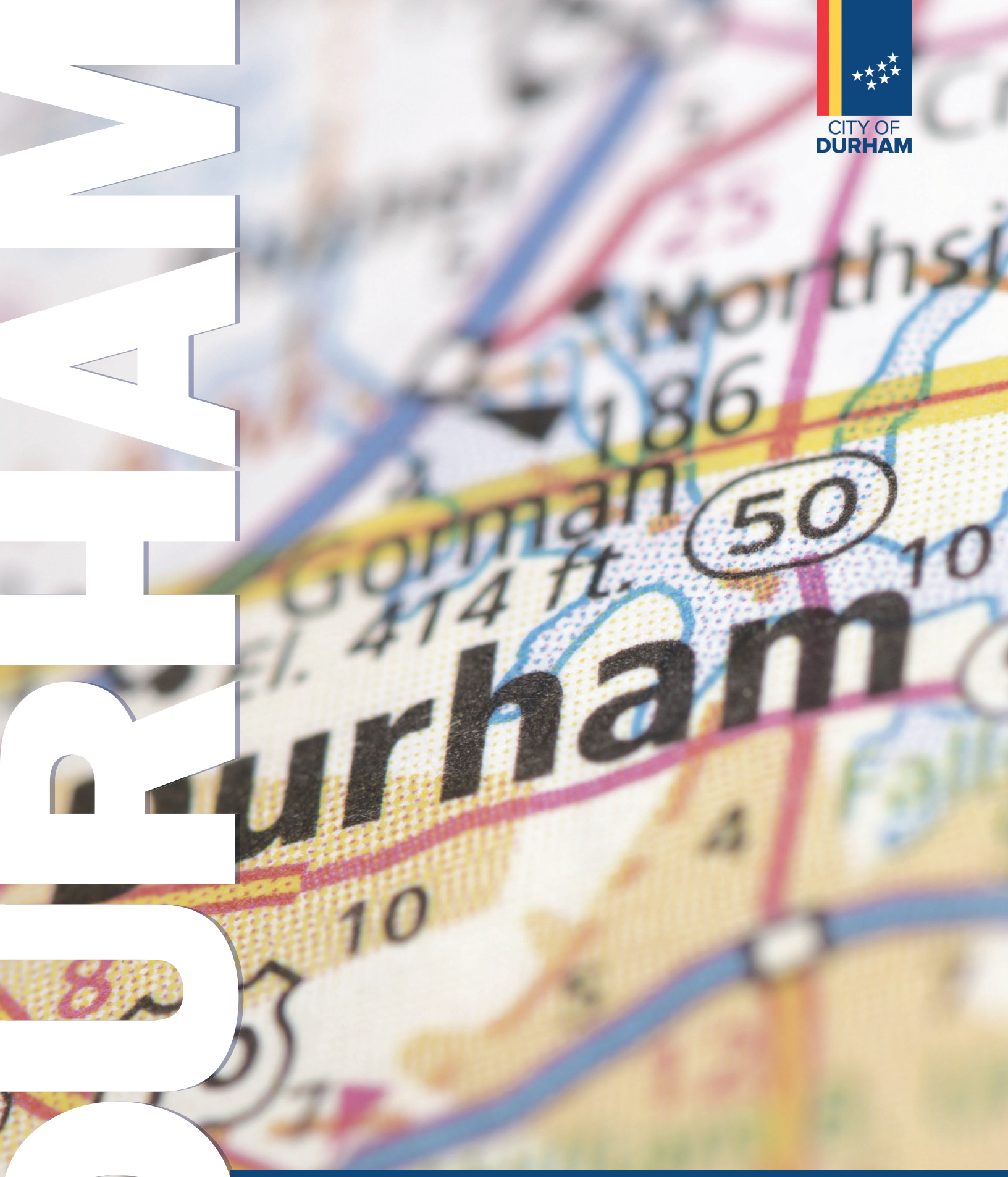

2021 CARBON NEUTRALITY & RENEWABLE ENERGY ACTION PLAN

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CITY OF DURHAM

Dear City of Durham Residents:

It is my honor to present the City of Durham's *Carbon Neutrality & Renewable Energy Action Plan,* which demonstrates the Bull City's commitment to lead in addressing the global climate crisis while creating a healthier environment and better quality of life for all of our residents.

This plan is the result of a year-long collaboration between multiple City departments, Environmental Affairs Board community stakeholders, and GDS Associates, Inc. of Marietta, GA. The tireless efforts by our City employees and other contributors has produced a comprehensive, technically-driven carbon reduction and renewable energy action plan.

Throughout this collaboration, team members worked to analyze data for City buildings, vehicle fleet, water and sewer facilities, power supply resources, and other contributing infrastructure to build a holistic picture of the impact the City's operations have on our environment.

The plan they have created will power our City organization with 100% renewable energy by 2050 and achieve carbon neutrality in City operations by 2040.

Along the way, our vehicles will run cleaner and quieter every year, our buildings will use less energy overall, generate electricity from the sun, and our consumption of fossil fuels will diminish.

Our efforts will prioritize equity and bring a cleaner environment to all of our residents, particularly those in underserved areas who stand to benefit substantially from reduced air pollution. The actions that we are taking today, guided by this action plan, will benefit future generations in all parts of our community by seeding a legacy of positive change and healthy growth.

As we all work together to implement this plan over the coming years, we can each contribute to making Durham a city that is welcoming, innovative, green, resilient, and equitable – literally the coolest city in America.

Sincerely,

Wanda S. Page
City Manager

Image by City of Durham

> We will continue to lead. We are increasing investments in renewable energy and energy efficiency. We will buy and create more demand for electric cars and trucks. We will increase our efforts to cut greenhouse gas emissions, create a clean energy economy, and stand for environmental justice.

— ***Mayor Steve Schewel***
Support for Paris Climate Agreement

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01 EXECUTIVE SUMMARY

Image by City of Durham

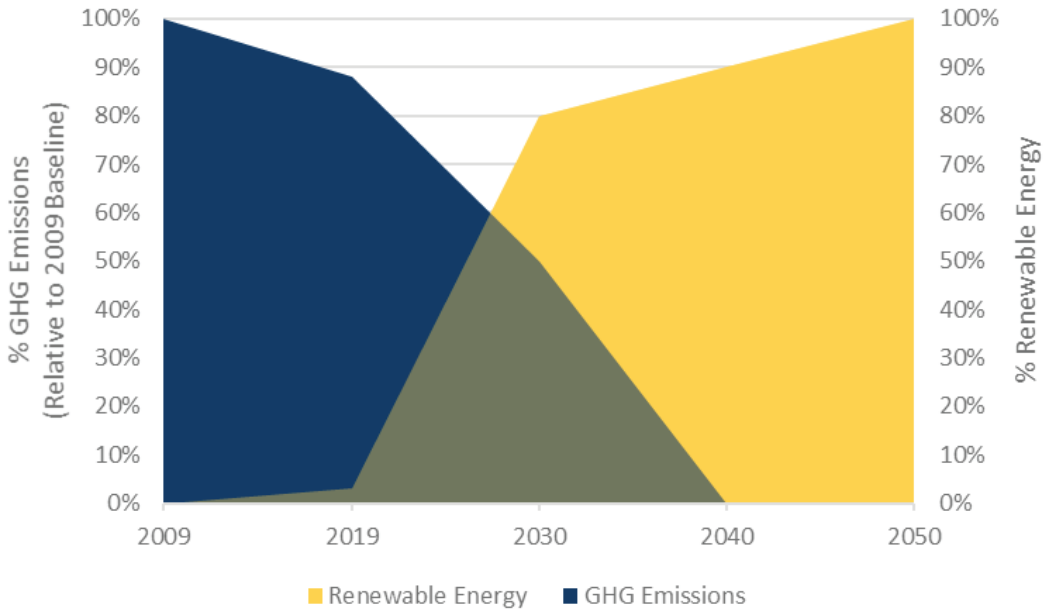
The City started its journey toward cleaner energy in 2007 with the development of the *City of Durham and Durham County Greenhouse Gas and Criteria Air Pollutant Emissions Inventory and Local Action Plan for Emission Reductions.* Building on its momentum, the City developed the *2019-2021 Durham Strategic Plan* and the *Roadmap to Sustainability*. Also, during this time, the City and County established independent sustainability offices to focus on their specific efforts.

Now, the City is again taking a leadership role as one of the first communities in North Carolina to commit to carbon neutrality and 100% renewable energy sourcing for City operations as illustrated in Figure 1-1. The *Carbon Neutrality and Renewable Energy Action Plan* (CNRE Action Plan or Plan) is a result of *The Resolution of the Durham City Council Supporting a Transition to Renewable Energy and Carbon Neutrality* (Resolution) which was approved on April 1, 2019. The City recognizes the potential benefits to the Durham community of cleaner air, increased resilience, reduced energy consumption, improved job opportunities and a healthier environment. Of critical importance, the implementation of this plan will focus on energy equity and environmental justice to ensure these benefits are available to all residents and future generations.

The scope of work for the CNRE Action Plan includes both a carbon neutrality plan and a renewable energy supply plan. The strategies and action items work in tandem and support the attainment of each goal. The GDS Associates team along with Diane Cherry, Principal with Diane Cherry Consulting (Consultant team) collaborated closely with the City of Durham staff to develop a customized, comprehensive, and achievable CNRE Action Plan. The overall approach included 1) consistent outreach with key stakeholders, 2) assessment of the current situation and baseline analysis, 3) identification and evaluation of strategies and action items, 4) assessment of regulatory and legislative policies, 5) examination of financial considerations, and 6) development of the Plan. The Consultant team developed models to evaluate the environmental and economic impacts of strategies and scenarios. In doing so, the team determined an optimal portfolio for the City of Durham to reach its clean energy goals.

The first step in building the CNRE Action Plan is to facilitate conversations with stakeholders for insights and feedback regarding existing initiatives, future projects, and expected outcomes of the plan. The initial stakeholder outreach efforts included City staff and the Durham City-County Environmental Affairs

FIGURE 1-1 CARBON NEUTRALITY AND RENEWABLE ENERGY GOALS



The first step in building the CNRE Action Plan *is to facilitate conversations with stakeholders for insights and feedback regarding existing initiatives, future projects, and expected outcomes of the plan.*

Board (EAB) members. The City of Durham is a retail commercial customer of Duke Energy and purchases its electricity from the utility. Therefore, Duke Energy is a key stakeholder in the development and implementation of the CRNE. As part of its initial step, the City executed a Memorandum of Understanding (MOU) and a Franchise Agreement with Duke Energy. Ongoing collaboration between the City, the Durham community, and Duke Energy will be paramount to achieving the City's carbon neutrality and renewable energy goals.

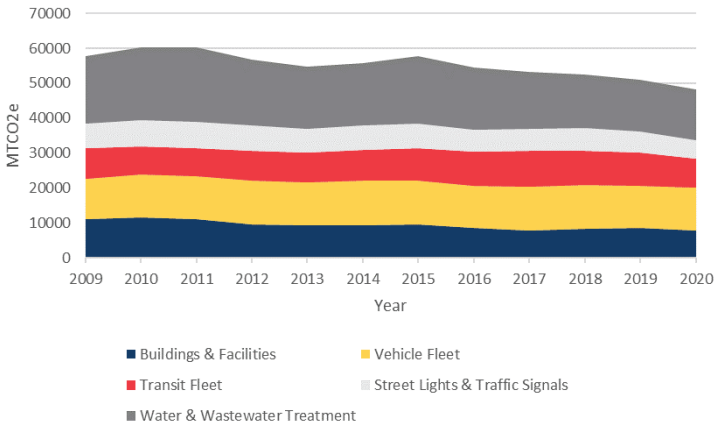
Carbon Neutrality

To develop the CNRE Action Plan strategies and action items, it was critical to understand the City's historical and current greenhouse gases (GHG) emissions. Durham uses the International Council for Local Environmental Initiatives (ICLEI) ClearPath Software to record and track GHG emissions. The City operation sectors tracked in the ICLEI tool are listed below.

- ***Building*** natural gas and electricity consumption
- ***Streetlights and traffic signals*** electricity consumption
- ***Vehicle fleet and transit fleet*** fuel use
- ***Water and wastewater plant*** natural gas and electricity consumption

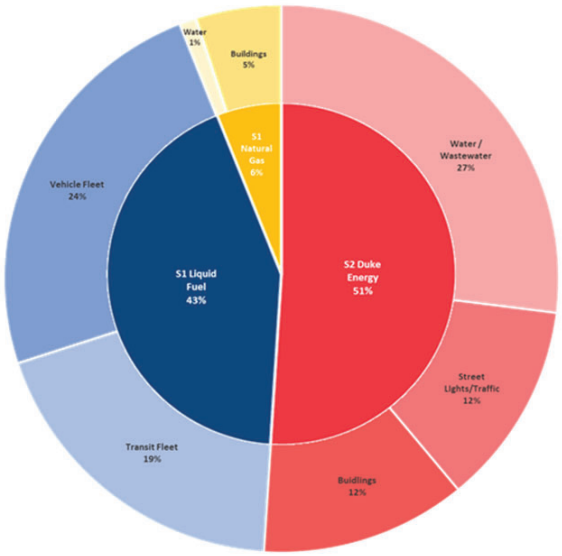
The GHG emission trends from 2009 – 2020 are illustrated in Figure 1-2. The City's total emissions in 2009 were 57,699 metric tons of carbon dioxide equivalent (MTCO2e). 2009 serves as the baseline year for the carbon neutrality analysis. Due, in part to energy efficiency efforts from the City and a cleaner energy supply from Duke Energy, the City's 2020 emissions were 48,319 MTCO2e, a 16% decline from the 2009 baseline.

FIGURE 1-2 CITY 2009 – 2020 EMISSIONS (MTCO2E)



The City's 2020 carbon footprint from energy consumption is illustrated in Figure 1-3. Scope 1 emissions account for 49% of the carbon footprint – primarily attributed to gasoline and diesel fuel consumption. Natural gas is a relatively small contributor to the City's GHG emissions. Scope 2 emissions account for 51% of the City's carbon footprint – including electricity consumed for water and wastewater facilities, streetlights and traffic signals, and buildings.

FIGURE 1-3 CITY OF DURHAM 2020 CARBON FOOTPRINT



The Consultant team developed and modeled a set of initiatives that the City can undertake to achieve its 2040 goal of carbon neutrality and its 2050 goal of 100% renewable energy sourcing in City operations. The CNRE Action Plan presents four overarching strategies and 36 action items for the City to pursue over the next three decades. These strategies will significantly reduce greenhouse gases from City operations and increase renewable energy generation and procurement.

Maximize Energy Efficiency in City Buildings and Operations

Expand Renewable Energy Generation and Procurement

Increase Electrification of Vehicles (Fleet and Transit)

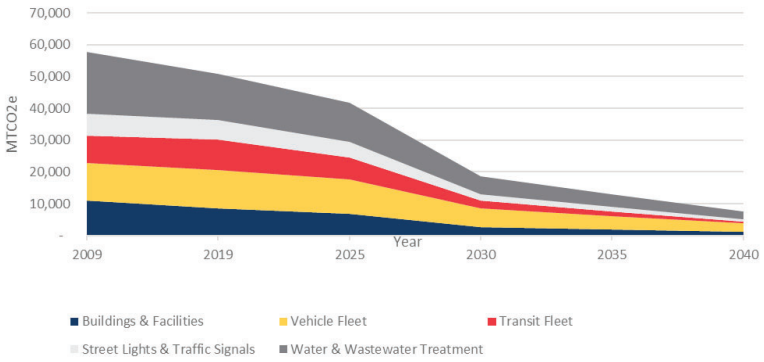
Establish Innovative Carbon Reduction Strategies and Community Partnerships

To bring about a measurable difference, the following action items, over a specified timeframe, will enable the Plan strategies. The items are actionable at the local level but adaptable to external changes such as regulatory or legislative policy, economic conditions, new and emerging technology, and environmental justice and equity considerations. A summary of the key action items is listed below.

- ***Continuing energy efficiency efforts*** for the City's buildings, facilities, and water and wastewater treatment system through initiatives such as energy audits, equipment retrofits, benchmarking, and LED conversions.
- ***Converting uses of natural gas*** within buildings and water system facilities to electricity.
- ***Electrifying a substantial portion of the City's vehicle fleet and transit system vehicles*** which reduces fossil fuel combustion.
- ***Investing in renewable energy resources*** such as on-site generation and off-site procurement to increase the portion of the City's energy consumption from cleaner energy sources.
- ***Purchasing renewable energy credits (RECs)*** or carbon credits as needed to close any gaps to meet the goals.
- ***Leveraging Duke Energy's expected ongoing emissions reductions*** based on its current IRP.
- ***Establishing and expanding innovative carbon reduction practices*** such as green roofs and low-embodied carbon concrete.
- ***Building partnerships*** with community members and sustainability focused organizations.

These action items result in decreasing the City's carbon footprint over time as illustrated in Figure 1-4. By 2040, the City's GHG emission are expected to be approximately 6,409 MTCO2e including the impact of renewable energy. This represents a reduction of 89% from the 2009 baseline. Based on current technology, even with these actions, some GHG emissions remain. To achieve carbon neutrality, it may require the City to purchase carbon offsets.

FIGURE 1-4 GHG EMISSIONS INCLUDING RENEWABLE ENERGY



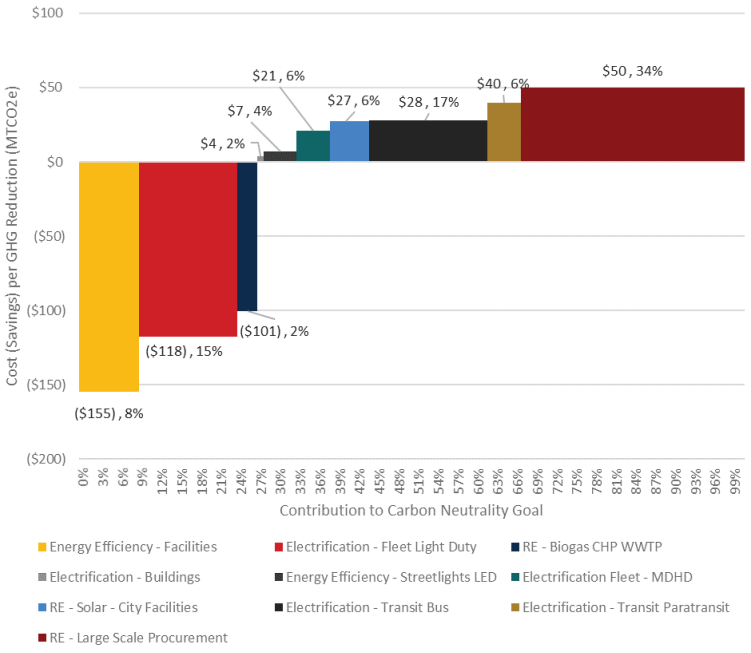
Achieving the City's decarbonization goals will require financial investments to implement the strategies and action items. Many of these investments are expected to lead to long-term cost savings. To offset these costs, the City will continue to seek innovative solutions and consider all potential funding sources including federal, state, and local funds, government financing, and public-private partnerships.

To better understand the economic impacts of the strategies and action items, a financial analysis was conducted. The financial analysis for the CRNE Action Plan is based on identifying the strategies that will enable the City to meet its goals using the minimum quantity of RECs and carbon offsets.

The marginal abatement cost curve or "supply curve" is a common tool for comparing various GHG emission strategies based on their cost and relative level of contribution to GHG reduction. For Durham, this cost curve indicates a mix of initiatives that can lead to lifecycle cost savings (<$0 per ton of carbon) as well as initiatives that lifecycle costs greater than $0 per ton of carbon. The supply curve describes the savings or cost per ton of carbon as well as the share each offers to reducing the City's carbon footprint. The height of the bar represents the cost (or savings) of reduction in MTCO2e. The taller the bar, the greater the cost (or savings) of the reduction strategy. The width of the bar represents relative share of emissions reduction. The wider the bar, the greater the contribution to GHG emissions reductions.

In Figure 1-5, the reduction strategies are ordered from left to right in order of lowest cost to highest cost. Strategies that save money over the lifecycle of the project have negative costs (savings). Energy efficiency strategies are often at the far left of the curve and projects with incremental cost or new/emerging technology will generally be at the right of the curve. The cost (savings) per GHG reduction (MTCO2e) and the relative percentage contribution to the carbon neutrality goal are shown below.

FIGURE 1-5 2021-2040 GHG SUPPLY CURVE



While there are capital expenditures and on-going annual expenses to implement the action items, several of these initiatives provide net savings over time and provide an overall positive contribution to the City. To achieve the City's goals, the capital investment is projected to be approximately $88,000,000 over 20 years based on current technology, trends, and financial information. The capital expenditures modeled for transportation and fleet electrification are the incremental costs above traditional internal combustion engine vehicles and

dominate the need for new capital investment. Transportation electrification represents about 67% of incremental capital costs ($59 million). Approximately 14% is associated with renewable energy projects ($12 million), and the remaining 19% is associated with energy efficiency projects for natural gas and electricity savings ($17 million).

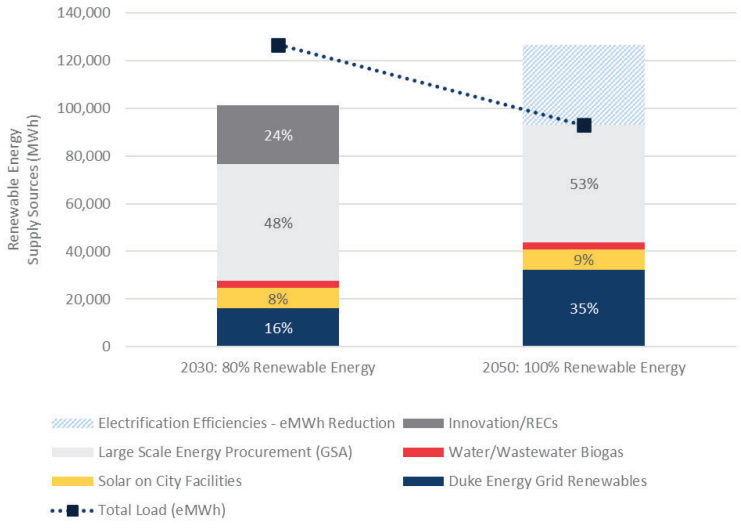
The City's actual cost will vary based on the final project scope and numerous implementation considerations. New technologies will emerge over the next three decades. Ongoing advances related to energy efficiency, electrification, and renewable energy may expand options for the City. It is expected that the cost of GHG abatement technologies will decline over time, especially in the transportation electrification sector. In addition, significant rebates and incentives are expected to be available. These factors, along with others such as financing mechanisms and alternatives to project ownership, may substantially reduce the expected capital costs associated with these strategies.

In addition to financial considerations, it is important to stay abreast of pending legislative and regulatory policy implications to the plan. The transition to cleaner energy is underway at global, national, and regional levels. At least 150 states and local jurisdictions have pledged to achieve 100% renewable energy supply – generally by 2050 or earlier. As such, there is a significant amount of legislative and regulatory policy and program activity relating to renewable energy, decarbonization strategies, transportation electrification, and energy equity. For example, the U.S. Department of Energy's (DOE) Office of Economic Impact and Diversity launched a new program called the Justice40 Initiative. The purpose is to develop a plan that addresses energy equity and deliver 40% of the benefits of climate investment to disadvantaged communities. Therefore, it is increasingly important that the City of Durham participate in policy proceedings and programs at a federal and state level.

Renewable Energy

The strategies to achieve 100% renewable energy supply include a variety of possible solutions including on-site generation and off-site procurements. Current on-site generation options modeled include rooftop solar, landfill solar, and biogas. Off-site procurements may include large-scale utility programs such as the Duke Energy Green Source Advantage (GSA) program and RECs. Advancements in technology are expected to provide innovative options for additional renewable energy sources. Figure 1-6 represents a portfolio of solutions to achieve the 80% and 100% renewable energy goals.

FIGURE 1-6 RENEWABLE ENERGY SUPPLY STRATEGIES



The City's expected on-site resources (solar on City facilities and water/wastewater biogas) contribute approximately 12% toward the attainment of the renewable energy goal. This contribution could increase if the City identifies additional facilities or technologies for renewable projects or if there are legislative or regulatory changes that allow for more flexibility in generating or procuring renewable energy resources. As for its own power generation, the City should continue to evaluate the costs and

benefits of pairing battery storage systems with solar projects. Battery storage systems may provide additional flexibility and resiliency for the City.

As a retail customer of Duke Energy, the City's renewable energy supply is impacted by the utility's generation mix. As Duke Energy incorporates more renewables into its generation portfolio, the City will realize a benefit from a cleaner energy supply. The City's electricity purchases from Duke Energy are expected to contribute approximately 16% in 2030 and 35% in 2050 toward the renewable energy goal. However, achievement of both the 80% renewable energy supply goal in 2030 and the 100% renewable energy supply goal in 2050 is heavily dependent on a large-scale procurement such as the Duke Energy GSA program which contributes approximately 50% of the goal. Without such a program, the City would need to increase its reliance on RECs to meet the goals. The City will continue to benefit from a cleaner electricity grid as Duke Energy and other utilities strive to decarbonize generation assets by 2050.

The incremental costs associated with the 2030 goal of 80% renewable energy is expected to be approximately $1,500,000 or $14.56 per MWh. The Duke Energy GSA program accounts for 56%, the City solar facilities account for 40%, and the remaining 4% is attributed to the purchase of RECs to achieve the 80% goal in 2030.

The incremental costs associated with the 2050 goal of 100% renewable energy is expected to be $1,300,000 or $14.34 per MWh. The Duke Energy GSA programs accounts for 60% of this cost and the City solar facilities account for 40%. REC purchases are not expected to be needed to reach the 100% goal in 2050.

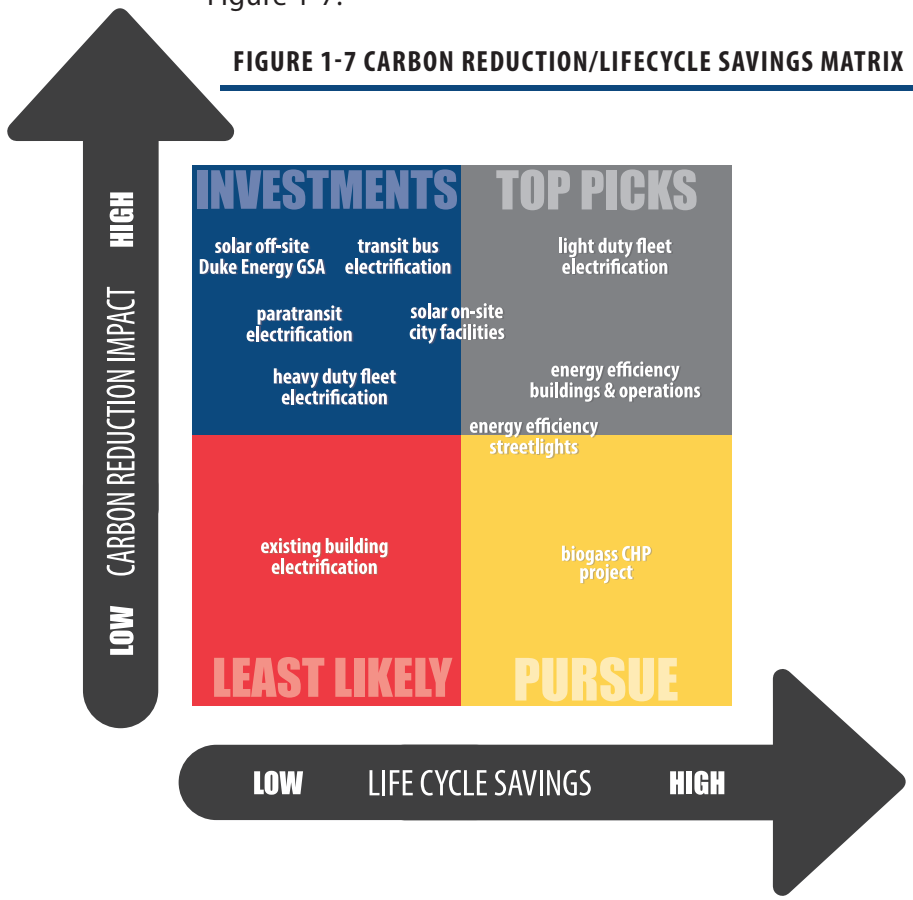
Implementation

The City has many choices regarding the implementation of the strategies and action items to achieve carbon neutrality and 100% renewable energy sourcing for City operations. When considering decisions to prioritize future efforts towards goals, the following tools may be helpful.

Decision Matrix – This tool includes six criteria - greenhouse gas reduction potential, cost implications, criticality of meeting resolution targets, demand/energy consumption reduction, environmental equity considerations, and timing and ease of implementation.

Carbon Reduction/Lifecycle Savings Matrix – this tool illustrates the strategies from a potential lifecycle savings and carbon reduction analysis. Those in the top right corner are considered to be "top picks" based on their relative high lifecycle savings and high carbon reduction potential. The "pursue" strategy is based on high lifecycle savings with a lower carbon reduction potential. The "investment" strategies yield higher carbon reduction potential but have a higher cost as well. Finally, the "least likely" category strategy does not provide significant savings or carbon reduction potential. This tool is represented in Figure 1-7.

FIGURE 1-7 CARBON REDUCTION/LIFECYCLE SAVINGS MATRIX



While the CNRE Action Plan is a long-term plan, implementation of short-term action items ensures a smooth and successful transition to clean energy for the City. *The Top 10 implementation action items for the City of Durham are listed below.*

1. Dedicate City staff to the implementation of the CNRE Action Plan. This task includes hiring additional staff and establishing a sustainability team.
2. Create a community-wide task force for the Durham community to advise and collaborate on implementation. A focus of the task force includes equity and environmental justice considerations.
3. Develop a comprehensive outreach and education strategy to inform Durham residents of the CNRE Action Plan and implementation efforts.
4. Advance initiatives identified in the Memorandum Of Understanding Work Plan with Duke Energy regarding renewable projects and energy efficiency pilot programs.
5. Advocate in regulatory and legislative policy processes at both the state and federal level to represent the interests of the Durham community.
6. Identify and pursue financial resources such as grants, loans, and rebate programs to offset capital investment expenses.
7. Complete energy audits and implement energy efficiency improvements in buildings and operations.
8. Install renewable energy on-site generation projects and procure large-scale off-site resources such as Duke Energy GSA or other renewable options. Monitor legislation for changes to renewable energy procurement options in North Carolina.
9. Accelerate vehicle fleet and transportation fleet (buses) electrification and install charging infrastructure.
10. Explore opportunities for public-private partnerships to leverage private sector resources to expand the City's capacity for sustainable projects.

In summary, it will take a portfolio of strategies and action items to achieve the City's carbon neutrality and renewable energy goals. There is not a single solution currently available that will meet the City's needs. The strategies include energy efficiency, electrification, renewable energy, innovative carbon reduction practices and community partnerships. The CNRE Action Plan updates will occur periodically to reflect technological, financial and policy impacts as well as equity and environmental justice considerations.

Congratulations to the City of Durham for taking the next step in its journey toward a cleaner, healthier environment for the community and its residents.

Image by City of Durham

02 INTRODUCTION

Image by City of Durham

The City of Durham's vision is to be North Carolina's leading city in providing an excellent and sustainable quality of life. To achieve its compelling vision, the approach must have at its core the reduction of greenhouse gases (GHG) and reliance on renewable energy, and thus create a resilient and vibrant community. *The Carbon Neutrality and Renewable Energy Action Plan* (CNRE Action Plan or Plan) is a result of *The Resolution of the Durham City Council Supporting a Transition to Renewable Energy and Carbon Neutrality* (Resolution) which was approved on April 1, 2019.[1] This CNRE Action Plan will focus on reducing the carbon footprint and increasing renewable energy supply for City operations.

The City's commitment is one of many pledged towards clean energy. For more than a decade, Durham has been a leader in creating positive environmental change for its community and citizens. Further, the state of North Carolina is addressing clean energy improvements through legislation. Some of the City's and North Carolina's initiatives are illustrated in Figure 2-1.

The City started its journey toward cleaner energy in 2007 with the development of the *City of Durham and Durham County Greenhouse Gas and Criteria Air Pollutant Emissions Inventory and Local Action Plan for Emission Reductions.* Also, in 2007, Senate Bill 3, the Renewable Energy and Energy Efficiency Portfolio Standard (REPS) was passed.

The North Carolina legislature passed key legislation in 2017, House Bill 589 – Competitive Solutions for North Carolina. In 2018, Governor Cooper issued Executive Order 80 – North Carolina's Commitment to Address Climate Change and Transition to a Clean Energy Economy. Along with these State initiated actions, the City also participated in several sustainability related activities. For example, in 2017, Mayor Schewel joined 467 other mayors across the country in support of the Paris Climate Agreement. In response to the United States withdrawal from the Paris Climate Agreement, the attending mayors issued the following statement. "We will continue to lead. We are increasing investments in renewable energy and energy efficiency. We will buy and create more demand for electric cars and trucks. We will increase our efforts to cut greenhouse gas emissions, create a clean energy economy, and stand for environmental justice."[2] Other activities include recognition as a 4-Star Community for national excellence in sustainability and completion of the City's first Leadership in Energy and Environmental Design (LEED) facilities.

Building on its momentum, the City developed the *2019-2021 Durham Strategic Plan* and the *Roadmap to Sustainability*. Also, during this time, the City and County established independent sustainability offices. Now, the City is again taking a leadership role as one of the first communities in North Carolina to commit to carbon neutrality and 100% renewable energy sourcing for City operations. The Resolution addresses climate change and the adverse impacts on the natural and built environment as well as the disproportionate impact to low-income communities and communities of color in North Carolina. It posits, as a goal, the transition towards clean energy, "energy derived from ongoing natural processes that rapidly replenish and is sustainably collected from renewable sources such as solar, wind, and geothermal."

> We will continue to lead. We are increasing investments in renewable energy and energy efficiency. We will buy and create more demand for electric cars and trucks. We will increase our efforts to cut greenhouse gas emissions, create a clean energy economy, and stand for environmental justice.
>
> ***Mayor Steve Schewel***
> *Support for Paris Climate Agreement*

FIGURE 2-1 CITY OF DURHAM'S CLIMATE ACTION TIMELINE

2007

SB3
SB3 - Renewable Energy and Energy Efficiency Portfolio Standard

EMISSIONS INVENTORY & LOCAL ACTION PLAN
City of Durham and Durham County Adopt *"Greenhouse Gas and Criteria Air Pollutant Emissions Inventory and Local Action Plan for Emissions Reductions"* Established Reduction Goals

2008

JOINT SUSTAINABILITY
City and County created Joint Sustainability Office

2017

CLIMATE PROTECTION AGREEMENT
Mayor's Climate Protection Agreement

HB 589
HB 589 - Competitive Solutions for North Carolina

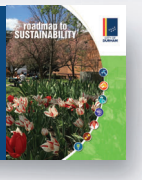
CERTIFIED COMMUNITY
4-Star Certified Community

LEED BUILDINGS
LEED Buildings

2018

GOVERNOR COOPER'S EO 80
Executive Order 80

ROADMAP TO SUSTAINABILITY
City of Durham Sustainability Roadmap completed



2019

DURHAM STRATEGIC PLAN
City of Durham Strategic Plan completed

RESOLUTION APPROVED
Durham City Council Approves Resolution

INDEPENDENT SUSTAINABILITY OFFICES
City and County established independent Sustainability Offices

2020

VOLKSWAGEN SETTLEMENT
VW Settlement – Electrify America

DUKE ENERGY IRP
Duke Energy Integrated Resource Plan (IRP)

DUKE ENERGY EV PILOT
2020 Duke Energy EV Pilot Program

CARBON NEUTRALITY & RENEWABLE ENERGY RFP ISSUED
City Issues Carbon Neutrality & Renewable Energy Request for Proposals RFP

2.1 BENEFITS

There are many direct and indirect benefits that may result from adopting clean energy and carbon neutrality strategies. Some of the benefits to the City of Durham and its residents include more efficient operations, economic development, job creation, reduced energy consumption, and a healthier environment.

- ***Cleaner air***
- ***Improved asset utilization***
- ***Energy equity and affordability***
- ***Community leadership***
- ***Energy security and independence***
- ***Energy savings***
- ***Innovation through smart city development***
- ***Community resilience***

To ensure these benefits are available to all community members, municipalities are increasingly approaching decarbonization and clean energy initiative through an equity lens, integrating economic and environmental justice interests and impacts. The American Council for an Energy Efficient Economy (ACEEE) recently identified four priority opportunities related to an equitable transition to clean energy.[3] They are listed below.

1. Prioritize and pursue equitable approaches to clean energy planning and implementation.
2. Incentivize energy efficiency and renewable energy for low-income homes.
3. Increase low-income access to affordable, reliable, and clean transportation options.
4. Develop an inclusive clean energy workforce.

Other organizations have similar interests to ACEEE and attend to prioritizing social equity along-side sustainable energy initiatives. They include the Environmental Justice Lab at the Duke University Nicholas Institute for Environmental Policy Solutions, the Southeast Energy Insecurity Project, Initiative for Energy Justice, and the Southeastern Energy Efficiency Alliance. Utilization of partnerships are needed to realize the maximum benefits and requires stakeholder involvement at the local level. The City should consider partnering with one or more of these types of organizations to enhance the benefits for all members of the community.

The City of Durham embraces diversity, equity and inclusion as demonstrated by the creation of the Equity and Inclusion Department.[4] This department includes two divisions. The Racial Equity and Inclusion Division examines policies, practices, budget allocations and programs that may perpetuate institutional racism and systemic inequities. The Contract and Compliance Division is responsible for implementation of the City's Equal Business Opportunity Program (EBOP) and Small Local Business Enterprise Program (SLBEP). Further, the City created the Durham Racial Equity Task Force and created the Equitable Community Engagement Blueprint. This Blueprint will expand on existing successes and, provide consistent, meaningful and equitable engagement opportunities.[5]

Image by City of Durham

2.2 SUMMARY OF GOALS

The scope of work for the CNRE Action Plan includes a baseline analysis of the City's current GHG reduction and renewable energy initiatives, identification of strategies and potential actions items, assessment of regulatory and legislative policy, documentation of potential funding sources and implementation recommendations.

The GDS Associates team along with Diane Cherry, Principal Diane Cherry Consulting (Consultant team) worked closely with the City of Durham staff to develop a comprehensive and achievable Plan. The overall approach includes 1) consistent outreach with key stakeholders, 2) assessment of the current situation and baseline analysis, 3) identification of strategies and action items, 4) assessment of policies, 5) examination of financial consideration, and 6) development of the Plan. The Consultant team developed models to evaluate the environmental and economic impacts of strategies and scenarios. In doing so, the team determined an optimal portfolio for the City of Durham to reach its clean energy goals.

The overall goals of the CNRE Action Plan are illustrated in Figure 2-1. The GHG emissions are zero by 2040 and the renewable energy supply is 100% by 2050.

The goals are further illustrated in Table 2-1. The carbon neutrality baseline is the 2009 GHG emissions of 57,699 metric tons of Carbon Dioxide equivalent (MTCO2e). The 2030 goal is 28,850 MTCO2e and the 2040 goal is zero emissions.

The renewable energy baseline is the 2019 percentage of equivalent megawatt hours (eMWh) from a renewable supply of less than five percent. The 2030 goal is 80% renewable energy sourcing and the 2050 goal is 100% renewable energy sourcing for City operations.

FIGURE 2-1 CARBON NEUTRALITY & RENEWABLE ENERGY GOALS

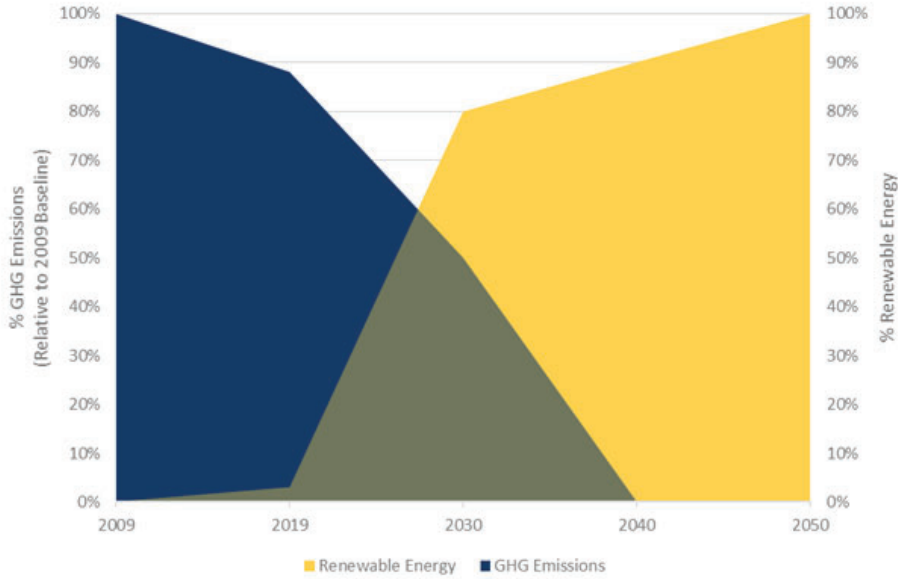


TABLE 2-1 CARBON NEUTRALITY & RENEWABLE ENERGY GOALS

Goal	Description	Baseline Year	Baseline Result	Goal Year	Goal Target
Carbon Neutrality	50% Reduction in GHG Emissions (MTCO2e)	2009	57,699	2030	28,850
	Carbon Neutrality (MTCO2e)	2009	57,699	2040	0
Goal	**Description**	**Baseline Year**	**Baseline Result**	**Goal Year**	**Goal Target**
Renewable Energy	80% Renewable Energy Sourcing (eMWh)	2019	< 5%	2030	80%
	100% Renewable Energy Sourcing (eMWh)	2019	< 5%	2050	100%

2.3 STAKEHOLDER INVOLVEMENT

As this CNRE Action Plan is focused on City operations, the initial stakeholder involvement included City staff and the Durham City-County Environmental Affairs Board (EAB) members. The City staff participants represented multiple departments including General Services, Fleet Management, Water Management, Transportation, Public Works, and Budget and Management Services. These individuals provided the group with extensive knowledge of City operations as well as the needs of residents and businesses in the Durham community.

The City staff was involved in the development of the CNRE Action Plan. These individuals began the process with a project kickoff meeting in July 2020. Following the initial kickoff, the City staff participated in weekly meetings and ongoing communication with various departments and other team members during the year-long project. Over 20 people attended the virtual kick off meeting and participated in a virtual whiteboard session.

The City staff members provided important insights to the process and the current initiatives underway by the City. They participated in a brainstorming exercise to create future headlines or quotes from a cover story which are illustrated in Figure 2-2. Some of the headlines created are listed below.

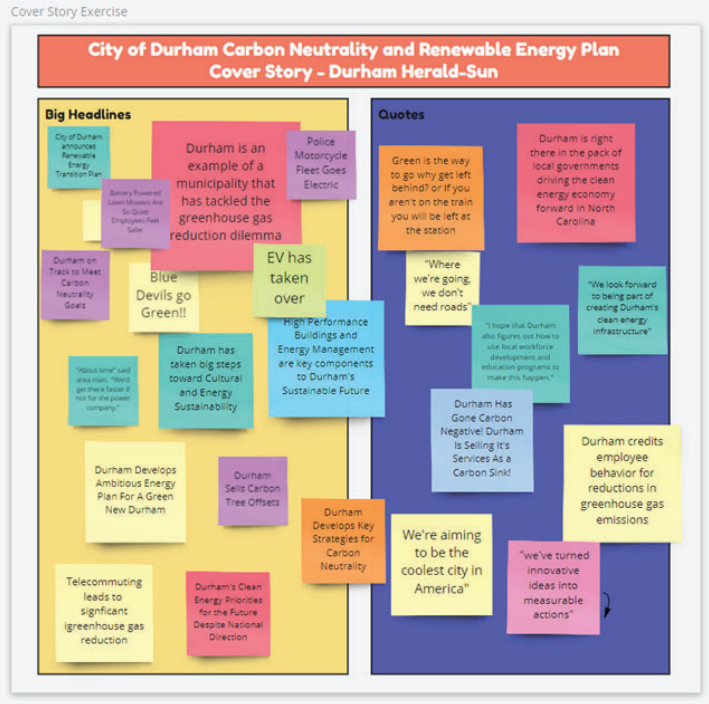
"Durham develops ambitious energy plan for a green new Durham."

"We've turned innovative ideas into measurable actions."

"Durham is right there in the pack of local governments driving the clean energy economy forward in North Carolina."

The EAB participants represented the broader Durham community along with an emphasis on equity and environmental justice for its residents. The City of Durham and Durham County jointly

FIGURE 2-2 VIRTUAL WHITEBOARD



established the EAB in 1991, in recognition of the importance of local cooperation on environmental issues. The EAB is an advisory board of appointed residents to provide the City and County with expert and comprehensive advice on various environmental matters.

The City and Consultant team met with the EAB on a regular basis through the development of the Plan to provide updates to and seek input from its members. As individuals with a broad industry background and expertise, these members were vital in assessing the needs of the community. An electronic survey was sent to EAB members in March 2021 to seek feedback and suggestions regarding the strategies and action items the City should consider. The key themes that emerged from the EAB Survey included justice, standards and investment, job creation, solar + storage, affordable housing, electric vehicles (EV),

> Everything Durham does, moving forward, should keep in mind environmental justice. The disadvantaged and marginalized should always be kept at the forefront of whatever plans are made -- we don't just want a greener future, we want a better future, for everyone.
>
> — *EAB Survey Respondent*

building codes, energy audits, and electric buses. In addition, tree canopy, composting and community gardens were topics cited by several members. Examples of the direct feedback from the survey are listed below. Please see Appendix C for a summary of the survey comments.

"It is critical that the process to transitioning to carbon neutrality is equitable, and that it incorporates and benefits all in Durham."

"Justice, Standards, and Investments is a helpful framework for policy."

"Moving towards more green energy infrastructure is an opportunity to create and support local jobs in the community."

"Renewable energy can be a huge asset, and we should implement it as much as quickly as possible. Every government building should have solar panels installed with storage to create resiliency in our communities."

"Energy efficiency new city buildings and retrofits should go beyond minimums. Building design should be considered as a tool. Energy efficiency should be incentivized for new construction."

"Any new cars or buses purchased by the city should be electric. Every public parking lot should include EV charging posts. Electric bikes and scooters could be brought in for the public to utilize as well as protected bike lanes and trees to shade paths where there could be high bike traffic."

"City buses should all be electric, and no new petrol buses should be purchased. The city should also invest in providing EV charging stations in parking lots around the city, to help enable Durham residents to go electric."

"Affordable housing units should use solar energy and/or be connected to viable geothermal sources for heating and cooling. Every building should strive for solar power, electric heat pump for water, heat pump for space heat, induction cooking appliances (no natural gas), on-site storage like a home battery, and EV charging."

"Investing in community gardens is a low-cost, high-impact, carbon-negative way to address the climate crisis and food deserts simultaneously."

"Reducing waste overall should be a major priority. This could be done, in part, via a composting program which could both reduce huge quantities of methane emissions and save the fiscal and environmental cost of transporting our trash to an entirely different county as we do now."

"A green infrastructure bond on the ballot in the next election would be an ideal way to raise funds for these projects and more."

"This energy potential action plan is very charged with great actions. If realized, Durham will be one of the top green cities and that is the goal!! Thank you for your hard work!!"

Travel_with_me / Shutterstock.com

2.4 STRATEGIES

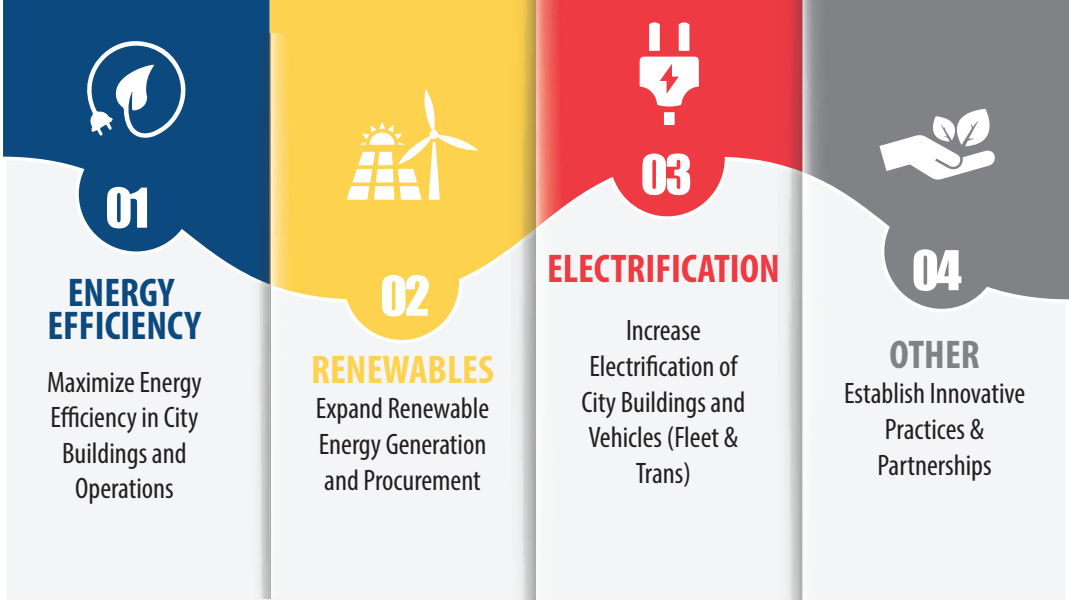
The CNRE Action Plan provides a portfolio of strategies and action items to meet the City's 2019 Resolution goals. The items are actionable at the local level but adaptable to external changes such as regulatory or legislative policy, economic conditions, new and emerging technology, and environmental justice and equity considerations. The Plan has four overarching strategies each having supporting action items.

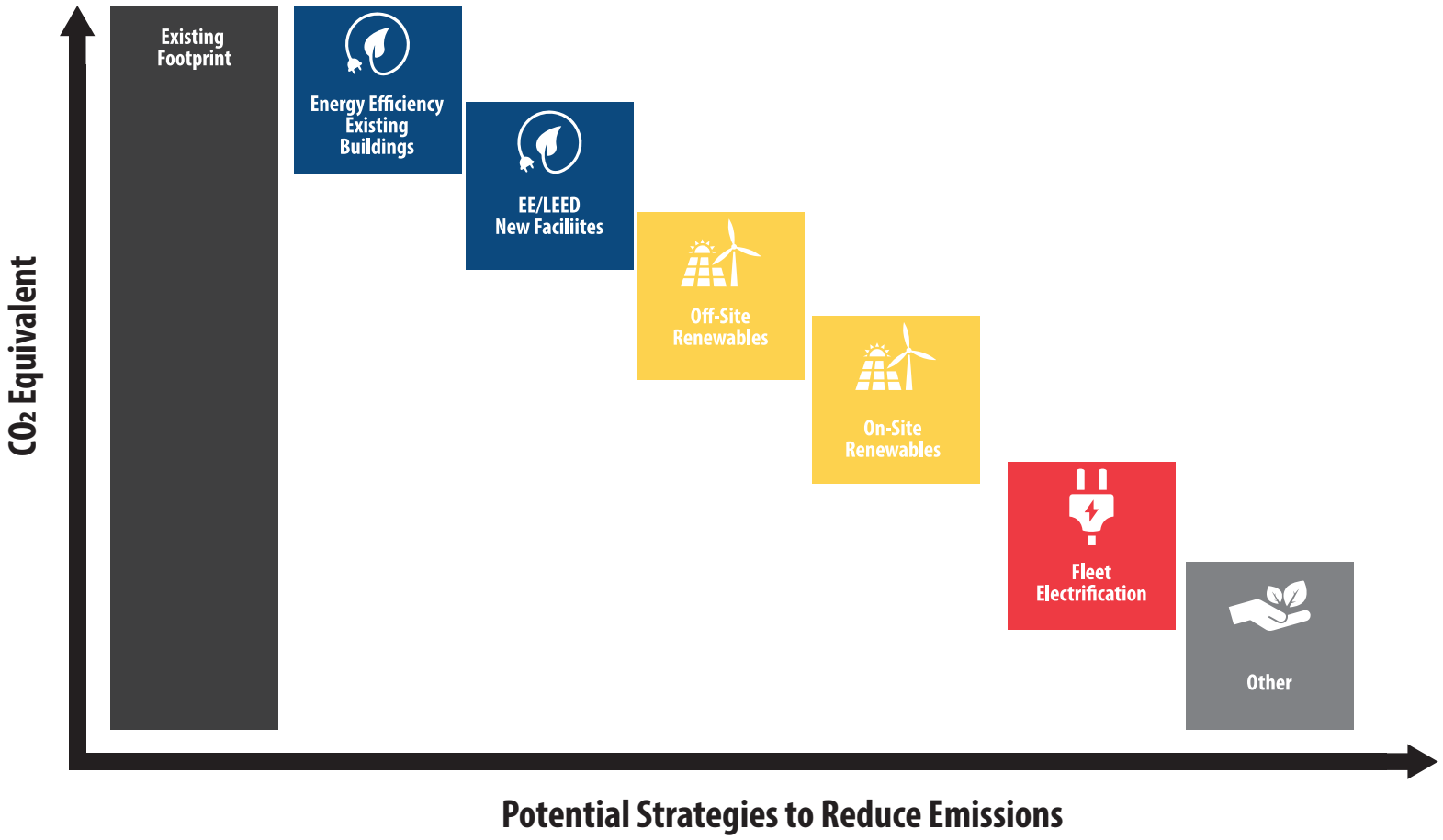
1. Maximize Energy Efficiency in City Buildings and Operations
2. Increase Electrification of Vehicles (Fleet and Transit)
3. Expand Renewable Energy Generation and Procurement
4. Establish Innovative Carbon Reduction Policies and Community Partnerships

The portfolio of strategies works together to achieve the goals of the City of Durham. There is not one single strategy or action item that will accomplish the ambitious goals the City has set forth. In addition, there is not one single entity or department that will implement the CNRE Action Plan. It will require extensive coordination and collaboration from the entire City staff and elected officials as well as the Durham business and residential community. Working together, the City will achieve its goals. In addition, broader cooperation from neighboring municipalities, state government, and utility providers will be a key component to the successful launch and implementation of these action items over a series of years and decades.

This CNRE Action Plan encompasses a 30-year time horizon to achieve both the carbon neutrality and renewable energy goals. The strategies and action items are based on the current regulatory and legislative landscape as well as existing and announced technologies (such as electric light duty trucks). It is imperative that the actions in this Plan are monitored and measured on an annual basis. In addition, as new technology advancements or legislative policies occur, the CNRE Action Plan may need to be modified periodically to reflect any changes and impacts to the City's strategies and action items. An update to the Plan should occur approximately every five years. The annual reviews and periodic updates will help ensure that City operations achieves these important goals.

Image by City of Durham


01
ENERGY EFFICIENCY
Maximize Energy Efficiency in City Buildings and Operations
02
RENEWABLES
Expand Renewable Energy Generation and Procurement
03
ELECTRIFICATION
Increase Electrification of City Buildings and Vehicles (Fleet & Trans)
04
OTHER
Establish Innovative Practices & Partnerships


Existing Footprint
Energy Efficiency Existing Buildings
EE/LEED New Faciliites
Off-Site Renewables
On-Site Renewables
Fleet Electrification
Other
CO2 Equivalent
Potential Strategies to Reduce Emissions

2.5 DURHAM AT A GLANCE 2020

283,506
population

2,400
city employees

$477 M
annual budget

74,000
electricity
MWh per year

1,600
fleet vehicles
**10 electric*

68
parks

1.2
million ft² **of of building space**

16
EV charging stations

21,000
100% LED
streetlights

2
100% LEED
certified buildings

8
electric buses
by the end of 2021

2
solar installations
on City Facilities

26 MGD
water usage

03

PART 1: CARBON NEUTRALITY PLAN

Image by City of Durham

The City of Durham is actively involved in sustainability initiatives with more than 10 years of effort to reduce GHG emissions in City operations. The City is progressing toward attainment of further reductions and 100% carbon neutrality by 2040.

According to the U.S. Environmental Protection Agency (EPA), greenhouse gas are gases that trap heat in the atmosphere and include Carbon Dioxide (CO2), Methane (CH4), Nitrous oxide (N2O) and Fluorinated gases.[6] There are three common sources of GHG emissions as illustrated in Figure 3-1.

Scope 1 GHG emissions are direct emissions from sources that are owned or controlled by the entity. They include on-site fossil fuel combustion and fleet fuel consumption.

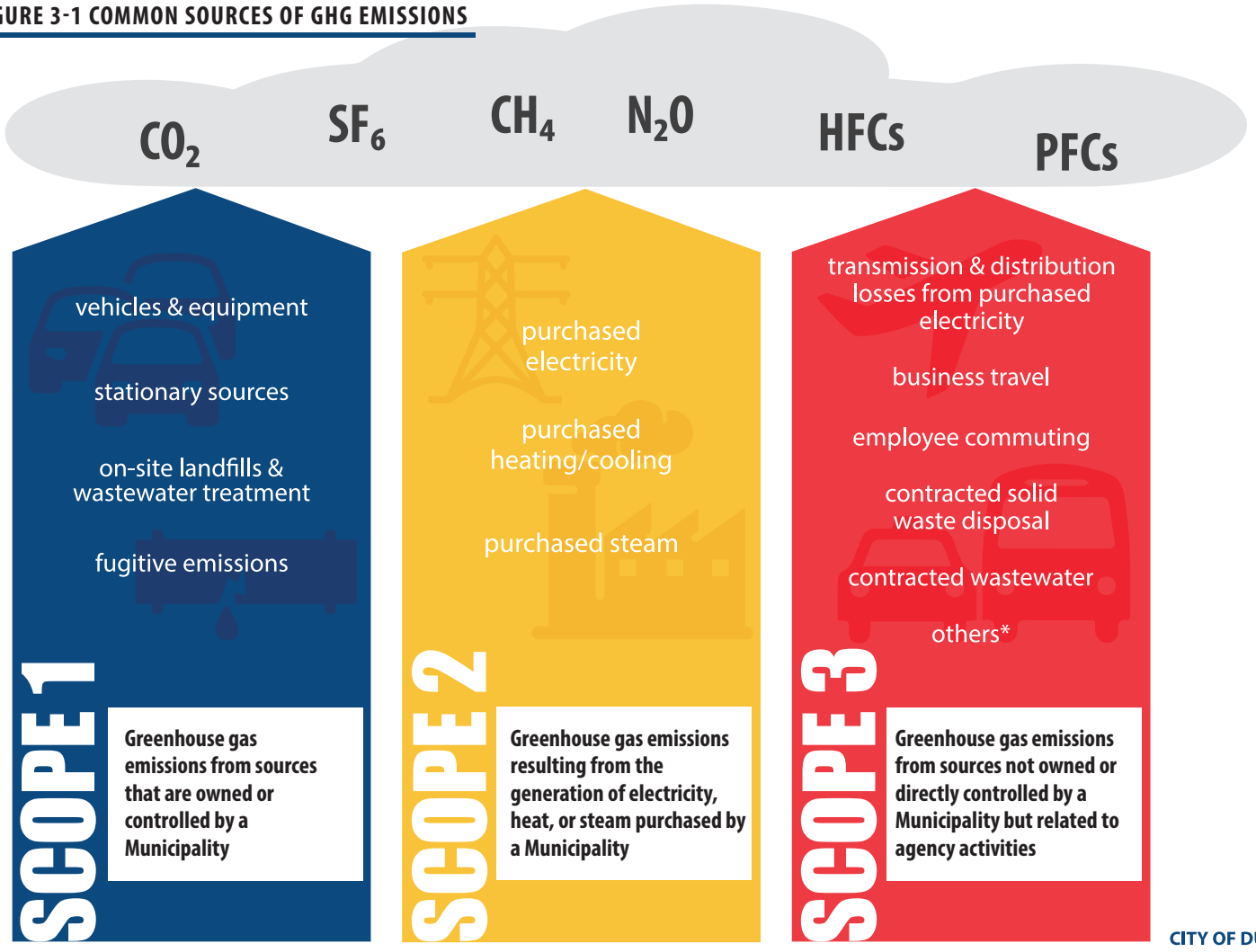
Scope 2 GHG emissions are indirect emissions from sources that are owned or controlled by the entity. They include emissions resulting from generation of electricity, heat or steam purchased by the entity from a utility provider.

Scope 3 GHG emissions are from sources not owned or directly controlled by the entity but are related to entity activities. They include emissions from employee travel or commuting, contracted solid waste disposal, and wastewater treatment, as well as transportation and distribution losses associated with purchased electricity.

CARBON NEUTRALITY

Carbon neutrality involves the balance between emitting carbon into and absorbing carbon from the atmosphere. To achieve net-zero emissions, all GHG emissions will have to be counterbalanced by carbon sequestration, or offset emissions made in one sector by reducing them in another. Carbon neutrality is most often achieved by investment in renewable energy or via energy efficiency efforts.

FIGURE 3-1 COMMON SOURCES OF GHG EMISSIONS



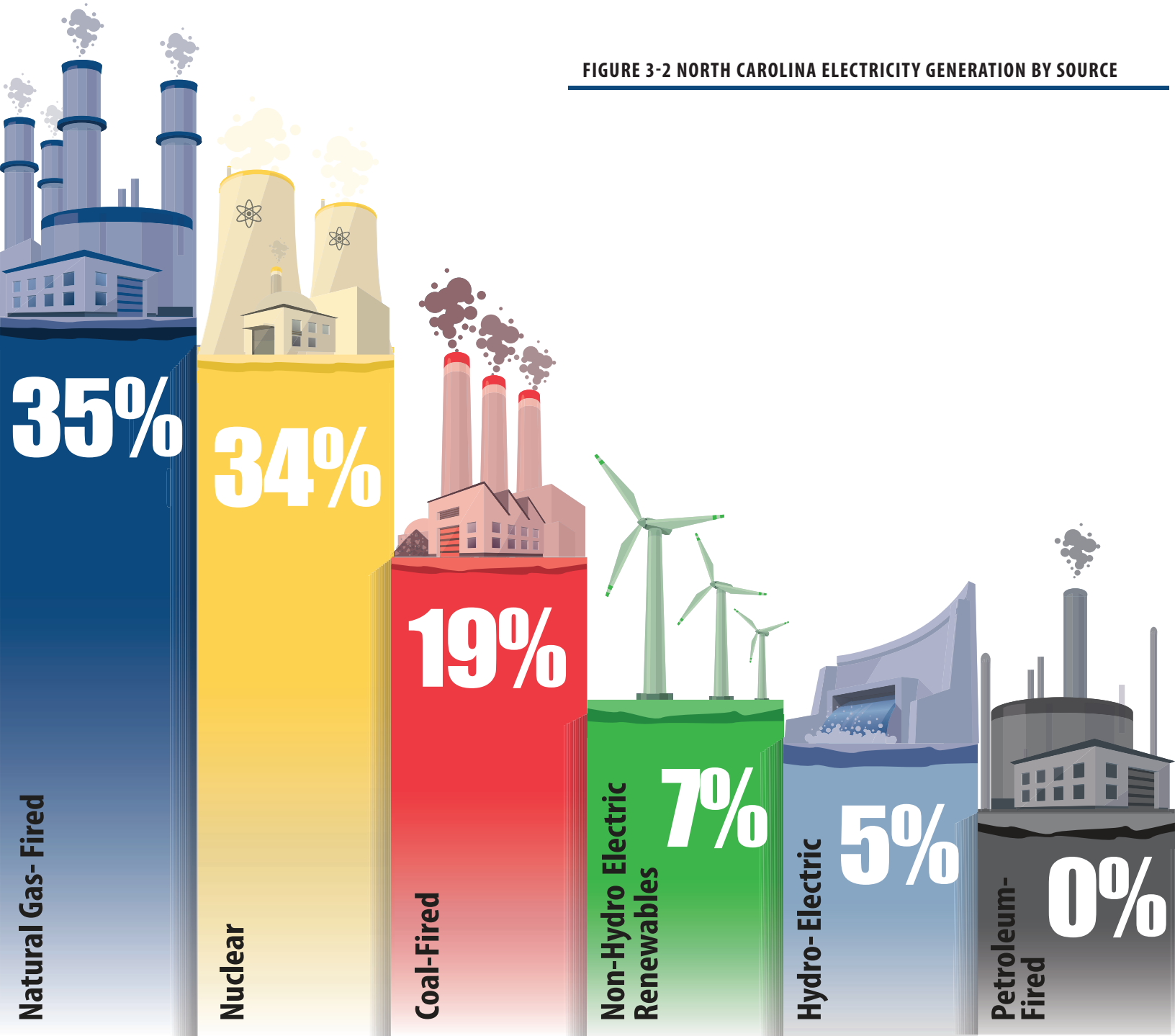
*additional significant Scope 3 emission sources exist beyond the examples provided

North Carolina Energy Market. It is important to understand the current mix and factors that shape the state energy landscape. North Carolina has three investor-owned utilities (IOUs): Duke Energy Progress, Duke Energy Carolinas (or Duke Energy more broadly) and Dominion Energy. North Carolina's publicly owned utilities are 26 rural cooperatives and 72 communities with municipal public power (ElectriCities). Of these providers, Duke Energy has the largest territory in North Carolina.

In 2007, North Carolina established the Renewable Energy and Energy Efficiency Portfolio Standard requiring cooperatives and municipal utilities to have 10% renewable energy supply by 2021 and IOUs to have 12.5% renewable energy supply by 2021. Duke Energy announced that 23% of energy produced by 2030 will be from wind, solar and hydroelectric sources.[7] Duke Energy also announced plans to achieve net-zero carbon emissions by 2050.

According to the U.S. Energy Information Administration (EIA), in 2019 North Carolina ranked second after California in both the amount of total installed solar power generating capacity at nearly 4,700 megawatts (MW) and actual solar generation. The total hydroelectric generation and non-hydroelectric generation represents about 12% of the energy with the remaining 88% coming from natural gas, nuclear and coal-fired generation sources as shown in Figure 3-2 below.[8]

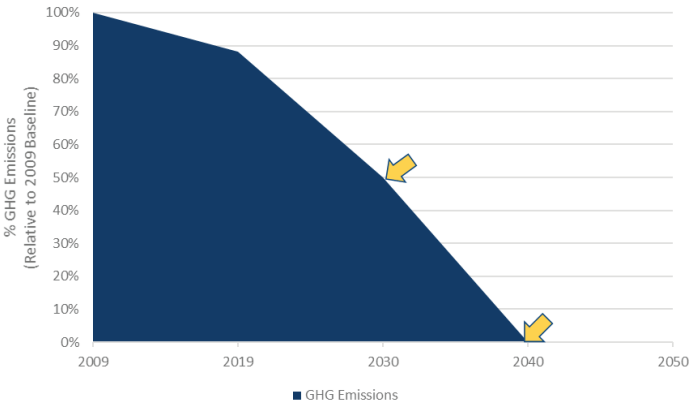
FIGURE 3-2 NORTH CAROLINA ELECTRICITY GENERATION BY SOURCE



3.1 GREENHOUSE GASES (GHG) REDUCTION TARGETS

The City strives to achieve carbon neutrality by 2040 and achieve a 50% reduction in GHG emission by 2030 from the 2009 baseline of 57,699 MTCO2e. The City's GHG reduction goals by percentage are graphically illustrated in Figure 3-3 below. The yellow arrows depict the 2030 goal of 50% reduction of the 2009 baseline and the 2040 goal of 100% carbon neutrality.

FIGURE 3-3 CARBON NEUTRALITY GOAL



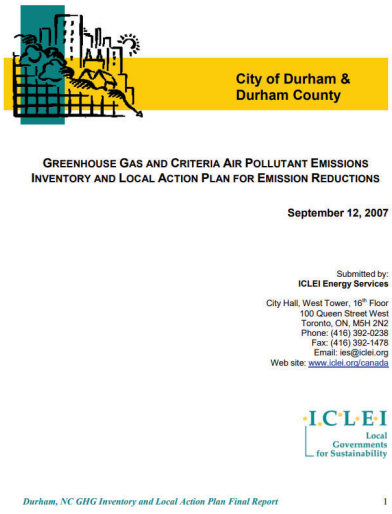
The GHG reduction goals by amount are represented in Table 3-1. The goal target is 28,850 MTCO2e of emissions in 2030 and zero emissions in 2040 compared to the baseline of 57,699 MTCO2e in 2009.

TABLE 3-1 GHG GOALS (MTCO2E)

Goal	Description	Baseline Year	Baseline GHG (MTCO2e)	Goal Year	GHG Goal Target (MTCO2e)
Carbon Neutrality	Achieve 50% Reduction in GHG Emissions	2009	57,699	2030	28,850
	Achieve Carbon Neutrality by 2040	2009	57,699	2040	0

Background/Baseline

Durham is the first community in North Carolina to adopt a greenhouse gas reduction plan. In 2007, the City commissioned a carbon footprint report that detailed major sources of GHG emissions from the City, County, and school district. The *City of Durham and Durham County Greenhouse Gas and Criteria Air Pollutant Emission Inventory and Local Action Plan for Emission Reductions* report describes the sources of emissions and outlines an initial plan to reduce those emissions. This report helps inform the City's subsequent adoption of the targeted goal to reduce local government emissions 50% by 2030.


City of Durham & Durham County

GREENHOUSE GAS AND CRITERIA AIR POLLUTANT EMISSIONS INVENTORY AND LOCAL ACTION PLAN FOR EMISSION REDUCTIONS

September 12, 2007

Submitted by:
ICLEI Energy Services

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ICLEI Local Governments for Sustainability

Durham, NC GHG Inventory and Local Action Plan Final Report 1

The 2007 carbon footprint, a measure of the amount of carbon dioxide emitted by the City, considered GHG emissions arising from energy consumption. The sources of these emissions are electricity generated from fossil fuels, transportation fuel, and natural gas or other combustion fuels used for buildings. The City's carbon footprint analysis did not address land use considerations (such as forestry or the loss of natural areas). Nor did the analysis identify emissions indirectly associated with the City, such as employee commuting energy consumption or supply chain emissions associated with the City's purchases. Therefore, the carbon footprint is focused on Scope 1 emissions (direct emissions from fossil fuel combustion) and Scope 2 emissions (emissions due to purchased energy) not Scope 3 emissions (supply chain emissions).[9] The focus on Scope 1 and Scope 2 emissions reflects the City's ability to directly affect carbon emissions through its energy consumption and source choices.

While the City has direct control over Scope 1 emissions, the City's Scope 2 emissions are affected by the City's consumption of electricity, emissions profile from Duke Energy, and the larger electricity marketplace. Scope 2 emissions, based on the EPA eGRID emissions factors for the SRVC region, reflect the larger power pool in which Duke Energy's North Carolina service territories operate. This region, and Duke Energy specifically, has exhibited a decreasing

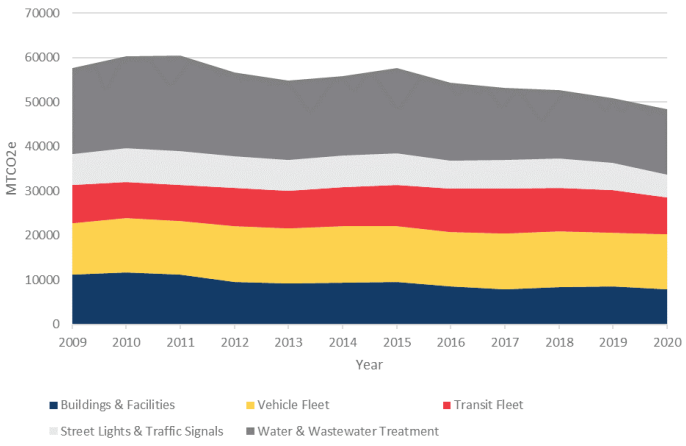
carbon emissions profile over time. As such, the City's carbon footprint related to electricity consumption is affected by Duke Energy's electricity resource decisions. Duke Energy's recent Integrated Resource Plan (IRP) and public statements indicate that Duke Energy will continue to reduce carbon emissions, with a 2030 goal of reducing carbon emissions by at least 50% from its 2005 baseline.[10] Therefore, the City can expect the portion of its carbon footprint associated with electricity to be reduced as Duke Energy reduces its carbon emissions.

The City uses the International Council for Local Environmental Initiatives (ICLEI) ClearPath Software to record and track MTCO2e emissions. The software ensures that GHG emissions accounting is using up to date emissions factors and provides a record back to the City of its ongoing GHG emissions and progress tracking. ClearPath accounts for energy data from major government operations, including:

- Building natural gas and electricity consumption,
- Streetlights and traffic signals electricity consumption,
- Vehicle fleet and transit fleet fuel use, and
- Water and wastewater plant natural gas and electricity consumption.

As part of this CNRE Action Plan, the Consultant team reviewed the data in the ICLEI program to understand the major trends and progress towards reducing the City's GHG emissions. The GHG emissions trends for City operations that are tracked in the ICLEI system are illustrated in Figure 3-4.

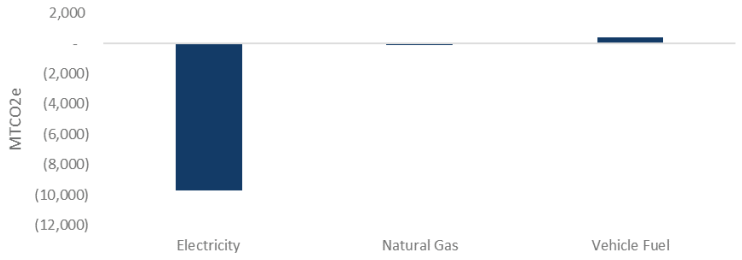
FIGURE 3-4 CARBON NEUTRALITY GOAL



As shown in Figure 3-4, emissions associated with buildings, streetlights, and water and wastewater facilities exhibit the largest decreases in emissions. Review of the underlying data indicates reductions in emissions from these operations are primarily due to Scope 2 electricity emissions reductions. Those emissions reductions reflect the City's efforts at energy efficiency as well as reductions in emissions from Duke Energy and the larger electricity power system.

Figure 3-5 illustrates changes in the City's GHG emissions since 2009 for each of the emissions sources tracked. Emissions from electricity consumption decreased by 29% and natural gas emissions decreased by 3% since 2009. Working against the trend of emissions reduction goals is the consumption of vehicle fuel for the City's vehicle fleet and transit fleet – those emissions have increased by 2%.

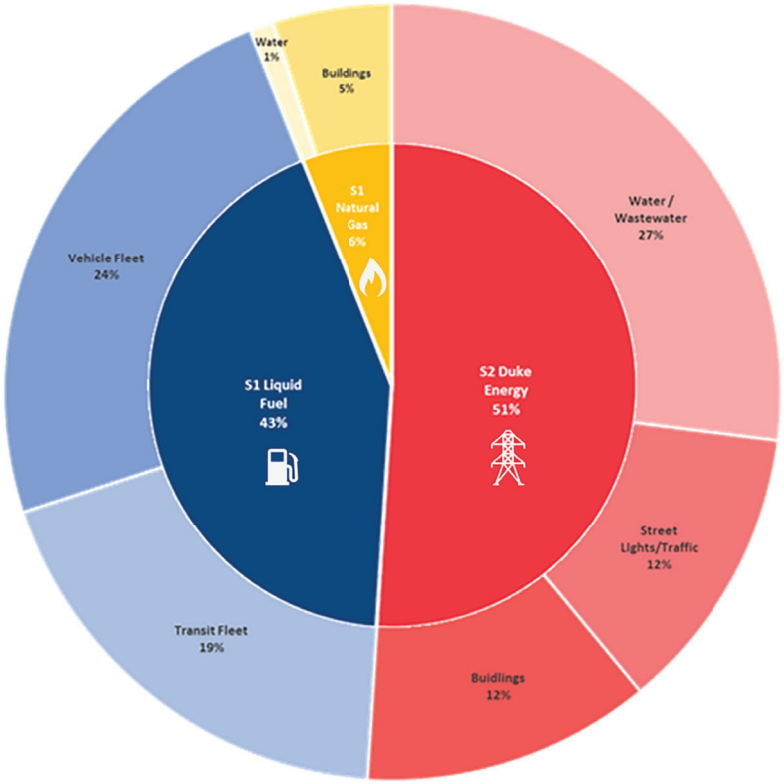
FIGURE 3-5 EMISSIONS CHANGES 2009-2020



The City's 2020 carbon footprint from energy consumption is illustrated in Figure 3-6. Electricity consumption remains the highest contributor to GHG emissions. In 2009, electricity represented 60% of GHG emissions with the smaller share in 2020 reflecting substantial progress toward goals. As electricity's contribution to the City's GHG emissions declines, vehicle fuel now represents a larger share of the remaining GHG emissions. Natural gas consumption's portion of GHG emissions has remained the same from 2009 to 2020, though absolute emissions have decreased.

Scope 1 Emissions. The City's Scope 1 emissions comprise 49% of the carbon footprint – primarily attributed to gasoline and diesel fuel consumption.

FIGURE 3-6 CITY OF DURHAM 2020 CARBON FOOTPRINT



Overall, the vehicle fleet at 24% contributes slightly more than the transit fleet at 19% towards the GHG emissions.

Natural gas is a relatively small contributor to the City's footprint at only 6%, nearly all of that consumption being related to building use for space heating and water heating.

Scope 2 Emissions. The City's Scope 2 emissions are from electricity provided by Duke Energy. The largest electricity consumers are the communities' water and wastewater treatment contributing 27% of the GHG emissions. Streetlights and buildings each contribute approximately 12%.

Strategies to Achieve 2030 Carbon Neutrality Goal

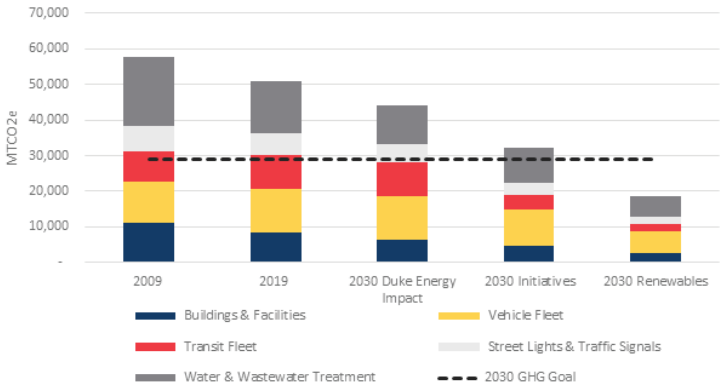
The Consultant team developed and modeled a set of initiatives that the City can undertake to achieve its 2030 goal of reducing GHG emissions by 50% and sourcing 80% of its energy from renewable sources. Aligning with the City's ICLEI ClearPath carbon footprint categories, the initiatives include:

- Continuing ongoing energy efficiency for the City's buildings, facilities, and water and wastewater treatment system;
- Leveraging Duke's expected ongoing emissions reductions by electrifying uses of natural gas within buildings and water system facilities;
- Electrifying a substantial portion of the City's vehicle fleet and transit system vehicles, reducing fossil fuel combustion, and further leveraging Duke's emissions reductions;
- Investing in renewable energy resources to increase the portion of the City's energy consumption from renewable energy;
- Purchasing renewable energy credits (RECs) or expanding renewable energy system investments beyond those currently identified to meet the City's renewable energy goal; and
- Benefiting from Duke Energy's expected ongoing emissions reductions based on its current IRP.

The Consultant team discovered, with the combination of Duke emissions reductions along with

the energy efficiency and electrification initiatives, the City could nearly achieve its GHG emissions goal in 2030. With the addition of several renewable energy projects owned by the City or via purchased energy, the City could well exceed its GHG emissions goal in 2030. Figure 3-7 illustrates the effect of the initiatives, Duke Energy's emissions reductions, and the investment in City-owned or directly purchased renewable energy. The effect of additional RECs or other renewable energy sources was not included but would further lower the 2030 carbon footprint.

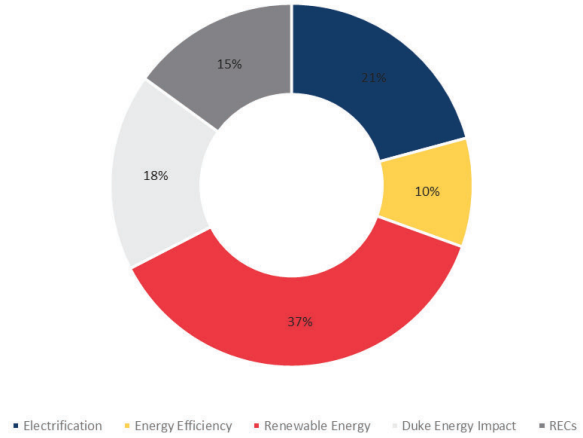
FIGURE 3-7 2030 CARBON NEUTRALITY ACTION ITEMS



The role of electrification (converting fossil fuel energy use to electricity) and energy efficiency is critical to attaining the City's carbon reduction and renewable energy goals. Not only do these solutions provide a combined 30% of the emissions reductions, but they also result in lowering the need for purchasing renewable energy. Energy efficiency directly reduces the volume of renewable energy required for the City, while also being cost effective. Electrification reduces direct fossil fuel emissions in favor of increasingly clean electricity, with a similar effect on reducing the need for renewable energy. The use of electricity, when substituted for fossil fuel combustion, is expected to result in greater thermal efficiency for the City. For example, replacing a natural gas furnace with a more efficient heat pump reduces overall energy consumption and the need for renewable energy purchases. Electrification is most important for the vehicle fleet and transit vehicles, with thermal efficiency gains and the ability to leverage increasingly clean electricity to substitute for difficult to find (and potentially more expensive) renewable forms of liquid fuels. Renewable energy projects and RECs play a large role in reducing GHG emissions. A substantial portion, 37%, is expected to be derived from renewable energy projects from City-owned systems and a large system developed through Duke Energy's Green Source Advantage (GSA) program. These projects aid the City in reaching its GHG emissions reduction goal and its renewable energy goal. However, these projects are not sufficient for the City to achieve its 80% renewable energy sourcing goal, requiring the purchase of RECs. Duke Energy's expected emissions reductions achieve approximately 18% of the overall reductions.

The targeted sectors of GHG emissions reduction are illustrated in Figure 3-8.

FIGURE 3-8 2030 GHG REDUCTION SOURCES



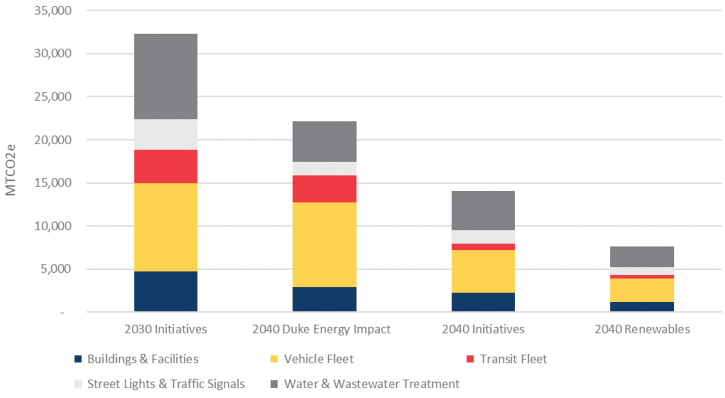
Strategies to Achieve 2040 Carbon Neutrality Goal

With the City having met its 2030 goals for carbon emissions reductions and renewable energy, the initiatives started in 2021-2030 are expected to continue. However, the impact of renewable energy is reduced. As the electricity grid is expected to have

substantially lower emissions in 2040 than today, the effect of renewable energy on offsetting emissions is also lower. Quite simply, a unit of energy from a solar electric system will displace less carbon from the electricity grid. As such, the role of renewable energy drops to 20% of the emissions reductions. Further, the Consultant team estimates the City will be able to nearly meet its 2050 renewable energy goal in 2040, relying on City-owned or purchased renewable electricity as well as the proportion of Duke Energy's electricity supply mix that is renewable. The reduced energy demand due to energy efficiency and electrification help to facilitate that outcome.

The modeling of the 2040 effect of City initiatives from the 2030 carbon footprint is presented in Figure 3-9. The impact of Duke's emission reductions provides a substantial share of GHG emissions reductions, reflecting lower emissions from electrified uses of fossil fuels. The focus of initiatives in 2031-2040 is on reducing vehicle emissions – substituting fossil fuel combustion for electrification, though it is possible additional alternatives will emerge in this timeframe such as green hydrogen.

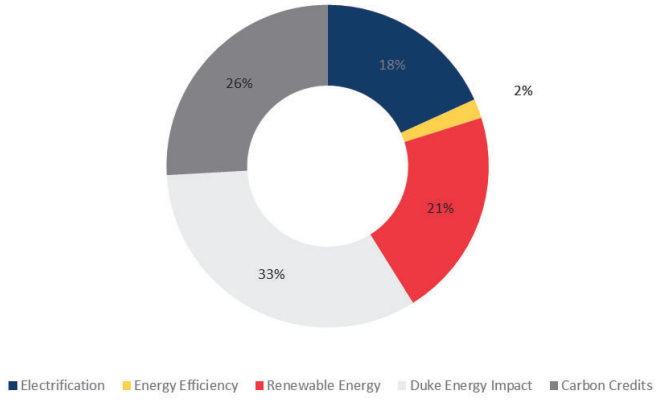
FIGURE 3-9 2040 GHG REDUCTION ACTION ITEMS



As demonstrated by the models, energy efficiency has a lower effect on emissions due to a cleaner electricity grid, though continues to provide cost-effective sources of GHG reductions. In addition to electrifying the fleet and transit vehicles, additional building electrification contributes to reducing the demand for natural gas. However, some vehicles – particularly heavy construction or emergency vehicles – may pose a challenge to electrify. As such, there is a potential need for the City to purchase carbon credits to offset remaining fossil fuel combustion to meet its goal of carbon neutrality in 2040. Should the City be able to electrify or otherwise find substitutes for heavy construction or emergency vehicles before 2040, those carbon credit purchases may be unnecessary. More aggressive efforts to electrify buildings may also yield additional carbon savings. To the degree that renewable natural gas or other options become available, the City may be able to directly purchase them or purchase the carbon offsets that these emerging energy resources can provide.

Figure 3-10 illustrates the source of emissions reduction from 2031-2040. The expected reduction in emissions from Duke Energy contributes about 30% of the reductions, with electrification and energy efficiency contributing a combined 20%. Renewable energy is expected to contribute 20% of the 2040 emissions reductions, with carbon credits required for the balance.

FIGURE 3-10 2040 GHG REDUCTION ACTION ITEMS



5-Year Benchmarks

Yearly benchmarks provide a point of reference to which the impact of the City's initiatives can be compared and assessed. Using 2019 as a baseline, Table 3-2 presents the impact of City initiatives and

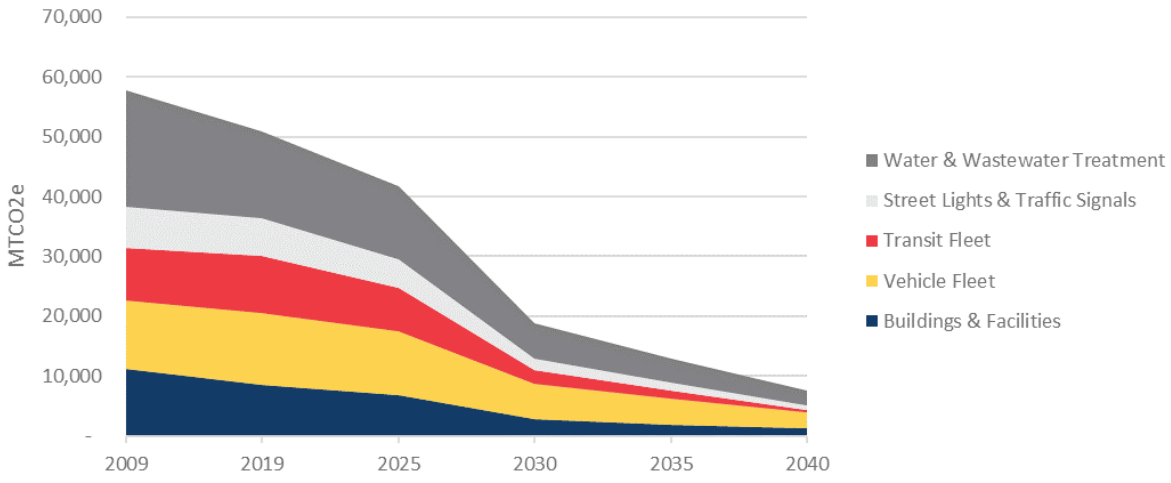
their effect on the City's carbon footprint, inclusive of the expected reduction of Duke's carbon emissions. It does not include the impact of renewable energy. The addition of renewable energy will further reduce the City's carbon footprint, though is not necessarily associated with the source of emissions. Tracking the sources of emissions and steady progress will facilitate the City in deciding whether it is meeting its goals via those initiatives or whether additional carbon credits may be needed. Table 3-2 provides for five-year milestones and progress tracking related to electrification and energy efficiency affecting City buildings and vehicles. The specific metrics correspond to the modeling of GHG reduction initiatives, though the total indicates the aggregate of expected emissions reduction. Assuming the City moves forward with GHG reduction initiatives the specific changes in emissions from various sources may ultimately differ.

In 2030, renewable energy is expected to contribute an additional 20,000 MTCO2e reductions (including RECs). While in 2040, renewable energy owned or purchased by the City is expected to contribute an additional 6,410 MTCO2e in reductions. The balance of GHG emissions would need to be made up of carbon credits or other reductions, totaling approximately 8,000 MTCO2e. The 2009 to 2040 GHG emissions levels including renewable energy are represented in Figure 3-11.

TABLE 3-2 5-YEAR TARGETS FOR PROGRESS TRACKING TOWARD 2030 & 2040 GOALS (MTCO2E)

Source	2019	2025	2030	2035	2040
Buildings & Facilities	8,537	6,650	4,763	3,499	2,235
Scope 1	2,308	1,848	1,389	1,140	892
Scope 2	6,229	4,802	3,374	2,359	1,343
Vehicle Fleet	12,064	11,123	10,182	7,559	4,935
Scope 1	12,064	10,841	9,617	6,916	4,215
Scope 2	0	282	565	643	720
Transit Fleet	9,528	6,729	3,929	2,367	804
Scope 1	9,528	5,974	2,420	1,210	0
Scope 2	0	755	1,509	1,157	804
Streetlights & Traffic Signals (Scope 2)	6,152	4,822	3,491	2,530	1,570
Water & Wastewater Treatment	14,601	12,266	9,932	7,217	4,503
Scope 1	863	677	492	479	466
Scope 2	13,739	11,589	9,440	6,739	4,037
Total Carbon Footprint w/o Renewable Energy	**50,882**	**41,590**	**32,297**	**23,172**	**14,047**

FIGURE 3-11 GHG EMISSIONS INCLUDING RENEWABLE ENERGY



3.2 ENERGY EFFICIENCY STRATEGY

Energy efficiency plays an essential role in accelerating the clean energy transition and achieving decarbonization goals. According to the EIA, buildings account for about 40% of total U.S. energy consumption.[11] For municipalities, buildings often account for approximately 20% of the total energy consumption in the portfolio of assets and are responsible for the corresponding carbon emissions. Fortunately, improving buildings is one of the most proven, cost-effective carbon reduction strategies available.

While significant improvements in building codes, appliance efficiency, and smart controls have contributed to a reduction in building energy use, there is still room for improvement. Numerous energy efficiency measures are available such as high-efficiency heat pumps for heating and cooling, high performance glass for improved insulation, light emitting diodes (LEDs) for efficient indoor and outdoor lighting, solar water heaters, smart thermostats, building retrofits and building management systems (BMS) to reduce energy consumption.

Buildings are not the only facilities that benefit from energy efficiency measures, water and wastewater facilities are also candidates for efficiency improvements. They often account for about 25% or more of the total energy consumption for a municipality. By incorporating energy efficiency practices into water and wastewater plants, cities are able to reduce energy consumption and costs.

Finally, using energy efficient street lighting could reduce energy consumption by as much as 50%. Converting inefficient outdoor lighting to LED is an effective strategy to help achieve decarbonization goals.

The City of Durham is realizing energy savings from the energy efficiency initiatives deployed in buildings, water and wastewater facilities as well as street lighting and traffic controls. Continuation of these efforts contributes to the achievement of the carbon neutrality goal.

Image by City of Durham

Buildings

The City of Durham owns and operates over 1.2 million square feet of building space for City operations. These spaces provide the community with vital services including clean and safe drinking water, transportation through GoDurham, emergency management including fire and police departments, solid waste management, street lighting and traffic control, as well as zoning and inspections. In addition, the City manages wonderful parks and recreation facilities, aquatic centers, athletic fields, recreation centers, parks, trails, lakes, and a golf course for the residents of Durham to enjoy.

CITY BUILDINGS

- Fire Stations
- Office Buildings
- Parks & Recreational Facilities
- Maintenance / Infrastructure
- City Hall
- Police Headquarters
- General Services

Energy Efficiency Baseline

The City of Durham has taken significant steps to understand and reduce its total energy consumption even when confronted with the challenges associated with the COVID pandemic. To understand energy usage and GHG emissions associated with building and facilities, a baseline was established.

In 2019, buildings and facilities accounted for 8,537 MTCO2e representing approximately 17% of the City's total GHG footprint. Table 3-3 presents the buildings and facilities total emissions as well as the 2030 and 2040 targets by Scope 1 and Scope 2 emissions. Nearly 75% of the emissions for buildings and facilities result from electricity purchases. In 2019, the total electricity consumption for buildings was approximately 18,000,000 kWh and natural gas consumption was 430,000 therms.

Overall, energy efficiency action items are targeted to achieve about nine percent of the GHG reductions while providing net lifecycle savings. The value in utilizing energy efficiency measures is that these courses of action are generally considered the first resource in a decarbonization strategy.

Energy Efficiency Initiatives

The City of Durham, in years past, generated energy and cost savings from several energy efficiency projects such as heating, ventilation and air-conditioning (HVAC) replacements, LED lighting retrofits, HVAC controls, and BMS for municipal buildings. In addition, the City was recognized with LEED Certification for two recently completed facilities and is seeking certification for two facilities under construction. These recent initiatives are summarized in Table 3-4 on the following page.

TABLE 3-3 BUILDINGS GHG EMISSIONS (MTCO2E)

Source	2019	2030	2040
Buildings & Facilities (MTCO2e)	8,537	4,763	2,235
Scope 1	2,308	1,389	892
Scope 2	6,229	3,374	1,343

Image by City of Durham

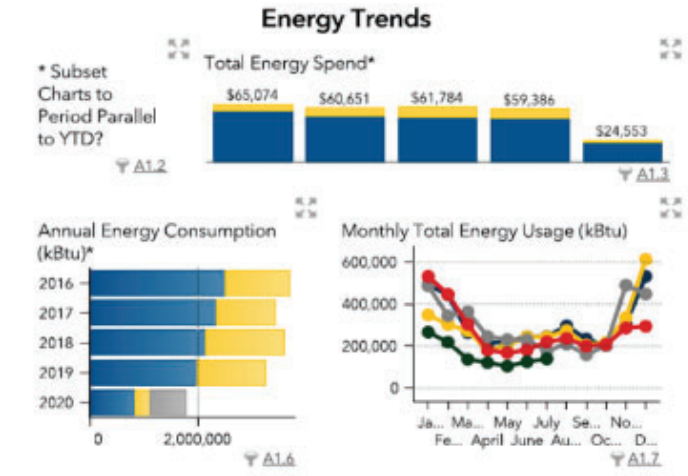
TABLE 3-4 SUMMARY TABLE OF EE INITIATIVES

Year	Facility	Lighting (LED)	HVAC	HVAC Controls	Other	LEED
2018	Edison Johnson Recreation Center	X	X			
2018	Fleet Maintenance Building	X	X			
2018	City Hall/Annex/Fire Station #1	X	X			
2018	Fire Station #2			X		
2018	Morreene Road Recreation Center			X		
2018	Solid Waste Management Building			X		
2018	Fire Station and EMS #17					Gold
2018	Police Headquarters					Silver
2020	Various Facilities*	X				
2020	Fire Stations #3, #4, #6, #13		X			
2020	Fire Stations #5, #9			X		
2020	City Hall, General Services Building, Police Headquarters				BMS**	
Pending	Fire and EMS Station #18					Gold
Pending	Water Management Complex (Mist Lake)					Silver
Pending	Public Works Operations Center				X***	

*NOTE: *Various Facilities*
***BMS – Building Management System*
****Other – Retrofit activities including rooftop solar*

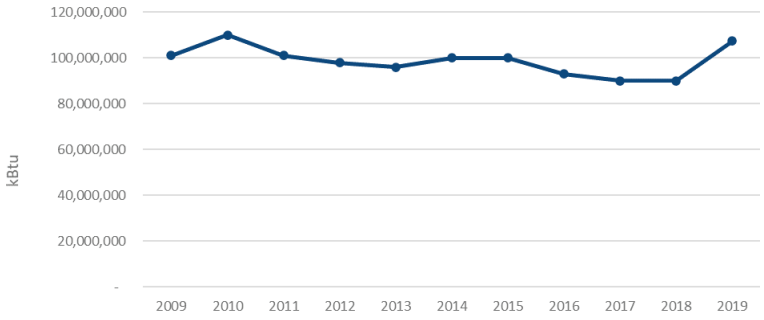
These initiatives including the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) Level 2 audits, Duke Energy/Lime Energy LED retrofit projects, and proactive building management are indicators of the City's momentum towards reducing the municipal buildings' footprint. Currently underway is active BMS monitoring through Building Clarity for the City Hall, General Services, and Police Department buildings. Active tracking of utility energy expenditures, and energy utilization impact are tracked on a monthly basis, providing for the ability to benchmark these facilities against their applicable counterparts throughout the country. An example of the dashboard view of the system for the General Services Building is shown in Figure 3-12.

FIGURE 3-12 DASHBOARD VIEW OF ENERGY TRENDS EXAMPLE



While the dashboard provides useful graphics and data for the General Services Building, the general trend of building energy usage is more useful when looking at a longer term but using the same metrics of kBTU per square foot of space. The results of the aggregated building performance are shown in Figure 3-13, highlighting an 8.5% increase in usage since 2017.

FIGURE 3-13 CITY ENERGY USE (KBTU/YR)



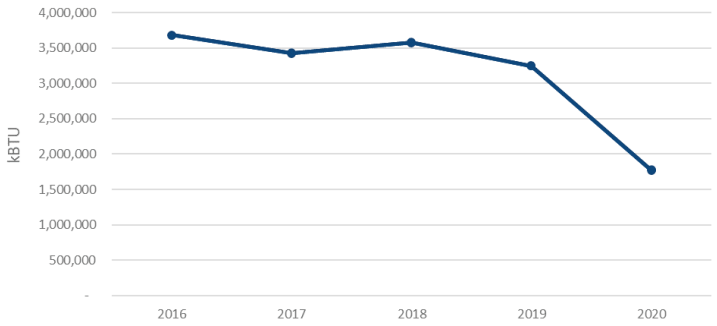
As the City is interested in managing these consumption patterns, select efforts are underway to monitor buildings in real time and increase the total data points that can be used to make energy capital decisions. For example, the City is currently refreshing a 2009 Policy for Sustainable Facilities outlining specific conservation measures for the building operational staff to follow and the subsequent years provided for limited increases in energy consumption as an aggregate, a testament that the staff is key to improving the building performance impact. Other exemplary efforts include the certification of Fire Station #17 as LEED Gold, targeting 56% energy savings over baseline and 40% of energy costs offset by renewables, as well as Fire Station #18 targeting a similar path towards LEED Gold and contribution to the City's goal of carbon neutrality by 2040.

Monitoring & Benchmarking

Durham understands that energy metric tracking is an important component of a successful overall strategy, but only with actionable data. The efforts underway to perform ASHRAE Level 2 audits on the top 25 energy consuming buildings (guided by ASHRAE 211-2018 procedures or Building EQ) are an indicator of aggressive and correct action towards building a complete picture of the building portfolio. The City has also taken progressive steps in order to quantify and qualify the energy consumption in the building stock, particularly through active BMS projects in the General Services building, Police headquarters, and City Hall by way of the Building Clarity SAS system.

Monthly monitoring of building energy has been shown to produce savings and influence performance as human behavior and building operational procedures change. Below, the General Services Building is shown on an annual kBTU basis for the period of 2016-2020. The corresponding Energy Use Intensity (EUI) for the facility was reduced from 88.5 in 2016 to 78.0 in 2019 and is showing about 49.0 in 2020, which is likely due to abnormal operations as a result of the pandemic. The General Services facility under the BMS monitoring system shows that the 2019 energy utilization trended downward while the aggregate had trended upward, supporting the beneficial impact of the monitoring system and recommendation to deploy it through more City facilities. Figure 3-14 shows the trend data in summary from the General Services Building in recent years, notably the downward trend of 2019.

FIGURE 3-14 MONITORED BUILDINGS: GENERAL SERVICES KBTU/YR



Strategies for Energy Efficiency

Numerous strategies and action items for energy efficiency, as represented in Table 3-5, are available to the City of Durham. The primary energy efficiency actions involve continued efforts to reduce energy consumption (electricity and natural gas) in existing facilities such as lighting and HVAC upgrades, additional monitoring and controls, building envelope improvements, and conservation measures. In addition, to these measures, the City should continue to pursue ASHRAE Level 2 audits on the larger energy intensive facilities and complete a Level 1 audit on all other facilities. It is also recommended to expand energy management systems beyond the current three facilities and to benchmark most of the municipal facilities through a tool such as ENERGY STAR Portfolio Manager.

For new construction, the City has begun to build in accordance with LEED Silver and LEED Gold Standards. Building to high performance and green building standards helps to minimize the City's GHG footprint moving forward. In addition, the City should consider solar plus storage, electric vehicle charging infrastructure and 100% electric buildings as the new construction standard.

It is important to note that four large facilities owned but not operated by City were not included in this analysis – the Durham Bulls Athletic Park, Durham Convention Center, Carolina Theater, and Durham Performing Arts Center. The City should collaborate with the operators of these facilities to understand current energy use and identify opportunities for efficiency improvements, electrification options, solar potential, and electric vehicle charging infrastructure.

Select action item projects are discussed in more detail in the following sections.

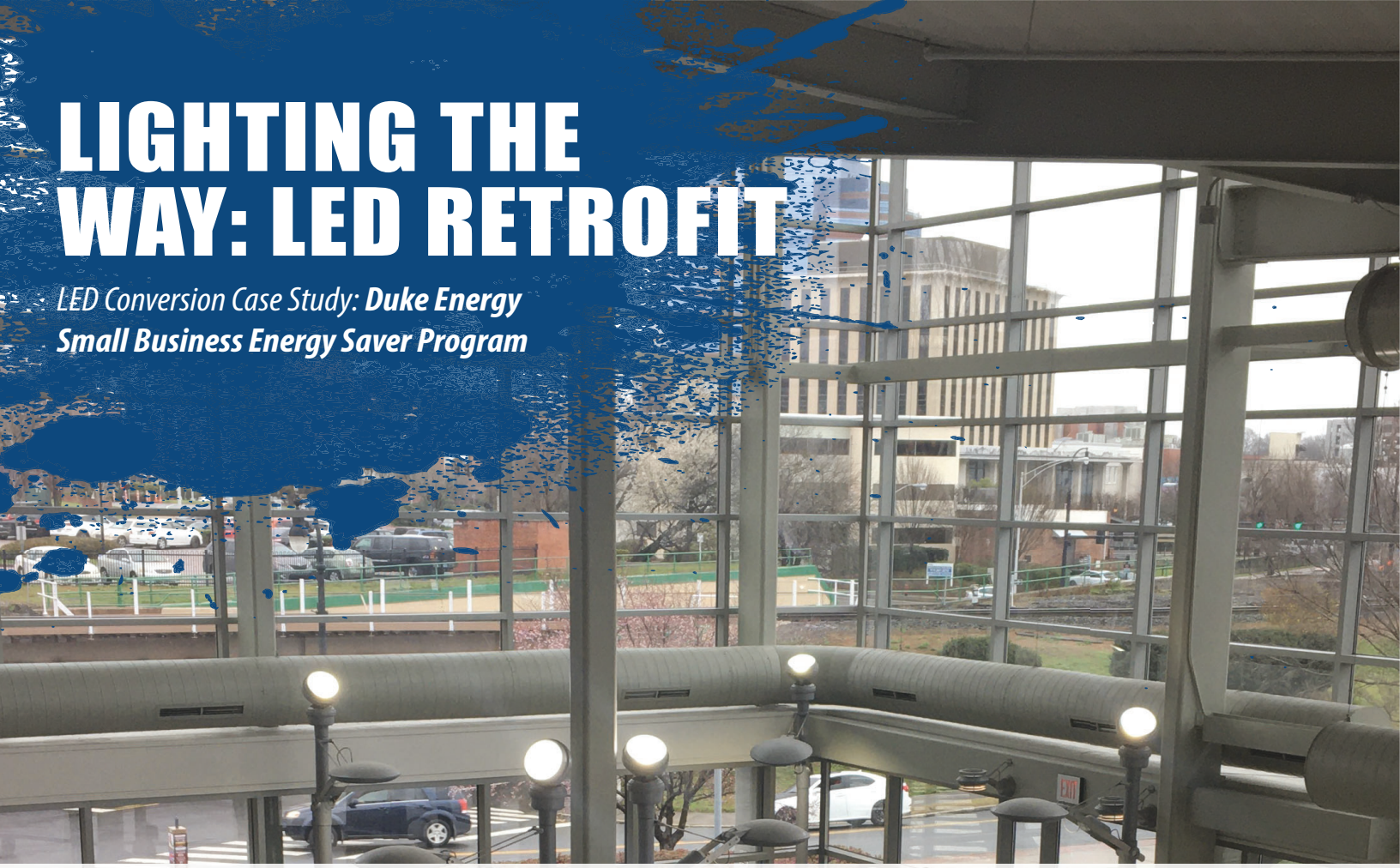
TABLE 3-5 ACTION ITEMS FOR BUILDINGS

Action Item ID	Project	Action Item Description
EE-1	Energy Efficiency	Continue energy efficiency efforts and retrofits in City buildings to achieve at least a 30% reduction in energy consumption by 2040. Leverage Duke Energy program incentives to reduce costs.
EE-2	Energy Audits	Conduct ASHRAE level 2 or 3 energy audits for the City's top 25 energy using buildings to identify savings opportunities and prioritize project plans for each facility. Conduct ASHRAE Level 1 energy audits for all other facilities.
EE-3	Building Energy Management System	Expand building energy management systems (BMS) beyond the current 3 facilities to the City's top 10 energy using buildings.
EE-4	Benchmarking and Data Analytics	Benchmark energy usage for City facilities. Procure a comprehensive data management platform (software or consultancy) consistent with City performance measure/data tracking methodology.
EE-5	High Performance Building Standards	Require new construction and extensive renovation projects on City owned and operated facilities to meet high performance and green building standards such as LEED.
EE-6	Outdoor Lighting	Upgrade existing outdoor pole lighting to high efficiency LED in parking lots, athletic fields, park venues and other public spaces.

Image by City of Durham

LIGHTING THE WAY: LED RETROFIT

LED Conversion Case Study: ***Duke Energy Small Business Energy Saver Program***



Years Active	Projects Completed to Date	Duke Energy Total Incentives	Estimated Annual Energy Savings	Estimated Annual Cost Savings
2016-present	**27**	**$852,567**	**2,617,401 kWh**	**$204,519**

Image by City of Durham

Image by City of Durham

Energy Efficiency Retrofits

Continue energy efficiency efforts and retrofits in City buildings to achieve at least a 30% reduction in energy consumption by 2040. Leverage Duke Energy program incentives to reduce costs.

To develop a complete picture of the Durham building stock and opportunities, the Consultant team engineers requested and received all available building data including historical utility information, square footage, major and minor projects completed inclusive of costs and savings where available, and other project details. A building retrofit and electrification model was developed to analyze the benefits and impacts of changes to the existing building stock over the timeframe of the study.

Given the breadth of building types and functions in the city, four categories were developed to represent the building stock and act as prototypes in the model. For this analysis, the municipal buildings were grouped by primary use cases.

- Fire stations
- Office buildings
- Parks and recreation facilities
- Infrastructure/maintenance facilities

Unique buildings were removed from the building stock as they are outliers due to size or other recent project work that would skew the data used as building characteristic averages. These characteristics were applied back to the actual building stock to produce savings estimates in kilowatt hour (kWh) and therms resulting from building retrofits and electrification projects over the next two decades. The components of the retrofit scenarios modeled include the following:

Standard Energy Efficiency Retrofits

- Efficiency upgrades for equipment that is either at or near the end of life, including HVAC, lighting, cooking equipment and easily accessible building shell components for weatherization upgrades.
- Applicable city facilities typically include smaller properties such as fire stations and infrastructure support facilities, where operation interruption is manageable if short in duration.
- Conventional HVAC and lighting systems with simple controls or schedules.
- Turnkey pricing can range from approximately $20,000 - $100,000 per project and is often eligible for prescriptive incentives from the utilities, assumed to be present in the modeled scenarios.
- Modeled assumptions include savings ranging from $0.41 to $1.76 kWh per square foot and an average cost of $1.86 per square foot.
- Result from ASHRAE Level 1 or Level 2 audits.

Deep Energy Retrofits

- Advanced energy projects that often include the commissioning of new or recommissioning of older HVAC systems, the design and incorporation of advanced controls and monitoring, and a thorough measurement and verification (M&V) process.
- Commonly requires interruption of the facility operation for an extended period of time or scheduling during planned maintenance or shutdown, such as a school in the summer, or major renovation project.
- A design team and charettes are key to successful implementation.
- Pay for performance is more frequent.
- Applicable city facilities can range in size, but often larger campuses or annexed building groups are good candidates.
- Pricing can range anywhere from $25 per square foot - $125 per square foot depending on the scope and measures targeted, expense can be drastically reduced when executed in tandem with a planned major renovation.
- Result from ASHRAE Level 3 audits or major building renovation.

From the analysis of 1.2 million square feet in the consolidated property list, 25% of the space to emergency services (fire, police), 26% to general services, 24% to maintenance and infrastructure

operations like public works and solid waste, 12% belonged to transportation operations, and 13% to parks and recreation.

Energy Audits

Conduct ASHRAE Level 2 or 3 energy audits for the City's top 25 energy using buildings to identify savings opportunities and prioritize project plans for each facility. Conduct ASHRAE Level 1 energy audits for all other facilities.

The City has demonstrated the momentum necessary to expand the existing building auditing efforts. The data collected from building audits quantifies the benefits. ASHRAE level audits provide in-depth assessments of all possible energy, water, and sustainability upgrades. The Level 2 audits include a more detailed explanation of energy use within the existing or designed facility than Level 1, along with the savings and associated costs for all suggested modifications. Based on the data, it is suggested that the City should look at the following components for the 25 highest energy users on a kBTU per square foot basis.

HVAC Systems

- Evaluate current HVAC systems to determine age, capacity, and operational efficiency of:
  - *Central fan systems and packaged fan systems*
  - *Boilers, chillers, motors, and variable frequency drives*
  - *Heating and cooling distribution systems*
  - *Controls, ventilation, HRV or ERV opportunities*
- Observe and record the condition of the existing HVAC equipment, components, and control systems.
- Review current temperature set-back schedules and analyze effectiveness.
- Measure efficiency (flue gas analysis, stack temperature, etc.) of boilers, if appropriate.

Building Envelope

- Site review for vegetation shading, heat/loss gain potential.
- Evaluate doors, windows, ceiling/roofs, and other openings for energy loss potential.
- Evaluate insulation in all areas of the building in plans and through visual inspection.
- Complete evaluation of building shell to advise on insulation and air infiltration.

Lighting Systems

- Evaluate current lighting systems, levels, and controls in all areas of the building.
- Connect data logging equipment for short term operational profiles, if necessary.

Plumbing Systems

- Evaluate existing on-site water treatment and pumping systems.
- Evaluate existing domestic water heating and hot water distribution system.
- Evaluate existing plumbing fixtures (faucets, toilets, janitor's closets, etc.).
- Review site vegetation for water demands and estimate usage.

Special Systems

- Unique systems that may be operating in facilities can many times consume large amounts of energy.
  - *Computers, elevators, medical devices, pool pumps*
  - *Greenhouses*
  - *On-site energy production*

Building Management Systems

Expand building energy management systems (BMS) beyond the current 3 facilities to the City's top 10 energy using buildings.

The concurrent efforts underway in the Durham building space show the benefit and the need for more data from the entire building stock. Going forward, a comprehensive effort to deploy energy and

utility data monitoring at all city buildings should be a focus of the next decade. Shown in the examples of both the General Services building and the North Durham Water Reclamation Facility, positive trends in energy reduction have multiple effects on the City outside of the energy impact, bringing recognition to conservation efforts and usable data for capital project planning.

Energy Benchmarking & Data Analytics

Benchmark energy usage for City facilities. Procure a comprehensive data management platform (software or consultancy) consistent with City performance measure/data tracking methodology.

From an initial view of the baseline performance and activity to date, it is likely that the performance of many of the City's buildings can be improved given more visibility through monitoring and a dedicated staff position such as an energy manager. This position would also be the responsible party for entering and maintaining the City's building data in EPA's ENERGY STAR Portfolio Manager.[12] Further, the energy manager would monitor and apply for involvement in Duke Energy's Demand Side Management (DSM) programs,[13] including EnergySaver, to continue the current efforts with the utility. This is an important effort that affects many of the other actionable concepts in the overall strategy for buildings.

The ENERGY STAR Score is a measure of how well a property is performing relative to similar properties, when normalized for climate and operational characteristics. The 1-100 scale is set so that 1 represents the worst performing buildings and 100 represents the best performing buildings. For example, if an office building produces a score of 72, this means the building is performing in the 72nd percentile. It is performing above the national median. The buildings in Durham may easily be entered in the ENERGY STAR Portfolio Manager system, providing insights to City facilities. Again, it is anticipated that the energy manager would be responsible for using the platform, analyzing results, and developing plans to improve lower performing buildings.

Duke Energy offers a variety of rate options, rebates, and incentives. The City should continue to monitor available rate options and leverage all demand side management or demand response programs that are applicable to Durham's operations.

High Performance/Green Building Standards

Require new construction and extensive renovation projects on City-owned and operated facilities to meet high performance and green building standards such as Leadership in Energy and Environmental Design (LEED).

The City is currently drafting a new policy for sustainable new construction which is critical to continuing the path to carbon neutrality. In late 2009, the City adopted a positive path towards carbon neutrality when considering new construction or major renovation projects by implementing the Policy for Sustainable Facilities, utilizing sustainable design programs such as the LEED rating system. This forward-thinking approach developed the groundwork protocols for major construction and the City should be able to continue adherence to the design standards of these programs as they evolve. For example, the Policy for Sustainable Facilities contains multiple key elements that are detailed with regard to new construction planning for City facilities, linking the details of the standards to the broad categories of the Green Design Standards, Net Zero facility frameworks, and LEED guidelines. While the intention of the protocol document is to cover existing and new facilities, the procedures do favor new construction and major renovation projects because of the emphasis on design phase standards including:

1. Sustainable design elements should be incorporated into each project concentrating on those which provide value and cost savings. LEED certification will be considered for all projects over 20,000 square feet and others on a case-by-case basis. While LEED certification will not be a requirement for all projects, certification will be pursued for selected projects where certification can be obtained for minimum additional cost. Since 2004, renewable energy, particularly solar photovoltaic electric energy production, has become more efficient and affordable. In view of this, renewable energy strategies shall be evaluated in the early design phase of all relevant projects.
2. For projects over 20,000 square feet the City will require a sustainable design review meeting to evaluate the potential for sustainable design strategies based on the current LEED scorecard as well as the scope of the project. If during this meeting, LEED certification is found to have minimum cost impact on the project, certification may be pursued.
3. All new public buildings and all renovations of public buildings involving upgrades or replacements of at least one major system (HVAC, lighting, and plumbing) will conform to the 2018 International Green Construction Code (ASHRAE 189.1).

The strategy for new construction should include a continuation of the efforts already defined by City leadership, with incorporation of the energy manager and other departmental representatives attending the sustainable design review meetings. With the limited data available for planned new construction projects, a conservative estimate of 15 new buildings before 2040 is appropriate. Using the New Building Institute's estimate that LEED certified buildings save on average about 25-30% of the energy of their conventional counterparts, this equates to a cumulative energy savings of about 818,000 kWh using our modeled average Durham office building energy usage for 2019.[14]

The U.S. Green Building Council LEED is the most widely used green building rating system in the world.[15] LEED provides a framework for healthy, highly efficient and cost saving green buildings. LEED Certification is recognized as a symbol of sustainability achievement and leadership. The LEED v4 scorecard for new construction and major renovation includes the following eight categories:

LEED V4 SCORECARD FOR NEW CONSTRUCTION & MAJOR RENOVATION

1 Location & Transportation
2 Sustainable Sites
3 Water Efficiency
4 Energy & Atmosphere
5 Materials & Resources
6 Indoor Environmental Quality
7 Innovation
8 Regional Priority

Fire Station No. 18 Seeking LEED Gold

Image by City of Durham

Image by City of Durham

Water Management Mist Lake Facility Seeking LEED Silver ***will save 1.1 million gallons of potable water annually***

Upcoming new facilities for the City of Durham include Fire Station and EMS #18 seeking LEED Gold and the Water Management Mist Lake Facility seeking LEED Silver. The new Mist Lake water management facility is designed to be LEED Silver and incorporates numerous high efficiency and sustainable building elements including a geothermal system for heating and cooling. The Mist Lake geothermal heating/cooling system will save 1.1 million gallons of potable water annually.

Image by City of Durham

FIRE STATION NO. 17

"LEEDING" the way with high performance, sustainable buildings

"LEEDING" the way with high performance, sustainable buildings.

The City of Durham has built its ***first LEED Gold project, Fire and EMS Station 17. LEED*** (Leadership in Energy and Environmental Design) is a certification system for green buildings developed by the US Green Building Council.

The Fire and EMS Station features rooftop solar panels, an electric vehicle charging station, and water efficient landscaping.

LEED certification helps identify ways to reduce the impacts associated with constructing and operating buildings, from the utilization of local and sustainable building materials, to thoughtful design that enables natural lighting, to energy and water efficient appliances and processes.

In addition, the City's new Police Headquarters achieved LEED Silver. The sustainable elements of the Police Headquarters include sustainably harvested wood, a high efficiency HVAC system using air-cooled chillers, and thermal insulated glazing to mitigate thermal loss.

The City is committed to continue to construct new facilities with LEED certification design component. Upcoming LEED projects include Fire Station 18 seeking LEED Gold and Water Management Complex seeking LEED Silver.

Image by City of Durham

Image by City of Durham

Water & Wastewater

The City's Department of Water Management operates two water treatment facilities – the Williams and Brown Water Treatment Plants which provide clean, safe drinking water to the Durham community, including most of Durham county. On average, residents and businesses use approximately 27 million gallons of water per day (MGD). The department's Water Efficiency and Conservation Program has received 5 consecutive WaterSense Excellence Awards from EPA (most recently for 2020) recognizing their efforts to educate and assist residents on water saving strategies.

The City also operates two Water Reclamation Facilities which serve the both the City and a portion of Durham County. The North and South Durham Water Reclamation Facilities (WRFs) discharge approximately 20 MGD (combined) of high quality effluent into the Neuse and Cape Fear river basins and maintain compliance with NDPES permit requirements.

Baseline

It takes a significant amount of energy to process and clean water. The water and wastewater treatment facilities account for nearly 30% of the City's current GHG emissions. Nearly 95% of the emissions are Scope 2 resulting from the purchase of electricity from Duke Energy. The remaining 5% of the emissions are Scope 1 resulting from natural gas consumption at the facilities. The 2019 energy use for water and wastewater treatment was approximately 40,500,000 kWhs and 162,000 therms. Table 3-6 represents GHG current and projected emissions.

TABLE 3-6 WATER MANAGEMENT GHG EMISSIONS (MTCO2E)

Source	2019	2030	2040
Water & Wastewater Treatment	14,601	9,932	4,503
Scope 1	863	492	466
Scope 2	13,739	9,440	4,037

Durham's water and wastewater treatment facilities account for a substantial impact on the carbon footprint of the City, but also represent some of the most progressive efforts of any department. Utility bill summaries and master plan documents were analyzed for the North and South Durham Water Reclamation Facilities, as well as the Brown and Williams Water Treatment plants. Operational improvements in recent years resulting from these plans have further advanced the carbon reduction effort, and the initial data suggests that efforts in aeration modification, solar, and building operational practices will be fruitful efforts of the City.

In addition to LEED certification efforts on some of the facilities, including a geothermal system at the headquarters building and ongoing methane/biogas capture (further described in the Renewable Energy section), the City has instituted water conservation programs at the end user level that have shown to be effective as the average daily consumption per capita has fallen from 53.7 gallons in 2009 to 48.0 gallons in 2019.

Further, the operational personnel of the treatment facilities are actively involved in energy and peak reduction techniques, as evident by the trend in reduced energy consumption. This type of unified conservation focus has proven to be effective in the energy performance of the NDWRF and is replicable amongst the remaining facilities. To support this, Figure 3-15 is a graphical representation of this reduction in energy at the North Durham Water Reclamation Facility from 2015 to 2019.

FIGURE 3-15 NDWRF ANNUAL KWH

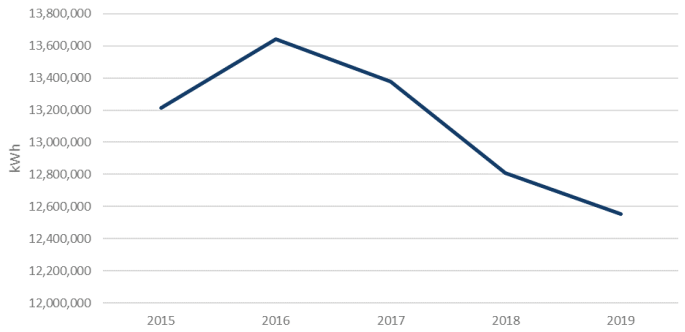


Image by CCL STUDIO/Shutterstock

Strategies

As water and wastewater operations have intricate requirements and commonly require in-depth study to provide defensible energy reduction calculations, the Consultant team reviewed these efforts at a high level and discovered the impact towards carbon neutrality to be significant. Primary recommendations are described in Table 3-7.

TABLE 3-7 ACTION ITEMS FOR WATER/WASTEWATER

Action Item	Project	Action
EE-7	Energy Efficiency	Continue energy efficiency efforts at water and wastewater facilities such as controls, equipment, and operational modifications. Consider machine learning/AI pilot.
RE-13	Renewable Energy NDWRF CHP Project	Install Combined Heat and Power (CHP) system at NDWRF. Update project conceptual analysis from previous report and solicit proposals from design/build firms.

Energy Efficiency Initiatives

Continue energy efficiency efforts at water and wastewater facilities such as controls, equipment, and operational modifications. Consider a machine learning/AI pilot.

Continued efforts to further reduce energy consumption were implemented in 2020 with a modification of the NDWRF aeration system's bubble diffusers and various projects designed to reduce system air leakage. The expectation is that these projects will provide substantial energy savings to the facility. A subsequent effort to modify two digesters is planned for 2021 to improve operations, and other facility lighting and motors are replaced with efficient versions on an ongoing basis. A reasonable estimate for the NDWRF annual energy reduction potential going forward to 2025, based on historical performance and proactive efforts to address consumption, is approximately 150,000 kWh per year.

An additional recommendation for the operation of all plants would be to implement a deep machine learning software tool or program that can proactively utilize SCADA data from all plant assets to advise the operators on the most cost-effective and energy-effective equipment schedule or pumping strategy. This type of product uses day ahead utility pricing based on system constraints, historical weather data, and equipment performance information to suggest a single operating schedule. While the actual savings estimates from vendors range up to 18% of annual operating energy, a more

conservative 2.5%-5.0% energy usage savings should be used and the capability to shift only 20% of peak demands to off peak energy times. One product example that the team has explored as viable and for reference only is called Pluto AI, or Plutoshift.[16]

This type of system is heavily dependent on a unified peak demand reduction effort and a holistic approach that includes commitment from all plants. A concurrent effort to reintroduce the facility assets into the Duke Energy Profiler program could either accompany this type of effort or prove beneficial on its own.

FIGURE 3-16 EXAMPLE AI PLATFORM

Image by Plutoshift

3.2.2.2.2 Combined Heat & Power (CHP)

Install Combined Heat and Power (CHP) system at NDWRF. Update project conceptual analysis from previous report and solicit proposals from design/build firms.

One of the most viable candidate projects for carbon reduction, the concept of using excess biogas at the NDWRF for a Combined Heat and Power (CHP) project, has been analyzed by the City previously. While the current quantity of excess biogas was not readily available for this study, it is likely that the amount available would be suitable for at least one CHP application, possibly as engine driven power for smaller aeration blowers and facility or digester heat. According to the EPA, for every million gallons of wastewater processed, the potential exists for approximately 26 kW of power born from digester biogas, along with 2.4 MMBtu per day of usable thermal energy.[17]

In 2011, the City of Durham analyzed the potential for a CHP installation at the NDWRF and found that there is viable potential for a CHP system that would operate continuously at 350 kW, on average, producing power as well as heat for the digester thermal process requirements. Further biogas quantification and an update to the 2011 analysis are recommended to confirm the current CHP potential at the NDWRF, but at a theoretical level, this system could produce approximately 3,000,000 kWh of energy annually, ignoring efficiency and loading losses. The system would also reduce the corresponding atmospheric impact (GHG) of both flaring the excess biogas and producing the same amount of power through conventional means and purchased through Duke Energy. It was estimated that the capital cost of the CHP system would be approximately $1.4 million in 2011, with roughly $30,000 per year in operations and maintenance (O&M) costs. Table 3-8 represents a theoretical scenario of power and heat production costs and benefits (held constant) at the 5-year milestones, assuming a 2022 installation.

TABLE 3-8 NDWRF CHP SCENARIO

Waukesha H36GL *(564kW nameplate)*	2022	2025	2030	2035	2040
kWh Generated	3,066,000	3,066,000	3,066,000	3,066,000	3,066,000
Value of kWh Sold	$195,000	$195,000	$195,000	$195,000	$195,000
Capital and O&M Cost	$280,000	$310,000	$30,000	$30,000	$30,000
Heating benefit (facility and digester heat)	$4,563	$4,563	$4,563	$4,563	$4,563
Net Cost or Savings (in dollars)	**$(80,438)**	**$(110,438)**	**$169,563**	**$169,563**	**$169,563**

Streetlights & Traffic Signals

The Transportation Department administers the City of Durham streetlight program. Streetlighting is provided for public City and state-maintained streets within the City limits. The City has initiatives underway to upgrade and expand the traffic signal system. Initiatives include the replacement of existing communications with new fiber optic cable, enlargement of the system with installation of new fiber optic cables, and expansion of closed-circuit television by adding new cameras.

In addition, many municipalities are exploring the applications for smart controls such as traffic and pedestrian monitoring, air quality monitoring, emergency management services, Wi-Fi access, electric vehicle charging and more. These are measures the City of Durham may wish to consider in the future.

Baseline

The City's streetlights and traffic signals currently account for approximately 10% of the City's annual GHG emissions. The GHG emissions are represented in Table 3-9. This is comprised of Scope 2 emissions based on electricity purchased from Duke Energy. Due to the Duke Energy rate structure, streetlights contribute nearly 25% of the cost of the City's energy while accounting for only about 10% of the energy consumed. In 2019, the energy usage for streetlights and traffic signals was approximately 18,000,000 kWhs.

TABLE 3-9 STREETLIGHT AND TRAFFIC SIGNAL GHG EMISSIONS (MTCO2E)

Source	2019	2030	2040
Streetlights & Traffic Signals (Scope 2)	6,152	3,491	1,570

The City of Durham streetlights are owned, operated, and maintained by Duke Energy. The City has approximately 21,000 streetlights which have recently been converted from high pressure sodium to LED. The City has aggressively converted inefficient streetlights and traffic lights to LEDs which may be up to 75% more efficient than traditional lighting. Some of the expected benefits of the LED conversion include projected energy savings of 6.2 million kWh per year and a reduction of 4.4 MTCO2e emissions. LED lights also offer enhanced safety and visibility with less light pollution.

The City has also installed a computerized traffic signal system for 387 signals which allow for future communication to autonomous cars for test and research.

Strategies

The City has completed the implementation of much of the energy savings and GHG reduction available through existing technology. The City should continue to convert all other street/outdoor lighting to LED, monitor new technology and leverage the existing system for Smart City applications such as traffic/pedestrian monitoring, pole-based EV charging, and environmental sensors. The streetlight conversion to LED contributes about 6% of the overall GHG reduction potential. Table 3-10 represents the strategies for streetlights.

Image by City of Durham

Image by City of Durham

TABLE 3-10 ACTION ITEMS FOR STREETLIGHTS

Action Item	Project	Description
EE-8	Expand Conversion to LED Lighting	Continue to expand conversion of LED lighting to other City facilities and locations.
EE-9	Explore Smart City Technology Applications	Explore Smart City applications such as traffic/pedestrian monitoring, pole-based EV charging, and environmental sensors.

Expand Conversion to LED Lighting

Continue to expand conversion of LED lighting to other City facilities and locations.

The City should continue to expand conversion to LED lighting to parks and other non-street outdoor lighting for additional energy savings and GHG emission reductions. This may include athletic fields, recreation centers, other City facilities, and new construction. In addition, the City should continue to monitor new technology including solar powered streetlights for future applications.

Explore Smart Cities Technology Applications

Explore Smart City applications such as traffic/pedestrian monitoring, pole-based EV charging, and environmental sensors.

Further, the City should expand existing smart city efforts beyond Information Technology resiliency to include some of the successful technology deployments found in other cities. Installation of networking and controls simultaneously with LED deployments will reduce overall costs, increase the efficiency and functionality of street lighting, and provide a platform for future Smart Cty applications.

In a world that depends on ubiquitous access to power and connectivity, the street lighting network is a valuable asset. In addition to improving the efficiency and value of city services, that network can also become a source of new revenue for the city. The right smart street lighting platform can also help cities deal with issues such pedestrian and driver safety as well as city revitalization projects. Some of these available Smart City technologies that utilize municipal streetlights or poles are described here and should be a part of the larger smart city discussion.

Traffic/Pedestrian Monitoring. Utilization of an integrated camera and data analysis system that can recognize the actions of both vehicles and pedestrians has many benefits. From the emissions point of view, the traffic organization can improve time efficiency for parking and reduce idling. Further, these systems can be linked to emergency management systems to provide valuable information and reduce response time.

Pole based EV Charging. Many cities are piloting or fully implementing a system of pole base mounted electric vehicle chargers that utilize existing 240- or 480-volt power supplies to the streetlights, providing vehicle charging during the daytime hours when the lights are not being used and the load can be utilized for the passenger cars for either DC fast charging or level 2 charging.

Environmental Sensors. The installation of air and sound quality measuring smart devices, such as the Argonne Array of Things (AoT), is a very simple way to gather valuable information on the environmental attributes that may provide guidance on the actual contaminants in the municipal area. The object of these long-term monitoring devices is to catalog data and send feedback in the preferred delivery method of the user. For example, a simple, unobtrusive measuring device can provide air quality impacts, from noxious gases, in a heavy traffic congestion or construction zone, or simply provide pre- and post-monitoring statistics for a defined project area.

Image by Leon Justice/Shutterstock

3.3 ELECTRIFICATION STRATEGY

Transportation Electrification. Transportation is the largest contributor to greenhouse gas emissions in the United States, comprising nearly 30% of the total emissions with electricity and industry each making up approximately 25% with the remaining emissions derived from agricultural, commercial, and residential sources.[18] Of the transportation emissions, about 50% are from light duty vehicles, 25% from medium and heavy duty trucks, with aircraft and other comprising the remaining 25%.

Across the country, there are numerous commitments to electrify fleets from state and local governmental agencies as well as the recent announcement by President Biden to transition the federal fleet of more than 600,000 vehicles to electric in the next decade. In addition, federal and state funding is expected to support the transition to transportation electrification. For example, announced in March 2021, the $174 billion American Jobs Plan EV investments include the items listed below.

$100b for EV rebates

$4b for EV charging tax credits

$15b for EV charging

$10b for medium duty and heavy duty incentives

$20b for electric school buses

R&D Opportunities for research and development investments

$25b for electric transit buses

500k deployment of 500,000 charging stations

1m growth in auto sector employment by 1 million jobs[19]

The major automotive brands including GM and Ford have announced significant investment in electric vehicles. General Motors announced plans to manufacture only electric vehicles by 2035, ending production of its cars, trucks and SUVs with diesel and gasoline powered engines.[20] Ford has introduced the new all-electric 2022 Ford F-150 Lightning and is currently taking reservations for the new truck.[21]

The emissions associated with the City's Fleet and Transportation make up approximately 40% of the City's total emissions. All of the emissions are Scope 1 from the uses of liquid fuels such as gasoline and diesel. The fleet and transit initiative goals have significant implications on the City meeting its carbon neutrality goals. Without substantial electrification of the vehicle fleet the City cannot achieve its carbon neutrality goals.

Building Electrification. As part of the decarbonization strategy, communities are evaluating conversion of natural gas equipment in buildings to electric as well as moving toward all-electric new construction. The primary uses of natural gas in buildings include space heat, water heat, cooking and laundry. There are ample high efficiency electric equipment alternatives for these commercial end-use applications.

For the City of Durham, natural gas comprises a relatively small percentage of the GHG emissions. While converting those applications to electric is optimal, it should be done in conjunction with other building renovations or improvements to reduce costs associated with fuel source conversion.

Image by City of Durham

City Receives 2020 GREEN FLEET AWARD from 100 Best Fleets

Fleet Electrification

The City of Durham fleet consists of more than 1,600 vehicles to enable and support City operations. The fleet is comprised of light duty cars and trucks, medium and heavy duty vehicles, construction equipment and miscellaneous vehicles. The City of Durham Fleet Management team received a 2020 Green Fleet Award from the 100 Best Fleets, ranking number 13 on the list of winners, as recognition for its work.

Fleet Baseline

The City fleet contributes 24% of the GHG emission. In 2019, the vehicle fleet consumed approximately 1,000,000 gallons of fuel with about 500,000 gallons of diesel fuel and 500,000 gallons of gasoline. As the fleet converts to electric vehicles, the GHG emissions will be comprised of both Scope 1 and Scope 2 reflecting the transition to electricity versus liquid fuel sources as detailed in Table 3-11.

TABLE 3-11 VEHICLE FLEET GHG EMISSIONS (MTCO2E)

Source	2019	2030	2040
Vehicle Fleet	12,064	10,182	4,935
Scope 1	12,064	9,617	4,215
Scope 2	0	565	720

Out of the City's entire 1,674 vehicle list, 271 vehicles were excluded from the baseline analysis such as trailers, lawn mowers, boats, pothole patchers, golf carts, and generators, leaving a total of 1,403 vehicles as shown in Table 3-12.

TABLE 3-12 FUEL ECONOMY AND FLEET QUANTITY

Fuel Economy - Vehicle Type	Average Miles Per Gallon (MPG)	Total Quantity
Passenger Car	14	671
Hybrid	25	45
Light Duty Truck	10	372
Heavy Duty Truck	3	258
Construction Equipment	2	57
Total Vehicles		1,403

Figure 3-17 illustrates the approximate fleet assets by vehicle fuel type aggregated by the primary department types. The City currently has seven electric vehicles (four Nissan Leafs and three Chevrolet Bolts) as well as three electric mowers.

FIGURE 3-17 VEHICLE FUEL TYPE BY DEPARTMENT

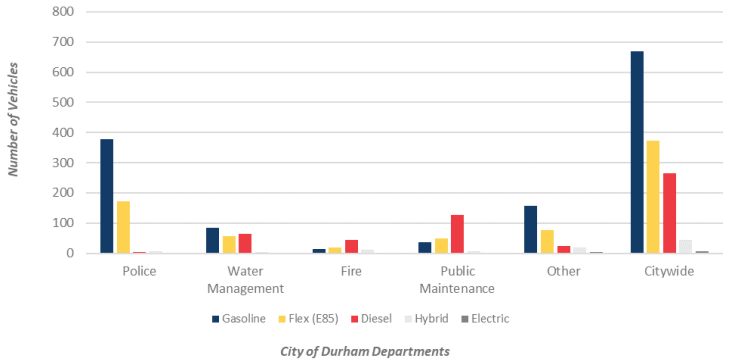
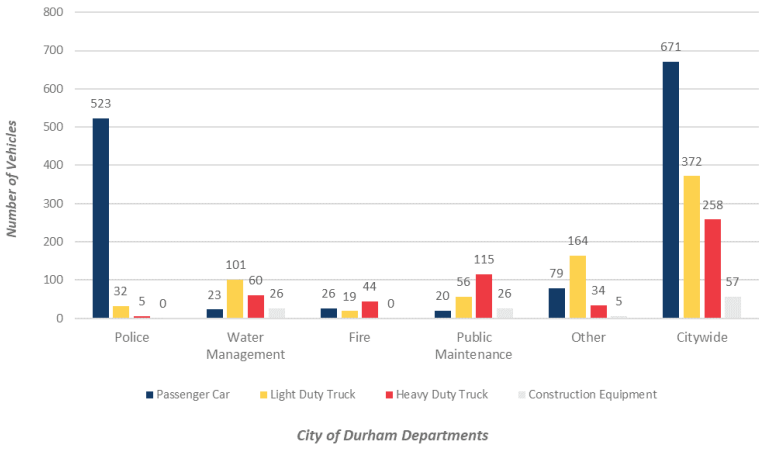


Figure 3-18 represents the type of vehicle by department. The police department accounts for nearly half of the fleet. An electric vehicle option that is well suited for police use is an important component for the City's fleet electrification strategy.

FIGURE 3-18 VEHICLE TYPE BY DEPARTMENT



Strategies for Fleet

The Consultant team performed a detailed analysis of the Durham City fleet and obtained additional information on the vehicle assets and policies from the City staff. Multiple scenarios were developed to showcase the range of impacts and costs resulting from modifications to the fleet vehicle makeup or policies. Select action items are described in Table 3 13, along with the modeling that was used to analyze the fleet.

Recommendations to achieve the City's carbon neutrality goals must focus on moving the City's fleet to electric within the current technology limits, examine any policies for vehicle replacement or purchase, and finally, consider any funding opportunities the City can leverage. Long-term planning and coordination are keys to success for fleet electrification. The City should develop a comprehensive approach and long-term outlook. The approach should include evaluating best practices, leveraging all funding opportunities, and collaborating with stakeholders.

From an operational standpoint in discussing electrification, it is important to note that the City should examine and consider networked or smart charging for the fleet in order to avoid negative impacts on the associated electric accounts. A majority of the electric vehicle charging software and hardware manufacturers have embraced the idea of a managed network of charges and the cost for this feature across a fleet of chargers is minimal. Networking requirements will vary based on the use case or application of the charging situation, so the Consultant team recommends developing a framework to evaluate various applications for networking requirements, payment options and equipment and siting considerations for Level 2 and Level 3 electric vehicle supply equipment (EVSE). Table 3-13 shows the action items for fleet electrification.

Image by City of Durham

TABLE 3-13 ACTION ITEMS FOR FLEET ELECTRIFICATION

Action Item	Project	Description
ET-1	Fleet - Light Duty Cars	Replace light duty passenger cars from gasoline to battery electric as vehicles reach the end of their 10-year life. Assume 50% conversion by 2030 and 100% conversion by 2040.
ET-2	Fleet - Light Duty Trucks	Replace light duty trucks from gasoline to battery electric as vehicles reach the end of their 10-year useful life. Assume 33% conversion by 2030 and 100% conversion by 2040.
ET-3	Fleet - Medium/Heavy Duty Vehicles and Equipment	Replace medium/heavy duty (MD/HD) vehicles to electric as technology is available. Consider pilot programs to test new viability of new options. Assume 20% conversion by 2040.
ET-4	Fleet - Electric Bikes	Evaluate potential to incorporate electric bikes into City fleet as an alternative to vehicle use.
ET-5	Vehicle Procurement	Update vehicle procurement policy to replace fossil fuel powered vehicles to battery electric as vehicle reaches end of useful life and technology is available. Evaluate potential benefits of lease versus buy options.
ET-6	Right-size/Telematics	Continue to install telematics on vehicles to determine mileage, usage patterns, and other factors to optimize fuel efficiency and cost effectiveness, Right-size the fleet.
ET-7	EV Charging Infrastructure	Continue installation of charging infrastructure to support City electric vehicle fleet expansion and provide public charging opportunities. Develop managed charging strategy and leverage all potential funding sources.
ET-8	EV Outreach and Education	Participate in community-wide outreach events to educate citizens on City use of electric vehicles and associated benefits.

Modeling City of Durham's Fleet

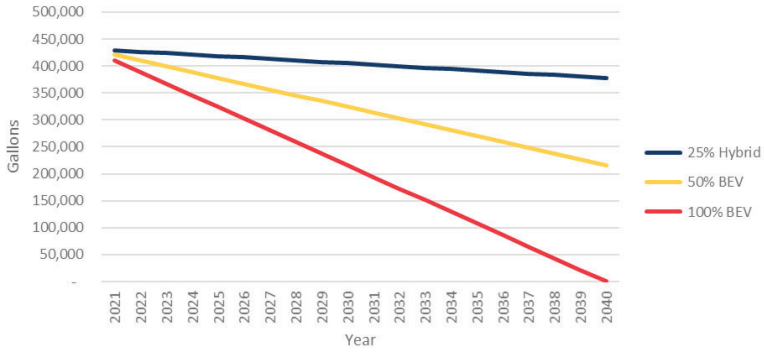
To develop a set of actionable recommendations for Durham's vehicle fleet, GDS developed an interactive model that incorporates all vehicles that are registered assets of the City. As described in the baseline scenario section above, vehicle details and driving patterns were analyzed on an annual basis to provide insight into behavioral impact if the vehicle type was altered to a more efficient type or removed altogether to right-size the fleet. From this baseline analysis, a set of scenarios was developed to explore both the carbon and financial impacts of changes in the vehicle fleet. A few of the scenarios are listed in Table 3-14.

TABLE 3-14 PASSENGER CAR FLEET MODELING

Scenario	Description
Minimum	Replace 25% of the gasoline passenger vehicles with hybrid vehicles.
Moderate	Replace 50% of gasoline passenger cars with battery electric vehicles (BEV).
Aggressive	Replace 100% of gasoline passenger cars with battery electric vehicles (BEV).

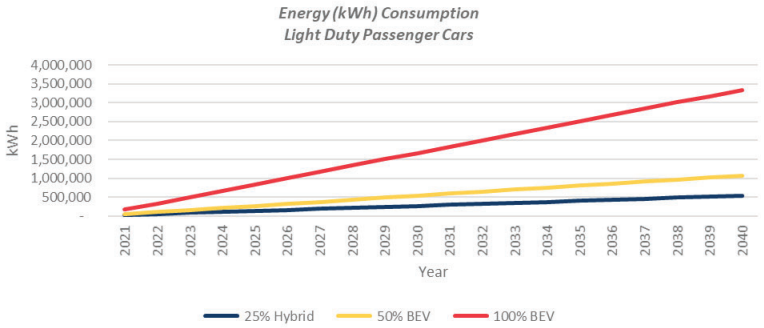
As Table 3-14 illustrated, the minimum case outlines the baseline scenario with no significant changes implemented, and the subsequent scenarios increase the effort of electrification; the aggressive scenario's full fleet electrification offer the quickest pace. As for costs and mileage assumptions, in the model, these premises are based on actual data provided in the Fleet Master analysis for gasoline or diesel vehicles and hybrid or electric purchases to date. To determine electric light duty truck prices and efficiencies, estimates were based on preview market reports of both the Ford F-150 Lightning and Rivian truck performance approximations. Heavy duty trucks and equipment, such as fire trucks or construction vehicles, were excluded from electrification with the exception of sanitation trucks which are modeled to convert to electric in the 2031–2040 timeframe. Figure 3-19 below shows the impacts of gasoline consumption from the Minimum scenario (25% Hybrid), Moderate scenario (50% BEV), and Aggressive scenario (100% BEV).

FIGURE 3-19 GASOLINE CONSUMPTION LIGHT DUTY PASSENGER CARS



Similarly, the kWh impact of adding the electric vehicles to the grid as part of the electric vehicle scenarios is shown in Figure 3-20, and therefore illustrates the increased electricity usage in kWh from electrification.

FIGURE 3-20 ENERGY IMPACT OF EV SCENARIOS



Fleet Electrification Light Duty PASSENGER CARS

Replace light duty passenger cars from gasoline to battery electric as vehicles reach the end of their 10-year life. Assume 50% conversion by 2030 and 100% conversion by 2040.

Replace light duty passenger cars from gasoline to battery electric as vehicles reach the end of their 10-year life. Assume 50% conversion by 2030 and 100% conversion by 2040.

One key strategy to reduce GHG emissions is for the City to replace light duty, gasoline powered passenger cars with battery electric cars at the end of their 10-year life. Passenger cars account for nearly 50% of the vehicle fleet.

The modeling assumes replacement of 671 passenger cars over the next 20 years. The rate of replacement is approximately 34 vehicles per year as the vehicles reach 10 years old. This assumes a 50% conversion by 2030 and 100% conversion of light duty passenger fleet by 2040. The police vehicles such as the Dodge Chargers are assumed to be converted to electric in the later years as the technology and availability of a comparable vehicle evolves.

The City is shifting to battery electric cars with seven EVs in the vehicle fleet - four Nissan Leafs and three Chevrolet Bolts.

Image by City of Durham

Police Vehicles

As the largest consumer of unleaded gasoline, public safety vehicles have immense potential for carbon reduction through policy or equipment changes. The Consultant team held numerous meetings with both the City staff of Durham and other cities to analyze the impact and state of the market for efficiencies in routine patrol cars, or interceptors. While this portion of the fleet seems to be a likely candidate for a total fleet efficiency project, two issues presented themselves as obstacles:

1. ***Idling Reduction.*** Public safety vehicles seen idling are often doing so in order to keep crucial electronics within a suitable operating temperature and powered up. Numerous auxiliary battery systems are available to augment existing interceptor vehicles with minimal modification, and new vehicle orders can be specified to include this technology.[22] These units can provide many of the benefits of a running engine, but not all. It is recommended that the police department implement a pilot program to explore the auxiliary power unit market for a sample of vehicles.
2. ***Physical Vehicle Constraints.*** As many officers will be wearing body armor and a range of tactical gear, the ability to move in and out of the vehicle quickly is important. Feedback from both Durham and comparable city police departments have indicated a concern with the interior space needed for these officers on the most popular hybrid models, including the Fusion models currently being tested in Durham.

While the auto industry news cycle may give more attention to Tesla prototypes and pilot projects in cities like Brookhaven, Georgia, other auto manufacturers have only begun to introduce larger, pursuit rated vehicles such as the Ford Police Interceptor Hybrid SUV.[23] The claims on performance and efficiency are based on limited testing, but the vehicle does address the primary issues of idling and space, so it is recommended that the Durham Police Department conduct a limited trial of this model when available.

Image by City of Durham

Image by Ford

TRUCKS

Replace light duty trucks from gasoline to battery electric as vehicles reach the end of their 10-year life. Assume 33% conversion by 2030 and 100% conversion by 2040.

Light duty trucks make up about 30% of the vehicle fleet and are used in nearly every department. Electric light duty trucks are assumed to be introduced in the City's fleet beginning in 2025 and approximately one-third of the light duty trucks are replaced by 2030 with the remaining two-thirds replaced in 2031-2040 timeframe. There are currently about 350 light duty trucks in the fleet and 20% are the Ford F-150. Since the F-150 is a staple in many fleets, a new electric version is considered to be a game changer for fleet electrification.

The 2022 Ford F-150 Lightning Electric Truck is expected to be available in Spring of 2022, the standard model starting at $39,974 with various models going up to a price of $90,000.[24] The Mid-series XLT that comes with an extended-range battery starts at $52,974. The standard battery has a range of 230 miles while the extended battery has a range of 300 miles. Trucks with the extended range battery have a maximum towing capacity of 10,000 lbs. and a maximum payload capacity of 2,000 lbs. The Lightning Electric Truck also has 563 horsepower, 775 pound-feet of torque and special features such as tailgate and interior work surfaces and a front trunk for storage.

Image by Motor Trend

Fleet Electrification Medium/Heavy Duty

Replace medium and heavy (MD/HD) duty vehicles with comporable electric vehicles as technology is available. Assume 20% conversion from liquid fuel to electric during 2030 – 2040. Consider pilot programs to test the viability of new options.

The City has approximately 250 medium and heavy duty (MD/HD) trucks. The City should replace MD/HD diesel vehicles to electric as technology is available. It is suggested that the City consider pilot programs to test the viability of the new options. The modeling assumes that 45 sanitation trucks are replaced beginning in 2031 at a rate of five per year until all are replaced. The remaining fire department, public works and water management medium and heavy duty vehicles are not projected to be replaced by an electric option prior to 2040.

The City of Durham has a number of MD/HD diesel vehicles that provide critical support to many departments, including fire, forestry, street maintenance, and collections to name a few. Traditionally, the diesel engine has been the powertrain provider of choice as the low-end torque requirements can range to a very high demand. Given the unique purpose and use cases for these vehicles, the base case equipment costs are often high. There are a handful of cities that are exploring the landscape of electrification options in this sector, either in idling reduction or overall drivetrain electrification. Many cities choose to run a small pilot in order to gather departmental input and feasibility research, although

Image by City of Durham

Image by Mack

Medium / Heavy Duty FLEET

some are converting their entire MD/HD fleet with the help of incentives and federal funding sources. Lessons are also to be learned from cities that are beginning to convert heavy duty fleet vehicles into alternative powertrains, so the City of Durham is encouraged to actively track results of similar cities and explore options for small pilot projects in select departments.

One viable MD/HD project that should be considered beyond just a pilot for Durham would be a transition of sanitation trucks to a 100% electric fleet. Combining the operations and maintenance savings estimated at about $10,000 annually per truck and the savings in diesel fuel, the added incremental cost of about $250,000 or more per truck may be recouped for lifecycle cost benefits. The use of regenerative braking to charge the electric propulsion system in a truck chassis, such as the Mack LR, would provide substantial carbon reduction and cleaner air to the immediate local area.

The City is expanding the applications of battery electric technology with the purchase of three Greenworks mowers as shown in the photo. These electric mowers perform extremely well while reducing noise, vibration, and air pollution.

Fleet Electric Bikes

Evaluate potential to incorporate electric bikes into City Fleet as alternative to vehicle use.

Electric bicycles (e-bikes) are a form of e-transportation that is quickly rising in popularity, especially for municipal purposes, as seen in police departments. These bikes can have a range of up to and above 150 miles per charge and can help police officers in low intensity contacts and daily routine/procedure. Police departments currently using e-bikes say that the bike's charging time is about 3 hours and lasts on average for 2-3 shifts. The estimated time period for a battery is 1,000 charges before batteries may require replacement, which should be approximately 4-6 years based on consistent usage.

Although e-bicycles are double the price of police outfitted mountain bikes, they are less expensive than cars and motorcycles and provide advantages in getting into areas where cars cannot, such as parks, walking trails, and downtown core areas. Electric bicycle integration can also provide police officers with more personable community contact and less physical strain on the officers.

Smart Columbus Smart City Initiative

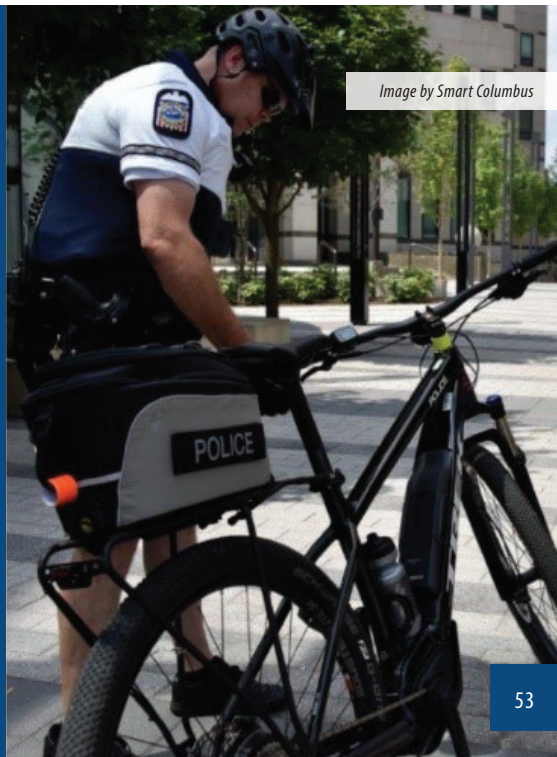


Image by Smart Columbus

As part of its Smart Columbus smart city initiative, the Columbus Division of Police Bike Patrol began using e-bikes in 2018.[25] They currently have a fleet of 180 bikes and more than 130 bike officers. The bikes were funded through a Paul G. Allen Family Foundation Grant.

Vehicle Procurement

Update vehicle procurement policy that supports the replacment of fossil fuel powered vehicles with battery electric options as the vehicles reach the end of useful life and technology is available. Evaluate potential benefits of lease vs buy options.

The City of Durham currently opts to purchase rather than lease vehicles. Vehicles are replaced based on several factors - mileage, maintenance cost history, life expectancy, and the vehicle condition. On average, vehicles are replaced every 10 years. The City of Durham should consider updating its vehicle replacement policy with an aspirational goal for vehicles to be replaced by electric alternatives at the end of useful life. Exceptions should consider the type of vehicle and whether an appropriate electric vehicle is currently available.

In addition, financial analysis for replacement vehicles should include a total cost of ownership view. Currently, electric light duty vehicles may have a higher initial cost but result in lifecycle savings due to reduced maintenance and fuel costs.

As an example of fleet right-sizing and vehicle replacement policy, consider the City of Charlotte which updated its Sustainable and Resilient Fleet Policy on June 1, 2020.[26] The policy mandates fleet right-sizing by minimizing the number of city-owned vehicles; development of guidelines for the deployment of managed idle technologies to reduce fuel consumption on new and legacy conventional fuel powered vehicles and purchasing zero or low emissions vehicles. Finally, the City of Charlotte policy ensures that electric vehicle and alternative fuel infrastructure are considered in tandem.

It is suggested that the City of Durham consider whether vehicles should be purchased outright versus leased. Many cities across the U.S. are leasing rather than purchasing EVs because it may potentially stretch limited budgets and allows for the most current EV technology.

The City of Durham is a member of the Climate Mayors Electric Vehicle Purchasing Collaborative, which works to leverage the buying power of Climate Mayor cities to reduce costs of EVs. Other North Carolina cities that are members include Charlotte, Roanoke, and Greensboro. The City of Durham should take full advantage of this partnership because the collaborative negotiates lower prices of EVs.

Right-Size & Telematics

Continue to install telematics on vehicles to determine mileage, usage patterns, and other factors to optimize fuel efficiency and cost effectiveness. Right-size the fleet.

The City should continue to evaluate how to best utilize the fleet to meet the needs of City employees and the greater community. The City of Durham should undertake a full analysis of its entire 1,600 vehicle to determine if it is the correct size for City operations, without comprising safety and service quality to the community. Some of the questions below could provide insights to a comprehensive assessment.

- ***What tasks are accomplished by each vehicle?***
- ***What is the daily, weekly, or monthly mileage of each vehicle?***
- ***Are fleet vehicles the optimal vehicle type,***

class, and size for the job?

- ***Are there any vehicles that are no longer cost effective to operate/no longer fulfilling their purpose?***
- ***Are there any vehicles that are no longer being used or have experienced significant downtime?***
- ***What is the fuel consumption of each vehicle? Can any vehicles be replaced by lighter, more fuel-efficient vehicles?***
- ***What is the age of the vehicles? Can any vehicles be replaced by newer, more efficient, and reliable vehicles?***
- ***Are there any alternatives to owning a vehicle such as leasing?***
- ***Considering the answers to the previous questions, what is the optimal composition of the fleet required to properly support the fleet's needs?***

Based on the answers to the questions above, vehicles should be categorized as "eliminate," "retain," "replace," or "pool". In tandem with this analysis, the City should continue to use telematics to provide accurate data on vehicle location, behavior, and mileage. Several cities in the southeastern U.S. have implemented contracts with products like Geotab, which provides a host of options to improve fleet efficiency and generate insights through data gathering.[27]

EV Charging Infrastructure

Continue installation of charging infrastructure to support City electric vehicle fleet expansion and provide public charging opportunities. Develop managed charging strategy and leverage all potential funding sources.

There are three classifications of EVSE or chargers.

- ***Level 1 chargers*** use 110/120 volts, it usually takes the longest to charge a vehicle and is mostly used for residential or backup charging.
- ***Level 2 chargers*** use 208/240 volts, they have a higher power output than Level 1 charging and are distinguished by non-networked chargers (single-family residences) and networked chargers (workplace settings).
- ***DCFC (Direct Current Fast Chargers)*** use between 200 and 600 volts. However, not every EV model is capable of this type of charging. There are three types of connectors for DC chargers including CCS, CHAdeMO, and Tesla. Fast chargers are mostly used for long distance trips and in urban environments where there are fewer drivers with at-home charging.

The City of Durham applied for funding for the EV ARC solar EV charging station through the Clean Fuels Advanced Technology (CFAT) grant program managed by the North Carolina Department of Transportation. The City of Durham also received a Volkswagen (VW) Settlement Phase 1 award for three Level 2 EV charging stations. The City continues to seek grants and funding through government agencies and utilities to offset the capital and installation costs for charging infrastructure.

As EVs proliferate, infrastructure must be available for the public to charge their vehicles. ChargeHub notes 156 charging stations in Durham, North Carolina. City of Durham has installed six public charging stations with at least 13 more currently planned in addition to facilities to support the City fleet vehicles. Table 3-15 shows the list of current and planned EV charging stations and locations.

Image by City of Durham

The City's Level 2 charger at the General Services Building is shown above with the Nissan Leafs.

TABLE 3-15 EV CHARGING STATIONS

Location	# Stations/#Plugs	Year Installed
Public Stations		
Morgan-Rigsbee Parking Garage	3/6	2019
Corcoran Street Parking Garage	1/2	2016
Parking Lot 32 (Fast Charger)	1/1	2015
Fire Station #17	1/2	2018
City Stations		
City Hall Annex	2/2	2011
General Services Department	1/2	2015
Water Management Department	2/2	2019
Police Headquarters Parking Garage	3/6	2017
Golden Belt Building	1/1	2016
Golden Belt Building	1/1	2009

Location	# Stations	Year Installed
Public Stations		
Church Street Parking Garage	2	Pending
Durham Centre Parking Garage	2	Pending
Corcoran Street Parking Garage	1	Pending
Water Management Department	TBD	Pending
Hoover Road Athletic Park	2	Pending
City Stations		
Go Durham (Buses)	5	Pending
Water Management Department	TBD	Pending
Fire Administration Building	3	Pending
City/Public		
Fire Station #18	2	Pending
Public Works Operations Center	4	Pending

Public charging stations make personal use of electric vehicles more convenient. Although many EV drivers will charge their vehicles at their personal residences, public charging areas will make EVs more accessible and help increase the number of people who convert from traditional vehicles to electric. Public charging stations are most useful when located where vehicles are parked for long periods of time such as the workplace, shopping centers, and recreational areas.

Managed Charging. As the City continues to build its fleet of EVs and charging infrastructure, it is critically important to install "smart" chargers to minimize the potential impact of higher electricity demand or energy costs. Smart charging refers to the ability to manage the impacts of EV charging on the grid and minimize costs by controlling the time, power, and location of charging.

Many utilities offer special rates for EVs to encourage charging during off-peak periods. The City will need to collaborate with Duke Energy to determine the best rate options for their EV charging infrastructure. In addition, it may be helpful to standardize with a particular vendor or supplier as the charging technology and capabilities continue to evolve.

Education & Outreach

Involve the community in outreach events to educate residents on City use of electric vehicles and associated benefits.

National Drive Electric Week is held annually and will be held September 25 - October 3, 2021, to celebrate and educate on the benefits of electric vehicles. The N.C. Clean Energy Technology Center (NCCETC) at N.C. State University plans events during this week and the City of Durham should consider participating to showcase some of the vehicles.

NATIONAL DRIVE ELECTRIC WEEK

N.C. Clean Energy Technology Center at N.C. State

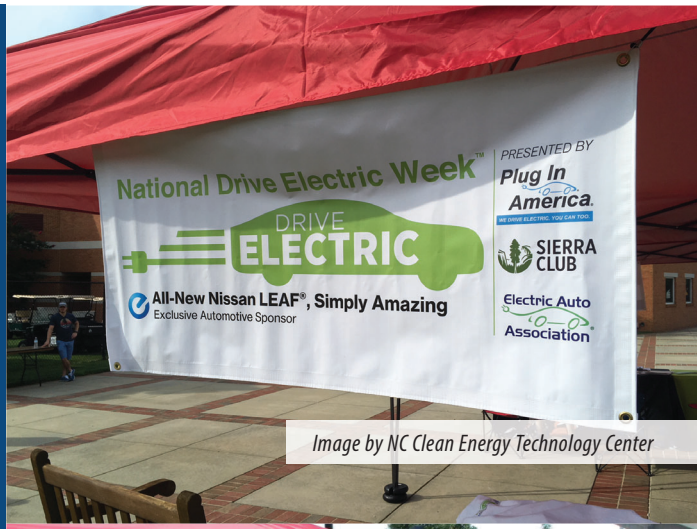


Image by NC Clean Energy Technology Center

Image by NC Clean Energy Technology Center

Image by City of Durham

DRIVING CHANGE

- General Services moving to more EVs
- Moved charging infrastructure to front of building for easier access
- Purchased additional vehicles
  – Chevy Bolts
  – Nissan Leafs
- Making charging available to the public at several locations across the City

Image by City of Durham

Image by City of Durham

Transportation Electrification

The Transportation Department is responsible for providing safe and reliable mobility service for Durham residents on transit buses and paratransit vehicles serving nearly $5.8 million riders in FY 2020. The City launched the first two electric buses into service in April 2021, is anticipating the delivery of an additional six all-electric buses by the end of 2021, and recently received an award from VW Settlement Phase 1 of $428,000 toward the purchase of an additional electric bus.

The Move Durham Transportation Study was completed in September 2020 and presents a clear vision for the future of transportation and mobility in Central Durham, with recommendations to improve sustainable transportation for bicyclists, pedestrians, and transit riders. GoDurham operates in partnership with GoTriangle, GoRaleigh, GoCary and Chapel Hill Transit.

Residents depend on the transportation system to get to and from employment, healthcare, education, and other daily needs for mobility. Accelerating conversion of the fleet from fossil fuels to electricity is an important consideration for the City as nearly 20% of emissions come from the transportation fleet. Converting to electric vehicles contributes to cleaner air for the residents that ride the bus as well as the drivers. In many communities, the people who use the City's transportation services – are among the most vulnerable populations.

An important component of fleet electrification is the incorporation of buses, especially electric transit buses. Electric buses are still prone to one of the difficult parts of transitioning to electric vehicles - large upfront costs compared to traditional buses. However, high utilization of buses often leads to increased savings in fuel costs. Due to standardized bus routes within a consistent geographical area, bus charging infrastructure should be streamlined and planned in advance. These savings are estimated at around $400,000 dollars in saved fuel costs and $125,000 in averted maintenance over the vehicle's lifetime. The Federal Transit Authority's Low or No Emission Program is an opportunity available to help fund efforts by fleet operators; the program provided just under $130 million in funding to state and local governments for electric transit buses in 2020.[28] The City should explore all potential funding sources to offset the incremental cost of electric buses and associated infrastructure.

Transportation Baseline

The City's Transportation fleet consists of over 100 vehicles including 57 buses and 53 paratransit vehicles and contributes nearly 20% of the City's GHG emissions. In 2019, the vehicle fleet consumed nearly 1,000,000 gallons of fuel with about 725,000 gallons of diesel fuel and 250,000 gallons of gasoline. As the transit fleet converts to electric buses and paratransit vehicles, the GHG emissions will be comprised of both Scope 1 and Scope 2 reflecting the transition to electricity versus liquid fuel sources. Electrification of the City transit fleet is critical to achieve the carbon neutrality goals representing nearly 25% of the GHG reduction potential. Table 3-16 represents the Transit fleet GHG emissions.

TABLE 3-16 TRANSIT FLEET GHG EMISSIONS (MTCO2E)

Source	2019	2030	2040
Transit Fleet	9,528	3,929	804
Scope 1	9,528	2,420	0
Scope 2	0	1,509	918

In 2018, GoDurham received a $2.1 million Federal Transit Administration grant that provided funds to the City to procure its first electric buses. Several of the buses in GoDurham's fleet are more than 15 years old. Grant funding allows for the replacement of four aging buses with electric models. Recommendations, from a transportation study conducted by the NCCETC at NC State University (NCSU), determined the GoDurham routes which might be most conducive to using electric buses are Routes 1, 2, 3T, 14, 23 and NHS.

In 2018, **GoDurham** Received **Federal Transit Administration Grant** ***for $2.1m***

Strategies for Transportation

Future transportation strategies expand the on the progress that Durham is making toward carbon reduction by way of converting to battery electric transit buses. Following the arrival and pilot testing of the City's two new Gillig transit buses, it is expected that Durham will continue to transition the remainder of the bus fleet and paratransit fleet to electric by 2040.

By deploying battery electric buses in place of the existing diesel vehicles, Durham will reduce the energy consumption and harmful emissions, including the release of greenhouse gases. For example, deploying only six zero-emission buses in place of six comparable standard buses (model year 2019 diesel buses) will prevent the release of about 848 MTCO2e. The action items associated with Transportation are shown in Table 3-17.

TABLE 3-17 ACTION ITEMS FOR TRANSPORTATION FLEET

Action Item	Project	Description
ET-9	Transit - Buses	Adopt electric bus purchasing policy and continue replacement of diesel buses to battery electric. Leverage federal and state funding sources.
ET-10	Transit - Paratransit Vehicles	Adopt electric paratransit vehicle purchasing policy and begin replacement of gasoline vehicles to battery electric as technology is available. Leverage federal and state funding sources.

Image by City of Durham

Electrify Buses

Adopt electric bus purchasing policy and continue replacement of diesel buses to battery electric. Leverage federal and state funding sources.

The City is already on track with its electric bus acquisition and charging infrastructure installation. In terms of electric bus acquisition, the City received two Gillig electric buses in Spring 2021 and expects to receive seven additional Gillig buses by 2022. Funding from a VW settlement grant is expected and will offset part of the incremental cost of purchasing electric buses. As for charging infrastructure, the first ChargePoint station was installed in the maintenance bay in 2020. The four remaining ChargePoint stations were installed in Spring 2021.

The modeling assumptions for transit buses include replacement of 57 buses at an average rate of approximately five buses per year. The conversion to an electric bus fleet is assumed to be complete in 2032.

The City will continue to explore the funding sources that are expected to be available. This could significantly reduce the projected incremental capital investment needed for the buses as well as the charging infrastructure.

As noted in the previous vehicle fleet section, managed or smart charging is critically important for the transportation fleet as it represents a significant new electrical load for the City. Again, the City should collaborate with Duke Energy to determine the best rate option to mitigate any potential impacts on peak demand and energy consumption.

Image by City of Durham

Electrify Paratransit Vehicles

Adopt electric paratransit vehicle purchasing policy and begin replacement of gasoline vehicles to battery electric as technology is available. Leverage federal and state funding sources.

The City should adopt a policy to begin replacement of gasoline vehicles to battery electric as technology is available. The electrification of the smaller paratransit fleet with battery electric chassis versions that consume less energy, per mile driven. Vehicles to be replaced include buses that use other common propulsion technologies, such as gasoline, diesel, and natural gas engines; the changes will contribute to GHG reduction for the City. Even when considering well-to-wheel energy requirements, battery electric paratransit buses are a more efficient transit solution compared to other vehicle technologies due to the reduction in the amount of idling and utilization of regenerative braking in many cases.

The modeling assumptions for paratransit vehicles assumes the replacement of four vehicles each year beginning in 2025 and completing the conversion by 2038. There is currently little data available on large-scale deployments of these vehicles.

However, this application for electric vehicles will continue to evolve and mature as technology becomes available. For example, the Optimal is currently in production with the first vehicles expected to be available in Fall of 2021.[29] The City should monitor the availability of this technology and seek to leverage funding from federal, state, and private sources.

Even when considering well-to-wheel energy requirements, battery electric paratransit buses are a more efficient transit solution compared to other vehicle technologies due to the reduction in the amount of idling and utilization of regenerative braking in many cases.

Image by Optimal

CLEAN & QUIET

Electric Buses Coming Soon!

Image by City of Durham

Image by City of Durham

Image by City of Durham

Building Electrification

Convert natural gas equipment to electric equipment as feasible in conjunction with building renovations or when equipment needs replacement or major service.

Advancements in building space and water heating contribute to the full electrification of buildings as a viable step towards cleaner site energy impacts and reduced GHG emissions compared to natural gas and other fossil fuels. Electric equipment offers many of the same services that fossil fuel equipment provides. It can heat spaces, processes, and water. Targeted installations for Durham would include replacement of:

- Fossil fueled water heaters with either heat pump water heaters or solar water heating,
- Natural gas fired space heating with either packaged or split system advanced heat pumps, and
- Natural gas fired cooking equipment with electric induction technology.

Lawrence Berkley National Labs estimates that the technical potential for electrification in residential and commercial buildings is "nearly 100% of all direct energy use."[30] The implication for commercial buildings is that, with off-the-shelf technologies, Durham's use of natural gas or propane for space heating, water heating, and cooking could be electrified.

In the HVAC space, heat pump technologies are available now for efficient, electrified space heating and water heating. Compared to electric resistance heating, heat pumps provide heat between roughly two and four times the efficiency of electric resistance heating. Moreover, heat pumps are improving. Once considered to be a "warm climate" heating option, heat pumps can now operate efficiently at cold outdoor temperatures. While all heat pumps have become more efficient over the decades, the advent of cold-climate heat pumps has ushered in a new era of high-performance technology. Cold-climate heat pumps are able to maintain substantial heating capacity at 5° F and colder.[31] These heat pumps use cold outdoor air to add heat to a home, with an additional benefit of providing very efficient air-conditioning during the summer.

While the technology is relatively affordable and the recommendation for new construction is to build it into the design for space and water heating, an aggressive retrofit scenario for Durham's existing buildings is not recommended as a priority project, but rather a consideration in major renovations as financially feasible. Since the City of Durham consumes a relatively small amount of natural gas, it is not a significant driver in GHG reduction strategy. Nevertheless, retrofitting gas water heating to heat pump or solar water heaters should be a consideration in major renovations of buildings when it is financially feasible.

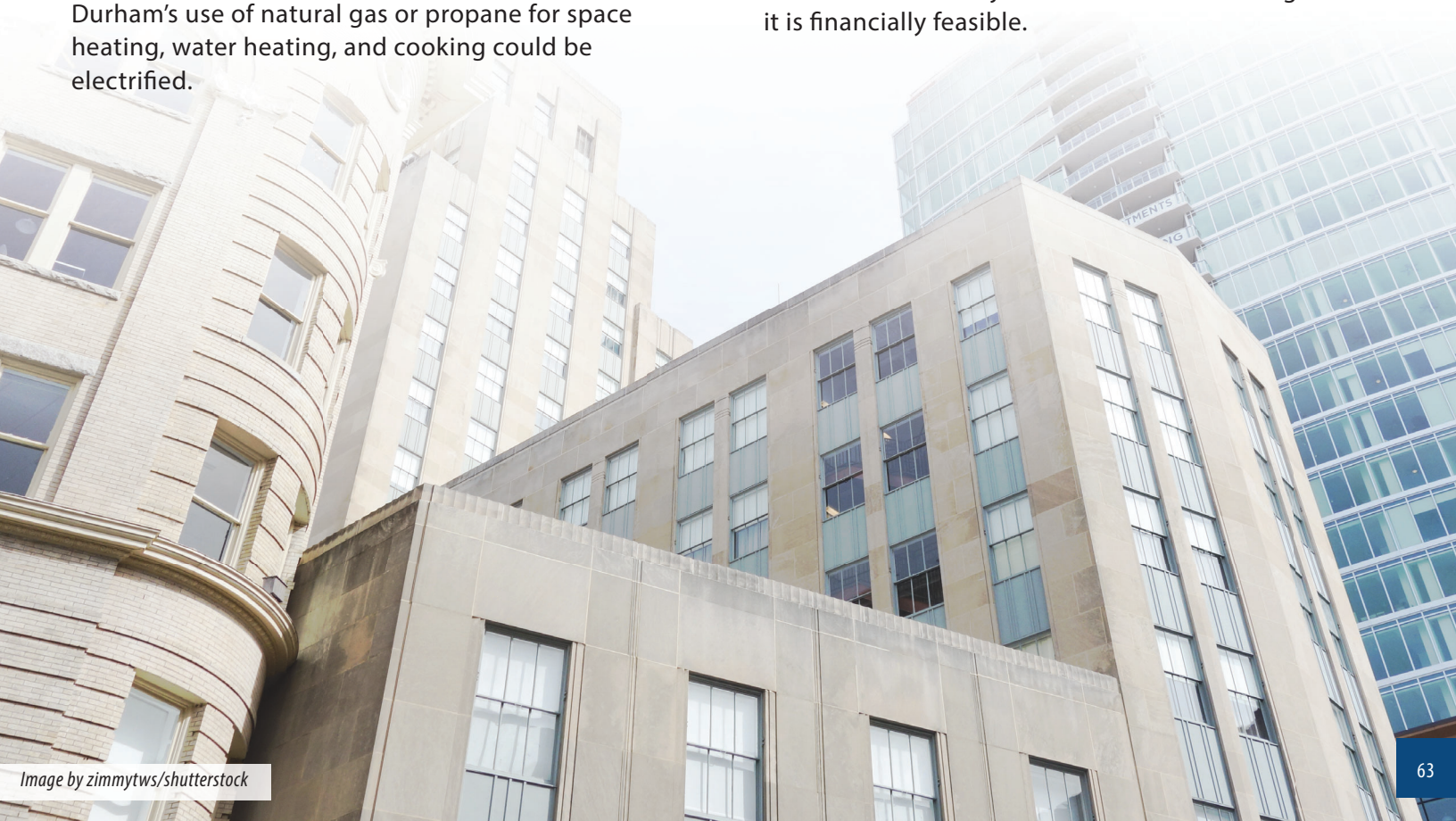
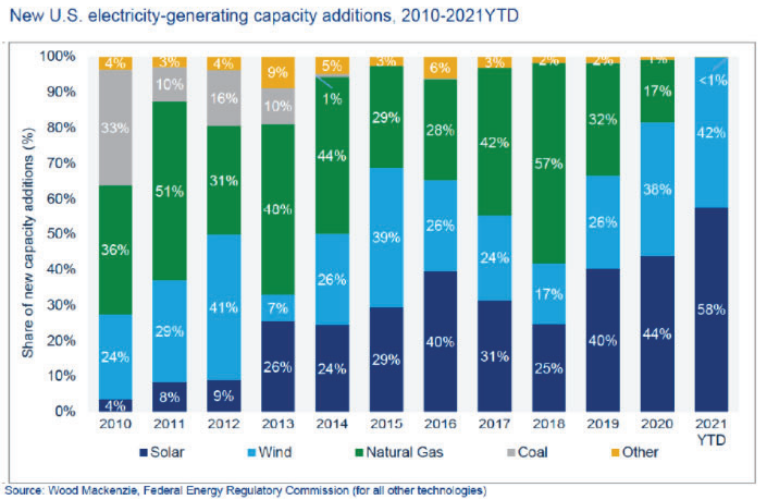


Image by zimmytws/shutterstock

3.4 RENEWABLE ENERGY STRATEGY

In recent years, support for clean energy initiatives heightens across the nation. A growing number of cities, counties, states, and investor-owned utilities have placed a higher emphasis on efforts to reduce their carbon footprint on the environment. Carbon neutrality becomes increasingly achievable as clean energy technology advancements continue to open the door to additional, viable generation alternatives at declining costs. Figure 3-21 below, from Solar Energy Industries Association (SEIA) and Wood Mackenzie, indicates the growing share of new capacity additions from renewable resources.[32]

FIGURE 3-21 NEW US ELECTRICITY-GENERATING CAPACITY ADDITIONS



Source: Wood Mackenzie, Federal Energy Regulatory Commission (for all other technologies)

Renewable Energy Baseline

The City currently generates renewable energy from several projects including - a landfill methane recovery system, two rooftop solar systems, a geothermal heat pump system under construction at the new water management complex, and solar thermal water heaters at various facilities. The City is actively seeking and evaluating additional renewable energy resources to help meet the carbon neutrality and renewable energy goals. The existing City renewable energy assets are listed on Table 3-18.

TABLE 3-18 CITY RENEWABLE ENERGY ASSETS

Project	Description of Renewable Energy Assets	Capacity (kW)	Year of Installation
Landfill Methane Recovery System	Landfill gas to energy facility	2,000 kW	2010
Fire and EMS Station #17	Rooftop Solar Array	46 kW	2019
Sign and Signal Shop	Rooftop Solar Array	34 kw	2021
Mist Lake Water Management	Geothermal Heat Pump System	n/a	2021

In 2019, the City of Durham was recognized by The Solar Foundation and the International City/County Management Association with the SolSmart Gold designation for encouraging solar development in its City.

Recently the City completed a couple of studies related to the potential of solar or solar plus storage for various facilities. These studies included the National Renewable Energy Laboratory (NREL) REopt analysis and the Yes Solar Solutions analysis. Analysts with the NREL completed the REopt Analysis for the City of Durham in July 2019. This analysis was part of the SolSmart designation program to provide cities with screenings for solar photovoltaics (PV) opportunities. City Hall and Police Headquarter facilities were evaluated to determine the potential of adding solar PV and battery storage to increase the City's renewable energy, provide resilience, and lower utility energy purchases.

The NREL REopt is a tool used to evaluate the techno-economic potential of adding solar PV and battery storage to increase the City's local renewable energy footprint, lower the cost of utility purchases, and provide added resilience. The analysis considers the electric load and utility rate tariff structure to size and dispatch PV and storage to minimize the lifecycle cost of energy, and to evaluate the resilience benefits of the cost optimal system sizes. The final NREL REopt report documents the following:

- An 86 kW standalone solar PV system at City Hall appears to be cost effective by reducing the total cost of electricity purchases by about $18,000 over the 25-year analysis period. Pairing the system with battery storage would accelerate savings.
- A standalone solar PV system at the Police Headquarters does not appear to be cost effective due to the different load shape and slightly lower

Image by City of Durham

> "This designation is an example of Durham's strong commitment to renewable energy and sustainability. We are proud to be a leader in promoting clean energy sources that support a healthy local economy, a clean environment, and a more livable community."
>
> — ***Mayor Steve Schewel***
> *Durham Mayor*

demand charge. If the system is paired with battery storage, a small battery storage system appears to be cost effective, saving the City approximately $17,000 over the 25-year analysis period.

- PV and storage at City Hall would increase resiliency by about 8%.
- PV and storage provide marginal improvement on resiliency at the Police Headquarters.

The City continues to evaluate these options as solar and battery technology evolves and prices trend downward. The City should proceed with monitoring and evaluating solar and storage projects to enhance resiliency in critical facilities.

The second study contains the Yes Solar Solutions analysis completed in March 2019. At the request of the City, Yes Solar Solutions completed an analysis for the City of Durham for potential sites for solar energy systems. The analysis includes a preliminary solar design, expected annual solar production and a 25-year financial analysis. The study identifies numerous potential sites including rooftop, ground mount and landfill projects representing a total of 4.25 potential MW of solar capacity across 11 city locations. The total cost of installing all proposed projects would be approximately $7.4 million after Duke Energy incentives but these facilities would produce roughly 5,900 megawatt hours (MWh) of local renewable energy annually and offset nearly 4,000 MTCO2e. The City has begun the installation of solar systems on City facilities.

Landfill Methane Recovery System

The first renewable energy project for the City of Durham is the landfill methane recovery system which began its operations in 2010. The City partnered with Methane Power to convert methane generated from decomposing waste in the closed landfill into electricity. Currently, MP Durham LLC operates the landfill gas to energy facility at the Durham County Landfill. The average annual output of the system is 15,000 MWh of energy.

CITY OF DURHAM'S 1ST RENEWABLE ENERGY PROJECT
2010 Landfill Methane Recovery System


Images by City of Durham

Rooftop Solar Installations

The City started the practice of installing solar systems on City facilities. In July 2019, the City of Durham completed installation on its first rooftop solar project located at the Fire and EMS Station #17, a LEED Gold certified facility. This new facility also incorporates sustainable building materials, rainwater harvesting, LED lighting and a high efficiency HVAC system.

A second rooftop solar project, located atop the existing Sign and Signal Shop, was installed in April 2021. This facility was renovated in 2018 with high efficiency improvements including updated HVAC, monitoring systems and conversion to LED lighting. These two solar projects are expected to produce over 100,000 kWh annually and save approximately 60 MTCO2e to contribute to the City's greenhouse gas reduction goals.

Numerous additional sites have been identified for similar projects, some of which already have pending budget approval. These sites include but are not limited to City facilities such as Police Headquarters and Emergency Communications, Fleet Maintenance, General Services Department, and the new Water Management Facility. Furthermore, the City is currently evaluating both the feasibility of the installation of solar at the closed landfill as well as participation in the Duke Energy GSA program. A summary of potential solar sites is listed in Figure 3-22.

ROOFTOP SOLAR SYSTEMS

Image by City of Durham

Image by City of Durham

FIGURE 3-22 POTENTIAL SOLAR SITES

CITY OF DURHAM BUILDINGS	
A	Carolina Theatre
B	City Hall & Annex
C	GoDurham Administration
D	Durham Performing Arts Center
E	Parks & Recreation Administration
F	Durham Convention Center
G	Edison Johnson Recreation Center
H	Fire Station #2
I	Fleet Maintenance Department
J	Police Forensic Storage
K	General Services Department
L	Community Development
M	Police Headquarters
N	Public Works Operations Center
O	Sign and Signal Shop
P	Solid Waste Department
Q	Walltown Recreation Center
R	WD Hill Recreation Center
S	Mist Lake Facility (under construction)

PARKING GARAGES	
A	Durham Centre Garage
B	Chapel Hill Street Garage
C	Church Street Garage
D	Corcoran Street Garage
E	Morgan-Rigsbee Garage

WATER TREATMENT SITES	
A	Brown Water Treatment Plant
B	N. Durham Water Reclamation.
C	S. Durham Water Reclamation
D	Williams Water Treatment Plant

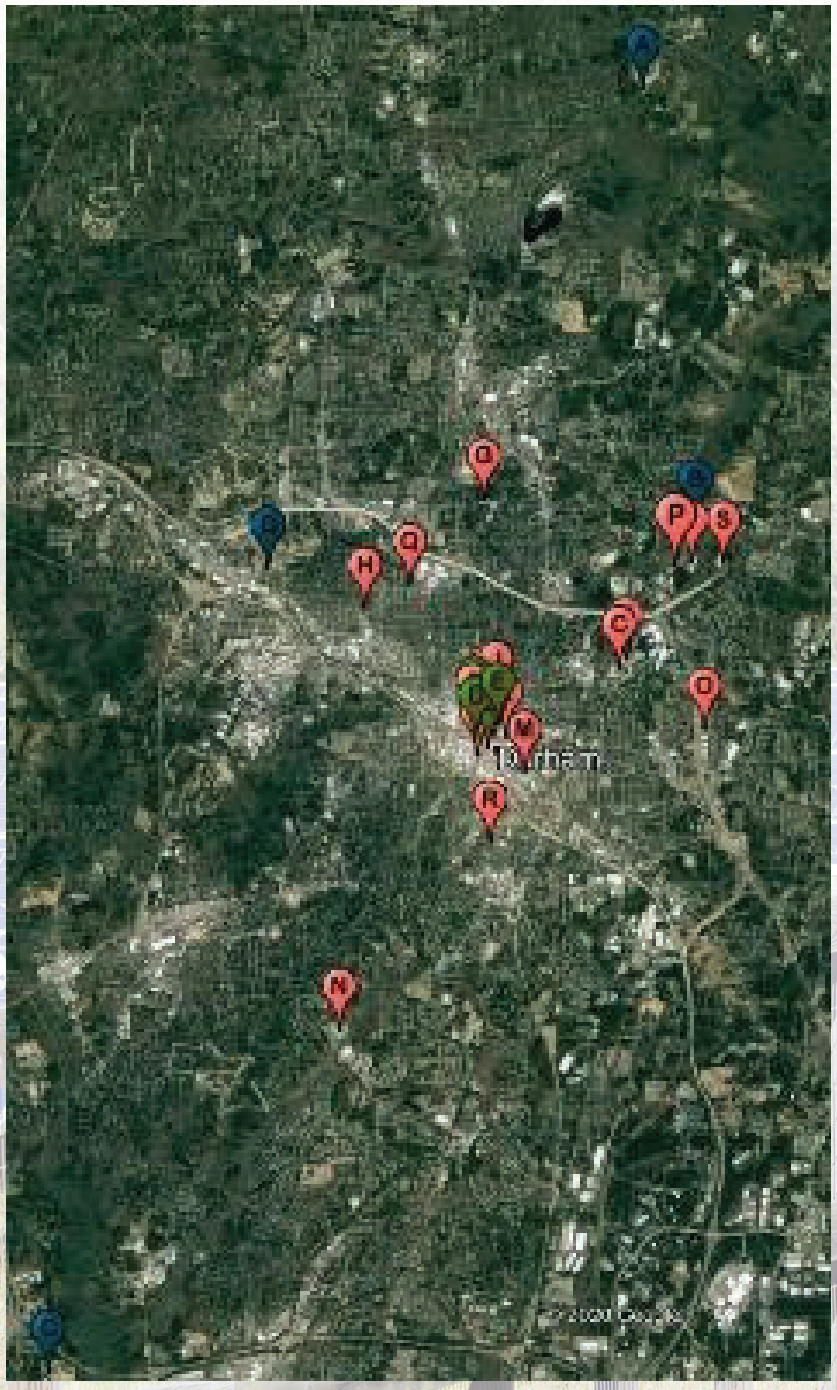


Image by Meister Photos/Shutterstock

Strategies for Renewable Energy

In order for the City to develop a strategy for evaluating opportunities in which the City can achieve the clean energy goals outlined in the 2019 resolution, Durham must assess the options available to them at present under existing regulatory and legislative policies. It is critical the City monitor and advocate for policy changes that promote and support additional renewable energy opportunities such as community solar and large-scale procurement options when they become available. Table 3-19 lists the renewable energy action items.

TABLE 3-19 ACTION ITEMS FOR RENEWABLE ENERGY

Action Item	Project	Description
RE-1	Rooftop Solar	Continue installation of rooftop solar systems on existing City facilities and all new construction as feasible. Explore the options to lease versus buy solar systems.
RE-2	Solar Canopies/EV Charging	Evaluate feasibility of solar canopies/systems at City parking facilities and fleet locations. Explore possibility to pair with battery storage or EV charging.
RE-3	Landfill Solar	Explore all potential landfill solar options including exposed geomembrane solar landfill cap.
RE-4	Microgrid/Solar/Storage	Study feasibility and implement projects using solar and battery storage for City facilities including community resilience hubs or recreation centers utilized as emergency housing.
RE-5	Architectural Solar Structure	Install solar structures such as flowers or trees at City parks or buildings for community education and awareness.
RE-6	Geothermal	Investigate the opportunity for geothermal energy to provide heating, cooling, and water heating in new construction.
RE-7	Large-scale procurement such Duke Energy Green Source Advantage (GSA) program	Continue pursuit of participation in Duke Energy Green Source Advantage Program (GSA) or similar program.
RE-8	Renewable Energy Certificates/Credits (RECs)	Evaluate purchase of Renewable Energy Credits (RECs) as needed to close any gaps to achieve renewable energy goals.
RE-9	Renewable Natural Gas (RNG)	Explore opportunities to source Renewable Natural Gas (RNG) supply from Dominion Energy.
RE-10	Duke Energy IRP	Advocate in Duke Energy's IRP for increased renewable energy resources and procurement options.
RE-11	Emerging Technology	Monitor and evaluate other potential technologies for renewable energy supply such as hydrogen, wind, and solar + storage.
RE-12	NDWRF CHP Project	Install Combined Heat and Power (CHP) system at NDWRF. Update project conceptual analysis from previous report and solicit proposals from design/build firms.

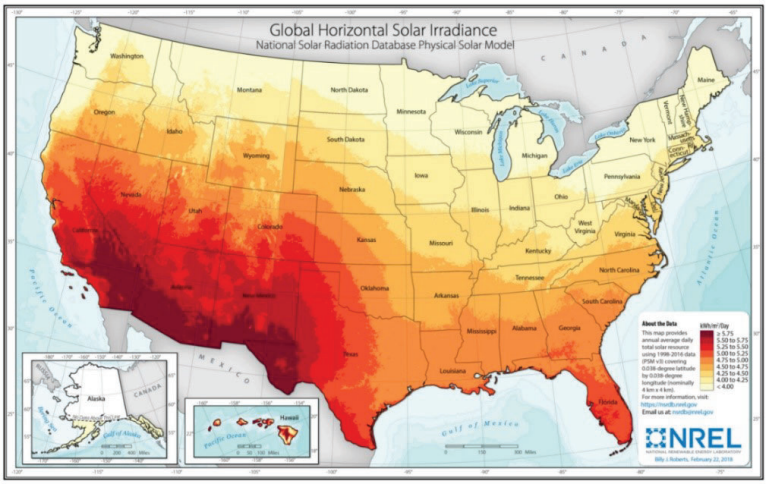
Image by Patrick Jennings/Shutterstock

On-Site Solar and Renewables

Solar PV proves to be the most prominent renewable resource that is used to achieve clean energy goals due to its relatively low cost and ease of installation. PV can be applied to smaller scale rooftops or parking canopies when available land is hard to obtain or installed on larger plots of land in rural or suburban locations in utility-scale applications.

It is useful to understand the solar energy potential to determine the expected level of renewable energy generation. Figure 3-23 below from NREL shows the United States Annual Solar Global Horizon Irradiance (GHI). North Carolina may achieve between 4.2-4.9 kWh/m2/day of solar irradiance.

FIGURE 3-23 US ANNUAL SOLAR GHI



ROOFTOP SOLAR

Continue installation of rooftop solar systems on existing City facilities and all new construction as feasible. Explore the options to lease versus buy solar systems.

As noted earlier, the City of Durham has completed studies and construction is underway with the installation of solar systems on City facilities. The City identified six additional sites for solar installation on existing facilities. Solar systems are also planned for new construction including Fire Station #19. The City should evaluate the feasibility of on-site solar for all new construction projects and renovations or expansions of existing facilities.

While it is important for the City to install rooftop solar for renewable energy generation and resiliency, the amount of rooftop solar is insufficient to meet the energy needs of the City. Therefore, larger scale solar projects are needed such as potential landfill projects, and utility-scale procurements. The City should explore all the potential funding sources for renewable energy projects including the incentives or rebates provided by Duke Energy. In addition, as more options become available, the City should evaluate leasing versus buying alternatives for renewable energy installations.

CANOPY AND GROUND-MOUNT SOLAR

Evaluate feasibility of solar canopies/systems at City parking facilities and fleet locations. Explore possibility to pair with battery storage or electric vehicle charging.

In addition to buildings, the City is evaluating parking decks for solar installations. The parking garage installation highlighted in Solar Power World that is located at the Staples headquarters in Framingham, Massachusetts is an example of innovative solar design.[33]

Image by SPW

Other potential City locations include the fleet management facility and transportation garage. Solar installations at these facilities could provide a renewable energy source to offset the electricity usage from increased vehicle electrification.

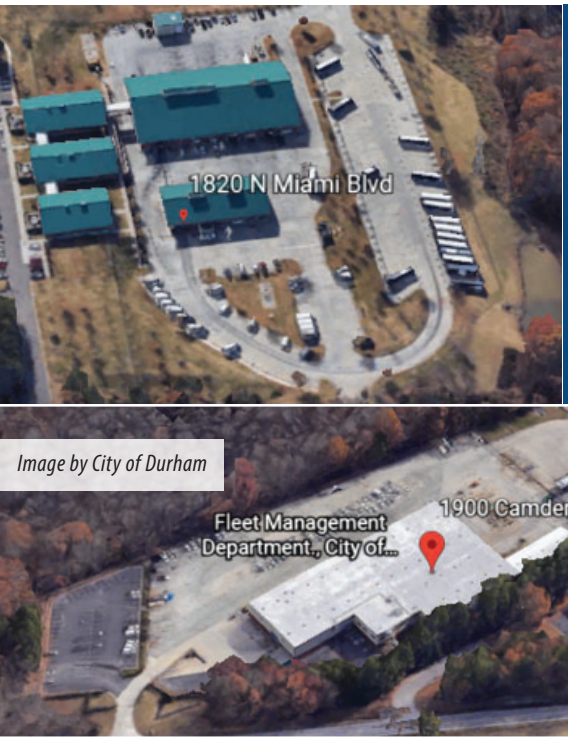


Image by City of Durham

City Locations for ***Potential Canopy and Ground-Mount Solar***

LANDFILL SOLAR

Explore all potential landfill solar options including exposed geomembrane solar landfill cap.

A landfill site generally provides a larger site and therefore a larger solar system around 2 MW. The City of Durham is actively exploring potential options for installing solar energy at the landfill. Several years ago, the City contacted a solar developer to provide an initial assessment on the feasibility of solar energy generation at the landfill. At that time, it was determined that the project may not be feasible for various factors. However, in recent months, the City has participated in conversations with municipal colleagues from other communities to share best practices and lessons learned. In order to develop a successful project, collaboration is needed with numerous stakeholders including the utility. Duke Energy and potentially the North Carolina Utilities Commission would need to be involved in the development and approval of a landfill solar project.

As with all renewable energy sources, technology is rapidly evolving. The City may want to reach out to learn more about the Hickory Ridge Landfill Solar Installation near Atlanta, Georgia. The facility is one of the first landfill solar installations in the world using geomembrane solar cap technology.[34]

Image by HDR

Hickory Ridge Landfill Solar Installation

Atlanta, GA

MICROGRID/SOLAR STORAGE

Study feasibility and implement projects using solar and battery storage for City facilities including community resilience hubs or recreation centers utilized as emergency housing.

As noted previously, the City of Durham received a study from NREL that analyzed solar plus storage opportunities at City Hall and Police Headquarters. As solar and storage technologies and pricing are rapidly changing, it would be worthwhile to update that analysis and expand the study to include other City facilities deemed critical infrastructure.

An economic energy storage system also has the potential to provide substantial benefits to diverse and underserved populations including increased energy reliability, decreased costs, improved health and safety, and improved service restoration following natural disasters or other crisis situations. By siting energy storage projects in areas with low-medium income populations, aging

infrastructure, senior citizen, and health care facilities as well as at-risk communities and schools the potential benefits may be realized and improve the quality of life for citizens. For these reasons, many municipal agencies will analyze their designated emergency shelter buildings such as recreation centers for solar storage analysis.

ARCHITECTURAL SOLAR STRUCTURE

Install solar structures such as flowers or trees at City parks or buildings for community education and awareness.

Architectural solar structures, sometimes referred to as solar trees or solar flowers, are a visual and innovative way to share solar success stories and to teach and inform the broader community about the benefits of solar. These structures may provide shade, cell phone charging, benches for seating, signage, and links to additional information.

The City can create an awareness of its efforts towards renewable energy with the installation of visible solar energy structures. Locations available to the public such as parks, recreation centers, City Hall, and Central Park are potential suitable sites for solar flowers and trees.

Image by Spotlight Solar

North Carolina State University Student-Funded Architectural Solar Structure

Designed & Built by Spotlight Solar

Image by City of Durham

GEOTHERMAL

Investigate the opportunity for geothermal energy to provide heating, cooling, and water heating in new construction.

Investigate the opportunity for geothermal energy to provide heating, cooling, and water heating in new construction.

Although North Carolina is not well-suited to generate utility-scale electricity from geothermal power, the City is still able to use it at its facility locations. Ground source heat pumps (GHPs), sometimes referred to as GeoExchange, are energy efficient clean energy technologies which transfer heat to or from the ground for heating and cooling purposes. Although many parts of the country experience seasonal temperature extremes -- from scorching heat in the summer to sub-zero cold in the winter—a few feet below the earth's surface the ground remains at a relatively constant temperature. Depending on latitude, ground temperatures range from 45° F (7° C) to 75° F (21° C). Like a cave, this ground temperature is warmer than the air above it during the winter and cooler than the air in the summer. The GHP takes advantage of this by exchanging heat with the earth through a ground heat exchanger.

The City should continue to evaluate the opportunity for geothermal energy as new facilities are designed.

The new Mist Lake Water Management facility currently under construction, incorporates a geothermal system for heating and cooling.

Off-Site Solar and Renewables

DUKE ENERGY GREEN SOURCE ADVANTAGE PROGRAM

Continue pursuit of application and RFP process to participate in Duke Energy Green Source Advantage Program (GSA) or similar program.

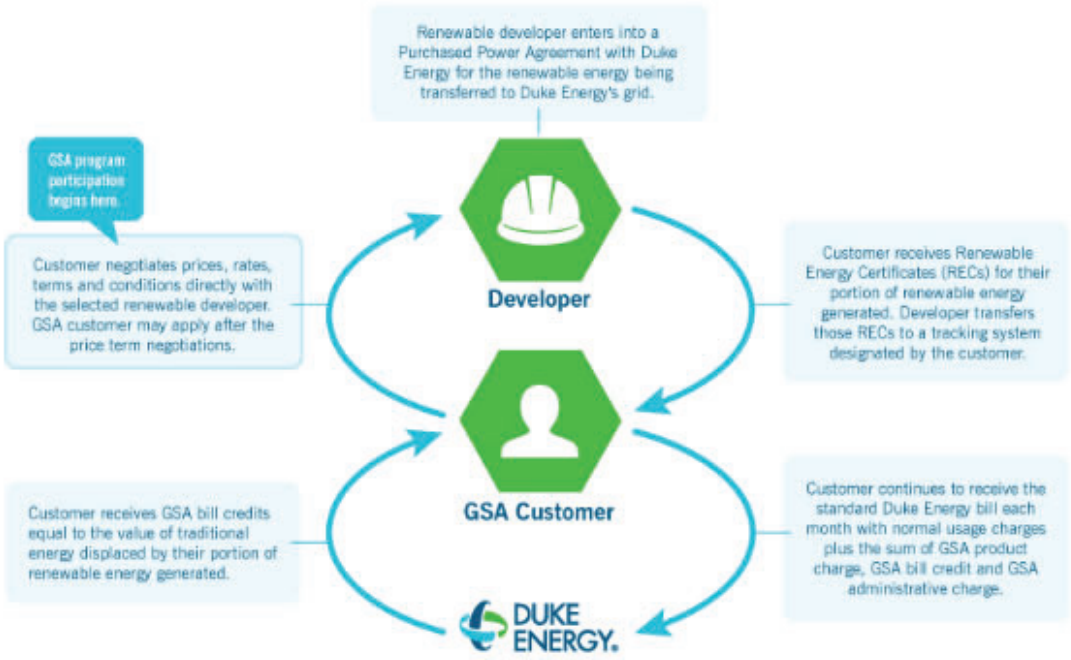
The Duke Energy Green Source Advantage (GSA)[35] program provides the opportunity for the City of Durham to support renewable energy development in North Carolina. GSA is one of the solar programs established by the Competitive Energy Solutions Law, better known as N.C. HB 589. Available on a first come, first-served basis, this renewable energy program will be available until the total 600 MW allocation is fully subscribed. Currently, 250 MW is reserved for large non-residential customers such as the City. The GSA relationship between Duke Energy, the City of Durham, and the renewable developer is represented in Figure 3-24.

The Consultant team worked with the City and County to evaluate the potential opportunity to participate in the Duke Energy GSA program. Also, meetings were conducted with the City of Charlotte, N.C. Utilities Commission (NCUC) Public Staff, and several solar developers.

The decision was made to issue a Request for Information (RFI) to determine level of interest from renewable suppliers and availability of eligible projects in the Duke Energy Interconnection Queue. The Consultant team supported the development of the RFI which was released on October 1, 2020, with responses due by October 16, 2020.

Based on the response from the RFI, the City and County issued a Request for Proposals (RFP) in January 2021 for up to a 30 MW solar system. The City's portion of this system would be 20 MW and the County's would be 10 MW. This renewable energy project would offset approximately a third of the City's total energy consumption. Several proposals were submitted and evaluated by a cross-functional team. The City is working toward an agreement with a solar developer to submit an application to the GSA program.

FIGURE 3-24 DUKE ENERGY GREEN SOURCE ADVANTAGE PROGRAM



RENEWABLE ENERGY CREDITS (RECS)

Evaluate purchase of Renewable Energy Credits (RECs) as needed to close any gaps to achieve renewable energy goals.

The City of Durham may need to purchase RECs to help close any remaining gaps to meet their renewable energy goals. Because the state of North Carolina does not currently have a renewable energy mandate, there is no formal REC market. As such, RECs can be procured from local North Carolina renewable generation facilities or purchased from clean energy generators located in any of the 50 states. The North Carolina Utilities Commission established the North Carolina Renewable Energy Tracking System (NC-RETS) to issue and track RECs and energy efficiency certificates.[36] North Carolina electric utilities use NC-RETS to demonstrate compliance with state or local renewable energy goals. The current market price for certified National Solar or National Wind RECs is approximately $3.50 per REC,[37] where one REC equals one MWh of renewable generation. The City of Durham would likely partner with or hire a REC broker that could introduce the City potential sellers of RECs across the U.S. and obtain competitive pricing for these credits. Brokers generally charge approximately a 2% commission.

RENEWABLE NATURAL GAS

Explore opportunities to source Renewable Natural Gas (RNG) supply from Duke Energy.

Although natural gas is a relatively small contributor to Durham's GHG emissions, the City should explore the potential to source RNG to reduce the impact of natural gas usage. Dominion Energy (Dominion) has recently pursued two partnerships that convert methane from both hog and dairy farms into clean RNG.[38] In December 2020, Dominion and Smithfield Foods, Inc. (Smithfield), completed the first large-scale RNG project through their joint venture, Align Renewable Natural Gas, in southwestern Utah. Align RNG is now producing renewable gas from a network of 26 hog farms under contract with Smithfield. At full capacity, the project can produce enough RNG to reduce annual emissions from participating farms by more than 100,000 MTCO2e and heat more than 3,000 homes and businesses. Dominion and Smithfield have jointly pledged to invest $500 million over the next 10 years to develop additional RNG projects across the country, including projects currently under development in North Carolina and Virginia.

Similarly, Dominion has partnered with Vanguard Renewables, investing more than $200 million in the conversion of methane from dairy farms into RNG. A dairy RNG production would include 20,000 to 30,000 cows.[39] The manure is processed through Vanguard's anaerobic digesters, capturing the methane that would have otherwise been emitted. This process cuts emissions from agricultural operations and provides farmers an additional revenue stream. By 2024, multiple projects are expected to be sited in Georgia, Nevada, Colorado, New Mexico, and Utah.

EMERGING TECHNOLOGY

Monitor and evaluate other emerging technologies such as hydrogen, wind and solar + storage for City operations.

Hydrogen. As more emphasis is placed on decarbonization and renewable energy, emerging technologies will become increasingly relevant as the cost of these alternatives continue to decline over time and the technologies are proven. Green hydrogen is an example of a fuel source that will help to decarbonize the future as the costs are expected to decrease and become competitive with traditional hydrogen fuel sources. Green hydrogen is produced using renewable energy instead of fossil fuels, typically through electrolysis, leveraging renewable generation to split water into oxygen and hydrogen. If electrolyzer manufacturing can scale up and costs

of electrolyzers continue to fall, renewable hydrogen will become cost competitive.

Wind. Wind resources are another renewable resource that the City could potentially benefit from in the future. Wind generation usually occurs in the evening or overnight and could be complimentary to the City's solar production and reduce reliance on RECs so as to meet the renewable energy goals. A small-scale wind turbine can have a generating capacity between 0.3 to 100 kW and typically needs wind speeds of four meters per second at the height of the turbine. Although North Carolina has relatively low annual average wind speeds, Figure 3-25 illustrates there may be potential for wind facilities near the Durham area.

Solar + Storage. Battery energy storage is still considered a new and growing technology as more systems are installed on the grid. Currently, much of the lithium-ion energy storage is limited to shorter duration facilities such as two-hour and four-hour configurations due to the higher cost of batteries modules. While the cost of batteries continues to decrease over time, other types of batteries are being developed, researched, and tested to solve efficiency problems, increase the available energy capacity, or combat system degradation. One example of this is vanadium, redox flow batteries that can withstand longer durations of discharge while maintaining low levels of annual degradation. Although these batteries are not commercially available yet, they can provide future support for the growing penetration of intermittent renewable resources.

When used to achieve renewable energy or carbon neutrality goals, solar PV is typically paired with battery storage systems to help mitigate issues of intermittency and extend the hours in which generation can be used to meet electricity needs. Investment in battery storage is increasingly important as more solar capacity is installed on the grid. Because battery storage remains the only way to maintain reliability while increasing solar penetration into one's portfolio, demand for the technology has grown and continues to increase significantly in both the utility as well as the transportation industry, driving down the cost of lithium-ion in recent years.

FIGURE 3-25 NORTH CAROLINA ANNUAL AVERAGE WIND SPEED AT 80 M

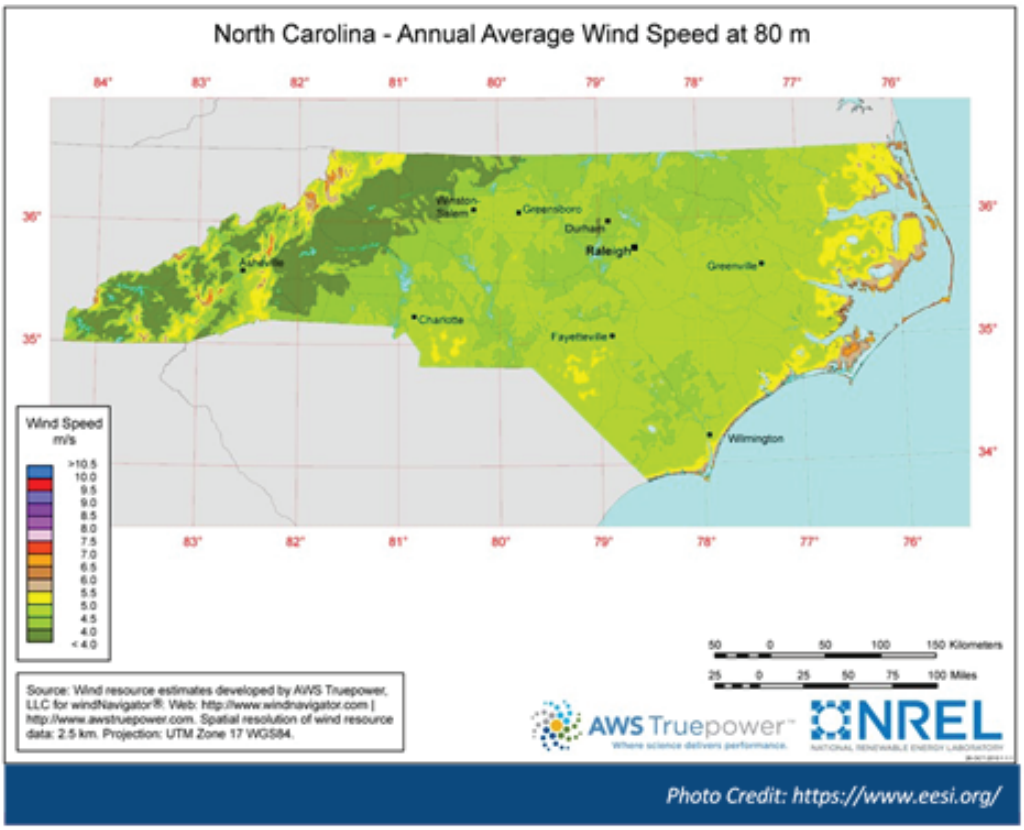


Image by samray/Shutterstock

3.5 INNOVATIVE CARBON REDUCTION PRACTICES AND COMMUNITY PARTNERSHIPS STRATEGY

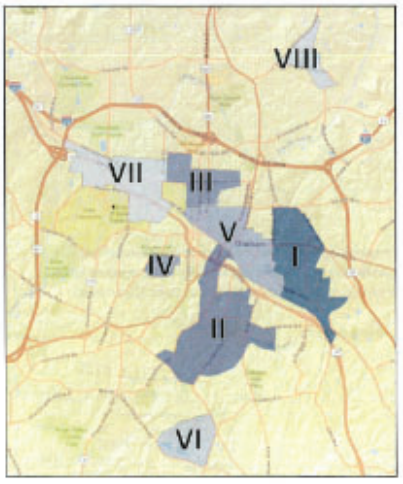
Achieving the City's ambitious goals requires new innovative carbon reduction practices and community partnerships. Carbon reduction practices incorporate existing initiatives such as expanding the City's tree canopy to emerging technologies such as low carbon concrete. Partnerships will be imperative for the City's completion of the action items. Therefore, the City will need to collaborate with stakeholders and community members to gain perspectives and insights throughout the implementation process. In addition, the City will need to examine and adapt its internal practices, programs, and policies to reflect its priorities to decarbonize operations and do so in a manner that is fair, just, and equitable to all of Durham's residents.

Innovative Carbon Reduction Practices

Reducing the City's overall GHG emissions will require establishing carbon reduction practices that incorporate innovative solutions. These solutions may be existing initiatives such as the tree canopy program as well as pilot programs for emerging solutions such as green roofs and low carbon concrete. These efforts should support energy efficiency, electrification, and renewable energy strategies with a focus on environmental justice and energy equity.

Tree Canopy

Durham enjoys a beautiful tree canopy comprised of over 16,000 trees. Trees provide many benefits: clean air, equity and social benefits for previously underserved communities, energy savings associated with increased shade, and general civic pride. The City currently seeks to maintain a 52% tree canopy and has a goal to increase the canopy to 55% by 2040. There are nearly 9,000 future planning sites identified to grow and maintain the canopy. The new trees will be primarily planted in underserved areas.[40]



COMMUNITY SPACES & GREEN ROOFS

The U.S. Forest Service estimated the carbon savings from Durham's current tree canopy is valued at $1.4 million and street trees are saving Durham residents over $682,000 per year through lower energy bills and improved air quality. The City of Durham currently has a Tree Planting Program with a goal of planting 1,500 trees per year among predetermined city rights-of-ways through 2025. The number of trees was determined based on a 2017 Tree Canopy Assessment done by Savatree and University of Vermont. A secondary study from the U.S. EPA determined eight neighborhoods in Durham that could benefit from this program and 85% of these trees will be planted there.

Community Green Spaces

The City of Durham and Durham County developed an Urban Open Space Plan in 2017.[41] This plan analyzed Durham's open space inventory based on community suitability, proximity, access, and identification of challenges/opportunities. In 2019, in coordination with the Conservation Fund, the City of Durham purchased the Durham Belt Line Property and with the Atlanta Belt Line as a model, the City plans to turn the property into an urban green space that will be an asset to several neighborhoods while also providing safe spaces for pedestrian and bicycle traffic.

Green Roofs

A green roof is an extension of an existing roof system and may include drainage systems, plants, renewable energy systems, water collection, and amenity spaces such as outdoor seating and walkways. Some of the many benefits are reduced heat island effect, enhanced air quality, noise reduction and stormwater management. Opportunities may also exist for a local community garden depending on the size and location of the facility. It is suggested that the City investigate the potential of creating green roofs on new and existing facilities.

Image by Greenroofs

Image by Greenroofs

The Southface Institute in Atlanta, Georgia is a showcase and training facility for sustainable building technologies. The 10,100 square foot Eco Office with a green roof opened in 2009. The Turner Foundation Green Roof on top of the third floor expands the office space into a rooftop patio with a beautiful view of downtown Atlanta. The vegetated roof is home to a 6.4 kW photovoltaic array and a 1,750 gallon rainwater collection cistern. The photovoltaic array is salvaged from a BP gas station and serves as a shade canopy for the deck. The rainwater cistern supplies water for several of the building's water uses and is backed up by water collected in the site cistern.[42]

Green Burial

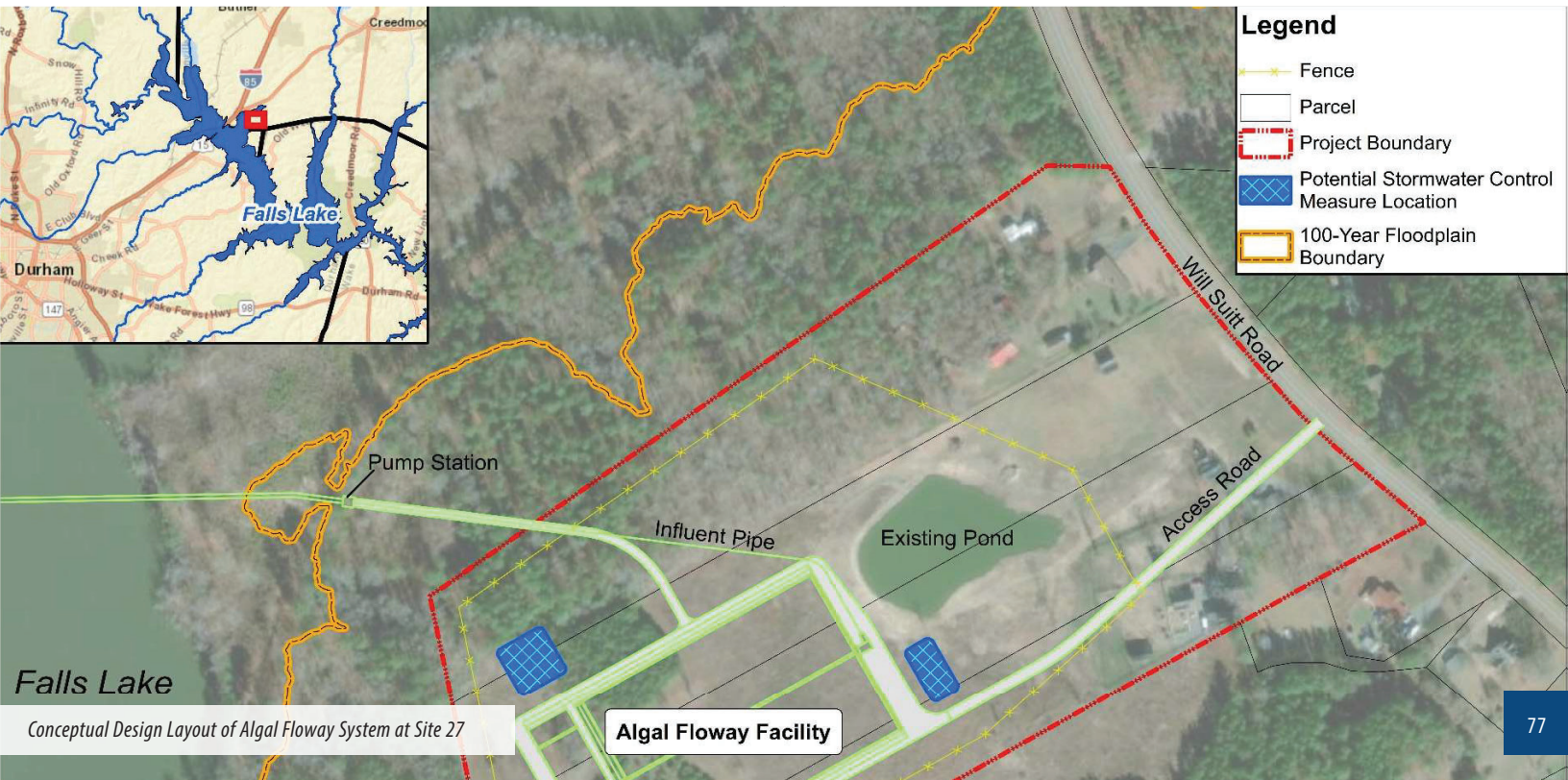
Throughout North Carolina, there are several green burial grounds, which adhere to the strict rules of burial without embalming, vaults, or impervious containers. The Green Burial Project is based out of Orange County, North Carolina and works to educate the community on the benefits of natural burial in terms of carbon emission reduction, conservation of natural resources, and preservation of natural habitats. Natural burial sites can also be established through hybrid sections of existing cemeteries or through partnerships with conservation organizations with plans for long-term conservation of the land.[43] The City should consider if this presents a viable option for Durham cemeteries.

Algal Floway Site

An algal floway system is constructed to provide clean and safe water. This system is an ecological technology that removes nutrients from surface waters by growing and harvesting algal biomass. A site selection and conceptual design plan for an algal floway was prepared for the City of Durham. An on-site solar array could provide renewable energy for the facility, which would create an additional environmental benefit of the project.

Low-Embodied Carbon Concrete (LECC)

According to the Chatham House, more than four billion tons of cement are produced globally, accounting for about 8% of global CO2 emissions.[44] Carbon Cure, a company based out of Nova Scotia, is producing a new concrete product from the process of CO2 mineralization in which carbon dioxide reacts with calcium ions in a wet concrete mix to form calcium carbonate.[45] These molecules remain within the mix and strengthen the resulting concrete. Carbon sequestering cement is a fairly new technology in any of its forms. As availability and price improve, low carbon cement companies could be helpful to cities trying to become carbon neutral while building new green infrastructure. LECCwork is a group of volunteers working to transform concrete through local action and has several resources for more information.[46] The City may want to consider a



Conceptual Design Layout of Algal Floway System at Site 27

pilot project such as a sidewalk made with low-embodied carbon concrete.

Affordable Housing

In November 2019, City of Durham voters approved a $95 million housing bond referendum.[47] This bond is planned to be used for building 1,600 affordable housing units, moving over 1,700 homeless individuals into permanent housing, and helping low-income renters remain in their homes. The City is currently partnered with the Durham Housing Authority in renovation of aging public housing units in central Durham which is also funded by the Affordable Housing Bond. The City should endeavor to renovate existing facilities and build new facilities to the highest possible green building standards. This could include high efficiency measures such as insulation, appliances, and heating and cooling systems. Renewable energy options should also be prioritized for affordable housing.

Green Leases

A green lease is a lease agreement with modified terms to achieve mutual sustainability goals between a landlord and tenant; many of these goals being focused on energy efficiency and reaching energy industry standards. Green leasing is estimated to reduce energy consumption in office spaces by 11-22% and create up to $3 billion in annual cost savings. The Building Owners and Management Association released a guide to green leasing with terms and amended clauses that they consider standard for commercial leases.[48] Potential clauses that could be added are insurance coverages for repairs and restorations in order to comply with new ENERGY STAR, LEED, and other certifications along with annual operating charges to ensure funds for these building restorations. Other potential terms of a green lease are mandatory recycling and trash separation compliance, bans on tenant generation/storage of hazardous materials that are known pollutants, landlord requirements to reduce

Image by City of Durham

Algal Floway Site

Image by City of Durham

single-person automobile use with parking reductions and included parking for electric vehicles, landlord requirements to use electric wiring and facilities under 0.85 watts persquare foot and tenant use of energy efficient appliances such as LED lightbulbs, water-conserving plumbing fixtures, and ENERGY STAR appliances.[49] The City may consider green lease options with tenants in City owned facilities.

Carbon Offsets

The City of Durham's goal is to achieve carbon neutrality by 2040. This CRNE identifies a series of strategies to move the city toward this goal. However, based on current technology and assumptions, carbon offsets may be needed to meet the carbon neutrality goal. A carbon offset is created by facilities or projects that mitigate carbon dioxide or carbon dioxide equivalents (greenhouse gas emissions, such

as methane or nitrous oxide). Similar to RECs, carbon offsets can be purchased and used to achieve carbon neutrality goals. In 2003, the NCUC approved the NC GreenPower program plan.[50] NC GreenPower is an independent, nonprofit program that uses voluntary contributions to encourage the development of electricity generated from renewable energy sources and mitigate greenhouse gases. The carbon offset projects that NC GreenPower is involved in are located in North Carolina, South Carolina, and Virginia. These projects are certified by a third party that provides accurate and transparent measurement, verification, and tracking of greenhouse gas reductions and their inventories. Large volume users in North Carolina may contribute a minimum of $100 per month toward renewable energy at $2.50 per block, where one block is equivalent to 1,000 pounds of carbon dioxide.

Community Partnerships Strategies

A key element of the CNRE Action Plan is to develop partnerships with key stakeholders - both internal and external to the City. Sustainability staffing, internal cross-departmental leadership and implementation teams are needed to accomplish the City goals. In the community, partnerships with residents, businesses, community service organizations, utilities, non-governmental organizations (NGO) and others should be created to advise and support the implementation of the strategies and action items.

Internal Partnerships

Sustainability Staffing

The successful implementation of the Plan requires City staff members who are dedicated to the various elements of the overall plan. In general, sustainability programs for municipal programs include four to ten or more dedicated resources. The City of Durham should consider creating a Sustainability Division lead by a Division Manager who oversees four sustainability staff positions: Sustainability and Energy Program Manager, Sustainability Resource Analyst Senior (Grants), Sustainability and Energy Program Analyst, and Sustainability and Energy Program Coordinator.

As energy efficiency, renewable energy and sustainability project funding are foundational to the achievement of the goals, the City should consider two additional positions to drive the execution of the CNRE Action Plan. The positions suggested are a Sustainability Resource Analyst Senior (Grants) and Sustainability and Energy Program Coordinator.

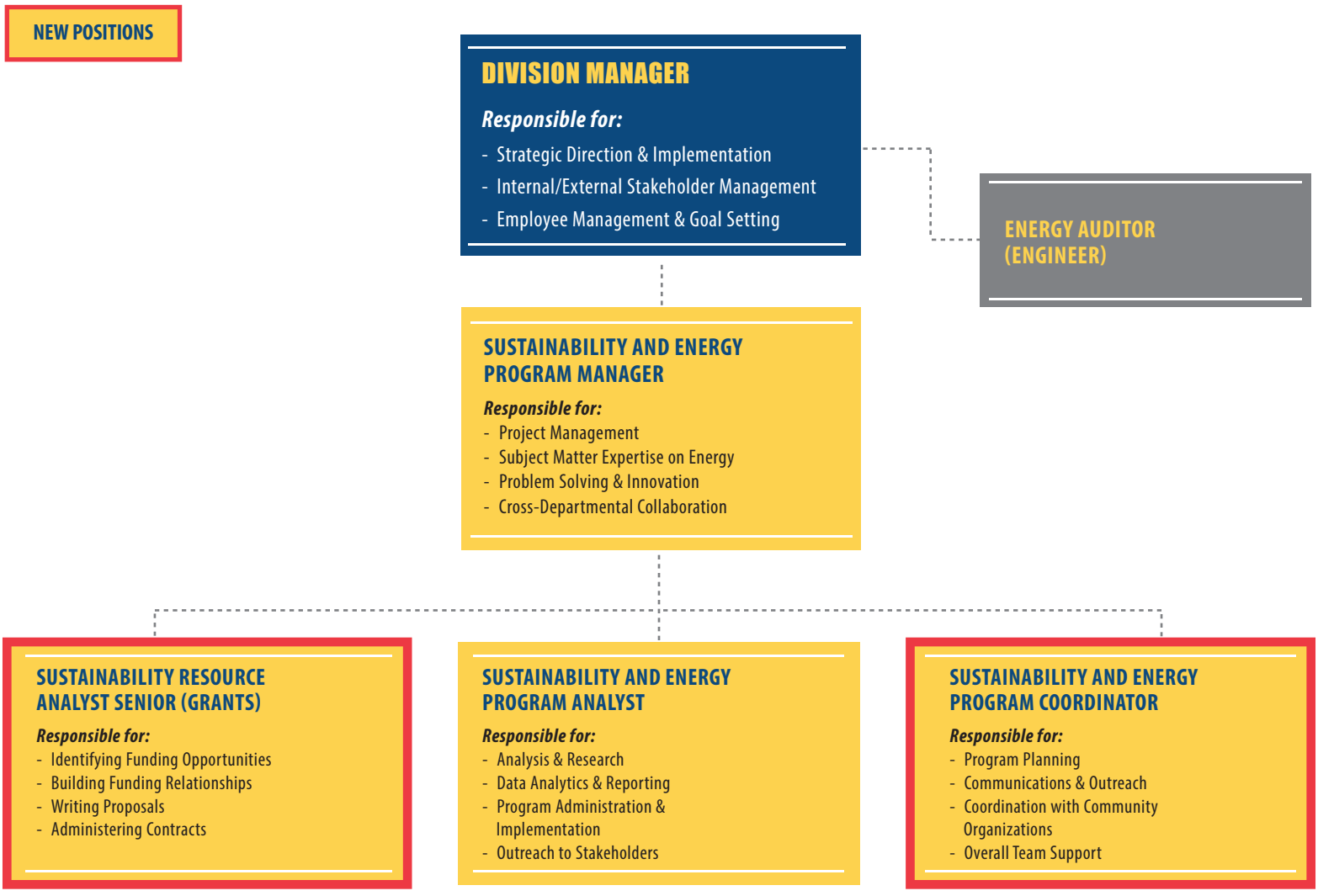
image by City of Durham

Sustainability and Energy Program Manager. The Sustainability and Energy Program Manager is responsible for developing, implementing, and leading efforts across the City in the areas of energy management, energy efficiency and renewable energy in close collaboration with other City departments including Finance, Procurement, Facilities, Water Management, Fleet and Transportation, and others as applicable. This position works cross functionally and proactively to establish and maintain clear and industry-leading standards and operations for the responsible purchase, use and tracking of energy, including renewables both currently available and future technologies.

Sustainability Resource Analyst Senior. The Sustainability Resource Analyst Senior is responsible for identifying, researching, and writing proposals for funding opportunities from federal, state, philanthropic, utility, private business, and other potential sources. This position supports the City across departments including General Services, Fleet, Transportation, and others as applicable. The Sustainability Resource Analyst Senior will create a strategic plan to identify sources, develop compelling proposals, build strong relationships with potential funding partners and coordinate contract and reporting requirements.

SUSTAINABILITY AND ENERGY PROGRAM MANAGER

SUSTAINABILITY RESOURCE ANALYST SENIOR



Sustainability Teams

The Sustainability staff will lead and coordinate a Sustainability Team made up of representatives from key City departments. This team will collaborate on implementation of the various action items identified in the CNRE Action Plan. Further, this team should develop a comprehensive education and outreach strategy to involve the external stakeholders and create community partnerships. These teams will also ensure coordination with other City initiatives including the Strategic Plan, Roadmap to Sustainability and LEED for Cities Certification. The team will produce an annual progress report on the goals identified in the CNRE Action Plan.

The General Service Department is the primary responsible party for management and implementation of the CNRE Action Plan. However, it will take many departments working together to attain the City's goals. Additional City departments that are crucial to the successful execution of the Plan include, but are not limited to, those listed below.

- **Budget and Management Services**
- **City Attorney's Office**
- **City Manager's Office**
- **City-County Planning**
- **Equity and Inclusion**
- **Finance**
- **Fleet Management**
- **Human Resources**
- **Community Development**
- **Neighborhood Improvement Services**
- **Office of Public Affairs**
- **Office on Youth**
- **Parks and Recreation**
- **Public Works**
- **Solid Waste Management**
- **Technology Solutions**
- **Transportation**

External Partnerships

The City of Durham is a thriving and vibrant community with residents eager to support the transition to a cleaner energy supply and decarbonization in a way that provides benefits to all. Partnerships with community organizations, educational institutions, local businesses, advocacy organizations, neighborhood associations, and more provide critical insights and ideas regarding the implementation of the plan's strategies and action items. As the City's energy provider, Duke Energy is a key partner in the development and implementation of the CNRE Action Plan.

Carbon Neutrality and Renewable Energy Community Task Force

The City will lead the facilitation of a community task force to involve citizens in the implementation of the CNRE Action Plan with emphasis on ensuring a fair, equitable and transparent process. This task force is expected to meet on a regular basis and develop the framework for energy equity and environmental justice, workforce development and job training, and community and economic development. Some of the organizations that should be part of the task force include, but are not limited to, those listed below.

- ***Durham Environmental Affairs Board***
- ***Keep Durham Beautiful***
- ***Community Action Agency***
- ***Colleges and Universities***
- ***Faith Community***
- ***Advocacy Organizations***
- ***Neighborhood Associations***
- ***Business Community***
- ***Sustainability Organizations***
- ***Duke Energy***

Universities and Technical Colleges

North Carolina is fortunate to have many universities and technical colleges within the immediate vicinity of Durham that can be leveraged for assistance with the City's carbon neutrality efforts. Job creation and economic development are expected benefits of the implementation of this Plan. The City should consider a partnership with universities and technical colleges to develop a workforce development strategy including "green" job training. In addition, the City may want to consider creating a sustainability internship program or sustainability days to further outreach opportunities.

Image by City of Durham

A summary of some of the higher education sustainability related initiatives in the local community are provided below.

The N.C. Community College System launched a "code green" program that was approved by the State Board of Community Colleges in 2012.[51] The "code green" work resulted in the redesign of five areas including buildings, energy, engineering, environment, and transportation technologies. Over 360 courses were revised or developed and competencies for renewable sources of energy and energy efficiency were incorporated.

Durham Technical Community College is the closest community college within the City of Durham and many of the specific trainings and pathways such as automotive systems technology which may prove useful for emerging technology training.[52]

The University of North Carolina System is also a great resource for the City of Durham in many respects. For example, the North Carolina Clean Energy Technology Center (NCCETC) has a variety of training, research, and technical assistance available.[53] A few include their energy and sustainability services, online training in solar PV, renewable energy, and vehicle electrification.

The University of North Carolina at Chapel Hill's School of Government has faculty expertise in numerous fields. If the City of Durham decides to initiate a green bond, tax increment financing, or other financial strategy, professors within the school are available to assist with implementation questions.

North Carolina Central University offers an Environmental Science concentration as part of an interdisciplinary program. ***Appalachian State University*** offers clean energy programs including the Bachelor of Science in Sustainable Technology. ***N.C. Agricultural and Technical State University*** has a Center for Energy Research and Technology that is focused on renewable energy, energy efficiency, alternative fuels, vehicle technologies, sustainable buildings, and the environment. ***East Carolina University*** has a Center for Sustainable Energy and Environmental Engineering that provides workforce training and research on clean energy technologies.

Students in these various programs may be good candidates for summer interns or future sustainability positions.

Within the private and independent colleges and universities, ***Duke University*** has the nationally renowned Nicholas School and the Nicholas Institute for Environmental Policy Solutions with research and teaching expertise across a spectrum of clean energy topics and technologies; ***Wake Forest University*** has a new Master's Program in Sustainability headed by a former Deputy Administrator of the U.S. EPA.

Duke Energy

Duke Energy is a critical partner in the City's efforts to achieve carbon neutrality and 100% renewable energy. It is imperative to continue the on-going collaboration through the MOU Workplan and other new initiatives and programs. Some of the current initiatives include an on-bill tariff financing pilot program, the GSA program, electric vehicle charger infrastructure programs, energy efficiency and DSM opportunities, as well as renewable energy innovations. As always, the City should work with Duke Energy to ensure each account is on the best rate option and conduct an annual evaluation of energy consumption and billing. This is especially important with the increased electricity usage due to fleet and transportation electrification.

In addition to serving the energy needs of the City, Duke Energy is actively involved in the communities which it serves. This involvement could provide additional support for community-wide initiatives and evaluation of new or existing programs such as the on-bill tariff financing pilot program, weatherization and energy efficiency resources for Durham residents, expansion of EV public charging infrastructure and overall community involvement and volunteerism.

Image by Wileydoc/Shutterstock

BUILDING NEIGHBORHOOD RESILIENCE

...in the Ellerbe Creek Watershed

SOUTHEAST SUSTAINABLE COMMUNITIES FUND GRANT PROJECT

The ***Southeast Sustainable Communities Fund*** awarded a $300,000 grant to the City and six other project partners (Durham County Soil & Water Conservation District, Durham Public Schools, Ellerbe Creek Watershed Association, North Carolina Cooperative Extension Service, Rebuilding Together of the Triangle, and The Conservation Fund) in 2019 for the purpose of Building Neighborhood Resilience in the Ellerbe Creek Watershed. Project partners are working in underserved Durham neighborhoods over the three-year grant term to reduce stormwater runoff, streambank erosion and flooding and improve energy and water efficiency in homes. An important secondary goal is to provide students with an opportunity to learn green infrastructure job skills through an innovative training program based at two local high schools. The grant will fund installation of stormwater mitigation measures such as downspout disconnections, cisterns, and rain gardens on homes and properties in underserved neighborhoods, as well as planting trees and stabilizing streambanks along streams that are vulnerable to erosion and flooding. It will weatherize homes in those same neighborhoods, install water-saving devices, and provide homeowners with information about available incentives for further energy savings. It will also provide training to residents and landscapers on green infrastructure measures.

Image by City of Durham

Image by City of Durham

3.6 FINANCIAL CONSIDERATIONS

Decarbonizing requires investment in new technologies and practices, though those investments can also lead to long-term cost savings. As communities, Fortune 500 companies, and countries around the world are developing decarbonization strategies and action plans, the financial community is investing in these initiatives and supporting sustainability efforts with clients. Larry Fink, CEO of BlackRock, has been advocating the importance of sustainability investment. In his 2021 client letter, he states, "We also believe that climate transition creates a historic investment opportunity. With the world moving to net zero, BlackRock can best serve our clients by helping them be at the forefront of that transition."[54]

In addition to the financial community's investment in clean energy and decarbonization, the Biden administration released a $1.52 trillion fiscal year 2022 budget proposal in April 2021. A recent article from Sidley Austin LLP summarizes the climate related funding, "As expected, the proposal includes an unprecedented amount of funding to advance the President's "whole-of-government" approach to addressing climate change and achieving net-zero greenhouse gas emissions by 2050. Notably, the word "climate" appears 146 times in the submission to Congress — more than "COVID," "pandemic," and "infrastructure" combined. Indeed, the President signed into law the $1.9 trillion COVID-19 relief bill last month and separately released a $2 trillion infrastructure proposal. The overall spending levels for climate, which cuts across nearly every federal agency, amounts to more than a $14 billion increase from FY21 spending levels."[55] Some of the agencies receiving funds will include the U.S. EPA, U.S. Department of Agriculture, U.S. Department of Commerce, U.S. Department of Energy (DOE), Department of Health and Human Services (HHS), Housing and Urban Development (HUD) and others.

Achieving the City's decarbonization goals will require the investment of resources including time and money. Even though some opportunities may provide a positive return on investment, upfront costs will be incurred. To help cover those costs, the City should seek out innovative solutions and consider all potential funding sources including federal, state, and local funds, government financing, and public-private partnerships.

Greenhouse Gas Supply Curve

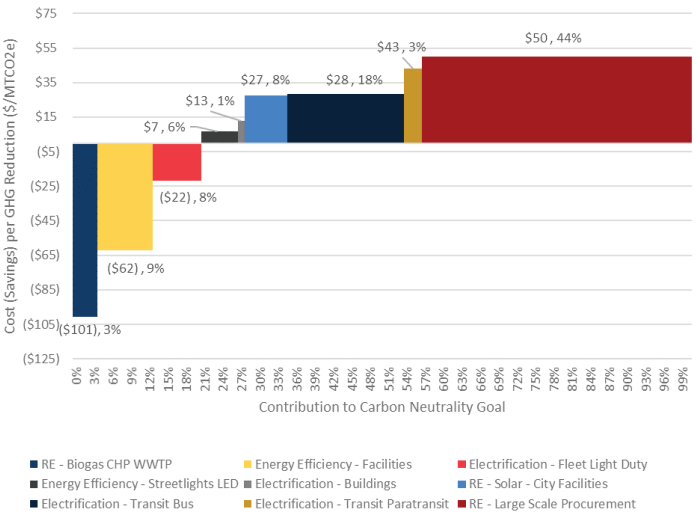
The marginal abatement cost curve or "supply curve" is a common tool for comparing various GHG emission strategies based on their cost and relative level of contribution to GHG reduction. For Durham, this cost curve indicates a mix of initiatives that can lead to lifecycle cost savings (<$0 per ton of carbon) as well as initiatives that lifecycle costs greater than $0 per ton of carbon. The supply curve describes the savings or cost per ton of carbon as well as the share each offers to reducing the City's carbon footprint. The height of the bar represents the cost (or savings) of reduction in MTCO2e. The taller the bar, the greater the cost (or savings) of the reduction strategy. The width of the bar represents relative share of emissions reduction. The wider the bar, the greater the contribution to GHG emissions reductions.

The reduction strategies are ordered from left to right in order of least cost to highest cost. Strategies that save money over the lifecycle of the project have negative costs (savings). Energy efficiency strategies are often at the far left of the curve and projects with incremental costs or new/emerging technology will generally be at the right of the curve.

2021–2030 Supply Curve

The 2021-2030 GHG Supply curve for the City of Durham is presented in Figure 3-26.

FIGURE 3-26 2030 GHG SUPPLY CURVE



The City of Durham GHG supply curve was developed from analysis of the various strategies and action items to determine the level of GHG reduction potential along with financial considerations of capital cost, operating costs, and annual savings. A summary of the results of the financial analysis and GHG supply curve is as follows.

1. Renewable Energy – Biogas CHP Wastewater Treatment Plant

The renewable energy biogas CHP offers the greatest potential savings of all the strategies and represents about 3% of the contribution to GHG emissions reduction.

2. Energy Efficiency – Buildings

Energy efficiency also offers savings while contributing about 9% to the GHG emissions reduction. This is in line with general industry trends for energy efficiency and is generally considered the first resource for a decarbonization strategy.

3. Electrification – Fleet Light Duty

Light Duty Fleet Electrification provides some savings and contributes about 8% of GHG emissions reduction in first 10 years. This increases to 15% by 2040 as more of the light duty fleet is converted to electric including police vehicles and light duty trucks. In addition, the savings will increase over time as cost parity between electric vehicles and internal combustion engine vehicles is achieved.

4. Energy Efficiency – Streetlights LED conversion

The conversion from Mercury Vapor and High-Pressure Sodium lights to LED offers significant energy savings for lighting and contributes about 6% of the GHG emissions reduction. However, due to the Duke Energy rate structure, there is an on-going incremental cost associated with these lights.

5. Electrification – Buildings

As the City uses a relatively small amount of natural gas, building electrification offers about 1% to the overall reduction in GHG emissions. In addition, it may be costly to replace the equipment and associated infrastructure so there is an incremental cost to this strategy.

6. Renewable Energy – Solar on City Facilities

The City has begun installation of rooftop solar on City buildings and is evaluating larger facilities for landfills or other city properties. Based on the current price estimates, there is an overall cost for City owned solar and it contributes about 8% of the GHG emissions reduction. On-site renewables, while a smaller percentage of contribution do provide value including increasing renewable energy generation, reducing need to purchase energy, and potential resilience – especially if paired with battery storage.

7. Electrification – Transit Fleet Buses

Transit buses offer a significant amount of GHG emissions reduction at 18%. At this time, based on the current price differential between conventional and electric buses as well as charging infrastructure, there is a cost associated with bus electrification. However, the analysis did not include the significant funding and grant resources that may be available to offset the capital cost difference.

8. Electrification – Transit Fleet Paratransit Vehicles

Paratransit vehicle conversion contributes about 3%

of the GHG emissions reduction potential by 2030 and doubles by 2040 as the remainder of the fleet transitions to electric. Similarly, there is currently a price premium for an electric paratransit vehicle; therefore, a cost associated with this strategy. In addition, there are not many options readily available in the market. In the next several years, it is expected that prices will decline, and more options will be available.

9. Renewable Energy – Large Scale Procurement (Duke Energy GSA)

A large-scale renewable energy procurement such as the Duke Energy GSA program is essential to meeting the City's carbon neutrality and renewable energy goals. GSA offers the largest percentage contribution at 44% to GHG emissions reduction. However, it is currently projected to have an incremental cost over the lifetime of the project based on actual RFP pricing and avoided cost information from Duke Energy. The City will need to monitor developments for this program and other large-scale renewable procurement options.

The financial analysis for the project is based on identifying the strategies that will enable the City to meet its goals using the minimum amount of RECs and carbon offsets. In analyzing costs, the approach did not consider possible grants or other incentives that may ultimately be available and help offset expenses – a deliberately conservative approach. However, extensive funding for transportation electrification for both vehicles and charging infrastructure may be available, which could significantly reduce the capital expenditures and net lifecycle costs of electrification.

To achieve 2030 goals, the capital investment is projected to be approximately $60,000,000. The capital expenditures modeled for transportation and fleet electrification are the incremental costs above traditional internal combustion engine vehicles and dominate the need for new capital spending, with over 70% of additional incremental capital costs being associated with vehicle fleet and transit fleet conversion ($35 million). Approximately 21% is associated with renewable energy projects ($12.3 million with approximately $11 million for City on-site solar systems), and the remaining 19% is associated with energy efficiency projects for natural gas and electricity savings ($11 million).

Finally, two initiatives do not require new capital investment but create on-going annual cost obligations. The Duke Energy GSA program is currently estimated to cost approximately $500,000 per year. Converting streetlights to LEDs is expected to cost nearly $10,000 per year based on Duke Energy's current rate structure. The financial analysis summary is shown in Table 3-20.

TABLE 3-20 FINANCIAL ANALYSIS SUMMARY CHART

Project	Annual MTCO2e Reduction	Cost per MTCO2e Lifetime ($)	Capital Cost ($)	Years	Net Annual Operating Savings (Costs)	Annual Return (%)	Simple Payback (Years)	Lifetime Savings (Costs) ($)
RE - Biogas CHP WWTP	740	(101)	1,400,000	20	144,411	10%	10	2,888,220
Energy Efficiency - Facilities	2,289	(62)	10,979,056	18	746,691	7%	15	13,440,431
Electrification - Fleet Light Duty	2,165	(22)	7,451,150	10	792,379	11%	9	7,923,786
Energy Efficiency - Streetlights LED	1,458	7	-	20	(9,775)	N/A	N/A	(195,504)
Electrification - Buildings	282	13	178,273	15	8,299	5%	21	124,488
RE - Solar - City Facilities	2,003	27	10,950,464	20	492,714	4%	22	9,854,270
Electrification - Transit Bus	4,821	28	24,225,000	12	1,881,463	8%	13	22,577,552
Electrification - Transit Paratransit	778	43	3,850,071	7	361,448	9%	11	2,530,139
RE - Large Scale Procurement (GSA)	11,532	50	-	20	(575,690)	N/A	N/A	(11,513,809)
Total	**26,069**		**59,034,015**		**3,841,938**			**47,629,573**

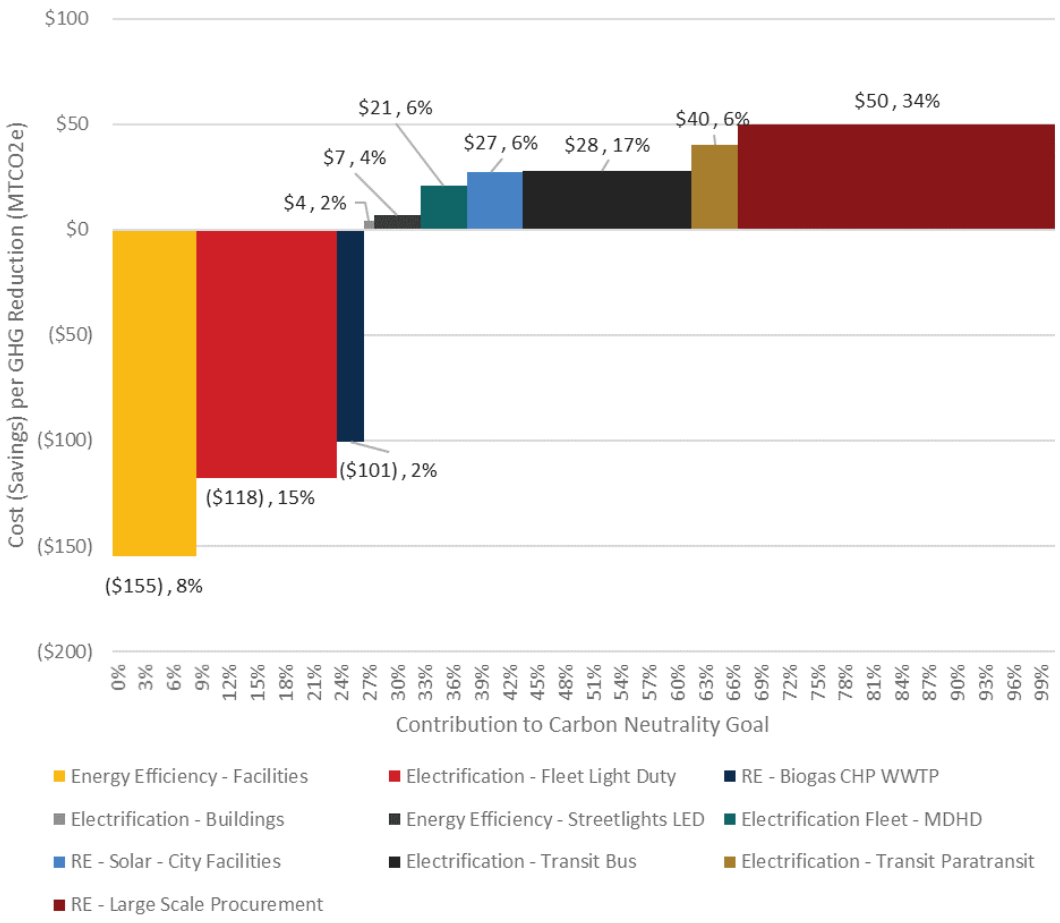
The City's actual cost will vary based on the final project scope and numerous implementation considerations. New technologies will emerge, and currently emerging technologies will enter the mainstream. Ongoing advances related to energy efficiency, electrification, and renewable energy may expand options for the City. It is expected that the cost of GHG abatement technologies will decline over time, especially in the transportation electrification sector. As noted previously, significant rebates and incentives are expected to be available. These factors, along with others such as financing mechanisms and alternatives to project ownership, may substantially reduce the expected capital costs associated with these strategies.

2021–2040 Supply Curve

The 2021-2040 supply curve includes all the elements of the 2030 supply curve plus MD/HD fleet electrification as shown in Figure 3-27. The changes for 2040 include incremental energy efficiency initiatives and additional vehicle fleet electrification including the remaining light duty trucks and police vehicles as well as electrification of the MD/HD fleet sanitation trucks. Also included are the additional transportation buses and paratransit vehicles. The additional capital investment is projected to be about $29 million with over 80% coming from fleet and transportation electrification and the remaining 15% represented by energy efficiency. Again, this does not include the potential grants, rebates and incentives that are expected to be available for fleet and transportation initiatives.

In summary, it will take a portfolio of strategies to achieve the City's carbon neutrality goals. There is not a single solution currently available that will meet the City's needs. Reduction of energy consumption through efficiency and conservation efforts is always a key component of any decarbonization strategy. Transportation electrification is vital to the efforts of the city as well as the nation and the world. Electric vehicle technology is evolving rapidly, and costs will continue to move toward parity with traditional vehicles. Finally, integration of renewables on City facilities and a large-scale renewable energy procurement are essential elements of a comprehensive strategy.

FIGURE 3-27 2040 GHG SUPPLY CURVE



Funding Sources

The City of Durham has a variety of funding sources to pursue to enable implementation of the actions items that are available to realize the City's carbon neutrality and renewable energy goals. It is critical to explore the various funding sources that might be available for the City. The Georgetown Climate Center created a Green infrastructure Toolkit to help local governments understand the array of funding sources, revenue models and financing strategies to support green infrastructure programs.[56] The Department of Energy also provides information on funding and financing energy projects.[57]

01 **Federal Funding**

02 **State Funding & Financing**

03 **Local Funding & Financing**

04 **Private Financing & Utility Programs**

05 **Fleet & Transportation Funding Sources**

Financing Strategies

Evaluate all potential financing and funding sources including federal, state, local, private, philanthropic, and utility programs. Monitor and pursue all fleet and transit funding sources.

The City should evaluate all potential financing and funding sources including federal, state, local, private, philanthropic, and utility programs. Due to significant capital costs associated with transportation electrification, particular emphasis should be placed on monitoring and pursuing all fleet and transit funding sources. Additional funding considerations include availability, flexibility, budget impact, administrative costs, legal constraints as well as equity and environmental justice. A City staff member dedicated to identifying and pursuing these funding opportunities may save the City millions of dollars in implementation costs.

01 Federal Funding

As noted earlier, there is an expectation of unprecedented levels of federal funding related to green infrastructure and transportation electrification projects. The City of Durham may be able to benefit from numerous federal programs including grants or formula programs. As stated previously, there are a wide range of federal agencies that may have funding sources to support these initiatives including the following:

- U.S. Department of Transportation (DOT)
- U.S. Department of Energy (DOE)
- U.S. Environmental Protection Agency (EPA)
- U.S. Department of Housing and Urban
- Development (HUD)
- Federal Highway Administration (FHA)
- Federal Transit Administration (FTA)

02 State Funding and Financing

State funding sources may include grants, loans, and administration of federal monies. Some of the agencies in North Carolina for potential funding include:

- North Carolina Department of Transportation,
- North Carolina Agricultural Finance Authority, and
- North Carolina Department of Environmental Quality.

In addition, the State of North Carolina is responsible for the distribution of the VW Settlement Funding. The States $92 million allocation is appropriated by the North Carolina General Assembly.

Green Loans. The North Carolina Agricultural Finance Authority currently has a loan program which is dedicated to encouraging alternative use of agricultural land in North Carolina for purposes such as wind energy facilities, closed loop biomass

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facilities and, technologies for the purpose of carbon capture and sequestration. These projects must meet the requirements of a Green Community Program which "promotes the purpose of energy and environmental conservation."[58]

03 Local Funding and Government Financing

Some of the local funding and financing sources may include general municipal budget, taxes and fees, capital improvement plans, revolving loans, bonds, and tax increment financing.

Green Infrastructure Bonds. Green bonds are local government bonds earmarked for infrastructure, climate, or other environmentally focused projects. Green bonds are not structurally different from other government bonds but are focused on financing environmentally beneficial activities. Often green bonds attract investors interested in environmental improvements. According to Bloomberg Energy Finance, municipalities in the U.S. have issued $15.3 billion in green bonds since 2010.

New York and California comprise 55% of the entire green bond market. In 2015, the City of Asheville became the first municipality in North Carolina to issue a green bond to finance infrastructure improvements and improve the city's water supply. The City of Durham is currently evaluating funding options for green and equitable infrastructure projects.

Tax Increment Financing. Tax increment financing (TIF) is a financing instrument that enables a local government to issue bonds without voter approval to pay for certain public investments needed to attract private investment. In November 2004, North Carolina voters approved an amendment to the state constitution allowing this economic development tool. The TIF works as follows: local government

designates a TIF district, establishes a base rate of taxation, pursues public investment such as green infrastructure, private development increases and the incremental tax value over the base value amortizes the TIF bond. Authorization of TIF financing includes green development such as storm water projects, preservation projects, or water systems. When compared with green bonds; however, this option may be less attractive due to its complexity.

04 Private Financing and Utility Programs

Municipalities are exploring more innovative financing alternatives such as funding from philanthropic or advocacy organizations that are committed to climate change initiatives such as Bloomberg Philanthropies. In addition, public-private partnerships (P3s), are emerging as an important mechanism to enable green infrastructure projects. Finally, utilities often have rebate or incentive programs associated with energy efficiency, renewable energy, and electric vehicles.

America is All In. The American Cities Climate Challenge through Bloomberg Philanthropy, launched in 2018, provided support for 25 of the largest cities in the United States to reduce greenhouse gas emissions. Within North Carolina, the City of Charlotte was one of the 25 chosen and provided support to help the city with its renewable energy and fleet electrification goals.

The American Cities Climate Challenge has been incorporated within a larger effort known as American is All In.[59] Also led by Mike Bloomberg, along with the United Nations Secretary-General's Special Envoy for Climate Ambition and Solutions, Washington Governor Jay Inslee, and Charlotte City Mayor Vi Lyles, the coalition is working to cut U.S. emissions in half by 2030 and reach net zero emissions by 2050. The City of Durham should consider adding their name to the list of organizations who are "all in" joining the North Carolina communities of Chapel Hill, Charlotte, and Asheville. Funding for carbon neutrality work may be a component of this organization's future work.

Renewables Accelerator. The Renewables Accelerator provides resources and technical assistance to help U.S. cities advance ambitious renewable energy goals.[60] The partnership supports the Bloomberg Philanthropies American Cities Climate Challenge and the Urban Sustainability Directors Network cities with renewable energy commitments. The Renewables Accelerator works with cities grouped around key renewable procurement methods. The City of Durham should become involved with their work and seek any potential funding opportunities.

Rocky Mountain Institute. The Rocky Mountain Institute (RMI) is an independent non-profit whose mission is to create a clean, prosperous, and secure low-carbon future.[61] RMI has provided seed funding for several local government initiatives including the City of Raleigh's early fleet electrification. There have been several recent funding announcements including a $10 million grant from the Bezos Earth Fund to help significantly reduce GHG emissions in both U.S. buildings and in energy-intensive industrial and transport sectors. RMI's Carbon-Free Buildings campaign will receive $8 million to reduce GHG emissions from homes, commercial structures, and other buildings, enabling RMI to increase its current work with a coalition of partners in key states.

Duke Energy. Duke Energy currently offers several programs to assist commercial customers such as the City of Durham with energy efficiency, renewable energy, and transportation electrification programs.[62] Some of these programs include energy assessments, energy efficiency rebates and incentives, solar rebates, and a new electric vehicle charger program. Some of these programs are subject to capacity limits and may not be available. The City is actively working with Duke Energy to leverage all available funding sources for on-going and new initiatives including large-scale solar procurement and electric vehicle charging infrastructure.

05 Fleet/Transportation Funding

There are several options for funding the City of Durham's transportation strategies. These important

opportunities include the U.S. DOT, the U.S. DOE, the VW Settlement funding, the Duke Energy EV pilot program, and the Congestion Mitigation Air Quality funding (CMAQ).

The U.S. DOE has two funding opportunities totaling more than $162 million to improve efficiency and reduce carbon emissions among cars, trucks, and off-road vehicles. The funding will support work toward electrifying freight trucking—along with efforts to expand EV infrastructure and lower emissions for on- and off-road vehicles.

Federal Transit Administration. The Federal Transit Administration (FTA) implements the Low or No Emission competitive program to provide funding to state and local governmental authorities for the purchase or lease of zero or low-emission transit buses and supporting infrastructure.

GoDurham was awarded an FTA grant to support the agency in purchasing its first electric buses. This is an on-going potential funding opportunity for electric buses.

Federal Highway Administration. The Federal Highway Administration (FHA) provides $50 million to the N.C. Department of Transportation (N.C. DOT) annually. Out of this $50 million, $10 million is reserved for public transit and administered through the state's metropolitan planning organizations. The City of Durham is covered by the Durham-Chapel Hill-Carrboro Metropolitan Planning Organization and is eligible to receive funding for electric buses through this regional organization.

Congestion Mitigation Air Quality (CMAQ). Another component of the $50 million Federal Highway funding is CMAQ funding administered by N.C. DOT but organized and packaged by the NCCETC.[63] Approximately $1.45 million is provided annually through this funding source for electric vehicle infrastructure. In the Spring of 2020, a list of CMAQ "shovel ready" EV infrastructure projects was submitted to N.C. DOT, primarily comprised of portable solar EV level 2 chargers. The City of Durham included two chargers in this list that are awaiting final funding notification.

VW Settlement Funding. VW violated the Clean Air Act from 2009 through 2016 by selling nearly 590,000 diesel engine vehicles that were engineered to report inaccurate data on nitrogen oxide (NOx) emissions. As part of a civil litigation settlement, they agreed to pay more than $2.9 billion into a national Environmental Mitigation Trust Fund. Each state receives a portion of settlement monies based on the number of affected vehicles sold in the state.

The State of North Carolina will receive $92 million over 10 years to offset the excess NOx pollution emitted by affected VW vehicles as illustrated in Table 3-21. There are three phases of the funding appropriated by the N.C. General Assembly and administered by the N.C. Department of Environmental Quality.

TABLE 3-21 VW SETTLEMENT FUNDING PHASES

Phase and Amount	Timing	Possible Uses
Phase 1 - $31 million	2020	Uses: DC Fast Charging; Diesel Bus & Vehicle Program; Level 2 EV Infrastructure Program. Funding has been distributed.
Phase 2 - $31 million	2021	Uses uncertain until DEQ develops RFP Guidance. Expected funding for VW Phase 2 funding is October 2021.
Phase 3 - $31 million	2022	Uses uncertain until DEQ develops RFP Guidance. Funding expected in Fall 2022.

Duke Energy Park and Plug Program. Duke Energy developed a pilot program to invest in electric vehicle charging infrastructure. They were granted a portion ($25 million) of their initial $76 million application to the NCUC in November 2020. That initial funding allows Duke Energy to install and own 280 charging stations and includes funds for an electric school bus program.

Duke Energy's Park and Plug program application was open for local governments who want the utility to own and operate any EV charging infrastructure.[64] The City of Durham has applied for this funding opportunity and is awaiting notification of whether its projects were selected.

3.7 POLICY ASSESSMENT

The energy transition is underway at global, national, and regional levels. As such, there is a significant amount of legislative and regulatory policy activity relating to renewable energy, decarbonization strategies, and transportation electrification.

At least 150 states and local jurisdictions have pledged to achieve 100% renewable energy supply – generally by 2050 or earlier. In addition, over 300 businesses have joined the Climate Group RE100 initiative to accelerate change towards zero carbon.[65] The Biden administration has announced trillions of dollars for investment in clean energy infrastructure and has pledged to convert the federal vehicle fleet to electric by 2035. According to EV Atlas Hub – there are currently over 48 active utility filings related to electric vehicle rates, incentives, programs and charging infrastructure representing over $1.5 million in investment.[66]

It is increasingly important that the City of Durham participate in policy proceedings to represent the needs of the community. Additionally, there are new initiatives to address energy equity and social justice such as the DOE's Office of Economic Impact and Diversity new program called the Justice40 Initiative. The purpose is to develop a plan to deliver 40% of the benefits of climate investment to disadvantaged communities.

State Policy

Legislative Policy

The legislative arena in North Carolina and the Southeast continues to evolve regarding renewable energy policy. North Carolina began pursuing renewable energy policy in 2002 with the Clean Smokestacks Law and in 2007, became the first state in the Southeast to pass a Renewable Energy and Energy Efficiency Portfolio Standard. Other key initiatives include passing a 35% investment tax credit for renewable energy in 2005 and passing an 80% property tax abatement for utility-scale solar systems in 2008.

North Carolina currently ranks third (behind California and Texas) in the cumulative amount of solar electric capacity through 2020 according to the Solar Energy Industries Association (SEIA).[67]

Recent statutory changes have supported the transition to increased renewable energy and have opened a limited market for competition in North Carolina. The first was the 2007 Senate Bill 3, North Carolina's Renewable Energy and Energy Efficiency Portfolio Standard (REPS)[68] and the other was the 2017 House Bill 589, the Competitive Energy Solutions for North Carolina.[69] HB 589 is the statute that allows renewable energy options into the energy supply mix for the city and outlines what is permissible for local government with respect to renewable energy procurement.

Image by Sean Pavone/Shutterstock

North Carolina State Capitol Building in Raleigh

Table 3-22 provides a brief summary of the key components of House Bill 589 and Senate Bill 3.

TABLE 3-22 NORTH CAROLINA LEGISLATIVE ACTIONS

Legislation	Section of the Statute	Explanation
HB 589	Green Source Advantage (GSA)	Allowed the creation of a program for large energy users to procure renewable energy RECs directly from a solar developer through participation in the Duke Energy GSA.
	Competitive Procurement of Renewable Energy (CPRE)	Required Duke Energy to procure 2,660 MW of renewable energy over a 45-month period in different tranches through a competitive solicitation process.
	Solar Rebate Program	Required creation of a solar rebate program for 20 MW of PV solar each year for five years.
	Solar Leasing Program	Allowed third party solar leasing as an alternative to outright purchase of solar panels.
	Community Solar Program	Required that Duke Energy offer 40 MW of community solar in North Carolina.
	Energy Storage Study	Study to confirm the services that energy storage provides North Carolina and what policies should be pursued for its deployment.
SB 3	REPS Requirement	REPS account for of state retail electricity sales by escalating from 3% in 2012 to 12.5% by 2021 with up to 40% of those requirements eligible to be met with energy efficiency.
	Cost Recovery Rider	Allows the NCUC to allow recovery of incremental costs incurred to comply with the REPS requirement.
	Swine & Poultry Waste Set Aside Requirement	Set aside for 0.2% by 2018.
	Solar Set Aside Requirement	Set aside for 0.2% of total electric power by 2018.
	N.C. Renewable Energy Tracking System	Required maintenance of an online REC tracking system to verify the compliance of electric power suppliers with the REPS requirements.

Current Legislative Initiatives. The N.C. General Assembly reconvened for the long session (January – August 2021) and will be addressing several energy issues. The House leadership (Rep. Szoka, Rep. Strickland) has convened a group of energy stakeholders with a goal of producing a compromise energy package that will move forward. Energy stakeholder groups included in this discussion include the Carolina Utility Customers Association, a group focused on energy issues for industrial and manufacturing customers; the Carolinas Clean Energy Business Association, a non-profit trade association for North and South Carolina's clean energy industry; lobbyists for the NC Sustainable Energy Association, and independent power producers, Duke Energy, and other energy interests. There is no companion Senate leadership, making it uncertain how consensus with a single legislative body moves forward.

There are several key energy items that will be considered in the current legislative session for the N.C. General Assembly.

Market Access to Renewable Energy. Increase options for renewable energy procurement, including changes to the current GSA program, expansion of the Competitive Procurement for Renewable Energy (CPRE), as well as improvements to the Community Solar and Solar Rebate programs.

PACE Financing. Initiate legislation to improve the Residential Property Assessed Clean Energy (PACE) program.[70] PACE financing, used for energy efficiency and clean energy projects, is repaid on a property's tax bill. Under this financing mechanism the loan stays with the property not the customer. North Carolina has not passed comprehensive enabling PACE legislation as 36 other states have done. SB 351 as introduced creates Commercial Property Assessed Clean Energy program and would allow for long-term financing for clean energy projects.

Market Reform Study. Examine the costs and benefits for the State of North Carolina to undertake electric market reform similar to the efforts of State of South Carolina to consider whether North Carolina should change the vertically integrated electric energy market to a Regional Transmission Organization (RTO) framework. In 2020, South Carolina General Assembly, passed an Electricity Market Reform Measures Study Committee.[71] The goal of the bill though is to study whether to recommend adoption of electricity reform measures and the potential public benefits with each of the measures. The report is due in November 2021. North Carolina Rep. Strickland introduced a bill entitled, "Study Electric Utilities' Resiliency" on April 20, 2021, to mirror the South Carolina study.[72]

VW Settlement Funding. North Carolina received a total of $92 million and has distributed the first third of that award. Phase 1 of $31 million was released in

August 2020 by the N.C. General Assembly and projects were reviewed and funded by N.C. Department of Environmental Quality (DEQ) shortly thereafter. The N.C. General Assembly must set aside the second funding allocation of Phase 2 VW Settlement Funding before the long session concludes in August 2021. Phase 2 project applications may begin in the early Fall 2021.

Governor Cooper & Executive Order 80

In October 2018, Governor Cooper issued Executive Order 80 titled, "North Carolina's Commitment to Address Climate Change and Transition to a Clean Energy Economy." Governor Roy Cooper laid out a series of goals for the state to strive to accomplish by 2025:

- Reduce statewide greenhouse gas emissions to 40% below 2005 levels.
- Increase the number of registered, zero-emission vehicles (ZEVs) to at least 80,000.
- Reduce energy consumption per square foot in state-owned buildings by at least 40% from fiscal year 2002-2003 levels.

The DEQ developed a Clean Energy Plan to achieve the Governor's goals, the most important of which is that North Carolina must establish a 21st century regulatory model that incentivizes business decisions that benefit both the utilities and the public in creating an energy system that is clean, affordable, reliable, and equitable.

Regulatory Policy and Duke Energy Carolinas

A collaborative partnership with the City's primary utility provider, Duke Energy Carolinas, is an important component of the implementation of the CNRE Action Plan. The City of Durham entered into a new Franchise Agreement and an MOU in October 2020 with Duke Energy. The MOU, in part, envisions increased collaboration between the City and the utility. In addition, the City is currently pursuing participation in Duke Energy's GSA Program.

While the MOU can help shape the City's collaboration with Duke Energy, City involvement in Duke's regulatory processes may also be a pathway to help the City achieve its goals. Duke Energy's regulatory environment has many elements, a few of which are highlighted in Table 3-23.

TABLE 3-23 DUKE ENERGY REGULATORY ITEMS

Regulatory Item	Name	Explanation
Duke Energy's 2020 Integrated Resource Plan (IRP)	15 Year Projected Pathway for Resource Portfolio 2020-2035	Potential scenarios in the IRP include delivery of energy at lowest cost, closing all coal plants by 2030, reduce CO_2 by 70 % and no new natural gas generation.
Duke Energy's Green Source Advantage Program	GSA Program for Fulfillment of One Section of HB 589	Duke Energy proposed a program for large energy consumers (city government, higher education, military) that enables customers to negotiate an agreement to purchase Renewable Energy Credits (RECs) from renewable energy supplier.
Duke Energy's Electric Vehicle Pilot Project	Pilot Program for Electric Vehicle Infrastructure	Duke Energy was granted a portion ($25 million) of their initial $76 million application for EV infrastructure by the NCUC.
Duke Energy Renewable Natural Gas Standard	RNG Standard	Opportunities to source Renewable Natural Gas supply from Duke Energy are dependent upon a RNG standard to be finalized by the NCUC.
Southeast Energy Exchange Market	SEEM Market	Several utilities including Duke Energy filed a proposal to the Federal Energy Regulatory Commission (FERC) in February to create the Southeast Energy Exchange Market (SEEM).

Duke Energy Integrated Resource Plan (IRP). One area for regular involvement with Duke Energy is via their periodic Integrated Resource Plans. IRPs are a regulatory tool used by utilities and regulators to manage long-term energy supply and demand

forecasts, planning, and investments. Duke Energy Carolinas and Duke Energy Progress filed their 2020 IRPs on September 1, 2020.[73] The 2020 IRP presents six potential pathways within the 15-year planning horizon that evaluate different possible resource portfolios. Each pathway keeps Duke Energy on a trajectory to meet its near-term CO2 emissions reduction goal of at least 50% by 2030 and long-term goal of net-zero by 2050. The Duke Energy IRP process uses a robust stakeholder engagement process to help shape utility energy supply and demand investments.

The NCUC is currently reviewing the most recent IRP. Figure 3-28 provides an excerpt of the 2020 Duke Energy IRP Plan, illustrating that all scenarios reduce Duke Energy's carbon emissions below 50% (from 2005) and the mix of power supply or demand management options that lead to the continued carbon reductions over time.

FIGURE 3-28 EXCERPT OF 2020 DUKE ENERGY IRP PLAN

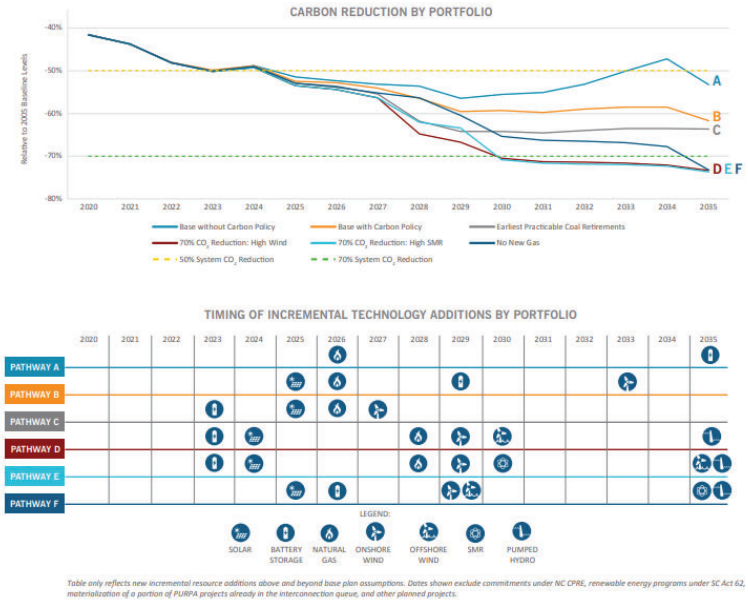


Table only reflects new incremental resource additions above and beyond base plan assumptions. Dates shown exclude commitments under NC CPRE, renewable energy programs under SC Act 62, materialization of a portion of PURPA projects already in the interconnection queue, and other planned projects.

Federal Policy

President Biden recommitted the United States to the Paris agreement on the afternoon of his Inauguration. In addition, he set ambitious targets for carbon neutrality in the electric power sector by 2035, and economy-wide decarbonization by 2050 communicated in The White House Fact Sheet.[74] The administration's proposed investment in clean energy and environmental justice will total nearly $2 trillion over the next ten years.

The Administration's stated plan includes aggressive executive action, including:

- Implementing more efficient, climate-ready technologies and new innovation into U.S. government facilities,
- Bolstering the Clean Air Act to reduce greenhouse gas emissions from transportation,
- Setting aggressive limits on methane pollution from oil and gas industries, and
- Requiring climate and greenhouse gas considerations in federal permitting decisions.

In addition to President Biden's climate proposals, there are other federal legislative actions that are important to note as represented in Table 3-24.

TABLE 3-24 FEDERAL LEGISLATIVE PROPOSALS

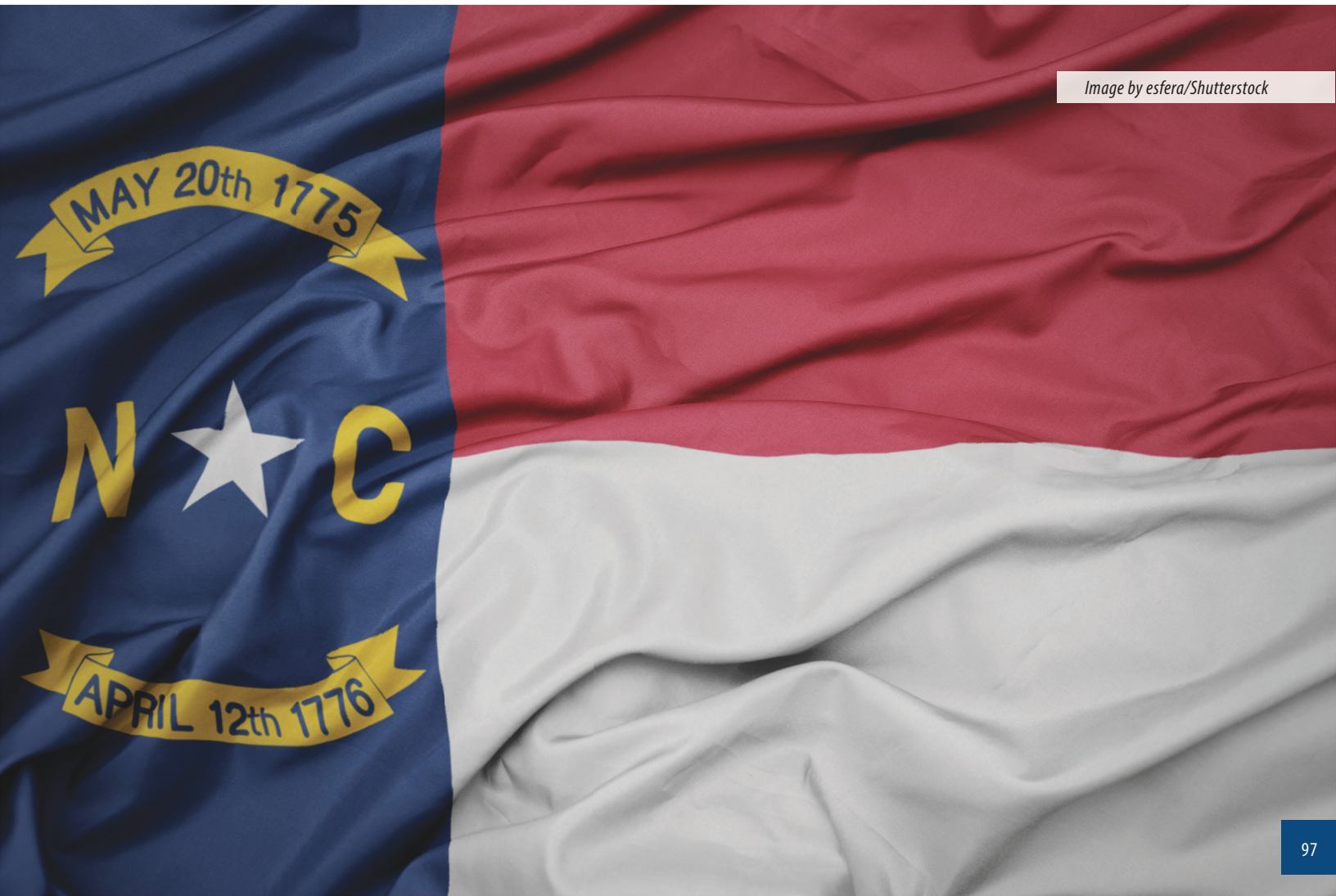
Legislative Proposal	Name of Section	Explanation
Climate Leadership & Environmental Action Act (CLEAN)	Target of GHG Reduction	The House Energy and Commerce Committee introduced CLEAN in March 2021. The bill as it is introduced would set national target of 50% reduction in GHG emissions by 2030 (from 2005 levels) and achieve a net carbon neutrality goal by 2050. Regulatory standards are mandated in the power, transportation, and industrial sectors along with federal spending of $565 billion over 10 years.
Growing Renewable Energy & Efficiency Now (GREEN)	Electric Vehicle Tax Credit	The Chairman of the House Ways and Means Subcommittee on Select Revenue Measures introduced GREEN Act with a base credit of $1,250 for buyers of used plug-in cars from date of purchase through 2026.
Energy Storage Tax Incentive and Deployment Act	Energy Storage Investment Tax Credit (ITC)	The ITC would mirror what is available with solar energy. Until now, the only way for energy storage to receive an ITC is if it stores energy from a solar project. A bipartisan group of lawmakers introduced legislation in March 2021 to apply the ITC to stand alone storage systems.

Strategies for Policy

Participate in federal and state policy proceedings related to decarbonization efforts such as energy efficiency, renewable energy, and transportation electrification as well as energy equity and environmental justice initiatives.

The City should participate in federal and state policy proceedings related to decarbonization efforts such as energy efficiency, renewable energy, transportation electrification as well as energy equity and environmental justice initiatives. Based on the current regulatory and legislative environment, many additional policies and changes are anticipated in the coming years. Some of the pending policies that Durham should monitor closely include the following:

- Funding opportunities and timeline for VW Settlement Phase 2 for applications due Fall 2021.
- Changes to Duke Energy's Community Solar program through legislative action as an option for subscription for community residents.
- Changes to Duke Energy's EV Pilot program after it is resubmitted to the NCUC in May 2021 and if program is approved, consider applying for EV infrastructure funding.
- Changes to Duke Energy's GSA program based on current legislative session.
- Actions from the NCUC regarding Duke Energy's IRP.
- Actions from the NCUC for final action on the RNG standard.



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04 PART 2: RENEWABLE ENERGY PLAN

Image by Steffen Gonzalez/Shutterstock

The Resolution of the Durham City Council Supporting a Transition to Renewable Energy and Carbon Neutrality approved on April 1, 2019, calls for 80% renewable energy sourcing for City operations by 2030 and 100% renewable energy sourcing for City operations by 2050. Figure 4-1 illustrates the percentage renewable energy goals by year. The blue arrows represent the 2030 and 2050 goals. The Resolution defines clean, renewable energy as "energy derived from ongoing natural processes that rapidly replenish and is sustainably collected from renewable sources such as solar, wind, and geothermal." In addition, the Resolution states, "other approaches may be included after being evaluated for sustainability and environmental justice implications. Energy efficiency will continue to be a critical part of our approach by minimizing the amount of energy used overall."

According to the Sierra Club, over 170 cities, more than ten counties, and eight states across the U.S. have goals to power their communities with 100% clean, renewable energy. These commitments—formalized in resolutions, climate action plans, renewable portfolio standards, and other policies—are the product of leadership from coalitions of civic champions, frontline activists, and Ready For 100 organizers nationwide. In total, over 100 million people now live in a community with an official 100% renewable electricity target.[75]

The City of Durham demonstrated its environmental leadership by the commitment to transition City operations to a supply of 100% renewable energy by 2050. As noted in the Resolution, adoption of renewable energy is a critical element to achieve carbon neutrality. The actions items to achieve both the carbon neutrality and renewable energy objectives will work in tandem and support the attainment of each goal. There are current technological and policy constraints to achieve the 80% renewable energy supply across the City's complete energy usage portfolio without the purchase of RECs. This CNRE Action Plan will need to be revised as new technology, economic, and policy changes occur over the short term and long term that may impact the City's strategies.

Renewable energy currently makes up only a small fraction of the City's current energy needs. A dramatic change in energy supply sourcing is needed to achieve Durham's goals as represented in Table 4-1. The City's total energy usage is comprised of electricity, natural gas, and liquid fuels including gasoline and diesel. To determine the amount of renewable energy needed, the energy sources are converted to a standard measure of energy defined as MMBTU (one million BTUs). The total MMBTU is then converted to an electricity equivalent of MWh or eMWh to determine the electricity equivalent needed to satisfy the City's complete energy needs.

FIGURE 4-1 RENEWABLE ENERGY GOALS

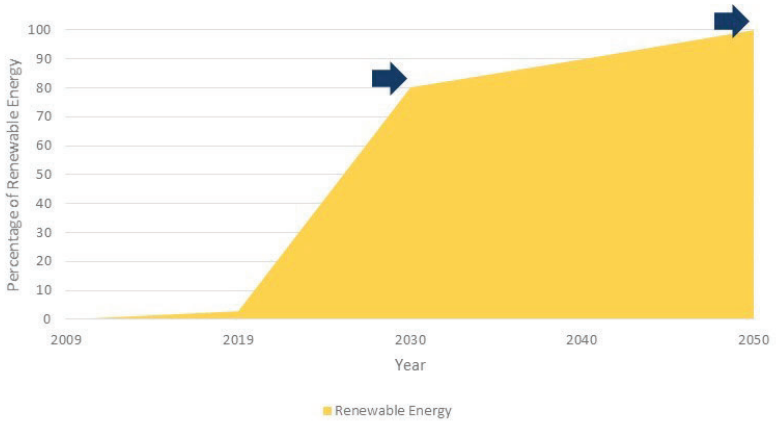


TABLE 4-1 RENEWABLE ENERGY SUPPLY GOALS

Goal	Description	Baseline Year	Baseline Result (eMWh)	Goal Year	Goal Target (ekWh)
Renewable Energy	80% Renewable Energy Sourcing	2019	< 5%	2030	80%
	100% Renewable Energy Sourcing	2019	< 5%	2050	100%

4.1 BASELINE

The City uses a variety of fossil fuel sourced energy in its municipal operations including electricity, natural gas, gasoline, and diesel. The current usage is split nearly 50% from electricity and natural gas, and 50% from liquid fuels. Table 4-2 lists the current purchased energy portfolio for the City of Durham.

Based on the current energy consumption, the Durham would need approximately 170,000 eMWh of electricity to meet operational needs of the City on an annual basis.

TABLE 4-2 CITY OF DURHAM PURCHASED ENERGY PORTFOLIO

Source	2020 MMBTU	Units	MTCO2e
Electricity (Duke Energy)	252,498	74,000 MWh	25,076
Natural Gas (Dominion)	49,550	495,000 therms	2,635
Liquid Fuels - Gasoline	125,760	1,006,400 gallons	8,966
Liquid Fuels - Diesel	159,046	1,151,926 gallons	11,642
Total	**586,854**		**48,319**

To offset the current energy usage with 100% renewable energy, the city would need approximately **80 MW of solar.**

An 80 MW ground mount solar system requires between 600 to 800 acres of land. **That is roughly the size of 500 football fields.**

Image by Meister Photos /Shutterstock

4.2 STRATEGIES FOR 100% RENEWABLE ENERGY

The strategies to achieve the 100% renewable energy goal include those discussed in the carbon neutrality plan – energy efficiency to reduce consumption, conversion of fossil fuel applications to more efficient and cleaner electric sources, and a combination of both on-site renewable energy generation and off-site renewable energy procurement. In addition, the City of Durham will benefit from the cleaner energy grid from Duke Energy through the reduction of fossil fueled utility-scale generation sources such as coal and natural gas, and an increase in renewables such as solar and wind resources, potentially paired with battery storage.

The first, and most important, step in achieving a 100% renewable energy goals is to reduce the amount of energy consumed by the City for lighting, heating, and cooling; facility and equipment operations; and vehicle fleet and transportation. Next, strive to electrify natural gas and liquid fuel applications while managing increased electric usage through demand side management and energy efficiency efforts. Transitioning to a complete supply of renewable energy is most achievable and easily measurable when the sources of energy used throughout the City, are benchmarked to electricity. At present, shifting the source of electricity within the City to 80-100% renewable energy would only help achieve a portion of the renewable energy goals, as traditional fuels still account for much of the City's energy usage.

For example, assuming 100% of Durham's electrical load was supplied by renewables, it would not offset the reliance on traditional liquid fuels in the transportation sector. If, however, the transportation fleet was transitioned to 100% electric vehicles, then the source of that energy could be tied to the renewables that make up the City's power supply portfolio. Energy efficiency and demand side management efforts are vital for any clean energy approach, but especially for those that involve the transition to an electricity dependent society.

The strategies to achieve 100% renewable energy supply include a variety of possible solutions including on-site generation and off-site procurements in addition to impact of reduced emissions based on the Duke Energy generation portfolio mix. Current on-site generation options modeled include rooftop solar, landfill solar, and biogas. Off-site procurements may include large-scale utility programs such as the Duke Energy GSA program and RECs. Advancements in renewable energy technology as well as policy changes are expected to expand the City's options for renewable energy sources for City operations. In addition, the City should continue to evaluate the costs and benefits of pairing battery storage systems with solar PV projects. Battery storage systems may provide additional flexibility and resiliency for the City.

2030 Strategies for 80% Renewable Energy

In 2030, the City is expected to need approximately 100,000 eMWh of renewable energy to achieve the 80% renewable energy sourcing goal. Similar to the carbon neutrality goal, this will require a portfolio of solutions including on-site and off-site resources.

On-site resources including rooftop solar on city facilities and the biogas CHP at the NDWRF represent 11% of the renewable energy, the Duke Energy GSA represents 48%, other innovations and the purchase of RECs represent 24%, and the cleaner grid from Duke Energy's renewable resources contributes 16% of the total renewable energy portfolio. The 2030 renewable energy actions are presented in Table 4-3.

In 2030, the City is expected to need approximately 100,000 eMWh of renewable energy ***to achieve the 80% renewable energy sourcing goal.***

TABLE 4-3 2030 RENEWABLE ENERGY ACTIONS

Action to 2030	Progress to 80% (eMWh)	Renewable Energy Contribution
2030 eMWH (expected)	126,684	
80% Renewable Energy Goal	**101,347**	**100%**
Duke Energy Supply (23% Renewable Energy)	16,062	16%
City Solar Facilities	8,517	8%
Water/Wastewater Biogas	3,066	3%
Duke Energy Green Source Advantage	49,037	48%
Innovation/RECs	24,665	24%

2050 Strategies for 100% Renewable Energy

In 2050, the City is expected to need approximately 93,000 eMWh of renewable energy to achieve the 100% renewable energy sourcing goal. The reduction is based on the increased electrification of the transportation and vehicles fleets and represents the efficiencies gained from reducing fossil fuel consumption. Similar to the 2030 strategy, this will require a portfolio of solutions including on-site and off-site resources.

The on-site resources including rooftop solar on city facilities and the biogas CHP at the NDWRF remain the same and represent 12% of the renewable energy, the Duke Energy GSA represents 53%, and the cleaner grid from Duke Energy's renewable resources contribute 35% of the total renewable energy portfolio. It is assumed that the City will not need to purchase RECs to achieve the 2050 goal of 100% renewable energy. The 2050 renewable energy actions are presented in Table 4-4.

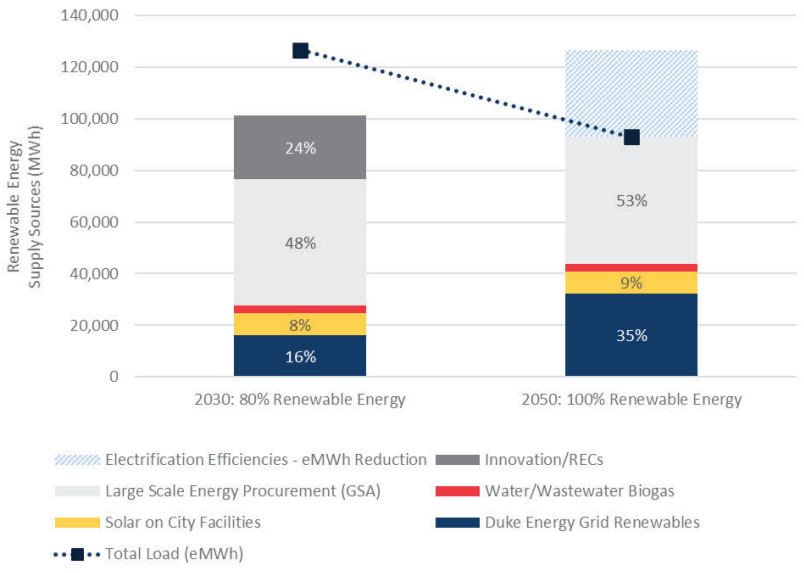
TABLE 4-4 2050 RENEWABLE ENERGY ACTIONS

Action to 2050	Progress to 100% (eMWh)	Renewable Energy Contribution
2050 eMWH (expected)	**92,914**	**100%**
Duke Energy Supply (60% Renewable Energy)	32,295	35%
City Solar	8,517	9%
Water/Wastewater Biogas	3,066	3%
Duke Energy Green Source Advantage	49,037	53%

Achievement of both the 80% renewable energy supply goal in 2030 and the 100% renewable energy supply goal in 2050 are heavily dependent on a large-scale procurement such as the Duke Energy GSA program which contributes approximately 50% of the goal. Without such a program, the City would need to increase its reliance on purchasing RECs to meet the goals.

The City's expected on-site resources contribute about 10% of the goal. This may increase if the City identifies additional facilities or technologies for renewable projects or if there are legislative or regulatory changes that allow the City more flexibility in generating or procuring renewable energy resources. Finally, the City will continue to benefit from a cleaner electricity grid as Duke Energy and other utilities strive to decarbonize generation assets by 2050. Figure 4-2 represents a portfolio of solutions to achieve the 80% and 100% renewable energy goals.

FIGURE 4-2 RENEWABLE ENERGY SUPPLY STRATEGIES



Duke Energy plans to increase renewable generation in its broader portfolio. The City of Durham will continue to purchase electricity from Duke Energy for its operations at the prevailing rate. It is anticipated that the City will benefit from increased renewable energy in the Duke Energy generation mix without an incremental cost for those energy purchases. The Duke Energy retail rate is expected to increase over time based on the IRP and rate filings with the NCUC.

However, other renewable energy sources will add incremental costs to the City with the exception of the CHP biogas installation which provides an incremental benefit. Based on the YES Solar cost analysis, the City could expect to see an incremental cost of approximately $70 per MWh for on-site solar. This estimation assumes the facilities have a useful life of 30 years and receive the YES Solar quoted Duke Energy incentives. The Duke Energy GSA program will provide the City with approximately 50% of its renewable energy needs at an incremental rate of approximately $17 per MWh. This rate includes the GSA program costs and the expected avoided cost rate of Duke Energy. The last renewable energy source is RECs, which have a relatively low cost because these credits can be sourced from any renewable generator in the United States. The total incremental cost impact associated with the City's renewable energy goals is in the range of $1.3-1.5 million. Hence, this cost equates to a weighted average incremental cost increase of approximately $14.50 per MWh on retail rates. Table 4-5 below shows the incremental cost/(benefit) breakdown by renewable energy source.

As the City moves toward achieving its renewable energy goals, it will be critical to work with community stakeholders, collaborate with utility providers, identify and secure funding resources, monitor national and state legislative and regulatory policy, and advocate for equity, affordability and environmental justice to ensure benefits of renewable energy are available for all community members.

TABLE 4-5 RENEWABLE ENERGY ACTIONS INCREMENTAL COSTS

Renewable Energy Source	Progress to 80% (eMWh)	Incremental Cost ($/eMWh)	Total Incremental Cost	Progress to 100% (eMWh)	Incremental Cost ($/eMWh)	Total Incremental Cost
Duke Energy (Renewable Energy)	32,295	$0.00	$0	32,295	$0.00	$0
City Solar	8,517	$70.00	$596,190	8,517	$70.00	$596,190
Water/Wastewater Biogas	3,066	($5.66)	($17,354)	3,066	($31.79)	($97,468)
Duke Energy Green Source Advantage	49,037	$17.00	$833,629	49,037	$17.00	$833,629
Innovation/RECs	24,665	$2.55	$62,896	0	$2.55	$0
Total	**101,347**	**$14.56**	**$1,475,361**	**92,914**	**$14.34**	**$1,332,351**

As the City moves toward achieving its ***renewable energy goals,*** it will be critical to work with community stakeholders, collaborate with utility providers, identify and secure funding resources, monitor national and state legislative and regulatory policy, and advocate for equity, affordability and environmental justice to ensure benefits of renewable energy are available for all community members.

4.3 RENEWABLE ENERGY POLICY ASSESSMENT

As stated previously, strategies for both the carbon neutrality and renewable energy plans work in tandem to support the attainment of each goal. Because of the overlap between the two plans, the policy assessment is the same. Therefore, please refer to section 3.7 for more information.

Legislative Opportunities

There are several legislative actions that are under consideration and could enable increased renewable energy options. Many of these items were outlined in the N.C. Environmental Defense Fund Cities' Initiative.[76] The program brought together the State of North Carolina and 12 cities, including Durham, that have made commitments to reduce their carbon footprint. Other legislative items have been discussed among energy stakeholders to ensure that North Carolina communities have greater procurement flexibility for clean energy resources.

- Increase options for more renewable energy procurement such as third-party sales.
- Address barriers to the Commercial Property Assessed Clean Energy (C-PACE) program.
- Consider legislation to establish a green bank to finance green infrastructure projects.
- Provide additional options for locally controlled transportation revenues.

Regulatory Changes

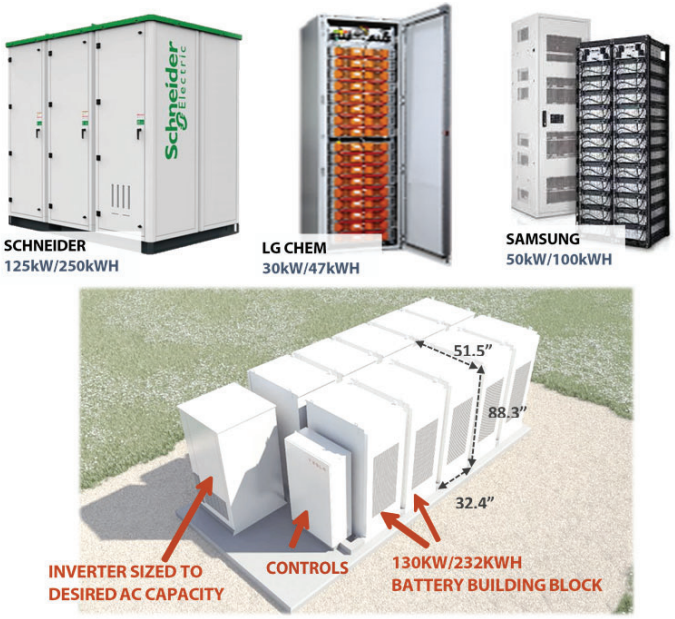
Duke Energy must submit to the NCUC an IRP which outlines the resources they will need to meet expected electricity demand over a long-term planning horizon. As Duke Energy decarbonizes its energy generation, the City of Durham stands to benefit by a cleaner electric grid. It is in the City of Durham's interest then to ensure that the IRP meets emerging energy and capacity needs in the cleanest manner.

The City of Durham's Mayor, and the mayors of The Town of Boone, Town of Carrboro, Town of Chapel Hill, City of Durham, Durham County, City of Greensboro, Town of Hillsborough, Town of Matthews, Orange County, City of Raleigh, and the City of Wilmington all submitted comments on February 24, 2021, to the NCUC for Duke Energy's IRP.[77] The recommendations they submitted in their joint letter are noted below.

1. Retire coal power plants as soon as possible to improve the health and public benefits of our communities and use all-source procurement for any replacement and expansion generation.
2. Update analysis methods to fully value the contribution of energy efficiency programs that help local governments and customers address affordability and climate concerns.
3. Expand the distributed generation and utility-scale renewable energy solutions offered to help directly address our local government renewable energy, climate, and equity goals.
4. Conduct a robust technological and economic analysis of the transmission investments needed to enable more renewables in future portfolios.
5. Reassess EV penetration rate and take a proactive approach to growing electrical load through transportation electrification offerings.

Renewable Energy and Battery Storage Opportunities

In basic terms, energy storage technologies capture energy and store it for future use. While North Carolina's energy storage cluster has grown in both revenue and employment, the state has not yet experienced significant deployments of storage that have occurred in other states. Considering national and international storage deployments, favorable technological properties, declining costs, and future projections, North Carolina leaders are exploring ways to develop a set of rules that allow energy storage to be fully utilized.



HB 589 includes a provision that required an Energy Storage Study to address the feasibility of energy storage technology use in North Carolina, the grid services storage provides, the economic impact of storage deployment for ratepayers, and the identification of existing policies and recommended policy changes that may be considered to address a statewide coordinated energy storage policy.

The North Carolina Energy Storage Study was overseen by the North Carolina Collaboratory, an organization within the University of North Carolina General Administration whose mission is to facilitate and fund research on environmental issues and new technologies.[78] The report was released in December 2018. The report highlights the status of energy storage deployment, storage applications and services, an overview of the modeling approach, and the identification of barriers and policy options. The study included each of the available technologies (batteries, flywheels, ice storage, pumped hydro, compressed air energy storage) based on current data and given the rapid decline in lithium-ion battery costs, the study also included projected costs for that technology in 2030. The NC State team also looked at a range of potential benefits associated with varying degrees of energy storage capacity.

Subsequent to the Energy Storage Study, in September 2019, the NCUC issued an order (Docket No. E-100 Sub 164) initiating a series of educational presentations by invited energy storage experts.

Battery Storage for Resiliency

As noted in section 3.4, the City of Durham received a study from NREL that analyzed solar plus storage opportunities at City Hall and Police Headquarters. The recommendations of the NREL study are under review.

The most prevalent type of energy storage on the market is the family of lithium-ion batteries, with new research showing a trend towards lithium iron phosphate installations for safety reasons. These batteries store more energy for their size and weigh more than other existing technologies, including advanced carbon batteries. Below are some highlights of available technology options that may be applicable to the City's facility sizes and facility loads.

- **Energy storage building blocks** are being offered by several vendors for deployment in commercial scale applications.
- **Tesla Power Pod** is an example of a product that can incrementally add up to 232 KWH of capability with lower capacity configurations available, shown below with spatial sizing estimates.
- **Samsung, Schneider, Sonnen, LG Chem, BYD** and several other vendors have viable products.
- **10 Year warranties** and service agreements are available.
- **Installed cost currently estimated at $1000/kwh** for commercial scale systems.

05 RECOMMENDED IMPLEMENTATION STRATEGY

Image by City of Durham

The implementation of the Carbon Neutrality and Renewable Energy Action Plan is projected to reduce the City's GHG emissions by nearly 90% from the 2009 baseline in 2040 and to achieve 100% renewable energy sourcing by 2050 for City operations. This represents approximately 51,000 MTCO2e of emissions reduction - resulting in a cleaner, healthier environment for the Durham community. The City's efforts to reduce its carbon footprint result in the equivalent of the GHG emissions from 11,091 vehicles driven for one year, 9,264 homes' electricity consumption, nearly 2,000,000 lightbulbs and the carbon sequestered by 843,296 tree seedlings as illustrated in Figure 5-1.

To achieve these amazing results, the Carbon Neutrality and Renewable Energy Action Plan presents a portfolio of strategies and related action items for the City of Durham. The key recommendations are illustrated in Figure 5-2. A summary table of all recommendations is shown in Appendix B.

The City has many choices regarding the implementation of the strategies and action items to achieve the goals of carbon neutrality and 100% renewable energy sourcing for City operations. The General Service Department is the primary responsible party for management and execution of the CNRE Action Plan. However, it will take many departments working together to attain the City's goals. The Sustainability team, made up of individuals from key departments will collaborate on the prioritization and implementation of the action items. This team will also involve external stakeholders and create community partnerships to gain insights and feedback to inform the implementation process. The action items are expected to evolve over the next 30 years based on technology advancements, financial viability, policy reforms and environmental justice considerations – among others. When considering decisions to prioritize future efforts towards goals, the following tools may be helpful – the Decision Matrix tool and the Carbon Reduction/Lifecycle Savings Matrix.

FIGURE 5-1 CARBON FOOTPRINT REDUCTION EQUIVALENCE

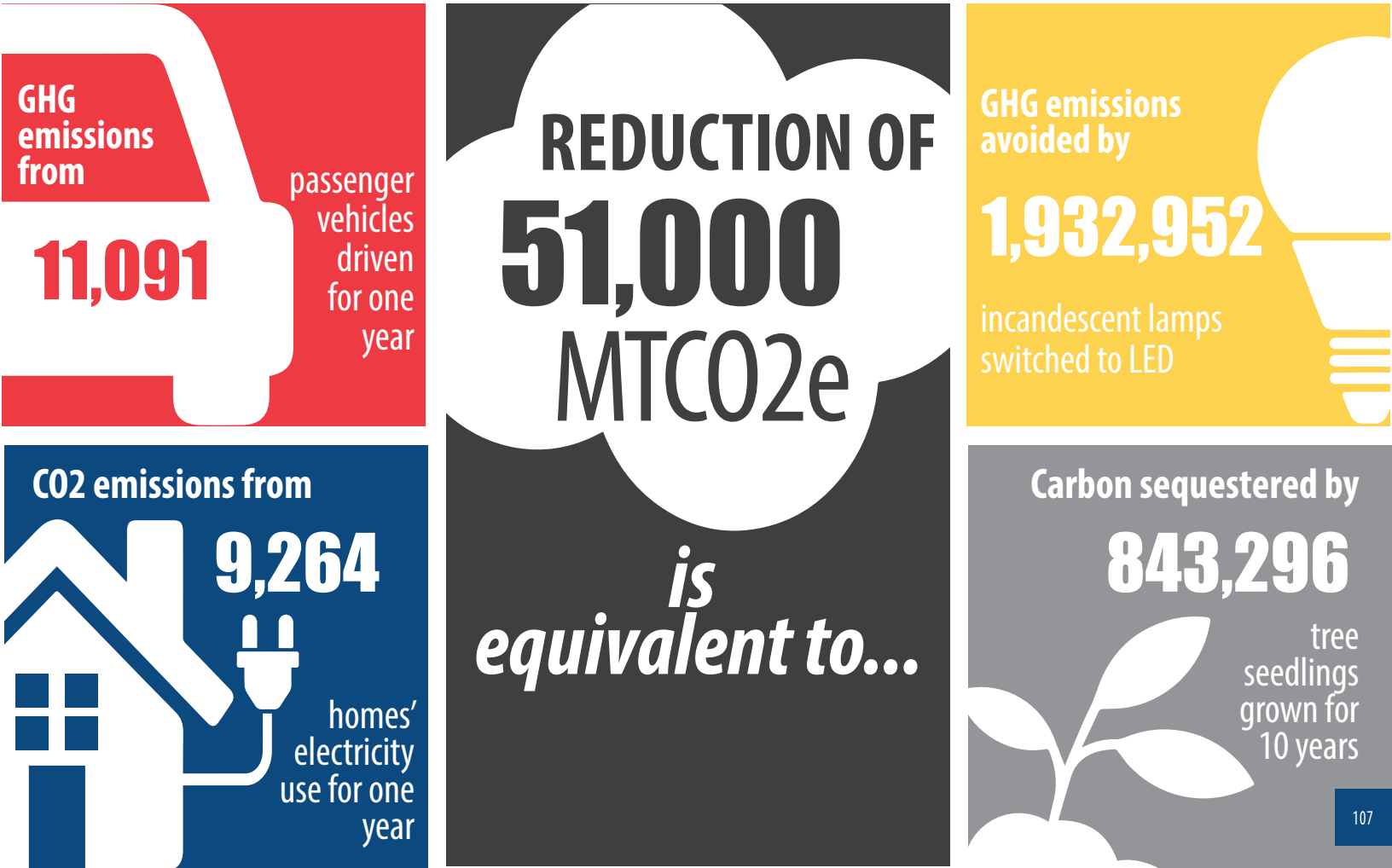


FIGURE 5-2 KEY RECOMMENDATIONS

GOALS

CARBON NEUTRALITY	50% Reduction by 2030 from 2009	100% Reduction by 2040
RENEWABLE ENERGY	80% Renewable Energy Sourcing	100% Renewable Energy Sourcing

	2021-2030	2031-2040	2041-2050
01 Maximize Energy Efficiency in City Buildings & Operations	Reduce energy consumption in buildings and operations by 20%	Reduce energy consumption in buildings and operations by 10%	Monitor and implement emerging technology applications
	Electrify and implement green building standards on 100% of new City buildings		
	Electrify and implement green building standards on 100% of new City buildings	Reduce 10% of City building energy consumption	Monitor and implement emerging technology applications
02 Increase Electrification of City Buildings & Fleet (Vehicle & Transit)	***Install charging infrastructure to support City fleet and public vehicle electrification***		
	Replace 50% of passenger cars with electric vehicles	Replace 50% of passenger cars with electric vehicles	On-going electric light duty passenger car fleet
	Replace 33% of light duty trucks with electric trucks	Replace 67% of light duty trucks with electric trucks	On-going electric light duty passenger truck fleet
		Replace 20% of MD/HD with electric alternatives	Replace 80% MD/HD vehicles with available electric technology
	Replace 80% of diesel buses with electric buses	Replace 20% of diesel buses with electric buses	On-going electric bus fleet
	Replace 40% of paratransit vehicles with electric vehicles	Replace 60% of paratransit vehicles with electric vehicles	
03 Expand Renewable Energy Generation & Procurement	Install distributed solar on existing and new City facilities	Install distributed solar on new City facilities	
	Develop landfill solar and biogas CHP projects	Explore additional landfill and large-scale solar projects and biogas projects	
	Implement Duke Energy GSA (or similar program)	Continue Duke Energy GSA (or similar program)	Renew or replace Duke Energy GSA (or similar program)
	Purchase supplemental RECs and carbon offsets as needed to meet resolution goals		
	Monitor new renewable energy technology applications and implement as feasible		
04 Establish Innovative Practices and Partnerships	***Establish carbon reduction practices that incorporate innovative solutions to reduce the City's overall GHG emissions such as green roofs and low carbon concrete. These efforts should enhance and support the energy efficiency, electrification, and renewable energy strategies.***		
	Develop partnerships with internal and external stakeholders. Expand internal sustainability staffing and departmental teams. Create community partnerships with residents, businesses, community organizations, utilities, and others to advise and support implementation with a focus on energy equity and environmental justice.		

Decision Matrix – this tool was created to help City officials and stakeholders prioritize the actions that will be implemented based on six criteria: greenhouse gases reduction potential, cost implications, criticality of meeting resolution targets, demand/energy consumption reduction, environmental equity considerations, and timing and ease of implementation. The criteria descriptions and scoring metrics are shown in Figure 5-3. The initial decision matrix is shown in Appendix B.

Carbon Reduction/Lifecycle Savings Matrix – this tool illustrates the strategies from a potential lifecycle savings and carbon reduction analysis. Those in the top right corner are considered to be "top picks" based on their relative high lifecycle savings and high carbon reduction potential. The "pursue" strategy is based on higher lifecycle savings with a lower carbon reduction potential. The "investment" strategies yield higher carbon reduction potential but have a higher cost as well. Finally, the "least likely" category strategy

FIGURE 5-3 DECISION MATRIX

25% *weighting*

GREENHOUSE GAS REDUCTION

To what degree does this action reduce greenhouse gas emissions from City operations?

0 Not applicable
1 No Impact to GHG emissions
2 Minimal reductions to GHG emissions
3 Moderate reducations to GHG emissions
4 Significant reductions to GHG emissions
5 Extreme reductions to GHG emissions

20% *weighting*

COST IMPLICATIONS

What is the total cost associated with taking this action? What are the up-front capital cost requirements? What are the projected long-term costs? Do the costs of this action improve Durham's local economy?

0 Not applicable
1 Cost prohibitive
2 Extremely expensive
3 Moderate cost implications
4 Extremely cost effective
5 No cost to implement

20% *weighting*

CRITICALITY OF MEETING RESOLUTION TARGETS

Is this action a significant contributor to achieving the City's carbon neutrality/renewable energy goals? Is it imperative to take this action to meet those goals?

0 Not applicable
1 No contribution towards targets
2 Minimal contribution towards achieving targets
3 Moderate contribution towards achieving targets
4 Significant contribution towards achieving targets
5 Essential action towards achieving targets

15% *weighting*

REDUCTION OF DEMAND/ENERGY CONSUMPTION

Does this action directly reduce the City's energy use? If energy demand increases, does it reduce overall greenhouse gas emissions?

0 Not applicable
1 No reduction in consumption
2 Minimal reduction in consumption
3 Moderate reducation in consumption
4 Significant reducation in consumption
5 Extreme reducation in consumption

10% *weighting*

ENVIRONMENTAL EQUITY

What impact would the outcomes of this action have on Durham's residents? Would this action improve environmental equity for historically marginalized communities?

0 Not applicable
1 No improvements to equity
2 Minimal improvements to equity
3 Moderate improvements to equity
4 Significant improvements to equity
5 Extreme improvements to equity

10% *weighting*

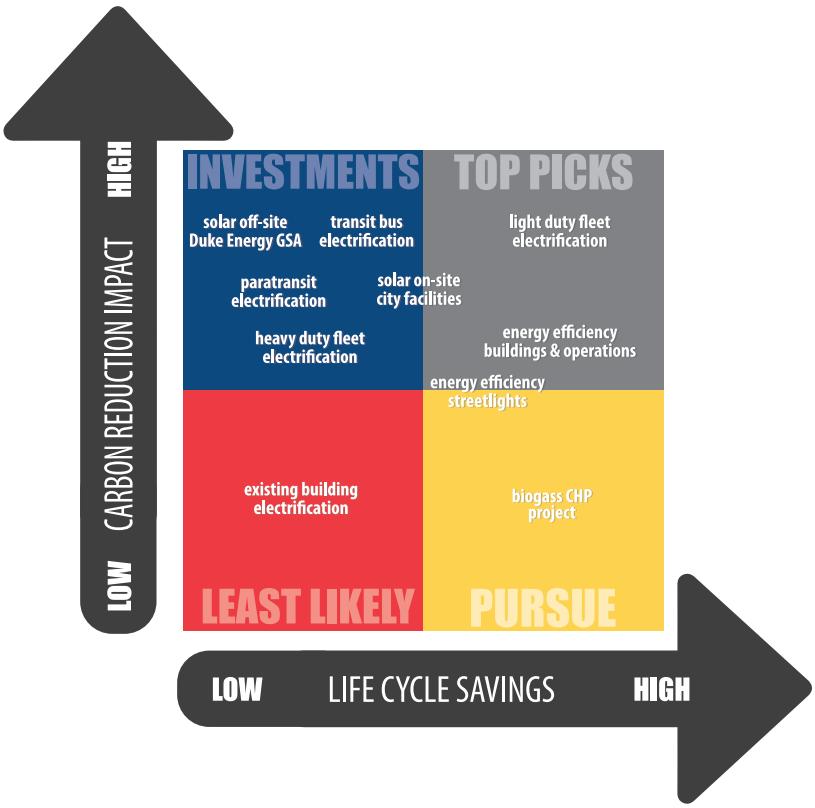
TIMING & EASE OF IMPLEMENTATION

What level of effort would be required to implement this action and is it able to be done quickly? Does this action rely on technology solutions that are currently available in the market?

0 Not applicable
1 Extreme time requirements/theoretical technology
2 Significant time/technology advancement required
3 Moderate time/technology advancement required
4 Minimal time/technology advancement required
5 Immediately available/market ready

does not provide significant savings or carbon reduction potential. This tool is represented in Figure 5-4. This tool may be updated over time as new carbon reduction technologies are available and financial conditions change.

FIGURE 5-4 CARBON REDUCTION/LIFECYCLE SAVINGS



While the CNRE Action Plan is a long-term plan, implementation of short-term action items ensures a smooth and successful transition to clean energy for the City. The Top 10 implementation action items for the City of Durham are listed below.

1. Dedicate City staff to the implementation of the Plan. This task includes hiring additional staff and establishing a sustainability team.
2. Create a community-wide task force for the Durham community to advise and collaborate on implementation. A focus of the task force includes equity and environmental justice considerations.
3. Develop a comprehensive outreach and education strategy to inform Durham residents of the CNRE Action Plan and implementation efforts.
4. Advance initiatives identified in the Memorandum Of Understanding Work plan with Duke Energy regarding renewable projects and energy efficiency pilot programs.
5. Advocate in regulatory and legislative policy processes at both the state and federal level to represent the interests of the Durham community.
6. Identify and pursue financial resources such as grants, loans, and rebate programs to offset capital investment expenses.
7. Complete energy audits and implement energy efficiency improvements in buildings and operations.
8. Install renewable energy on-site generation projects and procure large-scale off-site resources such as Duke Energy GSA or other renewable options. Monitor legislation for changes to renewable energy procurement options in North Carolina.
9. Accelerate vehicle fleet and transportation fleet (buses) electrification and install charging infrastructure.
10. Explore opportunities for public-private partnerships to leverage private sector resource to expand the City's capacity for sustainable projects.

In summary, it will take a portfolio of strategies and action items to achieve the City's carbon neutrality and renewable energy goals. There is not a single solution currently available that will meet the City's needs. The strategies include energy efficiency, electrification, renewable energy, innovative carbon reduction practices and community partnerships. The CNRE Action Plan updates will occur periodically to reflect technological, financial and policy impacts as well as equity and environmental justice considerations.

APPENDIX A

Resolution of Durham City Council Supporting a Transition to Renewable Energy and Carbon Neutrality

Image by City of Durham

Resolution 10124

RESOLUTION OF THE DURHAM CITY COUNCIL SUPPORTING A TRANSITION TO RENEWABLE ENERGY AND CARBON NEUTRALITY

WHEREAS, climate change is real, and increasing levels of greenhouse gas emissions are having adverse effects on both the natural and built environments;

WHEREAS, these physical effects are expected to lead to water scarcity, food insecurity, increasing numbers of refugees, increased poverty, and mass extinctions of species; and

WHEREAS, low-income communities and communities of color in North Carolina and the United States are disproportionately exposed to hazardous pollutants released by fossil fuel burning that can lead to serious health problems such as cancer and asthma exacerbation; and

WHEREAS, clean, renewable energy is defined as energy derived from ongoing natural processes that rapidly replenish and is sustainably collected from renewable sources such as solar, wind, and geothermal. Other approaches may be included after being evaluated for sustainability and environmental justice implications. Energy efficiency will continue to be a critical part of our approach by minimizing the amount of energy used overall; and

WHEREAS, a Stanford University and University of California-Davis study concludes the United States energy supply could be based entirely on renewable energy by the year 2050 using current technologies and 80% renewable energy by 2030 while creating numerous jobs[1]; and

WHEREAS, leading economists, policy experts, and business leaders conclude that transitioning to a clean energy economy would create millions of green jobs nationally, improve living standards, and boost economic growth; and

WHEREAS, Mayor Steve Schewel has committed Durham to the U.S. Conference of Mayors' Climate Agreement to significantly reduce carbon emissions in cities to combat climate change; and

WHEREAS, the City of Durham's Sustainability Report, Roadmap to Sustainability, Greenhouse Gas Emissions Inventory and Local Action Plan lays out goals across social, economic, and environmental impact areas and demonstrate alignment with steps required to transition to renewable energy; and

WHEREAS, in June 2018, the City Council adopted the Strategic Plan Goal 5 – "Sustainable Natural and Built Environment", which calls on the City to "guide equitable, efficient and environmentally sound investments in the City's built and green infrastructure assets"; and

WHEREAS, in October 2018, Governor Roy Cooper signed an executive order, "North Carolina's Commitment to Address Climate Change and Transition to a Clean Energy Economy", which states that North Carolina will honor the 2015 Paris Agreement goals and the state's commitment to the United States Climate Alliance, and requires the state to reduce its greenhouse gas emissions to 40% below 2005 levels by 2025; and

WHEREAS, as of January 2019, eleven cities and towns and seven counties in North Carolina, and more than 100 localities in the United States, have already resolved to transition to clean energy as proposed below.

NOW, THEREFORE, BE IT RESOLVED BY THE CITY COUNCIL OF THE CITY OF DURHAM THAT:

SECTION 1: The City of Durham will develop an action plan by 2020 that communicates how to transition City operations to a supply of 80% renewable energy by 2030, achieve carbon neutrality in city operations by 2040, and reach 100% renewable energy sourcing by 2050.

Adoption of renewable energy is the critical element to achieve carbon neutrality. Transitioning from fossil fuel-powered operations to 100% clean, renewable energy is also vital to build a more resilient community, promote job creation and sustainable economic growth, and protect our local community and the Earth for current and future generations.

Under current realities, the City of Durham faces external policy and technological limitations on its ability to increase renewable energy as a share of consumption across relevant sectors. Making the transition to 80% renewable energy by 2030 and 100% renewable energy by 2050 will depend on federal and state policy changes not fully within the City of Durham's control.

As we take the necessary steps to enable to a renewable energy transition, Durham commits itself to a renewable energy transition, the City of Durham commits itself in its own operations, policies and guidelines to continuing its efforts towards clean energy, reduction of greenhouse gas emissions, and sustainability. These efforts include increasing energy efficiency in existing buildings, constructing new buildings to the highest standards of energy efficiency, increasing the use of renewable energy such as solar photovoltaics, and greening the City fleet by purchasing hybrid and electric vehicles where feasible.

The City of Durham firmly commits to achieving equity, affordability, and access for all members of the community in the transition to carbon neutrality and renewable energy. Furthermore, we commit to a transparent and inclusive process for planning and implementation, ensuring that the public has an opportunity to participate as the City of Durham develops and adopts a plan.

SECTION 2: The City of Durham will develop an actionable advocacy plan to petition the North Carolina General Assembly, Departments and Agencies of the Executive Branch of North Carolina, the United States Government, and utility and energy organizations serving the City, to affect policy, regulatory, and contract changes necessary to achieve a transition from fossil fuels to clean, renewable energy for all energy sectors by 2050. This includes advocating for a federal price on carbon, as outlined in H.R. 763, Energy Innovation and Carbon Dividend Act, along with other policies that will facilitate the City of Durham in achieving 100% renewable energy.

SECTION 3: In addition to its plans for city operations, the City of Durham supports a transition to carbon neutrality and 100% clean, renewable energy community-wide by 2050. The City will advocate strongly for relevant policies to be adopted in coming years to enable this transition. In the short term, the City will encourage the development of clean energy and energy efficient infrastructure in the local residential and commercial sectors.

SECTION 4: The City Manager shall annually submit to the City Council a report setting forth the actions taken and progress made toward fulfilling the goals stated in this Resolution.

SECTION 5: This Resolution is effective upon passage and shall remain effective until repealed or amended by the City Council.

APPROVED BY
CITY COUNCIL

APR 1 2019

CITY CLERK

APPENDIX B

Summary of Action Items & Decision Matrix

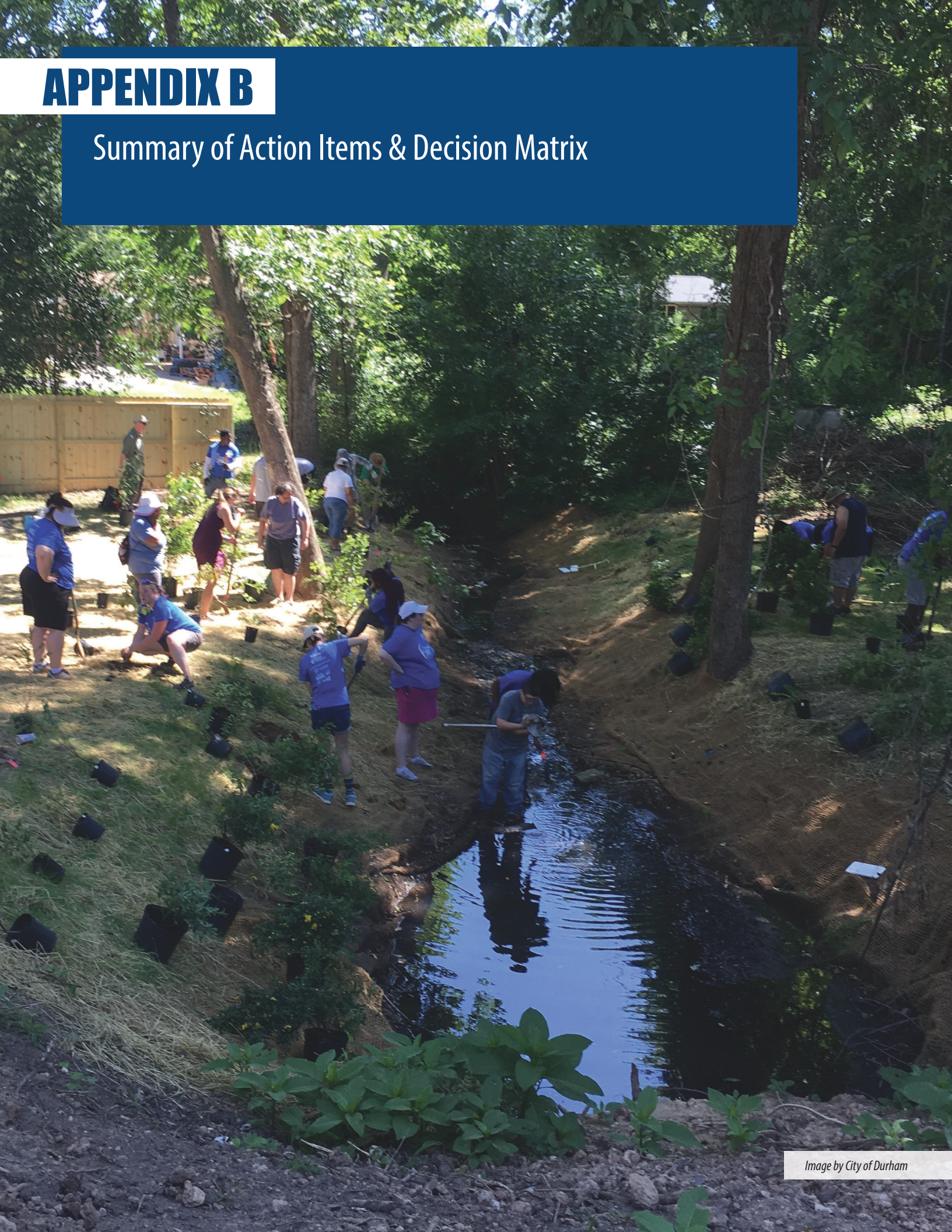


Image by City of Durham

TABLE B-1 SUMMARY OF ACTION ITEMS

ID	Project	Action Item Description
EE-1	Energy Efficiency	Continue energy efficiency efforts and retrofits in City buildings to achieve at least a 30% reduction in energy consumption by 2040. Leverage Duke Energy program incentives to reduce costs.
EE-2	Energy Audits	Conduct ASHRAE level 2 or 3 energy audits for the City's top 25 energy using buildings to identify savings opportunities and prioritize project plans for each facility. Conduct ASHRAE Level 1 energy audits for all other facilities.
EE-3	Building Energy Management System	Expand building energy management systems (BMS) beyond the current 3 facilities to the City's top 10 energy using buildings.
EE-4	Benchmarking and Data Analytics	Benchmark energy usage for City facilities. Procure a comprehensive data management platform (software or consultancy) consistent with City performance measure/data tracking methodology.
EE-5	High Performance Building Standards	Require new construction and extensive renovation projects on City owned and operated facilities to meet high performance and green building standards such as LEED.
EE-6	Outdoor Lighting	Upgrade existing outdoor pole lighting to high efficiency LED in parking lots, athletic fields, park venues and other public spaces.
EE-7	Energy Efficiency	Continue energy efficiency efforts at water and wastewater facilities such as controls, equipment and operational modifications. Consider a machine learning/AI pilot.
EE-8	Expand Conversion to LED Lighting	Continue to expand conversion of LED lighting to other City facilities and locations.
EE-9	Explore Smart City Technology Applications	Explore Smart City applications such as traffic/pedestrian monitoring, pole based EV charging, and environmental sensors.
ET-1	Fleet - Light Duty Cars	Replace light duty cars from gasoline to battery electric as vehicles reach the end of their 10-year useful life. Assume 50% conversion by 2030 and 100% conversion by 2040.
ET-2	Fleet - Light Duty Trucks	Replace light duty trucks from gasoline to battery electric as vehicles reach the end of their 10-year useful life. Assume 33% conversion by 2030 and 100% conversion by 2040.
ET-3	Fleet - Medium/Heavy Duty Vehicles and Equipment	Replace medium/heavy duty (MD/HD) vehicles to electric as technology is available. Consider pilot programs to test new viability of new options. Assume 20% conversion from 2031-2040.
ET-4	Fleet - Electric Bikes	Evaluate potential to incorporate electric bikes into City fleet as alternative to vehicle use.
ET-5	Vehicle Procurement	Update vehicle procurement policy to replace fossil fuel powered vehicles to battery electric as vehicle reaches end of useful life and technology is available. Evaluate potential benefits of lease versus buy options.
ET-6	Right-size/Telematics	Continue to install telematics on vehicles to determine mileage, usage patterns, and other factors to optimize fleet fuel efficiency and cost effectiveness. Right-size the fleet.
ET-7	EV Charging Infrastructure	Continue installation of charging infrastructure to support City electric vehicle fleet expansion and provide public charging opportunities. Develop managed charging strategy and leverage all potential funding sources.
ET-8	EV Outreach and Education	Participate in community-wide outreach events to educate residents on City use of electric vehicles and associated benefits.
ET-9	Transit - Buses	Adopt electric bus purchasing policy and continue replacement of diesel buses to battery electric. Leverage federal and state funding sources.

TABLE B-1 SUMMARY OF ACTION ITEMS (CONTINUED)

ID	Project	Action Item Description
ET-10	Transit - Paratransit Vehicles	Adopt electric paratransit vehicle purchasing policy and begin replacement of gasoline vehicles to battery electric as technology is available. Leverage federal and state funding sources.
EB-1	Building Electrification	Convert natural gas equipment to electric equipment as feasible in conjunction with building renovations or when equipment needs replacement or major service.
RE-1	Rooftop Solar	Continue installation of rooftop solar systems on existing City facilities and all new construction as feasible. Explore the options to lease versus buy solar systems.
RE-2	Solar Canopies/EV Charging	Evaluate feasibility of solar canopies/systems in City parking facilities and fleet locations. Explore possibility to pair with battery storage or EV charging.
RE-3	Landfill Solar	Explore all potential landfill solar options including exposed geomembrane solar landfill cap.
RE-4	Microgrid/Solar/Storage	Study feasibility and implement projects using solar and battery storage for City facilities including community resilience hubs or recreation centers utilized as emergency housing.
RE-5	Architectural Solar Structure	Install solar structures such as flowers or trees at City parks or buildings for community education and awareness.
RE-6	Geothermal	Investigate the opportunity for geothermal energy to provide heating, cooling, and water heating in new construction.
RE-7	Large scale procurement such as Duke Energy Green Source Advantage (GSA) program	Continue pursuit of participation in Duke Energy Green Source Advantage (GSA) or similar program.
RE-8	Renewable Energy Certificates/Credits (RECs)	Evaluate purchase of Renewable Energy Credits (RECs) as needed to close any gaps to achieve renewable energy goals.
RE-9	Renewable Natural Gas (RNG)	Explore opportunities to source Renewable Natural Gas supply from Dominion Energy.
RE-10	Duke Energy IRP	Advocate in Duke Energy's IRP for increased renewable energy resources and procurement options.
RE-11	Emerging Technology	Monitor and evaluate other potential technologies for renewable energy supply such as hydrogen, wind, and solar + storage.
RE-12	NDWRF CHP Project	Install Combined Heat and Power (CHP) system at NDWRF. Update project conceptual analysis from previous report and solicit proposals from design/build firms.
IS-1	Carbon Reduction Practices	Establish carbon reduction practices that incorporate innovative solutions to reduce the City's overall GHG emissions such as the tree canopy program, green roofs and low carbon concrete.
IS-2	Community Partnerships	Develop partnerships with key stakeholders - both internal and external to the City. Internal sustainability staffing, internal cross-departmental teams are needed. External partnerships with residents, businesses, community service organizations, utilities, and others should be created to advise the City.
FS-1	Financing and Funding Sources	Evaluate all potential funding sources including federal, state, local, private, philanthropic and utility programs. Monitor and pursue all fleet and transit funding sources.
PS-1	Legislative and Regulatory Policy	Participate in federal and state policy proceedings related to decarbonization efforts such as energy efficiency, renewable energy, and transportation electrification as well as energy equity and environmental justice initiatives.

TABLE B-2 DECISION MATRIX

				Scoring Criteria							
				25%	20%	20%	15%	10%	10%		
ID	Project	Action Item Description	Weighted Score (100 Possible)	Greenhouse Gas Reduction	Cost Implications	Criticality of Meeting Resolution Targets	Reduction of Demand/ Energy Consumption	Environmental Equity	Timing & Ease of Implementation	Responsible Department
ET-1	Fleet - Light Duty Cars	Replace light duty cars from gasoline to battery electric as vehicles reach the end of their 10-year useful life. Assume 50% conversation by 2030 and 100% conversion by 2040.	91	5	4	5	4	4	5	Fleet Management
ET-9	Transit - Buses	Adopt electric bus purchasing policy and continue replacement of diesel buses to battery electric. Leverage federal and state funding sources.	89	5	3	5	4	5	5	Transportation
RE-7	Large scale procurement such as Duke Energy Green Source Advantage (GSA) program	Continue pursuit of participation in Duke Energy Green Source Advantage (GSA) or similar program.	84	5	4	5	1	5	5	General Services
ET-2	Fleet - Light Duty Trucks	Replace light duty trucks from gasoline to battery electric as vehicles reach the end of their 10-year useful life. Assume 33% conversation by 2030 and 100% conversion by 2040.	83	5	3	5	4	4	3	Fleet Management
EE-1	Energy Efficiency	Continue energy efficiency efforts and retrofits in City buildings to achieve at least a 30% reduction in energy consumption by 2040. Leverage Duke Energy program incentives to reduce costs.	80	3	4	4	5	4	5	General Services, Water Management
EE-7	Energy Efficiency	Continue energy efficiency efforts at water and wastewater facilities such as controls, equipment, and operational modifications. Consider a machine learning/AI pilot.	78	3	4	4	5	4	4	Water Management
ET-5	Vehicle Procurement	Update vehicle procurement policy to replace fossil fuel powered vehicles to battery electric as vehicle reaches end of useful life and technology is available. Evaluate potential benefits of lease versus buy options.	78	4	3	4	4	4	5	Fleet Management
EE-8	Expand Conversion to LED Lighting	Continue to expand conversion of LED lighting to other City facilities and locations.	78	3	4	3	5	5	5	General Services, Transportation
ET-10	Transit - Paratransit Vehicles	Adopt electric paratransit vehicle purchasing policy and begin replacement of gasoline vehicles to battery electric as technology is available. Leverage federal and state funding sources.	78	5	2	5	3	5	3	Transportation
ET-6	Right-size/Telematics	Continue to install telematics on vehicles to determine mileage, usage patterns, and other factors to optimize fleet fuel efficiency and cost effectiveness. Right-size the fleet.	75	4	3	4	3	4	5	Fleet Management
EE-5	High Performance Building Standards	Require new construction and extensive renovation projects on City owned and operated facilities to meet high performance and green building standards such as LEED.	75	3	4	4	4	4	4	General Services
RE-1	Rooftop Solar	Continue installation of rooftop solar systems on existing City facilities and all new construction as feasible. Explore the options to lease versus buy solar systems.	75	4	4	4	1	5	5	General Services

TABLE B-2 DECISION MATRIX (CONTINUED)

				Scoring Criteria							
				25%	20%	20%	15%	10%	10%		
ID	Project	Action Item Description	Weighted Score (100 Possible)	Greenhouse Gas Reduction	Cost Implications	Criticality of Meeting Resolution Targets	Reduction of Demand/ Energy Consumption	Environmental Equity	Timing & Ease of Implementation	Responsible Department
EE-2	Energy Audits	Conduct ASHRAE level 2 or 3 energy audits for the City's top 25 energy using buildings to identify savings opportunities and prioritize project plans for each facility. Conduct ASHRAE Level 1 energy audits for all other facilities.	74	3	4	3	5	3	5	General Services
ET-3	Fleet - Medium/Heavy Duty Vehicles and Equipment	Replace medium/heavy duty (MD/HD) vehicles to electric as technology is available. Consider pilot programs to test new viability of new options. Assume 20% conversion from 2031-2040.	73	5	2	4	4	4	2	Fleet Management
IS-2	Community Partnerships	Develop partnerships with key stakeholders - both internal and external to the City. Internal sustainability staffing, internal cross-departmental teams are needed. External partnerships with residents, businesses, community service organizations, utilities, and others should be created to advise the City.	73	3	4	4	2	5	5	General Services
EE-4	Benchmarking and Data Analytics	Benchmark energy usage for City facilities. Procure a comprehensive data management platform (software or consultancy) consistent with City performance measure/data tracking methodology.	72	3	4	3	5	3	4	General Services
FS-1	Financing and Funding Sources	Evaluate all potential funding sources including federal, state, local, private, philanthropic, and utility programs. Monitor and pursue all fleet and transit funding sources.	68	3	4	4	1	4	5	General Services
EE-3	Building Energy Management System	Expand building energy management systems (BMS) beyond the current 3 facilities to the City's top 10 energy using buildings.	67	3	3	3	4	3	5	General Services
EE-6	Outdoor Lighting	Upgrade existing outdoor pole lighting to high efficiency LED in parking lots, athletic fields, park venues and other public spaces.	65	3	3	2	4	5	4	General Services
PS-1	Legislative and Regulatory Policy	Participate in federal and state policy proceedings related to decarbonization efforts such as energy efficiency, renewable energy, and transportation electrification as well as energy equity and environmental justice initiatives.	65	3	3	3	2	5	5	General Services
ET-8	EV Outreach and Education	Participate in community-wide outreach events to educate residents on City use of electric vehicles and associated benefits.	64	3	4	3	3	3	3	General Services
RE-12	NDWRF CHP Project	Install Combined Heat and Power (CHP) system at NDWRF. Update project conceptual analysis from previous report and solicit proposals from design/build firms.	63	2	4	3	3	4	4	Water Management
ET-7	EV Charging Infrastructure	Continue installation of charging infrastructure to support City electric vehicle fleet expansion and provide public charging opportunities. Develop managed charging strategy and leverage all potential funding sources.	62	3	3	3	3	4	3	Fleet Management
RE-6	Geothermal	Investigate the opportunity for geothermal energy to provide heating, cooling, and water heating in new construction.	62	3	3	3	3	3	4	General Services

TABLE B-2 DECISION MATRIX (CONTINUED)

				Scoring Criteria							
				25%	20%	20%	15%	10%	10%		
ID	Project	Action Item Description	Weighted Score (100 Possible)	Greenhouse Gas Reduction	Cost Implications	Criticality of Meeting Resolution Targets	Reduction of Demand/ Energy Consumption	Environmental Equity	Timing & Ease of Implementation	Responsible Department
RE-2	Solar Canopies/EV Charging	Evaluate feasibility of solar canopies/systems in City parking facilities and fleet locations. Explore possibility to pair with battery storage or EV charging.	61	4	2	3	3	4	2	General Services
ET-4	Fleet - Electric Bikes	Evaluate potential to incorporate electric bikes into City fleet as alternative to vehicle use.	61	3	3	2	4	4	3	Fleet Management
RE-10	Duke Energy IRP	Advocate in Duke Energy's IRP for increased renewable energy resources and procurement options.	60	3	4	3	1	3	4	General Services
RE-4	Microgrid/Solar/Storage	Study feasibility and implement projects using solar and battery storage for City facilities including community resilience hubs or recreation centers utilized as emergency housing.	59	3	4	2	2	4	3	General Services
RE-5	Architectural Solar Structure	Install solar structures such as flowers or trees at City parks or buildings for community education and awareness.	58	2	4	2	2	4	5	General Services
RE-3	Landfill Solar	Explore all potential landfill solar options including exposed geomembrane solar landfill cap.	57	4	2	4	1	3	2	General Services
RE-11	Emerging Technology	Monitor and evaluate other potential technologies for renewable energy supply such as hydrogen, wind, and solar + storage.	57	3	4	2	2	4	2	General Services
IS-1	Carbon Reduction Practices	Establish carbon reduction practices that incorporate innovative solutions to reduce the City's overall GHG emissions such as the tree canopy program, green roofs and low carbon concrete.	57	3	3	2	2	4	4	General Services
EE-9	Explore Smart City Technology Applications	Explore Smart City applications such as traffic/pedestrian monitoring, pole-based EV charging, and environmental sensors.	51	2	3	2	3	3	3	General Services, Transportation
EB-1	Building Electrification	Convert natural gas equipment to electric equipment as feasible in conjunction with building renovations or when equipment needs replacement or major service.	47	2	2	2	3	3	3	General Services
RE-8	Renewable Energy Certificates/Credits (RECs)	Evaluate purchase of Renewable Energy Credits (RECs) as needed to close any gaps to achieve renewable energy goals.	46	1	4	3	1	1	4	General Services
RE-9	Renewable Natural Gas (RNG)	Explore opportunities to source Renewable Natural Gas supply from Dominion Energy.	31	2	1	1	1	3	2	General Services

APPENDIX C

Summary of EAB Survey Responses

Image by City of Durham

CITY OF DURHAM

Carbon Neutrality and Renewable Energy Action Plan Survey Summary

PURPOSE Survey to seek input and suggestions regarding the CNRE strategies and action items for each of the major categories – Renewable Energy, Energy Efficiency, Electrification - Transportation, Electrification – Buildings, and Other.

WHO Durham City-County Environmental Affairs Board (EAB) – 20 survey responses were received

HOW Electronic Survey via Constant

WHEN March 2021

Survey questions and summary of responses below.

1. PLEASE PROVIDE YOUR SUGGESTIONS FOR THE RENEWABLE ENERGY CATEGORY. INCLUDE THE FOLLOWING INFORMATION: PROJECT NAME PROJECT DESCRIPTION OTHER INFORMATION (EXPECTED COST, WEBSITE LINK, REFERENCE PROJECT/CASE STUDY, ETC.)

KEY THEMES: Overall support for the City to invest in solar panels on the roofs of government buildings and pair with storage systems for resiliency. Other renewable options mentioned include landfill solar, wind turbines and waste biomass.

- ***Suggestion to invest in this technology quickly and explore creative financing. Also, install solar at affordable housing.***
- ***Suggestion to take advantage of MOU with Duke Energy for community solar and participate in Duke Energy Green Source Advantage program.***
- ***Suggestion regarding the City acquiring oil terminals and converting oil tanks into waste biogas processors. Biodiesel could be used by city bus or county school transit.***

> "State advocacy agenda for RE to increase options for city. Other cities in other states have better options for procurement. Durham asserting the need for better options to meet goals will very likely have an impact on state regulatory and legislative decisions."

2. PLEASE PROVIDE YOUR SUGGESTIONS FOR THE ENERGY EFFICIENCY CATEGORY. INCLUDE THE FOLLOWING INFORMATION: PROJECT NAME PROJECT DESCRIPTION OTHER INFORMATION (EXPECTED COST, WEBSITE LINK, REFERENCE PROJECT/CASE STUDY, ETC.)

KEY THEMES: Overall support for City to expand the tree canopy, replace government lights with LED lights, weatherization in City buildings, and incentives for new construction and affordable housing.

- ***Suggestion to convert the Durham Reuse Arts District into a low renewable energy and energy efficiency demonstration site.***

> "The city should work to develop grants, regulations, and programs that fund, incentivize, or build capacity around the delivery of energy efficient and affordable housing."
>
> "Durham would likely benefit from explicit policy to allow Departments/agencies that implement energy efficiency retrofits to capture part or all of the operations and maintenance budget savings and flexibly apply that to other parts of Department/Division budgets. North Carolina has already implemented similar policy for public universities and state funds."

3. PLEASE PROVIDE YOUR SUGGESTIONS FOR THE ELECTRIFICATION-TRANSPORTATION CATEGORY. INCLUDE THE FOLLOWING INFORMATION: PROJECT NAME PROJECT DESCRIPTION OTHER INFORMATION (EXPECTED COST, WEBSITE LINK, REFERENCE PROJECT/CASE STUDY, ETC.)

KEY THEMES: Overall support for transitioning city fleet to all electric vehicles and buses. Additional support for increased public charging stations including fast charging.

- ***Suggestion to expand bike/scooter lanes throughout city.***
- ***Suggestion for education of City employees and better communication with residents on the future plans for transportation.***

> "City buses should all be electric, and no new petrol buses should be purchased. The city should also invest in providing EV charging stations in parking lots around the city, to help enable Durham residents to go electric."

4. PLEASE PROVIDE YOUR SUGGESTIONS FOR THE ELECTRIFICATION-BUILDING CATEGORY. INCLUDE THE FOLLOWING INFORMATION: PROJECT NAME PROJECT DESCRIPTION OTHER INFORMATION (EXPECTED COST, WEBSITE LINK, REFERENCE PROJECT/CASE STUDY, ETC.)

KEY THEMES: Overall support for new affordable housing units to be all-electric and retrofit existing affordable housing with solar. Additional support to adopt green building requirements and phase out natural gas use in City buildings.

- ***Suggestion for viable geothermal sources for heating and cooling.***
- ***Suggestion to upgrade load centers and main panels to enable building electrification.***

> "Affordable housing units should use solar energy and/or be connected to viable geothermal sources for heating and cooling. Every building should strive for solar power, electric heat pump for water, heat pump for space heat, induction cooking appliances (no natural gas), on-site storage like a home battery, and EV charging."

5. PLEASE PROVIDE YOUR SUGGESTIONS FOR THE OTHER CATEGORY. INCLUDE THE FOLLOWING INFORMATION: PROJECT NAME, PROJECT DESCRIPTION, OTHER INFORMATION (EXPECTED COST, WEBSITE LINK, REFERENCE PROJECT/CASE STUDY, ETC.)

KEY THEMES: Overall support for reducing waste in community, composting program, and community gardens. Additional feedback to ensure transition occurs equitably, benefitting all members of the Durham community.

- ***Suggestion for Green infrastructure bond on the ballot to pay for initiatives.***
- ***Suggestion to establish Climate Projects Fund: Establish a 1/2 cent tax of assessed property tax value to fund climate projects.***
- ***Suggestion to develop/support green job training: support local job creation in partnership with higher education institution and to establish carbon neutrality task force.***

6. PLEASE PROVIDE ANY ADDITIONAL SUGGESTIONS OR COMMENTS BELOW.

KEY THEMES: Overall support that justice, standards, and investment is a helpful framework for policy. General concern regarding potential for greenwashing from utility. Additional feedback that additionality matters and to procure new renewable energy projects as well as to invest resources into the community and support local jobs.

- ***Suggestion to keep environmental justice in mind and increase city walkable areas.***
- ***Suggestion to look into smart city and circular economy programs.***

> "Everything Durham does, moving forward, should keep in mind environmental justice. The disadvantaged and marginalized should always be kept at the forefront of whatever plans are made -- we don't just want a greener future, we want a better future, for everyone."

APPENDIX D

Glossary

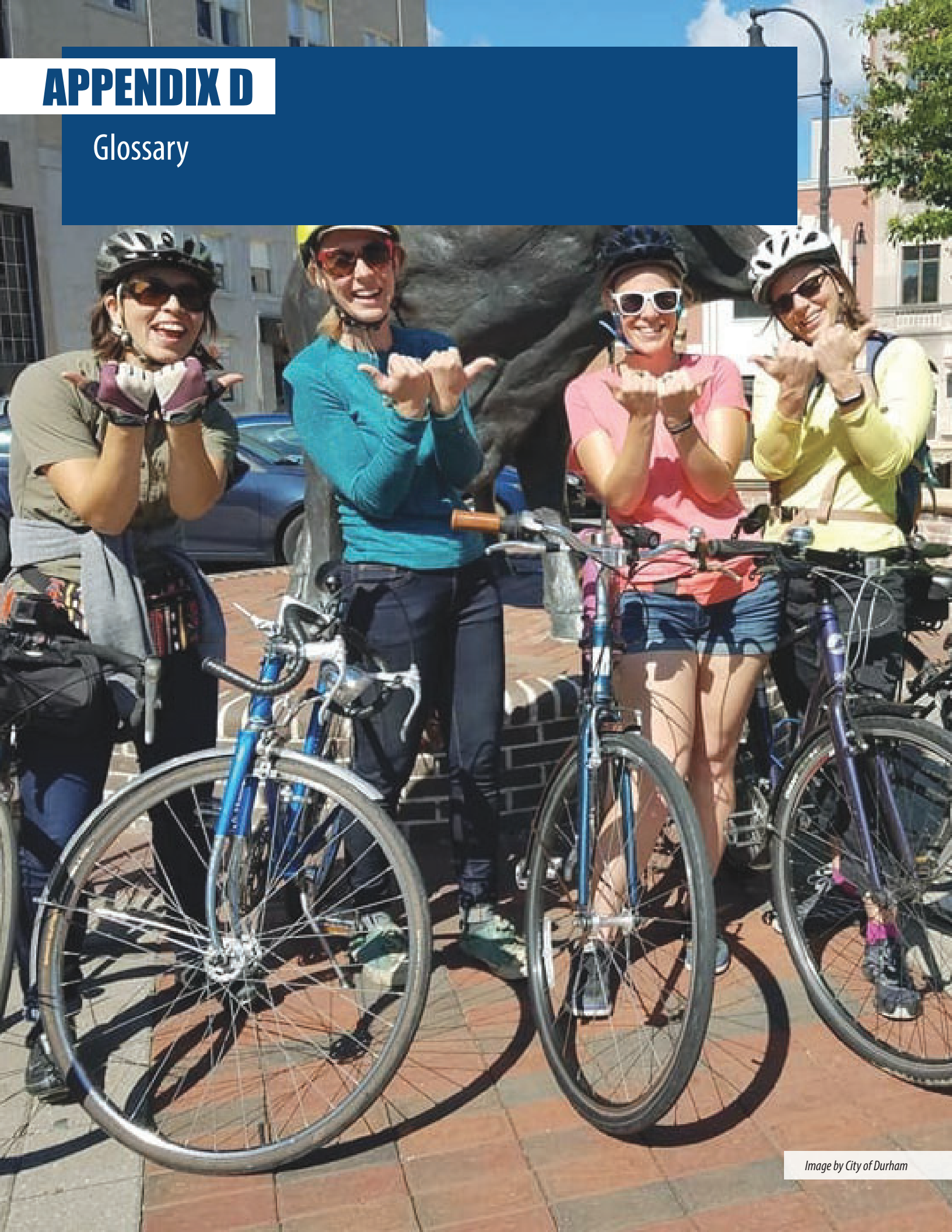


Image by City of Durham

ASHRAE – The American Society of Heating, Refrigerating, and Air-Conditioning Engineers

BMS – Building Management System

BTU – British Thermal Unit

CCTV – Closed circuit television

CFAT – Clean Fuels Advanced Technology

CHP – Combined Heat and Power

CPRE – Competitive Procurement of Renewable Energy

DC – Direct Current

DEQ – Department of Environmental Quality

DOE – U.S. Department of Energy

DSM – Demand Side Management

EAB – Environmental Affairs Board

EEC – Energy Efficiency Certificate

EIA – Energy Information Administration

ekWH – Equivalent Kilowatt hour

EPA – Environmental Protection Agency

EV – Electric Vehicle

EVSE – Electric Vehicle Supply Equipment

FERC – Federal Energy Regulatory Commission

GHG – Greenhouse Gases

GHP – Ground-source Heat Pump

GSA – Duke Energy Green Source Advantage Program

HVAC – Heating, Ventilation, and Air Conditioning

ICLEI – International Council for Local Environmental Initiatives

IOU – Investor-Owned Utility

IRP – Integrated Resource Plan

ITC – Investment Tax Credit

kWH – Kilowatt hour

LECC – Low-embodied Carbon Concrete

LED – Light Emitting Diode

LEED – Leadership in Energy and Environmental Design

MACC – Marginal Abatement Cost Curve

MGD – Millions of gallons per day (water)

MOU – Memorandum of Understanding

MTCO2e – Metric Carbon Dioxide equivalent

MW - Megawatt

MWH – Megawatt hour

NCUC – N.C. Utility Commission

NREL – National Renewable Energy Laboratory

PURPA – Public Utility Regulatory Policies Act

REC – Renewable Energy Credit

REPS – Renewable Energy and Energy Efficiency Portfolio Standards

RTO – Regional Transmission Organization

SCADA – Supervisory Control and Data Acquisition

SEEM – Southeast Energy Exchange Market

SEIA – Solar Energy Industries Association

Solar PV – Solar Photovoltaics

WRF – Water Reclamation Facility

APPENDIX E

Resources / References

Image by City of Durham

ENDNOTE RESOURCES / REFERENCES

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ADDITIONAL PHOTO CREDITS

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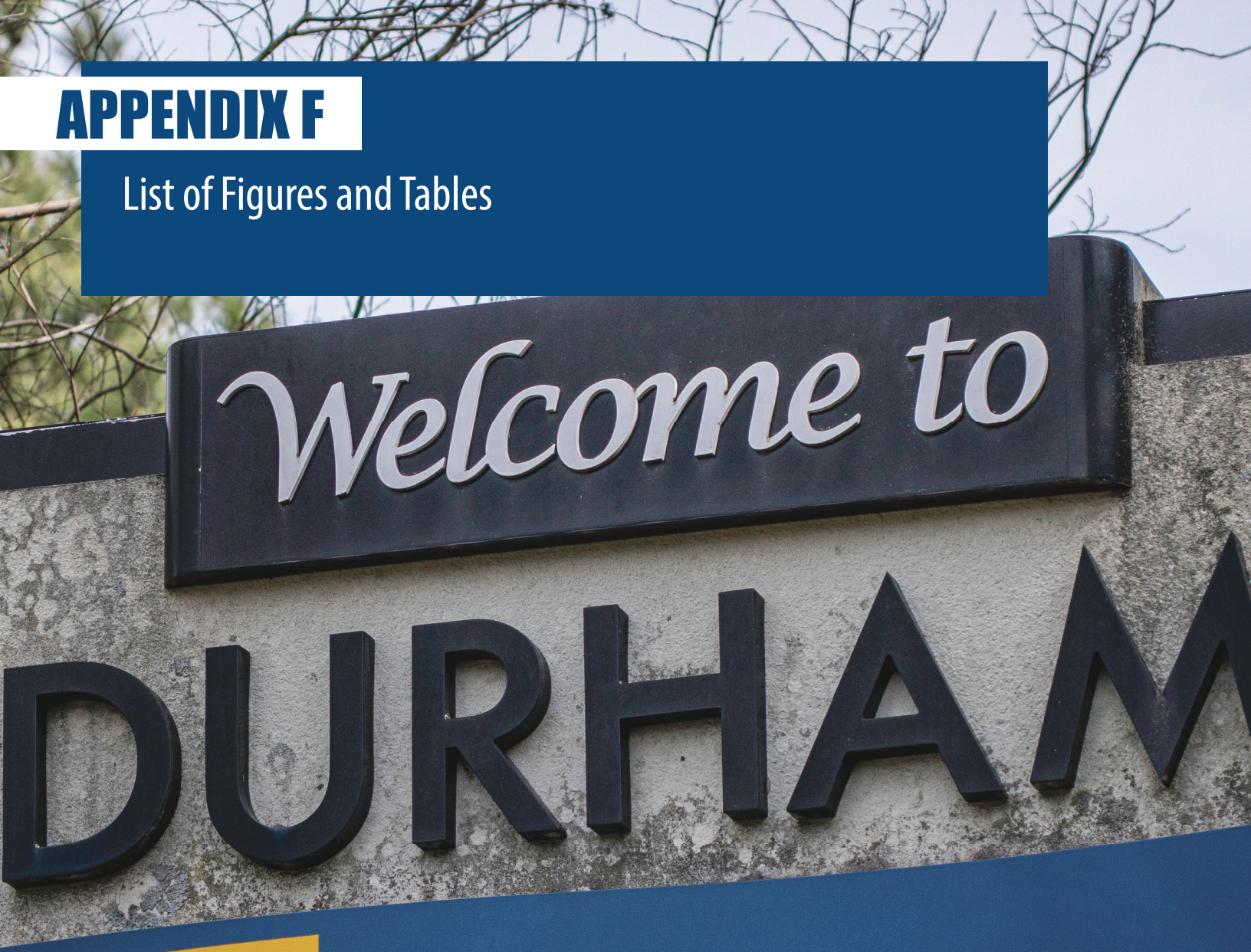
APPENDIX F

List of Figures and Tables



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