an example, Tennessee Urban League Affiliates (TULA), helped contractors in a joint training program with the Tennessee Valley Authority (TVA) apply for SBA loans (S. Hart, Milepost Consulting, pers. comm., May 11, 2020).

Pivot and adapt programs to continue serving customers while adhering to public health guidelines and restrictions

Programs are focusing on measures and approaches that minimize or eliminate direct customer contact, such as the Massachusetts program prioritizing wall insulation and other outside work that is on the premises, but avoids customer-occupied areas (Mass Save 2020). Programs must procure personal protective equipment for workers, and focus on retooling their efforts to support healthy homes and buildings (Taylor Engineering 2020).

Manage funds so that efficiency can be a tool for economic recovery

Many programs are not spending their full budgets due to slowdowns and shifts in services. We recommend that such accrued program funding be used, where possible, to accelerate and expand program services once full operations can resume. Administrators can plan for a program surge to regain progress toward saving targets.

By following these recommendations and creatively pivoting to meet the challenge of this moment, programs can continue to provide vital services to customers and prepare to rebound—by both helping reduce energy costs during a prolonged economic recovery and cutting GHG emissions.

BUILDINGS

Buildings make up the state's largest end-use sector, which is responsible for more than 50% of total energy consumption in North Carolina (Weiss 2019). Because so many of us spend most of our time indoors, policies affecting building energy use can have a significant and long-term impact on our daily lives. From lowering residential and commercial utility costs, to improving indoor air quality, comfort, safety, and productivity, to creating better resilience in the face of extreme temperatures and weather, investments in building EE return far more benefits than simply reducing energy demand.

We analyzed various policies and programs to improve EE throughout North Carolina's buildings sector. Of the buildings programs and policies we analyzed, the greatest savings came from improving the statewide building energy code by increasing stringency. This significant opportunity for long-term savings is due to the state's high volume of new construction: In 2019, North Carolina ranked fourth in the nation in terms of residential building permits (Census Bureau 2019). Further savings may be realized through sector- and region-specific programs and policies. Enacting building energy benchmarking and disclosure policies in the Raleigh and Charlotte metropolitan areas would yield efficiency improvements in large commercial and multifamily buildings. We recommend expanding several existing programs to increase savings, including the successful state-run performance contracting program for public sector buildings, and IOU programs targeted specifically toward the hard-to-reach affordable multifamily sector.

Residential and Commercial Building Code Stringency and Compliance

Updating North Carolina's building energy code represents an opportunity to lock-in long-term energy savings and quality-of-living improvements for the state's residents and businesses. The latest building codes, which went into effect on January 1, 2019, are based on the 2015 IECC for residential and ASHRAE 90.1-2013 for commercial construction with several North Carolina-specific amendments (DOE 2020c). Based on recommendations from the EE Roadmap, we evaluated the energy savings achievable through transitioning North Carolina building codes to the latest 2021 IECC standards.

We estimated the savings that North Carolina can expect from the most recent code cycle as part of our CEE case. Maintaining the current stringency level in existing building codes is critical to ensuring energy affordability for North Carolina's homes and businesses. Both residential and commercial codes already contain several amendments that mainly serve to weaken the energy requirements, thereby lowering total energy savings from current code cycle. Due to these amendments, Pacific Northwest National Labs found that the actual level of building energy intensity and savings achieved through the current code cycles is equivalent to the 2009 IECC for residential codes and ASHRAE 90.1-2007 for commercial (DOE 2020b). Even with these weakening amendments, current codes are still expected to save approximately 1,071 GWh per year by 2030, and 2,026 GWh annually by 2040 relative to the prior code cycle.

To support adoption of more energy-efficient building codes, we modeled a phased implementation plan over the next two code cycles. On this timeframe, the 2021 IECC standards are expected to go into effect in 2030. The interim cycle (2024) would involve repealing the amendments in the current building code cycle and tightening standards to reflect actual energy savings expected from the 2015 IECC.

RESULTS

Table 6. Summary of electricity savings from updated building energy codes

Total annual electricity savings by sector (GWh)	2030	2040	Total savings in 2040 (% of overall load)
Residential	2,416	5,786	3.4%
Commercial	645	1,328	0.8%

Table 6 shows the expected total annual savings from updating North Carolina's building code policies. New building codes in the residential and commercial sectors could save more than 6,000 GWh annually across residential and commercial sectors by 2040. Figure 10 shows a comparison between annual energy use in 2040 from different code cycles. Because buildings may last upward of 20 years, savings from codes are expected to persist even after our study's time period. Updated codes could lower building energy use by 27% relative to the current code cycle and 34% relative to the previous cycle.

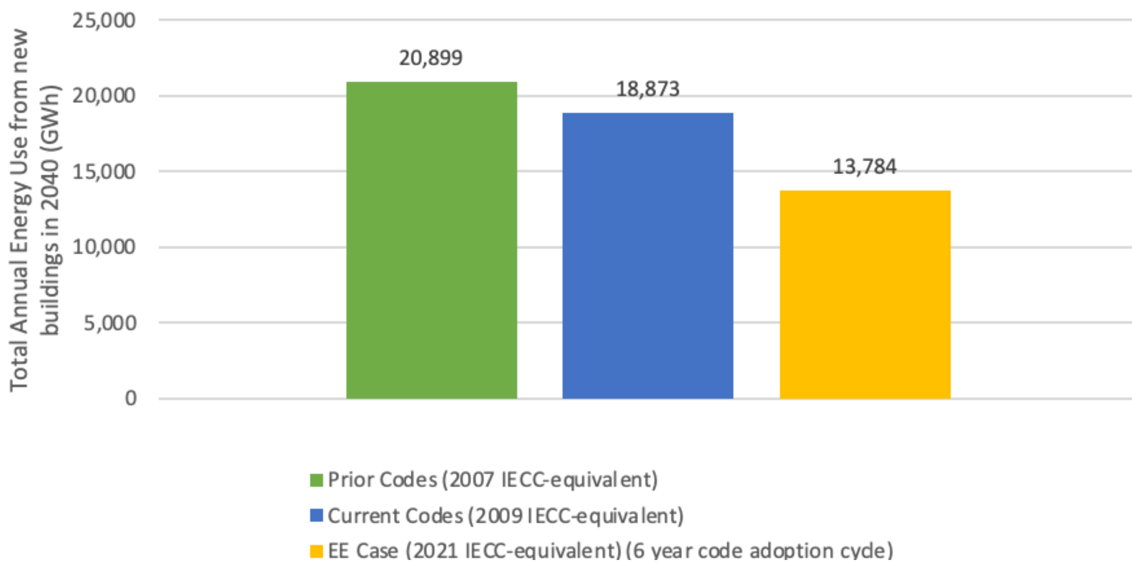


Figure 10. Annual energy use in the reference case, the CEE case, and the EE case

Returning to a Three-Year Code Cycle

Prior to 2016, North Carolina updated its residential building codes every three years. This was changed to every six years when homebuilders in the state pushed to delay the code adoption cycle, as EE Roadmap recommendation #8 notes (Weiss 2019). A faster code adoption process was not identified as a major priority by the stakeholders we spoke to and therefore is not included among the savings in our EE case.

Under a three-year cycle, North Carolina's new buildings could attain 2021 IECC standards as soon as 2024. This could save residents and businesses in North Carolina an additional 919 GWh per year by 2030, or approximately $77,000,000 in avoided annual energy costs.

COST OF BUILDING CODES

The cost to homebuilders of complying with 2021 IECC standards is estimated at approximately $90.7 million in 2030. This increase in upfront cost is why some groups are opposed to increasing standards, and in some cases have pushed through rollbacks of even modest energy conservation measures, as mentioned in EE Roadmap recommendation #8 (Weiss 2019). However, the benefits to building tenants far exceed the costs. We estimated residential energy savings at $280 million and commercial savings at $54 million in avoided energy costs in 2030. This 3.6:1 benefit–cost ratio does not factor in additional benefits such as comfort, productivity, and environmental consequences from reduced energy use. (See the tables in Appendix B for more details on program costs and savings.)

Despite the increase in upfront cost, the persistent energy savings from improved codes produces more affordable living for North Carolinians. Opponents of improved codes, however, will still object on the grounds of housing affordability. To ensure housing stays affordable for homebuyers of all economic levels, it is important to continue funding the North Carolina Housing Trust Fund, which offers low-cost loans and payment assistance for income-qualified renters and homebuyers throughout the state (EE Roadmap recommendation #17). The NCHFA also manages tax credits for low-income housing developers who meet a certain standard of efficiency under its Qualified Allocation Plan. We cover more detailed recommendations for this program in the "Multifamily Energy Efficiency" section of this report.

Zero Energy Buildings

EE Roadmap recommendation #7 calls for North Carolina to establish a pathway to net zero; by following it, buildings could achieve net zero energy use through efficiency and on- or offsite renewable generation by 2042. While our code compliance model does not estimate the savings from a net zero mandate, many states and cities are looking to adopt a "Zero Energy Appendix" addition to the 2021 IECC (Perry 2018).

If the legislature or governor's office establishes a state-level target for zero energy buildings and a compliance path to meet that target, it will help drive market demand for zero-energy-ready buildings and simplify the process to achieve sector-wide carbon neutrality by 2050. Several cities and states have already adopted zero energy codes or implemented a pathway to adoption by 2030, including Santa Monica, California, and New York State (NBI 2020).

POLICY DESIGN CONSIDERATIONS

North Carolina is a Dillon's Rule state, meaning that codes are established on the state level, and cities and towns have limited authority to implement increased stringency over statewide codes. However, codes are enforced at the permitting stage across nearly 600 jurisdictions. The cost of training code inspectors to comply with new stringency requirements is estimated to be $3 million for each updated cycle (Williams, Price, and Vine 2014).

The NCBCC develops and enacts new codes. The council make-up is established by the legislature, and the governor appoints its members. Currently, EE is not represented by a seat on the NCBCC. EE Roadmap recommendation #6 calls for the state's legislature to add an EE seat to the NCBCC in order to increase awareness among code officials. Although the NCBCC is statutorily charged with developing codes, a legislative loophole allows the state's legislature to circumvent the NCBCC's authority and pass amendments to state building codes directly without going through the standard review process. EE Roadmap recommendation #8 calls for closing this loophole and restoring the NCBCC's authority to oversee and review all changes to state codes (Weiss 2019).

Residential and Commercial Benchmarking

The Raleigh and Charlotte metropolitan areas are some of North Carolina's fastest growing economic and population centers. ACEEE evaluated the EE performance of both cities in its 2019 *City Clean Energy Scorecard* and identified several opportunities to improve EE, especially in the buildings sector (Ribiero et al. 2019). As a member of the American Cities Climate Challenge,[22] the City of Charlotte is looking toward improving sustainability with its 2040 Comprehensive Plan (City of Charlotte 2020). Raleigh updated its 2030 Comprehensive Plan this year, making environmental sustainability and energy security a central objective for current and future development (City of Raleigh 2020). Citywide benchmarking and transparency can help building owners and businesses in each city to control their energy use and make cost-effective efficiency investments in their buildings.

Many cities and metropolitan areas across the nation are implementing policies that require qualified buildings to benchmark and publicly disclose their building energy usage. The primary function of a building benchmarking and transparency policy is to enable building owners to compare their own energy use with that of their peers. Benchmarking data also allow cities to deliver targeted technical assistance to help underperforming buildings improve their EE, and to publicly recognize exceptional performance. Many top-ranking cities in the ACEEE *City Clean Energy Scorecard* have benchmarking policies in place, such as Atlanta, Austin, Philadelphia, and Orlando (Ribeiro et al. 2019). While simply requiring building owners to benchmark and disclose their energy use does not by itself lower energy consumption, it addresses a major information barrier among building owners. Understanding their energy use in the context of other buildings in the same metropolitan area can help drive a wide variety of changes: from behavioral change to targeted energy audits and whole building retrofits. A meta-analysis of building benchmarking results found that cities with benchmarking policies reduced energy use in covered buildings by an average of 1.38% per year (Mims et al. 2017). Appendix B offers a detailed summary of this meta-analysis.

One procedural barrier to benchmarking identified by the EE Roadmap was a lack of easy access to energy data disclosure (e.g., through a Green Button "Download My Data") as highlighted in its recommendation #27a (Weiss 2019). As of spring 2020, the NCUC is engaged in rulemaking that will allow an authorized third party secure and private access to utility customer data (NCUC Docket E-100 sub 161, 2020). Once implemented, building owners should be able to more easily enter their building energy data into a management platform such as ENERGY STAR Portfolio Manager.

Further, North Carolina's cities and municipalities have jurisdictional limits on how much they can change building codes, which are established on a state level. This can create ambiguity as to whether city and municipal governments can implement a mandatory

[22] For more information, see www.bloomberg.org/program/environment/climatechallenge/#overview.

benchmarking policy. Because this policy primarily concerns data disclosure, however, with no changes to buildings at the code level, we believe it could be enacted without additional enabling legislation. That said, having support from the legislature or a directive from the governor's office would eliminate any ambiguity. Other cities in Dillon's Rule states that have implemented benchmarking policies include New York, Chicago, and Philadelphia.

RESULTS

Table 7. Summary of electricity savings from public building benchmarking

Total annual electricity savings (GWh)	2030	2040
Raleigh	151	171
Charlotte	295	342
Total	445	513

Both Raleigh and Charlotte contain many high-rise buildings, with 72% of total square footage in Raleigh and 78% in Charlotte found in buildings larger than 50,000 square feet. Our analysis suggests that a benchmarking and transparency policy targeting buildings greater than 50,000 sq. ft., starting in the year 2020, could reduce their energy usage by more than 12% by 2030 relative to the nonbenchmarking scenario. In particular, this would save Charlotte building owners more than $4 million per year (2020$) in avoided electricity expenditures, and potentially even more in natural gas, water, and other energy costs that were outside our scope. Appendix C offers more detailed cost assumptions. The expenditure on cost-effective energy upgrades results in a total of $2.80 saved for every $1.00 invested in efficiency for buildings above 50,000 square feet.

Beneficial Electrification in Buildings

Beyond electric efficiency measures, converting from fossil fuels (natural gas, propane, and oil) to high-efficiency electric heat pumps is an increasingly cost-effective and low-carbon option for space and water heating as North Carolina's grid is increasingly supplied by lower-emission options. The Clean Energy Plan highlights the importance of electrification strategies and includes a recommendation to analyze the costs and benefits of using electrification to reduce energy burden and GHG emissions (North Carolina DEQ 2019b). The EE Roadmap did not include electrification, but several of its recommendations—including a HPWH rental program—could apply to fuel-switching opportunities.

In 2018, ACEEE analyzed full replacements of existing oil and propane systems with heat pump systems when an existing system fails and needs to be replaced in North and South Carolina (Nadel 2018). That study found energy savings and favorable GHG reductions for oil and propane furnaces relative to heat pumps, as well as oil and propane boilers relative to ductless heat pumps in the Carolinas, where the grid mix includes some average combined-cycle plants and some renewable energy. Such measures also had favorable consumer economics in cases of heat pump installation instead of a central air conditioner when the central air conditioner needs to be replaced. Generally, HPWHs use less source energy than non-condensing water heaters fueled by propane or oil with any electricity-generating technology. The 2018 water heater analysis was conducted at a national level, as hot-water use does not vary extensively by region.

In addition, a 2020 analysis from Rocky Mountain Institute (RMI) found that, in North Carolina, GHG emissions would be 57.9% lower over the lifetime of an air source heat pump compared to a 95% Annual Fuel Utilization Efficiency (AFUE) gas furnace (McKenna, Shah, and Silberg 2020). The RMI analysis did not explore consumer economics. Despite the potential for fuel-switching measures to produce GHG reductions—and, in some cases, customer bill savings—they face barriers in North Carolina. Fuel-switching measures for natural gas, propane, and oil furnaces would require approval by the NCUC for IOU programs, where they face a higher burden of proof than other efficiency programs (R8-68).

Utility Savings Initiative—Expanded Targets for State Buildings and UNC

As noted in the CEE case, EO 80 expanded an energy savings target for cabinet agency buildings. Under this target, the Comprehensive Program to Manage Energy works to reduce the energy intensity per square foot by 40% by 2025 (relative to a 2002–2003 baseline). Draft legislation would extend this target to other state agencies and UNC system buildings.[23] Including non-cabinet agencies and UNC buildings would expand the comprehensive program to encompass an additional 94 million square feet of public building stock. We evaluated the impacts of expanded eligibility for this target in the EE case.

By reducing EUI for non-cabinet agency and UNC buildings by 40% compared to 2005, North Carolina could save an additional 1,593 GWh over the next 10 years. This is incremental to existing savings from the established target for cabinet agencies under EO 80. Overall, we estimated that an expanded program could save 2,310 cumulative GWh by 2030 through increased efficiency for public buildings and UNC schools. This is equal to nearly $100 million in avoided electricity costs for taxpayers. Due to the short-term nature of this savings target, we do not expect additional further energy savings past 2030 absent

[23] As of summer 2020, the Efficient Government Buildings & Savings Act (HB 330) has passed the House and remains in committee discussion in the Senate. www.ncleg.gov/BillLookUp/2019/h330.

increased targets.[24] Additional savings are likely in natural gas and other fuels, but those are outside our study's scope.

Opportunity for Energy Efficiency in K-12 Public Schools

Although K-12 public schools make up a significant portion of both public building stock and utility expenditures in North Carolina, there is currently no coordinated statewide initiative to improve energy savings in these buildings. The Energy Efficiency Roadmap Recommendation #2 calls for the creation of a program to fund energy managers across all 114 local education agencies. It would be operated out of the existing SEO Utility Savings Initiative. This would allow monitoring and benchmarking of data relating to energy consumption and spending in K-12 schools. Without this data, it is difficult to predict the savings potential from energy efficiency in public schools.

Stakeholders have identified funding as a major barrier to efficiency in schools. Because school budgets are set on a county level, areas of the state with the greatest levels of need are often least able to cover the costs of energy retrofits. For this reason, alternative sources of funding should be considered, including utility program incentives targeted at the institutional consumer sector, appropriations from the state legislature, and/or financing through ESPCs or a Green Bank.

Finally, it should be noted that COVID-19 presents both complications and opportunities for public schools throughout the state. In situations where large numbers of students are participating in virtual learning, schools can undergo energy retrofits while buildings are unoccupied. Additionally, there may be an opportunity to leverage economic stimulus funds to improve school facilities. An example of this is Vermont's School Indoor Air Quality grant program for K-12 schools (Efficiency Vermont 2020). Any statewide approach to these issues should consider the potential for energy efficiency to align cost savings, public health, and quality of life improvements for students and teachers across North Carolina.

FINANCING

Significant investments will be needed in EE and electrification to achieve North Carolina's climate goals of 70% emissions reduction by 2030 and carbon neutrality by 2050, as well as its goals to strengthen its economy and community resilience. A variety of clean energy financing strategies will be essential to leverage public and ratepayer investments with private capital. Together, public and private investments can help achieve a higher scale of energy savings and clean energy investments. A wide range of finance strategies can enable greater investments, including traditional bank and mission-driven lending; energy service agreements; commercial property assessed clean energy (C-PACE); government-run, quasi-governmental, and nonprofit green banks (i.e., clean energy funds); and utility on-bill lending including tariffs and financing. Much work remains to scale and improve the effectiveness and accessibility of each strategy in North Carolina. Here, we discuss opportunities for a clean energy fund, C-PACE, and performance contracting. On-bill financing also presents a significant opportunity for achieving savings for utility programs. To avoid double counting, we do not separately model the electricity savings opportunities for on-bill programs or a clean energy fund. These programs, however, provide an important means to achieve the utility program savings discussed above. The on-bill text box offers further information.

[24] Savings estimates assume a five-year measure life based on estimates used by agency staff for internal savings forecasts.

Clean Energy Fund

State efforts to scale EE will require leveraging private dollars in addition to public and ratepayer dollars. The Clean Energy Plan (recommendation F-3) and the EE Roadmap (recommendation #18) include establishment of clean energy fund[25] to catalyze the development of clean energy markets by issuing loans, providing credit enhancements, offering technical assistance, and investing in projects. The state or local governments can create a clean energy fund to address the upfront barriers that consumers and lenders face in financing clean energy projects and environmentally beneficial technologies. Clean energy funds take many shapes, but in general, they share the following key features:

- They are publicly chartered financing institutions, often a public entity or nonprofit.
- They have a mission to invest in clean energy and EE deployment.
- They leverage public funds to attract private capital.
- They offer products across sectors, focusing on bridging market gaps.

These funds are not actual banks because they do not hold deposits. Instead, they attract and deploy private capital investment to finance clean energy policy goals of a state or local government. These mission-driven funds work to expand access to financing in difficult-to-reach market sectors, working to complement existing programs by targeting market gaps and underserved populations unique to their geography. In their focus on bridging market gaps, they often also focus on supporting affordable and healthy buildings in low-to-moderate income (LMI) communities and emerging technologies. A clean energy fund can and should also include a technical assistance function that can help develop and scope projects with vendor neutrality. This technical support role is important for an efficiency financing entity.

Clean energy fund projects may also leverage other financing tools for customers; some might be statewide, while others are implemented by individual utilities. They could also serve as administrators for other clean energy financing programs, such as C-PACE. The Connecticut Green Bank, for example, administers its state's C-PACE program.

Clean energy funds have grown significantly in recent years, having generated more than $5 billion in clean energy investment nationally since 2011 and $1.5 billion of that in 2019 alone (Coalition for Green Capital 2020). Building on this success, 2019 federal legislation was introduced in both the House and Senate calling for the creation of a National Climate Bank. This proposed $35 billion fund would deploy capital through existing state and local green banks while creating new institutions across the country to further scale the impact of clean energy funds. In June, a national Clean Energy and Sustainability Accelerator was added as an amendment to a House infrastructure package coming out of the House Committee on Energy and Commerce (Dingell 2020). If enacted, this proposal would create a national-level green bank (or accelerator) that would be funded with $20 billion over six years and would direct funding into regional projects and support new and existing state banks. If a national

[25] Many states use the term "green bank" for these entities. However, they are not banks in that they do not hold deposits. Therefore, for the purposes of the recommendations in this paper, we use the term *clean energy fund*. The term *green bank* is often used by other states and in the national research reports of such entities. So, we use it to refer to specific entities or to the research findings of such entities around the country.

fund were to be created, North Carolina could be a recipient of capital intended for state-based green banks.

Most clean energy funds invest in both renewable energy and EE projects, but data on energy savings have been somewhat limited. While ACEEE's last review of state green banks found that energy savings were still low (Gilleo, Stickles, and Kramer 2016), more recent trends suggest that efficiency projects can make up a majority of clean energy projects supported through green banks (Hannah Beinecke, Coalition for Green Capital, pers. comm.). ACEEE's 2016 research also found that partnerships can be the key to success; most green banks worked in tandem with utility-administered programs, leveraging ratepayer-funded programs to achieve deeper energy savings.

For this analysis, we assumed that a statewide clean energy fund is established in 2021. The North Carolina EE Roadmap provides information on how this might happen. We recommend that a North Carolina clean energy fund leverage ratepayer-funded utility programs where possible. All projects supported through a state or local clean energy fund could help attract participation in target market segments, which could include agriculture and LMI households in North Carolina. Based on a review of the size of other states' clean energy funds relative to population, we assumed that North Carolina's clean energy fund would have an initial capitalization of $50 million and would generate annual investments in efficiency projects (with projects starting implementation in 2022), and then another $75 million of funds would be injected in 2030. We estimated that 75% of the total funds would go toward efficiency investments, with the remaining going toward renewable energy projects. We further assumed that 40% of the efficiency investments would be made in the LMI sector, with 60% in non-LMI projects. Appendix C has further details. We estimated that a clean energy fund of this size and investment pattern toward efficiency projects could achieve electricity savings of 520 GWh in 2040. Additional savings and benefits would be realized through renewable energy projects.

To avoid double counting, we do not count these savings as additional to other programs. For example, if the clean energy fund focused on the agriculture sector, it could readily achieve the savings that we identified for the agricultural audit program recommendation (100 GWh in 2040), with the remaining savings occurring in the LMI market segment.

Commercial Property Assessed Clean Energy (C-PACE)

PACE is a financing instrument for implementing EE or renewable energy projects. It enables property owners to finance up to 100% of the upfront cost of clean energy projects, which they pay back through a voluntary assessment on their property tax bill. Thus, PACES uses "special assessments" as a financial instrument. The funds for financing PACE can come from the state or local government that enables the PACE program, or they can be provided by a third-party financier (the predominant approach).[26] Different features of local

[26] The financing method is not a loan. It is typically like a loan with a term length and interest rate, but unlike a loan, it is tied to the property and not the individual property owner/borrower. PACE transactions can also use other forms of financing like leases and power purchase agreements, but the loan-like structure of repayment—principal plus interest—is the most common. However, because the PACE assessments and transactions are not technically loans, the term "PACE loan" is a misnomer.

government finance impact how property special assessments are used, and they vary by state (Parker and Hughes 2013).

The use of PACE is increasing across the United States. According to the Lawrence Berkeley National Laboratory (LBNL) (Deason et al. 2016), PACE's 2014 lending volume totaled $18 million in the C&I sector.[27] From 2016 to 2017, the C-PACE market increased by 75%, completing $251 million in funding by the end of 2017 and $280 million in 2018 (PACENation 2017, 2020). Using data from PACENation on the relative share of funding going to EE, we estimate that total funding of $158 million nationally went to efficiency projects in 2018.

In North Carolina, state legislation (SB97)[28] authorized PACE in 2009, but programs have yet to be established. Further, the 2009 legislation sunsetted in July 2020 (North Carolina DEQ 2019a). North Carolina's Clean Energy Plan recommended that the legislature take action to reduce barriers with existing legislation that would allow C-PACE to be implemented and meet the state's clean energy goal.

Local governments have faced challenges in establishing C-PACE in North Carolina. These include lack of familiarity with using specialty tax assessments for public investments, inability to delegate administration and financing (issuance of bonds) to a central authority, and need for state-level approval for all local debt (Rosenfeld 2015). While the first challenge could be addressed over time as assessments are used more often, resolving the other challenges may require legislative changes.

Stakeholders have also expressed a desire for consumer protections with C-PACE programs, especially for small businesses. National organizations have recommended various consumer protection policies for residential PACE (R-PACE) (NCLC 2019; PACENation 2017). While R-PACE was not recommended in North Carolina's stakeholder processes (and is not included in our analysis) some of the consumer protection lessons learned from R-PACE could be applied to C-PACE programs. Stakeholders should consider and address consumer protection concerns in efforts to re-establish authorizing PACE legislation and implementation of programs.

For our analysis, we assumed that North Carolina addressed these challenges and launched a C- PACE program over the next couple of years, with projects beginning to be implemented in 2023. We estimated the scale of investments for North Carolina using data from PACENation on CPACE programs in 17 other states (PACENation 2020). In 2019, those states on average invested $3.50 per capita in efficiency via C-PACE. We estimated that a program in North Carolina would ramp up to that level of investment in three years, starting in 2023—that is, we assumed investments of $12 million in 2023, $24 million in 2024, and $37 million in 2025 and each year thereafter.

[27] The residential market was much larger at $248 million. However, since then, the residential market has declined significantly after market changes in California and elsewhere.

[28] General Assembly of North Carolina, Session 2009. Senate Bill 97. www.ncleg.net/Sessions/2009/Bills/Senate/PDF/S97v6.pdf

On-Bill Programs

On-bill is a method of financing EE improvements that uses the utility bill as the repayment vehicle. On-bill programs cover the upfront cost of efficiency upgrades; customers then repay those costs using a portion of the energy bill savings. Ideally, these programs also provide direct rebates for measures, for example, efficient HVAC equipment or insulation, consistent with levels offered via the utility's other efficiency programs. Doing so lowers the upfront cost of the efficiency upgrades and makes the payback period more attractive for customers. On-bill programs have many variations. Below are general definitions of the three main types. Each of these programs can play an important role in North Carolina. The stakeholder-driven EE Roadmap recommends improving the effectiveness and accessibility of EE financing programs to serve multiple sectors, and on-bill is featured.

On-bill financing. The utility is the lender in an on-bill financing program. Ratepayer funds collected for efficiency programs are the most common funding source, but utility shareholder funds or other debt instruments can also be used. In some contexts, on-bill financing has become an umbrella term for any financing program that includes charges on a utility bill, including on-bill repayment and tariffed on-bill. Ideally, however, *on-bill* should be used as the umbrella term, with *on-bill financing* used when the utility is the lender.

Tariffed on-bill. In a tariffed on-bill program, efficiency upgrades are financed not through a loan, but rather through a utility offer that pays for upgrades under the terms of a new, customized tariff. This tariff includes a cost recovery charge on the bill that is designed to be less than the estimated savings. The on-bill charge is associated with the meter at the address of the property or facility where upgrades are installed, and the cost recovery charge is treated as equal to other utility charges on the bill.

On-bill repayment. In on-bill repayment, the capital provider is a third party, and the utility operates as a repayment conduit for that capital provider. A utility may opt to use its own funds to offer administrative support or credit enhancements.

These program types are good options for North Carolina's rural co-ops, municipal utilities, and IOUs to use to achieve significant energy savings, and the EE Roadmap recommends expanded access to creative financing options (Weiss 2019). The roadmap generally supports Pay as You Save (PAYS), which is an example of tariffed on-bill or other reasonable repayment EE programs financed through on-bill tariffs or third-party partners. Some examples already exist. For example, Roanoke Electric Cooperative offers a tariffed on-bill program, the Upgrade to $ave Program, to its residential and business customers. Eligible measures include insulation, duct and air sealing, heat pump improvements, water heater wraps, and LED lighting.

Smaller utilities' willingness to implement on-bill programs may be limited by the costs associated with billing and administration. Also, smaller utilities may perceive a risk potential in underperformance (Weiss 2019). However, these are challenges that can be overcome. Much potential remains for additional program offerings throughout the state.

LOW-INCOME PROGRAMS

Many households throughout North Carolina face persistent poverty and high energy burdens, defined as the percentage of household income that goes to paying energy bills.[29] Households with low incomes facing high energy burdens are also more likely to live in older, less-efficient housing. Low-income households in the Charlotte metro region face median energy burdens of nearly 8%, which is more than twice as high as median burdens for all households across all metro areas (3.5%) (Drehobl and Ross 2016).

These challenges extend to rural customers as well. Although 15 of North Carolina's 100 counties grew 10% or more in population between 2010 and 2018, 43 counties saw a net loss of people. In completely rural counties, median household income was more than $10,000 below the state average for 2013–2017. This discrepancy was driven by a 30% increase in private employment in large, urban counties between 2000 and 2018, whereas private employment in rural counties fell by about 6% (Henderson and Chemtob 2019). The policies below are designed to address energy burdens across North Carolina by targeting resources and offerings at the most disadvantaged or underserved customer segments.

Expanding Weatherization

In addition to bill assistance programs, which help customers pay energy bills in the short term, EE services, or weatherization, are a critical tool for these households. Weatherization helps customers upgrade their homes, thereby reducing their energy usage and bills over the long term. These investments also help improve comfort, health, and safety for participants.

The North Carolina DEQ administers the state's WAP using federal funding. The program helps low-income residents[30] save energy by providing in-home weatherization services. NC WAP is administered through 16 CAAs, one regional council of government, two local governments, and one nonprofit entity. Funding is allocated based on the number of low-income persons in each service area of the state and will be revised based on the next census figures. Weatherization providers are required to prioritize services to the elderly, persons with disabilities, children, those with a high energy burden (more than 15% of income going to energy costs), and those with high energy intensity (usage per square foot) or high usage (with electric strip heating as the primary heating source).

Other programs in the state support EE services to households with low incomes. These include LIHEAP, which supports bill assistance primarily, but also has some of its funding allocated to EE through WAP. Utilities also offer EE programs for income-eligible households.

Stakeholders in North Carolina have considerable interest in increasing the impacts of weatherization and have developed new resources to track and increase the program's impact. For example, the Powering Energy Efficiency and Impacts Framework project, a two-year initiative sponsored by the DOE, provides a data-driven framework to increase energy-related program effectiveness in low-income households (NCCETC 2019). The project led to a database and a geospatial-mapping tool of homes located in five eastern North Carolina counties served by the Upper Coastal Plain Council of Governments.

Given that North Carolina's statewide household eligibility far exceeds available resources for WAP, there is significant opportunity to expand investments in weatherization services for income-eligible households. For this program analysis, we focused on the unique additional savings from WAP participants. Additional funding is possible through

[30] Eligible residents are those whose income is at or below 200% of the federal poverty level; as of the 2010 Census, approximately 614,084 North Carolina residential households were at or below this level (North Carolina DEQ 2020c).

increased federal budgets for WAP, which could include federal stimulus investments. Another opportunity is to braid funding from the health sector into the weatherization program (see Hayes and Gerbode 2020). See Appendix C for details on key assumptions and methodology.

Minimum Requirement for Low-Income Efficiency Programs

In addition to statewide weatherization programs, utility-offered programs can target savings to customers with the highest energy burden, providing families more disposable income for nonenergy necessities. Options include no- or low-cost measures, weatherization programs, affordable multifamily programs, and programs targeted at nonresidential community-serving institutions in low- to moderate-income areas (e.g., nonprofits, schools, shelters, community centers). These programs tend to offer higher incentives to address challenges in accessing upfront capital among residents and affordable housing owners, which often results in higher program costs (Berg and Drehobl 2018).

As a result, many utilities tend to focus on market-rate customers and may struggle to deliver energy savings for these critical populations. North Carolina's largest utilities, DEP and DEC, offer the Neighborhood Energy Saver program, targeting low-income neighborhoods for home energy audits and direct-install measures at no cost to the resident. DEP also offers a weatherization program, which is a part of its Pay for Performance Pilot Program, that provides payments, based on kWh savings, to local nonprofit organizations that provide weatherization upgrades to residential low-income households. In total, the DEP and DEC income qualified programs were less than 2% of residential savings in 2018 and 2019, respectively, which are the most recent years for which data were available (DEC 2020b; DEP 2019a).[31] In addition, some LMI customers participate in other programs, including home energy assessments, the online store, retail lighting, and multifamily programs. Dominion offers a Residential Income and Age Qualifying Home Improvement Program, which provides in-home energy assessments and installation of select energy-saving products at no cost to qualified customers.

Such programs are particularly important in light of the large numbers of customers at risk of disconnection due to the COVID-19 economic crisis (Mission:data Coalition 2020). In addition to expansion of weatherization and Neighborhood Energy Saver programs to newly vulnerable customers, utilities can design programs that match debt relief with utility incentive programs for participating in EE programs. One emerging idea is a Clean Relief for Energy Debt (CRED) program in which a customer would have the option to forgive their arrearage and convert it into an upfront incentive to participate in an approved EE or demand response program. Designed well, such a solution would reduce the customer's bills over the long term, provide upfront forgiveness of past due bills based on their prospective participation in programs, and enable utilities to recover arrearages without fees or shutoffs (Fitch 2020).

To address the need to ensure offerings for low-income customers, the EE Roadmap recommends that 20% of the EERS savings come from savings for low-income customers

[31] Low-income savings represent a great proportion (7.5%) of DEC's residential savings when MyHER savings are removed (L. Shafer, strategy and collaboration manager, Duke Energy, pers. comm., July 21, 2020).

(Weiss 2019). This equates to 2% savings by 2030 from a 2020 baseline for IOUs, ramping up to savings of 0.2% of sales/year. It also represents 1% savings from a 2020 baseline by 2030 for co-ops and municipal utilities, ramping up to savings of 0.1%/year. Such a requirement would be consistent with delivering a portfolio that minimizes cross-subsidization and ensures savings for all customer groups.

Twenty-one states have adopted rules or legislation establishing a minimum required level of spending or savings on low-income EE programs. Most states do so through a minimum spending set-aside, either established as a dedicated funding stream or a requirement that utilities spend a minimum amount or percentage of efficiency program funding on low-income programs. Two states, Pennsylvania and California, have taken the approach recommended by North Carolina stakeholders and set a minimum target specific to low-income programs. Pennsylvania's goal requires that 5.5% of the total consumption reduction comes from savings in the low-income sector; California sets electric and natural gas targets in a specific amount for the utilities' low-income portfolio of offerings (Pennsylvania PUC 2015; CPUC 2016).

Our analysis assumes that utilities will meet these savings goals, and that the average first-year cost of saved energy is $0.996/kWh, based on a cost of saved energy study examining data from 2009–2015 (Hoffman et al. 2018). In North Carolina, low-income programs are generally not required to meet cost-effectiveness tests, but they are not officially exempted from such testing, nor is a special screen used for such programs.[32] With these assumptions, we projected savings of 1,400 GWh in 2030, rising to 2,300 GWh in 2040, for low-income customer programs.

Affordable Multifamily Program Expansion

Multifamily residences are historically an underserved market for EE, as identified in EE Roadmap recommendation #15: Expanding access for low-income single and multifamily residences (Weiss 2019). The impacts of natural and human-made disasters often have a disproportionate impact on lower-income households, where only 23% say they have enough funds set aside to cover expenses such as energy costs in the event of a sudden loss of income (Parker, Horowitz, and Brown 2020). This need is particularly acute in the wake of COVID-19, where families across the nation are facing a staggering energy burden and the threat of disconnection from their utility's service due to outstanding bill payments (Rott and Samuel 2020). The dual economic pressures of COVID-19 and high energy burdens are even more likely to affect Black and Latino communities.

EE in low-income multifamily homes is an opportunity to address these inequities. However, unique barriers exist to delivering efficiency to multifamily households, such as the split incentive for rental property owners, who have little incentive to cover the cost of

[32] No specific adjustments or exceptions to general cost-effectiveness rules are in place for low-income programs. The rules (Rule 8-68, 8-69) do not mention specific cost-effectiveness rules for low-income programs, but in practice, low-income programs are generally not required to meet cost-effectiveness thresholds (ACEEE State Policy Database).

efficiency upgrades when their tenants pay their own utility bills.[33].Because of these barriers, it is imperative that EE programs and resources continue to be made available to residents and building owners of multifamily units in order to address the energy burden these groups face.

As of 2020, several overlapping utility programs exist that target this sector. The largest in the state are run by DEC and DEP. The Neighborhood Energy Saver program targets both single- and multifamily units in select income-qualified neighborhoods for home energy audits and direct-install measures, at no cost to participating units. Additionally, the multifamily program works with rental property owners to provide energy audits and deliver lighting and water-saving measures, also at no cost to participants. While these two programs capture a portion of this market, opportunities exist for deeper penetration into the multifamily space. A 2015 NRDC and EEFA study of this sector identified cumulative potential savings of 621 GWh for low-income multifamily housing across North Carolina, with 461 GWh in Duke utilities' service territory (Mosenthal and Reed 2015).

We examined the current participation and per-unit savings in Duke Energy's Multifamily Energy Efficiency and Neighborhood Energy Saver programs. Although both are direct-install programs that include home lighting and water measures at no cost to participants, Neighborhood Energy Saver is available only to customers in specific neighborhoods. These neighborhoods are selected based on income, where 50% or more of households have incomes at or below 200% of federal poverty levels. Program administrators said that approximately 20% of the Neighborhood Energy Saver units are multifamily for both DEC and DEP. Neighborhood Energy Saver offers a broader range of measures than the Multifamily Energy Efficiency program, including lighting and water measures as well as EE education, infiltration reduction (air sealing), and HVAC filter replacement (DEC and DEP 2019a).

To evaluate the achievements of Duke's low-income and multifamily programs, we benchmarked each program's savings against a variety of similar programs from other utilities and program administrators in the Southeast region and beyond.

Table 8. Affordable direct-install program examples—low-income multifamily

Administrator	State	Program	Year	Total units *(MF units)*	Spending per unit	Savings per unit (kWh)
Duke Energy Carolinas	NC	Neighborhood Energy Saver[34]	2017–2018	6516 *(1303)*	$780.95	779
Duke Energy Progress	NC	Neighborhood Energy Saver	2017–2018	3825 *(765)*	$502.66	676

[33] ACEEE has undertaken a multiyear study into energy efficiency for multifamily buildings; see aceee.org/multifamily-project.

[34] DEC low-income programs also include weatherization and appliance replacement. Savings from those programs were excluded from this analysis and the spending per unit represents only NES for DEC. Values shown here represent all unit types (single and multifamily).

Administrator	State	Program	Year	Total units *(MF units)*	Spending per unit	Savings per unit (kWh)
Duke Energy Carolinas	NC	Multifamily	2018	*(3,770)*	$1643.12	824
Dominion Energy[35]	NC	Income and Age-Qualifying Home Improvement	2017	5,552	n/a	322
DCSEU	DC	Energy Savings Assistance	2017	6,080	$74.73	417
DCSEU	DC	Low-Income Multifamily Custom	2017	*(1,770)*	$703.26	1,156
PECO Energy	PA	Low-Income EE	2017	*(2,227)*	$1,032.77	854
National Grid	RI	Income-Eligible Multifamily	2017	*(5,162)*	$553.77	769
National Grid	MA	Low-Income Multifamily	2017	*(6,141)*	$465.49	2,045
Ameren	MO	CommunitySavers	2017	*(4,486)*	$473.52	1,635

Sources: DEC 2019, DEP 2019a, Dominion Energy 2018b. Other low-Income program examples from Samarripas and York 2019, "Closing the Gap in Energy Efficiency Programs for Affordable Multifamily Housing." DCSEU stands for the District of Columbia Sustainable Energy Utility.

Although it is difficult to do a true comparison of many of these programs due to fundamental differences in measure types, market conditions, program budgets, and enrollment, Duke's low-income and multifamily programs demonstrate average to above-average savings per unit in comparison with spending per unit. Deeper savings may yet be achieved, however, particularly by expanding measure offerings in the Neighborhood Energy Saver programs. In their report, program evaluators stated that additional savings might be reached by emphasizing air infiltration measures and prioritizing neighborhoods with electric space and water heating (DEC 2020b).

Because Neighborhood Energy Saver is the only Duke program that specifically targets units that are both low-income and multifamily, we examined costs and energy savings from an expanded version of that program, targeting the achievable potential of 461 GWh for Duke territories in the EEFA 2015 report. (Although we conducted this analysis five years ago, a comprehensive potential study into this sector has not taken place since then.) Taking both DEC and DEP programs together, we modeled what an increased multifamily target would look like. We assumed increased program participation, from 2.72% of eligible properties per year to 3.7%, representing an additional 500–700 units per year. In addition, per-unit savings were increased by 35% to an average of 1 MWh/year. These additional per-unit savings could be achieved through an expanded array of solutions beyond lighting and

[35] Program spending data for Dominion are confidential to the public.

water measures, including whole-building savings opportunities unique to the multifamily sector.

Table 9. Projected savings—Duke affordable multifamily programs

Year	Participation (units)	Energy savings (MWh)	Participant savings ($)	Program administration costs ($)
2030	3,970	25,800	$3,010,000	$3,960,000
2040	4,950	32,500	$3,980,000	$4,930,000

Due to the relatively high cost of saved energy for programs targeting low-income customers—and the fact that the program is free to participants—this program is more expensive per saved MWh than many other EE programs (Mims et al. 2017). Duct-sealing and other measures may bring with them additional nonenergy benefits, particularly in terms of improving comfort and indoor air quality. Therefore, the value of measures installed in these programs goes beyond just the savings on customer energy bills. However, North Carolina does not currently value nonenergy benefits—such as increased comfort, health, and productivity— in its cost–benefit testing (NESP 2020a). Expanding cost–benefit testing to include such benefits (EE Roadmap recommendation #23) would more fully capture the value these programs deliver.

Multifamily Savings beyond Duke's Service Territory

The NRDC potential study identifies an additional 252 cumulative GWh of potential energy savings for low-income multifamily households that exist outside Duke's service territory. Of these, 19 GWh are in areas serviced by Dominion Energy, 15 GWh are served by EnergyUnited Electric Cooperative, and the remaining 218 GWh are in various other municipal utilities and electric co-ops throughout the state.

Achieving these potential savings will require a combination of direct-install and new build-oriented programs targeting these sectors. We discuss the Qualified Allocation Plan for new builds in the next section. For delivering efficiency audits and measures to existing structures, we recommend the following:

- *Dominion Energy.* NRDC estimates costs at $9 million and total program benefits at $24 million in utility bill reductions and other nonenergy benefits in Dominion's North Carolina service area. Dominion Energy already offers an income- and age-qualified EE program in its North Carolina territory, and while it is not multifamily-specific, many of the units receiving direct-install measures fall under this category. In addition, continued WAP funding will also assist Dominion North Carolina in hitting its low-income savings targets.
- *Co-ops and Municipal Utilities.* Due to the high capital and program administrator costs associated with running a targeted multifamily program, requiring every non-IOU to operate its own program would be infeasible. Because of this, we recommend a statewide technical assistance entity to work with smaller utilities in meeting low-income efficiency targets. Advanced Energy is an existing nonprofit that provides these services and has an established reputation as a program administrator. The

technical assistance it provides could be funded through a clean energy fund (EE Roadmap recommendation #18).

Qualified Allocation Plan—Standards for New Multifamily Construction

The Qualified Allocation Plan is a state tax credit administered to housing developers that meet certain criteria in constructing affordable multifamily housing units (NCHFA 2020). This tax credit program is administered by the North Carolina Housing Finance Agency. To qualify for the tax credit, developers must—in addition to satisfying other criteria—meet a minimum standard of EE, currently equal to ENERGY STAR 2.0. These standards lag the updated 2018 Building Energy Codes in areas such as duct leakage (NCBPA 2019). Advocates recommend increasing these standards to equal ENERGY STAR version 3.0 or higher, while offering additional incentives for further tax credits for developers who exceed those standards. This aligns with EE Roadmap recommendation #17, which calls for continued funding of the Housing Trust Fund, which funds the Qualified Allocation Plan as well as other grants and assistance to keep housing affordable throughout the state.

INDUSTRY AND AGRICULTURE

Improving EE in industry, including in manufacturing and agriculture, is an essential way to reduce electricity demand, advance decarbonization, and provide cost savings to integral parts of North Carolina's economy. This is especially important because of the relatively cheap cost of saved energy in the industrial and commercial sectors. North Carolina manufacturing accounted for 10.6% of the state's workforce and $103.6 billion in total output in 2018 (NAM 2020), while agriculture accounted for a further $11.5 billion (USDA and NCDA&CS 2018). Industrial customers as a whole were responsible for more than 27,000 GWh, or about 20%, of North Carolina's electricity sales in 2018. Agriculture, a critical part of the state's economy, is not only energy intensive but also underserved by EE and renewable energy programs. The EE Roadmap notes this and explains that the agricultural sector is particularly vulnerable to the effects of climate change; it recommends that EE rebates, incentives, and other programs better address underserved sectors, including the agricultural sector (Weiss 2019).

Large Customer Savings beyond Strategic Energy Management

The EE Roadmap notes that one regulatory and policy barrier to increased EE adoption in North Carolina is the ability of industrial and large commercial customers to opt out of utility programs (Weiss 2019). C&I customers with usage over 1,000,000 kWh per year can notify their electric power supplier that they have implemented or plan to implement alternative EE or demand-side management (DSM) measures, allowing them to then opt out of utility EE and DSM programs (NCUC R8-69 (d) 2007). The regulation has no requirement for evaluation, measurement, and verification of savings, nor is there a transparent mechanism for customers to manage their individual fee contributions and apply funds toward their projects (e.g., dedicated escrow-like accounts).

In North Carolina, large customers are clearly contributing to the state's policy goals, as the EE Roadmap notes that "EE measures implemented in industrial facilities as well as non-utility investment in existing and new buildings will play a vital role in keeping the demand curve flat in the coming decades." For example, some customers voluntarily report savings as a part of the ESI and some also participate in federal SEM programs (described in the

SEM section below). However, without some basic record of energy savings, it is unclear how much additional savings are being captured from these opted-out customers. Capturing these savings would support transparent utility system planning, as well as acknowledge this sector's current and potential contributions to achieving the EO 80 GHG, affordability, and economic development goals.

State policy that allows large industrial, commercial, or institutional customers to opt out without reporting their energy savings or conducting evaluation, measurement, and verification (EM&V) can leave some efficiency and emissions reductions on the table due to the persistent market failures that large customers face (Russell and Young 2012). This data gap can lead to energy forecasts that are higher than they otherwise would be, ultimately increasing everyone's energy costs by prompting unnecessary investments (Neubauer et al. 2013). While SEM is an important strategy to address operational savings opportunities and identify capital projects, it cannot overcome barriers such as access to capital and capital allocation policies that disadvantage EE projects that require capital expenditures. Solutions such as incentives and low-interest financing can better address internal obstacles and drive investments, including those in process modernization, smart manufacturing, and motors system optimization.

To address this gap, we recommend that North Carolina capture industrial savings opportunities through legislative action or a stakeholder process initiated by the executive branch, such as the Energy Efficiency Advisory Council.[36] Rather than suggest a "one size fits all" option, we see various policy options for that process or legislation that can better capture this opportunity. First, utilities can continue to work with large customers on custom projects that are mutually beneficial and deliver system benefits. Second, the NCUC or legislature could adopt a self-direct program, which continues to offer large energy users flexibility and control over investment of their EE contributions, while ensuring that measurable, cost-effective energy savings are achieved for all customers in the utility system.[37] These programs require customers to make their own cost-effective EE investments, and utility program administrators to measure and verify EE savings. In successful programs, utilities provide clear guidance to support reporting consistency and to ensure transparency while protecting confidential information. Third, the legislature can consider minor changes to the thresholds of who can opt out to bring more customers into default utility EE service. Finally, the legislature could consider a wholesale change to the industrial opt-out so that customers are directly served by utility offerings.

---

[36] The EE Roadmap recommendation for the EEAC notes that it would target the residential and commercial sectors but could occasionally provide oversight to and recommendations for industrial customers. As a result, the EEAC might require guidance to initiate such a process, depending on its chartered scope.

[37] These best practices include: 1) Report savings to regulators with routine data collection, standard approaches to measuring and verifying energy savings, and regular progress reporting. 2) Establish a transparent mechanism for customers to manage their individual fee contributions and apply funds toward their projects (e.g., dedicated escrow-like accounts, rebates earned upon project completion, or rate credits earned concurrently with EE investments and/or energy savings). 3) Provide customers with greater flexibility and control over their EE funds (e.g., through multiyear time frames to let customers spend aggregated EE fees) (ACEEE 2020).

We separately estimated the savings from customers' continued voluntary efforts in the ESI program in the CEE case and estimated further savings from opted-out customers participating in SEM programs in the SEM section below.

To characterize the additional potential savings from this sector, we analyzed the potential savings from industrial customers served by IOUs. These savings could be achieved either through a self-direct program or a change to the industrial opt-out so that customers are directly served by utility offerings. Some of these savings may be currently captured by efforts reported as a part of the ESI program, or they may occur in projects that are completed but not reported. These are important savings to capture in our analysis in order to recognize the current and potential contributions toward achieving the EO 80 goals from this sector.

We started with a baseline of all opted-out load from IOU customers, as each of these facilities must notify its electric power supplier that it has implemented or will implement alternative EE measures. To estimate savings, we used the same percentage savings and participation estimates as for the EERS modeled in this report, ramping up over time to participation equivalent to savings 1.2% of opted-out load per year.[38] Appendix A offers further details. We estimated that the large customer sector could achieve electricity savings of more than 2,100 GWh in 2040, including some planned efforts that may not be reported or otherwise captured. To avoid double counting, we subtracted savings from the proposed SEM and industrial assessment programs described in the following.

Industrial Assessments

North Carolina has many university, government, and nonprofit programs providing energy assessments and technical assistance to the industrial sector, including IACs, Advanced Energy, WRP, and the North Carolina Clean Technology Center. IACs, which perform energy use assessments for industrial customers, are critical to expanding industrial EE. These centers and their assessments provide industry-specific expertise and help to create a workforce that is knowledgeable about EE.[39] IACs connect small and medium industrial customers with information about available low-cost, high-return on investment energy-saving opportunities for their facilities and quantify their potential energy and cost savings.

The North Carolina State University (NCSU) IAC is one of 31 IACs supported by the DOE at various large engineering universities across the United States. Through this program, teams of NCSU faculty members and engineering students conduct plant assessments at no cost to eligible manufacturers. During assessments, the teams identify energy-saving

[38] Based on the EE Roadmap recommended target of achieving 10% electric energy savings by 2030, below a baseline of each IOU's total gross electric sales in 2020. We adjusted each utility's ramp up to 1% per year savings in 2030 and 1.2% in 2032 based on their current energy savings as described in the EERS section above.

[39] IACs were created in 1976 to focus on helping small and medium-sized manufacturing facilities cut back on unnecessary costs from inefficient energy use. Today, IAC programs have expanded to include exploring smart manufacturing technologies and implementing comprehensive energy management systems. The IAC program is administered through the Advanced Manufacturing Office under the DOE's Office of Energy Efficiency and Renewable Energy. To date, the program has conducted more than 19,253 assessments and made more than 145,129 associated recommendations.

opportunities and quantify the potential energy and cost savings. Since its creation in 1992, the NCSU IAC has conducted more than 500 assessments and assisted manufacturers in implementing 1,808 cost-effective, voluntary EE measures that have resulted in savings of $24,876,714. About 67 recommendations have been implemented per year, with average savings of 124 MWh per recommendation since 2012 (DOE 2020e), although savings are highly variable year to year. Without changes to funding, we project savings will reach 36 GWh in 2030, and 50 GWh in 2040. In addition, WRP, a program of the Land of Sky Regional Council in partnership with NCDEQ, has conducted effective statewide energy assessments. WRP utilizes retired engineers to help perform approximately 50 energy assessments annually. We included savings attributed to this program, and our projections of those savings, in the CEE case and to the total EE case for industrial assessments (T. Albrecht, state director, WRP, pers. comm., July 8, 2020).[40] We recommend that the state provide supplemental funding to increase the electricity and cost savings that are possible through the NCSU IAC. Mature centers such as this one can always find additional assessments to perform. We assumed that if the state were to double current IAC funding, the number of implemented recommendations and resultant savings would also double. We estimate that such an investment would result in 100,000 MWh in savings in 2040. These savings would add to the existing efforts of WRP's industrial audit program for combined savings of 176 GWh in 2030 and 208 GWh in 2040. Based on analyses of other assessment centers, we estimate DOE funding of approximately $310,000 annually per center.[41] If these funds are matched by the state, doubling the funding, we estimate net bill electricity savings through the supplemented IAC to reach $3 million in 2030 and $2.9 million in 2040 based on average retail rates. By changing rate schedules, shifting plant operational schedules, and reducing loads, these improvements could also deliver significant peak savings.

Additional savings opportunities exist from further investments, including an IAC at another major engineering university in North Carolina. The state could also explore complementary policies to reduce its industrial energy consumption, including support for smart manufacturing. Smart manufacturing uses information and computer technology to increase flexibility in manufacturing and transition data into knowledge while reducing wasted materials and energy. Such support would likely take the form of training and grants. An industrial initiative that includes IAC and smart manufacturing funding could leverage capital from the Clean Energy Fund for small to medium-sized industrial firms. Any federal legislation, including potential stimulus, that would increase funding to the centers, expand their scope for assessments, or increase the size of centers would significantly contribute to new savings. Additionally, because recommendations associated with industrial energy audits typically have an implementation rate of 50% or less, if a policy were to incentivize implementation, savings could be deepened even further.

[40] Total client savings from WRP programs for the five-year period 2015–2020 were more than $24 million, and cumulative electricity savings were 1,106 GWh for all nonresidential sectors served.

[41] To support industrial assessments, DOE has awarded the Georgia Tech IAC $1.6 million over five years and the Louisiana State University IAC $1.5 million over five years.

Strategic Energy Management

SEM is a method of managing energy use that empowers organizations to consistently achieve systematic energy performance improvements. These continuous energy-saving improvements are made through structured approaches to management, including assistance with identifying and prioritizing energy-savings projects, and providing hands-on support. SEM involves—at minimum—a commitment to energy management planning and implementation, complemented by a system for measuring and reporting performance. This strategy holds substantial potential for energy savings. State-wide programs often report savings as high as 10% of annual energy spend for participants (Bernaf and Buffum 2017). There are several approaches and programs relevant to SEM in North Carolina.

Industry has already made significant strides toward improving EE in North Carolina through the efforts of state offices such as the DEQ, industrial customers that have established and report on their energy savings goals, and third-party organizations. We now describe the state's existing SEM programs and their projected savings, assuming no changes to their current approach and scope.

DEQ has operated the ESI since 2002, helping to achieve significant electricity, natural gas, diesel, propane, and other fuel savings in addition to emissions and cost reductions for industrial and commercial enterprises in North Carolina. ESI's primary objective is to assist organizations in reducing their environmental impacts beyond the level of existing regulatory requirements—and to recognize those organizations for their commitment. The program is free and voluntary, and all members self-report their savings and set their own energy goals. From 2012 to 2018, the program reported more than 432 GWh of electricity savings. We forecast annual electricity savings of approximately 666 GWh in 2040 from continuation of these activities (North Carolina DEQ 2020b). Combining energy-saving potential of the ESI program with the technical assistance efforts of DEQ's WRP could yield significant additional savings.

In addition to the ESI program, North Carolina's industrial facilities have participated in federal SEM programs. Currently, 10 facilities in the state use the 50001 Ready Navigator to track the progress of their energy management system (EnMS) implementations. DOE defines EnMS as an integrated management culture that focuses on the continual improvement of energy performance as an everyday business practice. To date, none of the companies have completed this program. Three facilities are certified under the DOE's SEP program, which differs from EnMS and 50001 Ready because it requires third-party verification of implementation and energy performance. The three facilities are Schneider Electric's Greensboro facility, Cummins' Rocky Mountain Engine Plant, and Daimler Trucks' Mount Holly facility (DOE 2015; DOE 2016). Advanced Energy is currently hosting an industry cohort using the 50001 Ready program. Additionally, the Utility Savings Initiative works with state agencies, the UNC system, and community colleges to educate and communicate the need for SEP. Both EO 80 and 143-64-12 require state agencies and the UNC system to have Strategic Energy Plans. In the 2017 *Annual Report for the Utility Savings Initiative*, 14 state agencies, 21 UNC institutions, and 58 community colleges reported their consumption and cost data, as well as their plans for continuous improvement of their strategic energy plans (North Carolina DEQ 2017).

Despite progress in voluntary state and federal programs, additional cost-effective industrial and large commercial potential remains in North Carolina. Approximately 99% of the estimated eligible industrial and commercial demand for 2020 has not participated in these voluntary programs. While SEM was not an explicit recommendation in the Clean Energy Plan or EE Roadmap, we see large potential for these programs across the United States. Some of these savings will be allocated as part of the EERS policy.

Given this potential, and the fact that these programs traditionally have catered to small and medium-sized companies, we recommend that DEQ launch a statewide SEM program to target medium and large customers that have opted out of their utility service provider's EE rider. The program would bolster the efforts of ISO 50001, DOE's 50001 Ready tool, DEQ's ESI and WRP, Advanced Energy, and DOE's SEP certification program, in addition to other utility offerings in the state. This SEM program would provide participants with options for funding and technical assistance; it could also include basic offerings to improve internal process efficiency and more advanced tiers that meet DOE's SEP program standards. The EE Roadmap also mentions SEM as a unique opportunity for the industrial sector (Weiss 2019).

To evaluate the savings from such a program, we focused on customers who had opted out of IOU programs, as savings from utility programs would be a part of the proposed EERS. Additional potential savings could come from customers of co-ops and municipal utilities who participate in a statewide SEM program, which we do not capture here. Opt-outs account for 40% of the commercial load and 73% of the industrial load for DEC and 30% of commercial load and more than 90% of the industrial load for DEP (Nexant S&P Group 2020; Duke Energy Progress 2019a). In addition, more than 58% of Dominion's 2019 nonresidential load opted out (Dominion Energy North Carolina 2018b).

We used 1 million kWh in annual energy consumption as the threshold for eligibility, based on a review of SEM program experience around the country (Kolwey 2013). We used all C&I load that had opted out from IOUs as the baseline for our analysis. We removed our estimates of savings from ESI from the opted-out load used as our baseline. Based on case studies of other SEM programs and a CEE 2014 survey, we assumed 8% savings each year for this analysis with a measure life of five years (NREL 2017).

To estimate how many customers might participate in such a program, we started with the amount of load that we estimated would be addressed by existing efforts in North Carolina SEM in 2022. We assumed an incrementally increasing participation rate to 2030 for the C&I sectors. Based on a CEE survey of 2015 SEM program performance (Burgess 2016), we estimated the participation rate for the commercial sector would reach customers representing 23% of the load cumulatively by 2030, while the industrial sector would reach customers representing 38% of the load cumulatively by 2030 (Rogers, Whitlock, and Rohrer 2019). These cumulative participation rates translate to an additional 5.5% per year of industrial load and 3.25% per year of commercial load in 2030; we assumed that the participation growth rate would stay constant at these yearly rates through 2040.

With these assumptions, we found average annual electricity savings of 420 GWh through a statewide SEM program from 2022 to 2040. We estimated savings in the program's first year of 25 GWh, reaching annual savings of 500 GWh in 2030 and 591 GWh in 2040. Of those savings, 31% would be commercial and 69% would be industrial. These values would account for 0.78% of the IOU nonresidential load in 2030 and 0.87% of the IOU nonresidential load in 2040. These savings are incremental to the EERS we analyzed. These savings would add to the existing efforts of DEQ's ESI program for combined savings of 1,116 GWh in 2030 and 1,257 GWh in 2040. We also backed out these savings from the estimate of a potential large customer program beyond SEM (e.g., self-direct or changes to opt-out rules). See Appendix C for additional details on key assumptions and methodology.

Additional potential savings are available through cohorts, such as the one being developed by Advanced Energy, or through SEM continuation after the program's first year. Additionally, participants may opt to have new sites from their organization participate, expanding potential savings. Finally, it is important to note that our analysis contains two conservative assumptions. First, in many of the case studies we examined, participants established standalone internal energy-saving procedures after they participated in SEM programs, and we did not estimate these savings. Second, many participants indicated that they had adopted SEM practices at other nonparticipating sites (DNV GL 2016).

Agricultural Programs

North Carolina is the third most agriculturally diverse state in the country, and the agricultural sector is a significant part of the state's economy, bringing in more than $4 billion in net income in 2017 (USDA 2019a). The state ranks first in the nation in farm cash receipts for tobacco and sweet potatoes, second for poultry and eggs, third for pork and trout, and eighth in total farm cash receipts (North Carolina DEQ 2018). However, North Carolina lags behind similar states in approved Rural Energy for America Program (REAP) efficiency grants from USDA. REAP is one of the largest federal funding mechanisms for agricultural EE in the country, and one of the only programs that focuses solely on rural clean energy (USDA and NCDA&CS 2018). DEQ's WRP program has provided 99 agricultural energy assessments supporting the REAP project in North Carolina since 2012 (T. Albrecht, state director, WRP, pers. comm., July 8, 2020). This indicates additional potential for state agencies, including DEQ and the North Carolina Department of Agriculture and Consumer Services, to help connect agricultural facilities in the state with these federal resources.

North Carolina also has the opportunity to expand state- and utility-offered programs to help farmers save electricity and money, building on the state's existing agricultural EE programs and measures. Agricultural customers of the state's electric co-ops have access to energy audits through a grant from USDA rural development, administered by EnSave in collaboration with the co-ops and the North Carolina Electric Membership Corporation. The program covers 75% of the cost of an energy audit, which provides an evaluation of EE opportunities at agricultural facilities. In the most recent year of data collection, 22 participants achieved more than 650 MWh of electricity savings from the audit program. REAP-funded farm energy assessments by WRP have achieved 90 GWh in cumulative savings from 2012–2020 (T. Albrecht, state director, WRP, pers. comm., July 8, 2020). We project that continuing this program will result in additional savings of 21 GWh in 2030 and 23 GWh in 2040.

The state's agricultural enterprises can use the North Carolina Energy Audit Program to access funding for equipment upgrades as well as gain eligibility for USDA REAP grants to pay the initial costs of efficient systems and equipment. The USDA's REAP program is designed to help farmers overcome the first-cost barrier, potentially covering up to 25% of eligible project costs up to $250,000. In 2019, REAP provided 19 such grants to North Carolina facilities, totaling $395,611 (USDA 2019b). Efficiency projects completed through REAP in North Carolina include lighting upgrades, upgraded grain dryers, electric motors, and poultry house insulation.[42] Analyses of the program have found that efficiency improvements can often reduce energy consumption by more than 30%, and that returns on investment are generally very good (Olsen 2009). Duke Energy, through its Smart $aver program, also offers prescriptive rebates for certain agricultural technologies to help with energy-efficient upgrades for poultry, dairy, swine, and crop farms.

We analyzed a statewide energy audit and implementation (incentives and training) program for agricultural facilities, including cost sharing to promote the uptake of available more-efficient agricultural technologies and practices. North Carolina, through DEQ WRP or the Department of Agriculture and Consumer Services, should develop such an agricultural program aimed at engaging the state's network of agricultural stakeholders and in-state experts. Audits funded by the program should be designed to support eligibility for federal programs, enabling producers to participate in REAP and the USDA Natural Resource Conservation Service's Environmental Quality Incentives Program.[43]

Based on relevant case studies of third-party agricultural audits in North Carolina and other states, we estimated that implementing efficiency measures identified through agricultural audits has an average savings value of 25 MWh per agricultural facility and a cost savings of $3,400 on average per implementation. Statewide audit and implementation programs in states such as Delaware and Maryland report similar numbers (DESEU 2019; MEA 2020). Based on stakeholder feedback, we assumed that, with state supplemental funding and the leveraging of existing third-party programs, the number of completed audits could scale up to reach 2,000 of the state's farms by 2030 and an additional 4,000 farms by 2040, and the associated recommendations could be implemented starting in 2020. Annual savings from these audits and associated implementations would reach 44 GWh in 2030, and 100 GWh in 2040, which would account for 3.7% and 6.2% of the total estimated agricultural load, respectively. These savings would add to our forecasts of the existing efforts of WRP's agricultural audit program for a combined savings of 65 GWh in 2030 and 123 GWh in 2040.

To realize the opportunity that audit recommendations present for reducing farm electricity use and spend, we recommend that state programs offer to cover 75% of EE project costs, including implementation of EE measures. The grant award should be based on potential energy savings. We would also anticipate further savings associated with USDA REAP grants enabled through eligible audits.

We estimated an average cost of $3,400 per participating customer, scaling up to 400 audits participating per year from 2030 onward. Of those costs, 75% would be provided by the state or third-party offerings, resulting in a total cost to all participants of $340,000 each year

[42] Poultry accounts for approximately 45% of agricultural energy consumption in North Carolina.

[43] Specifically, such energy audits should meet USDA NRCS criteria and/or ANSI/ASABE S612 Performing On-Farm Energy standards.

after 2030. Participant costs could be further offset by low-interest loans provided by a state clean energy fund, enabling increased program participation. A parallel loan guarantee program run by the state or federal government would ensure confidence and increase participants' willingness to pursue EE opportunities more aggressively. We estimated that net electricity savings from the program, based on average retail rates, would represent 0.03% of annual North Carolina farm spend in 2022, growing to 2.44% ($6,900,000) of annual farm electricity spend in 2040.

Results: Energy Efficiency Program and Policy Case

COSTS AND BENEFITS OF ENERGY EFFICIENCY CASE

EE investments provide multiple benefits to participating households and businesses, to utilities and all customers in their system, and to society at large. This range of benefits includes lower bills and improved health outcomes and comfort for those who receive efficiency upgrades; avoided energy, capacity, and T&D savings to utilities and all of their ratepayers; and avoided pollution including harmful GHG emissions, which provides societal benefits. Analysts can and should use multiple perspectives to examine these benefits relative to the costs of deploying efficiency policies and programs. Different perspectives adopt different traditional cost–benefit tests. As figure 11 shows, for example, a participant perspective might adopt the PCT, while a program administrator or utility perspective might use the PACT or UCT, and a broader public policy and societal perspective might use the Societal Cost Test (SCT). Recent efforts, however, have recognized that those traditional tests may not be right for states. Indeed, the *National Standard Practice Manual* (NSPM) for Benefit–Cost Analysis of Distributed Energy Resources (DERs) recommends that states consider designing their own tests to align with their specific public policy goals (NESP 2020b). The NSPM also recommends universal principles for developing and applying cost-effectiveness assessments. It provides the step-by-step *NSPM Benefit–Cost Analysis (BCA) Framework* (see figure 11) for jurisdictions to use to develop their primary cost-effectiveness test—the Jurisdiction Specific Test—and offers guidance for selecting and quantifying the test components. North Carolina may want to consider such an approach going forward.

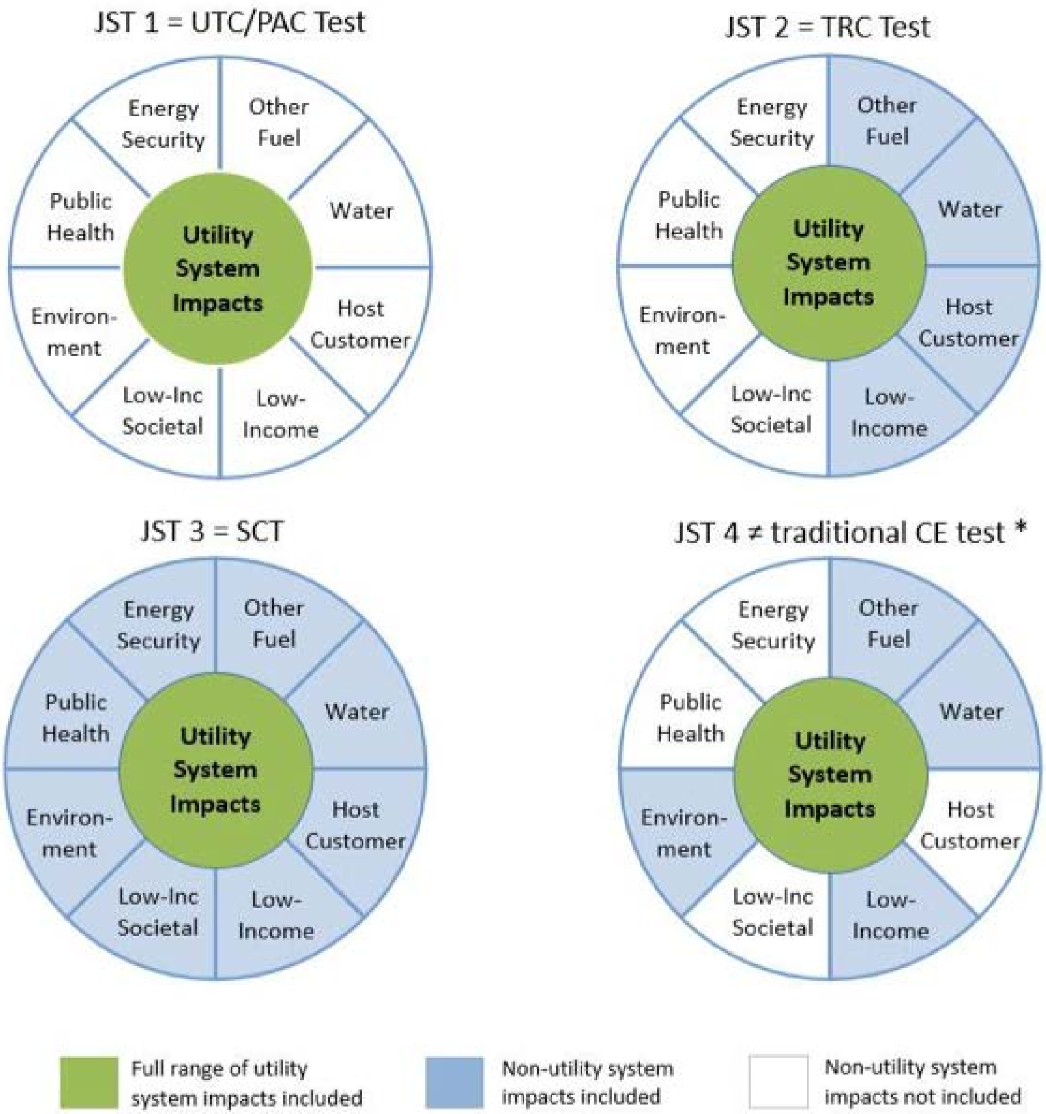


Figure 11. Primary tests, and an example Jurisdiction Specific Test (JST), that states can develop using the NPSM BCA Framework. *Source: National Standard Practice Manual for Benefit–Cost Analysis of DERs*, NESP 2020b.

Many states use the TRC test, but it has proven problematic because it is generally not symmetrical—that is, it captures all costs incurred by program administrators and by customers, yet it captures only a portion of the benefits to program administrators and customers. North Carolina has specified the TRC as its primary test for decision making around utility EE programs (Database of State Efficiency Screening Practices (NESP 2020a)). However, there has been a recent settlement agreement to use the UCT instead (DEC and DEP 2020). The primary assessment level is the efficiency measure, and the secondary is the program level. Rule R8-68 states the rules for cost–benefit tests (NCUC 2008).

For our analysis of the broad benefits of EE policies and programs in North Carolina, we chose to focus on three perspectives: 1) the program administrator or utility perspective; 2) a societal perspective, using a limited societal cost approach; and 3) a participant perspective. We chose the first because it is most closely aligned with the perspective of utility resource planning and other program administrators; it has also been proposed by stakeholders as the future direction for North Carolina's cost-effectiveness test approach. We chose the second because it most closely aligns EE with the broader policy objectives of both using efficiency as an emissions reductions strategy and helping reduce energy burdens for low-income households. And finally, we examined participant benefits to study the perspective of North Carolinian residents and businesses that directly invest in efficiency.

We did not include a rate impact measure (RIM) test, which is no longer widely used as a primary cost-effectiveness test for EE because of its limitations. Its purpose is to indicate whether an EE resource will increase or decrease electricity rates and should not be used for the purpose of determining which efficiency resources are cost effective (NESP 2017). However, rate impacts are still an important consideration when assessing the scale of efficiency investments and the impacts on different rate classes. While the RIM test is not a useful tool for putting such rate impacts in context, regulators may benefit from other types of analyses that fully examine both rate and bill impacts over time from efficiency investments. Such analyses could also consider various rate designs, including different scenarios of volumetric and fixed charges, to examine impacts on energy bills and efficiency savings. These topics were outside the scope of this study but could be avenues for further research.

Program Administrator or Utility Cost Test

For the program administrator's cost test (PACT), which is also known as the utility cost test (UCT), we first estimated the costs of administering these policies and programs. Those costs include direct incentives to participating customers as well as program administrative costs (such as design, marketing, and evaluation). We relied on data from existing North Carolina programs when possible and also pulled from national data sets of specific types of efficiency programs, including LBNL for efficiency program costs.

To estimate the benefits to the utility or program administrator, we used avoided electricity costs, which are the values of avoiding the generation or purchase of electricity (including both energy and capacity). We use values approved by the NCUC for use in evaluating EE program benefits. To estimate average annual total avoided electricity resource costs, which combines avoided energy, capacity, and T&D costs, we made simplifying assumptions by converting avoided capacity and T&D costs to the energy cost equivalent using an average system load factor and by averaging summer and winter values (see the "Reference Case" discussion for additional details).

We then conducted a net present value analysis to compare the present value (PV) of benefits to the present value of costs for efficiency programs and policies. We assumed a weighted average capital cost (WACC) of 7% for the discount rate, which is based on an average of utility WACC values in North Carolina. Our analysis includes programs administered through 2040, and we assumed measures continued to save energy over an average measure lifetime. Appendix B includes our key assumptions about measure lifetime for each program or policy.

Table 10 shows the results for some of the programs or policies including benefit/cost (B/C) ratios. Building energy codes or benchmarking is highly favorable from a program administrative perspective because program administrative costs are low. We did not include weatherization here because that cost–benefit analysis should include a broader set of benefits than just those that accrue to utility ratepayers.

Table 10. The program administrator cost test (PACT) net present value analysis

	Discount rate:			7%
	PV costs	PV benefits	Net benefit	B/C ratio
EERS	$3,198,700,878	$4,958,610,209	$1,759,909,331	1.6
Co-ops and municipal utilities	$530,792,303	$1,317,266,866	$786,474,563	2.5
Building energy codes	$42,809,443	$2,379,611,174	$2,336,801,731	56
Benchmarking	$3,789,493	$215,485,907	$211,696,415	57
Utility savings initiative	$1,585,093	$42,766,651	$41,181,558	27
C-PACE	$29,487,061	$389,713,648	$360,226,587	13
Large customer savings	$538,965,722	$810,138,281	$271,172,558	1.5
Industrial assessments	$6,556,394	$77,719,347	$71,162,953	12
Strategic energy management	$49,628,272	$109,505,180	$59,876,907	2.2
Agricultural programs	$6,692,242	$39,867,704	$33,175,462	6.0
Total	**$4,409,006,900**	**$10,340,684,965**	**$5,931,678,065**	**2.3**

Table 10 shows a cumulative net benefit of $5.9 billion over the lifetime of the program measures and a benefit–cost ratio of 2.3, meaning that every dollar invested in the suite of programs and policies leads to $2.30 of benefits to all electricity customers. The cost–benefit ratio represents the whole suite of programs combined and is a weighted average result rather than a simple average.

Limited Societal Perspective

Societal tests typically include benefits such as benefits of avoided environmental damages, benefits of increased system reliability, nonenergy benefits of reduced water usage, nonenergy benefits for low-income programs, and the benefits of fuel diversity. These analyses could also include the benefits of improved resilience and jobs.

A full SCT was beyond our scope here, so our societal benefits analysis was limited. To examine some societal benefits of EE, we estimated the monetized CO_2 emissions benefits and the associated health benefits with those emissions reductions. Additional benefits that should be included but were outside our scope include indoor health benefits, criteria pollutant reductions, and avoided natural gas, fuel, and water savings. It is important, therefore, to view our analysis as a *limited* SCT.

For both emissions reductions and its attendant health benefits, we based the results on the GHG analysis, which is presented in the next section. We estimate CO_2e emissions reductions for GHGs through 2040. This is a conservative estimate because it does not include GHG emissions reductions post-2040. We monetized emissions reductions through 2040 using two different estimates of a carbon price from Duke Energy's 2018 IRP (DEC 2018). The first is a base case price of $5–50 per ton from 2025–2040, and the second is a high case price of $5–110 per ton from 2025–2040. We then discounted those benefits using a societal discount rate of 3%. Avoided emissions are $1.6 billion through 2040 in the base case and $3.3 billion in the high case. Additional health benefits from avoided emissions through 2040 are $300–700 million, as estimated from the Environmental Protection Agency (EPA) CO-Benefits Risk Assessment (COBRA). The next section offers further details.

Table 11. Range of results of a limited societal analysis through 2040, discounted at 3%

Benefits and costs	Results (billion $)
Avoided CO_2e emissions through 2040 ($5–110/ton per year)	$3.3
Avoided CO_2e emissions through 2040 ($5–50/ton per year)	$1.6
Health benefits from avoided emissions	$0.3 - $0.7

Participant Perspective

Finally, we examined costs and benefits from the perspective of residents and businesses that invest in EE upgrades. We first estimated total participant costs associated with installing the upgrades, and then estimated the electricity bill savings. Additional participant benefits would come in the form of avoided fuel and water savings for some measures, but we did not include those in this analysis. Our results are therefore a limited analysis of participant benefits. Still, the results indicate that participants' electricity savings benefits alone would offset investments by 3.5:1. As table 12 shows, net benefits are $15.6 billion over the life of the measures, which assumes a discount rate of 5%. The average benefit-to-cost ratio is 3.5 for all programs and policies combined. The benefit–cost ratio represents the whole suite of programs combined and is a weighted average result rather than a simple average.[44]

[44] We exclude weatherization from this analysis because upfront costs are provided by the program and not incurred by participants. We also excluded the USI from the participant cost–benefit analysis because the program is designed to have a positive benefit-to-cost ratio for participants by having energy bill reductions exceed the costs of the upgrades. We expect the project economics to be similar to commercial building efficiency projects as estimated in the C-PACE analysis.

Table 12. Results of participant cost analysis, discounted at 5%

Program	Costs	Benefits	Net benefit	B/C ratio
EERS	$2,345,451,949	$10,842,444,696	$8,496,992,748	4.6
Co-ops and municipal utilities	$1,315,576,668	$3,089,946,841	$1,774,370,173	2.3
Building energy codes	$1,233,709,828	$4,744,207,093	$3,510,497,265	3.8
Benchmarking	$13,623,880	$422,210,400	$408,586,520	31
C-PACE	$309,299,090	$520,149,182	$210,850,091	1.7
Large customer savings	$1,058,621,098	$1,528,581,498	$469,960,401	1.4
Industrial assessments	$21,180,594	$106,188,205	$85,007,611	5.0
Strategic energy management	$60,286,787	$670,641,620	$610,354,833	11
Agricultural programs	$2,663,451	$51,100,843	$48,437,391	19
Total	**$6,360,413,345**	**$21,975,470,380**	**$15,615,057,035**	**3.5**

Table 13 summarizes annual program and participant costs for each of the programs and policies.

Table 13. Annual program and participant costs by program in 2030 and 2040

Program	2030	2040
EERS	$295,159,352	$401,966,892
Co-ops and municipal utilities	$73,087,848	$81,429,715
Building energy codes	$2,340,967	$3,213,503
Benchmarking	$300,190	$300,190
C-PACE	$37,000,000	$37,000,000
Weatherization	$109,606,730	$38,217,504
Large customer savings	$48,566,181	$62,053,778
Industrial assessments	$620,000	$620,000
Strategic energy management	$5,819,124	$6,916,397
Agricultural programs	$1,000,382	$1,018,200

Program costs for the Utility Savings Initiative are not shown because we assume public buildings attain their targeted savings by 2025 per EO 80. Based on a six-year measure life, these savings are expected to sunset by 2031.

GREENHOUSE GAS IMPACTS

North Carolina has set ambitious goals in its Clean Energy Plan to reduce GHG emissions along three major timeframes: 40% by 2025 statewide, and, 70% by 2030 and 100% by 2050 (carbon neutrality) in the electric power sector (North Carolina DEQ 2019c). As we discussed in the CEE case above, EE is already playing an important role in meeting these goals through North Carolina's existing policies. Here, we describe projected GHG emissions in the Reference case, the CEE case, and the EE case, in which North Carolina adopts our report's recommendations. We also describe the impacts of the proposed portfolio of EE policies and programs on air emissions and public health.

Projected Greenhouse Gas Emissions

Under current conditions, over the next 20 years, we project that GHG emissions from the electric sector will decline by 10% in North Carolina. We base this projection on historic data and emissions forecasts developed by DEQ in its 2019 *Greenhouse Gas Inventory Report*, including emissions from electricity imported from out-of-state, measured in millions of metric tons of CO_2 equivalent (North Carolina DEQ 2019c). The electricity sector is the largest source of GHG emissions in North Carolina as of 2017, representing 35% of all GHG emissions. Emissions from this sector have declined 34% since 2005 (North Carolina DEQ 2019). The *Greenhouse Gas Inventory Report* forecasts a slight decline of 10% out to 2030 (North Carolina DEQ 2019c). To extend this analysis to 2040, we looked to load forecasts from the EIA AEO, which projects future CO_2 emissions in the electricity sector across the U.S. Southeast (EIA 2019). We allocated this regional forecast based on North Carolina's proportional share of load, which is approximately 17% of total electricity use in the region. Under this forecast, electric sector CO_2 remains flat for the following decade. Although DEQ's GHG inventory projections contain small amounts of CO_2e emissions alongside CO_2, for the purposes of this analysis, we assumed that GHG forecasts for the electric sector contain a negligible amount of non-CO_2 emissions.[45]

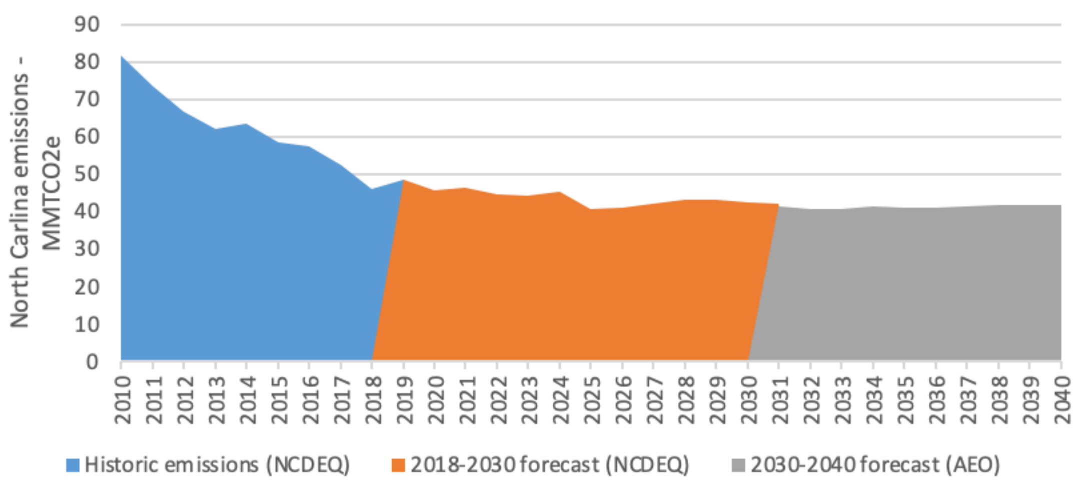


Figure 12. North Carolina greenhouse gas emissions forecast. ***Source:*** **North Carolina DEQ 2019c, AEO 2019.**

[45] In 2018, 98.9% of CO_2e in the U.S. electric sector came from CO_2, with 0.2% from CH_4, and 0.9% from N_2O (EPA 2018).

The historic decline in emissions is due in large part to the shift in electricity generation over the past decade. The use of coal, which once dominated more than 50% of the grid mix, has declined by more than half, while natural gas generators in the state have more than tripled their output since 2010 (see figure 13). This shift, combined with the growth of North Carolina's solar energy industry, has led to a 35% decline in CO_2 emissions per unit of energy generated between 2010 and 2018 (EIA 2019). More retirements of coal plants are planned by 2030 (Duke Progress IRP 2019).

Energy Efficiency as a Greenhouse Gas Reduction Strategy to Date

EE investments have already helped the state progress toward its GHG reduction goals. We estimated North Carolina's cumulative MWh saved from efficiency relative to the electricity (MWh) generated or consumed in North Carolina from 2010 through 2018 (see figure 13). Although EE program savings were equivalent to less than 1% of annual electricity sales in 2010, by 2018, these programs resulted in total annual energy savings equivalent to 4.87% of total electric demand.

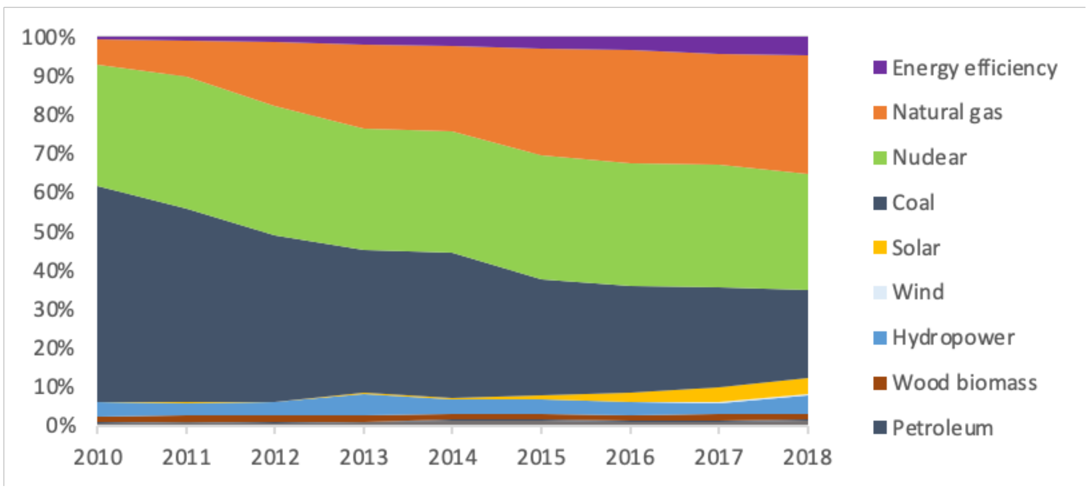


Figure 13. Electricity generation by source in North Carolina 2010–2018. *Sources:* EIA 2019 and ACEEE *State Scorecard* 2010–2019.[46]

Greenhouse Gas Reductions from EE Case

By reducing energy consumption and demand, EE can be a highly effective tool to reduce GHG and other air emissions, including NO_x, SO_2, and $PM_{2.5}$. These benefits occur in North Carolina as well as for the larger regional grid. For our estimates of impacts within the state, we developed a measure of carbon intensity per GWh based on the forecasted numbers in figure 12. By dividing the emissions forecasted for North Carolina's electric sector by the total forecasted electricity demand, we derived an annual ratio of TCO_2/GWh in North Carolina through 2040. We multiplied these ratios with the annual GWh savings estimate

[46] We estimated North Carolina's cumulative MWh savings from EE compared to other electricity generation resources (see figure 7). We assumed that savings from investments made from 2010–2018 would persist at the end of the period in 2018, based on the average portfolio measure life of 11.25 years across utilities in the *Utility Scorecard* (Relf et al. 2020). EE program savings equivalent to less than 1% of total sales in MWh per year starting in 2010 resulted in cumulative energy savings equivalent to 4.87% of total electric industry demand by 2018.

from our EE case for an estimate of statewide CO_2 emissions avoided through EE (see figure 14).

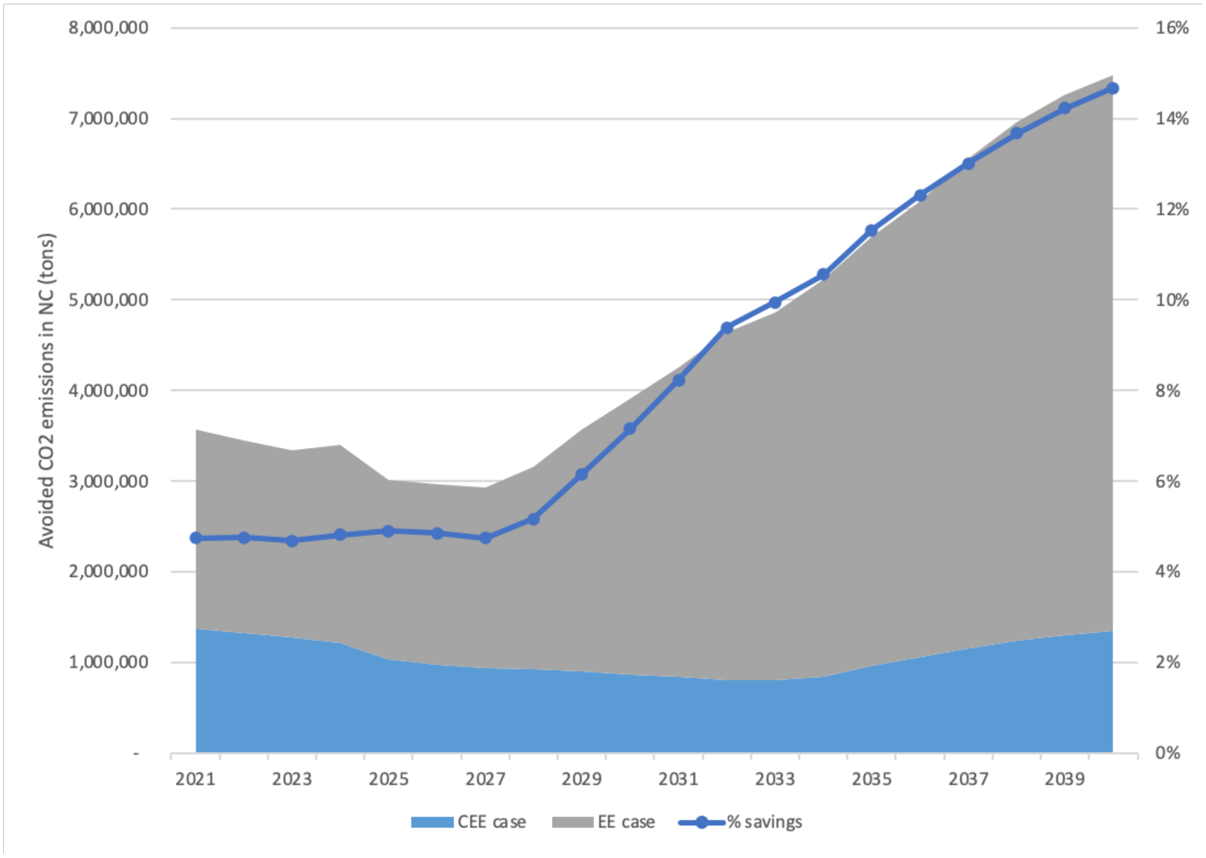


Figure 14. GHG avoided emissions in the CEE and EE cases in North Carolina. Total GHG baseline from DEQ GHG Inventory through 2030 and regional AEO forecast adjusted for North Carolina through 2040. *Sources:* North Carolina DEQ 2019c, EIA 2019.

As figure 14 shows, EE policies in our EE case will reduce statewide GHG emissions from the electric sector by approximately 14.7% over adjusted AEO projections in 2040—the equivalent of 6 million metric tons of CO_2. Continuing existing policies will contribute to GHG reductions but will deliver reductions of only 3.25% of total projected emissions in 2040.

DEQ's Clean Energy Plan aims to reduce electric power sector emissions by 70% below 2005 levels by 2030 and attain economy-wide carbon neutrality by 2050. In 2005, North Carolina's electricity sector emitted 79.37 $MMTCO_2e$ (North Carolina DEQ 2019b). A 70% reduction from that level would bring annual emissions down to 23.81 $MMTCO_2e$. Based on the current statewide forecast, if North Carolina continues with existing policies and programs, it is projected to emit 42.46 $MMTCO_2$ in 2030. As figure 15 shows, continuing and expanded EE policies outlined in this report are expected to save 3.04 $MMTCO_2$, which brings statewide electric sector emissions an additional 11% closer to the 2030 target of 23.81 $MMTCO_2e$.

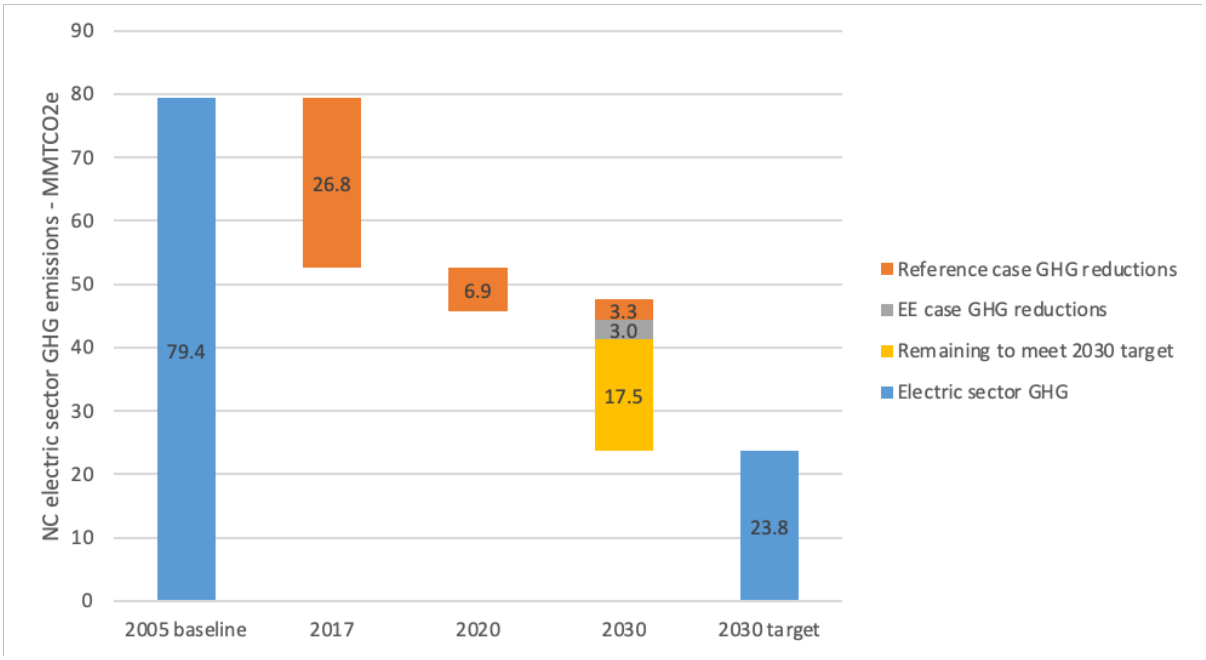


Figure 15. North Carolina electric sector GHG emissions forecasts and targets. *Source:* NC DEQ GHG Inventory 2019, NC Clean Energy Plan 2019.

North Carolina is not an island, and its electric grid is interconnected with those of other states. To analyze impacts across the entire Southeast region, we utilized EPA's AVERT tool to model emissions including CO_2, NO_x, SO_2, and $PM_{2.5}$ (EPA 2020a). We created future year scenarios within AVERT using planned power plant retirements in North Carolina, as published in the 2019 resource plans for Duke utilities and Dominion. Appendix B offers a more detailed account of our modeling methods.

Figure 16 shows the results of our analysis. We estimated the regional impacts of avoided emissions in the EE case at 18,780,800 annual avoided tons of CO_2 per year by 2040. This is 4.8% lower than the AEO's baseline estimate for the Southeast region. Beyond just CO_2, reducing GWh through EE also avoids more than 21,800,000 pounds of NO_x, 21,170,000 pounds of SO_2, and 2,500,000 pounds of $PM_{2.5}$ per year by 2040. These air pollutants can have far-reaching environmental and health impacts.

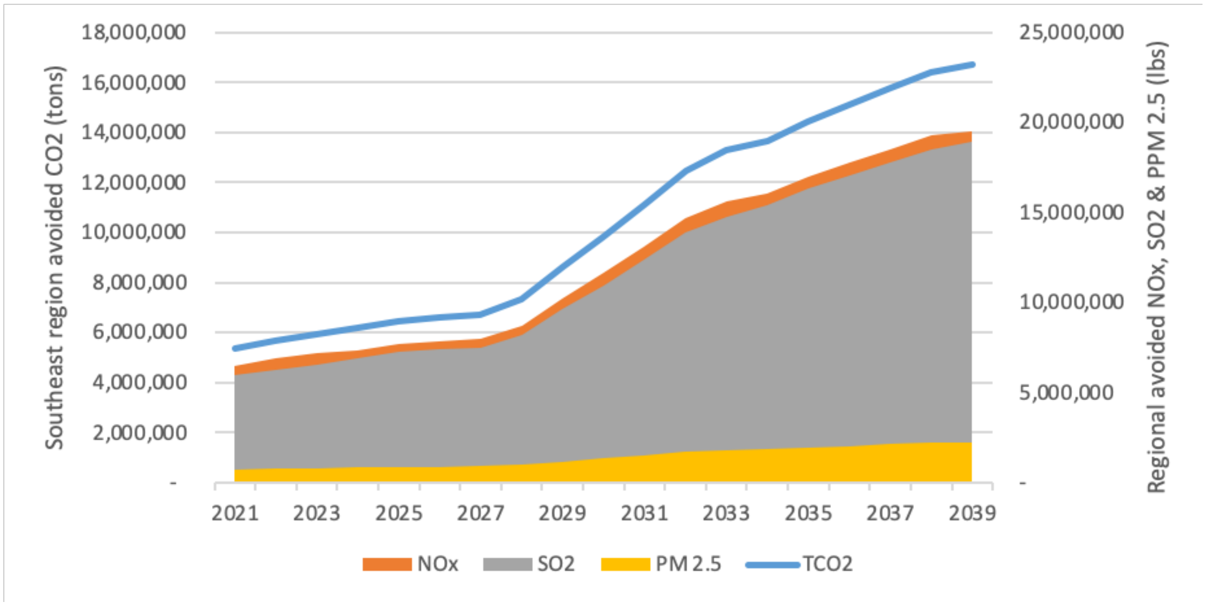


Figure 16. Avoided regional air emissions from EE case

In the 2019 Clean Energy Plan, DEQ outlines a goal of achieving a 70% reduction in carbon emissions relative to a 2005 level by 2030, and economy-wide carbon neutrality by 2050 (North Carolina DEQ 2019b). The efficiency programs and policies outlined in our EE case can help North Carolina reach that goal in a cost effective way. The importance of energy efficiency in meeting climate goals aligns with ACEEE's *Halfway There* report, which finds that we can get halfway to nationwide carbon neutrality by 2050 through the use of EE (Nadel and Ungar 2019).

Reducing emissions is also key to delivering equitable solutions to marginalized and historically underserved groups. For example, residents of multifamily housing, low-income populations, and agricultural workers are frequently the victims of many coincident health and economic stressors, such as job loss, proximity to emissions sources and environmental hazards, health and respiratory problems, high energy burdens, the effects of climate change, and the impacts of COVID-19. Multifamily housing residents are also more likely to be racial minority groups, children, elderly, and/or immigrants.

Utilizing the EPA's COBRA Health Impacts Screening and Mapping Tool, we estimated the financial impact on public health from the emissions reduction scenario above, based on avoided deaths, hospital admissions, and lost work productivity due to respiratory illness related to $PM_{2.5}$ air emissions (EPA 2020b). This analysis is specific to North Carolina, as it examines local source air emissions on a county level. We found that health-related savings for North Carolina were between $13,850,000 and $31,361,000 in 2030 and between $23,114,000 and $52,323,000 in 2040. As figure 17 shows, we estimated the cumulative impact of these policies on public health as being between $309,093,000 and $699,712,000 throughout the analysis time period.

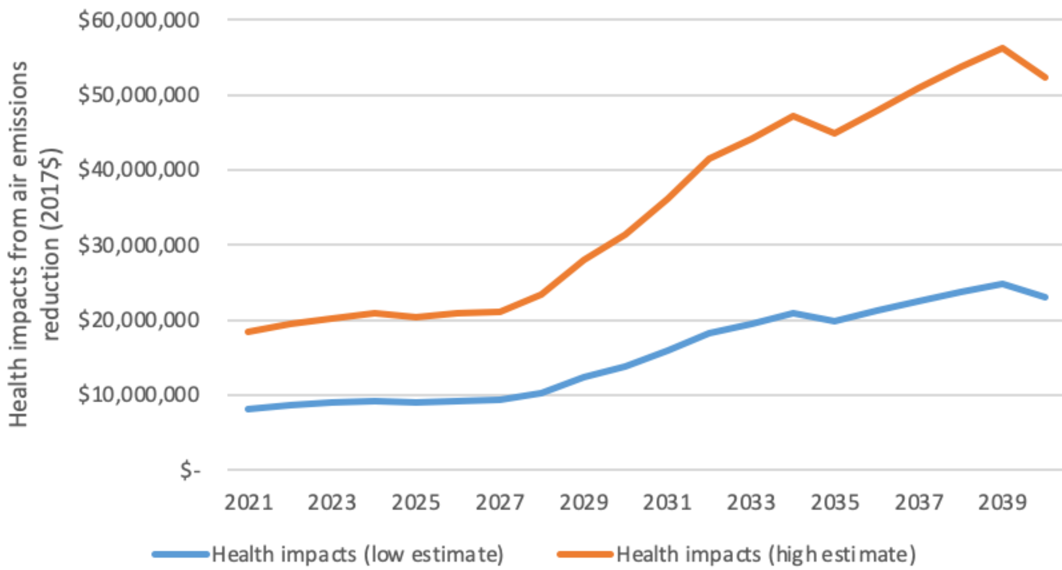


Figure 17. Health-related savings due to avoided emissions in North Carolina[47]

Recommendations

Our research finds that, with changes to policies and programs, EE can be a cornerstone of North Carolina's climate and economic future. We now offer a set of recommendations and strategies to support North Carolina policymakers and stakeholders in growing the state's EE economy.

Build Upon Existing Foundation of Programs

To create a strong foundation for continued growth in North Carolina's clean energy economy, it is imperative to defend and maintain the existing programs and policies that have driven growth in the state throughout the last decade and are expected to continue to do so in the future (the CEE case). These policies—which include utility efficiency programs; the building energy code standards implemented in 2018; and programs such as voluntary industrial assessments, low-income home weatherization, on-bill financing of efficiency upgrades for co-op members, and the many IOU programs—are already delivering major energy savings throughout the state. Continuing these programs at their present levels is expected to deliver more than 9,400 GWh of energy savings to consumers in 2040, which is the equivalent of $765 million (2020$) in savings on utility bills, or $105 for each North Carolina household.

Some of these programs could be at risk of having their funding stripped away or having the policies that support them changed or revoked. Notably, building energy codes have been amended by the legislature, bypassing the regular code adoption process and weakening energy standards as a result (NCBPA 2018). Because codes lock-in energy use for up to 20 years or more, backtracking on modest and cost-effective improvements to energy standards can result in large energy losses and higher costs over a long timeframe. Now

[47] The differing estimates are based on two different models of the effects of $PM_{2.5}$ emissions on adult health (EPA 2020c).

more than ever, a strong defense of EE in North Carolina is important to secure future growth of and progress on its climate goals.

Leverage Energy Efficiency as a Tool for Job Growth

EE is a driver of job growth and economic revitalization, which is particularly important in the wake of COVID-19's expected impact on North Carolina's economy. The clean energy sector has seen much growth over the past decade, but that growth is under threat as a consequence of the pandemic. By nature, efficiency jobs are local to the area, and money spent on efficiency stays in the North Carolina economy. Investing in cost-effective efficiency programs—such as home retrofits; efficiency for the industrial and agricultural sectors; and low-cost financing mechanisms such as PACE, on-bill financing, or on-bill tariffs—will help align North Carolina's sustainability goals with the need for well-paying jobs and economic growth.

Establish Minimum Efficiency Targets to Drive Utility Sector Progress

EERS are critical drivers of substantial energy savings for states that implement these policies. While REPS allows some EE certificates (EECs) to participate, it lacks the ability to focus utility efforts in a way that guarantees pursuit of all available cost-effective savings for customers. Our research finds ample opportunities for the state's utilities to scale up their portfolios using best practices from the region and similar utilities. Efficiency targets are also important for co-ops and municipal utilities, whose customers may be more likely to face significant energy burdens. We have found that the leading co-ops and municipal utilities around the country deliver some of the most innovative, effective programs to customers—when those utilities have a target to work toward. Alongside these minimum targets, North Carolina should consider reforms to align the utilities' business model with energy savings performance, including full revenue decoupling and robust performance-based incentives.

Reform Policies that Prevent Utilities from Contributing to Greenhouse Gas Reductions

North Carolina policy curbs participation from industrial customers in utility EE programs, limiting deployment of one of the best sources of cost-effective emissions reductions and economic development for the state. Although some industrial customers voluntarily report savings through the ESI program, many do not, and many may be unaware of available efficiency opportunities. We recommend that North Carolina consider policy options that deliver more transparency around savings and the opportunity to better support and capture the potential for capital improvements for these large consumers, such as a self-direct program or a change to opt-out rules.

North Carolina's rules also fail to encourage EE programs to help households or businesses make upgrades that involve replacing fuel-burning equipment with electric-powered systems. As described above, this inertia has limited zero energy new construction and has restrained efforts to add new efficient fuel-switching measures. Given our report's scope, the EERS modeled here focused on electricity savings, but we encourage North Carolina policymakers to consider a fuel-neutral EERS and cost-effectiveness rules that encourage investment in both EE and beneficial electrification.[48] Such a change would enable utilities to pursue beneficial electrification opportunities that are needed to meet North Carolina's GHG reduction goals (North Carolina DEQ 2019b).

Focus Efforts on Underserved or Newly Vulnerable Populations

The scale of economic and climate challenges that North Carolina faces in coming years will disproportionately impact traditionally underserved sectors. Economic development and climate efforts are doomed to fail without adequate focus on these populations. Underserved sectors identified by stakeholders include low-income populations, the agricultural sector, the industrial sector, and customers of co-ops and municipal utilities.

For agricultural customers, we recommend creating a new statewide energy audit and implementation program that would leverage existing networks and federal programs to deliver energy-saving, cost-effective efficiency projects directly to farmers. The program could also include technical and financial assistance for those projects. For the industrial sector, we recommend expanded funding for the NCSU IAC, which would help to increase the number of cost-effective EE recommendations made to eligible industrial customers. We also recommend a statewide SEM program that would help large C&I customers with systematic energy performance improvements.

To reach low-income customers, we recommend an expanded weatherization assistance program that includes home energy retrofits. Finally, we recommend increased funding to affordable multifamily buildings, and a minimum low-income savings goal for North Carolina utilities. The minimum savings goal could include a low-income carve out for electric energy savings of a percentage of 2030 targets. To broaden EE opportunities for co-op and municipal utility customers, we recommend enacting a stand-alone EERS or spending goal. In the short-term, we recommend utilities design programs that target and support customers at risk of disconnection.

Futureproof North Carolina's Policy Environment with Advances in Financing and Buildings

North Carolina can also futureproof its policy environment for EE by establishing long-term investment opportunities and sustainable funding sources. Efficiency financing solutions will be a critical strategy for leveraging public and ratepayer funds. The state can do this by building on its experience with performance contracting for buildings projects and establishing the necessary policies for deployment of C-PACE and on-bill tariff programs. Also, the state can establish a statewide clean energy fund to leverage public dollars for private investments.

Futureproofing must also apply to the state's new and existing buildings. Immediate opportunities include improving building energy codes to adopt building energy benchmarking for the state's commercial buildings. These are necessary steps to improve the efficiency and resilience of new buildings and to immediately start tracking and benchmarking the energy use of existing buildings. These are just the starting points.

---

[48] Stakeholders can look to Berg, Cooper, and Cortez 2020, which describes states adjusting rules to enable fuel switching, and Gold, Gilleo, and Berg 2019, which includes examples of states modifying EERS to include goals measured in Btu or GHG.

Additional opportunities that will generate more savings—but that were not included in our efficiency policy case—include building performance standards for all large buildings and zero energy codes for all new construction.

Establish a Statewide Efficiency Advisory Council or Collaborative

To ensure the state holds itself accountable to the many efficiency program and policy recommendations in the state's Clean Energy Plan and to improve coordination, its executive branch should establish a statewide EE advisory council or collaborative (EEAC). Efficiency councils offer an opportunity to build stronger efficiency portfolios that better reflect the needs of different customer groups, leverage the expertise of efficiency business and service providers, and align program development with public policy (Li and Bryson 2015). EEACs work best when they operate under a clear set of objectives and use an independent facilitator. Statewide collaboratives can improve efficiency policy and program effectiveness and can improve timeliness of implementation.

Such a collaborative could help North Carolina maximize efficiency as a core strategy to achieve its decarbonization and economic development goals. The North Carolina EE Roadmap includes a recommendation that an EEAC be established and comprised of representatives from utilities, state agencies, higher education, industry, advocates, and other efficiency experts (Weiss 2019). As the EE Roadmap recommends, the new EEAC would enable coordination between stakeholders, increase efficiency measures for residential and commercial programs across the state, and oversee implementation of the efficiency recommendations included in the state's Clean Energy Plan.

Conclusions

As the 10th fastest growing state in the country, and the 11th largest economy by gross state product, North Carolina is poised to become a national leader in clean energy (Census Bureau 2019). With leadership from Governor Cooper's administration and a strong clean energy business community and engaged stakeholders, North Carolina is ambitiously planning for a lower carbon future. The recommendations outlined in this report can help the state realize the benefits offered by a clean energy economy; they are readily achievable and can help meet a sizeable portion of its climate goals set forth under EO 80. These potential achievements are particularly important as part of the state's COVID-19 recovery strategy. Efficiency can create local jobs and directly benefit homes and businesses by reducing bills and targeting savings where they are needed most.

To capitalize on this opportunity, North Carolina will need to continue and expand the successful efficiency activities that are already underway, including utility-run programs; DEQ's USI, ESI, and WAP efforts; and the 2018 improved building energy codes. While this existing slate of policies has already made the state a regional leader in climate and energy policy in the Southeast, on their own they are insufficient to meet the states' climate goals or to respond to the scale of the economic crisis.

This report details the potential for North Carolina to enhance EE by adopting a set of policies and programs recommended in the stakeholder processes conducted by DEQ and Duke University in 2019. In analyzing the policy priorities of stakeholders, we focused on vulnerable, disproportionately affected, and underserved sectors, including policies focused on farmers, low-income residents, and renters in affordable multifamily housing. We also aimed for high-impact policies that deliver large GHG reductions, including utility targets, building codes, and industrial customer efficiency. We estimate that the total annual electricity savings from this selection of programs and policies could reduce electricity consumption relative to the baseline case by 18.5% in 2040. The benefits of these programs would exceed the costs by 2x from a utility system perspective and would deliver estimated net benefits of $5.9 billion in avoided electricity costs to the state. The societal benefits of reduced GHG emissions would provide an additional $1.3–2.7 billion, with avoided health harms from reduced air pollution of more than $250 million.

With a commitment to EE from policymakers, utilities, and customers, North Carolina can address its twin challenges of climate change and economic recovery. We estimate that adopting this set of recommendations will avoid a cumulative 212 million tons of CO_2 across the U.S. Southeast from 2022–2040. Further, improving local air quality through these reductions will deliver $309–699 million in avoided health harms in North Carolina communities. Finally, a robust clean energy industry can help to make up the severe losses in the efficiency sector due to COVID-19 and support new, sustainable economic development in the state.

References

ACEEE. 2019. *Halfway There: Energy Efficiency Can Cut Energy Use and Greenhouse Gas Emissions in Half by 2050.* Washington, DC: ACEEE. aceee.org/fact-sheet/halfway-there.

——. 2020. "Self-Direct Programs for Large Energy Users." *Toolkit*, February 5. aceee.org/toolkit/2020/02/self-direct-programs-large-energy-users.

Ameren Illinois. 2016. *Ameren Illinois Demand Side Management Market Potential Study: Volume 1 – Executive Summary.* Docket No. 16-0453, September 27. Prepared by AEG (Applied Energy Group). Chicago: Illinois Commerce Commission. www.icc.illinois.gov/docket/P2016-0453/documents/246411.

Baatz, B. 2015. *Everyone Benefits: Practices and Recommendations for Utility System Benefits of Energy Efficiency*. Washington, DC: ACEEE. aceee.org/research-report/u1505.

Baatz, B., A. Gilleo, and T. Barigye. 2016. *Big Savers: Experiences and Recent History of Program Administrators Achieving High Levels of Electric Savings.* Washington, DC: ACEEE. aceee.org/research-report/u1601.

Bailey, D., and J. Rokke. 2016. *ComEd and Nicor Gas Strategic Energy Management (SEM) Evaluation Report – Final: Energy Efficiency/Demand Response Plan: Electric Plan Year 8 (EPY8)/Gas Plan Year 5 (GPY5) (6/1/2015-5/31/2016)*. Prepared by Navigant Consulting. Oakbrook Terrace, IL: ComEd. Naperville, IL: Nicor Gas. library.cee1.org/system/files/library/13219/ComEd_Nicor_SEM_EPY8_GPY5_Evaluation_Report_2016_12_16_Final.pdf.

Bartlett, R., M. Halverson, V. Mendon, J. Hathaway, Y. Xie, and M. Zhao. 2017. *North Carolina Residential Energy Code Field Study: Baseline Report*. Prepared by Pacific Northwest National Laboratory. Washington, DC: DOE. www.energycodes.gov/sites/default/files/documents/North_Carolina_Residential_Field_Study.pdf.

Berg, W., and A. Drehobl. 2018. "State-Level Strategies for Tackling High Energy Burdens: A Review of Policies Extending State- and Ratepayer-Funded Energy Efficiency to Low-Income Households." In *Proceedings of the 2018 ACEEE Summer Study on Energy Efficiency in Buildings* 13: 1–16. Washington, DC: ACEEE. www.aceee.org/files/proceedings/2018/index.html#/paper/event-data/p390.

Berg, W., E. Cooper, and N. Cortez. 2020. *State Policies and Rules to Enable Beneficial Electrification in Buildings through Fuel Switching.* Washington, DC: ACEEE. aceee.org/policy-brief/2020/04/state-policies-and-rules-enable-beneficial-electrification-buildings-through.

Berg, W., S. Vaidyanathan, E. Junga, E. Cooper, C. Perry, G. Relf, A. Whitlock, M. DiMascio, C. Waters, and N. Cortez. 2019. *The 2019 State Energy Efficiency Scorecard.* Washington, DC: ACEEE. aceee.org/research-report/u1908.

Bernath, A., and M. Buffum. 2017. "Estimating Energy Savings Resulting from Strategic Energy Management Programs: Methodology Comparison." In *Proceedings of the 2017 International Energy Program Evaluation Conference.* Madison, WI: IEPEC (International Energy Program Evaluation Conference). cadmusgroup.com/wp-content/uploads/2018/03/Cadmus-SEM-Methodology-Comparison-IEPEC-2017-AB-MB.pdf.

Bickford, A., and H. Geller. 2016. *Review of Leading Rural Electric Cooperative Energy Efficiency Programs.* Boulder: SWEEP (Southwest Energy Efficiency Project). www.swenergy.org/data/sites/1/media/documents/publications/documents/Leading_REC_Energy_Efficiency_Programs_Jan_2016.pdf.

Bradley-Wright, F. 2020. *Direct Testimony and Exhibits of Forest Bradley-Wright on Behalf of North Carolina Justice Center, North Carolina Housing Coalition, and Southern Alliance for Clean Energy.* Docket No. E-7 Sub 1230, June 9. Raleigh: NCUC (North Carolina Utilities Commission). starw1.ncuc.net/NCUC/page/docket-docs/PSC/DocketDetails.aspx?DocketId=3eb7537a-b6ab-4ebe-b626-ae964c5c74aa.

Burgess, J. 2016. *CEE 2016 Strategic Energy Management Program Summary*. Boston: CEE (Consortium for Energy Efficiency). library.cee1.org/system/files/library/12994/CEE_2016_Industrial_SEM_Program_Summary_Public.pdf.

CEE (Center for Energy and Environment). 2018. *Minnesota Energy Efficiency Potential Study: 2020–2029*. St. Paul: Minnesota Department of Commerce. mn.gov/commerce-stat/pdfs/mn-energy-efficiency-potential-study.pdf.

Census Bureau. 2019. "North Carolina." data.census.gov/cedsci/profile?q=North%20Carolina&g=0400000US37.

City of Charlotte. 2020. "Charlotte Future: 2040 Comprehensive Plan." charlottenc.gov/charlottefuture/pages/default.aspx.

City of Philadelphia. 2019. *Philadelphia Building Energy Benchmarking.* Philadelphia: City of Philadelphia Office of Sustainability. www.phila.gov/media/20191210091804/2019-Municipal-Energy-Benchmarking-Report.pdf.

City of Raleigh. 2020. *2030 Comprehensive Plan.* Raleigh: City of Raleigh Department of Planning and Development. raleighnc.gov/services/zoning-planning-and-development/2030-comprehensive-plan.

City of Seattle. 2018. *Seattle Energy Benchmarking Analysis Report*. Seattle: Seattle Office of Sustainability & Environment. www.seattle.gov/Documents/Departments/OSE/Seattle%20Energy%20Benchmarking%20Analysis%202016%20for%20web.pdf.

Coalition for Green Capital. 2020. *Green Banks in the United States: 2020 US Green Bank Annual Industry Report*. Washington, DC: Coalition for Green Capital. greenbankconsortium.org/annual-industry-report.

CPUC (California Public Utilities Commission). 2016. *Decision on Large Investor-Owned Utilities' California Alternate Rates for Energy (Care) and Energy Savings Assistance (ESA) Program Applications*. Decision 16-11-022, November 21. San Francisco: CPUC. docs.cpuc.ca.gov/PublishedDocs/Published/G000/M169/K760/169760972.PDF.

Deason, J., G. Leventis, C. Goldman, and J. Carvallo. 2016. *Energy Efficiency Program Financing: Where It Comes From, Where It Goes, and How It Gets There*. Prepared by Berkeley Lab. Washington, DC: DOE. emp.lbl.gov/publications/energy-efficiency-program-financing.

DEC (Duke Energy Carolinas). 2018. *Duke Energy Carolinas, LLC 2018 Integrated Resource Plan and 2018 REPS Compliance Plan*. Docket No. E-100 Sub 157, September 5. Raleigh: NCUC. starw1.ncuc.net/NCUC/ViewFile.aspx?Id=aa9862b5-5e31-4b3f-bb26-c8a12c85c658.

———. 2019 *Duke Energy Carolinas Integrated Resource Plan Update Report (Public)*. Docket No. E-100 Sub 157, October 29. Raleigh: NCUC. starw1.ncuc.net/NCUC/ViewFile.aspx?Id=d5888a19-da40-42c6-b75c-f2ce7bdb1ac4

———. 2020. *Duke Energy Carolinas, LLC's Application for Approval of Demand-Side Management and Energy Efficiency Cost Recovery Rider*. Docket No. E-7 Sub 1230, February 25. Raleigh: NCUC. starw1.ncuc.net/NCUC/page/docket-docs/PSC/DocketDetails.aspx?DocketId=3eb7537a-b6ab-4ebe-b626-ae964c5c74aa.

DEC and DEP (Duke Energy Progress). 2020. *Proposed Revisions to the DSM/EE Cost Recovery Mechanisms of Duke Energy Carolinas, LLC, and Duke Energy Progress, LLC and Request for Comment Cycle*. Docket Nos. E-2 Sub 931 and E-7 Sub 1032, January 15. Raleigh: NCUC. starw1.ncuc.net/NCUC/ViewFile.aspx?Id=6fab3317-611f-4e25-bbbd-f12d046551f4.

Dingell, D. 2020. "House Passes Clean Energy and Sustainability Accelerator." Press release, June 30. debbiedingell.house.gov/news/documentsingle.aspx?DocumentID=2546#:~:text=The%20Clean%20Energy%20and%20Sustainability,energy%20and%20emissions%20reduction%20projects.

DEP (Duke Energy Progress). 2019a. *Application of Duke Energy Progress, LLC for Approval of Demand-Side Management and Energy Efficiency Cost Recovery Rider*. Docket No. E-2 Sub 1206, June 11. Raleigh: NCUC. starw1.ncuc.net/NCUC/PSC/PSCDocumentDetailsPageNCUC.aspx?DocumentId=d8ade6f9-2b38-426a-8784-cbc91d4b6109&Class=Filing.

———. 2019b. *Duke Energy Progress Integrated Resource Plan Update Report*. Docket No. E-100 Sub 157, September 3. Raleigh: NCUC. starw1.ncuc.net/NCUC/ViewFile.aspx?Id=7f4b3176-95d8-425d-a36b-390e1e57a175.

DESEU (Delaware Sustainable Energy Utility). 2019. *2018 Annual Report*. Dover: DESEU. www.energizedelaware.org/wp-content/uploads/2019/12/DESEU_Annual_Report_2018_FINAL2.pdf.

DNV GL. 2016. *Impact Evaluation of Commercial Strategic Energy Management: Final Report*. Portland: Energy Trust of Oregon. www.energytrust.org/wp-content/uploads/2017/03/FinalReport_EnergyTrust_CommSEM_ImpactEvaluation_wStaffResponse.pdf.

DOE (Department of Energy). 2015. *Cummins Improves Energy Performance 12.6% with SEP*. Washington, DC: DOE. www.energy.gov/sites/prod/files/2015/07/f24/Cummins_case_study_SEP_revised_Final.pdf.

——. 2016. *Schneider Electric Saves $1.8 Million with SEP Enterprise-Wide Rollout*. Accessed Washington, DC: DOE. betterbuildingssolutioncenter.energy.gov/sites/default/files/attachments/Schneider%20SEP%20EWA%20Case%20Study_5-1-17%20(final).pdf.

——. 2020a. "Better Buildings: State of North Carolina." Accessed February. betterbuildingssolutioncenter.energy.gov/partners/state-north-carolina.

——. 2020b. "Building Energy Codes Program: Determinations." www.energycodes.gov/development/determinations.

——. 2020c. "Building Energy Codes Program: North Carolina." www.energycodes.gov/adoption/states/north-carolina.

——. 2020e. "Industrial Assessment Center: North Carolina State University Implemented Recommendations." Accessed May. iac.university/searchRecommendations?center=NC&state=NC&yearThen=lt&year=2020&implemented=I.

Dominion Energy North Carolina. 2018a. *Biennial Determination of Avoided Cost Rates for Electric Utility Purchases from Qualifying Facilities*. Docket No. E-100 Sub 158, November 1. Raleigh: NCUC. starw1.ncuc.net/NCUC/PSC/PSCDocumentDetailsPageNCUC.aspx?DocumentId=7fa8cd0d-11b8-47ec-b643-617301b8c53e&Class=Filing

——. 2018b. *Dominion Energy North Carolina Application for Approval of Cost Recovery for Demand-Side Management and Energy Efficiency Measures.* Docket No. E-22 Sub 556, August 21. Raleigh: NCUC. starw1.ncuc.net/NCUC/ViewFile.aspx?Id=eee2ff9d-5a93-4938-8626-bea8f836c00e.

——. 2019a. *Application for Approval of Cost Recovery for Demand-Side Management and Energy Efficiency Measures.* Docket No. E-22 Sub 577, August 13. Raleigh: NCUC. starw1.ncuc.net/NCUC/ViewFile.aspx?Id=025245ce-d489-45dd-b6fe-c249a19a48de.

——. 2019b. *Virginia Electric and Power Company's 2019 Update to 2018 Integrated Resource Plan*. Docket No. E-100 Sub 157, August 29. Raleigh: NCUC. starw1.ncuc.net/NCUC/PSC/PSCDocumentDetailsPageNCUC.aspx?DocumentId=08a2f95c-33bd-4ad5-ad79-a900f5bec1fd&Class=Filing.

Drehobl, A., and L. Ross. 2016. *Lifting the High Energy Burden in America's Largest Cities: How Energy Efficiency Can Improve Low-Income and Underserved Communities.* Washington, DC: ACEEE. aceee.org/research-report/u1602.

Drehobl, A., and K. Tanabe. 2019. *Extending the Benefits of Nonresidential Energy Efficiency to Low-Income Communities.* Washington, DC: ACEEE. aceee.org/research-report/u1910.

Duke Energy and NCUC. 2012. *Settlement Agreement*. Docket No. 2011-158-E, November 30. Columbia: South Carolina PSC (Public Service Commission). dms.psc.sc.gov/Attachments/Matter/41190a9f-155d-141f-1d62702c2c41a691.

Duke Energy Collaborative. 2019. *Portfolio Level Opportunities & Challenges Summary Report*. Charlotte: Duke Energy Collaborative. starw1.ncuc.net/NCUC/ViewFile.aspx?Id=fd415538-f16a-47e6-9763-534eae7a37c8.

——. 2020. *Duke Energy Carolinas Collaborative Meeting.* Charlotte: Duke Energy Collaborative. starw1.ncuc.net/NCUC/ViewFile.aspx?Id=fd415538-f16a-47e6-9763-534eae7a37c8.

Duke Energy North Carolina. 2020. *Duke Energy North Carolina EE and DSM Market Potential Study*. Docket No. E-100 Sub 165, June 23. Raleigh: NCUC. starw1.ncuc.net/NCUC/PSC/PSCDocumentDetailsPageNCUC.aspx?DocumentId=ed359aa7-73e8-4aa1-95ea-27b47d28720c&Class=Filing.

E4TheFuture and E2. 2019. *Energy Efficiency Jobs in America.* Framingham, MA: E4TheFuture and E2. e4thefuture.org/new-report-energy-efficiency-workforce-grows-to-over-2-3-million/.

Efficiency Vermont. 2020. *School Indoor Air Quality Grant Program*. Burlington: Efficiency Vermont. www.efficiencyvermont.com/Media/Default/docs/school-intake/Final%202020%20K-12%20Schools%20IAQ%20Grant%20Packet.pdf.

EIA (Energy Information Administration). 2017. *2012 Commercial Building Energy Consumption Survey.* www.eia.gov/consumption/commercial/.

——. 2018. "Table CE3.4 Annual Household Site End-Use Consumption in the South—Totals and Averages, 2015." *Residential Energy Consumption Survey.* Washington, DC: EIA. www.eia.gov/consumption/residential/data/2015/c&e/pdf/ce3.4.pdf.

——. 2019. *Annual Electric Generator Inventory 2018.* Washington, DC: EIA. www.eia.gov/electricity/data/eia860/.

——. 2020a. "Annual Electric Power Industry Report, Form EIA-861 Detailed Data Files." www.eia.gov/electricity/data/eia861/.

——. 2020b. "Annual Energy Outlook 2020: Reference Case Projections Tables." www.eia.gov/outlooks/aeo/tables_ref.php.

——. 2020c. "North Carolina Electricity Profile 2018." www.eia.gov/electricity/state/northcarolina/.

Eldridge, M., R. Elliott, S. Vaidyanathan, S. Laitner, J. Talbot. D. Trombley, A. Chittum, S. Black, E. Osann, D. Violette, M. Hagenstad, S. Schare, K. Darrow, A. Hampson, B. Hedman, D. White, and R. Hornby. 2010. *North Carolina's Energy Future: Electricity Water, and Transportation Efficiency*. Washington, DC: ACEEE. aceee.org/research-report/e102.

ENERGY STAR®. 2020. ENERGY STAR® Portfolio Manager. Accessed June 2020. www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/use-portfolio-manager.

EPA (Environmental Protection Agency). 2020a. *AVoided Emissions and geneRation Tool (AVERT)*. Version 2.3. Accessed June 2020. www.epa.gov/statelocalenergy/avoided-emissions-and-generation-tool-avert.

——. 2020b. *CO-Benefits Risk Assessment (COBRA) Health Impacts Screening and Mapping Tool.* Version 4.0. www.epa.gov/statelocalenergy/co-benefits-risk-assessment-cobra-health-impacts-screening-and-mapping-tool.

——. 2020c. *User's Manual for the Co-Benefits Risk Assessment Health Impacts Screening and Mapping Tool (COBRA) Version: 4.0*. Washington, DC: EPA. www.epa.gov/sites/production/files/2018-05/documents/cobra_user_manual_may2018_508.pdf.EPRI (Electric Power Research Institute). 2017. *State Level Electric Energy Efficiency Potential Estimates*. Palo Alto: EPRI. www.epri.com/research/products/000000003002009988.

FERC (Federal Energy Regulatory Commission). 2019. "Form No. 714—Annual Electric Balancing Authority Area and Planning Area Report." www.ferc.gov/industries-data/electric/general-information/electric-industry-forms/form-no-714-annual-electric/overview.

Fitch, T. 2020. *Principles for Protecting Electric Utility Customers in the Regulatory Response to COVID-19*. Oakland: Vote Solar. votesolar.org/files/2415/9552/8462/Principles_for_Protecting_Electric_Utility_Customers_in_the_Regulatory_Response_to_COVID19.pdf.

Garth, L., A. Velonis, T. Bettine, A. Grant, A. Sojka, K. Heinrich, J. Colby, J. Stewart, S. Cofer, and C. Bicknell. 2017. *Focus on Energy 2016 Energy Efficiency Potential Study.* Prepared by The Cadmus Group, Inc. Madison: Public Service Commission of Wisconsin. focusonenergy.com/sites/default/files/WI%20Focus%20on%20Energy%20Potential%20Study%20Final%20Report-30JUNE2017.pdf.

GDS Associates. 2016a. *Ameren Missouri Demand-Side Management Market Potential Study*. St. Louis, MO: Ameren. www.ameren.com/-/media/missouri-site/files/environment/2017-irp/chapter-8-appendix-a.pdf?la=en-us-mo&hash=D8BA272701DB1E43BF154F8F8B41994CF9E58ACA.

——. 2016b. *DTE Energy Electric Energy Efficiency Potential Study*. Detroit: DTE Energy. www.michigan.gov/documents/mpsc/DTE_2016_Electric_ee_potential_study_w_appendices_REV_B_554359_7.pdf.

Gilleo, A., B. Stickles, and C. Kramer. 2016. *Green Bank Accounting: Examining the Current Landscape and Tallying Progress on Energy Efficiency*. Washington, DC: ACEEE. aceee.org/research-report/f1602.

Gold, R., A. Gilleo, and W. Berg. 2019. *Next Generation Energy Efficiency Resource Standards.* Washington, DC: ACEEE. aceee.org/research-report/u1905.

Hayes, S., and C. Gerbode. 2020. *Braiding Energy and Health Funding for In-Home Programs: Federal Funding Opportunities.* Washington, DC: ACEEE. aceee.org/research-report/h2002.

Hayes, S., and C. Kubes. 2018. *Saving Energy, Saving Lives: The Health Impacts of Avoiding Power Plant Pollution with Energy Efficiency*. Washington, DC: ACEEE and PSR (Physicians for Social Responsibility). aceee.org/research-report/h1801.

Henderson, B., and D. Chemtob. 2019. "Two North Carolinas: Cities Grow at Record Pace While Rural Counties Fall Behind." *Charlotte Observer*, December 10. www.charlotteobserver.com/news/local/article237501534.html.

Hoffman, I., C. Goldman, S. Murphy, N. Mims, G. Leventis, and L. Schwartz. 2018. *The Cost of Saving Electricity through Energy Efficiency Programs Funded by Utility Customers: 2009–2015.* Prepared by Berkeley Lab. Washington, DC: DOE. eta-publications.lbl.gov/sites/default/files/cose_final_report_20200429.pdf.

ICF International. 2016. *ComEd Energy Efficiency Potential Study, 2017–2030 – Final Report.* Oakbrook Terrace, IL: ComEd (Commonwealth Edison). s3.amazonaws.com/ilsag/ComEd_2017-2030_EE_Potential_Final_Report_5-2016.pdf.

Jordan, P. 2020. "MEMORANDUM: Clean Energy Employment Initial Impacts from the COVID-19 Economic Crisis, June 2020." e4thefuture.org/wp-content/uploads/2020/07/Clean-Energy-Jobs-June-COVID-19-impact.pdf.

Kolwey, N. 2013. Utility Strategic Energy Management Programs. Boulder, CO: SWEEP. www.swenergy.org/data/sites/1/media/documents/publications/documents/Utility_SEM_programs_03-2013.pdf

Kramer, C., E. Fadrhonc, C. Goldman, C. Schiller, and L. Schwartz. 2015. *Making It Count: Understanding the Value of Regulated Energy Efficiency Financing Programs.* Washington, DC: SEE Action (State and Local Energy Efficiency Action Network).

www4.eere.energy.gov/seeaction/system/files/documents/making-it-count-final-v2.pdf.

Kushler, M., B. Baatz, S. Nowak, and P. Witte. 2015. *Municipal Utility Energy Efficiency: Successful Examples around the Nation*. Washington, DC: ACEEE. aceee.org/sites/default/files/publications/researchreports/u1510.pdf.

Lazard. 2017. *Lazard's Levelized Cost of Energy Analysis: Version 11.0*. New York: Lazard. www.lazard.com/media/450337/lazard-levelized-cost-of-energy-version-110.pdf.

Li, M., and J. Bryson. 2015. *Energy Efficiency Collaboratives*. Washington, DC: SEE Action. www4.eere.energy.gov/seeaction/system/files/documents/EECollaboratives-0925final.pdf

Mahajan, M. 2020. *Estimating U.S. Energy Demand and Emissions Impacts of COVID-19 with the Energy Policy Simulator*. San Francisco: Energy Innovation. energyinnovation.org/wp-content/uploads/2020/05/Modeling-COVID-Impacts-On-US-Emissions.pdf.

Mass Save. 2020. "Virtual Assessments: No-Cost Home Energy Assessments Have Just Gone Virtual." www.masssave.com/en/saving/energy-assessments/virtual-assessments.

McKenna, C., A. Shah, and M. Silberg. 2020. "It's Time to Incentivize Residential Heat Pumps." *Rocky Mountain Institute Blog,* June 8. rmi.org/its-time-to-incentivize-residential-heat-pumps/.

MEA (Maryland Energy Administration). 2020. "Kathleen A. P. Mathias Agriculture Energy Efficiency Program." Accessed April. energy.maryland.gov/business/Pages/incentives/mathiasag.aspx.

MEETS Accelerator Coalition. 2020. *MEETS: The Metered Energy Efficiency Transaction Structure.* Vashon, WA: MEETS Accelerator Coalition. www.meetscoalition.org/wp-content/uploads/MEETS-AC-Description.pdf.

Mims, N., S. Schiller, E. Stuart, L. Schwartz, C. Kramer, and R. Faesy. 2017. *Evaluation of U.S. Building Energy Benchmarking and Transparency Programs: Attributes, Impacts, and Best Practices.* Prepared by Berkeley Lab. Washington, DC: DOE. emp.lbl.gov/sites/default/files/lbnl_benchmarking_final_050417_0.pdf.

Mims Frick, N., I. Hoffman, C. Goldman., G. Leventis, S. Murphy, and L. Schwartz. 2019. *Peak Demand Impacts from Electricity Efficiency Programs.* Prepared by Berkeley Lab. Washington, DC: DOE. emp.lbl.gov/publications/peak-demand-impacts-electricity.

Minor, L. 2019. *"DSM Budget Trends through 2020." ESource*, June 14. www.esource.com/429191abpd/dsm-budget-trends-through-2020.

Mission:data Coalition. 2020. *Comments and Proposed Rules by Mission:data Coalition in the Matter of: Commission Rules Related to Customer Billing Data*. Docket No. E-100 Sub 161, February 10. Raleigh: NCUC. starw1.ncuc.net/NCUC/ViewFile.aspx?Id=e2e057ef-0b05-4670-93a4-3ae87dcb1cd5.

Misuriello, H., S. Kwatra, M. Kushler, and S. Nowak. 2012. *Building Energy Code Advancement through Utility Support and Engagement.* Washington, DC: ACEEE. aceee.org/research-report/a126.

Molina, M., and M. Kushler. 2015. *Policies Matter: Creating a Foundation for an Energy-Efficient Utility of the Future.* Washington, DC: ACEEE. aceee.org/sites/default/files/policies-matter.pdf.

Molina, M., and G. Relf. 2018. "Does Efficiency Still Deliver the Biggest Bang for Our Buck? A Review of Cost of Saved Energy for U.S. Electric Utilities." In *Proceedings of the 2018 ACEEE Summer Study on Energy Efficiency in Buildings* 6: 1–12. Washington, DC: ACEEE. aceee.org/files/proceedings/2018/assets/attachments/0194_0286_000125.pdf.

Mosenthal, P., and G. Reed. 2015. *Potential for Energy Savings in Affordable Multifamily Housing*. Washington, DC: EEFA (Energy Efficiency for All). www.energyefficiencyforall.org/resources/potential-for-energy-savings-in-affordable-multifamily-housing/.

Nadel, S. 2018. *Energy Savings, Consumer Economics, and Greenhouse Gas Emissions Reductions from Replacing Oil and Propane Furnaces, Boilers, and Water Heaters with Air-Source Heat Pumps*. Washington, DC: ACEEE. aceee.org/research-report/a1803.

———. 2020. *Weatherization and Home Improvements: A Promising Path for Improving Health and Reducing Medical Costs for Older Adults.* Washington, DC: ACEEE. aceee.org/white-paper/2020/04/weatherization-and-home-improvements-promising-path-improving-health-and.

Nadel, S., and C. Kallakuri. 2016. *Opportunities for Energy and Economic Savings by Replacing Electric Resistance Heat with Higher Efficiency Heat Pumps*. Washington, DC: ACEEE. aceee.org/research-report/a1603.

Nadel, S., and L. Ungar. 2019. *Halfway There: Energy Efficiency Can Cut Energy Use and Greenhouse Gas Emissions in Half by 2050*. Washington, DC: ACEEE. aceee.org/research-report/u1907.

NAM (National Association of Manufacturers). 2020. "2019 North Carolina Manufacturing Facts." www.nam.org/state-manufacturing-data/2019north-carolina-manufacturing-facts/.

NASCSP (National Association for State Community Service Programs). 2019. *Weatherization Assistance Program Funding Report: PY 2017.* Washington, DC: NASCSP. nascsp.org/wp-content/uploads/2019/02/NASCSP-2017-WAP-Funding-Survey_FINAL_2.9.-2019.pdf.

NBI (New Buildings Institute). 2020. "Stretch Codes (Advanced Codes)." newbuildings.org/code_policy/stretch-codes-advanced-codes/.

NCBPA (North Carolina Building Performance Association). 2018. *The North Carolina Energy Efficiency Potential Report*. Raleigh: NCBPA. buildingnc.org/wp-content/uploads/NCBPA_2018-EE-Potential-Report_Web-Version.pdf.

——. 2019. *NCHFA 2020 QAP Program Comments.* Raleigh: NCHFA (North Carolina Housing Finance Agency). www.nchfa.com/sites/default/files/page_attachments/2020QAP%E2%80%94NCBuildingPerformanceAssociation.pdf.

NCCETC (North Carolina Clean Energy Technology Center). 2019. *Powering Energy Efficiency and Impacts: A Data-Driven Project Supporting Low-Income Households in Northeastern North Carolina.* Raleigh: NCCETC. nccleantech.ncsu.edu/wp-content/uploads/2019/03/PEEIF-Final-Report-w-Appendices.pdf.

NCHFA (North Carolina Housing Finance Agency). 2020. "Housing Moves North Carolina Forward." Accessed June. 2019.housingbuildsnc.com/.

——. 2020. "2020 Qualified Allocation Plan (QAP)." Accessed July 2020. https://www.nchfa.com/rental-housing-partners/rental-developers/qualified-allocation-plan/2020-qualified-allocation-plan-qap

NCLC (National Consumer Law Center). 2019. *Property Assessed Clean Energy (PACE) Loans: State and Local Consumer Protection Recommendations*. Boston: NCLC. www.nclc.org/images/pdf/energy_utility_telecom/pace/ib-pace-nov2019.pdf.

NC-RETS (North Carolina Renewable Energy Tracking System). 2020. "Utility REPS Compliance Report." Accessed May. portal2.ncrets.org/myModule/rpt/myrpt.asp?r=114.

NCUC (North Carolina Utilities Commission). 2020. Comments of the Public Staff on the Matter of 2019 REPS Compliance Plans and 2018 REPS Compliance Reports. Docket E-100, Sub. 163. starw1.ncuc.net/NCUC/ViewFile.aspx?Id=5f5878c9-b448-4f91-938f-f94219f596fd.

2008. "R8-68: Incentive Programs for Electric Public Utilities and Electric Membership Corporations, Including Energy Efficiency and Demand-Side Management Programs." ncrules.state.nc.us/ncac/title%2004%20-%20commerce/chapter%2011%20-%20utilities%20commission/04%20ncac%2011%20r08-68.html.

NESP (National Efficiency Screening Project). 2017. *National Standard Practice Manual for Assessing Cost-Effectiveness of Energy Efficiency Resources.* Framingham, MA: NESP. nationalefficiencyscreening.org/wp-content/uploads/2017/05/NSPM_May-2017_final.pdf.

——. 2020a. "Database of State Efficiency Screening Practices (DSESP)." nationalefficiencyscreening.org/state-database-dsesp/.

——. 2020b. *The National Standard Practice Manual for Benefit-Cost Analysis of Distributed Energy Resources*. www.nationalenergyscreeningproject.org/wp-content/uploads/2020/08/NSPM-DERs_08-24-2020.pdf.

Nexant S&P Group. 2019. *Technical Potentials Draft Results Review*. Prepared for Duke Energy Carolinas (North Carolina). December 5. PowerPoint Slide deck.

Nexant S&P Group. 2020. *Achievable Potential Final Results Review*. Prepared for Duke Energy Carolinas Collaborative Meeting. May 15. PowerPoint Slide deck.

North Carolina Department of Commerce. 2018. *North Carolina Employment Projections to 2026*. Raleigh: North Carolina Department of Commerce. files.nc.gov/nccommerce/documents/LEAD/Projections/2026_NC_Employment_Projections_Summary.pdf.

North Carolina DEQ (Department of Environmental Quality). 2017. *Annual Report for the Utility Savings Initiative for Fiscal Years July 1, 2015–June 30, 2017*. Raleigh: North Carolina DEQ. files.nc.gov/ncdeq/Environmental+Assistance+and+Customer+Service/Utility+Savings+Initiative/2015-17-USI-Legislative-Report---2-.pdf.

——. 2018. *Energy Policy Council Biennial Report*. Raleigh: North Carolina DEQ. files.nc.gov/ncdeq/Energy%20Mineral%20and%20Land%20Resources/Energy/Energy%20Policy%20Council/2018%20EPC%20Biennial%20Report%20-%20FINAL.pdf.

——. 2019a. *Comprehensive Program to Manage Energy, Water, and Other Utility Use for State Agencies and State Institutions of Higher Learning: Comprehensive Program Update and Energy Data Report*. Raleigh: North Carolina DEQ. files.nc.gov/ncdeq/Environmental%20Assistance%20and%20Customer%20Service/Utility%20Savings%20Initiative/comprehensive-reports/DEQ-Comprehensive-Energy-Program-Report-2019-12-01.pdf.

——. 2019b. *North Carolina Clean Energy Plan: Transitioning to a 21st Century Electricity System*. Raleigh: North Carolina DEQ. files.nc.gov/governor/documents/files/NC_Clean_Energy_Plan_OCT_2019_.pdf.

——. 2019c. *North Carolina Greenhouse Gas Inventory (1990–2030)*. Raleigh: North Carolina DEQ. deq.nc.gov/energy-climate/climate-change/greenhouse-gas-inventory.

——. 2020a. "Appendix B. North Carolina Natural and Working Lands Action Plan." *North Carolina Climate Risk Assessment and Resilience Plan: Impacts, Vulnerability, Risks, and Preliminary Actions*. Raleigh: North Carolina DEQ. files.nc.gov/ncdeq/climate-change/resilience-plan/Appendix-B-NWL-Action-Plan-FINAL.pdf.

——. 2020b. "NC Environmental Stewardship Initiative Annual Reports." deq.nc.gov/about/divisions/environmental-assistance-customer-service/deacs-data/reports-studies.

——. 2020c. *NC Weatherization State Plan FY20–21*. Raleigh: North Carolina DEQ. files.nc.gov/ncdeq/Energy%20Mineral%20and%20Land%20Resources/Energy/NC-Weatherization-State-Plan-FY21.pdf.

Neubauer, M., B. Foster, R. Elliott, D. White, and R. Hornby. 2013. *Ohio's Energy Efficiency Resource Standard: Impacts on the Ohio Wholesale Electricity Market and Benefits to the State*. Washington, DC: ACEEE. aceee.org/research-report/e138.

NCBPA (North Carolina Building Performance Association). 2019. *NCHFA 2020 QAP Program Comments*. Presented to NC Housing Finance Agency on August 27, 2020. www.nchfa.com/sites/default/files/page_attachments/2020QAP%E2%80%94NCBuildingPerformanceAssociation.pdf

North Carolina General Assembly. 2007. *An Act to: (1) Promote the Development of Renewable energy and Energy Efficiency in the State through Implementation of a Renewable Energy and Energy Efficiency Portfolio Standard (REPS)*. Senate Bill 3, Session Law 2007-397. Raleigh: North Carolina General Assembly. www.ncleg.net/Sessions/2007/Bills/Senate/PDF/S3v6.pdf.

North Carolina Office of the Governor. 2018. *Executive Order No. 80: North Carolina's Commitment to Address Climate Change and Transition to a Clean Energy Economy*. Raleigh: North Carolina Office of the Governor. files.nc.gov/ncdeq/climate-change/EO80--NC-s-Commitment-to-Address-Climate-Change---Transition-to-a-Clean-Energy-Economy.pdf.

North Carolina OSBM (North Carolina Office of State Budget and Management). 2020. "County/State Population Projections." Accessed June. www.osbm.nc.gov/demog/county-projections.

NREL (National Renewable Energy Laboratory). 2017. *Strategic Energy Management (SEM) Evaluation Protocol*. Golden, CO: NREL. www.nrel.gov/docs/fy17osti/68316.pdf

NV Energy. 2018. *DSM Market Potential Study Report Prepared for NV Energy*. Prepared by AEG (Applied Energy Group) and Tetra Tech. Joint Application Vol. 10—DSP Technical Appendix. Docket No. 18-06003, June 1. Carson City: Nevada PUC (Public Utilities Commission). www.nvenergy.com/publish/content/dam/nvenergy/brochures_arch/about-nvenergy/rates-regulatory/recent-regulatory-filings/nve/irp/NVE-18-06003-IRP-VOL10.pdf.

NW Natural. 2014. *Schedule 301 Public Purposes Funding Surcharge*. Portland: NW Natural. www.nwnatural.com/uploadedFiles/25301ai(4).pdf.

NYSERDA (New York State Energy Research and Development Authority). 2020. *NY Forward Return-to-Work: Guidance for New York's Energy Workforce*. Albany: NYSERDA. www.nyserda.ny.gov/-/media/ny/CoVID-19/NY-Forward-Return-to-Work.pdf.

Off, G. 2018. "What do state workers earn? Search our database of 85,000 NC employees." Charlotte, NC: Charlotte Observer. Updated March 05, 2019. www.charlotteobserver.com/news/local/article203505319.html

Olsen, A. 2009. *Farm Energy Success Stories*. Chicago: ELPC (Environmental Law and Policy Center). farmenergy.org/wp-content/uploads/2009/04/FarmEnergySuccessStories2010.pdf.

Opinion Dynamics. 2020. *Duke Energy Carolinas and Duke Energy Progress 2017 Neighborhood Energy Saver Program Evaluation Report – Final*. Docket No. E-7 Sub 1230, February 25. Raleigh: NCUC. starw1.ncuc.net/NCUC/PSC/PSCDocumentDetailsPageNCUC.aspx?DocumentId=cca92341-f5a6-437f-89c4-7b890d97d36e&Class=Filing

Optimal Energy. 2018. *Study of Potential for Energy Savings in New Orleans*. New Orleans: New Orleans City Council. www.all4energy.org/uploads/1/0/5/6/105637723/2018_08_31_ud-17-03_optimal_energy_dsm_potential_study_final.pdf.

Ouzts, E. 2020. "Popular Energy-Savings Measure Sidelined Again in North Carolina Senate." *Energy News Network*, June 5. energynews.us/2020/06/25/southeast/popular-energy-savings-measure-sidelined-again-in-north-carolina-senate/.

PACENation. 2017. *2017 C-PACE Economic, Energy, and Environmental Impact Report*. Pleasantville, NY: PACENation. www.pacenation.org/wp-content/uploads/2018/08/2017-C-PACE-Annual-Impact-Report-Optimized.pdf#page=31.

———. 2020. "PACE Market Data." pacenation.org/pace-market-data/.

Parker, A., and J. Hughes. 2013. *How the Local Government Finance Authority and Culture of Special Assessments in North Carolina, Georgia, and Florida Impact Property Assessed Clean Energy Programs in Each State.* Chapel Hill: University of North Carolina School of Government Environmental Finance Center. efc.sog.unc.edu/sites/default/files/PACE%20Aug%2013%20Update.pdf.

Parker, K., J. Horowitz, and A. Brown. 2020. "About Half of Lower-Income Americans Report Household Job or Wage Loss Due to COVID-19." *Pew Research Center Social & Demographic Trends*, April 21. www.pewsocialtrends.org/2020/04/21/about-half-of-lower-income-americans-report-household-job-or-wage-loss-due-to-covid-19/#.

Pennsylvania PUC (Public Utility Commission). 2015. *Implementation Order*. Docket No. M-2014-2424864, June 11. Harrisburg: Pennsylvania PUC. www.puc.state.pa.us/pcdocs/1367313.doc.

Perry, C. 2018. *Pathways to Zero Energy Buildings through Building Codes.* ACEEE White Paper. Washington, DC: ACEEE. aceee.org/white-paper/zeb-codes.

Relf, G., D. York, and M. Kushler. 2018. *Keeping the Lights On: Energy Efficiency and Electric System Reliability*. Washington, DC: ACEEE. aceee.org/research-report/u1809.

Relf, G., E. Cooper, R. Gold, A. Goyal, and C. Waters. 2020. *The 2020 Utility Energy Efficiency Scorecard*. Washington, DC: ACEEE. aceee.org/utility-scorecard.

Ribeiro, D., S. Samarripas, K. Tanabe, H. Bastian, E. Cooper, A. Drehobl, S. Vaidyanathan, A. Jarrah, and M. Shoemaker. 2019. *The 2019 City Clean Energy Scorecard*. Washington, DC: ACEEE. aceee.org/research-report/u1904.

Rogers, E., A. Whitlock, and K. Rohrer. 2019. *Features and Performance of Energy Management Programs.* Washington, DC: ACEEE. aceee.org/sites/default/files/publications/researchreports/ie1901.pdf.

Rosenfeld, C. 2015. "Property Assessed Clean Energy: North Carolina, PACE-ing Itself." *The Environmental Finance Blog*, October 16. efc.web.unc.edu/2015/10/16/pace-nc/.

Rott, N., and M. Samuel. 2020. "'Tidal Wave' of Power Shut-Offs Looms as Nation Grapples with Heat." *NPR*, July 28. www.npr.org/2020/07/28/892995058/tidal-wave-of-power-shut-offs-looms-as-nation-grapples-with-heat.

Russell, C., and R. Young. 2012. *Understanding Industrial Investment Decision-Making* Washington, DC: ACEEE. aceee.org/research-report/ie124.

Samarripas, S., and D. York. 2019. *Closing the Gap in Energy Efficiency Programs for Affordable Multifamily Housing.* Washington, DC: ACEEE. aceee.org/research-report/u1903

Scheer, A., S. Borgeson, R. Kasman, M. Geraci, and F. Dahlquist. 2018. "Customer Targeting via Usage Data Analytics to Enhance Metered Savings." In *Proceedings of the 2018 ACEEE Summer Study on Energy Efficiency in Buildings* 6: 1–12. Washington, DC: ACEEE. aceee.org/files/proceedings/2018/index.html#/paper/event-data/p195.

Schurhoff et al. 2020. *North Carolina State Electrification Assessment. Task 4: Utility Level Assessment; Light-Duty Vehicles (On-Road).* Electric Power Research Institute. Feb. 20.

Schwartz, L., I. Hoffman, S. Schiller, S. Murphy, and G. Leventis. 2019. *Cost of Saving Electricity through Efficiency Programs Funded by Customers of Publicly Owned Utilities: 2012–2017.* Prepared by Berkeley Lab. Washington, DC: DOE. emp.lbl.gov/publications/cost-saving-electricity-through-0.

SELC (Southern Environmental Law Center). 2015. *Members Save Money While Saving Power: Roanoke Electric Cooperative Leads the Way with a Debt-Free On-Bill Program for Energy Efficiency*. Charlottesville, VA: SELC. www.southernenvironment.org/uploads/infographics/SELC_Roanoke_Electric_OBF_Handout_Final.pdf.

Sergici, S., and N. Irwin. 2019. *Energy Efficiency Administrator Models: Relative Strengths and Impact on Energy Efficiency Program Success.* Prepared by Brattle Group. Boulder: Uplight.

www.brattle.com/news-and-knowledge/news/report-by-brattle-economists-evaluates-effectiveness-of-energy-efficiency-administrator-models.

Stephen, R., E. Tennant, C. Freyman, J. Ozawa, J. Chase, and D. Querejazu. 2015. *Saving Energy, Building Skills: Industrial Assessment Centers Impact*. Menlo Park, CA: SRI International. www.energy.gov/sites/prod/files/2019/03/f60/eere-industrial-assessment-centers-impacts.pdf.

Taylor Engineering. 2020. *COVID-19 White Paper*. Alameda, CA: Taylor Engineering. www.taylorengineers.com/wp-content/uploads/2020/05/TE-COVID19-White-Paper.pdf.

Tonn, B., D. Carroll, E. Rose, B. Hawkins, S. Pigg, D. Bausch, G. Dalhoff, M. Blasnik, J. Eisenberg, C. Cowan, and B. Conlon. 2015. *Weatherization Works II – Summary of Findings from the ARRA Period Evaluation of the U.S. Department of Energy's Weatherization Assistance Program*. Prepared by Oak Ridge National Laboratory. Washington, DC: DOE. weatherization.ornl.gov/wp-content/uploads/pdf/WAPRecoveryActEvalFinalReports/ORNL_TM-2015_139.pdf.

USDA (Department of Agriculture). 2019a. *2017 Census of Agriculture State Profile: North Carolina*. Washington, DC: USDA. www.nass.usda.gov/Publications/AgCensus/2017/Online_Resources/County_Profiles/North_Carolina/cp99037.pdf.

——. 2019b. "USDA Invests in Energy Projects in North Carolina." www.rd.usda.gov/sites/default/files/NC_REAP_Release121119.pdf.

USDA and NCDA&CS (North Carolina Department of Agriculture and Consumer Services). 2018. *2018 North Carolina Agricultural Statistics*. Washington, DC: USDA. Raleigh: NCDA&CS. www.nass.usda.gov/Statistics_by_State/North_Carolina/Publications/Annual_Statistical_Bulletin/AgStat2018.pdf.

Weiss, J. 2019. *North Carolina Energy Efficiency Roadmap*. Durham, NC: Duke University Nicholas Institute for Environmental Policy Solutions. nicholasinstitute.duke.edu/publications/north-carolina-energy-efficiency-roadmap.

Williams, A., S. Price, and E. Vine. 2014. "The Cost of Enforcing Building Energy Codes." In *Proceedings of the 2014 ACEEE Summer Study on Energy Efficiency in Buildings* 4: 403–14. Washington, DC: ACEEE. aceee.org/files/proceedings/2014/data/papers/4-76.pdf.

Wilson, D., and M. Shober. 2020. *Seasonal Electric Demand in the Southeastern United States*. Knoxville, TN: Southern Alliance for Clean Energy. cleanenergy.org/wp-content/uploads/Seasonal-Electric-Demand-in-SE-SACE-Final.pdf.

Wilson, E., C. Christensen, S. Horowitz, J. Robertson, and J. Maguire. 2017. *Energy Efficiency Potential in the U.S. Single-Family Housing Stock*. Prepared by NREL (National Renewable Energy Laboratory). Washington, DC: DOE. www.nrel.gov/docs/fy18osti/68670.pdf.

York, D. 2020. "8 Ways Efficiency Programs Can Retool during the Crisis and Plan for a Strong Recovery." *ACEEE Blog*, June 19. aceee.org/blog-post/2020/06/8-ways-efficiency-programs-can-retool-during-crisis-and-plan-strong-recovery.

Appendix A: Reference Case Key Assumptions

To estimate projected electricity sales through 2040, we applied growth rates from the integrated resource plans (IRPs) that the three IOUs filed with the North Carolina Utilities Commission (NCUC). These IRPs provide load forecasts to 2034. Based on those forecasts and the IOUs' own growth rate, we extended the forecasts to 2040. For utilities such as municipal utilities and co-ops that did not file IRPs with the NCUC, we calculated a growth rate using municipal utility and co-op electricity sales data from the Energy Information Administration (EIA) 861 and 861s. Because the Electric Power Research Institute predicts 4,000 GWh of additional load due to electric vehicle adoption in North Carolina by 2040, we added this amount to the forecast values for municipal and co-op utilities on a load-proportional basis (IOU resource plans already account for EV impact). We excluded the continuation of Duke's existing utility EE programs from reference case sales projections, as these savings are captured in the CEE analysis. Duke provides sales projections without the continuation of its UEE programs in its IRPs. We also removed wholesale sales from these figures and applied an allocation factor to differentiate North Carolina from South Carolina.

Using this methodology, we estimate that statewide electricity usage will increase steadily over the next 20 years, especially in areas served by IOUs. Statewide sales are expected to grow from 138,000 GWh in 2018 to 148,000 GWh in 2040. The estimated compound annual growth rate (CAGR) from 2008 to 2040 is 1.2% per year. The state's three IOUs together serve 76.1% of the load as of 2018. They provide electricity to some of the fastest-growing areas of the state, including the metropolitan areas of Raleigh and Charlotte. Municipal and cooperatively owned utilities together account for about 24% of the load in North Carolina (EIA 2019). For electric co-ops, which mostly serve some of the state's more-rural areas—including areas with slow or negative population growth—we forecast that total energy sales will decline slightly at a rate of –0.37% per year over the next 20 years. We anticipate that municipal utilities will see a 0.16% increase in overall load per year, which is less than the Duke utilities. In 2030, we anticipate sales to be 43% residential, 36% commercial, and 21% industrial. In 2040, although we project sales to increase across sectors by 10,000 GWh, we expect the ratio of sales by sector to be the same as in 2030.

We sourced peak demand forecast values from IRPs filed by two of the state's three IOUs (DEP 2019b; DEC 2019). These figures include the impact of preexisting utility EE programs, which "roll off" at the end of the program's measure life (DEP 2019b; DEC 2019). In the case of projecting peak demand for Duke Energy Carolinas (DEC) and Duke Energy Progress (DEP), those peak values included an average annual growth rate out to 2034 of 1.0% (summer) and 0.8% (winter) for DEC, and 1.0% (summer) and 0.9% (winter) for DEP. These figures include the impact of preexisting EE and DSM programs through the end of their useful life, and then assume that appliance efficiency trends replace those savings in future years. We used these growth rates to extend forecasts to 2040 with an allocation factor to determine the percentage of peak demand attributable solely to North Carolina, which is expected to shift from a summer to winter peak in some utility territories by 2025.[49] Because the IRPs for the Duke utilities apply to their entire service territory, which includes both North Carolina and South Carolina, we needed an allocation factor to determine the percentage of peak demand attributable solely to North Carolina. We found this factor

[49] NCUC filings for EE and DSM program cost recovery for both DEP and DEC.

(86.5% for DEP and 73.6% for DEC in 2018) in the NCUC filings for EE and DSM program cost recovery for the two utilities (DEP 2019a; DEC 2019). We then applied the load allocation factor to the overall peak load forecast reported in the Duke IRPs to create a peak demand forecast specific to North Carolina. Peak demand forecasts were not publicly available for the state's electric co-ops and municipal utilities. However, we used this forecast statewide because co-op utilities and ElectriCities, the association for municipal utilities, buy most of their power from Duke Energy.

We estimated changes in average retail price (cents/kWh) for each sector based on historical trend data from 2010–2018 applied to a base year of 2018, removing outliers from consideration beyond two standard deviations. We checked our projections for reasonableness using data from EIA, electric sales, revenue, and average price (2018), and from EIA's *Annual Energy Outlook* (EIA 2020a). The average annual percentage change for the commercial sector in North Carolina from historical rates projected forward is –0.19%, which is relatively similar to regional (South Atlantic) projections of –0.31% per year and national projections of –0.30% (EIA 2020b). The annual percentage change in our data for the industrial sector is –0.59%, which again is reasonably similar to the EIA's regional projections for the South Atlantic Region of –0.45% and the national projections of –0.30%.

For the residential retail price, however, we used EIA data from AEO 2020 for SERC-East, as we found conflicting projections between historical data and South Atlantic Regional Forecasts. These projections forecasted end-use prices to decline an average of –0.30% per year. We applied this rate to North Carolina prices. With this annual percentage change, we estimate that retail price in the residential sector will be 10.38 cents per kWh by 2040. Across these sectors, we estimate that North Carolina's total retail prices will decline by an average rate of –0.32% annually.

Appendix B: Key Assumptions across Energy Efficiency Case

PROGRAM COSTS

Table B1 summarizes our estimates of annual program and participant costs in 2030 and 2040 for each program and policy.

Table B1. Summary of program and participant costs by program and policy in EE case, 2030 and 2040

Program	Costs	2030	2040
Building codes	Total cost	$ 93,091,376	$ 127,705,283
	Program cost	$ 2,340,967	$ 3,213,503
	Participant cost	$ 90,750,409	$ 124,491,780
SEM	Total cost	$ 11,638,248	$ 13,832,794
	Program cost	$ 5,819,124	$ 6,916,397
	Participant cost	$ 5,819,124	$ 6,916,397
Benchmarking	Total cost	$ 1,386,839	$ 1,548,944
	Incentive cost	$ 0	$ 0
	Program cost	$ 300,190	$ 300,190
	Participant cost	$ 1,086,649	$ 1,248,754
Performance contracting	Total cost	$ 386,831	$ 386,381
	Incentive cost	$ 0	$ 0
	Program cost	$ 386,831	$ 386,831
	Participant cost	$ 0	$ 0
Muni and co-op programs	Total cost	$ 153,484,481	$ 170,822,402
	Incentive cost	$ 73,087,848	$ 81,429,715
	Program cost	$ 80,396,633	$ 89,572,687
	Participant cost	$ 73,087,848	$ 81,249,715
EERS	Total cost	$ 400,397,018	$ 545,292,975
	Incentive cost	$ 76,754,480	$ 104,522,592
	Program cost	$ 295,159,352	$ 401,966,893
	Participant cost	$ 105,237,666	$ 143,326,082
CPACE	Total cost	$ 37,000,000	$ 37,000,000
	Incentive cost	$ 0	$ 0
	Program cost	$ 3,700,000	$ 3,700,000
	Participant cost	$ 33,300,000	$ 33,300,000
Weatherization	Total cost	$ 109,606,730	$ 38,217,504
	Incentive cost	$ 0	$ 0
	Program cost	$ 109,606,730	$ 38,217,504
	Participant cost	$ 0	$ 0

Program	Costs	2030	2040
IACs	Total cost	$ 2,720,947	$ 2,720,947
	Incentive cost	$ 0	$ 0
	Program cost	$ 620,000	$ 620,000

GREENHOUSE GAS IMPACTS

To determine the greenhouse gas (GHG) emission impacts and related health benefits through improved efficiency in North Carolina, we used data from the state Department of Environmental Quality (DEQ) *Greenhouse Gas Inventory Report* to forecast electric sector CO_2e emissions out to 2030 (NCDEQ 2019c). For 2030–2040, we used regional projections for the South Atlantic from the *Annual Energy Outlook* (AEO), allocated on a load factor basis for North Carolina at approximately 16.78% of regional electricity use (EIA 2019). This GHG forecast was divided by the GWh load forecasted in our reference case to create an approximate estimate of tons of CO_2e per GWh.

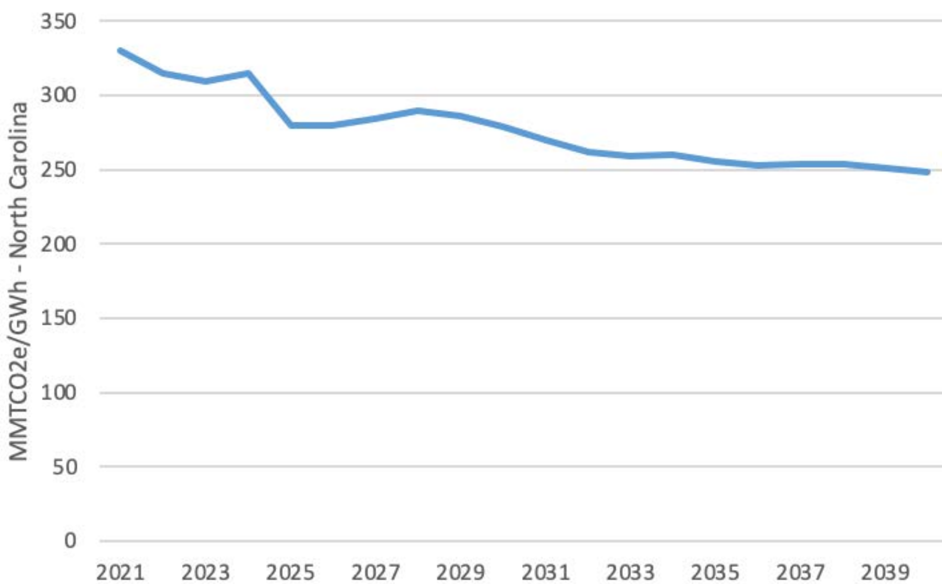


Figure B1. CO_2 intensity per GWh in North Carolina. *Sources:* North Carolina DEQ 2019c, EIA 2019, EIA 2019.

Because DEQ's GHG forecast is based on load forecasts in the electric sector, these estimates include some GWh reductions due to Duke's planned EE programs (referred to as *Utility Energy Efficiency*, or UEE, in the IRPs for DEP and DEC). Because these values are accounted for in our Continue Existing Efforts (CEE) case, to avoid double counting these savings, we subtracted Duke UEE's total GWh savings from the anticipated savings in the CEE and EE cases.

For our regional analysis, we used the EPA's AVoided Emissions and Generation Tool (AVERT) GHG modeling tool (EPA 2020a). Using AVERT allows us to calculate total emissions reductions based on a dataset of electricity generators in the U.S. Southeast region. The base year for this data set is 2018. To more accurately account for planned fossil fuel power plant retirements, we used the AVERT Future Year Scenario template and Statistical Module to construct future year data sets for 2025, 2030, 2035, and 2040. We found information on future power plant retirements in the IRPs for the state's three IOUs. For every year of our report's primary timeframe (2021–2040), we ran the AVERT main module to calculate total annual GHG reductions based on the expected GWh savings in the EE case.

Using the 2021–2040 emissions savings data output from AVERT, we then applied the EPA's CO-Benefits Risk Assessment (COBRA) to calculate and quantify associated health benefits from avoided emissions (EPA 2020b). We based the health benefits on total values for avoided deaths, hospital and emergency room admissions, and workplace productivity loss due to respiratory health issues from exposure to particulate matter. We calculated this on a county level for North Carolina; the health savings we present are the sum of all values for the state. As figure 17 in the main report shows, COBRA produces a low and high estimate based on two different models for evaluating impacts of $PM_{2.5}$ on adult mortality (EPA 2020).

Appendix C: Key Assumptions by Policy and Program Recommendation

Table C1 lists each of the recommendations in the EE case, along with the recommendation's source—that is, the Clean Energy Plan, the EE Roadmap, or our stakeholder engagement and research.

Table C1. Program recommendation and source

Program recommendation	Source
Energy efficiency resource standard (EERS)	Clean Energy Plan recommendation K-3 EE Roadmap recommendation #25
Co-ops and municipal utilities	EE Roadmap recommendations #12 and #22
Residential and commercial building codes	EE Roadmap recommendation #7
Commercial and multifamily building benchmarking	EE Roadmap recommendations #21, #31, and #32
Clean energy fund	Clean Energy Plan recommendation F-3 EE Roadmap recommendation #18
Financing—on-bill tariffs	EE Roadmap recommendation #19
Financing—C-PACE	Clean Energy Plan recommendation F-2
Utility savings initiative	EE Roadmap recommendations #2, #20, and #21
Low income	EE Roadmap recommendation #17
Minimum savings goal	EE Roadmap recommendation #26
Multifamily	EE Roadmap recommendation #13
Weatherization	EE Roadmap recommendations #10 and #11
Large customer savings beyond SEM	Best practices from leading states; feedback from stakeholder meetings
Industrial assessments	Best practices from leading states; feedback from stakeholder meetings
Strategic energy management	Feedback from stakeholder meetings and gap analysis in the ACEEE *2020 Utility Scorecard*
Agricultural audit and implementation program	EE Roadmap recommendation #13 Clean Energy Plan recommendations I–3

Below, we provide detailed assumptions and sources for each of the recommendations in the EE case.

ENERGY EFFICIENCY RESOURCE STANDARD

To determine savings for the CEE case, we documented past savings from 2012–2020 as available in regulatory filings. DEC and DEP reported net incremental annual savings at the meter in annual DSM cost recovery filings. The reporting in Dominion's cost recovery was inconsistent; it appears to be reported in net incremental annual savings through 2018, and then total annual savings from 2019 onward.[50] We projected savings as constant going forward based on the last available estimate in DSM cost recovery filings, 2020 for DEP, and 2021 for DEC. For Dominion, we projected savings from 2018 forward. To calculate total annual savings, we assumed a measure life of seven years, a rough average of the reported portfolio average measure lives for DEP (6.6 years) and DEC (8.2 years) in the 2020 *ACEEE Utility Scorecard* (Relf et al. 2020).

To determine eligible load, we projected the three IOUs' baseline electricity sales through 2040, applying growth rates from the IRPs they filed with the North Carolina Utilities Commission (DEP 2019b; DEC 2019; Dominion Energy North Carolina 2019b). The IRPs provide load forecasts to 2034; based on those forecasts and each IOU's growth rate, we extended those forecasts to 2040. We removed opt-out customers using the projected industrial load for each IOU, multiplied by the proportion of industrial load that opted out—90.6% of customers over 1,000,000 KWh for DEP, 63% for DEC, and 69.29% for Dominion.

To determine savings in the EE case, we used the EE Roadmap's recommended target of achieving 10% electric energy savings by 2030, below a baseline of each IOU's total gross electric sales in 2020. This translates to approximately 1%/year of incremental annual savings from 2021–2030. However, since each IOU has slightly different current savings, we assumed savings of 0.8%/year in 2021 for DEP and DEC, ramping up to 1% per year in 2023–2030. We modeled one-third of that target for Dominion in 2021, consistent with that utilities' use of EE for approximately one-third of the Renewable Energy and Energy Efficiency Portfolio Standard (REPS) compliance in 2015–2017, ramping up to 1% by 2030. We assumed that savings for all IOUs would ramp up 0.1% per year to 1.2% in 2032, with savings at 1.2% until 2040. 1.2% is the current savings goal for Arkansas, the regional leader, and less than the achievable potential in Appendix C's meta-analysis.

We assumed an 11-year measure life, using the average measure life from the *Utility Scorecard*, and calculated total annual savings in each year. This reflects our hope that North Carolina IOUs will improve their delivery of long-lived measures to at least the national average. The new incremental EERS savings build on remaining savings from the previous program years; we included still-persisting savings from 2012–2019 in our projection, with an average seven-year measure life (Relf et al. 2020). Because 2020 is likely to be a particularly abnormal year due to COVID-19, we used projected load in each year 2022–2040 as the baseline. Modeled savings from 2022–2030 were 8% less than the savings using 10% of 2030 against a 2020 baseline.

[50] Our review of Dominion's DSM cost recovery filings report savings in 2018 of 10,420 MWh and in 2019 of 124,394 MWh. Such a large increase could be attributable to changes in accounting; it could also be attributable to Dominion's increased investment in Virginia in 2018 in response to the Grid Transformation and Security Act of 2018. It is not clear from the filings how those savings are allocated to Dominion's North Carolina service territory.

The EE Roadmap includes a low-income carve-out for electric energy savings of 2% (of the 10% target) for IOUs, or 20% of the total savings. To calculate savings for low-income programs, we calculated 20% of the total savings for each IOU.

For program administrator costs, we calculated the first year cost by dividing the total program costs by total system energy reduction for EE for DEP and DEC. We used data from the 2020 program year as reported in DEP's 2019 cost recovery filing and the 2021 program year in DEC's 2020 cost recovery filing. First-year costs were not clearly delineated in Dominion's filing; we used the average cost of saved energy (CSE) for North Carolina from the Lawrence Berkeley National Laboratory's (LBNL) CSE study (Hoffman et al. 2018). We assume that customer incentives are 61% of program administration costs, based on a recent analysis of planned utility budgets 2016–2020 (Minor 2019). All costs are reported as 2020$. For all IOUs, we used LBNL data for the participant CSE in North Carolina. Table C2 details the first-year costs for each IOU's program administration, participant, and incentive costs.

We assume that 80% of savings are associated with market-rate programs. This is a conservative estimate; the CSE from DEP and DEC filings and the LBNL *Cost of Saved Energy* report includes higher-cost low-income programs. For the 20% of costs associated with low-income programs, we use LBNL estimates (Hoffman et al. 2018).

Table C2. Projected first year costs for investor-owned utilities

Utility	Cost category	First-year cost of saved energy in 2020$/kWh
DEP	Program administration (including incentive) costs	0.219
	Participant costs	0.124
	Incentive costs	0.134
DEC	Program administration (including incentive) costs	0.192
	Participant costs	0.124
	Incentive costs	0.117
Dominion	Program administration (including incentive) costs	0.186
	Participant costs	0.124
	Incentive costs	0.113
Low income—all IOUs (20% of savings)	Program administration (including incentive) costs	0.996
	Participant costs	0.12
	Incentive costs	0.00

COOPERATIVES AND MUNICIPAL UTILITIES: ENERGY EFFICIENCY PROGRAMS AND STATEWIDE TECHNICAL ASSISTANCE

For our analysis, we first reviewed energy savings from co-ops and municipal utilities from EIA and the North Carolina Renewable Energy Tracking System (NC-RETS). It appears that, in 2018, municipal utilities achieved incremental annual electricity savings of 4,800 MWh and co-ops achieved savings of 73,000 MWh, or 0.03% and 0.4% of sales, respectively. Combined savings from co-ops and municipal utilities were an estimated 0.2% of sales combined. For the policy analysis, we then assumed that these utilities ramp up from a statewide average of 0.2% electricity savings per year in 2021 to 1% annual electricity savings by 2030 and 1.1% annual electricity savings by 2032 and each year thereafter through 2040. Utilities could commit to these levels through voluntary targets or could be required to meet these levels by a statewide policy. Savings levels of 1% per year are consistent with Bickford and Geller 2016, which reported that electric co-ops in six states found that leading utilities saved about 1.0–1.1% relative to their retail energy sales, and with Kushler et al. 2015, which found that leading municipalities achieved savings of 1.4% per year. To estimate costs, we drew upon LBNL data on the cost of saved electricity through publicly owned utilities' efficiency programs (Schwartz et al. 2019).

To fund the programs, one option is to implement a 2% rider on all non-IOU customer electricity bills. Michigan provides an example of this approach. The state's original EERS legislation (PA 295 of 2008)[51] required that all utilities add an itemized charge on customer bills to fund EE. Another option is to incorporate EE program costs into rates, which is what co-ops in Minnesota have done. We estimate that such a rider or embedding costs into rates would provide a $75 million investment each year in cost-effective EE projects in North Carolina, which would provide net benefits to all customers of co-ops and municipal utilities. These cost-effective investments would allow the public power utilities to offset more expensive investments in generation and distribution. We estimate that phasing in a 2% rider by 2030 would enable electric public power utilities to achieve 1% electricity savings per year that year.

Moreover, a 2% rider on customer energy bills for natural gas, fuel oil, and propane would provide an estimated additional $40 million, which could be used toward cost-effective EE investments. These funds could be delivered through a statewide technical assistance entity that would help customers implement cost-effective efficiency projects. We did not estimate additional savings from such funds. The state of Oregon, for example, uses a 3% natural gas rider to fund the Energy Trust of Oregon, the statewide entity that implements cost-effective EE programs (NW Natural 2014).

[51] State of Michigan, Legislative Council. Clean and Renewable Energy and Energy Waste Reduction Act 295 of 2008. www.legislature.mi.gov/%28S%28zovnn1an1tdvcy55sp04phbe%29%29/documents/mcl/pdf/mcl-Act-295-of-2008.pdf

One option for a statewide efficiency requirement on co-ops and municipal utilities is to allow electrification programs to count as credit toward energy savings targets if the programs are cost effective for customers and result in GHG emissions reductions.

BUILDING CODES

To evaluate the impacts of more stringent codes for our building codes analysis, we first gathered data on building characteristics, including rates of new construction and energy intensity. For residential homes, we developed an estimate of new builds based on U.S. Census data for annual residential permits in North Carolina (Census Bureau 2019). Based on these data and North Carolina's population growth forecasts from the state's Office of State Budget and Management, we estimated new residential construction per annual population growth (North Carolina OSBM 2020). (Again, these population projections were developed before the impacts of COVID-19.) For new commercial construction, building permit data were less reliable due to different permitting requirements in various jurisdictions throughout the state. Instead, we developed an estimate of additional floor space per new employee using job growth forecasts from North Carolina Department of Commerce (North Carolina Department of Commerce 2018).

We developed building energy use averages based on South Atlantic regional data from the 2015 Residential Energy Consumption Survey (RECS) and 2012 Commercial Building Energy Consumption Survey (CBECS) (EIA 2017, 2018). Where necessary, we allocated total building energy intensity proportionally based on the percentage of end-use energy that goes to electricity in order to avoid counting gas, oil, and other heating fuels (which go beyond the electricity-only scope of our analysis).

We obtained the energy code savings estimate per cycle from DOE technical determinations (DOE 2020a). For savings based on climate zones, we developed a weighted average based on the proportion of North Carolina counties in climate zones 3, 4, and 5, respectively.

We determined compliance rates based on a 2017 DOE field study, which found that 88% of new builds surveyed in North Carolina were compliant with code standards (Bartlett et al. 2017).

We divided costs into three subcategories: cost of implementing new codes, cost of code reviews/inspections, and homebuilder costs for standards compliance. We estimate implementation costs at $6 million per each upgraded code cycle, based on an average cost of $5,000 per jurisdiction per code type (residential and commercial) and 600 code jurisdictions throughout the state (Williams, Price, and Vine 2014). The case incurs this cost twice: once in 2022, with building codes updated to IECC 2018 standards; and again in 2026, with the update to IECC/ASHRAE 2021. We calculated enforcement costs on the basis of cost per square foot—$0.023/sq. ft. for residential and $0.026 for commercial—for an average of $3,257,969 per year.

Costs to homebuilders for building code compliance were based on CSE estimates for North Carolina from LBNL (Hoffman et al. 2018), which estimates the levelized CSE for North Carolina at $0.021 ¢/kwh. Based on that amount, using a discount rate of 6% and an average measure life of 11.8 years, we calculated a first-year CSE of $311/MWh.

BENCHMARKING

To evaluate the impact a building benchmarking policy would have in Raleigh and in Charlotte in terms of energy and GHG savings, we began with a meta-analysis of other cities with similar benchmarking policies already in place. We chose a minimum square footage requirement of 50,000 square feet, based on a similar threshold being used in cities such as Philadelphia, New York, and Washington, DC (Mims et al. 2017; City of Seattle 2018; City of Philadelphia 2019). On average, cities that implemented benchmarking saw a 1.38% annual reduction in building energy use from participating properties, with a compliance rate of 90% (table C3).

Table C3. Meta-analysis of benchmarking savings studies

Benchmarking study	Years covered	% savings	Compliance rate (%)
EPA Meta-Study	2008–2011 (3 years)	2.7%	n/a
Seattle, WA	2013–2015 (3 years)	3.7%	99%
Chicago, IL	2013–2016 (4 years)	4%	80%
New York, NY	2013–2016 (4 years)	6%	87%
Minneapolis, MN	2015–2018 (3 years)	5.5%	91%
Philadelphia, PA	2013–2017 (4 years)	5%	91%
Washington, DC	2009–2012 (3 years)	5.8%	89%
Average (normalized per year)		1.38%	90%

Sources: EPA 2016, City of Seattle 2018, Mims et al. 2017, Jossi 2020, City of Philadelphia 2019

Building count and square footage data for Raleigh and Charlotte were provided by CoStar via the EERE State and Local Energy Database (SLED) (DOE EERE 2020). Based on that data, we estimated new additional commercial and multifamily square footage per year based on growth estimates in the Raleigh and Charlotte Master Plans (City of Raleigh 2020; City of Charlotte 2020). To avoid double-counting savings that were already achieved through the existing DOE Better Buildings benchmarking initiative, we excluded public sector buildings from the analysis.

We derived average commercial building energy usage estimates from National Renewable Energy Laboratory data, which we accessed via SLED. Based on the total number of qualifying units (buildings over 50,000 sq. ft.), we developed a projection of total energy consumption in MWh in both cities for the base case. From there, we used the average annual rate of savings of 1.38% at a compliance rate of 90% to develop an estimate of energy use in the benchmarking case.

Because benchmarking can result in a wide variety of efficiency measures, from behavioral changes to whole building retrofits, a singular measure life can be difficult to determine. For our analysis, we chose a measure life of 11 years, based on the average utility program measure life reported in the 2019 *Utility Energy Efficiency Scorecard* (Relf et al. 2020), rounded down. From year 11 onward, we subtracted the first-year savings from the total estimated savings from implementing building benchmarking.

Once established, benchmarking programs generally require three to four full-time staff members to run during the first years, and two to three staff members in subsequent years[52] (Mims et al. 2017). These staffing needs primarily consist of a full-time help center to offer support and answer questions from property owners, as in Seattle's successful benchmarking program, which has a 99% compliance rate. The ENERGY STAR Portfolio Manager software platform is provided for free by the EPA (ENERGY STAR® 2020). Operating and staffing costs for city governments are estimated at $225,000 per year for three full-time staff members. The other costs will be borne by property owners investing in EE measures. The total cost to building owners of lowering building energy use by 1.38% annually is estimated at around $900,000 per year.

FINANCING—CLEAN ENERGY FUND AND COMMERCIAL PROPERTY ASSESSED CLEAN ENERGY (C-PACE)

A statewide clean energy fund would provide an important enabler for EE investments in North Carolina. To estimate the size of a potential clean energy fund in the state, we reviewed the size of other established state clean energy funds relative to population. Based on that review, we assumed that a new clean energy fund in North Carolina would be established in 2021 and provided an initial capitalization of $50 million, with projects to start in the year 2022. We then assumed another injection of $75 million in funds in 2030. We also assumed a leverage ratio of 3:1—that is, that every dollar of public funding leverages $3 of private capital. This is consistent with leverage ratios found in U.S. green banks (Coalition for Green Capital 2020). Of the total public and private funds, we assumed that 75% of clean energy investments made through the fund would go toward EE projects (with the remaining 25% invested in renewable energy projects).

Next, we assumed that 40% of the efficiency investments would be made in the LMI sector and 60% in non-LMI projects. With this investment pattern, we used LBNL data on program administrator CSE to derive a first year CSE of $0.47/kWh. This allowed us to estimate electricity savings from clean energy fund investments in efficiency projects. Finally, we assumed an average measure life of 11 years, which is a 40/60 blended average of low-income/non-low-income measure lifetimes from the LBNL data set.

For C-PACE, we reviewed data from PACENation to analyze per-capita investments in 19 states for C-PACE. We found that average C-PACE investments in 2019 were about $3.50 per capita for EE projects. We assumed that North Carolina could ramp up a C-PACE program to the same level over a period of three years (2023–2025), reaching investments of $37 million per year in 2025 and each year thereafter on average.

To estimate electricity savings for C-PACE, we used LBNL's total CSE for commercial and industrial (C&I) to estimate first-year costs of EE investments of $0.58/kWh. We estimated that 10% of costs would go toward program administration and the remaining 90% would

---

[52] DOE provides resources for state and local leaders interested in developing a building energy benchmarking and transparency policy. These are consolidated in the following factsheet: www.energy.gov/sites/prod/files/2019/02/f59/Benchmarking_Transparency_Resource_PDF_Final_2.14.pdf.

be direct project investments. We assumed an average measure lifetime of 13 years, which is also from LBNL.

UTILITY SAVINGS INITIATIVE FOR GOVERNMENT BUILDINGS

Baseline square footage and building energy performance data for state-owned buildings and UNC schools were provided in the USI *Comprehensive Program FY2019* report (NCDEQ USI 2019). For the CEE case, we modeled continuous improvements in cabinet agency buildings up to a 40% reduction in EUI/sq. ft. by 2025, relative to a 2002–2003 baseline (currently at 29.4%). We used a five-year measure life based on the assumptions USI uses in its own modeling. For the EE case, we applied the same 40% by 2025 target to non-cabinet agencies and UNC schools.

Participant costs are estimated based on a first-year CSE of $873.38/MW. We calculated this number based on the average value of approved performance contracts from 2018–2019, discounted to first year and adjusted for inflation. Although these upfront costs may appear high, public sector financing allows for access to low-cost debt and other financing mechanisms such as Guaranteed Energy Savings Contracts.

Regarding program administrator costs, because this program has no dedicated budget of its own, the 2019 report identified the lack of full-time staffing and outreach as a barrier.[53] We looked to expand program administration from three to six full-time staffers to meet these needs and facilitate program expansion, as well as accommodate an increased volume of projects to meet these expanded targets. Based on public salary records for North Carolina government employees, we assumed the addition of two analyst-level positions at $60,000 a year and one manager-level position at $73,550 per year—for a total staffing expense of $386,381 per year, including existing positions (Off 2019).

EXPANDING WEATHERIZATION

In 2019, nearly 1,500 households were weatherized and nearly 900 HVAC units were replaced or repaired, with the vast majority of those units in the participating weatherization households (M. Hickman, NC DEQ, pers. comm., 2020). These annual participation levels are far lower than needed. By comparison, the state had 614,000 eligible households in 2010 (North Carolina DEQ 2020c); those estimates will be updated based on the 2020 U.S. Census. Annual spending levels in recent years have ranged from $12 million to nearly $26 million (NASCSCP 2019), and NSCSP data suggest that annual participation has ranged from 2,500 to 5,200 households. Average project costs per household have been approximately $7,000 for direct project costs without factoring in administrative or health and safety costs. Including administrative, health, and safety costs, per-project costs have been about $10,000 for weatherization projects and about $6,800 per project for HVAC projects (M. Hickman, NC DEQ, pers. comm., 2020).

---

[53] From the 2019 *Comprehensive Program* report: "State Agencies are working with other primary responsibilities and limited resources to identify energy efficiency projects. Requests have been made to expand financial resources so that identified energy projects can be implemented. Prioritization and reinforcement is needed from within the agency and the Governor's office, and funding from the legislature is needed for the goal to be achieved."

We assumed average household electricity savings of 8.5%, which is the midpoint of the savings range provided by NC DEQ (M. Hickman, NC DEQ, pers. comm., May 2020). We then estimated that household energy savings could increase in 2022 to 10%, which is the approximate midpoint of the moderate-climate regional data from a national evaluation of the program (Tonn et al. 2015). That evaluation found average electricity savings in the moderate climate region were about 7% in homes heated with natural gas and 7–10% in homes heated with electricity (figure 2.6 in Tonn et al. 2015). We assumed a baseline electricity usage per household for participants of 18,000 kWh (M. Hickman, NCDEQ, pers. comm., 2020). Weatherization participants use more electricity than average households in the state, which use 13,585 kWh per EIA data for North Carolina. We estimated that baseline electricity usage per household would decrease over time to about 17,000 kWh in 2025 and 16,000 kWh in 2030 as the program began reaching more of the highest energy users.

After 2030, we assumed that annual spending would level off and slowly decline until all eligible customers were reached through the program by 2040. We assumed the program costs would be consistent with recent cost data per household in the first few years of the analysis, but that the program would then achieve cost efficiencies and leverage other funding sources, such as health care funding, in order to achieve a CSE of $1.12/first-year kWh by 2030. We assumed that average measure lifetimes in the program would be 13 years, per LBNL data (Schwartz et al. 2019).

Our analysis assumed that annual WAP investments would increase significantly in the next decade, increasing five-fold to about $110 million in 2030. This increase would allow the state to reach at least one-third of eligible customers by 2030. The new funding could come from increased federal spending on WAP, LIHEAP, and/or braiding health care dollars. By providing preventive health services in conjunction with energy-saving measures, the program could maximize societal benefits and potentially leverage financial resources from the health sector, such as government-funded health housing initiatives, federal and state health funds, health insurance, and funds from hospitals and private practice (Hayes and Gerbode 2020).

AFFORDABLE MULTIFAMILY PROGRAM EXPANSION

We obtained statistics on the Duke Neighborhood Energy Saver program enrollment and savings per unit from evaluation, measurement, and verification reports for the Neighborhood Energy Saver program for DEC and DEP (Opinion Dynamics 2020). We estimated the multifamily portion of participating Neighborhood Energy Saver units at 20% based on internal correspondence with Duke program management (C. Fields, pers. comm., May 14 2020). Because costs for this program are not listed separately from other income-qualified Duke programs—such as appliance replacement and weatherization in the DSM cost recovery filing—we estimated program costs based on LBNL's CSE for low-income at $0.996/MWh (Schwartz et al. 2019).

To forecast future participation, we obtained data on affordable multifamily housing in North Carolina by utility service territory from the *Potential for Energy Savings in Affordable Multifamily Housing* report (Mosenthal and Reed 2015). We divided annual enrollment in Duke programs by the service area's total multifamily housing stock to get an average percentage per year of multifamily units that participate in Duke's program, which is equivalent to 2.72% of total eligible units.

We predicted future trends in the multifamily housing stock based on the North Carolina Office of State Budget and Management population forecast, as well as the U.S. Census report on the state's total housing stock. We found that 7.6% of total housing units were classified as *affordable multifamily*. Based on the U.S. Census, which reported an average tenancy rate of 2.52 tenants per unit, we estimated total affordable housing stock up to 2040. We then multiplied it by the percentage of affordable housing in Duke's service area and rounded to the nearest integer to get an estimate of total eligible properties.

For our estimate of CEE, we applied Duke's current participation rate and MWh savings per unit. For the EE case, we modeled expanding both Duke's annual units enrolled in the program and savings per unit to target 1 MW annual savings per unit and the cumulative achievable potential of 461 GWh by 2040 within Duke service territory as indicated in the 2015 EEFA report. Annual units enrolled and savings per unit would increase by 35% to meet that potential; we assumed the rate of enrollment and increase in savings per unit would increase over the span of three years, beginning with an increase of 15% in 2021 and 10% per year for 2022–2023.

LARGE CUSTOMER SAVINGS BEYOND STRATEGIC ENERGY MANAGEMENT ("SELF DIRECT")

We started with a baseline of all opted-out load from IOU customers, because each industrial customer facility must notify its electric power supplier that it has implemented or will implement alternative EE measures.

To evaluate opted-out load, we used Duke's potential studies and DSM cost recovery filings to determine that, for DEC, opt outs account for 40% of the commercial load and 73% of the industrial load, while for DEP, opt outs account for 30% of the commercial load and 90.6% of the industrial load (Nexant S&P Group 2020; Duke Energy Progress 2019a). We obtained Dominion's nonresidential opt-out figures from its 2019 DSM filing (Dominion Energy North Carolina 2018b). We estimated which percentages of Dominion's opted-out load were industrial and commercial by the ratio of total nonresidential sales for each sector.

To determine savings, we used the same percentage of savings and participation estimates as for the EERS modeled in this report, ramping up over time to participation equivalent to savings of 1.2% of opted-out load per year.[54] Those savings ramp up differently for each of the three major IOUs based on their current savings rate. This assumes that, if included in a robust self-direct program, savings from large customers would represent a proportional amount of the total system EE savings across sectors.

We assumed a 12-year measure life, using the average measure life for C&I programs from the LBNL DSM program database, since the 2020 *ACEEE Utility Scorecard* did not break down portfolio average measure life by sector (LBNL 2015). Because 2020 is likely to be a

[54] We base this on the EE Roadmap's recommended target of achieving 10% electric energy savings by 2030 below a baseline of each IOU's total gross electric sales in 2020. We adjusted each utility's ramp up to 1% per year savings in 2030 and 1.2% in 2032 based on its current energy savings (as described in the EERS section above).

particularly abnormal year due to COVID-19, we used projected load in each year 2022–2040 as the baseline. We subtracted savings from the industrial assessment and SEM recommendations to avoid double counting.

For program administrator costs, we used the average CSE for North Carolina from the LBNL *Cost of Saved Energy* study (Hoffman et al. 2018). We assume that customer incentives are 61% of program administration costs, based on a recent analysis of planned utility budgets 2016–2020 (Minor 2019). All costs are reported as 2020$. We also used LBNL data for the participant CSE in North Carolina. Table C4 shows each IOU's first-year costs for program administration, participant, and incentive costs.

Table C4. Projected first year costs for C&I programs

Cost category	First-year cost of saved energy in 2020$/kWh
Program administration (including incentive) costs	0.280
Participant costs	0.290
Incentive costs	0.171

Source: LBNL 2015

INDUSTRIAL ASSESSMENTS

Small and medium-sized manufacturers with annual energy bills of more than $100,000 and less than $2.5 million are eligible to receive no-cost energy assessments provided by DOE's Industrial Assessment Centers (IACs) (DOE 2020e). To determine potential future energy and cost savings possible through this IAC program, supplemented by additional funds, we used historical data from 2012 to structure our forecast. We determined average savings per implemented recommendation from 2012 to 2019 to be 124 MWh, and the average number of implemented recommendations per year to be 67; we excluded 2019 from our analysis, because its efficiency measures and savings are still being calculated. We also excluded natural gas and other fuel savings from our analysis (DOE 2020e).

To project these savings forward with supplemental funding, we assumed that the number of assessments would increase proportionally to the increase in funding provided by the state over DOE funding. We also assumed that mature centers, such as the one at North Carolina State University (NCSU), could always find additional assessments to perform. If state funding doubled existing federal funding, it is reasonable to claim that the average number of implemented recommendations per year since 2012 would also double to 135, at the same average savings per implemented recommendation, resulting in 16,600 MWh in new savings at that recommendation rate. With input gathered from experts, we determined an average measure life of EE savings recommended by the NCSU IAC and implemented by participating industrials to be seven years. This value is based on conversations with a relevant expert, as well as by the 2015 SRI International study, in which IAC directors and staff were quoted on a figure of "around 5-10 years on average for longer-term modifications… for savings persistence estimates" (Stephen et al. 2015; S. Terry, director, NCSU IAC, pers. comm., April 14, 2020).

Using this value, and discounting savings measures implemented before 2020, we projected savings starting in 2020 and scaled up the amount of implemented recommendations possible to reach 135 by 2025. In 2040, we projected savings from the NCSU IAC with supplemental funding to be 100 GWh in annual savings. Combined with existing efforts, we estimated total EE savings from industrial energy assessments to be 176 GWh in 2030 and 208 GWh in 2040. We included CEE case savings from WRP industrial assessments in the total EE case savings. To project WRP savings forward, we used average annual savings from 2012–2020 and 15-year measure lives.

The potential for significant peak savings also exists through recommendations to change rate schedules and reschedule plant operations or reduce load to avoid peaks. Savings potentials beyond our calculations are possibly even higher due to research and development in more efficient technologies and process alterations.

The IAC website (https://iac.university/) also provides costs of implemented measures, as well as the electricity savings enabled by those measures for industrials. From the collection of 2012–2019 historical data, we determined that the average historical cost of an implemented electricity saving measure is $15,580 (DOE 2020e). We estimated the savings by multiplying projected savings by projected industrial electricity prices in cents per KWh. With the increase in number of recommendations to 135 promoted by the supplemental funding detailed above, this means that the net savings would reach $3,029,000 in 2030 and $2,875,000 by 2040. Federal funding to each IAC is approximately $310,000, which the state would have to match to increase the number of recommendations, resulting in $620,000 in administrative costs annually. We estimate the costs of saved energy through the NCSU IAC at approximately $0.12 per KWh, not including administrative costs. We arrived at this estimate for DOE funding to IACs from averages of reports on the centers at Louisiana State University, Georgia Tech, and Case Western Reserve University. We also suggest that the state explore the possibility of a new center at another major engineering university, such as the University of North Carolina at Charlotte, which would likely be able to quickly replicate similar savings to the NCSU IAC.

STRATEGIC ENERGY MANAGEMENT

The first step in our analysis was to determine savings if efforts are continued as expected for SEM programs in North Carolina. The first program we looked at was DEQ's Environmental Stewardship Initiative (ESI), which has operated since 2002 and helps any self-reporting business achieve electricity and fuel savings. We used DEQ's annual reports on the program and its reported electricity savings to determine that, from 2010 to 2018, the program reported 432 GWh of total electricity savings (North Carolina DEQ 2020b). We used DEQ's program projections to forecast new savings of 666 GWh in 2040. These values do not account for current proposals from third-party stakeholders, such as Advanced Energy, to continue with plans to create an SEM cohort based around ESI participation; if implemented, savings would increase further.

We also looked at federal SEM programs that operate in North Carolina, including the 50001 Ready Navigator tool and Superior Energy Performance (SEP) certification. There are 10 facilities in the state using the Ready Navigator to track the progress of their energy management system (EnMS) implementations. To date, none have completed implementation and self-attested; DOE has therefore yet to recognize them. Three facilities in North Carolina are SEP certified: Schneider Electric's Greensboro facility, Cummins' Rocky Mountain Engine Plant, and Daimler Trucks' Mount Holly facility. We identified them using the Better Buildings portal on recognized facilities (DOE 2015, 2016). Despite recording significant savings and serving as a good example for industrials that want to increase focus on energy and cost savings through energy management, we did not include the electricity use reductions in our analysis because they did not amount to more than 10% of the savings possible through the proposed SEM program in our recommendations.

We used Duke's potential studies and DSM cost recovery filings to determine the proportion of large customer load that opted out of Duke's EE programs (Nexant S&P Group 2020; Duke Energy Progress 2019a). We obtained Dominion's nonresidential opt-out figures from its DSM filing for 2019 (Dominion Energy North Carolina 2018b). We estimated the percentages of Dominion's opted-out load that were industrial and commercial using the ratio of total nonresidential sales for each sector. We assumed that these opt-out figures would remain consistent over the analysis period.

To evaluate potential savings, we used the same threshold for eligibility that we used for determining which customers were opted out. Typically, we see 1 million kWh in annual energy consumption as an appropriate threshold for successful participation in an SEM program. Therefore, the opted-out load determined above served as the eligible load from which we calculated savings.

We assumed 8% savings each year for this analysis, with a measure life of five years (NREL 2017). We also assumed that each participant goes through the SEM program only once and that the program length would be one year. We assumed an incrementally increasing participation rate for both the C&I sectors based on a CEE survey of 2015 SEM program performance. The participation rate for the industrial sector will reach 38% cumulatively by 2030, while the commercial sector will reach 23% cumulatively by 2030. After 2030, participation levels out in our analysis, with the program reaching an additional 5.5% of industrial load and 3.25% of commercial load every year to 2040. We determined these percentages by using the rate of participation in 2030 and maintaining it out to 2040. These participation estimates are conservative, as the study notes that cumulative participation rates could potentially be as high as 50% of the commercial load and 75% of the industrial load by 2030.

We determined a starting point of 1% for both C&I sector participation based on the amount of load we estimate will be addressed by existing efforts in North Carolina SEM in 2022. We increased these baseline participation estimates incrementally to 2030 to reach our cumulative projections, and then leveled them out toward 2040. We determined these increments by increasing our starting point participation linearly to reach our cumulative totals by 2030. We also removed the 666 GWh savings made through existing programs from the eligible opted-out load in the statewide SEM program. We assumed that existing programs reach large C&I customers such that their savings would overlap with those in the SEM analysis.

With these assumptions, we find that average annual electricity savings through a statewide SEM program from 2022–2040 are 420 GWh. We estimate savings in the first year of the program of 25 GWh, reaching annual savings of 500 GWh in 2030 and 591 GWh in 2040. Of the savings, 31% would be commercial and 69% would be industrial. These values would account for 0.78% of the IOU nonresidential load in 2030 and 0.87% of the IOU nonresidential load in 2040. Based on average retail rates, net cost savings from these electricity savings would reach $21 million in 2030 and $24 million in 2040. Combined with the existing efforts of DEQ's ESI program, we estimate total EE electricity savings from SEM to be 1,116 GWh in 2030 and 1,257 GWh in 2040.

AGRICULTURAL PROGRAMS

Our first step in analyzing the savings potential for the agriculture sector through an audit and implementation program was to determine the load of sales made to the sector, which is not differentiated from the rest of industrial sales on IOU IRPs or in the EIA 861 data. We obtained data on value added for 2010–2018 to the North Carolina economy, which provides immediate product expenses for North Carolina farms from USDA's North Carolina Agricultural Statistics, provided by the North Carolina Department of Agriculture and Consumer Services (USDA and NCDA&CS 2018). These data include electricity spending in thousands of dollars. We also looked at historical rate of change in sales (in $) since 2010 and projected it forward to 2040. To determine the electricity sold in GWh by spend in dollars, we assumed that the rates were similar to each year's equivalent commercial rate of electricity and divided farm spend by that rate, including projected sales and projected commercial prices. Through this methodology, we arrived at figures that estimate the agricultural load to be 1,187 GWh in 2030 and 1,601 GWh in 2040.

The next step was to determine the state of existing EE measures in the state and the level of savings those programs enabled; we also sought a way to project those savings forward through their expansion and leverage. In North Carolina, EnSave currently works in collaboration with the North Carolina Electric Management Corporation and North Carolina electric co-ops through a grant from USDA rural development to offer energy audits to North Carolina co-op members. The audit provides an evaluation of EE opportunities at agricultural facilities. The program covers 75% of the cost of an energy audit, which can be used to access funding for equipment upgrades as well as gain eligibility for USDA grants. The electricity savings achieved by implementing the EE measures identified by EnSave's audit program have helped a total of 75 participants achieve more than 1,800 MWh of savings. In 2019, the Rural Energy for America Program (REAP), which offers grants of up to $250,000 to rural farms for EE projects, provided 19 grants totaling $395,611 to North Carolina facilities (USDA 2019b).

Based on EnSave's audit information, WRP, and similar numbers from state-supported audit, implementation, and loan programs in Maryland and Delaware, we estimate that the implementation of efficiency measures identified through agricultural audits has an average savings value of 24.67 MWh per agricultural facility and an average bill savings of $3,394. Based on a conversation with relevant stakeholders, we determined that approximately 2,000 North Carolina farms could be reached by a state-run and -funded program of beneficial energy audit and implementation measures by 2030, with another 4,000 farms reached by 2040 (C. Metz, president and CEO, EnSave, pers. comm., May 27, 2020). Based on these participation estimates, the average electricity savings from the examined case studies, and an estimated average measure life of 13 years for agricultural EE measures, we project savings of 44 GWh in 2030 and 100 GWh in 2040—that is, 3.67% and 6.23% of those years' estimated agricultural load, respectively. Combined with existing efforts, we estimated total EE savings from agricultural energy assessments to be 65 GWh in 2030 and 123 GWh in 2040. We included CEE savings from WRP agricultural assessments in the total EE case savings. To project WRP savings forward, we used average annual savings from 2012–2020 and 15-year measure lives.

With an average cost of $3,394 for both audit and EE implementation, the expansion of the program in terms of number of audits and resulting recommendations would increase costs proportionally such that once the program reached 400 annual audits, total annual costs would be $1,358,000; we arrived at this figure by multiplying the number of audits by the average, increasing from $115,000 in 2022 and $584,000 in 2025 as the number of audits scales up. Of these costs, 75% would be provided by the state or a third party, resulting in a total cost to all participants of $340,000 each year after 2030. We arrived at this value by dividing costs by energy saved in KWh. We determined that net savings would increase from $51,249 in 2022, or 0.03% of the annual North Carolina farm spend, to $6,872,000 in 2040, or 2.44% of annual North Carolina farm spend—a figure we arrived at by multiplying state averaged projections for commercial prices by the amount of anticipated saved energy.

Other potential additional sources of agricultural sector savings include increasing the food supply chain's efficiency to reduce food and fuel waste, as noted in the *North Carolina Natural & Working Lands Action Plan* (North Carolina DEQ 2020a).

Appendix D: Meta-Analysis of Electricity Energy Efficiency Potential Studies

This appendix details our analysis of electricity efficiency potential studies to establish a baseline of potential savings for the targeted EERS, co-operative utilities, and municipal utilities analyses. We reviewed nine recent EE potential studies for electricity savings (kWh) as a guide for target setting in North Carolina. A meta-review of potential studies from other jurisdictions provides critical information for target setting, but it also includes many caveats. For example, each jurisdiction faces unique economic factors and differences in weather and in building and housing types. All of the studies have been completed since 2016, and seven out of nine of them are from jurisdictions with electricity prices similar to those of North Carolina.[55]

Another important caveat: These studies relied on various assumptions for cost-effectiveness screening tests, which are used as a benchmark against which efficiency potential is assessed. Studies with a more inclusive approach to cost–benefit analysis typically identify higher levels of cost-effective potential. In our review, some of the studies used versions of the Societal Costs Test (SCT) while others used versions of the Total Resource Cost (TRC) test. We did not restrict our review to only studies using an asymmetrical TRC test, which is North Carolina's current approach.[56] These studies also varied in their use of net and gross savings. North Carolina uses net savings in its reporting and cost-effectiveness testing, but gross savings in its most recent *Market Potential Study* and gross savings for REPS reporting (Duke Energy North Carolina 2020; NC-RETS 2020).

Finally, efficiency potential studies have other limitations. For example, they are not typically good tools for predicting or analyzing emerging technologies; as a result, they may not identify the full savings opportunity in the long term. They also tend to screen efficiency potential by individual measures rather than bundling, sequencing, and optimizing measures together into programs and policy solutions (e.g., when a program sequences envelope measures first to reduce space conditioning needs). This can be a conservative approach and leave cost-effective potential savings opportunities on the table. We did not complete a thorough review of the methodologies and approaches of these studies; we focused on the key results.

Table D1 shows results for "Average Achievable" and "Maximum Achievable" potential scenarios. The studies identify average achievable savings of 1.07% per year and maximum achievable savings of almost 1.4% per year. See ACEEE literature for a full discussion of the differences in these scenario approaches.[57]

[55] We restricted our sample to states with rates close to the U.S. average of 10.53 cents/kwh in 2018. Based on EIA 861 annual survey data, North Carolina's average retail price in 2018 (9.25 cents/kWh) was close to the U.S. average (10.53 cents/kWh). Only Wisconsin (10.58 cents/kWh) and Michigan (11.4 cents/kWh) were higher.

[56] North Carolina's TRC includes participant costs but does not include many participant benefits, such as those related to savings from other fuels, asset value, productivity, economic well-being, comfort, health and safety, or satisfaction (NESP 2020a).

[57] For an overview of the definitions and analytical approaches for these different types of efficiency potential scenarios, see ACEEE 2014, *Cracking the TEAPOT: Technical, Economic, and Achievable Potential Studies*.

Table D1. Energy efficiency electricity savings results: achievable and maximum achievable scenarios

Covered entity	Number of years	Time period (years)	Achievable average annual savings as a % of baseline	Maximum achievable average annual savings as a % of baseline
Ameren (IL)	10	2017–2026	0.70%	0.94%
ComEd (IL)	14	2017–2030	1.05%	1.33%
Xcel (CO)	11	2018–2028	0.71%	0.78%
New Orleans (LA)	10	2018–2027	1.80%	2.50%
Ameren (MO)	10	2019–2028	1.00%	1.34%
NV Energy (NV)	20	2019–2038	ND	0.84%
Minnesota (statewide)	10	2020–2029	1.40%	2.10%
Focus on Energy (WI)	12	2019–2030	1.06%	1.18%
DTE (MI)	20	2016–2035	1.25%	ND
Average			**1.12%**	**1.38%**
Median			1.06%	1.26%

Where not reported, we calculated average savings as a percentage of baseline, by dividing cumulative savings as a percentage of baseline by study period years. *Sources:* Ameren Illinois 2016, ICF International 2016, Optimal Energy 2018, Bailey and Rokke 2016, GDS Associates 2016a, NV Energy 2018, CEE 2018, Garth et al. 2017, GDS Associates 2016b.

Maximum achievable results are a reasonable guide for target setting for a few reasons. First, we find evidence of states already achieving savings levels above these thresholds. Second, we find that potential studies generally make several constraining assumptions and that "achievable" scenarios may be overly conservative. We recommend using "maximum achievable" when available as a better guide to inform target setting. Finally, there are other policy tools—such as utility performance incentives—that can work alongside targets to provide further guidance and flexibility, which can encourage utilities to achieve savings above the required targets. Setting targets too low will limit the opportunity to use these other policy tools to aim for the most ambitious, cost-effective savings possible.

Appendix E: Recommendations by Actor

This appendix outlines our report's recommendations by actor. In tables E1–E5, we highlight the roles of state policymakers (executive branch and legislature), utilities (public and investor-owned), and city and local governments. Energy savings from those policies and programs in *italics* are quantified in the body of the report.

Table E1. North Carolina executive branch

Policy	Detailed policy action
North Carolina executive branch	
Utility savings initiative	Establish statewide energy manager program to benchmark energy use in K-12 schools (EE Roadmap recommendation #2).
Utility savings initiative	Oversee energy savings projects utilizing financing mechanisms, including Guaranteed Energy Savings Contracts, to achieve a 40% reduction in energy intensity for all state-owned buildings and UNC schools (pending passage of HB 330). Increase USI staffing from three to six members.
Clean energy fund	Establish a statewide, nonprofit clean energy fund at an initial capitalization of $50 million. The fund will catalyze the development of clean energy markets by issuing loans, providing credit enhancements, and investing in projects. Leverage ratepayer-funded utility programs where possible.
Strategic energy management	Establish a statewide SEM program to help large C&I customers implement continuous EE improvements.
Agriculture audit and implementation	Establish a statewide audit and implementation program to identify and implement cost-effective EE improvements at North Carolina farms. Leverage existing third-party offerings and infrastructure.
Weatherization	Leverage new funding sources, such as health care and possible federal stimulus funds, to expand weatherization for low-income households in North Carolina. Expand coordination efforts to create streamlined statewide delivery of utility and state-led programs.
Statewide efficiency advisory council or collaborative	*Establish a Statewide Efficiency Advisory Council or Collaborative to ensure that the state holds itself accountable to the many efficiency programs and policy recommendations in its Clean Energy Plan, as well as to improve coordination between stakeholders.*
North Carolina Housing Finance Agency	
Qualified allocation plan	Tighten home energy standards for qualifying units to equal ENERGY STAR version 3.0 or higher. Offer additional tax credits for developers who exceed those standards.
North Carolina Building Code Council	
Building codes	*Begin a phased transition to adopt 2021 IECC/ASHRAE standards in North Carolina by 2030.*

Policy	Detailed policy action
Building codes	Increase EE awareness on the NCBCC by establishing an energy seat (EE Roadmap recommendation #6).
Building codes	Revert residential building code update from a six-year to a three-year cycle (savings not included in EE case).

Table E2. North Carolina state legislature

Policy	Detailed policy action
North Carolina state legislature	
EERS and minimum requirement for low-income efficiency programs	Enact a stand-alone EERS requiring 10% electric energy savings from IOUs by 2030 and 5% from co-ops and municipal utilities, below a baseline of each utility's total gross electric sales in 2020. Savings ramp to 1.2% of sales by 2032 and continue through 2040.
Efficiency by co-ops and municipal utilities	Enact a requirement that co-ops and municipal utilities meet an energy savings targets relative to a baseline of each utility's total gross electric sales in 2020. Annual savings ramp to 1.2% of sales by 2032 and continue through 2040. A rider on all non-IOU customer electricity bills of 2% could provide significant capital to be invested each year in cost-effective EE projects. Utilities can use on-bill tariffs to help meet the savings goals. Provide an option for building electrification programs to count as credit toward the goals if the programs save money and reduce emissions.
Building codes	Add an energy representative to the NCBCC and repeal the statute enabling the legislature to bypass the NCBCC process to pass code amendments.
Utility savings initiative	*Pass the Efficient Government Buildings & Savings Act (HB330).*
Utility savings initiative	Increase the budget for the state energy office to support increased staffing necessary to achieve savings targets under HB 330 and direct an energy management strategy for K-12 schools (estimated $193,550 per year until 2025).
Benchmarking	If necessary, pass enabling legislation to allow municipalities to benchmark, track, and disclose building energy use in their jurisdictions.
C-PACE	Update and extend enabling legislation to launch a C-PACE program in North Carolina to provide a financing instrument for property owners to implement EE projects. PACE enables property owners to finance the upfront costs of such projects, paid through a voluntary assessment on their property tax bills. Address consumer protection concerns in efforts to re-establish the authorizing of PACE legislation and the implementation of programs.

Policy	Detailed policy action
Large customer savings beyond strategic energy management	Capture industrial savings opportunities through legislative action or a stakeholder process initiated by the executive branch, such as the Energy Efficiency Advisory Council. The legislature could adopt a self-direct program, which continues to offer large energy users flexibility and control over investment of their EE contributions, while ensuring that measurable, cost-effective energy savings are achieved for all utility system customers.[58] Alternatively, the legislature could consider minor changes to the thresholds of who can opt out to bring more customers into default utility EE service, or it could consider a wholesale change to the industrial opt-out so that customers are directly served by utility offerings.
Industrial assessments	Provide state funding to match DOE funding to the NCSU IAC to increase the number of assessments made to eligible industrials.

Table E3. Utilities

Program	Detailed program action
Investor-owned utilities[59]	
High-efficiency heat pumps	Expand existing heat pump and HPWH electricity efficiency offerings by utilities, including co-ops and municipal utilities.
New construction	Extend Residential Construction program offered at DEP to DEC. A filing for this program was submitted in September 2017, but was rescinded after DEC and local natural gas utilities were unable to agree on its design; DEC must file modifications (DEC 2020b).
Multifamily	DEC/DEP: Expand enrollment of multifamily units in the Neighborhood Energy Saver income-qualified direct-install program by 35% over two years, targeting savings of 0.93 MWh/unit/year. Dominion Energy: Expand the existing income-qualified energy retrofit and weatherization program to multifamily units to achieve cumulative potential savings of $24 million by 2035.
Income-qualified weatherization	Extend the DEP program to DEC, coordinating support to help scale offerings to the need in the state.

[58] Such best practices include: 1) Report savings to regulators with routine data collection, standard approaches to measuring and verifying energy savings, and regular progress reporting. 2) Establish a transparent mechanism for customers to manage their individual fee contributions and apply funds toward their projects (e.g., dedicated escrow-like accounts, rebates earned upon project completion, or rate credits earned concurrently with energy efficiency investments and/or energy savings). 3) Provide customers with greater flexibility and control over their energy efficiency funds (e.g., through multiyear time frames to let customers spend aggregated energy efficiency fees) (ACEEE 2020).

[59] These recommendations apply to all investor-owned utilities. Many also apply to municipal utilities and co-ops, but because of significant variability among those utilities, some may have already implemented these recommendations. For additional recommendations specific to Dominion Energy, which currently has a narrower portfolio, see the "Utility" section of the EE case.

Program	Detailed program action
Strategic energy management	Expand SEM program adoption (currently in the Smart $aver Customer program) to help medium and large businesses manage energy through continual improvement and a systematic approach to energy performance.
Agricultural programs expansion	Duke currently offers a Smart $aver Prescriptive program that includes rebates for some agricultural equipment. Enhance diversity of agricultural offerings, and target incentives at those customers alongside proposed statewide agricultural audit and incentive program.
Energy Efficiency as a Service (EEaaS)	Offer program models where the service provider (usually a third party) maintains ownership of installed equipment while the customer pays for the energy services provided (ACEEE 2019).
Metered EE Transaction Structure (MEETS) for Commercial Buildings	Pilot MEETS, a financing arrangement in which the yield from metered EE (the difference between a dynamic baseline and actual consumption) is delivered to the utility, enabling EE to be treated like a long-term power purchase agreement (if investor/customer-driven) or like a utility-owned generation or leased property (if utility-driven) (MEETS Accelerator Coalition 2020).
Nonresidential EE in LMI communities	Target small business and public building offerings to nonresidential community-serving institutions in low-to-moderate income areas (Drehobl and Tanabe 2019).
Industrial customer programs	Continue to co-develop attractive, mutually beneficial EE program offerings for customers.
Expanded midstream and upstream offerings	Offer programs (beyond lighting) that transform the market for EE products by targeting upstream manufacturers or midstream retailers.
Expanded retail products platforms	Minimize barriers to participation during and after COVID-19 by bringing more products and even services online in marketplace offerings for energy-efficient products.
Leveraging AMI data to improve cost effectiveness, participation	Use granular customer energy usage data (AMI) to improve program effectiveness by targeting programs to customers who: 1) can participate (e.g., have relevant end uses), 2) are likely to participate, or 3) are likely to save more energy when they do participate.
On-bill financing and tariffs	Offer on-bill financing and/or tariffed on-bill programs, enabling customers to pay down the cost of EE investments through monthly electric bill payments, either through loans (utility or third party) or on-bill tariffs
Geotargeted programs/EE for nonwires alternatives	Target businesses in specific geographic locations that will yield high savings and value for the grid.
Braiding health funding	Modify residential programs to include measures that promote better health outcomes for residents (asthma, falls, extreme temperature exposure) and identify complementary funding sources (e.g., insurance, Medicaid, philanthropic grants, government programs) for the preventative health care services provided (Hayes and Gerbode 2020).

Program	Detailed program action
Co-ops and municipal utilities	
Targets	Adopt voluntary targets for saving or spending, absent legislative action.
Expand program offerings	To meet new target for energy savings and extend reach to more customers, expand program portfolio using the program options listed above.

Table E4. North Carolina Utilities Commission

Policy	Detailed policy action
NCUC	
Energy Efficiency Resource Standards	Implement stand-alone EE targets for IOUs based on legislative direction, or set targets independently if NCUC has appropriate regulatory authority. Targets should meet at a minimum 10% electric energy savings by 2030, below a baseline of each utility's total gross electric sales in 2020. Savings ramp to 1.2% of sales by 2032 and continue through 2040.
Cost effectiveness	Shift to a UCT from the current asymmetrical TRC test to better capture EE's value. In addition, shift to portfolio-, sector- or program-level assessment; current measure-level assessment can reduce overall net economic benefits of efficiency investments (NESP 2020a, 2017).
Beneficial electrification	Review Rule R8-68 and consider updating process to enable consideration of electrification where beneficial for customers, GHG emissions, reduced overall costs, and primary energy savings across fuels.
Code implementation support	Review rules to ensure that utilities can receive appropriate credit for advancing adoption, implementation, and/or compliance verification of building energy codes (Misuriello et al. 2012). Note that these savings are currently captured in this report's Building Codes section and would be incremental to the proposed EERS.

Table E5. Cities and municipal governments

Policy	Detailed policy action
Benchmarking	*City of Raleigh and Charlotte: Establish a building energy benchmarking, tracking, and disclosure policy for privately owned buildings of 50,000 sq. ft. or more.*
Utility savings initiative	Coordinate with local school districts to establish embedded energy managers in K-12 schools throughout the state. Access public sector financing (e.g., Green Bank, C-PACE, Performance Contracting) to enact building energy retrofits in K-12 schools.