City of Greensboro Strategic Energy Plan: Pathways to 100% Renewable Energy

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GREENSBORO

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List of Acronyms

BAS Building Automation System

CH_4 Methane

CIP Capital Improvements Program

CNG Compressed Natural Gas

CO_2 Carbon Dioxide

CO_{2e} Carbon Dioxide equivalent

CSC Community Sustainability Council

ESCO Energy Service Company

EV Electric Vehicle

GHG Greenhouse Gas

GWP Global Warming Potential

HUB Historically Underutilized Business

ICE Internal Combustion Engine

ICLEI Local Governments for Sustainability

IPCC Intergovernmental Panel on Climate Change

IRP Integrated Resource Plan

kW Kilowatt

kWh Kilowatt Hour

L4C LEED for Cities

LEED Leadership in Energy and Environmental Design

MT Metric Tons

MT CO_{2e} Metric Tons of Carbon Dioxide equivalent

MW Megawatt

MWBE Minority-and Women-Owned Business Enterprise

N_2O Nitrous Oxide

O_3 Ozone

PV Photovoltaic

REC Renewable Energy Certificate

SEP Strategic Energy Plan

WRI World Resources Institute

Table of Contents

Executive Summary

The City of Greensboro *Strategic Energy Plan (SEP): Pathways to 100% Renewable Energy* was developed in response to the *Resolution to Support the Establishment of a 20-Year Strategic Energy Plan and Goals to Transition to 100% Renewable Energy for the City of Greensboro*[1] adopted unanimously by the Greensboro City Council in 2019.

The SEP was developed through a series of meetings held with both City staff and the community throughout the process. The information, input, and strategies proposed from these meetings all informed the plan. Goals and strategies, and later, actions were developed to reduce energy consumption and shift to renewables. The final goals, strategies, and actions found in this plan are the result of many meetings with the SEP Leadership Team and Community Partnership.

The development process included an analysis of 2019 energy use by source (electricity, natural gas, gasoline, and diesel) for City operations, to determine the City's usage of these energy sources. GHG emissions were also calculated for each source. Totals were then broken down by department to identify the primary users of each energy source. The 2019 energy profile provided insight into prioritization of goals and development of departmental specific strategies to reduce consumption and integrate renewable energy.

Goals, strategies, and actions were developed for each department. Recommended actions the City can take to accelerate the implementation of the SEP were developed as well, with significant input from the Community Partnership. A prioritization of actions was determined, a financing strategy was outlined, and an evaluation plan recommended.

2019 Energy and Emissions Breakdown

The table below shows energy consumed by source, the amount of CO_{2e} emitted from each source, and the percentage of emissions produced by each source. Electricity use accounts for 60% of the City's emissions. Diesel emissions account for 19%; gasoline, 14%; and natural gas, 7%.

Energy Source (Unit)	2019 Consumed	MT CO_{2e}	GHG Emissions
Electric Use (MWh)	139,414	47,254	60%
Diesel (Gal)	1,478,395	15,022	19%
Gasoline (Gal)	1,181,995	10,552	14%
Natural Gas (MMBTu)	94,872	5,320	7%

[1] City of Greensboro. *Resolution to Support the Establishment of a 20-Year Strategic Energy Plan and Goals to Transition to 100% Renewable Energy for the City of Greensboro.* Community Sustainability Council. Accessed October 15, 2021. https://www.greensboro-nc.gov/departments/planning/boards-commissions-meetings/community-sustainability-council-csc

Key Findings

Electricity

Three departments make up 80% of electricity consumption:

- Water Resources, 49%
- Transportation, 18%
- Coliseum Complex, 12%

Pathway to 100% renewable energy:

- Reduce consumption buildings and equipment through energy efficiency measures.
    - Water Resources, Central Library, The Depot and The Coliseum measures are identified as high impact.
- Integrate on-site renewable energy.
    - 1 MW ground array (project formerly listed in the CIP) and Central Library rooftop (proposed project).
    - Using ground-mounted arrays to meet the City's current electricity demand is estimated to require 87 MW of solar at a cost of $131 million and the utilization of 410 acres of City-owned land.

Natural Gas

Natural gas accounts for only 7% of emissions. Goals and strategies are in place to address natural gas but are not considered priorities.

Gasoline

Two departments make up almost 80% of gasoline consumption:

- Police, 49%
- Transportation, 30%

Pathway to 100% renewable energy:

- Reduce gasoline consumption through integration of hybrid and electric vehicles into the fleet.
    - Police patrol vehicle conversion has been identified for high prioritization (high use/mileage).

Diesel

Two departments make up 86% of diesel consumption:

- Field Operations, 65%
- Transportation, 21%

Pathway to 100% renewable energy:

- Reduce diesel consumption through integration of hybrid and electric vehicles into both fleet vehicle replacement and equipment replacement as comparable vehicles/equipment become available.

Pathway to 2040 Goals

The strategies outlined below are identified to provide a pathway to 100% Renewable Energy by 2040.

- **Advocate for renewable energy on the grid** - Changes to the grid generation mix can have the biggest impact on the City reaching its renewable energy goal. Increasing the amount of renewable energy on the grid means electricity purchased will generate lower GHG emissions and enable the City to meet its goal faster. City staff and CSC members have been participating in the Cities Initiative convened by the North Carolina Chapter of the Environmental Defense Fund, in part to advocate for renewable energy on the grid. Greensboro Mayor Nancy Vaughan joined the highest elected office holders from 12 other large local governments in the state in signing joint comments on Duke Energy's proposed biennial Integrated Resource Plan. In response to these comments and many others, expressing opposition to aspects of the IRP, it was announced on January 24, 2022, that Duke Energy would withdraw the proposed IRP in order to focus on developing the State-mandated Carbon Plan.
- **Ensure a just transition -** The transition to 100% renewable energy goal must ensure that any environmental burdens created are not placed on the City's most impacted and vulnerable communities, that benefits are distributed equitably, and the process is broadly diverse and inclusive.
- **Energy efficiency measures on City owned buildings in order of inefficiency and impact** - Buildings account for 32% of the electricity footprint. Efficiency measures will reduce the amount of electricity needed which will reduce emissions as well as electricity costs. Performance contracts are an option to finance these measures. A 25% reduction in building electricity use will drop total use 8%.
- **Sustainable Fleet -** Reducing gasoline and diesel consumption can be achieved through the integration of hybrid and EVs into the fleet. The Police Department accounts for 50% of gasoline emissions and Field Operations account for 47% of diesel emissions. The Ford Hybrid Interceptor is identified to replace the current Interceptors and other patrol vehicles. Hybrid and EV options are available for some vehicles and equipment used by Field Operations. A commitment to hybrid and EV integration of all applicable vehicles and equipment according to the current replacement schedules will drop fuel consumption by 6% per year.
- **Solar Installation -** Installation of ground solar and rooftop arrays are identified to increase the amount of renewable energy used to meet yearly energy demand. Meeting the City's total 2019 electricity demand with solar PV would require a total capacity of approximately 87 MW. With currently available technology, a one MW array occupies

roughly 5 acres. Installing enough arrays to provide 87 MW would require combined land area and rooftop space of 410 acres or more.

- **Other renewable opportunities -** Several smaller renewable energy projects have been identified to produce electricity. Feasibility studies and cost/benefit analysis will determine if these projects will be chosen and advanced for funding.
- **Purchasing Green Power -** Purchasing renewable energy credits or offsets can be effective options for meeting emissions and renewable energy goals that cannot be met through other paths. Using these options supports the increase of renewable energy on the grid.

Conclusions

The City of Greensboro's Resolution to achieve 100% renewable energy by 2040 is an ambitious goal. It will be achievable through long term commitment to meeting the goals established in the SEP. It will require the City to become more efficient, to re-think current practices and systems, to consider new factors in decision making, and to invest public resources differently. Through careful, data-informed decisions and consistently taking deliberate steps forward, Greensboro can achieve 100% renewable energy in City operations by 2040.

Introduction and Background

Pathway to 100% Renewable Energy: City of Greensboro *Strategic Energy Plan (SEP)* was developed in response to the *Resolution to Support the Establishment of a 20-Year Strategic Energy Plan and Goals to Transition to 100% Renewable Energy for the City of Greensboro*[2] adopted by the Greensboro City Council in 2019. This Resolution had strong support from the community and was passed unanimously by City Council. There was also strong support for the development of the SEP by the community, City staff, and City Council.

The SEP is the result of many voices converging to create it. An internal Leadership Team representing every department was formed and met numerous times as both a group and at a departmental level. They reviewed data, proposed strategies, and provided information and context throughout the process. A diverse and dedicated Community Partnership formed which included business, academic, civic, and faith sectors who actively participated in SEP meetings, as well as at Community Sustainability Council (CSC) meetings where updates to the plan were provided.

The Resolution calls for the SEP to address cost burdens to ensure a just transition to renewable energy for all and prioritize at-risk populations. This was a consistent theme at the Community Partnership meetings, and one voiced across all sectors. The input received during these meetings evolved into goals, strategies, and actions for this plan. A task force was assembled to review the SEP through an environmental justice "lens." This review produced a framework for identifying and engaging with vulnerable communities and give priority to energy projects in vulnerable neighborhoods that would provide positive benefits. Strategies and actions to support this priority can be found throughout the SEP.

At-risk population is defined in this plan as the impacted and vulnerable communities which have traditionally bore a disproportionate share of negative environmental consequences in the City. A *just transition* is defined in this plan as one that increases environmental benefits while decreasing the environmental burdens of the City's most impacted and vulnerable communities. Throughout the SEP goals and strategies are woven in to address cost burdens to ensure a just transition to renewable energy for all and a focus on providing environmental benefits to the most impacted and vulnerable communities.

The SEP provides a baseline of 2019 energy consumption (electricity, natural gas, gasoline, and diesel) and costs broken down by department. This information was used to determine where strategies should be focused to provide the City with the greatest energy reduction and renewable energy potential. The energy data was also used to calculate Greensboro's 2019 Greenhouse Gas (GHG) emissions and compare to the 2007 GHG emissions. Presentations of the data were given at meetings with the Leadership Team and the Community Partnership. Early goals and strategies began to emerge at these meetings.

[2] City of Greensboro. *Resolution to Support the Establishment of a 20-Year Strategic Energy Plan and Goals to Transition to 100% Renewable Energy for the City of Greensboro.* Community Sustainability Council. Accessed October 15, 2021. https://www.greensboro-nc.gov/departments/planning/boards-commissions-meetings/community-sustainability-council-csc

Goals and strategies were developed for reducing consumption of each of the energy sources and shifting to more renewable options. The highest departmental users of electricity, natural gas, gasoline, and diesel were identified. Then goals and strategies, and later, actions were developed to reduce consumption and shift to renewables. The final goals, strategies, and actions found in this plan are the result of many meetings with the Leadership Team and Community Partnership.

Potential funding strategies are identified for implementing actions outlined in the plan. An Implementation Plan prioritizes the actions. An Evaluation Plan explains how progress toward goals will be measured.

Climate Change

A transition to 100% renewable energy in City operations by 2040 for its operations will allow Greensboro to be in alignment with the United Nations Intergovernmental Panel on Climate Change (IPCC) pathway for reducing greenhouse gas emissions. The IPCC is an intergovernmental body of the United Nations mandated to provide objective scientific information relevant to understanding human-induced climate change, its natural, political, and economic impacts and risks, and possible response options. According to the IPCC anthropogenic (human created) GHG emissions are trapping heat in the atmosphere, which is causing the planet to warm and the climate to change[3]. The IPCC pathway calls for a 45% reduction in GHG emissions globally by 2040, and net zero emissions by 2050[4]. Greensboro's 2040 energy goal of 100% renewable energy, if met, will exceed the GHG reduction goals of the IPCC.

Greensboro Sustainability

The SEP is not the first step made by the City to address sustainability. The same year the Resolution called for the development of the SEP, Greensboro applied for and was awarded a grant as an inaugural city in the US Green Build Council's LEED for Cities (L4C) Certification Program. Greensboro ultimately earned LEED for Cities Silver Certification. The L4C assessment provided the City with a stronger understanding of strengths and weaknesses regarding sustainability of City operations and will be used to inform the future focus of sustainability actions.

In 2020 the City published its ***GSO****2040 Comprehensive Plan* which contains a strong sustainability focus. The plan was the product of two years of outreach and feedback from the community. Two of the *6 Big Ideas* in the plan are *Prioritizing Sustainability* and *Becoming Car Optional*. Both of the "Ideas" have threads that connect to the SEP.

Greensboro has been demonstrating commitment to sustainability for many years. The City Council voted to support the U.S. Conference of Mayors Climate Protection Agreement[5] in 2007,

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[3] IPCC. *About the IPCC.* Intergovernmental Panel on Climate Change. 2021. *https://www.ipcc.ch/about/*

[4] IPCC. *Special Report Global Warming of 1.5ºC Summary for Policymakers.* Intergovernmental Panel on Climate Change. 2018. https://www.ipcc.ch/sr15/

[5] The United States Conference of Mayors. Mayors Climate Protection Agreement. The United States Conference of Mayors. 2021. https://www.usmayors.org/tag/mayors-climate-protection-agreement/

and established the CSC in 2008.[6] In 2009, using funding from the American Recovery and Reinvestment Act, the City developed its first greenhouse gas inventory.[7] The GHG inventory was updated in 2015 and included emissions for both City operations and the community.[8] From 2009 to 2010, the CSC developed the Sustainability Action Plan, which was presented to the City Council on January 11, 2011. In 2017 Mayor Nancy Vaughan joined the *Mayor's National Climate Action Agenda*, with a commitment to City actions to reduce GHG emissions.[9] The City began participating in the Carbon Disclosure Project Cities Program, a climate and sustainability reporting and measurement platform in 2017.[10] Greensboro has been recognized by the North Carolina Forest Service and Arbor Day Foundation as a Tree City since 1991.[11]

The City of Greensboro will continue its commitment to sustainability with the implementation of the SEP over the next twenty years. The increase in energy efficiency and renewable energy adoption resulting from the implementation of the SEP will allow the City to contribute to the GHG reduction goals set by the IPCC and fulfill the vision of the SEP to achieve 100% renewable energy for City operations by 2040.

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

That it hereby directs the City Manager to initiate preparation of a 20-year Strategic Energy Plan for the City of Greensboro, which includes the following:

- Specific steps to reduce Scope 1 and Scope 2 greenhouse gas emissions (from city operations) by 40% or more from estimated 2005 levels by 2025;
- Specific steps to reduce overall energy consumption per square foot in all city-owned buildings by 40% or more from estimated 2005 levels by 2025;
- Achievable goals for transitioning to 100% renewable energy in city operations by 2040 from any combination of on-site and off-site renewable sources, including but not limited to: solar, wind, hydroelectric, renewable energy certificates (RECs), and green power purchases;
- Recommended practices and tools to measure avoided costs and return on investment resulting from implementation of renewable energy projects;
- Recommended funding strategies for projects that advance established goals for GHG reduction, energy efficiency, and renewable energy use;
- Recommendations for incentivizing Greensboro residents and businesses to achieve similar progress on GHG reduction, energy efficiency, and renewable energy use, address cost burdens to ensure a just transition to renewable energy for all, and prioritize at-risk populations;
- A robust and inclusive program of public engagement, outreach, and education;
- Preparation of an updated GHG inventory every two years; and
- Publication of an annual progress report.

AND BE IT FURTHER RESOLVED THAT: the City Manager, or a designee, shall establish a diverse community partnership comprised of city staff, residents, corporate partners, and other interested stakeholders, to collaborate and provide guidance in developing the Strategic Energy Plan; the Strategic Energy Plan shall be submitted for review and consideration by the City Council, within one year; and officials and staff will consider all municipal decisions in light of whether they will bring the City and its residents, businesses, and institutions closer to achieving the goal of 100% renewable energy.

Figure 1 Resolution for Strategic Energy Plan

[6] City of Greensboro. *Community Sustainability Council.* City of Greensboro. Accessed October 15, 2021. https://www.greensboro-nc.gov/departments/planning/boards-commissions-meetings/community-sustainability-council-csc

[7] Ibid

[8] Ibid

[9] Ibid

[10] Ibid.

[11] City of Greensboro. City Receives its 28th Tree City Award. City of Greensboro News. https://www.greensboro-nc.gov/Home/Components/News/News/14492/

Scope of the Plan

The 20-year Strategic Energy Plan is for the City of Greensboro's municipal operations. The scope aligns directly with the direction in the *Resolution to Support the Establishment of a 20-Year Strategic Energy Plan and Goals to Transition to 100% Renewable Energy for the City of Greensboro*.[12]

The SEP contains the following requirements as directed in the Resolution:

- Specific steps to reduce Scope 1 and Scope 2 greenhouse gas emissions (from City operations) by 40% or more from estimated 2007 levels by 2025.
- Specific steps to reduce overall energy consumption per square foot in all City-owned buildings by 40% or more from estimated 2007 levels by 2025.
- Achievable goals for transitioning to 100% renewable energy in City operations by 2040 from any combination of on-site and off-site renewable sources, including but not limited to: solar, wind, hydroelectric, renewable energy certificates (RECs), and green power purchases.
- Recommend practices and tools to measure avoided costs and return on investment resulting from implementation of renewable energy projects.
- Recommend funding strategies for projects that advance established goals for GHG reduction, energy efficiency, and renewable energy use.
- Recommendations for incentivizing Greensboro residents and businesses to achieve similar progress on GHG reduction, energy efficiency, and renewable energy use, address cost burdens to ensure a just transition to renewable energy for all, and prioritize at-risk populations.
- A robust and inclusive program of public engagement, outreach, and education.
- Preparation of an updated GHG inventory every two years.
- Publication of an annual progress report.

Although 2005 is stipulated in the Resolution as the baseline year the City has an established GHG baseline for 2007, so the baseline year for the SEP was adjusted to 2007. This will provide a solid GHG baseline to use for evaluation of SEP progress.

[12] City of Greensboro. *Resolution to Support the Establishment of a 20-Year Strategic Energy Plan and Goals to Transition to 100% Renewable Energy for the City of Greensboro.* Community Sustainability Council. Accessed October 15, 2021. https://www.greensboro-nc.gov/departments/planning/boards-commissions-meetings/community-sustainability-council-csc

Methodology

The SEP was developed using the U.S. Department of Energy's *Guide to Community Energy Planning*[13] as a blueprint. SEP meetings were regularly held with both the Leadership Team and the Community Partnership team. Input from those meetings was incorporated in developing draft versions of the plan which were then published for further review.

GHG emissions for Greensboro were calculated using the *Global Protocol for Community-Scale Greenhouse Gas Emissions Inventories*[14] tool developed jointly by the World Resources Institute (WRI), C40 Cities, and Local Governments for Sustainability (ICLEI).

Energy Plan Guide

The City of Greensboro utilized the ten-step process[15] found in the guide and began work on the plan in late January 2021.

1. Form leadership team
2. Identify and engage stakeholders
3. Develop an energy vision
4. Assess the current energy profile
5. Develop energy goals and strategies
6. Identify and prioritize actions
7. Put together a financing strategy
8. Develop a blueprint for implementation
9. Develop an evaluation plan
10. Adopt plan and publicize

Greenhouse Gas Inventory

The SEP includes Scope 1 and Scope 2 greenhouse gas emissions totals by energy source for 2007 and 2019. A comparison of 2007 emissions to 2019 emissions was made to determine reduction in emissions. The Resolution called for specific steps to reduce Scope 1 and Scope 2 greenhouse gas emissions (from City operations) by 40% or more from estimated 2007 levels by 2025.[16]

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[13] Department of Energy. *Guide to Community Energy Strategic Planning.* 2021. https://www.energy.gov/eere/slsc/guide-community-energy-strategic-planning

[14] World Resources Council. *Global Protocol for Community-Scale Greenhouse Gas Emissions Inventories*. 2014. Greenhouse Gas Protocol. https://ghgprotocol.org/greenhouse-gas-protocol-accounting-reporting-standard-cities

[15] Department of Energy. *Guide to Community Energy Strategic Planning.* 2021. https://www.energy.gov/eere/slsc/guide-community-energy-strategic-planning

[16] City of Greensboro. *Resolution to Support the Establishment of a 20-Year Strategic Energy Plan and Goals to Transition to 100% Renewable Energy for the City of Greensboro.* Community Sustainability Council. Accessed October 15, 2021. https://www.greensboro-nc.gov/departments/planning/boards-commissions-meetings/community-sustainability-council-csc

Emissions Scope

Emissions are calculated according to "Scope" as depicted in Figure 2. Scope 1 represents emissions that are under direct control of the City such as City Owned Vehicles. Scope 2 represents emissions for purchased electricity for which the City has indirect control. Scope 3 represents emissions that are not under direct control, but indirectly resulting from municipal operations such as staff driving to work. The 2019 GHG inventory for the SEP includes an accounting of Scope 1 and Scope 2 emissions. Scope 3 emissions are not included.

Quantifying Emissions

Emissions are calculated by accounting for the quantity of each emissions source and then multiplying it by an emissions factor to determine the metric tons of carbon dioxide equivalent (MT CO_{2e}) for each source and in aggregate. Carbon Dioxide equivalent (CO_{2e}) is used to provide a common measurement for the combination of greenhouse gases that are contributing to increasing the temperature of the planet. These greenhouse gases are comprised of carbon dioxide (CO_2), methane (CH_4), Nitrous Oxide (N_2O), and Ozone (O_3), along with several synthesized gases used in refrigeration and industrial processes. Carbon dioxide is the most prevalent of the GHGs and is causing the greatest total impact.[17]

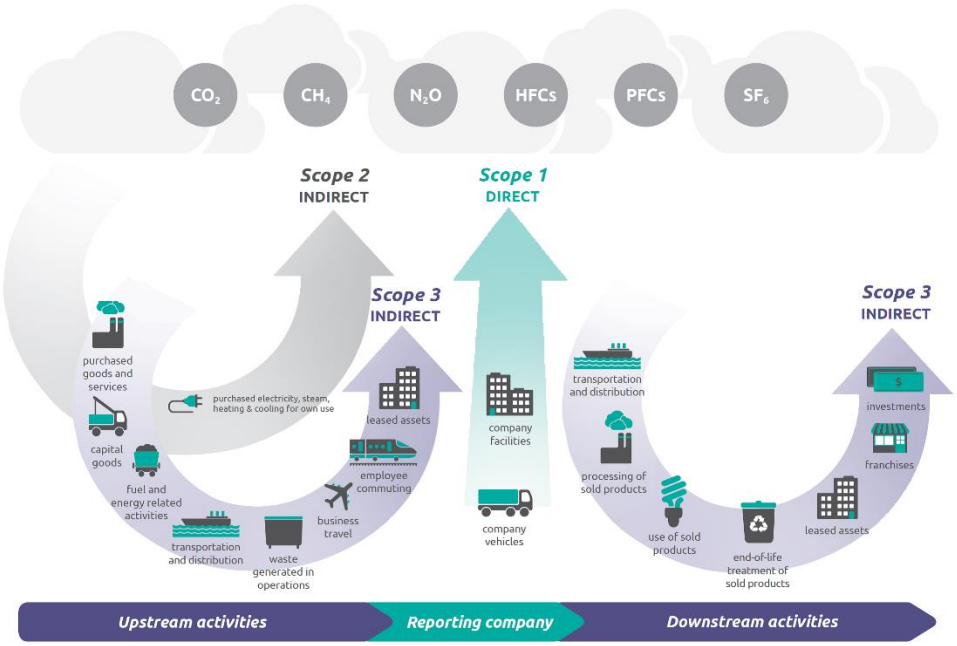


Figure 2. Depiction of greenhouse gas emissions by scope (Source: EPA.gov)

[17] EPA. *Overview of Greenhouse Gases.* 2021. https://www.epa.gov/ghgemissions/overview-greenhouse-gases

Global Warming Potential

CO_{2e} is calculated by using the Global Warming Potential (GWP) for each of the GHGs as shown in Table 1.[18] GWP is the ratio of radiative forcing (degree of warming in the atmosphere) that would result from the emission of one unit of a given GHG compared to one unit of carbon dioxide over a one-hundred-year time horizon.[19] This means that 1 unit of methane is equivalent to 28 units of carbon dioxide, and 1 unit of Nitrous Oxide is equivalent to 265 units of carbon dioxide over a one-hundred-year time horizon.

Table 1. Global Warming Potential (GWP) for Major Greenhouse Gases

Common Name	GHG	GWP
Carbon Dioxide	CO_2	1
Methane	CH_4	28
Nitrous Oxide	N_2O	265
Fluorinated Gases	CFC	4,500 – 14,000

Global Emissions

A breakdown of global emissions by specific greenhouse gas as calculated by the Environmental Protection Agency (EPA) is shown in Figure 3.[20] Carbon Dioxide is by far the largest contributor of GHG emissions at 80%. This is followed by Methane at 10%. Methane emissions are expected to grow with the increase in use of natural gas.

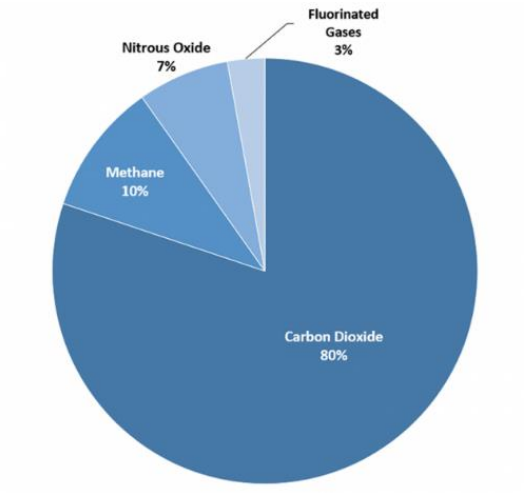


Figure 3. Global greenhouse gas emissions percentage by gas type (EPA, 2021)

[18] IPCC. *Special Report Global Warming of 1.5°C Summary for Policymakers.* 2018. https://www.ipcc.ch/sr15/

[19] Ibid

[20] EPA. *Overview of Greenhouse Gases.* 2021. https://www.epa.gov/ghgemissions/overview-greenhouse-gases

SEP Leadership Team

The SEP Leadership Team shown in Table 2 was formed with staff members representing almost every City department. This team first met in late January 2021 to review the ten-step process that would be used to develop the plan. Follow-up meetings were held at key points in the process. Meetings with individual department representatives were held to review the energy data and discuss appropriate strategies for reducing the energy demand for that department. Drafts of the SEP were shared with the Team and feedback informed revisions. Jeff Sovich, Senior Planner, was instrumental in scheduling these meetings, as well as meetings with the City Manager's Office to provide milestone reports. Dr. Vicki Foust with Energy and Sustainability Solutions provided project management for the development of the SEP.

Table 2. Strategic Energy Plan Leadership Team

Name	Title	Department
Kimberly Sowell	Assistant City Manager	Executive
Jeff Sovich	Senior Planner	Planning
Mike Borchers	Director	Water Resources
Richard Lovett	Environmental Compliance & Support Manager	Field Operations
Chris Marriott	Deputy Director	Field Operations
Sara Hancock	Analyst	Budget & Evaluation
Elizabeth Link	Urban Designer	Planning
Elizabeth Jernigan	Planner	Parks & Recreation
Karen Kixmiller	Analyst	Budget & Evaluation
Zachary Petersen	GIS Analyst	Water Resources
Jake Keys	Communications Specialist	Communications
Sergey Kobelev	Energy Management Engineer	Engineering and Inspections
Kenney McDowell	Director	Engineering and Inspections
Tori Carle	Solid Waste Reduction Supervisor	Field Operations
Mike Mabe	Street Maintenance Manager	Field Operations
Melanie Neal	Director	Guilford Metro 911
Love Jones	Director	Human Rights
Melanie Buckingham	Environmental Education Librarian	Libraries and Museum
Judson Clinton	Arborist	Planning
Kym Smith	Street Lighting Specialist	Transportation
Gray Johnston	Transportation Planner	Transportation
Lydia McIntyre	Transportation Planner	Transportation
Chandler Hagen	Transportation Planner	Transportation
Jerry Gunter	Fleet Procurement	Financial & Administrative Services
Allen Hunt	Primary Complaint Officer	Human Rights
Jodie Stanley	Education and Outreach Coordinator	Human Rights
Rodney Roberts	Deputy Chief Information Officer	Information Technology
Russ Behn	Housing Rehabilitation Coordinator	Neighborhood Development
Mike Perdue	Maintenance & Production Manager	Coliseum
Hylton Johnson	Supervisor, Mechanical Trade	Tanger Center for the Performing Arts

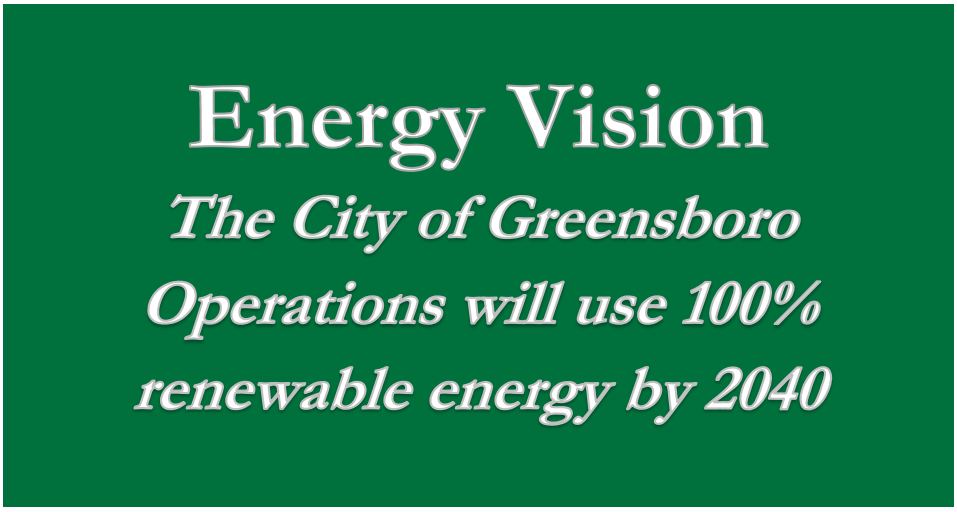
Community Partnership

A Community Partnership of stakeholders was formed of environmental and social equity advocacy groups, higher education faculty and staff, faith organization leaders, members of several Greensboro Commissions and Councils, utility provider representatives, and other interested community members. An initial meeting was held January 27, 2021, where the Ten Step Process to develop the SEP was presented. Stakeholders were given extensive opportunity to ask questions and provide initial recommendations.

Follow-up presentations of the plan in each stage were presented at Community Partnership meetings held May 6, July 14, and September 22, and at CSC Official Meetings held March 8, May 10, July 12, and September 27. Due to COVID restrictions the meetings were all held virtually, via Zoom and were also broadcast live over the City's Facebook page. These meetings were well attended, and many valuable recommendations were made.

Energy Vision

City Council's stated intent for developing a 20-year Strategic Energy Plan is to recommend goals, strategies, and actions to the City to reduce its use of non-renewable energy and the resulting greenhouse gas emissions. The overall goal is to increase the use of renewable sources in City operations to 100% by 2040. To achieve this goal, the Resolution states that "officials and staff will consider all municipal decisions in light of whether they will bring the City and its residents, businesses, and institutions closer to achieving the goal of 100% renewable energy." As the development of the SEP moved through the steps of the process, it became clear that this overarching goal should form the basis of the City's Energy Vision.



2019 Energy Profile

Energy data from January 1 – December 31, 2019 was used to establish an energy profile of City operations. The energy profile identified how each City department consumes electricity, natural gas, and vehicle and equipment fuels such as diesel, gasoline, compressed natural gas (CNG) and E85. The profile will serve as a baseline from which to measure progress toward goal achievement and inform decisions regarding conversion to renewable energy.

The energy profile examines energy use by department, by type of use, and by quantity and cost of each energy source: electricity, natural gas, and vehicle and equipment fuels (diesel, gasoline, E85, CNG) for 2019. The profile also reveals the 2019 GHG emissions. A comparison of the 2007 and 2019 GHG Inventories, as well as a comparison of the 2019 GHG Inventory using the AR 2 and AR 5 GWP emissions factors are also included in the profile.

The City's GHG emissions are a result of its consumption of non-renewable energy sources. Electricity makes up 60% of Greensboro's energy consumption and is the largest contributor to the City's greenhouse gas emissions. The high emissions from electricity are due to the generation mix of the electricity supplier.

Duke Energy

Duke Energy is a major supplier of electricity in North Carolina, including for the City of Greensboro. As shown in Figure 4, Duke Energy's 2019 generation output was comprised of Natural Gas 39%, Nuclear 37%, Coal 22%, 2% Renewables (including hydro).[21] Over half (61%) of the output is from two fossil fuels (coal and natural gas) which contribute significantly to the GHG emissions for the City of Greensboro.

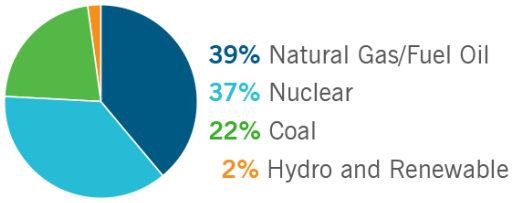


Figure 4 Duke Energy grid mix in North Carolina

In North Carolina, Duke Energy is required to submit an Integrated Resource Plan (IRP) to the State Utilities Commission every two years. An IRP is a "roadmap that identifies potential plans for a utility to meet future energy and demand requirements while considering the associated risks and benefits to customers."[22] Future changes to Duke Energy's electricity generation mix will impact the City's Scope 2 greenhouse gas emissions goals as will be shown later in the plan. Duke Energy withdrew its draft IRP in January 2022 to focus on development of its state mandated Carbon Plan. This change of focus by Duke Energy could mean its electricity generation mix becomes cleaner, and thus making it easier for the City to reach its energy vision.

[21] Duke Energy *Electric Utilities and Infrastructure.* 2021. https://sustainabilityreport.duke-energy.com/introduction/duke-energy-at-a-glance/

[22] Duke Energy *Integrated Resource Plan.* 2021. https://www.duke-energy.com/Our-Company/About-Us/IRP

Electricity and Natural Gas Totals from City Operations

Table 3 shows the energy profile for Electricity and Natural Gas use in City operations during 2019. Electricity usage is shown in kilowatt hours (kWh) and Natural Gas is shown in Therms for each City department. These are standard units of measurement for each of these energy sources. The Table also provides the yearly total cost for each of the energy sources for each City department.

Table 3. Electricity and natural gas totals from City operations (2019)

Department	Electricity (kWh)	Total Electricity Cost	Natural Gas (Therms)	Natural Gas Cost	Total Energy Cost
Coliseum	16,805,791	$1,219,528	319,313	$257,552	$1,477,079
Engineering & Inspections	266,700	$24,794	3,958	$3,676	$28,469
Executive	1,462,392	$106,746	27,624	$23,314	$130,061
Field Operations	1,727,683	$163,033	37,278	$31,990	$195,025
Financial & Administrative Services	344,817	$31,487	11,470	$10,288	$41,775
Fire	3,036,774	$254,462	73,255	$68,173	$322,636
General	5,011,283	$326,503	25,870	$22,691	$349,194
Guilford Metro 9-1-1	966,436	$62,737	7,432	$6,991	$69,728
Human Resources	40,883	$5,366	1,350	$1,700	$7,067
Information Technology	14,575	$2,096	0	$0	$2,096
Libraries	5,376,169	$381,188	56,439	$48,127	$429,314
Parks & Recreation	6,674,015	$783,687	134,773	$124,987	$908,675
Planning	47,400	$5,549	0	$0	$5,549
Police	3,731,547	$290,876	95,922	$81,422	$372,297
Transportation	25,411,039	$3,231,710	111,309	$93,651	$3,325,360
Water Resources	68,496,885	$4,425,601	42,726	$38,950	$4,464,551
Total	**139,414,389**	**$11,315,363**	**948,719**	**$813,512**	**$12,128,876**

Electricity Profile

Electricity consumption in kWh and cost is broken down by department to determine the level of usage by department. Figure 5 shows total electricity use by department as a percentage of the total electricity usage in 2019 for City operations. The Water Resources Department used 49% of the electricity purchased by the City, which makes the department by far the largest user of electricity. The Transportation Department used 18% of the electricity purchased, making it the second largest user. The Coliseum used 12% of the electricity purchased. All other departments used less than 5% of total electricity and are not included in Figure 5.

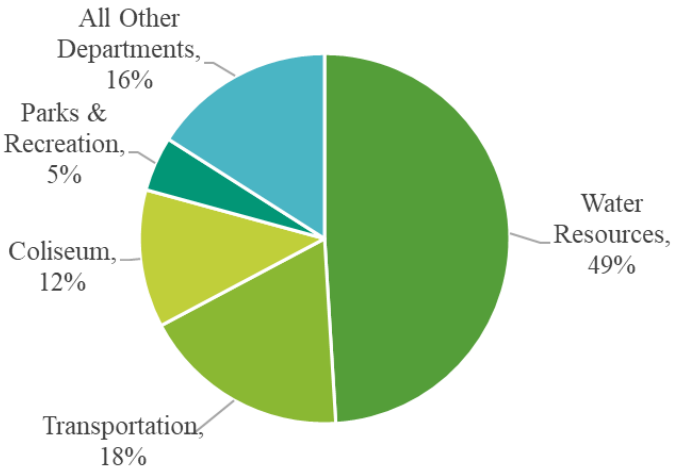


Figure 5. Electricity use by department - percentage of total kWh.

Figure 6 shows the percentage of electricity used by Use Type for 2019. Water and Wastewater Treatment and Pumping was the largest use type at 48%, with Buildings at 32%, and Streetlamps at 14%. All other Use Types each consumed 2% or less, for a total of 6%.

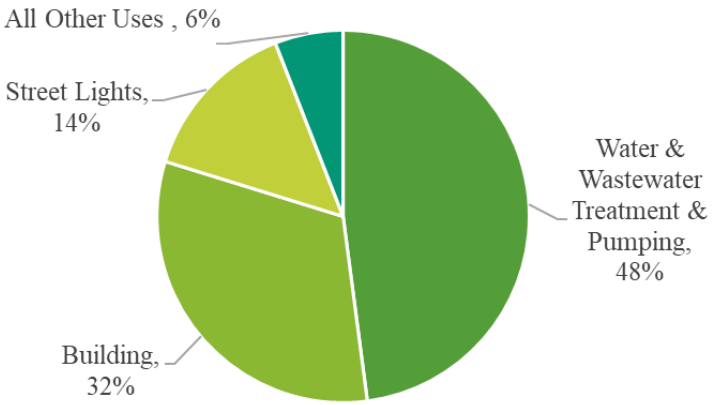


Figure 6. Electricity use by Use Type – percent of total kWh.

Figure 7 shows CO_{2e} emissions in metric tons (MT) by department for electricity usage in 2019. The largest departmental emitters are Water Resources at 23,240 MT, followed by the Transportation at 8,622 MT, the Coliseum at 5,702 MT, Parks and Recreation at 2,264 MT, Libraries at 1,824 MT, General Fund at 1,700 MT, Police at 1,266 MT, and Fire at 1,030 MT. All other departments emitted less than 1,642 MT of CO_2 collectively in 2019.

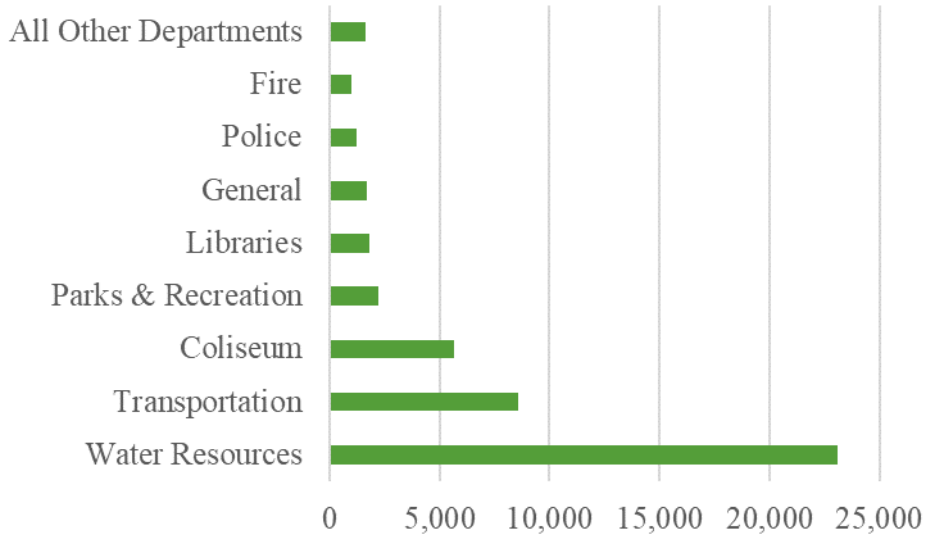


Figure 7. Electricity CO_{2e} emissions (MT) by department.

Natural Gas Profile

Natural gas as a percentage of the total usage for each department is shown in Figure 8. The Coliseum was the largest user of natural gas at 34%. Parks and Recreation was the second largest user at 14%, followed by Transportation at 12%, Police at 10%, Fire at 8%, and Libraries at 6%. All other departments combined used 11%.

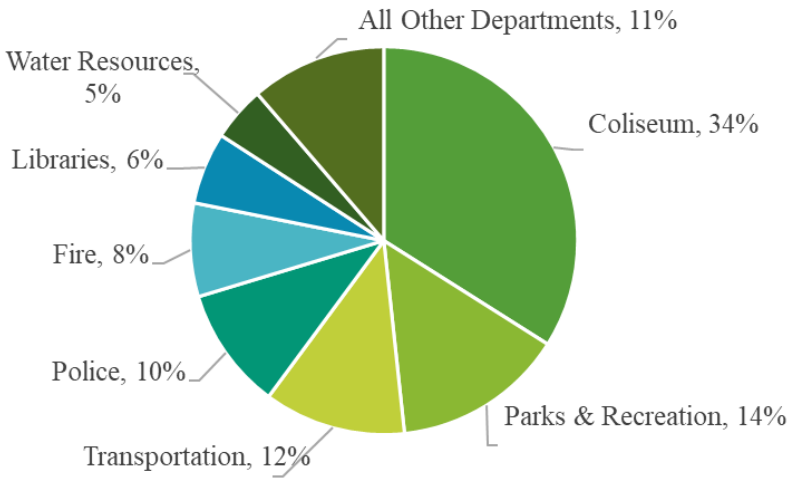


Figure 8. Natural gas use by department – percent of total Therms.

Figure 9 shows CO_{2e} emissions in metric tons (MT) by department for natural gas usage in 2019. The highest emitting departments by MT are the Coliseum at 1,738 MT, followed by Parks & Recreation at 734, Transportation at 606, Police at 522 MT, Fire at 399 MT, Library at 307 MT, Field Operations at 203 MT, Executive at 150 MT, General at 141 MT. All other departments emitted at total of 423 MT in 2019.

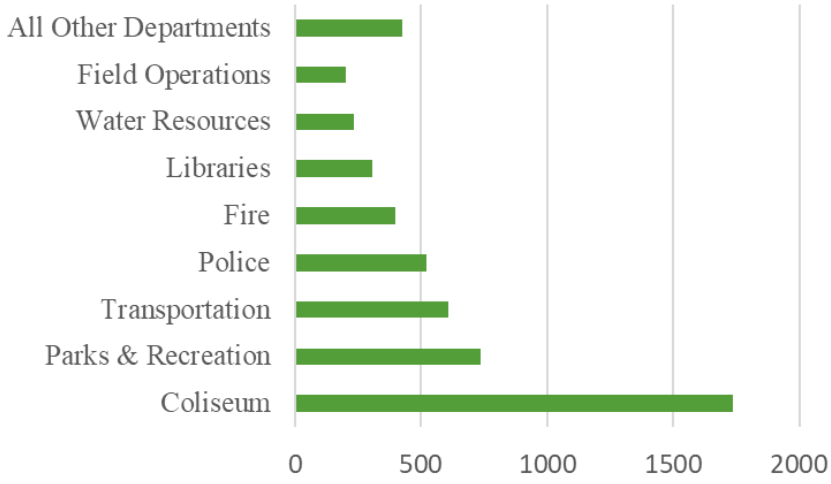


Figure 9. Natural gas CO_{2e} emissions (MT) by department.

Vehicle and Equipment Fuel Totals for City Operations

Table 4 shows the Vehicles and Equipment Fuels profile for Diesel, Gasoline, Compressed Natural Gas (CNG) and E85 for City Operations in 2019. Usage is shown in gallons for each City department. The table also provides the yearly cost for each of the fuels for each City department.

Table 4. Vehicle and Equipment Data Quantity and Cost by Fuel Type (2019)

	Gallons of Fuel					Fuel Cost				
Department	**Diesel**	**UNL**	**CNG**	**E85**	**Total**	**Diesel**	**UNL**	**CNG**	**E85**	**Total**
Coliseum	834	1,997	0	0	2,831	$1,741	$3,599	$0	$0	$5,340
Engineering & Inspections	1,788	60,050	0	0	61,837	$3,740	$109,617	$0	$0	$113,357
Executive	0	372	0	0	372	$0	$669	$0	$0	$669
Field Operations	698,569	48,611	12,210	0	759,391	$1,458,121	$88,130	$24,064	$0	$1,570,314
Financial & Administrative Services	5,667	9,256	0	0	14,922	$11,802	$16,761	$0	$0	$28,563
Fire	121,755	37,039	0	15	158,810	$295,649	$71,074	$0	$37	$366,759
Information Technology	123	531	0	0	654	$270	$965	$0	$0	$1,235
Legislative	0	108	0	0	108	$0	$196	$0	$0	$196
Libraries	0	2,042	0	0	2,042	$0	$3,680	$0	$0	$3,680
Metro 911	0	2,288	0	0	2,288	$0	$4,137	$0	$0	$4,137
Neighborhood Development	0	1,314	0	0	1,314	$40	$2,380	$0	$0	$2,380
Parks & Recreation	31,147	13,159	0	0	44,307	$66,606	$25,743	$0	$0	$92,348
Planning	0	377	0	0	377	$0	$678	$0	$0	$678
Police	5,163	576,207	0	1,728	583,098	$11,102	$1,295,042	$0	$3,989	$1,310,133
Transportation	487,153	371,682	0	0	858,834	$1,013,120	$669,708	$0	$0	$1,682,828
Water Resources	126,196	60,177	0	0	186,373	$263,735	$109,129	$0	$0	$372,864
TOTAL	**1,478,395**	**1,185,210**	**12,210**	**1,743**	**2,677,559**	**$3,125,886**	**2,401,507**	**$24,064**	**$4,025**	**$5,555,481**

*Gasoline Quantity and Cost includes Unleaded, Super, and Unleaded Plus Gasoline.

Gasoline Profile

Gasoline by percentage of usage by department is shown in Figure 10. The Police Department accounted for 49% of all gasoline usage, followed by Transportation at 31%. These two departments account for 80% of the gasoline used by the City. Water Resources and Engineering and Inspections each used 5%. Gasoline usage for all other departments combined was 10%.

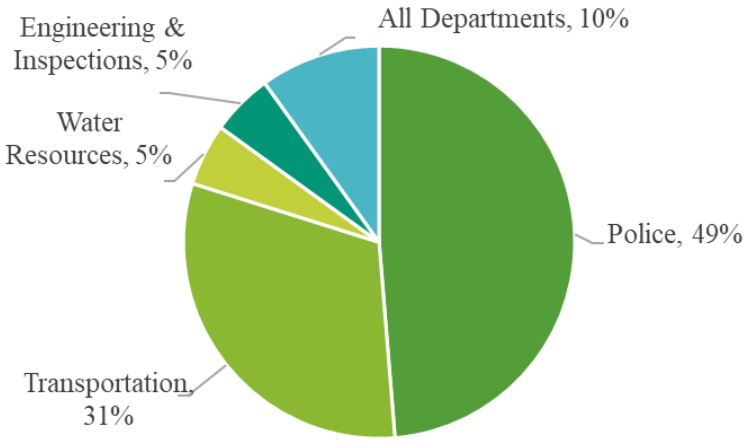


Figure 10. Gasoline usage percentage by department.

Gasoline CO_2 emissions in metric tons (MT) by department is shown in Figure 11. The Police Department was the largest emitter with 5,121 MT. This was followed by Transportation 3,303, Water Resources 535, Engineering & Inspections 534 MT, and All Other Departments combined is 1,041 MT CO_{2e}.

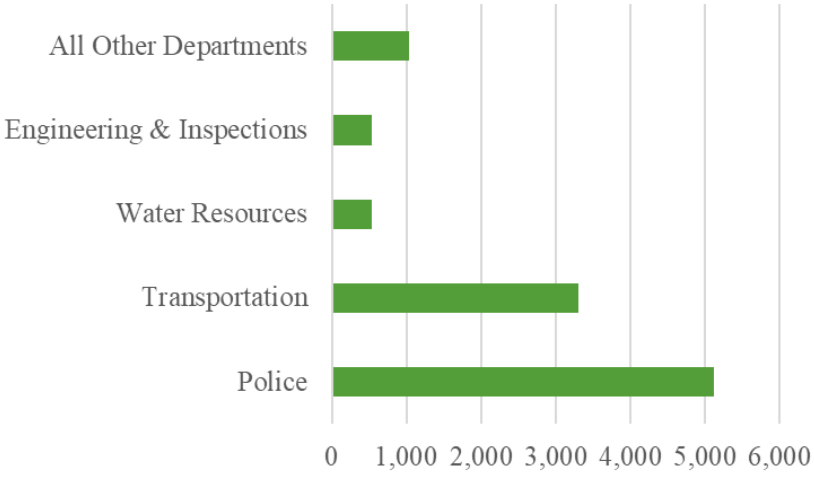


Figure 11. Gasoline CO_{2e} emissions by department.

Diesel Profile

Figure 12 shows the percentage of diesel usage by department for 2019. Field Operations had the highest percentage with 47%, followed by Transportation at 33%, Water Resources at 9%, Fire at 8%, and Parks and Recreation at 2%. Combined Diesel usage by all other departments was 1%.

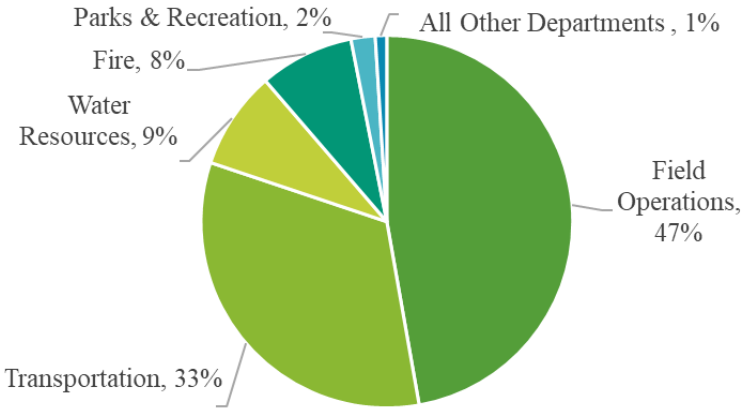


Figure 12. Diesel use by department - percentage of gallons.

Figure 13 shows CO_2 emissions from diesel by department in metric tons (MT) of CO_2 emissions. Field Operations had the highest rate of emissions with 14,150 MT, followed by Transportation with 4,329 MT, Water Resources with 1,122 MT, and Fire with 1,082 MT. All Other Departments were responsible for a combined 406 MT of CO_2 emissions in 2019.

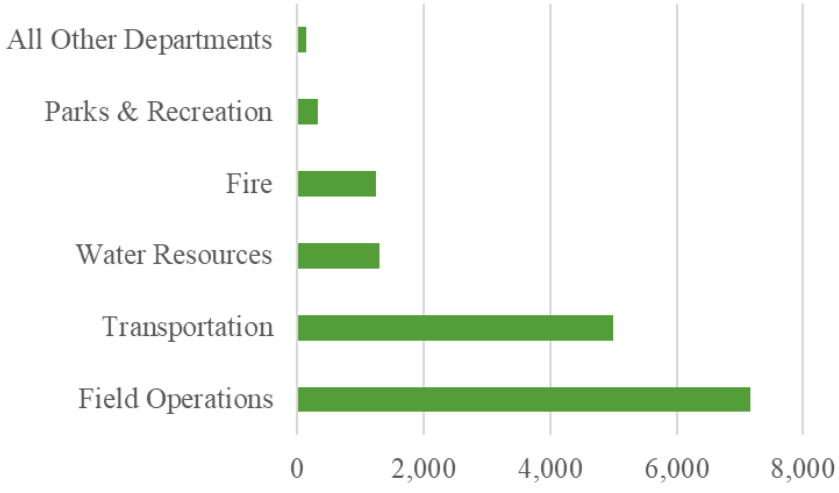


Figure 13. Diesel CO_{2e} emissions by department.

Compressed Natural Gas

The City uses only a small amount of compressed natural gas (CNG) as a transportation fuel. GTA uses 330 gallons equivalent and Solid Waste uses 12,210 gallons equivalent for a total of 12,540. Since this is such a small amount of usage, CNG will not be discussed further in the baseline assessment of this report. It will also not be included in the Greenhouse Gas Inventory.

E85

The City uses only a small amount of E85, which is a gasoline product made with 85% ethanol, a biofuel. Ethanol is made of organic feedstocks such as corn and used to replace petroleum-based fuel products. The Police Department used 1,728 gallons of E85 in 2019 and the Fire Department used 15 gallons. Since this is such a small amount of usage, E85 usage will not be discussed further in the baseline assessment of this report. It will also not be included in the Greenhouse Gas Inventory.

Greenhouse Gas Profile

A 2019 GHG inventory was completed for Scope 1 and 2 emissions using the *Global Protocol for Greenhouse Gas Emission Inventories* developed by the World Resources Council, ICLEI, and C40 Cities. A baseline emissions inventory using 2007 energy data was completed for City operations in 2008 using the Clean Air/Cool Planet Carbon Calculator. Since the 2007 inventory there have been changes to the global warming potential (GWP) and to the emissions factors for electricity. These changes impact the results of the comparison. A comparison using the 2007 GWP and emissions was completed to illustrate the impact of the changes.

GWP

The global warming potential (GWP) has been updated by the IPCC for greenhouse gases since the 2007 inventory was completed. GWP is the ratio of radiative forcing (degree of warming in the atmosphere) that would result from the emission of one unit of a given GHG compared to one unit of carbon dioxide over a one-hundred-year time horizon.[23] This means that 1 unit of methane is equivalent to 28 units of carbon dioxide, and 1 unit of Nitrous Oxide is equivalent to 265 units of carbon dioxide. The newer GWP values reflect increased accuracy in the measurement of the global warming potentials of these gases.

The 2007 City inventory used the GWP from Assessment Report (AR) 2 published by the IPCC. The IPCC has subsequently issued updates to GWP, with AR5 the latest. A comparison of GWP values for AR2, AR4, and AR5 are shown in Table 5.[24]

Table 5. Comparison of GWP of IPCC Assessment Reports

		GWP Values for 100-Year Time Horizon		
Greenhouse Gas	**Formula**	**AR2**	**AR 4**	**AR 5**
Carbon Dioxide	CO_2	1	1	1
Methane	CH_4	21	25	28
Nitrous Oxide	N_2O	310	298	265

Emissions Factors

Energy use is multiplied by an emissions factor to calculate the emissions. The emissions factor is a multiplier that equates to the amount of greenhouse gas created from the consumption of a specific unit of the energy source. Emissions factors are specific to both energy source and specific greenhouse gases.

[23] IPCC. *Special Report Global Warming of 1.5°C Summary for Policymakers.* 2018. https://www.ipcc.ch/sr15/

[24] Ibid

The emissions factors can change for energy sources, specifically electricity. Electricity is generated from a mixture of sources such as coal or natural gas combustion, hydroelectric, nuclear, solar, wind, and other renewable sources. The changes in generation will impact the emissions factor.

The City purchases most of its electricity from Duke Energy. Since 2007 Duke Energy's generation mix has changed. A reduction in coal and increase in natural gas for generation were major factors, along with a slight increase in renewable energy generation. The emissions factor change for electricity was significant as shown in Table 6. The 2007 CO_2 emissions factor was 1,446.50 MWh/lb. of carbon, while in 2019 it was 743 MWh/lb. of carbon[25]. The emissions factor was reduced 51% for Carbon (CO_2), increased 372% for Methane (CH_4), and decreased 41% for Nitrous Oxide (N_2O).

Table 6. Comparison of Emissions Factors 2007 & 2019

GHG	2007 Emissions Factor (lbs./MWh)	2019 Emissions Factor (lbs./MWh)	Change in Emissions Factor
Carbon Dioxide (CO_2)	1,446.50	743.00	- 51%
Methane (CH_4)	0.02	0.07	+ 372%
Nitrous Oxide (N_2O)	0.02	0.01	- 41%

GHG Emissions Summary

GHG emissions were calculated for all energy sources (electricity, natural gas, diesel, and gasoline) in MT CO_{2e} and as a percentage of total emissions for both 2007 and 2019 as shown in Table 7. A change in emissions and percentage change from 2007 are also shown in Table 7. Emissions of CO_{2e} from electricity decreased 45,978 MT (49%), diesel increased by 2,200 MT (17%), gasoline increased by 3,366 MT (47%), and natural gas increased 852 MT (19%). Although emissions increased for all sources except electricity, there was a 34% overall reduction in emissions due to the 49% reduction in electricity emissions.

[25] EPA. *E-Grid Power Profiler*. 2021. https://www.epa.gov/egrid/power-profiler#/

Table 7. Summary of GHG Emissions for 2007 and 2019

	2007 Emissions		2019 Emissions		Change in Emissions	
Emission Source	**Emissions (MT CO_{2e})**	**% of Emissions**	**Emissions (MT CO_{2e})**	**% of Emissions**	**Emissions (MT CO_{2e})**	**Change from 2007**
Electricity	93,232	79%	47,254	60%	- 45,978	- 49%
Diesel	12,822	11%	15,022	19%	+ 2,200	+ 17%
Gasoline	7,186	6%	10,552	14%	+ 3,366	+ 47%
Natural Gas	4,468	4%	5,320	7%	+ 852	+ 19%
Total	**117,708**	**100%**	**78,148**	**100%**	**- 39,560**	**- 34%**

Comparison of GHG Emissions by Energy Source and Specific GHG

A comparison of emissions by energy source for 2007 and 2019 with a breakdown of the emissions by specific greenhouse gases is provided in Table 8. Energy use is multiplied by the emissions factor to calculate emissions in MT. The MT are then multiplied by the GWP to determine the emissions in CO_{2e}.

As mentioned earlier, the change in emissions factors and GWP impacts the comparison in emissions. The GWP did change between 2007 and 2019 but did not result in a significant impact on total emissions.

As shown in Table 8 total electricity emissions for 2007 were 93,232 MT CO_{2e}. In 2019 emissions were 47,254. The emissions factor for electricity was 1,447 lbs/MWh in 2007 and was 743 lbs./MWh in 2019. The 2019 emissions factor is almost half that of 2007. This means most of the electricity emission reduction between 2007 and 2019 can be attributed to the change in emissions factor.

Emissions factors for other energy sources remained constant. Natural gas emissions increased by 852 MT CO_{2e}. Gasoline increased by 3,366 MT CO_{2e}. Diesel increased by 2,200 MT CO_{2e}. However, the decrease in electricity emissions of 45,978 MT CO_{2e} exceeds the increases of all other sources. This is mainly a result of the lower 2019 emissions factor.

Table 8. Emissions by energy source for 2007 and 2019 for comparison (2007 emissions factors)

	Estimated 2007 Emissions					Estimated 2019 Emissions				
GHG	Electric Use (MWh)	Emissions Factor (lbs./MWh)	Emissions (MT)	GWP	Emissions (MT CO_{2e})	Electric Use (MWh)	Emissions Factor (lbs./MWh)	Emissions (MT)	GWP	Emissions (MT CO_{2e})
CO_2	141,392	1,446.50	92,771	1	92,771	139,414	743.00	46,985.00	1	46,985
CH_4	141,392	0.02	1,154	21	24	139,414	0.07	4.24	28	119
N_2O	141,392	0.02	1,411	310	437	139,414	0.01	0.57	265	151
Total Electricity Emissions					93,232	Total Electricity Emissions				47,254
GHG	Natural Gas (MMBtu)	Emissions Factor (kg/MMBtu)	Emissions (MT)	GWP	Emissions (MT CO_{2e})	Natural Gas (MMBtu)	Emissions Factor (kg/MMBtu)	Emissions (MT)	GWP	Emissions (MT CO_{2e})
CO_2	79,715	56.00	4,456	1	4,456	94,872	56.00	5,304.00	1	5,304
CH_4	79,715	0.01	0.42	21	9	94,872	0.01	0.50	28	14
N_2O	79,715	0	0.01	310	3	94,872	0	0.01	265	3
Total Natural Gas Emissions						Total Natural Gas Emissions				5,320
GHG	Gasoline (Gal)	Emissions Factor (kg/Gal)	Emissions (MT)	GWP	Emissions (MT CO_{2e})	Gasoline (Gal)	Emissions Factor (kg/Gal)	Emissions (MT)	GWP	Emissions (MT CO_{2e})
CO_2	803,444	8.81	7,078.00	1	7,078	1,181,995	8.81	10,413.00	1	10,413
CH_4	803,444	0.02	0.25	21	5	1,181,995	0.02	0.37	28	10
N_2O	803,444	0.02	0	310	102	1,181,995	0.02	0	265	129
Total Gasoline Emissions					7,186	Total Gasoline Emissions				10,552
GHG	Diesel (Gal)	Emissions Factor (kg/Gal)	Emissions (MT)	GWP	Emissions (MT CO_{2e})	Diesel (Gal)	Emissions Factor (kg/Gal)	Emissions (MT)	GWP	Emissions (MT CO_{2e})
CO_2	1,261,650	10.15	12,806.00	1	12,806	1,478,395	10.15	15,006.00	1	15,006
CH_4	1,261,650	0.01	0.05	21	1	1,478,395	0.01	0.06	28	2
N_2O	1,261,650	0.01	0.05	310	15	1,478,395	0.01	0.06	265	15
Total Diesel Emissions					12,822	Total Diesel Emissions				15,022

To better explain the consequences of the change in emissions factors for calculating electricity emissions, Table 9 shows emissions in MT CO_{2e} for 2007 and 2019 using 2007 emissions factors for both years. Instead of a 45,978 MT reduction in electricity emissions as shown in Table 9, the reduction in Table 8, using the same emissions factor results in only a 1,298 MT CO_{2e} reduction. Therefore, only a little over 1% of the actual electricity emissions reduction can be attributed to a decrease in electricity use by the City.

Table 9. Comparison of Electricity Emissions using 2007 Emissions Factors

	2007 Electricity Emissions (2007 Emissions Factors)					2019 Electricity Emissions (2007 Emissions Factors)				
GHG	Electric Use (MWh)	Emissions Factor (lbs./MWh)	Emissions (MT)	GWP	Emissions (MT CO_{2e})	Electric Use (MWh)	Emissions Factor (lbs./MWh)	Emissions (MT)	GWP	Emissions (MT CO_{2e})
CO_2	141,392	1,446.50	92,771	1	92,771	139,414	1,446.50	91504.00	1	91,504
CH_4	141,392	0.02	1,154	21	24	139,414	0.02	1.14	21	24
N_2O	141,392	0.02	1,411	310	437	139,414	0.02	1.39	310	431
Total Electricity Emissions					93,232	Total Electricity Emissions				91,959

Greensboro Emissions Progress

Although the emissions factor was the main cause of the emissions reduction for the City, there is progress to recognize. Table 10 shows City electricity use decreased by a little over 1% between 2007 and 2019 which resulted in a reduction in emissions of 1,305 MT CO_{2e} based on the 2019 emissions factor. While this is not a huge reduction it is notable as it is the only energy

source to reduce consumption. That this reduction occurred while the City's population grew 17%, its land area increased, and the number of City employees grew makes this 1% reduction in consumption remarkable, and an indication that municipal operations have been focused on providing services and facilities to the community in a more energy efficient manner. However, since electricity is the largest source of emissions for the City further reduction in the energy source will have the greatest impact on reducing emissions.

Table 10 shows the change in energy use by energy source between 2007 and 2019. The City's natural gas usage increased by 19%, gasoline increased by 47% and diesel increased by 17%. The significant growth in use for all the energy sources except electricity should be reviewed further to identify the causes and develop strategies for reducing consumption and increasing efficiency.

Table 10. Change in Energy Consumption 2007-2019

Energy Source (Unit)	2007 Consumed	2019 Consumed	Change in Use	% Change
Electric Use (MWh)	141,392	139,414	- 1,978	- 1%
Natural Gas (MMBtu)	79,715	94,872	+ 15,157	+ 19%
Gasoline (Gal)	803,444	1,181,995	+ 378,551	+ 47%
Diesel (Gal)	1,261,650	1,478,395	+ 216,745	+ 17%

Cost of Carbon

Greenhouse gas emissions impose real economic costs on businesses, families, and governments in the form of increased health care expenses, destruction of property, increased food and commodities prices, and more. Economists have measured this economic harm, known as the 'social cost of carbon'. The current average estimate of the social cost of carbon is $51 per ton.[26] With the GHG Inventory for City of Greensboro municipal operations calculated at 122,841 metric tons of CO_{2e} in 2019, this represents a total economic cost of at least $6,264,891 per year. For perspective, this is just under 1% of the City's approved $619 million budget for fiscal year 2021-2022.

The cost of carbon emissions from City operations generally imposes the greatest hardships on the lowest income households and our most vulnerable residents (women, children, and persons who are disabled, have chronic health conditions, are elderly, or are members of racial, ethnic, or linguistic minorities). Reducing the City's greenhouse gas footprint can lighten this economic burden on our community and promote environmental justice.

[26] EDF. *The True Cost of Carbon Pollution.* 2021. https://www.edf.org/true-cost-carbon-pollution

Green Dividend

A "Green Dividend" allows citizens to keep more money in their pockets because of City sustainability measures. If the City makes it more convenient for people to drive less, they will spend less on gas, leaving them with more disposable income.[27] Investing in more energy-efficient city facilities and equipment can help Greensboro provide equal or better service to residents at a lower cost, creating opportunities for further public enhancements. But tackling climate change and creating a new sustainable community are efforts that have a value far beyond just the savings from improved efficiency. A study by The Global Commission on the Economy and Climate (aka The New Climate Economy), found that making a worldwide transition to a "low-carbon, sustainable growth path could deliver a direct economic gain of $26 trillion through to 2030 compared to business-as-usual. And this is likely to be a conservative estimate."[28] While this study examined the opportunities for economic gain at the global level, these gains are strongly correlated with the level of investment -- the nations, cities, and corporations that make the largest investments will see the greatest increases in GDP or profit.

[27] Cortright, Joe. *Portland's Green Dividend. June 6, 201.* City Observatory. *https://cityobservatory.org/portlands-green-dividend/*

[28] New Climate Economy. *Unlocking the Inclusive Growth Story of the 21st Century: Accelerating Climate Action in Urgent Times.* 2018. https://newclimateeconomy.report/2018/wp-content/uploads/sites/6/2018/09/NCE_2018_FULL-REPORT.pdf

SEP Goals and Strategies

The SEP includes recommendations, goals, strategies, and actions for policy and operational processes that will expedite the City achieving its vision of 100% renewable energy by 2040. Also included are goals, strategies, and actions for reducing nonrenewable energy consumption and increasing the use of renewable energy, organized by energy source and then by department.

These goals and strategies align with the SEP Resolution directives which state that the Strategic Energy Plan should include:

1. Specific steps to reduce Scope 1 and Scope 2 greenhouse gas emissions from City operations by 40% or more from estimated 2005 levels by 2025.

2. Specific steps to reduce the overall energy consumption per square foot in all City-owned buildings by 40% or more from estimated 2005 levels by 2025.

3. Achievable goals for transitioning to 100% renewable energy in City operations by 2040 by any combination of on-site and off-site renewable sources, including, but not limited to: solar, wind, hydroelectric, renewable energy certificates (RECs), and green power purchases.

4. Recommendations for incentivizing Greensboro residents and businesses to achieve similar progress on GHG reduction, energy efficiency, and renewable energy use, address cost burdens to ensure a just transition to renewable energy for all and prioritize at-risk populations.[29]

These organization-wide recommendations are followed by goals and strategies for reducing consumption of each of the primary energy sources: electricity, natural gas, gasoline, and diesel. The goals and strategies for each energy source are then organized by departments with the highest consumption of each type of energy source.

[29] City of Greensboro. *Resolution to Support the Establishment of a 20-Year Strategic Energy Plan and Goals to Transition to 100% Renewable Energy for the City of Greensboro.* Community Sustainability Council. Accessed October 15, 2021. https://www.greensboro-nc.gov/departments/planning/boards-commissions-meetings/community-sustainability-council-csc

Organization-Wide Recommendations for City of Greensboro

The vision of the SEP is 100% renewable energy by 2040. The recommendations that follow emerged from the many meetings that took place during the SEP planning process. These recommendations will accelerate the implementation of the SEP. Changes could be expedited through changes to current City operations. These changes would include priority in awarding contracts related to the plan to historically underutilized businesses, environmental and social justice sensitivity in decision-making, green building standards for new or substantial renovations of City owned assets, commitment to convert to a sustainable fleet, and protection of the tree canopy.

Recommendation 1: The City should establish a Sustainability Office.

Strategy 1: Approve and fund creation of a Sustainability Office.
Strategy 2: Establish and fill Chief Sustainability Officer position.
Strategy 3: Develop the Sustainability Office's Year 1 work plan.

The City has made a commitment to 100% renewable energy of operations by 2040. The implementation of the SEP will require full-time staff dedicated to that purpose. Staff in the newly created Sustainability Office will be responsible for providing leadership, ensuring actions are completed, measuring progress, and communicating with internal and external stakeholders. An additional staff position is recommended to analyze energy usage and monitor progress toward meeting the goals of the SEP. Careful management of energy reduces consumption, and therefore, cost and greenhouse gas emissions.

Recommendation 2: Clean energy audit/installation/maintenance contracts will give priority to Historically Underutilized Businesses (HUBs) and Minority and Women Business Enterprise (MWBE).

Strategy 1: Energy focused Requests for Proposals should contain language indicating a preference to work with a HUB or an MWBE.
Strategy 2: The Minority and Women Business Enterprise (MWBE) Office will offer workshops on how to obtain HUB Certification.

The City has established goals for contracting with both HUB and MWBE firms. The intent of this recommendation is for the City to be proactive in nurturing connections with local energy businesses that are qualified for HUB or MWBE status, but not certified. This rationale is these strategies will increase the pool of qualified contractors for the City and promote the growth of green energy jobs.

Recommendation 3: Ensure energy decisions are made in a way that promotes a just transition to renewable energy for all and prioritizes vulnerable communities.

Strategy 1: Establish criteria to identify the most impacted and vulnerable communities in the City.
Strategy 2: Identify the most impacted and vulnerable communities.

Strategy 3: Increase outreach and assistance to impacted and vulnerable communities to encourage more community participation to determine impacts of energy projects on the community and provide education around energy and water conservation.

Strategy 4: Vet energy projects to ensure that negative environmental/equity consequences are not created.

Strategy 5: Prioritize vulnerable communities first in rolling out individual parts of the Energy Plan, i.e., building retrofits, new facilities, etc.

This recommendation is a directive in the Resolution. However, the importance of this directive was emphasized throughout the SEP development process and encouraged to be included as a recommendation. Identification of vulnerable communities is seen as a necessary first step, followed by outreach to encourage participation and provide education. An important strategy is to prioritize vulnerable communities when implementing actions in the SEP that could positively benefit those communities.

Recommendation 4: All New and Substantially Renovated City-Owned Buildings will meet Green Building standards

Strategy 1: Use of ANSI/ASHRAE/USGBC/IES Standard 189.1, *Standard for the Design of High-Performance Green Buildings except Low-Rise Residential Buildings*, or comparable standard.

Strategy 2: Decommission older buildings that are inefficient and too costly to upgrade.

Strategy 3: Designs for future parking decks should structurally allow for the installation of solar canopies on top level.

As the City works to reduce energy consumption, the highest priority should be on constructing new City buildings and substantial renovations of existing buildings to green building standards. This practice will increase building energy efficiency, while decreasing energy costs and carbon emissions. When a building reaches the end of its service life or if renovations to a green standard would be too costly, decommissioning, and replacement with new construction may be warranted. New parking decks should structurally allow for solar canopies, so that this can be considered as an option for future solar siting.

Recommendation 5: The City fleet should be comprised of zero-emission vehicles by 2040.

Strategy 1: Create a Sustainable Fleet Policy.

The City's vehicle fleet and equipment account for 20% of total emissions. The development of a sustainable fleet policy will focus the City on reducing emissions and electrifying the fleet. Fleet policy recommendations include a transition of Police vehicles to hybrids as quickly as practicable.

A conversion to the Ford Hybrid Interceptor would reduce gasoline use by 1,276 gallons, save $3,509 in fuel costs, and eliminate 22,560 lbs. of CO_{2e} emissions per year per vehicle. Conversion of other City vehicles to electric vehicles (EV) should begin as soon as possible. The shift to EVs will require a plan for developing the needed charging infrastructure in all areas

of the City. Until internal combustion engine (ICE) vehicles are phased out, a fleet-wide policy against vehicle idling should be established and enforced.

Recommendation 6: Establish a policy to achieve no net loss of the tree canopy throughout the city for improved air quality, reduced heat island effect, and ongoing carbon sequestration.

Strategy 1: Collaborate with Greensboro Beautiful, Sierra Club, Planning Department, City Arborist, Neighborhood Development, and Neighborwoods, and other stakeholders to develop a 20-year strategy to maintain the tree canopy.
Strategy 2: Conduct a baseline tree canopy audit, followed by an update every five years.
Strategy 3: Focus planting efforts in vulnerable communities which have limited/no tree canopy.

Greensboro has been designated a Tree City USA since 1991. The community cares about the City's trees. Beyond the beauty the trees add they also improve air quality, reduce heat island effect, provide energy-saving shade, and sequester atmospheric carbon. For these reasons it is recommended that the City be intentional about maintaining its tree canopy. This strategy should include the collaborative development of a long-term tree canopy plan. To ensure the City is maintaining its tree canopy a tree canopy audit is recommended every five years. Focus planting efforts in vulnerable communities that may be impacted by limited or no tree canopy.

Recommendation 7: Develop an Energy and Water Education Program for all City staff.

Strategy 1: Human Resources development of three courses: Electricity Conservation, Water Conservation and Eco-Driving.

The education program is recommended to increase conservation awareness to City staff and create a conservation culture. As conservation thinking takes hold it will have ripple effect. The results will include reduced energy use and reduced water demand, reduced emissions, and a greater stewardship ethic, in which City staff lead the community by example.

Recommendation 8: Review current vehicle and equipment purchase/lease process for potential efficiency improvements.

Strategy 1: Evaluate departmental sharing of specialized vehicles and equipment infrequently used equipment.

Currently the City purchases/leases vehicles based on the needs of each department individually. This approach often results in duplicate purchasing of identical equipment for different departments. A fleet efficiency study will identify potential opportunities to reduce the size of the fleet by sharing intermittently used vehicles and equipment. While this would not decrease emissions it will decrease the amount of money the City spends on fleet vehicles and equipment and expedite the phase-in of hybrid or electric models.

Energy Goals, Strategies and Actions

The vision of the SEP is 100% renewable energy by 2040. The goals and strategies that follow emerged from the many meetings that took place during the SEP development process. The goals and strategies are organized broadly by the City's energy sources: electricity, natural gas, gasoline, and diesel. Goals and strategies are grouped at a more detailed level by the departments with the highest usage of each energy source. This allows the departments to integrate the goals and strategies into existing and future plans, budgets, and align annual work plans with them.

Community Incentives are also included in goals and strategies to encourage residents to follow the City's example and make similar progress in energy conservation, emissions reduction, and renewable energy use.

Actions to achieve the goals and strategies outlined are all important contributions to achieving the vision. However, some actions will have more impact; especially if completed early in the plan. Actions that meet these criteria will be prioritized.

A breakdown of 2019 emissions from energy usage by energy source for the City is provided in Figure 14. It shows that electricity makes up 60% of the City's GHG footprint. Diesel is the second largest source at 19% of the City's GHG emissions. Gasoline emissions are slightly less at 14%. Natural gas is the lowest emitter at 7%.

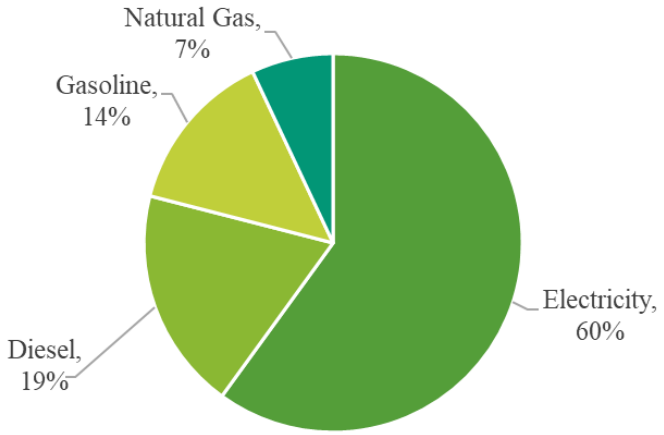


Figure 14. Breakdown of 2019 emissions from energy usage by source.

Electricity makes up most of the emissions for the City so there will be an early focus on reducing total electricity use and increasing the use of renewable sources, in order to reduce electricity emissions and move toward the goal of 100% renewable energy.

In 2019, Greensboro's municipal government had a larger land area with a larger population, using more vehicles than in 2007. It's no surprise that both gasoline and diesel use increased significantly since the 2007 inventory, so there also will be an early focus on reducing consumption of gasoline and diesel through integration of hybrid and electric vehicle options.

The goals, strategies, and actions that follow were developed to enable the City to achieve the goal of 100% renewable energy by 2040.

Renewable Energy

The goal of the SEP is to transition the City to 100% renewable energy by 2040. Solar photovoltaic (PV) is a feasible renewable source for electricity generation and can be installed on rooftops or as ground arrays. Estimates were calculated for meeting electricity demand with rooftop and ground solar.

Ground

A typical 1 MW ground solar array is estimated to generate 1.7 million kWh per year, which is approximately 1.3% of the City's current annual electricity usage. The estimate is calculated by taking 1 million watts and multiplying it by the solar insolation for North Carolina, which according to the National Renewable Energy Laboratory (NREL) is 4-5 hours per day. This daily generation is then annualized to 1.7 million kWh. Insolation is the amount of solar energy that hits the panel over a 24-hour period, annualized. It is expressed kWh/m^2.[30] A 1 MW ground solar array is estimated to cost $1.6 million[31] and utilize 5 acres of land.

To produce enough solar energy to offset the City's 2019 non-renewable electricity consumption would require constructing solar arrays with a total estimated generation of 82 MW. Developing this solar generation capacity would cost approximately $131.2 million and cover 410 acres. This estimate does not address the energy needs associated with the City's natural gas, gasoline, or diesel consumption.

Rooftop

Rooftop solar costs are estimated at $1.6 thousand per kW installed. Approximately 100 square feet are needed per kW. To produce enough solar to offset the current non-renewable electricity consumption is estimated to be 8.2 million square feet of solar compatible roof space. The City rooftop surface area of all City buildings is a fraction of the needed space and will limit the amount of the City's electricity needs that can be met through rooftop solar.

Owned solar generation can help move the City toward the SEP goal but measures to reduce energy use and to purchase Renewable Energy Credits (RECs) and other clean renewable energy sources, such as hydroelectric, wind, geothermal, etc. will be needed to achieve the goal of 100% renewable energy by 2040.

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[30] NREL. *Solar Resource Map and Data.* National Renewable Energy Laboratory. 2021. https://www.nrel.gov/gis/solar-resource-maps.html

[31] NREL. (2020). *Data and Tools.* National Renewable Energy Laboratory. 2020. www.nrel.gov/publications

Electricity Reduction

Electricity Current State

60% of GHG Emissions
30 MW Demand
139,414 MWh Usage
$11.3 million Cost

Electricity is the City's largest source of energy by both emissions and cost. Therefore, reducing electricity use is a priority. There are many opportunities to reduce electricity consumption through energy efficiency measures, energy education integration, and adoption of renewable energy for electricity needs. Recommended funding for projects includes Performance Contracts and internal funding mechanisms.

The following three departments make up roughly 80% of all the City's electricity use and should be considered a priority for reduction:

- Water Resources, 49%
- Transportation, 18%
- Coliseum Complex, 12%

Similarly, 94% of the City's electricity consumption is attributable to the following use types, which will be prioritized for energy efficiency and reduction measures:

- Water and Wastewater Treatment & Pumping, 48%
- Buildings, 32%
- Streetlamps, 14%

Reducing the demand for electricity and investigating renewable energy projects to address the electricity needs for these three departments and Usage Types will be critical to achieving the goals of the SEP. It is recommended that a reduction in electricity consumption be a priority for early implementation. Efficiency measures as a first step to reduce consumption can be followed by actions to increase the use of solar and other clean renewable sources to reduce emissions and move toward the City's 2040 energy vision.

Electricity Measurements Defined

To effectively manage and make decisions regarding electricity, it is necessary to understand the units of measurement:

Kilowatt (kW) is a measurement of the total electricity demand for an asset such as a building.

Megawatt (MW) is one thousand kilowatts.

Kilowatt Hour (kWh) is a measurement of the amount of electricity consumed by an asset over a specific period.

Water Resources Department

49% of Electricity Consumed
16 MW Demand
68,496 MWh Usage
$4.4 million Expense

The Water Resources Department consumes 49% of the electricity used by the City. A large amount of energy is needed to pump and treat water and wastewater, and to incinerate biosolids for a population of almost 300,000.

Since electricity represents 60% of the City's GHG emissions, a focus on reducing electricity consumption by the Water Resources Department should be given priority. Reduction in water demand and associated electricity consumption will have a significant impact on reducing GHG emissions. The integration of renewable energy sources to meet electricity demand will further reduce emissions. Table 11 presents the Goals, Strategies, and Actions recommended for reducing the energy and emissions footprint of Water Resources.

Table 11. Electricity Reduction Actions for Water Resources Department

Goal 1: Reduce water demand by 20% per capita by 2030.	
Strategy 1.1 Water efficiency campaign.	A1.1.1: Audit all City buildings for water efficiency opportunities. A1.1.2: Audit and fix distribution leaks. A1.1.3: Education citizens on the importance of water conservation. A1.1.4: Develop incentives to citizens to reduce personal water demand. A1.1.5: Funding to assist vulnerable residents to reduce water demand. A1.1.6: Perform a study of other cities' water pricing structures.
Goal 2: Reduce Electricity Demand by 40% by 2025 from 2007.	
Strategy 2.1: Increase equipment efficiency. Strategy 2.2: Increase Building Energy Efficiency.	A2.1.1: Audit water and wastewater equipment. A2.1.2: Implement efficiency measures suggested by audit. A2.1.3: Monitor equipment to ensure efficiency levels are met. A2.2.1: Perform an energy audit on J. Edward Kitchen Operations Center. A2.2.2: Implement efficiency measures suggested by audit. A2.2.3: Monitor buildings to ensure efficiency levels are met.

Goal 3: Meet Total Demand with Renewable Energy by 2040.	
Strategy 3.1: Install 1 MW ground PV solar project at T. Z. Osborne.	A3.1.1: Secure funding for project. A3.1.2: RFP developed/bids secured/contract awarded.
Strategy 3.2: Install additional ground solar.	A3.2.1: Identify suitable land for array (5 acres for a 1 MW array). A3.2.2: Identify suitable land for smaller arrays (>1MW). A3.2.2: Conduct feasibility study of solar installation on existing parking decks.
Strategy 3.3: In-Line Hydro Electric.	A3.3.1: Determine cost effectiveness of the project. A3.3.2: Investigate and resolve previously identified federal permitting issues. A3.3.3: If A3.3.1 is positive, RFP developed/bids secured/contract awarded.
Strategy 3.4: Research electricity generation by capturing waste heat from biosolid incineration.	A3.4.1: Feasibility study to determine compatibility w/existing equipment. A3.4.2: Determine cost effectiveness of the project if A3.4.1 is positive. A3.4.3: If A3.4.2 is positive, RFP developed/bids secured/contract awarded.

Water Reduction

The Water Resources Department has already made inroads to reduce water demand by performing annual water audits since 2018 to determine non-revenue water losses (system leaks). It has also participated in the Wyland Foundation National Mayor's Challenge for Water Conservation. The challenge is designed to encourage Mayors to challenge their residents to conserve water, energy, and other natural resources on behalf of the city through a series of informative, easy-to-use pledges online. Cities with the highest percentage of residents who take the challenge win.[32] Equipment efficiency measures have been completed or are scheduled for most of the department's facilities.

Water reduction strategies include incentives for citizens to reduce personal water demand by installing high efficiency toilets, dishwashers, washing machines and showerheads. A strategy for assisting vulnerable residents to reduce water demand includes funding for water saver appliances. It also includes a Train/Work program developed with GTCC to install the retrofits. It will further include a water conservation education program to be developed and implemented jointly by Neighborhood Development and Water Resources departments.

[32] Wyland Foundation. *Wyland National Mayor's Challenge for Water Conservation.* Wyland National Mayor's Challenge. 2022. https://mywaterpledge.com/

Efficiency
The Department has completed or scheduled energy efficient improvements at North Buffalo Creek Pumping Station, the T.Z. Osborne Water Reclamation Facility, the N.L. Mitchell Water Treatment Plant, the Lake Townsend Water Treatment Plant, and the Reedy Fork Pumping Station. The equipment at all lift and pump stations has been audited. There is further opportunity to improve system controls, install energy efficient blowers and diffuser technologies. Audits of building equipment for increased efficiency measures is a priority action. Opportunities to reduce electricity consumption for this department are specifically important since it represents half of the electricity use.

Renewables
Installation of a proposed 1 MW PV solar PV array at the T. Z. Osborne (TZO) facility, with an estimated cost of $1.6 million, had previously been included in the Capital Improvement Program (CIP). The TZO facility is situated on approximately 400 acres which could easily accommodate the 5 acres needed for a 1 MW array. The project could produce approximately 1,700 MWh per year which is about 2.5% of the Department's annual electricity consumption and $88 k of its annual electricity costs. If this project is successful, the goal is to install additional ground PV solar arrays at TZO and include battery storage into these projects.

Hydroelectric Generation
An in-line hydroelectric generation project has been previously studied as a renewable energy project. It would work by installing turbines inside a pipe running from a water source (reservoir) to a second site. As the water runs through the pipe it moves the turbines to generate electricity. The previous study estimated that this project would have an 87-kW generation capacity. The proposed cost for the project in the 2009 study was $722k with a payback period of just over 10 years. It is recommended that a cost benefit analysis of the project is prepared to determine if would be cost effective to implement. A concern is the amount of energy produced for the cost of the project.

Electricity Generation from Incineration
The Department uses a great deal of electricity to run two incinerators to burn the biosolids and then landfill the ashes. The incinerators must reach high temperatures to burn the biosolids, which produces heat. A process exists to capture the waste heat from the incinerator to convert it to electricity with a generator. A feasibility study is recommended to determine the compatibility with existing equipment, cost of equipment, and amount of electricity that could be generated, in order to determine if this project warrants further consideration.

Transportation Department

18% of Electricity Consumed
1.5 MW Demand
25,411 MWh Electricity Consumed
$3.2 million Cost

The Transportation Department uses 18% of the City's total electricity consumption. Streetlamps account for 78% of the department's consumption. The Transportation Department buildings account for 15%, while parking decks use 4%. Table 12 outlines the actions recommended for reducing electricity use and emissions.

Table 12. Electricity Reduction Actions for Transportation Department

Goal 1: Increase LED streetlamp conversion by 5% per year.	
Strategy 1.1: Increase the conversion of street lighting to LED.	A1.1.1: Work with Duke Energy to ensure conversion meets the yearly goal.
Goal 2: Reduce electricity demand by 40% by 2025 from 2007.	
Strategy 2.1: Increase Building Energy Efficiency.	A2.1.1: Perform an energy audit on Transportation buildings. A2.1.2: Implement efficiency measures suggested by audit. A2.1.3: Monitor buildings to ensure efficiency levels are met.
Goal 3: Meet total electricity demand with renewable energy by 2040.	
Strategy 3.1: Examine the feasibility of rooftop solar on department's buildings. Strategy 3.2: Evaluate rooftop canopy for parking decks.	A3.1.1: Project included in budget. A3.1.2: RFP developed/bids secured/contract awarded. A3.2.1: Determine if existing parking decks can structurally support solar. A3.2.2: Conduct feasibility study of solar installation on existing parking decks.

Building Efficiency

The J. Douglas Galyon Depot accounts for 8% of the Department's total electricity usage. It is a historical building with myriad efficiency issues. This makes renovations and energy conservation measures challenging. A significant investment has been made in the Depot's historic character and function as the City's multi-modal transportation hub, so increasing the efficiency and sustainability of this building will be a good investment long term. Energy conservation measures in the building could significantly reduce electricity consumption, but the historical nature of the building will make those measures more costly.

Streetlamps
The City's Streetlamps are mainly owned and maintained by Duke Energy. Duke Energy has begun converting the more than 26,000 streetlamps to LED fixtures, although it is unknown when this process will be completed. Two items to note concerning the conversion: (1) Duke Energy charges the City more per kWh for electricity supplied to LED lamps, compared to traditional incandescent lamps, and (2) Duke Energy would charge the City extra to accelerate the conversion of LED lamps. It is recommended that a schedule of completion be requested from Duke Energy, so that the costs and benefits of various conversion options can be evaluated.

Renewable Energy
The Transportation Department currently has a rooftop solar array above the passenger platforms at the Depot, which powers the rapid chargers for GTA's electric buses. The top levels of the public parking decks could be an additional opportunity for solar installation. Canopies can be installed on the top level to support the panels. Parking would be available under the panels. Feasibility and solar capacity studies are recommended to see if the decks are viable options for rooftop solar canopy installation.

Coliseum Complex

12% of Electricity Consumed
2.4 MW Demand
16,806 MWh Electricity Consumed
$1.2 million Cost

The Coliseum Complex consumes 12% of the City's total electricity use. It is comprised of 8 assets as shown in Table 13 including two parking lots. The Greensboro Coliseum uses 56% of the electricity for the Complex. Efficiency measures and solar feasibility are strategies for reducing non-renewable electricity consumption.

Table 13. Coliseum Complex Buildings

Site	kW
Greensboro Coliseum	1,392
Greensboro Aquatic Center	467
Pavilion	187
Convention & Visitors Center	108
Tanger Performing Arts Center	*84
Lee St Parking Lot B	76
White Oak Amphitheater	63
Total	2,377

*under construction during 2019

As shown in Table 14, goals for the Coliseum Complex are to increase building efficiency, evaluate rooftop solar options, and consider adding a green fee to parking fees.

Table 14. Electricity Reduction Actions for the Coliseum Complex

Goal 1: Reduce electricity demand by 40% by 2025 from 2007.	
Strategy 1.1: Increase building energy efficiency.	A1.1.1: Perform an energy audit on Coliseum Complex buildings. A1.1.2: Implement efficiency measures suggested by audit. A1.1.3: Monitor buildings to ensure efficiency levels are met.
Goal 2: Meet total demand with renewable energy by 2040.	
Strategy 2.1: Evaluate rooftop solar options.	A2.1.1: Review existing engineering reports/contract report. A2.1.2: Contract scope development for projects.
Strategy 2.2: Add a green fee to parking fees, to fund energy efficiency and renewable energy projects.	A2.1.3: RFP/Proposals. A2.2.1: Investigate green fee as an option.

Reduce Electricity

The electricity use for the Greensboro Coliseum is over 11 thousand MWh and is exceeded only by T.Z. Osborne Water Reclamation facility. It is a huge building and uses large amounts of electricity for lighting, heating, and air conditioning. The potential electricity reduction and avoided costs for increasing the energy-efficiency of the Coliseum are significant. However, the building is old and presents major challenges for energy-efficiency retrofits. The recommended improvements to the Greensboro Coliseum will require considerable planning and are recommended during Years 6-10 of implementing the SEP.

A building energy audit is a recommended action for the Greensboro Coliseum. Increasing the efficiency of this building will lower electricity consumption and costs. An investment grade audit to identify potential energy saving measures is a recommended action. The investment grade audit will allow the City to finance the implementation of the efficiency measures under a performance contract. This will allow the City to finance the improvements with the electricity savings from the improvements during Years 6-10.

The Greensboro Aquatics Center also uses great deal of electricity. The building is large and open which makes efficiency measures difficult. It and other buildings in the complex are recommended for energy audits and conservation measures to reduce electricity use.

Solar

To determine the potential for rooftop solar at the complex, the roofs will need to be evaluated for structural compatibility and solar potential. The roof of the Greensboro Coliseum may be an option for solar. A review of existing engineering reports is an initial action for determining rooftop feasibility. An additional study is recommended to determine solar capacity. Provided the studies indicate solar is viable on the roof then installation is a recommended action.

Energy conservation measures and rooftop solar generation can be showcased in Coliseum promotional materials as a sign of the City's commitment to reduce emissions and use renewable energy sources.

Green Fee

To offset the cost of energy projects it is proposed that a Green Fee be added to parking fees to pay for Renewable Energy Credits (RECs) or added to a Green Fund for future energy projects. RECs and Green Fund are explained in the Financing Strategy section of the SEP.

Buildings Managed by Engineering and Inspections

32% of Emissions by Usage Type
5.35 MW Demand
$2.4 million Cost

Many of the City's buildings are managed by the Engineering and Inspections Department and represent 32% of emissions by Usage Type. The buildings with the highest electricity demand (1st Tier) are listed in Table 15 in descending order. Buildings with demand below 90 kW are 2nd Tier buildings and are not listed. Strategies for reducing electricity consumption are to increase building energy efficiency and equipment efficiency as shown in Table 16.

Table 15. Highest Electricity Demand Buildings* (1st Tier)

Site	Demand (kW)
Melvin Municipal Office Building	750
Central Library	562
Greensboro Cultural Center	432
Kitchen Operation Center	412
Public Safety Training Facility	310
Sportsplex	248
Police Headquarters	245
Police District 3	200
Greensboro Historical Museum	186
Justice Building	165
Service Center Building 1 Generator	157
Police District 4	106
Kathleen Clay Edwards Library	90

*Not including buildings discussed under Department Strategies

Table 16. Electricity Reduction Actions for Buildings

Goal 1: Reduce electricity demand by 40% by 2025 from 2007.	
Strategy 1.1: Increase building energy efficiency (1st Tier buildings).	A1.1.1: Perform energy audits on buildings. A1.1.2: Implement efficiency measures suggested by audit. A1.1.3: Monitor buildings to ensure efficiency levels are met.
Strategy 1.2: Increase building energy efficiency (2nd Tier buildings).	A1.2.1: Perform energy audits on buildings. A1.2.2: Implement efficiency measures suggested by audit. A1.2.3: Monitor buildings to ensure efficiency levels are met.
Goal 2: Meet total demand with renewable energy by 2040.	
Strategy 2.1: Evaluate solar for Tier 1 roofs.	A2.1.1: Review existing engineering reports/contract report. A2.1.2: Contract scope development for projects. A2.1.3: RFP/Proposals
Strategy 2.2: Purchase Renewable Energy Credits (RECs) and Offsets.	A2.2.1: Investigate green fee as an option.

Efficiency

To reduce electricity demand building energy efficiency will need to be increased. Energy efficiency measures have been taken, in differing degrees, on many of the buildings. Increasing building energy efficiency will be achieved through auditing and implementation of identified efficiency measures. These actions will be phased over time, giving highest priority to the buildings using the most electricity. Some of the auditing and implementation measures can be handled internally. Large, complex buildings that are targeted for efficiency improvements will need an investment grade audit if a performance contract is to be utilized for financing. Buildings should be monitored after efficiency measures are taken to ensure the intended results.

There will be an early focus on several buildings with high usage shown in Table 15. The Melvin Municipal Office Building (MMOB) has the highest electricity usage. The building has had past energy conservation measures; however, opportunities remain for improved efficiency. The Central Library needs several capital improvements to improve the building's efficiency and potentially install rooftop solar. The roof will need to be replaced. Windows throughout the building will need to be replaced.

The Greensboro Cultural Center building is another large electricity user. The open design of the building is difficult to heat and cool. Capital improvements are needed to improve the building's efficiency.

The Police Headquarters building was also identified for early conservation measures. Efficiency improvements in the part of the building which are used 24/7 are identified as a priority for early completion. Two floors of the building are not currently in use. It is recommended that these unused floors be evaluated for energy losses and corrective actions taken to eliminate these losses.

The Kathleen Clay Edwards Library is recommended for early energy conservation measures. The building uses a large amount of electricity per square foot of floor space. In addition to general holdings, this library specializes in nature, gardening, and environmental resources for children and adults. For this reason, increasing the efficiency of this building and integrating educational elements presents an important opportunity to raise community awareness of energy conservation.

Renewable Energy

To increase renewable energy use through rooftop solar installation, an evaluation of the solar compatibility and capacity of Tier 1 buildings (Table 15) will be conducted. Later, Tier 2 buildings, which have a smaller electricity demand, will be evaluated for solar compatibility. To increase renewable energy use, land will be identified that is compatible for ground-mounted solar will be identified.

The Central Library roof has been identified as a potential site for rooftop solar. A preliminary study was conducted to assess feasibility and solar capacity. This solar project was favored by both the Community Partnership and Leadership Team and was identified as the highest priority rooftop solar project to complete. This project was viewed as a win since the solar will offset part of the building's energy needs with renewable energy. The Central Library is also in the heart of downtown Greensboro and is used by many residents, so solar panels on the roof sends a strong message of the City's commitment to 100% renewable energy.

Natural Gas Reduction

Natural gas makes up only 4% of the GHG emissions for the City. The following five departments account for roughly 80% of the City's natural gas usage and should be considered priorities for reduction: Coliseum 34%, Parks and Recreation 14%, Transportation 12%, Police 10%, and Fire 8%. However, natural gas will not be considered a priority action at the City level.

Goals and strategies for the Departments can be found in Tables 17-19. The goals and strategies for reducing natural gas are similar for these five departments and will not be discussed individually as to avoid repetition.

Strategies to reduce natural gas include audits and efficiency measures, which coincide with electricity reduction strategies, so these strategies will serve a dual purpose of reducing both electricity and natural gas.

Natural gas is primarily used to provide heat to buildings and to heat water. Heating system evaluation and efficiency improvement are additional strategies to reduce natural gas consumption. Natural gas fired heating systems can be converted to electric, with the long-term intention of meeting the electricity demand through renewable sources. Reducing the demand for natural gas for heating water could be partially achieved by investigating the installation of solar thermal arrays; applicable rooftops should be evaluated for compatibility. Eleven of the City's fire departments currently have solar thermal arrays.

Coliseum Complex

319,313 Therms
$257,552 Cost

Table 17. Natural Gas Reduction Actions for the Coliseum Complex

Goal 1: Reduce natural gas demand by 40% by 2030 from 2007.	
Strategy 1.1: Increase building energy efficiency.	A1.1.1: Perform an energy audit on Complex buildings. A1.1.2: Implement efficiency measures suggested by audit. A1.1.3: Monitor buildings to ensure efficiency levels are met.
Strategy 1.2: Increase heating system efficiency.	A1.2.1: Evaluate heating system to determine level of efficiency. A1.2.2: Implement efficiency measures suggested by evaluation. A1.2.3: Monitor equipment to ensure efficiency levels are met.
Strategy 1.3: Convert natural gas systems to electric.	A1.3.1: Replace natural gas equipment with electric at end of life.

Parks and Recreation

134,773 Therms
$125k Cost

Table 18. Natural Gas Reduction Actions for Parks and Recreation

Goal 1: Reduce natural gas demand by 40% by 2030 from 2007.	
Strategy 1.1: Increase building energy efficiency.	A1.1.1: Perform an energy audit on all buildings. A1.1.2: Implement efficiency measures suggested by audit. A1.1.3: Monitor buildings to ensure efficiency levels are met.
Strategy 1.2: Increase heating system efficiency.	A1.2.1: Evaluate heating system to determine level of efficiency. A1.2.2: Implement efficiency measures suggested by evaluation. A1.2.3: Monitor equipment to ensure efficiency levels are met.
Strategy 1.3: Convert natural gas systems to electric.	A1.3.1: Replace natural gas equipment with electric at end of life.
Strategy 1.4: Evaluate swimming pool heating.	A1.4.1: Audit facilities for increased energy efficiency measures.

Fire Department

73,255 Therms
$68k Cost

Table 19. Natural Gas Actions for Fire Department

Goal 1: Reduce natural gas demand by 40% by 2030 from 2007.	
Strategy 1.1: Increase building energy efficiency.	A1.1.1: Perform an energy audit on all buildings. A1.1.2: Implement efficiency measures suggested by audit. A1.1.3: Monitor buildings to ensure efficiency levels are met.
Strategy 1.2: Increase heating system efficiency.	A1.2.1: Evaluate heating system to determine level of efficiency. A1.2.2: Implement efficiency measures suggested by evaluation. A1.2.3: Monitor equipment to ensure efficiency levels are met.
Strategy 1.3: Convert natural gas systems to electric.	A1.3.1: Replace natural gas equipment with electric at end of life.
Goal 2: Meet water heating demand with renewable energy by 2040.	
Strategy 2.1: Rooftop thermal solar.	A2.1.1: Continue installation of solar for hot water.

Gasoline and Diesel Reduction

Gasoline and Diesel make up 33% of the GHG emissions for the City with Diesel accounting for 19% and Gasoline accounting for 14%.

Diesel is used for both on-road fleet and transportation vehicles as well as off-road vehicles and equipment. Reducing the amount of diesel used will primarily be achieved by investigating comparable (cost and performance) electric vehicles and equipment. Diesel-electric hybrid vehicles may be considered if suitable EV options are not available. As the City's population and land area grows, the number of City personnel also grows, and City crews become capable of handling more and larger projects internally. Fuel usage and associated GHG emissions increasingly shift from private contractors to municipal operations.

Gasoline is used for fleet vehicles and small off-road equipment. Reducing the amount of gasoline will primarily be achieved by converting vehicles to comparable (cost and performance) hybrids in the short-term, and then converting to comparable electric vehicles in the long-term. The conversion of the fleet will include pilot testing of vehicles/equipment to determine feasibility and workability (ability to handle the task as well as current vehicle/equipment/energy source). Most small gasoline powered off-road equipment can be readily replaced with all-electric models.

Vehicle and Equipment Definitions:

Fuels: (gasoline and diesel) are used by the City for operating on-road vehicles and equipment.

On-Road Vehicles: such as passenger cars, light and heavy trucks, and buses. State law requires these vehicles to have a valid license plate in order to be operated on public highways.

Equipment: stationary equipment such as generators and pumps; off-road vehicles such as ATVs, tractors, and front loaders; and portable equipment such as blowers, mowers, and chainsaws. Off-road vehicles and portable equipment are typically transported to a jobsite on truck or trailer and are rarely operated on public highways, except in posted construction zones.

Gasoline Reduction

Gasoline is used to provide fuel for fleet vehicles. Two departments account for roughly 80% of gasoline emissions for the City and should be considered a priority for reduction: Police Department (49%) and Transportation (30%).

Police Department

49% of Emissions
576,207 Gallons
$1,295,042 Cost

Almost half of the City's gasoline usage can be attributed to the Police Department. One of the primary functions of the department is to patrol all areas of the City's 137 square miles and respond to calls, so a large amount of fuel is required. Reducing gasoline consumption and right sizing the fleet are the two goals as shown in Table 20. The first goal will be accomplished through fleet conversion to hybrids and EVs and increasing the number of bicycles used for patrol.

Table 20. Gasoline Reduction Actions for Police Department

Goal 1: Reduce gasoline consumption by 5% per year.	
Strategy 1.1: Fleet conversion to hybrid vehicles.	A1.1.1: Purchase hybrid for replacement patrol cars. A1.1.2: Purchase hybrid for replacement non-patrol vehicles. A1.1.3: Explore hybrid options for replacement. A1.1.4: Hire fleet technicians with hybrid/EV experience.
Strategy 1.2: Fleet conversion to electric vehicles.	A1.2.1: Purchase EV when cost is comparable to hybrid. A1.2.2: Explore transition of Prisoner Transport, CSI and Evidence vans to EV. A1.2.3: Budget for charging stations to meet needs of increased EV fleet. A1.2.4: Explore cost associated with charging stations at Swing Road. A1.2.5: Explore potential grant funding opportunities. A1.2.6: Hire fleet technicians with EV experience.
Strategy 1.3: Increase the number of bicycles used for patrol.	A1.3.1: Explore opportunities to increase bicycle patrol.
Goal 2: Right Size Fleet to ensure all leased vehicles are necessary.	
Strategy 2.1: Review and justify all vehicles.	A2.1.1: Conduct a fleet optimization study.

Hybrid Conversion

Converting the patrol fleet to hybrid will reduce gasoline consumption in two ways: (1) in miles per gallon (mpg), and (2) in gasoline consumed from idling. A hybrid vehicle has a higher mpg than an internal combustion vehicle (ICE). Table 21 provides a comparison of the Ford Interceptor Hybrid and Ford Interceptor ICE which shows that over a100-mile distance the hybrid uses 28.9% less fuel, saving 1.7 gallons, $5.13 and 33.52 lbs. of CO_2 emissions. A hybrid uses stored energy from its battery when the vehicle is stopped, so it is not consuming gasoline.

Table 21. Comparison of hybrid and traditional Ford Interceptor Police vehicle

Comparison	Interceptor Hybrid	Interceptor ICE	Savings/100 miles
100 Miles Compared	24 mpg = 4.17 gallons	17 mpg = 5.88 gallons	**1.7 gallons**
Emissions Formula	19.6 lbs. CO_2/gallons	19.6 lbs. CO_2/gallons	
CO_2 Emissions	81.73 lbs.	115.25 lbs.	**33.52 lbs.**
Cost	$3/gallon = $12.51	$3/gallon = $17.64	**$5.13**

Ford Interceptor Hybrid

Ford produces the Interceptor Hybrid police vehicle. Ford compared it to its non-hybrid Interceptor and estimates that it saves 1,276 gallons per year per vehicle. A savings of $3,509 in gasoline costs and a reduction in CO_2 emissions of 22,560 lbs. per vehicle is estimated.[33] This vehicle (or other hybrid vehicles that meet patrol car standards) is recommended for all future patrol vehicle replacements/additions to the fleet.

Electric Vehicles

Non-patrol vehicles are recommended to be replaced with EVs when a comparable option is available and a plan for charging stations is in place. Table 22 provides a comparison of an EV to a gasoline vehicle. Accounting for the electricity to charge the EV there is a savings of $8.35 per 100 miles and 45 lbs. of CO_2 emissions. It is also worth noting that because EVs have no moving parts, they generally incur lower yearly maintenance costs. When suitable EV models are not available, the vehicles may be replaced with comparable hybrid models. Non-patrol vehicles should only be replaced with new ICE models if suitable EV and hybrid models are not available.

Table 22. Comparison of EV and gasoline vehicles

Comparison	Electric Vehicle	Gasoline Vehicle	Savings/100 miles
100 Miles Compared	100 miles = 30 kWh	100 miles = 3.45 gallons*	
Emissions Formula	0.743 lbs. CO_2/kWh	19.6 lbs. CO_2/gallons	
CO_2 Emissions	22.29 lbs.	67.59 lbs.	**45.30 lbs.**
Cost	$0.08/kWh = $2.40	$3/gallon = $10.35	**$8.35**

*Assumes 29 mpg vehicle

[33] Ford. *Responsive to Your Budget. 2021.* https://www.ford.com/police-vehicles/police-interceptor/hybrid-utility/calculator/

Idling
Idling accounts for approximately 20% of gasoline use per shift in a patrol car. There are several ways to reduce gasoline consumption from idling. Hybrid and EV transitions have already been mentioned. There are also auxiliary battery packs which can be stored in the trunk to operate the necessary vehicle systems and police equipment.

Bicycles
The City currently utilizes bicycles for patrol. Opportunities to increase the use of bicycle patrols is recommended. This strategy also aligns with the Becoming Car Optional "Big Idea" of the GSO2040 Comprehensive Plan.

Right Sizing the Fleet
It is recommended that a comprehensive study be conducted to determine if the fleet inventory can be reduced through elimination of rarely used vehicles, vehicles that no longer meet job requirements, and development of departmental sharing of specialized vehicles that are used infrequently. While this goal will not directly impact energy or emissions reduction it could potentially reduce the fleet requirements and reduce some costs.

Transportation Department

30% of Emissions
371,682 Gallons
$669,708 Cost

The Transportation Department has made great progress with integrating electric buses into the Greensboro Transit Authority Fleet. Greensboro was the first city in the southeastern US to integrate electric buses into its transit fleet. To make further progress in reducing gasoline consumption, goals and strategies have been outlined in Table 23.

Table 23. Gasoline Reduction Actions for Transportation Department

Goal 1: Reduce gasoline consumption by 5% per year.	
Strategy 1.1: Fleet conversion to electric vehicles.	A1.1.1: Purchase electric vehicles when cost is comparable to hybrid. A1.1.2: Budget for charging stations to meet needs of increased EV fleet.
Strategy 1.2: Fleet conversion to hybrid vehicles.	A.1.2.1: Purchase hybrid for replacement vehicles.

Hybrids and EV

There are opportunities to integrate hybrids and EV into other areas of the Transportation Department fleet. Many vans and other smaller vehicles are used for special transportation services, including AccessGSO. Electric vehicles are recommended when a comparable option is available and a plan for charging stations is in place. When suitable EV models are not available, Transportation Department vehicles may be replaced with comparable hybrid models. Transportation Department vehicles should only be replaced with new ICE models if suitable EV and hybrid models are not available.

Diesel Reduction

Diesel is used as a fuel for on-road fleet vehicles, off-road vehicles, and equipment. Two departments account for 86% of diesel emissions for the City and should be considered a priority for reduction: Field Operations (65%), and Transportation (21%). Since diesel accounts for 19% of the City's emissions it will be important to take steps early to begin reducing diesel consumption.

Field Operations

65% of Emissions
698,569 Gallons
$1,458,121 Cost

The Field Operations Department uses an assortment of diesel powered on-road vehicles, off-road vehicles, and equipment. To reduce diesel usage, goals, strategies, and actions have been outlined in Table 24.

Table 24. Diesel Reduction Actions for Field Operations

Goal 1: Reduce diesel consumption by 5% per year.	
Strategy 1.1: Right size fleet/equipment.	A1.1.1: Review inventory of fleet/equipment. A1.1.2: Only replace or eliminate if justified.
Strategy 1.2: Fleet conversion to hybrid vehicles.	A1.2.1: Purchase hybrid for replacement vehicles. A1.2.2: Focus on replacing the most fuel inefficient first.
Strategy 1.3: Fleet conversion to electric vehicles.	A.1.3.1: Replace fleet vehicles with EV of a justifiable cost & performance. A1.3.2: Focus on replacing the most fuel inefficient first.
Strategy 1.4: Equipment conversion to electric equivalent.	A1.4.1: Replace equipment at retirement w/electric at a justifiable cost. A1.4.2: Focus on replacing the most fuel inefficient first. A1.4.3: Replace fleet vehicles with EV of a justifiable cost & performance.

Hybrids and EVs

Strategies to reduce diesel consumption include converting to hybrid or EV equivalent models for both vehicles and equipment. The most fuel inefficient vehicles should be replaced first. However, suitable hybrid or EV replacements are not always available for many of these heavy-duty specialized vehicles and equipment. Options that are available may not be feasible. Research into hybrid and EV options for heavily used vehicles and equipment is recommend as

an early action so that integration of these options can begin. To ensure these options are suitable, pilot testing of vehicles/equipment will be completed to determine feasibility and workability (ability to handle the task as well as current vehicle/equipment/energy source).

Right Sizing the Fleet

It is recommended that a comprehensive study be conducted to determine if the fleet inventory can be reduced through elimination of rarely used vehicles, vehicles that no longer meet job requirements, and development of departmental sharing of vehicles that are used infrequently While this goal will not directly impact energy or emissions reduction it could potentially reduce the fleet requirements and avoid those costs.

Transportation Department

21% of Emissions
487,153 Gallons
$1,013,120 Cost

To reduce diesel use goals, strategies, and actions have been outlined in Table 25. There are opportunities to integrate hybrids and EVs into other areas of the Transportation Department fleet. Many vans and other smaller vehicles are used for special transportation services, including AccessGSO. Electric vehicles are recommended when a comparable option is available and a plan for charging stations is in place. When suitable EV models are not available, Transportation Department vehicles may be replaced with comparable hybrid models. Transportation Department vehicles should only be replaced with new ICE models if suitable EV and hybrid models are not available.

Table 25. Diesel Reduction Actions for Transportation Department

Goal 1: Reduce diesel consumption by 5% per year.	
Strategy 1.1: Right size fleet/equipment.	A1.1.1: Review inventory of fleet/equipment. A1.1.2: Only replace or eliminate if justified.
Strategy 1.2: Fleet conversion to hybrid vehicles.	A1.2.1: Purchase hybrid for replacement vehicles. A1.2.2: Focus on replacing the most fuel inefficient first.
Strategy 1.3: Fleet conversion to electric vehicles.	A.1.3.1: Replace fleet vehicles with EV of a justifiable cost & performance. A1.3.2: Focus on replacing the most fuel inefficient first.
Strategy 1.4: Support implementation of GTA Mobility Greensboro 2040 Plan to increase ridership throughout the City.	A1.4.1: Identify opportunities to support the implementation of the plan to increase ridership.

GTA Mobility Greensboro 2040 Plan

The GTA Mobility Greensboro 2040 Plan has strategies to increase ridership and improve efficiency across the transportation system. The first strategy will encourage ridership which may incentivize more residents to utilize GTA rather than drive. Improved efficiency of the transit system should help to reduce diesel consumption and CO_2 emissions throughout the community but would not significantly advance the 2040 Energy Vision. Ongoing replacement of diesel vehicles with EVs and hybrids should steadily reduce the Transportation Department's diesel consumption and associated CO_2 emissions.

As part of the commitment to address cost burdens to ensure a just transition to renewable energy for all and prioritize at-risk population it is recommended that electric buses be assigned primarily to routes that pass through communities identified as at-risk, until the GTA fleet has been completely replaced with EV buses. This approach will decrease the impacts of noise and pollution on these communities.

Community Incentives

The SEP Resolution included a directive for incentivizing residents and businesses to achieve similar progress on GHG reduction, energy efficiency, and renewable energy use as the City. It also called for recommendations to address cost burdens to ensure a just transition to renewable energy for all and prioritize at-risk populations. The goals, strategies, and actions focused on these directives are shown in Table 26.

One strategy to incentivize residents is to provide community-wide energy efficiency education. An action to educate is a contest through the Arts and Cultural program to create a product out of a common City waste or biproduct to promote alternative thinking about waste.

Table 26. Strategies and Actions to Encourage Community Efficiency and Renewable Efforts

Goal 1: Incentivize Greensboro residents and businesses to achieve similar progress on GHG reduction, energy efficiency, and renewable energy use as the city.	
Strategy 1.1: EE educational outreach.	A1.1.1: Communications Department to create energy efficiency educational materials and distribute them through City channels. A1.1.2: Arts & Culture Program to develop a contest for creating a product out of common city waste/biproducts.
Strategy 1.2: Remove obstacles to energy installation.	A1.2.1: Review land use ordinances and building permit policies for obstacles. A1.2.2: Advocate for homeowner associations to make Bylaw changes to rooftop solar. A1.2.3: Obtain SolSmart Designation.
Strategy 1.3: Encourage community solar.	A1.3.1: Explore opportunities to increase bicycle patrol.
Goal 2: Address cost burdens to ensure a just transition to renewable energy for all and prioritize at-risk populations.	
Strategy 2.1: Funding to assist lower-wealth citizens in reducing water and electricity demand.	A2.1.1: Funding to assist citizens to reduce utility demand. A2.1.2: Funding provides high efficiency toilets, showerheads, appliances. A2.1.3: Collaborate with GTCC to create a Train/Work program for retrofits. A2.1.4: Neighborhood Development to develop and run education program.

Another strategy is to remove obstacles to renewable energy installation. The City is currently working to obtain a SolSmart designation. To obtain the designation, a thorough review of all policies and ordinances is conducted to determine the ease of obtaining solar permitting. A third strategy could include hosting seminars on solar installation to encourage solar in the community.

To address disparities in utility cost burden, it is recommended that funding be established to assist low- and moderate-income households to reduce their water, electricity, and natural gas usage. This funding could be used to provide high efficiency toilets, faucets, and showerheads, energy conservation measures, rooftop solar installation, energy-efficient appliance purchases, etc.

Utility costs are rising and increasing the percentage of total income that low- and moderate-income residents must pay on their monthly utility bills. Efficiency measures will assist these residents to lower their monthly utility costs. It is recommended to collaborate with GTCC to create a Train/Work program for installing energy-efficiency retrofits to homes in low- and moderate-income neighborhoods. It is also recommended that the Neighborhood Development Department develop and run an energy-efficiency education program to educate and encourage low- and moderate-income residents to improve the efficiency of their homes and reduce utility costs.

Additional actions for incentivizing residents and businesses to achieve similar progress on GHG reduction, energy efficiency, and renewable energy use could include:

- Economic Development & Business Services Office (EDBS) - collaborate with the Nussbaum Center for Entrepreneurship to incubate new local green businesses (ie those with a focus on energy efficiency, renewable energy, and/or GHG reduction).
- EDBS - offer economic development assistance grants/forgiveable loans to green businesses relocating to, or expanding in Greensboro.
- EDBS - offer grants/forgiveable loans to businesses that implement energy saving or emissions reducing improvements to their facilities.
- Neighborhood Development Department - offer grants/forgiveable loans to low & moderate income homeowners and affordable housing landlords who implement energy saving or emissions reducing improvements to their properties.
- Sustainability Office - collaborate with Libraries to organize an annual Neighborhood Sustainability Challenge program to spread awareness among residents and increase adoption of energy saving and emissions reducing actions; with a City hosted block party highest participating neighborhoods in each City Council District.
- Sustainability Office - establish funding and collaborate with CSC to formally launch the previously proposed Greensboro Responsible Business Awards program.

Prioritize Actions

Immediate Actions (Years 1-5):

1. Adopt City of Greensboro Recommendations.
2. Execute performance Contract for Tier 1 and Tier 2 building audits to:
    A. Address deferred maintenance on buildings and building equipment.
    B. Implement energy conservation in buildings with highest energy use.
3. Adopt and implement hybrid purchase policy for fleet vehicles (specifically police).
4. Approve and provide funding for 1 MW Ground-Solar project at TZ Osborne.
5. Evaluate feasibility of rooftop solar project at Central Library.
6. Energy conservation measures and new roof for Central Library.
7. Install rooftop solar array on Central Library.
8. Approve Green Revolving Fund and establish initial budget.
    A. Develop process for managing fund.
9. Include SEP projects in Capital Improvements Plan (CIP).
10. Conduct rooftop study for solar compatibility and capacity to identify rooftop solar projects.

Actions (Years 6-10):

1. Adopt and implement EV purchases for fleet vehicles.
2. Install appropriate EV charging stations to meet demand for City fleet vehicles.
3. Solar project (2 & 3) at TZ Osborne or another site (1 MW each).
4. Identify, approve, and budget for identified rooftop solar projects.
5. Gasoline/Diesel equipment converted to electric.
6. Identify energy efficiency renovations for The Depot that align with its historic designation and complete renovations.
7. Perform energy audit on The Coliseum and complete conservation measures from the audit.
8. Perform Energy Audit on Cultural Center and complete conservation measures from the audit.
9. Get next round of SEP projects added to CIP.

Actions (11-15)

1. Identify, approve, and budget for additional rooftop solar projects.
2. Continue to convert remaining gasoline/diesel equipment to electric.
3. Continue to install charging stations to meet demand for City fleet vehicles.
4. Purchase RECs and/or Offsets.

Actions (16-20)

1. Purchase Renewable Energy Credits (RECs) to meet remaining emissions reduction goal.
2. Evaluate appropriate Carbon Offsets to achieve final emission reduction goals.

Putting Together a Financing Strategy

The SEP Resolution requires a recommendation of funding strategies for projects that advance established goals for GHG emissions reduction, energy efficiency, and renewable energy use.

Energy Efficiency and Energy Conservation Financing

Building efficiency, energy conservation, and deferred building maintenance needs will play a significant role in reducing electricity consumption and therefore GHG emissions, since electricity consumption accounts for 60% of the City's emissions. Financing for these building projects should be given priority since the benefits derived will be long-term, including avoided utility costs, lower emissions, and lower energy demand.

Energy Savings Performance Contracting

Energy Savings Performance Contracting (ESPC) is a "budget-neutral approach to make building improvements that reduce energy and water use and increase operational efficiency."[34] A building owner contracts with an energy service company (ESCO) to fund and install the improvements. The future energy savings from the improvements will pay for the upgrades, which results in the budget-neutral approach. The savings from the improvements are specified in the contract. The owner benefits from the improvements without using capital funds.

Performance Contracts can provide the City with the financial means to achieve a reduction in electricity and emissions without the need for the full up-front capital investment on the part of the City. The downside is that the financial savings realized from the energy savings will go to pay the debt incurred from the projects funded through the Performance Contract. Therefore, it is budget neutral until the City has fully paid for the project. The City has previously executed two performance contracts for building system improvements, efficiency, and conservation measures.

City Funded

City Capital Improvements Program (CIP)

The Capital Improvements Program (CIP) is an annually updated financing and construction/acquisition plan for projects that require a significant capital investment. The CIP describes the City's capital project schedules and priorities over a 10-year period. The CIP specifies the sources of funding, by year, for each project. Some CIP projects are funded through annual operating funds, such as the General Fund and the Water Resources Fund. In these cases, CIP and the City's annual adopted budget are directly linked. Project funding through debt financing-typically voter authorized bonds-also impact the annual budget through ongoing debt service expense. Many CIP projects include funding from sources outside the City's ordinary revenue stream, such as federal, state, and private grants. Transportation and housing related projects often use grant funding.

[34] Department of Energy. *Energy Savings Performance Contracting.* 2021. Department of Energy. https://www.energy.gov/eere/slsc/energy-savings-performance-contracting

SEP projects with high capital costs which will make a significant impact towards meeting the SEP goals should be prioritized and scheduled through the CIP.

Green Revolving Fund
A Green Revolving Fund re-uses the money from energy savings or avoided costs derived from energy efficiency and renewable energy projects to fund further energy projects. Instead of the savings achieved through reduced energy costs being absorbed and diverted to other budget areas, the savings are deposited into the Green Revolving Fund account to use for future projects. Any debt incurred from a project will be paid before the savings from the project is allocated to the Green Revolving Fund.

Green Fee
Another possible funding mechanism could be to add a small surcharge to certain City services, which would be deposited into the Green Revolving Fund. Further investigation is needed to determine whether the City has the statutory authority to charge such a "green fee" and what types of services it could be added to.

Energy or Green Bonds
Green Bonds, or Energy Bonds are a special version of ordinary General Obligation Bonds, issued specifically to finance energy efficiency or renewable energy projects. Such bonds levy a specified additional amount on the municipal property tax rate, in order to repay the principal and interest on the debt incurred to carry out the project. This mechanism is best used for a package of several large multi-year projects that will achieve major energy savings and emissions reductions, which are expected to continue long after the debt is retired.

American Rescue Plan Funds
The American Rescue Plan Act (ARPA) of 2021 (H.R. 1319) is a $1.9 trillion package intended to combat the COVID pandemic, including public health and economic impacts. A $350 billion allocation to state and local governments is included in the package. The allowable uses for the local government funding is limited, with one potential use for water and sewer infrastructure improvements.[35]

The City has been allocated $59 million from ARPA. ARPA funds are meant to address negative impacts from the COVID pandemic. Rising energy costs disproportionately affect lower-to-moderate income households. Water and sewer infrastructure improvements can start to address the cost burden to these households for water and sewer service, which is a goal of the SEP.

Solar Installation Financing

Solar Power Purchase Agreement (SPPA)

A Solar Power Purchase Agreement (SPPA) is a common way for local governments to fund their solar projects. The SPPA approach requires no money out of pocket. A third party will own, operate, and maintain the solar project. The City provides the site for the project and

[35] National Association of Counties. *American Rescue Plan Act Funding Breakdown.* NACO. https://www.naco.org/resources/featured/american-rescue-plan-act-funding-breakdown

purchases the generated electricity from the solar project at a low-cost. The provider receives tax credits and income.[36]

Duke Energy Solar Rebate

Duke Energy offers a $0.75 a watt incentive to install solar. There is a $75,000 maximum incentive and a 100-kW system maximum.[37] This rebate program is offered yearly until all available rebates have been claimed. The program offers rebates to residential, commercial, and nonprofit customers. The rebates are claimed quickly when Duke Energy releases them. However, the nonprofit rebates are typically easier to acquire. The City can apply for these rebates yearly for any solar installation, provided it does not exceed 100 kW.

Energy Project Financing

North Carolina Clean Energy Fund

The North Carolina Clean Energy Fund (NCCEF) is a newly formed (but not yet operational) not-for-profit financial institution (Green Bank) that invests its capital in energy efficiency and renewable energy projects. The NCCEF is particularly interested in projects that benefit underserved populations.[38] Accordingly, NCCEF funding would be especially helpful to use in ensuring a just transition to renewable energy for all and prioritizing at-risk populations.

Grants

Various federal, state, local, and private grants are routinely made available which could be used to fund pilots and feasibility studies, service enhancements, technical assistance, and capital projects. Grants can be an effective means of supplementing the budget of the Sustainability Office to carry out optional or lower priority projects. However, grants should generally not be pursed as a primary method of funding essential projects, or as a substitute for an adequate annual sustainability budget. Competitive grants frequently involve completing extensive and time-consuming applications and developing significant project proposals, with no guarantee of receiving funding. Grants also often involve extensive monitoring and follow-up reporting to ensure that awarded funds are used for eligible purposes and as described in the application.

GHG Emissions Reduction Strategies

Renewable Energy Certificates (RECs)

A Renewable Energy Certificate (RECs) is a "tradeable, market-based instrument that represents the legal property rights to the renewable-ness – or non-power (environmental, social) attributes - of renewable electricity generation)."[39] "A REC is created for every megawatt-hour (MWh) of electricity generated and delivered to the electricity grid from a renewable energy resource. On a

[36] EPA. *Solar Purchase Power Agreements.* Environmental Protection Agency. 2021. https://www.epa.gov/greenpower/solar-power-purchase-agreements

[37] Duke Energy. *NC Solar Rebate Program.* 2021. https://www.duke-energy.com/home/products/renewable-energy/nc-solar-rebates?jur=NC01

[38] NCCEF. *About*. North Carolina Clean Energy Fund. 2022. https://www.nccleanenergyfund.com/

[39] EPA. Offsets and RECS: *What's the Difference?* 2018. Environmental Protection Agency. https://www.epa.gov/greenpower

shared grid, whether from on-site or off-site resources, RECs are the instrument that electricity consumers must use to substantiate renewable electricity use claims."[40]

The City can purchase RECs to reduce the City's GHG emissions. Purchasing a 1 MW REC is equivalent to installing a 1 MW solar PV array or reducing energy use (and associated greenhouse gas emissions) by 1 MW. Pricing of RECs can vary widely and should be monitored closely to obtain advantageous pricing. RECs can be purchased through Duke Energy's Green Source Advantage program.[41]

Offsets

An offset is a "specific activity or set of activities intended to reduce GHG emissions, increase the storage of carbon, or enhance GHG removal from the atmosphere." To qualify as an offset, a project must be deemed additional: the resulting emissions reductions must be real, permanent, and verified; and credits (i.e. offsets) issued for verified emissions reductions must be enforceable. The offset may be used to address direct and indirect emissions associated with an organization's operations. The reduction in GHG emissions from one place can be used to "offset" the emissions that take place somewhere else. Offsets are often used for meeting voluntary commitments to lower GHG emissions where it is not feasible to lower an organization's direct or indirect emissions."[42]

The City can reduce one metric ton of its CO_{2e} emissions by purchasing offsets equivalent to one metric ton of CO_{2e} reduction.

Bio-Char Production

Bio-char is an emissions offset. The production of bio-char sequesters organic carbon, in the form of solid, nearly pure porous carbon. Bio-char has excellent moisture retaining properties and is highly sought after as a soil amendment. The Field Operations Department has proposed purchasing a device called an "Air Curtain Burner" (ACB). An ACB is capable of rapidly processing a large amount of vegetative material (such as yard waste currently received by the City at the White Street Landfill) into bio-char. Currently, Field Operations turns this yard waste into mulch or compost and offers it for sale to the public. However, the organic material in the mulch and compost continues to decompose, releasing methane and carbon dioxide into the atmosphere. Bio-char production uses very high temperatures to break down organic molecules into pure carbon, oxygen, and hydrogen, while releasing only about 10% of the carbon into the atmosphere, versus decomposition or combustion. The solid bio-char that remains, when added to soil for agricultural purposes, hold the carbon in place for centuries of longer. Accordingly, bio-char is seen as a potential revenue source for Field Operations.

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[40] EPA. *Renewable Energy Certificates.* Environmental Protection Agency. 2021. https://www.epa.gov/greenpower/renewable-energy-certificates-recs

[41] Duke Energy. (2021). *Renewable Energy Programs.* https://www.duke-energy.com/Business/Products/Renewables/Green-Source-Advantage

[42] GHG Protocol. (20XX). *GHG Project.* https://www.ghgprotocol.org/standards/project-protocol

Evaluation Plan

The SEP Resolution requires the following:

1. Preparation of an updated GHG inventory of City operations every two years.
2. Publication of an annual progress report.

Strategic Energy Plan Evaluation Plan for Goals

City of Greensboro Operations Recommendations

Recommendation 1: The City should establish a Sustainability Office.

Evaluation method: Recommendation implemented.

Recommendation 2: Clean energy audit/installation/maintenance contracts will give priority to Historically Underutilized Businesses (HUBs) and Minority and Women Business Enterprise (MWBE).

Evaluation method: City includes language to this effect and gives priority to HUBs in energy contracts.

Recommendation 3: Ensure energy decisions are made in a way that promotes a just transition to renewable energy for all and prioritizes vulnerable communities.

Evaluation method: A matrix for vetting energy decisions with respect to environmental justice is used when making energy decisions.

Recommendation 4: All City-Owned Buildings will meet Green Building standards (New Construction and Substantial Renovated City-Owned).

Evaluation method: A policy is established requiring City owned buildings to meet green building standards for both new construction and substantial renovation.

Recommendation 5: The City fleet will be comprised of zero-emission vehicles by 2040.

Evaluation method: NA

Recommendation 6: Establish a policy to achieve no net loss of the tree canopy throughout the City for improved air quality, reduced heat island effect, and carbon sequestration.

Evaluation method: (1) Baseline tree canopy survey completed and follow-up survey every five years. (2) 20-year tree canopy strategy developed.

Recommendation 7: Develop an Energy and Water Education Program for all City staff.

Evaluation method: Programs is developed and implemented.

Recommendation 8: Review current purchase/lease process for potential efficiency improvement of vehicle and equipment inventory.

Evaluation method: Review has been completed and findings presented.

Electricity Reduction

Water Resources

Goal 1: Reduce water demand by 20% per capita by 2030.

Evaluation Method: Track yearly water usage and normalize per capita. Compare to previous year normalized water usage for change in usage. Usage per capita should drop by an average of at least 1% yearly.

Goal 2: Reduce the department's electricity demand by 40% by 2025 from 2007.

Evaluation Method: Track and report electricity consumption in kWh at the end of each year and compare to previous year for change in usage.

Goal 3: Meet the department's total electricity demand with renewable energy by 2040.

Evaluation Method: Track and report the amount of electricity generated by renewable sources for Water Resources.

Transportation Department

Goal 1: Increase LED Streetlamp conversion to 5% per year.

Evaluation Method: Track and report the increase in streetlamps converted to LEDs at the end of each year.

Goal 2: Reduce the department's electricity demand by 40% by 2025 from 2007.

Evaluation Method: Track and report electricity consumption in kWh at the end of each year and compare to previous year for change in usage.

Goal 3: Meet the department's total electricity demand with renewable energy by 2040.

Evaluation Method: Track and report the amount of electricity generated by renewable sources for Transportation Department.

Coliseum Complex

Goal 1: Reduce the department's electricity demand by 40% by 2025 from 2007.

Evaluation Method: Track and report electricity consumption in kWh at the end of each year and compare to previous year for change in usage.

Goal 2: Meet the department's total electricity demand with renewable energy by 2040.

Evaluation Method: Track and report the amount of electricity generated by renewable sources for Coliseum Complex.

Buildings Managed by Engineering and Inspections

Goal 1: For all managed buildings, reduce electricity demand by 40% by 2025 from 2007.

Evaluation Method: Track and report electricity consumption in kWh at the end of each year and compare to previous year for change in usage.

Goal 2: Meet total energy demand for all managed buildings with renewable energy by 2040.

Evaluation Method: Track and report the amount of electricity generated by renewable sources.

Natural Gas Reduction

Coliseum Complex

Goal 1: Reduce department's natural gas demand by 40% by 2030 from 2007.

Evaluation Method: Track and report energy consumption in Therms at the end of each year and compare to previous year for change in usage.

Parks and Recreation

Goal 1: Reduce department's natural gas demand by 40% by 2030 from 2007.

Evaluation Method: Track and report energy consumption in Therms at the end of each year and compare to previous year for change in usage.

Fire Department

Goal 1: Reduce department's natural gas demand by 40% by 2030 from 2007.

Evaluation Method: Track and report energy consumption in Therms at the end of each year and compare to previous year for change in usage.

Goal 2: Meet department's water heating demand with renewable energy by 2040.

Evaluation Method: Track and report the amount of heated water generated by renewable sources.

Vehicle and Equipment Fuels Reduction: Gasoline Reduction

Police Department

Goal 1: Reduce department's gasoline consumption by an average of 5% per year.

Evaluation Method: Track and report gasoline consumption in gallons at the end of each year and compare to previous year for change in usage.

Goal 2: Right Size the on-road and off-road vehicle fleet to ensure all leased vehicles are necessary.

Evaluation Method: A fleet optimization study is completed.

Transportation Department

Goal 1: Reduce department's gasoline consumption by an average of 5% per year.

Evaluation Method: Track and report gasoline consumption in gallons at the end of each year and compare to previous year for change in usage.

Vehicle and Equipment Fuels Reduction: Diesel Reduction

Field Operations

Goal 1: Reduce department's diesel consumption by an average of at least 5% per year.

Evaluation Method: Track and report gasoline consumption in gallons at the end of each year and compare to previous year for change in usage.

Transportation Department

Goal 1: Reduce department's diesel consumption by an average of at least 5% per year.

Evaluation Method: Track and report gasoline consumption in gallons at the end of each year and compare to previous year for change in usage.

Community Incentives

Goal 1: Incentivize Greensboro residents and businesses to achieve similar progress on GHG reduction, energy efficiency, and renewable energy use as the City.

Evaluation Method: Track and report all efforts by the City to incentivize residents to achieve similar progress on GHG reduction, energy efficiency, and renewable energy use.

Goal 2: Address cost burdens to ensure a just transition to renewable energy for all and prioritize at-risk populations.

<u>Evaluation Method</u>: Track and report all efforts by the City to address cost burdens to ensure a just transition to renewable energy for all and prioritize at-risk populations

Strategic Energy Plan Annual Progress Report

Goals	Evaluation Method	Baseline (2019) Year Status	Current (2021) Year Status	Year to Date
Electricity Reduction Goals				
Water Resources Department				
Reduce water demand by 20% per capita by 2030	Change			
Reduce electricity demand by 40% by 2025 from 2005	Change			
Meet total demand with renewable energy by 2040	RE %			
Transportation Department				
Reduce electricity demand by 40% by 2025 from 2005	Change			
Increase LED street light conversion by 5% per year	Change			
Meet total demand with renewable energy by 2040	RE %			
Coliseum Complex				
Reduce electricity demand by 40% by 2025 from 2005	Change			
Meet electricity demand with renewable energy by 2040	RE %			
Buildings managed by Engineering and Inspections				
Reduce electricity demand by 40% by 2025 from 2005	Change			
Meet electricity demand with renewable energy by 2040	RE %			
Natural Gas Reduction Goals				
Coliseum Complex				
Reduce natural gas demand by 40% by 2030 from 2005	Change			
Parks and Recreation	Change			
Reduce natural gas demand by 40% by 2030 from 2005	Change			
Fire Department				
Reduce natural gas demand by 40% by 2030 from 2005	Change			
Meet water heating demand w/ renewable energy by 2040	RE %			
Vehicle and Equipment Fuels Reduction Goals: Gasoline				
Police Department				
Reduce gasoline consumption 5% per year	Change			
Right size fleet to ensure all leased vehicles are justified	Yes			
Transportation Department				
Reduce gasoline consumption 5% per year	Chane			
Vehicle and Equipment Fuels Reduction Goals: Diesel				
Field Operations				
Reduce diesel consumption 5% per year	Change			
Transportation Department				
Reduce diesel consumption 5% per year	Change			
Community Incentives				
Incentivize residents and businesses to achieve similar progress on GHG reduction, energy efficiency, and renewable energy use as the City	Yearly Progress			
Address cost burdens to ensure a just transition to renewable energy for all and prioritize at-risk populations	Yearly Progress			

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