Climate Action Plan

FOR THE MIDLANDS REGION
OF SOUTH CAROLINA

April 22nd, 2026

A regional comprehensive climate action plan written by the Central Midlands Council of Governments with support under contract from Sustainability Solutions Group

Authors

Jory Fleming*

Program Manager | Regional Environmental Planner – Central Midlands Council of Governments

Maurya Braun

Principal Consultant – Sustainability Solutions Group

Congaree National Park, South Carolina. Photo by Jory Fleming.

Contributors

Gregory Sprouse
Director of Research, Planning and Development – Central Midlands Council of Governments

Joana Lagunes Arauz
Environmental Planning Intern – Central Midlands Council of Governments

Jason Kent
GIS Manager – Central Midlands Council of Governments

Jocelyn Falkenstine
CPRG Implementation Grant Manager – Central Midlands Council of Governments

Kourtné Onyeocha
Regional Planning Intern - Central Midlands Council of Governments

Legare Jenkins
Communications Intern - Central Midlands Council of Governments

Deryn Crockett
Principal Consultant – Sustainability Solutions Group

Aishah Mohd Isa
Senior Consultant – Sustainability Solutions Group

Amber Nicol
Senior Modeller – Sustainability Solutions Group

Camilla Melrose
Senior Consultant - Sustainability Solutions Group

Silvie Harder
Consultant - Sustainability Solutions Group

Bernard di Girolamo
Graphic Designer - Sustainability Solutions Group

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*Direct questions to Jory Fleming at *jfleming@centralmidlands.org* or 803-898-4524

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Image at the cover:
A collage of landmark sites at the CMCOG: City of Columbia and Congaree River, Palmetto Trail and Broad River, Town of Lexington and Town of Winnsboro.
Images adapted from photos by Jory Fleming and digidreamgrafix/stock.adobe.com

Disclaimer

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Reasonable skill, care, and diligence have been exercised by the authors to assess the information acquired during the preparation of this analysis, but no guarantees or warranties are made regarding the accuracy or completeness of this information. Citations via footnotes direct to additional information in some portions of the report, while the appendices also provide additional details. Additional information is provided in the separate Data, Methods & Assumptions Manual.

This report and the data and analysis contained here can inform climate action in the Midlands, but community partners are encouraged to reach out to CMCOG for technical assistance with implementing climate actions, understanding climate science and resilience, or other needs.

You can find our current staff experts at *https://centralmidlands.org/*

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Glossary of Terms and Acronyms

Abbreviation	Definition
Air Pollution	A climate action plan may typically only discuss greenhouse gases, the air pollutants that cause global warming. EPA has required the Central Midlands Council of Governments to focus on greenhouse gas emissions, but also to analyze criteria air pollutants and hazardous air pollutants. When the term "air pollution" is used in this document, it generally refers to gases from two or more of these categories. An example is "air pollution from vehicles" where the vehicle's tailpipe emits both greenhouse gases and criteria air pollutants.
BAP	Business-as-Planned Scenario
BAU	Business-as-Usual Scenario
CAP	Criteria Air Pollutant - The Clean Air Act designates the following six gases - carbon monoxide, lead, nitrogen dioxide, ozone, particulate matter, and sulfur dioxide. The alternative term Criteria Air Contaminant (CAC) is less commonly used.
Carbon Sequestration	In this document, carbon sequestration refers to biological processes that store atmospheric carbon in plants and soils. Readers should be aware that many forms of carbon storage are temporary, meaning that on certain geological or biological timescales, it will be released back into the environment as part of the carbon cycle.
CCAP	Comprehensive Climate Action Plan: A narrative report that provides an overview of the region's significant GHG sources/sinks and sectors, establishes near- and long-term GHG emission reduction goals, and identifies strategies to help the region meet those goals. This plan speaks to many, but not all, aspects of climate planning. Its main focus is on reducing air pollution.

Abbreviation	Definition
CDD	Cooling Degree Days - a measure that represents the amount of energy required to cool the indoor environment when the daily average temperature exceeds 65°F. The higher a location's number of CDDs, the higher the demand for energy for cooling.
CEJST	Climate and Economic Justice Screening Tool
CH_4	Methane - a greenhouse gas that is 28 times as potent as carbon dioxide over a period of 100 years.
CMCOG	Central Midlands Council of Governments
CO	Carbon monoxide - a criteria air pollutant commonly produced as a result of combustion. CO can be found both indoors and outdoors but is more harmful at high concentrations indoors.
CO_2	Carbon dioxide - the most common greenhouse gas
CO_2e	Carbon dioxide equivalent - used to compare different greenhouse gases based on how severely they contribute to global warming. For example, one metric ton of methane has a CO_2e of 28 metric tons, because it is 28 times as potent as CO_2, as a greenhouse gas.
COMET	Central Midlands Regional Transit Authority
CPRG	Climate Pollution Reduction Grant
EJScreen	Environmental Justice Screening and Mapping Tool
EPA	U.S. Environmental Protection Agency
EV	Electric Vehicle
FAIN	Federal Award Identification Number

Abbreviation	Definition
GHG	Greenhouse Gas. These gases occur naturally as part of the carbon cycle, but when humans release additional greenhouse gases into the atmosphere as a result of our economic activities, they change the Earth's radiation budget and become an air pollutant. Greenhouse gases that humans emit and cause global warming are carbon dioxide, methane, nitrous oxide, and fluorinated gases.
GHG Inventory	A calculation of the total emissions generated during one calendar year from a specific region. The emissions are grouped by source and can also be sorted based on the type of greenhouse gas produced, and other qualities. Inventories use standardized methods so that they can be compared across regions. This climate action plan includes a GHG inventory for the project area for 2022.
GPC	Global Protocol for Community-Scale Greenhouse Gas Emissions Inventories - a standard methodology for reporting greenhouse gas emissions for a geographical area.
GWP	Global Warming Potential - a unit conversion that allows for a single number that encompasses all greenhouse gases. Each gas that alters Earth's radiation budget is evaluated and given a number that allows all gases to be compared to carbon dioxide, the main greenhouse gas. We used IPCC 5th Assessment Report (AR5) Global Warming Potentials, 100 year time horizon values to perform these conversions.
HAP	Hazardous Air Pollutant. The EPA regulates these gases under the Clean Air Act. At the time of this plan's publication, 188 pollutants are included.[1]

1 U.S. EPA (2026). Initial List of Hazardous Air Pollutants with Modifications. https://www.epa.gov/haps/initial-list-hazardous-air-pollutants-modifications

Abbreviation	Definition
HC	Hydrocarbons - Organic compounds composed entirely of hydrogen and carbon atoms, primarily sourced from fossil fuels, and forming the fundamental building blocks of today's combustion-based energy sources.
HDD	Heating Degree Day - a measure that represents the amount of energy required to heat the indoor environment when the daily average temperature is below 65°F. The lower a location's number of HDDs, the lower the demand for energy for heating.
HFC	Hydrofluorocarbons - a category of fluorinated gases[2] which are greenhouse gases
ICE	Internal Combustion Engine
IPCC	Intergovernmental Panel on Climate Change
IRA	Inflation Reduction Act
Job Years	A single year of work for one person
LIDAC	Low-Income and Disadvantaged Community
MMBtu	Million British Thermal Units
$MMtCO_2e$	Million Metric Tons of Carbon Dioxide Equivalent
MPO	Metropolitan Planning Organization - a Federal government designation used in regional transportation planning and programs.[3] CMCOG manages the MPO for the Columbia, SC metro area, called the Columbia Area Transportation Study or COATS MPO

2 U.S. EPA (2026). Fluorinated Gas Emissions. https://www.epa.gov/ghgemissions/fluorinated-gas-emissions

3 U.S. Department of Transportation (2026). Metropolitan Planning Organization. https://www.transit.dot.gov/regulations-and-guidance/transportation-planning/metropolitan-planning-organization-mpo

Abbreviation	Definition
MSA	Metropolitan Statistical Area - a designation by the Federal government that seeks to define a region by urban life and movement rather than political boundaries of individual cities.[4]
MSW	Municipal Solid Waste. The category of trash that most people are familiar with (produced by households and small businesses), containing a mix of organic materials and non-organic materials.
MT	Metric Ton (or Tonne) - equals 1,000 kilograms or 2,205 pounds
MW	Megawatt - a measure of electricity-generating capacity
MWh	Megawatt Hour - a measure of power produced
NDC	Nationally-Determined Contribution - a commitment by a country to reduce its greenhouse gas emissions.[5]
NF3	Nitrogen trifluoride - a type of fluorinated gas which is a greenhouse gas
N_2O	Nitrous oxide - a greenhouse gas that is 265 times as potent as carbon dioxide over a period of 100 years.
NO_2	Nitrogen dioxide - a criteria air pollutant commonly produced as a result of combustion. NO_2 is found in the exhaust of cars, trucks and buses, offroad equipment, and also at power plants.
NOx	Nitrogen oxides - a shorthand for nitrogen dioxide (NO_2) and nitric oxide (NO)
O3	Ozone - a criteria air pollutant

4 U.S. Census Bureau (2026). Metropolitan and Micropolitan. https://www.census.gov/programs-surveys/metro-micro.html

5 United Nations (2026). Nationally Determined Contributions. https://unfccc.int/process-and-meetings/the-paris-agreement/nationally-determined-contributions-ndcs

Abbreviation	Definition
PFC	Perfluorocarbon - a category of fluorinated gases[6] which are greenhouse gases
PM2.5 / PM10	Particulate Matter that is smaller than 2.5 micrometers or 10 micrometers. Particulate matter is a criteria air pollutant
SO2	Sulfur dioxide - a criteria air pollutant
SSG	Sustainability Solutions Group - the consulting firm supporting the development of CMCOG's Comprehensive Climate Action Plan.
Stationary Energy	Energy that is consumed for purposes other than transportation
UNFCCC	United Nations Framework Convention on Climate Change
USDA	U.S. Department of Agriculture
VMT	Vehicle Miles Traveled
VOC	Volatile Organic Compounds - a wide range of harmful, carbon-based air pollutants occurring in both indoor and outdoor air.
WWTP	Wastewater Treatment Plant

6 U.S. EPA (2026). Fluorinated Gas Emissions. https://www.epa.gov/ghgemissions/fluorinated-gas-emissions

How to Read This Document

This document is a climate action plan. It is a roadmap developed by the Central Midlands Council of Governments (CMCOG) to reduce greenhouse gas emissions that cause climate change within the region. Supported by the U.S. Environmental Protection Agency's (EPA) Climate Pollution Reduction Grant (CPRG) Program, the plan outlines how local communities can reduce greenhouse gas emissions (GHGs), improve air quality, strengthen the local economy and prepare for climate-related risks.

Why This Plan Matters

This plan is part of a nationwide effort to reduce pollution and improve quality of life. It is built on local data, shaped by feedback from interested and affected parties, and designed to ensure that the benefits of climate action are shared by everyone.

What You Will Find in This Document

- **Introduction (Chapter 1):** Provides background information about the Midlands, global warming, and climate impacts.
- **Community Responses (Chapter 2):** Shares how local governments are beginning to respond to climate change, and chronicles community engagement over the past two years.
- **Low-Income and Disadvantaged Communities Analysis (Chapter 3):** Explores community impacts and outlines pathways towards a more equitable future.
- **Greenhouse Gas Inventory (Chapter 4):** Summarizes the sources and sinks of greenhouse gas emissions in the Midlands,[7] what gases they are, and how much was emitted from all sources and sinks in the year 2022.[8]

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7 This geography was decided by the EPA under the CPRG Planning Grant and is discussed in Chapter 1.

8 For the purposes of this plan, 2022 was defined as the baseline year against which future projections can be compared.

- **Targets and Future Projections (Chapter 5)**: Shares targets for emissions reductions by 2035 and 2050, and projections of energy use and emissions in possible future scenarios.
- **Climate Actions (Chapter 6):** Describes actions (or changes) between 2025 and 2050 that would create a low-carbon future.
- **Benefits Analysis (Chapter 7)**: Evaluates the broader societal outcomes of climate actions beyond greenhouse gas reductions - from cleaner air, to more affordable homes, and the creation of good jobs.
- **Implementation and Funding (Chapter 8):** Discusses how the actions in this plan can move from vision to reality by examining potential roles, implementation strategies, and funding sources.
- **Workforce Analysis (Chapter 9):** Looks at regional growth in the clean economy and the number of good, long-term jobs that will be created by investing in climate action over time.

If you are interested in:

- **Responding to Climate Change:** Explore Chapter 6 and Chapter 8
- **Greenhouse Gas Emissions in the Midlands:** Explore Chapter 4 and Appendix A
- **Economics, Costs & Benefits, and Jobs:** Explore Section 1.4, Section 3.3, Chapter 7, and Chapter 9
- **Community:** Explore Chapter 2, Chapter 3, Chapter 7, and Appendix D
- **The Modeling Behind the Numbers:** Explore the project archive at the Open Science Framework (DOI: *10.17605/OSF.IO/VZEPC*). The Data, Methods and Assumptions Manual explains the models and documents the data sources used. An interactive dashboard and key data sheets allow you to explore the data directly.

How to Approach This Document

- Start with the Introduction for a quick overview of the plan's goals and priorities.[9]
- Use the tables, figures and maps to help make the technical data easier to understand.
- Each section builds on the last — read them all if you're looking for the complete picture, or skip to topics that interest you most.
- Search the glossary and appendices for more detail.

Who This Plan Is For

This plan is for everyone in the Midlands, with a focus on actions that can be championed by different community stakeholders like local governments, businesses, community groups, and residents. CMCOG's intent is to use this climate action plan to align activities in the project area with practices that will reduce greenhouse gases and other pollutants, and increase jobs and well-being in the region. This may include assistance accessing financial support, education, and strategic guidance for municipalities, counties, community groups, utilities, and industry members to help them make the changes within their direct control and to catalyze change within their spheres of influence.

We all have a role to play in shaping a healthier, more sustainable future. This plan offers a clear path forward, and highlights how local climate action can benefit communities now and in the years to come.

9 We are also developing a Visual Report which should be available in early Fall 2026. This will be a synthesis and visual overview of the plan's contents.

1 Introduction

1.1 What is Climate Planning?

Climate planning can help identify ways to reduce the greenhouse gas emissions that cause climate change (often called "mitigation") or can help communities respond to negative impacts of climate change (often called "adaptation" or "resilience"). This plan focuses on mitigation. It helps by:

- Identifying where greenhouse gases are coming from in the Midlands and likely future emissions (Chapter 4 and Chapter 5, respectively)
- Suggesting actions for residents, businesses, and local governments that reduce greenhouse gas emissions and other types of air pollution (Chapter 6)
- Highlighting how these actions would benefit our community (beyond solving climate change), how to begin acting, and how it will benefit our economy and workforce (Chapters 7 – 9)

There are multiple ways to plan for the future that are also relevant for a community responding to climate change but that are not considered here. For example, communities may wish to know in more detail which climate impacts are most likely to affect them and potential options to increase their ability to prepare for, respond to, and recover from these impacts. These are important considerations included in other plans like regional comprehensive plans, emergency management plans, or adaptation and resilience plans. Midlands communities can consult the National Climate Assessment[10] or the South Carolina Strategic Statewide Resilience and Risk Reduction Plan[11] as initial sources of information about these topics.

1.2 How was this Plan Created?

This plan is written by scientists and regional planners at the Central Midlands Council of Governments (CMCOG), whose mission is to provide the highest quality of planning, technical assistance and services to local governments and citizens in the Midlands. CMCOG is not a regulatory body and has no legal authority to stop pollution from occurring.

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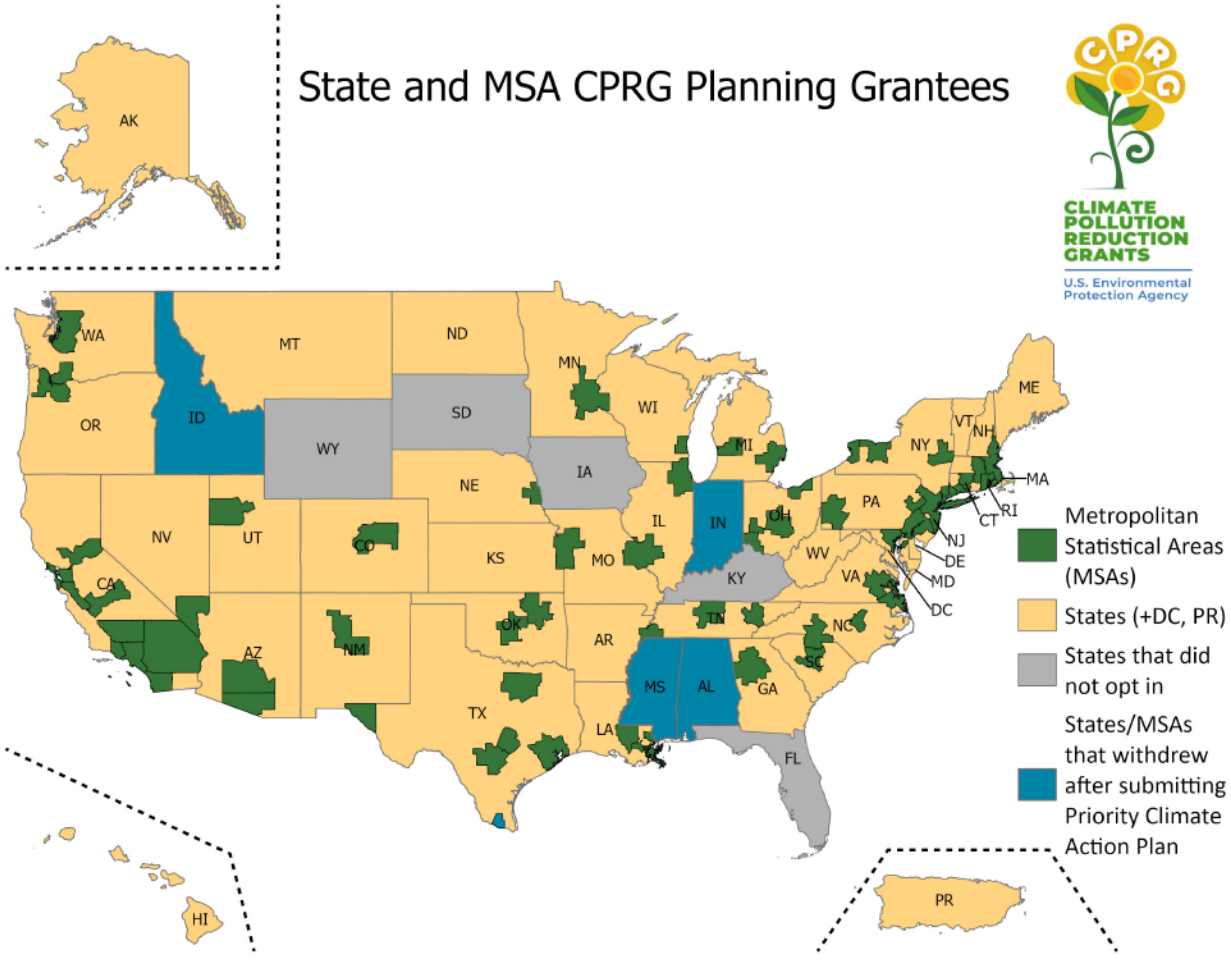
10 5th National U.S. Climate Assessment (2023). Accessible via https://nca5.climate.us/

11 South Carolina Office of Resilience (2023). Accessible via https://scor.sc.gov/resilience

CMCOG collaborated with others, including experts at the Sustainability Solutions Group (SSG), regional universities, state agencies, and non-profits. We also learned from others in our community, which we describe under Community Engagement (Chapter 2) below.

This plan has been developed with funding provided by the U.S. Environmental Protection Agency (EPA) under the Climate Pollution Reduction Grant (CPRG) Program. The CPRG program under the Inflation Reduction Act of 2022 helped states and major metropolitan areas across the country work on climate planning (see Figure 1.1). CMCOG had the opportunity to engage with some of these local and state governments during the planning process.

Figure 1.1.
Areas developing climate action plans under the EPA's Climate Pollution Reduction Grant program.[12]



12 Figure provided by, and copyright of, the U.S. EPA.

Our climate planning has been ongoing for two years. CMCOG wrote an early version of this plan which highlighted actions that should be initiated as soon as possible; this was our priority climate action plan, which was published in March 2024 and is available via the project archive at the Open Science Framework (DOI: *10.17605/OSF.IO/VZEPC*).

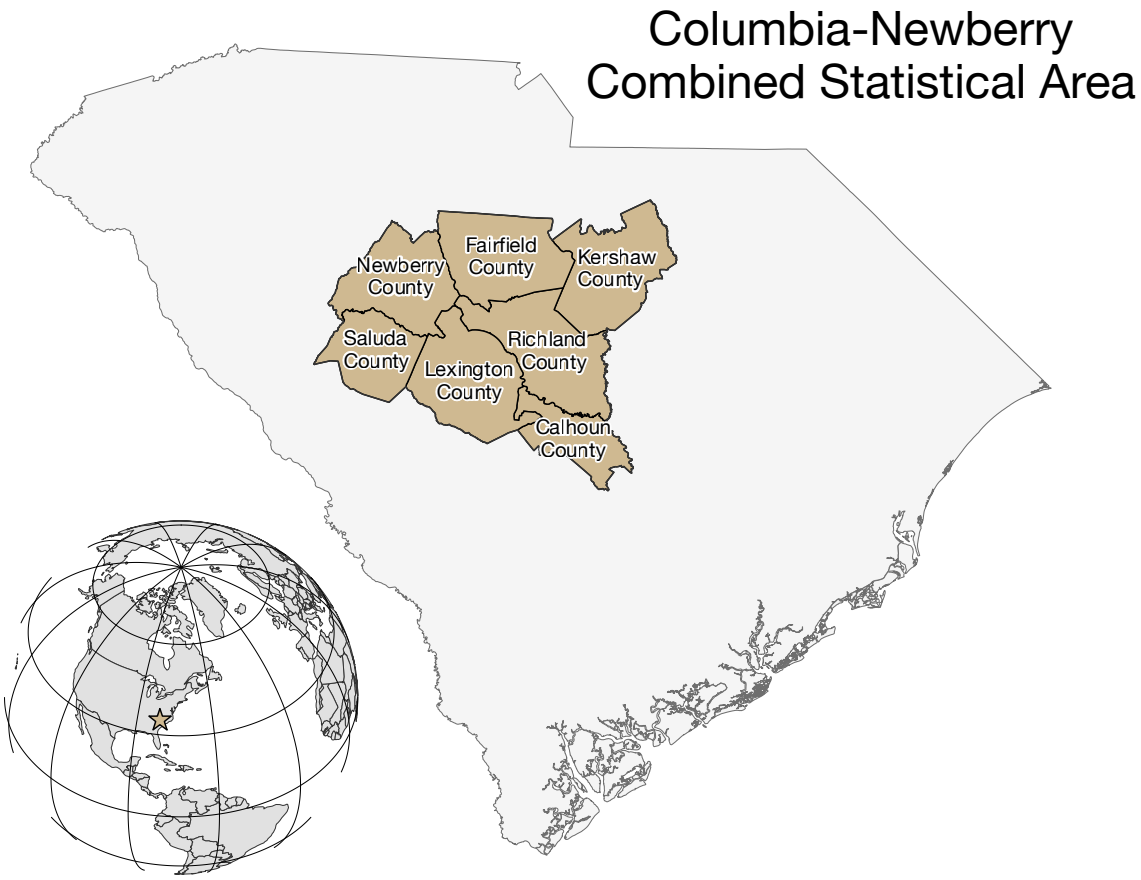
This document is a comprehensive climate action plan for our area, meaning it provides a complete picture of the climate actions required to address all of our emissions, both in the short and longer term. Climate action planning is a process that must be continuously revisited and improved. Climate action should not stop until all greenhouse gas emissions are eliminated, communities are more resilient, with renewable energy sources, and more sustainable behaviors, land use, and urban planning embedded in their daily lives and government structures. In this final state, our community will be able to more effectively and equitably respond to environmental change. This plan should continue to be updated with new ideas and new data in the future.

One of the best ways to move forward or to have your questions answered is to contact us. CMCOG has staff experts, and other areas of local technical assistance include university faculty, local government staff, business experts in related areas, and non-profit community groups. If our scientists and environmental planners cannot answer your question, we may be able to connect you with other experts in the community. You can find the planning department's staff contact information on CMCOG's website (*https://centralmidlands.org*).

1.3 The Geography of the Midlands

This plan is focused on the Midlands, or specifically the Columbia Metropolitan Statistical Area and the Newberry Micropolitan Statistical Area. This area covers the seven counties of Richland, Lexington, Kershaw, Newberry, Fairfield, Saluda, and Calhoun (see Figure 1.2). This area is referred to as the Midlands.

Figure 1.2.
The seven counties included in this climate plan.



The land area of the Midlands is 4,480 square miles (11,605 square kilometers). As of 2022 there are 869,831 people living in the Midlands according to the Census Bureau (16.9% of the state's population), representing 343,776 households with a median household income of $57,184.[13] In 2022 the combined Gross Domestic Product of the Midlands was $55.8 billion according to the U.S. Bureau of Economic Analysis.[14] The Midlands is growing both economically and in number of residents; in the last decade the population grew by 7.7%. Additional socio-economic details are shown below in Table 1.1.

13 U.S. Census Bureau (2024). American Community Survey, 5-year estimates for 2022. https://data.census.gov

14 U.S. Bureau of Economic Analysis (2022). Gross Domestic Product, county-level estimates for 2022. https://www.bea.gov/data/gdp/gdp-county-metro-and-other-areas

Table 1.1.
Selected socio-economic characteristics, by county. All data represent the year 2022 from the U.S. Census Bureau American Community Survey 5-year estimates.

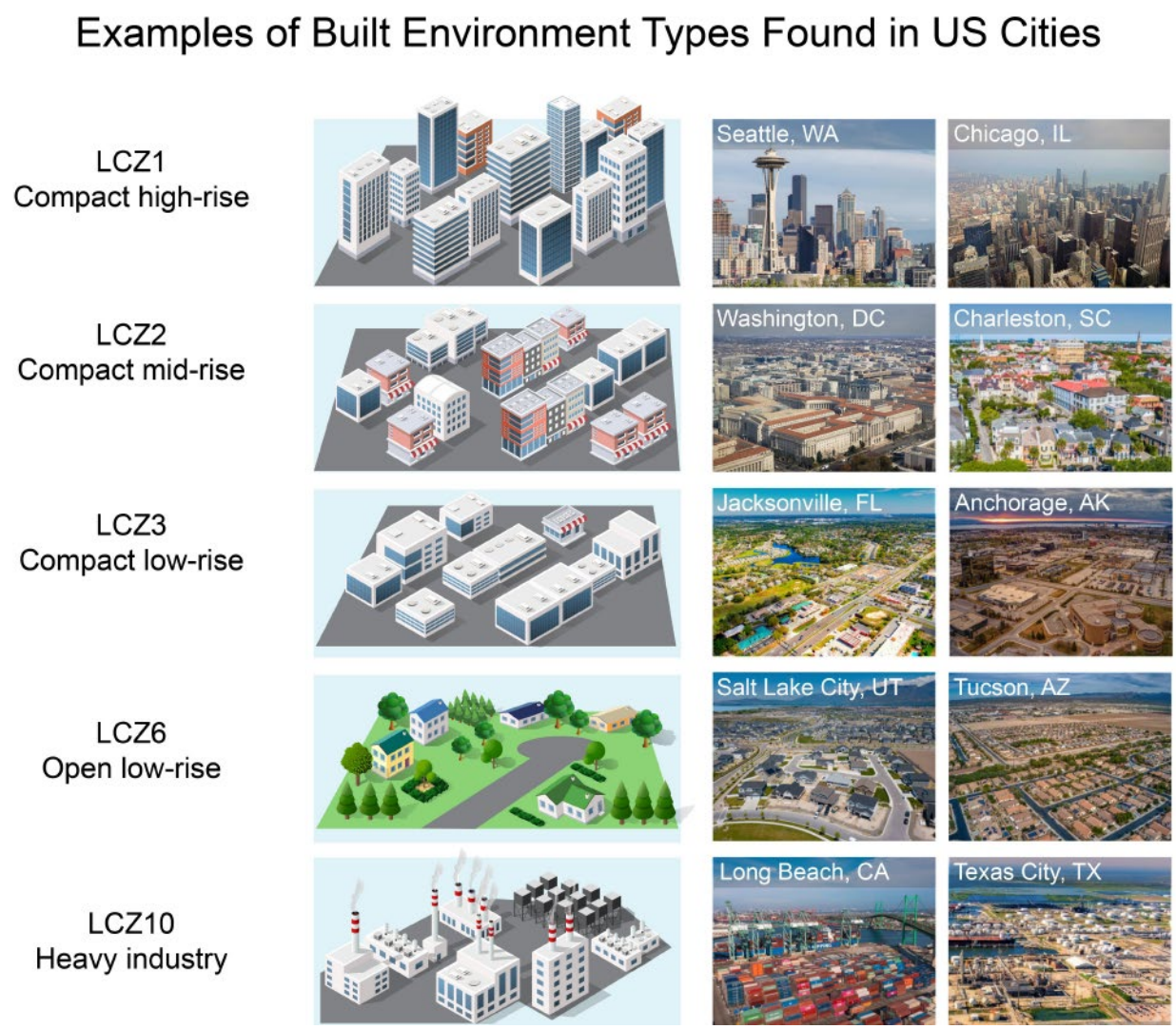
County	Minority Population (%)	Education: at least a high school diploma (%)	Education: at least a bachelor's degree (%)	Unemployment Rate (%)	Population Below the Poverty Line (%)
Richland	57.6	92.2	40.2	6.8	16.8
Lexington	25.0	91.3	32.6	4.4	11.6
Kershaw	31.3	88.9	21.3	4.7	14.4
Newberry	38.3	85.5	22.5	3.9	15.5
Fairfield	61.4	84.1	14.7	6.9	18.7
Saluda	39.1	83.2	19.2	3.3	17.9
Calhoun	44.2	86.5	19.1	7.3	18.7

Columbia is the largest of many municipalities within this area. According to the land-use classifications of local climate zones used in the National Climate Assessment (see Figure 1.3). Urban areas of the Midlands are most commonly open low-rise built environments, with some exceptions including downtowns of some larger Midlands municipalities.[15]

15 Stewart, I.D. and Oke, T.R. (2012). Local climate zones for urban temperature studies. Bulletin of the American Meterological Society, 93. https://doi.org/10.1175/BAMS-D-11-00019.1 The Midlands LCZ data is available at https://lcz-generator.rub.de/factsheets/e226fe5f85a118c48b9f020108a87e147a17752c/e226fe5f85a118c48b9f020108a87e147a17752c_factsheet.html

Figure 1.3.

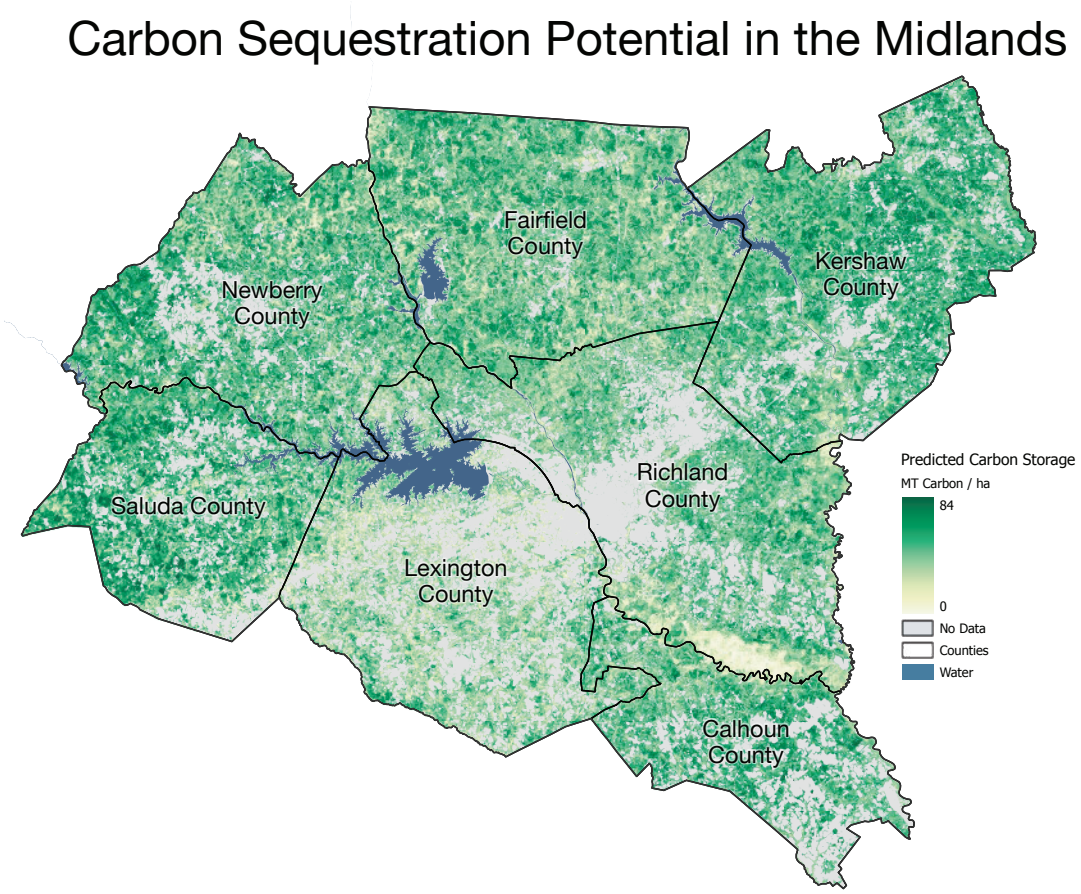
Left - Illustrative land-use classifications of local climate zones (LCZs).[16]



16 Figure copied from, and copyright of, the U.S. Global Change Research Program. USGCRP, 2023: Fifth National Climate Assessment. Crimmins, A.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, B.C. Stewart, and T.K. Maycock, Eds. U.S. Global Change Research Program, Washington, DC, USA. *https://doi.org/10.7930/NCA5.2023*

Developed land currently covers about 15% of the region, and the Midlands is rapidly developing. The Midlands currently still has a large amount of open land and rural areas that are not developed, with about 56% forest cover, 19.7% grassland (which includes hay\pasture, shrub\scrub, and other herbaceous cover), 5.1% cropland, and 3.5% wetland.[17] Forests and green spaces are a treasured part of the local landscape and temporarily store carbon. The map below shows how much carbon these lands will store up in the next few decades if they remain part of our landscape (see Figure 1.4).

Figure 1.4.
The amount of carbon (metric tons of carbon per hectare) that are predicted to be stored by forests between 2020 and 2050 in the Midlands, if they remain standing and are not cut down or converted to other land use types.[18]

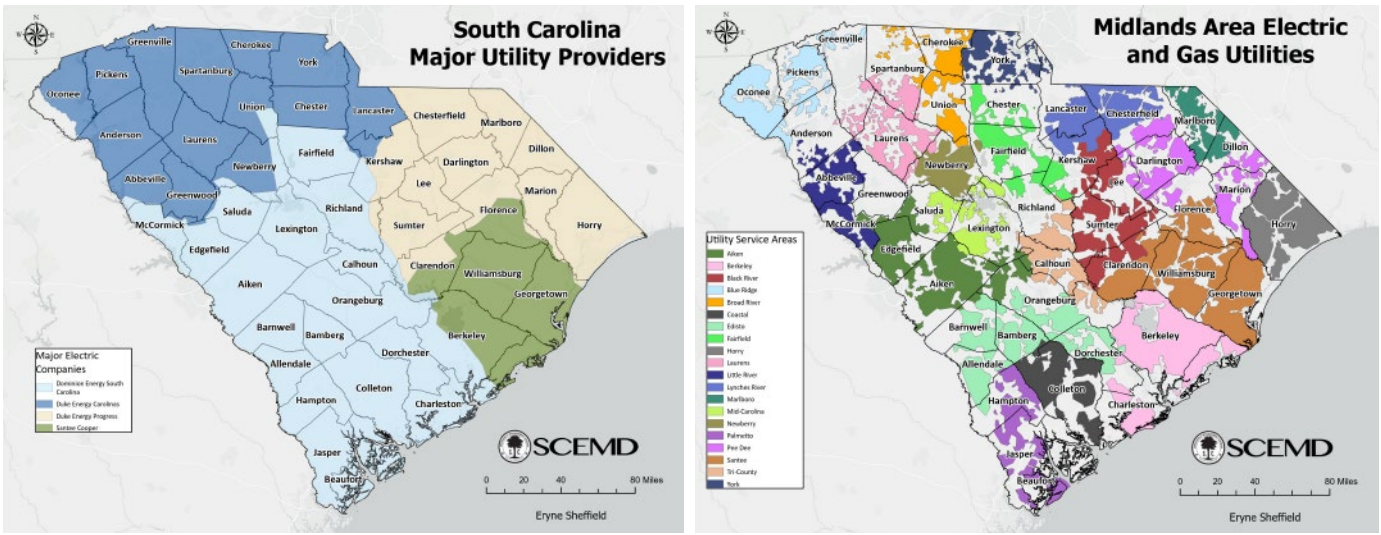


17 ICLEI – Local Governments for Sustainability USA (2025). Land Emissions and Removals Navigator. Tools and Technical Services. https://icleiusa.org/learn-tool/. Note that the forest cover reported here is 3% higher than the dataset used to evaluate living landscapes in Section 3.3 due to differences in the cell size of the raster datasets used.

18 Hasler & Williams (2025). National Forest Carbon Monitoring System (NFCMS) version 3.0 - Carbon stocks and potential sequestration over conterminous U.S. forests. *https://doi.org/10.2737/RDS-2025-0019*. Special thanks to the staff scientist at The Nature Conservancy for providing technical guidance on this dataset and CMCOG's spatial analysis methodology.

Another feature of the Midlands built environment relevant for regional climate planning is energy utility service territories. Energy utilities in the Midlands are regulated by the South Carolina Public Service Commission and given a defined territory.[19] This means that each building/address does not have a choice about which utility to purchase energy from, which has various resulting considerations for local climate action.[20] In the Midlands, most people and businesses are served by investor-owned monopoly utilities (see Figure 1.5 - left) while some are served by rural electric cooperatives (see Figure 1.5 - right). There are also four Midlands municipal governments (Town of Prosperity, City of Camden, City of Newberry, and Town of Winnsboro) that provide electricity to residents within their boundaries, which are referred to as "municipal utilities".

Figure 1.5.
Left - Major utilities in South Carolina. Right - Electric cooperatives in South Carolina. Both maps were created by the SC Emergency Management Division, responding to a CMCOG request.



19 Energy utilities provide electricity and/or natural gas to customers. Defined utility territories are set for the entire state.

20 For further discussion, see Harrison, C., & Welton, S. (2023). "Why Change?" Monopoly and Competition in the Southeastern US Electricity System. Annals of the American Association of Geographers, 113(6), 1402-1418. https://doi.org/10.1080/24694452.2023.2185198

Table 1.2 summarizes information about these types of utilities in the Midlands. Note that these geographies are also fluid to some extent. For example, cooperatives and municipal utilities may generate electricity but typically buy a large percentage (or even all) of their electricity from one of the larger utilities.[21] Utilities in South Carolina do not necessarily charge the same price for energy or even charge for energy in the same way, and some offer differential pricing/rates to different customers (resulting implications for driving inequality are discussed in Chapter 3).

Table 1.2.
Midlands energy utility summary characteristics.

Utility Type	Number of Utilities	Percentage of Midlands Customers Served*[22]	Governance
Private	3*[23]	69%	Privately owned businesses with variable governance structures, and accountable to investor-owners via public stock exchanges. Use of profit is variable, with the two main uses usually reinvestment into the business or dividends to investors.
Cooperatives	9	29%	Owned by its customers and operated by professional staff. Each coop's board decides how profits are invested or distributed.

21 Including from utilities outside the Midlands, like Santee Cooper.

22 The SC Emergency Management Division provided data for the number of customers for private utilities and for cooperatives, but did not differentiate between customer types (residents, businesses, etc.). Duke Energy Carolinas and Duke Energy Progress are not treated as different utilities in the data. The dataset did not contain the number of customers for municipal utilities and did not contain all four municipal utilities in the Midlands, so CMCOG estimated their customers by using the number of households in each municipality, as defined by the U.S. Census Bureau 2024 American Community Survey Data. Thus, municipal utilities will be underestimated compared to private utilities and coops because this method does not estimate non-residential customers.

23 Duke Energy Carolinas and Duke Energy Progress have distinct service territories, but are part of the larger Duke Energy System and thus may be better considered as one utility depending on the question being asked. For example, the SC Emergency Management Utility does not differentiate between these two business units of Duke Energy in the data provided to CMCOG.

Utility Type	Number of Utilities	Percentage of Midlands Customers Served*[22]	Governance
Municipal	4	2%	Owned and operated by the local municipality. How profits are used varies, but municipalities are ultimately governed by elected officials.

1.4 Climate Change in the Midlands

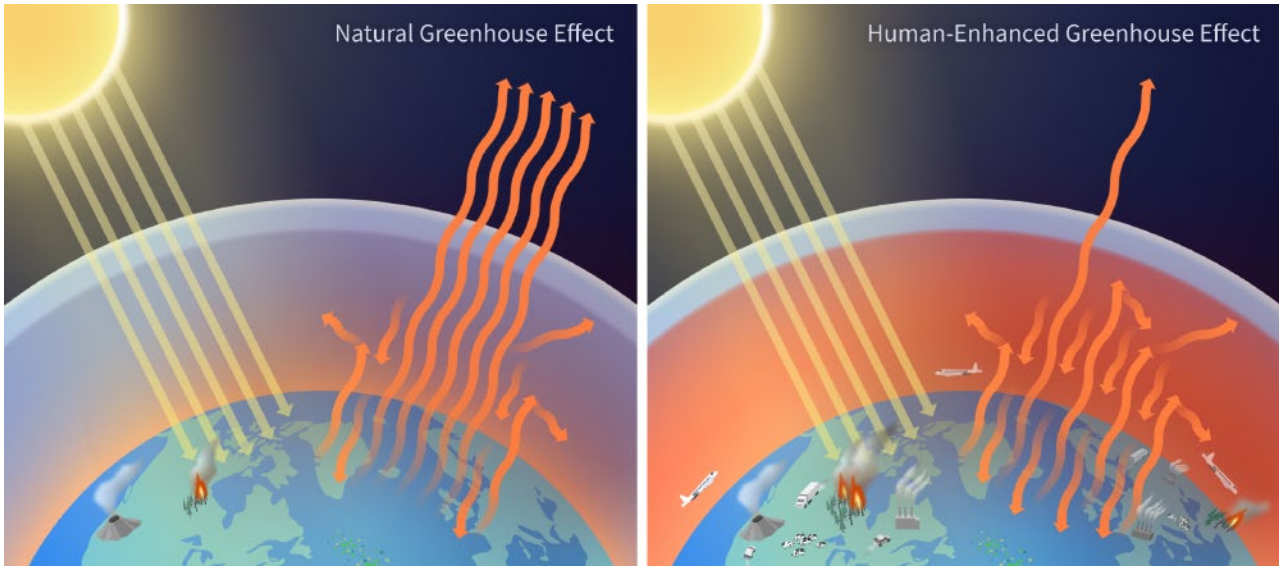
Why is the climate changing?

Climate change is an air pollution problem, caused by the economic activities of people that release greenhouse gases[24] into the atmosphere. The atmospheric physics behind the greenhouse effect were quantified by the early 1900s, and it is an established scientific fact that human emissions of greenhouse gases cause global warming. The physics of global warming can be summarized with the analogy of a blanket (see Figure 1.6). Each greenhouse gas, while it is in the atmosphere, makes the blanket thicker, holds in solar energy, and makes our atmosphere warmer. The greenhouse gas effect is a natural part of our planet's geophysics. Without it, Earth would be very cold. However, greenhouse gases being released by human activities in large amounts cause global warming by reducing the rate of energy lost from the atmosphere to space.

24 These gases occur naturally as part of the carbon cycle, but when humans release additional greenhouse gases into the atmosphere as a result of our economic activities, they become an air pollutant. Greenhouse gases that humans emit that cause climate change are carbon dioxide, methane, nitrous oxide, and fluorinated gases.

Figure 1.6.

Human-produced greenhouse gases have intensified Earth's natural greenhouse effect by changing the balance between the amount of sunlight that reaches the surface and the amount of heat that escapes the atmosphere.[25]



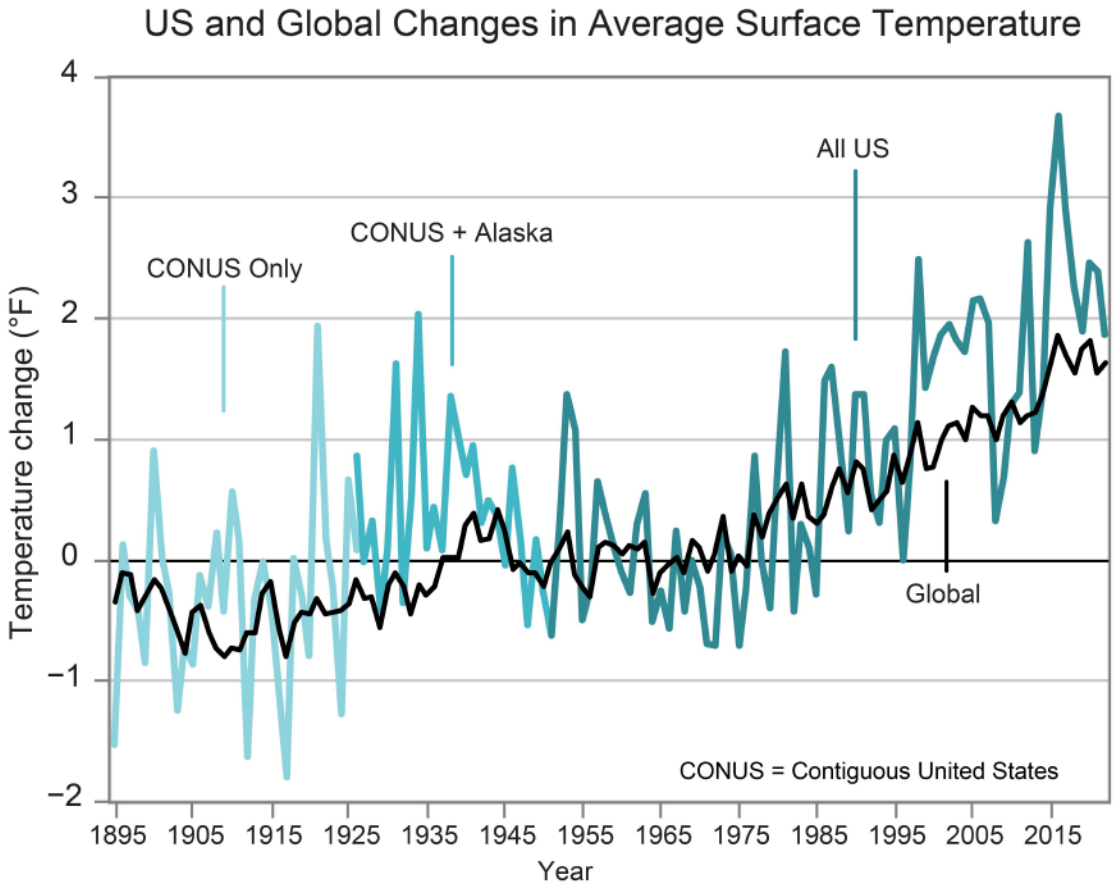
What are climate impacts? How is the Midlands affected by climate change?

The Earth's climate has changed over many millions of years, including the levels of greenhouse gases in the atmosphere and the average global temperature. However, our current climate is changing at a scale and speed not seen for thousands of years because of our economic activities, especially the burning of fossil fuels (see Figure 1.7). This graph shows temperature for the last 100 years. Temperatures around the planet have been observed with thermometers for several hundred years. Scientists have reconstructed prior temperatures using a variety of methods. The average annual temperature in Columbia, South Carolina has risen by approximately 3 degrees Fahrenheit since 1970.[26]

25 Figure copied from, and copyright of, NOAA Climate Program Office, Graphic by Anna Eshelman. *https://www.climate.gov/media/16408*

26 Climate Central (2025). Earth Day: Fastest-Warming U.S. Cities and States. https://www.climatecentral.org/climate-matters/earth-day-fastest-warming-us-cities-and-states

Figure 1.7.
Earth's atmosphere responds to rising levels of greenhouse gases by warming.[27]



Changing seasons or long-term averages impact people (e.g. needing to use more energy to cool a building, or changes the yield of crops). Climate change also contributes to extreme weather or damaging events that harm people or nature. These are sometimes called "climate impacts" and they are made either more frequent or more severe by climate change (or both. See Figure 1.8). According to the National Centers for Environmental Information, there have been over 50 "billion-dollar events" affecting South Carolina just since 2010, most of which impacted Midlands communities to some degree.[28]

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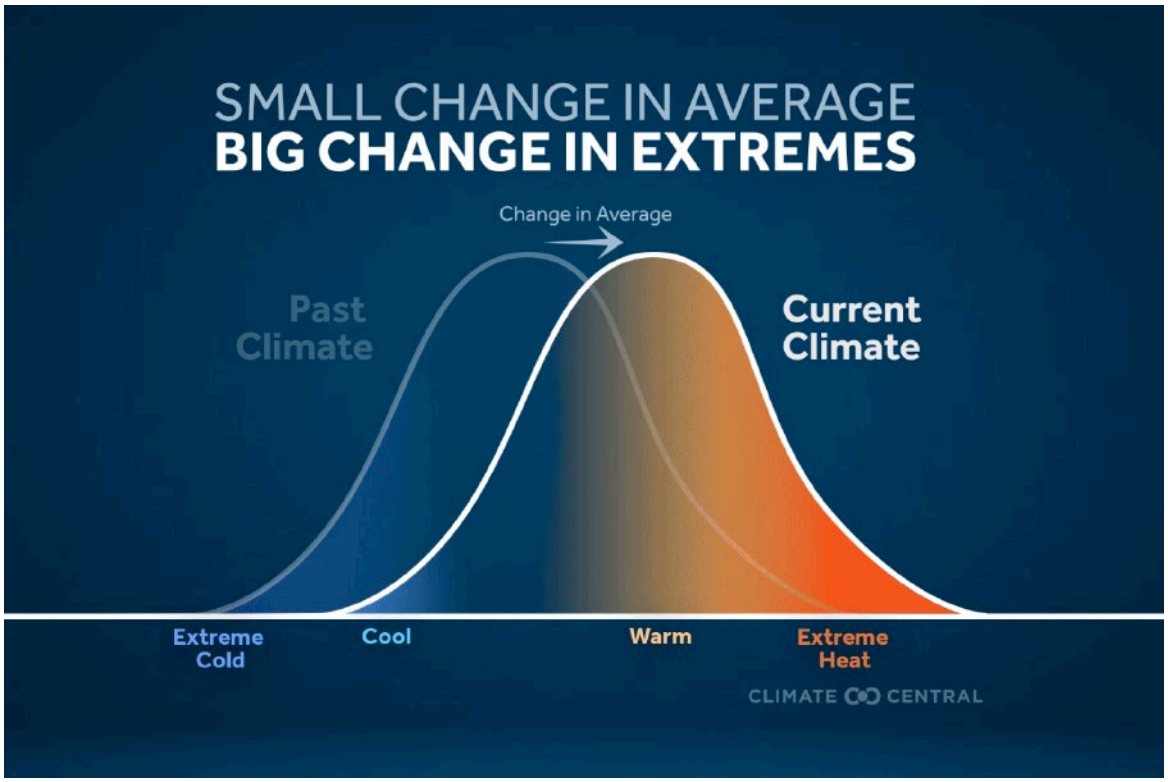
27 Figure copied from, and copyright of, the U.S. Global Change Research Program. USGCRP, 2023: Fifth National Climate Assessment. Crimmins, A.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, B.C. Stewart, and T.K. Maycock, Eds. U.S. Global Change Research Program, Washington, DC, USA. *https://doi.org/10.7930/NCA5.2023*, see also Intergovernmental Panel on Climate Change, 6th Assessment Report, Working Group I for more information..

28 NOAA National Centers for Environmental Information (NCEI) U.S. Billion-Dollar Weather and Climate Disasters (2025). https://www.ncei.noaa.gov/access/billions/, DOI: *10.25921/stkw-7w73*

Figure 1.8.
A visual depiction of how global warming affects more than just a change in average global temperature.[29]



29 Image source - Climate Central. https://www.climatecentral.org/climate-matters/climate-change-key-facts

In the Midlands, we are already experiencing many climate impacts and they are predicted to get worse without collective action. The key climate impacts we are already facing include:

Extreme Heat

Extreme heat and heatwaves are already affecting the Midlands in various ways, including:

1) Gradually increasing temperatures impact Midlands residents too. For example, over the past 50 years the number of warm or hot days in a year has increased each decade and contributed to rising utility bills.[30] Energy used for cooling homes has already risen by over 20% over the past 50 years,[31] and is expected to rise by an additional 10% over the next 30 years in Columbia.[32]

2) Extreme heat has already increased in the Midlands, with an additional 14 days that threaten public health today compared to 50 years ago.[33] Most areas in the Midlands are expected to experience a further increase of 9 more days per year where the high temperature exceeds 98 degrees Fahrenheit (see Figure 1.9). Extreme heat harms public health and places stress on physical infrastructure in the community like the electricity grid.

30 The number of cooling degree days has increased by about 90 per decade. NOAA National Centers for Environmental information, Climate at a Glance: County Time Series, published September 2025, retrieved on November 14, 2025 from https://www.ncei.noaa.gov/access/monitoring/climate-at-a-glance/county/time-series

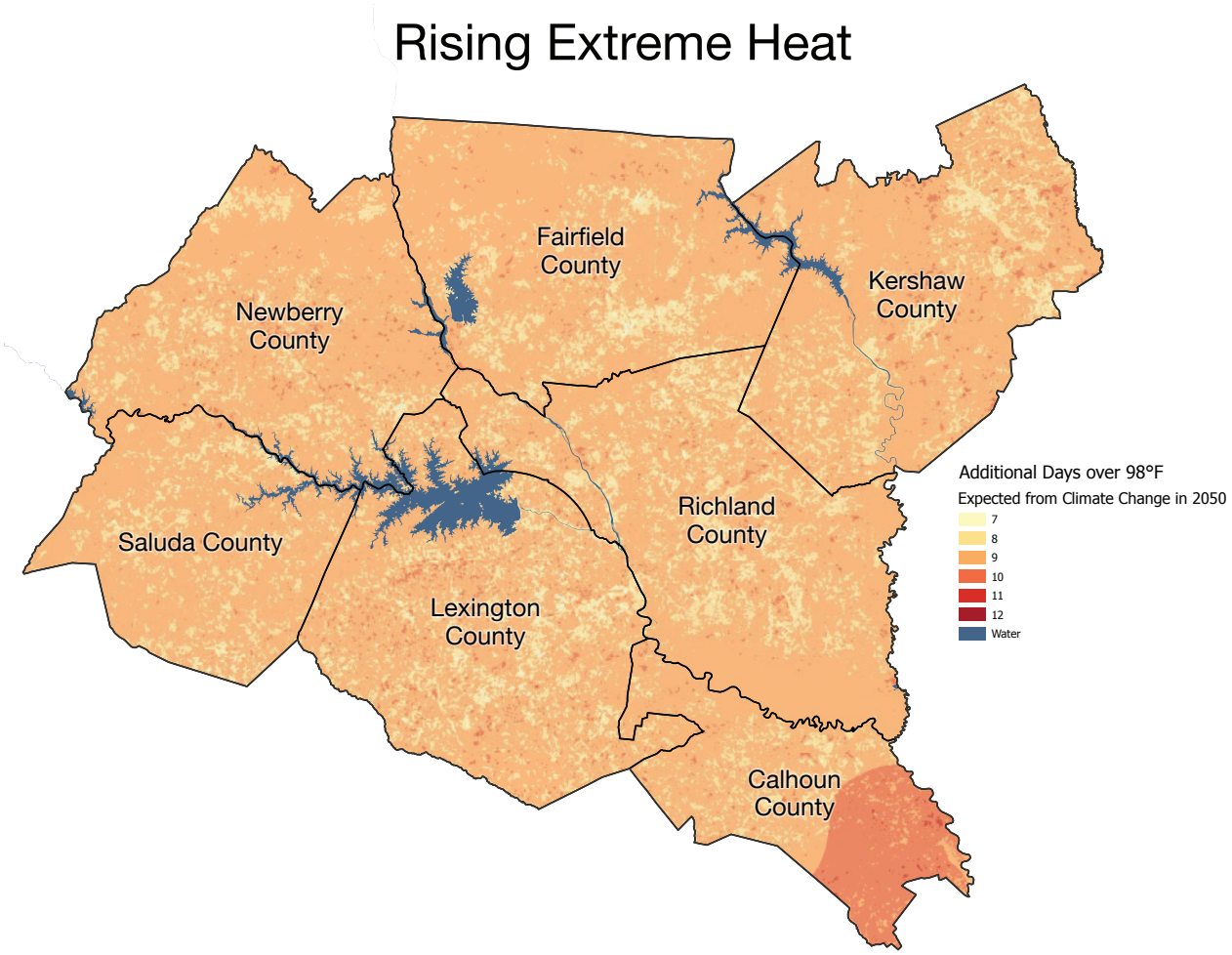
31 Climate Central (2024) Cooling Schools in a Hotter Climate. https://www.climatecentral.org/climate-matters/hotter-climate-higher-cooling-demand-2023.

32 Analysis conducted by CMCOG, via First Street Foundation property level climate model ensemble. Data provided through a license and access agreement with the South Carolina Office of Resilience.

33 Climate Central (2024). Rising Heat Risks for Workers. https://www.climatecentral.org/climate-matters/rising-heat-risks-for-workers

Figure 1.9.

The number of additional extreme heat days in 2050 (compared to today) that exceed 98 degrees Fahrenheit.[34]



34 Analysis conducted by CMCOG, via First Street Foundation climate model ensemble. Data provided through a license and access agreement with the South Carolina Office of Resilience. This threshold would be considered a day where risk for heat illness would be elevated, especially for outdoor workers and those without easy access to air conditioning.

Flooding

Climate change makes flooding more likely and worse. In the past decade, our community has experienced multiple 1-in-100 year floods.[35] The major flood event in October 2015 was particularly harmful, where some areas in the Midlands exceeded 20 inches of rainfall in one week.[36] The 2015 flood event killed several people, damaged many homes and businesses, and almost knocked out the City of Columbia's water utility network servicing the downtown area threatening hospitals and other major institutions. The damage done to the drinking water system is still not fully repaired. This event was memorialized by the community in different ways on its 10th anniversary in 2025 (see Figure 1.10).

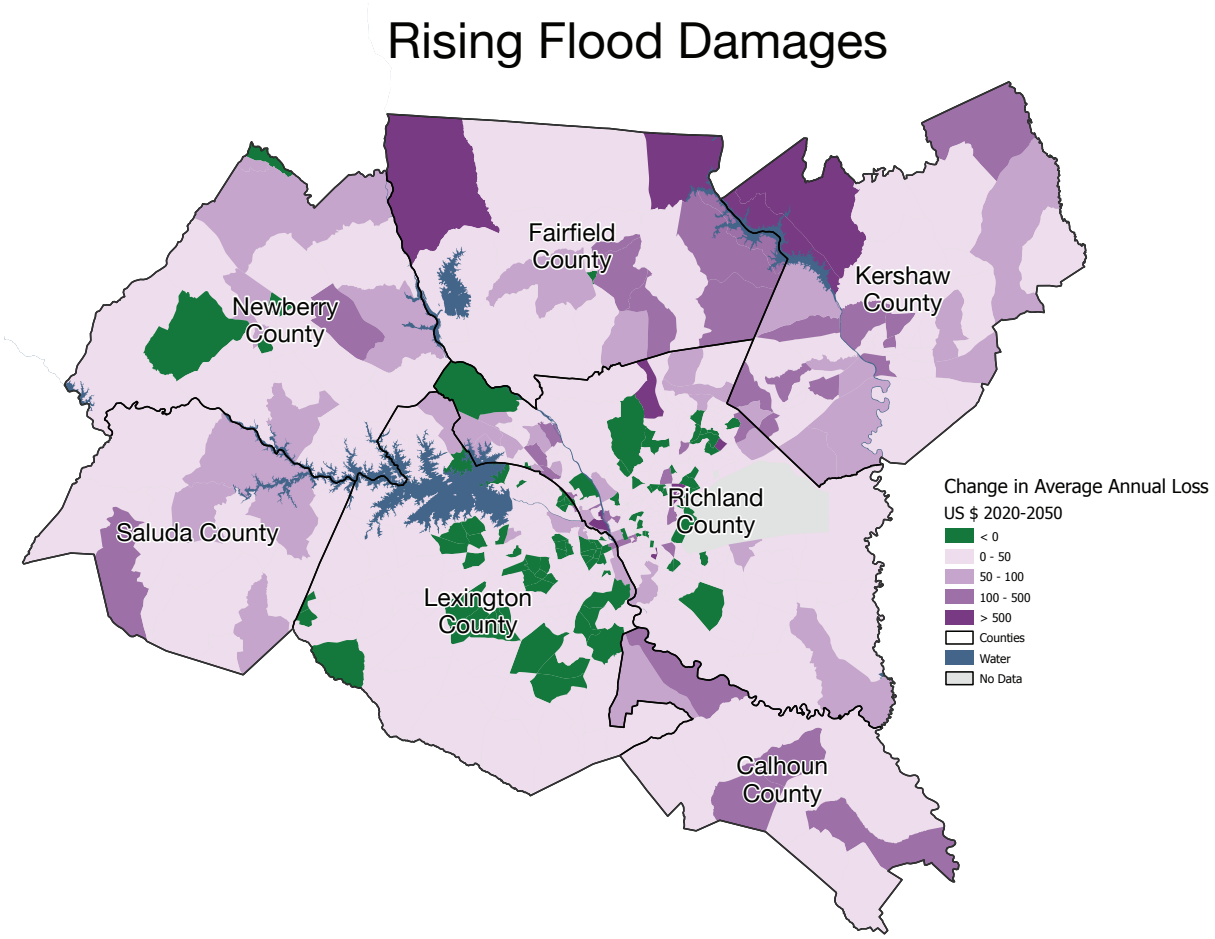
Figure 1.10.
The front page of the weekly newspaper freetimes in early October, 2025.

35 A 1-in-100 year event means that in any future year, the probability it will occur in that year is 1%.

36 South Carolina Office of Resilience (2023). Strategic Statewide Resilience and Risk Reduction Plan. https://scor.sc.gov/resilience

Models project an 11.7% cumulative probability of at least a 12 inch flood occurring within the next 30 years[37], with increases in economic losses from floods predicted to exceed $2 million[38] a year by 2050 (see Figure 1.11). The map compares the damages expected from flooding in 2050 vs. the typical damages from flooding in recent years, and shows the difference between the two. It shows damages are expected to rise in most parts of the Midlands, but not all. In areas with projected decreases, there would still be damages anticipated.

Figure 1.11.
The change in average economic damages from flooding in different parts of the Midlands.[39]



37 Analysis conducted by CMCOG, via First Street Foundation climate model ensemble. Data provided through a license and access agreement with the South Carolina Office of Resilience.

38 Wing, O.E.J., Lehman, W., Bates, P.D. et al. Inequitable patterns of US flood risk in the Anthropocene. Nat. Clim. Chang. 12, 156–162 (2022). https://doi.org/10.1038/s41558-021-01265-6

39 Analysis conducted by CMCOG, via First Street Foundation climate model ensemble. Data provided through a license and access agreement with the South Carolina Office of Resilience.

Hurricanes and Major Storms

Many factors are involved in the formation of hurricanes, but once a tropical storm begins, abnormally warm ocean temperatures provide fuel and make them much stronger than they would have been without global warming.[40] Hurricane Helene is a good example,[41] with bathtub-like ocean waters contributing to its rapid intensification (see Figure 1.12). In addition to hurricane intensification, climate change is also changing the way we experience other high precipitation events (sometimes called extreme precipitation events), which can cause damage to buildings and infrastructure, as well as contribute to flash floods.[42]

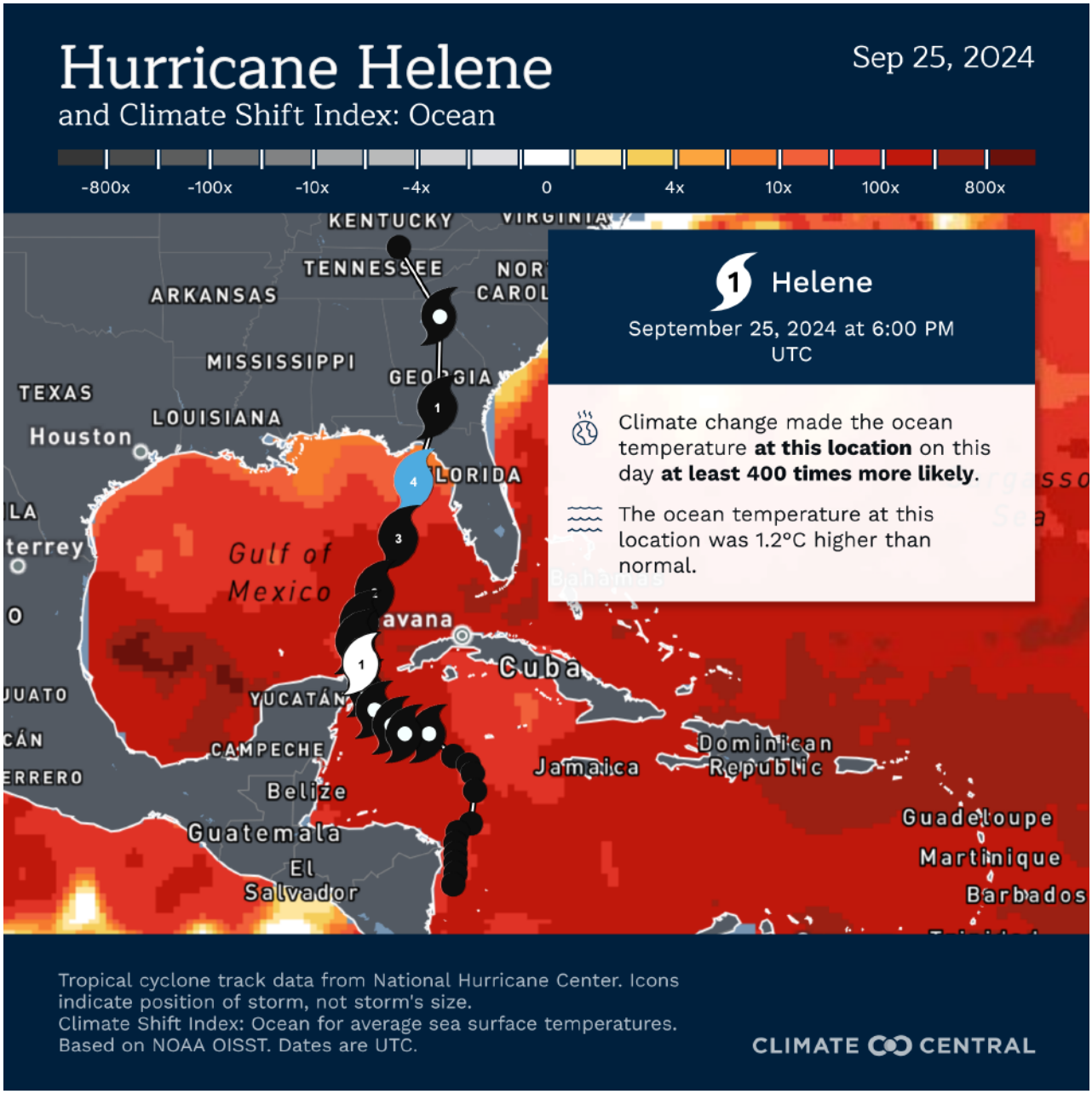
40 Tandon, A. (2024). Explainer: How hotter oceans can fuel more intense Atlantic Hurricanes. CarbonBrief. https://www.carbonbrief.org/explainer-how-hotter-oceans-can-fuel-more-intense-atlantic-hurricanes/ and Climate Signals (2025). Hurricanes. https://www.climatesignals.org/pillars/climate-change-hurricanes

41 See Climate Central (2025). Climate change amplifying ocean heat along the projected path of Potential Tropical Cyclone Nine [Hurricane Helene]. https://www.climatecentral.org/climate-shift-index-alert/helene-september-2024 and Clarke, B. et al. (2024). Climate change key driver of catastrophic impacts of Hurricane Helene that devastated both coastal and inland communities. Imperial College London - Centre for Environmental Policy. *https://doi.org/10.25561/115024*. For an interactive story, see Bhatia, A. et al. (2023). 'A Beautiful Place That Has a Dragon': Where Hurricane Risk Meets Booming Growth. The New York Times. https://www.nytimes.com/interactive/2023/11/19/upshot/carolina-hurricanes.html

42 U.S. Global Change Research Program. USGCRP, 2023: Fifth National Climate Assessment. Crimmins, A.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, B.C. Stewart, and T.K. Maycock, Eds. U.S. Global Change Research Program, Washington, DC, USA. *https://doi.org/10.7930/NCA5.2023*. For a visual story, see Noll, B. et al. (2025). Deadly Rivers in the Sky: A Washington Post investigation shows where climate forces are fueling more dangerous floods. The Washington Post. https://www.washingtonpost.com/weather/interactive/2025/deadly-flooding-moisture-hotspots-maps/

Figure 1.12.

During Hurricane Helene, climate change made hot ocean temperatures at least 400 times more likely in some locations. The box shows the time when the storm transitioned from tropical storm to hurricane intensity.[43]



43 Climate Central (2025). Ocean Shift Index - Hurricane Helene. https://csi.climatecentral.org/ocean

Understanding Harm to People and Nature

Climate change and climate impacts affect our economy, our health, and nature in the Midlands. These effects are varied, and a full accounting of them are beyond the scope of this plan. However, you can connect to experts at CMCOG or other places in the community to learn more.

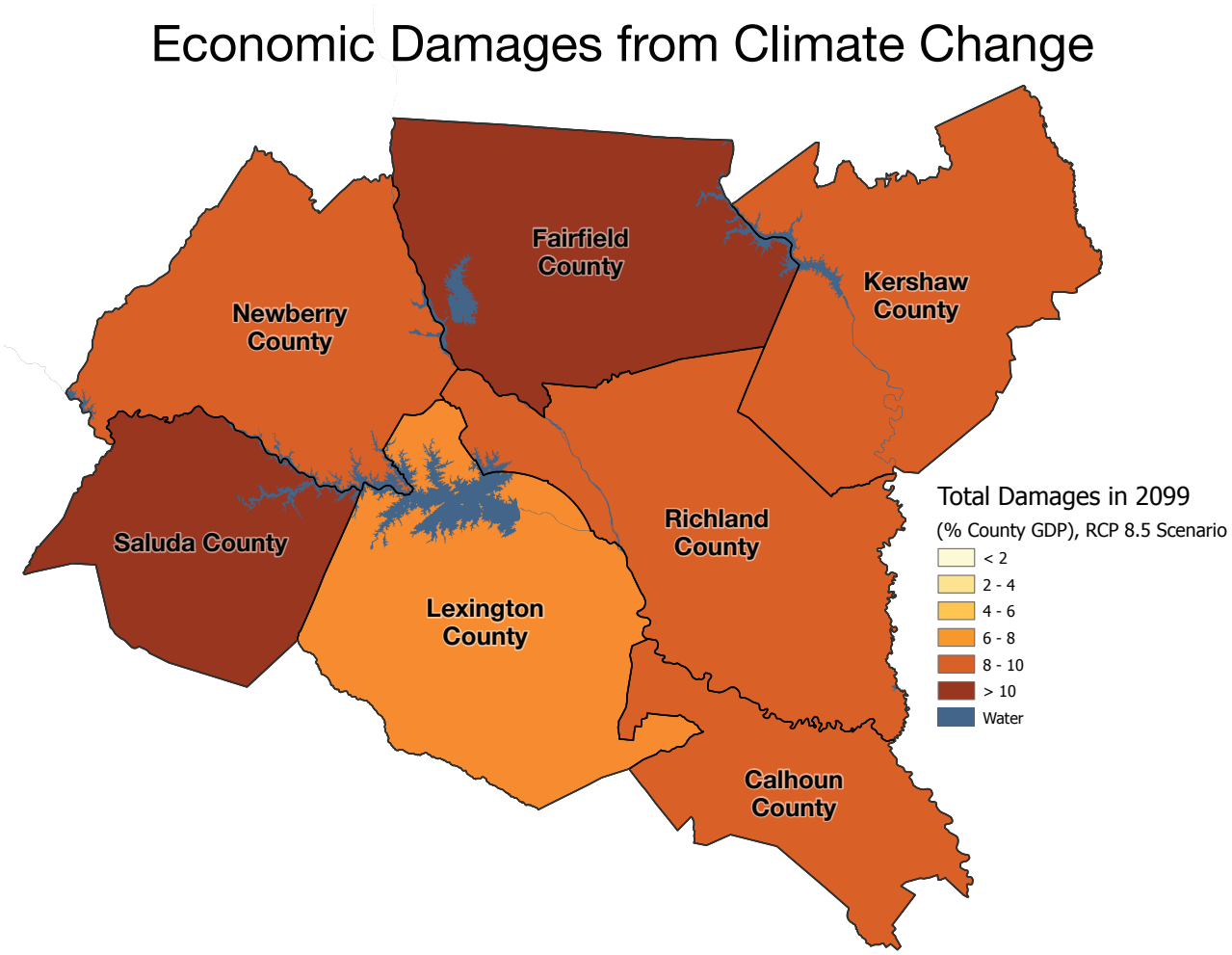
Economic Damage

Severe weather events and other environmental impacts carry economic costs which affect the Midlands. Economists have created forecasts for our area showing that, by the end of century, climate change could cost nearly $1 out of every $10 created in the Midlands (see Figure 1.13), either as a result of lower economic output or having to pay for damages from climate impacts.[44] Economic damages in the map encompass multiple sectors and are expressed as a percentage of total gross domestic product, a measure that aims to encompass the value of all goods and services in a region's economy. However, it is important to remember that climate action also creates opportunities for economic growth. The Midlands is rapidly becoming a hub where businesses are creating products in clean energy or clean transportation that help reduce emissions and lower air pollution (see Chapter 9).

44 Solomon Hsiang et al. Estimating economic damage from climate change in the United States. Science 356, 1362-1369 (2017). DOI:10.1126/science.aal4369

Figure 1.13.

This map shows total economic damages resulting from unmitigated climate change in a high emissions scenario (RCP 8.5) by the end of the century.[45]



While Figure 1.13 shows total economic damages, these translate into many different types of impacts on individuals and businesses.[46]

45 Solomon Hsiang et al. Estimating economic damage from climate change in the United States. Science 356, 1362-1369 (2017). DOI:*10.1126/science.aal4369*

46 Fleming, J. & Windsor, C. (2022). The Role of a Green Bank in South Carolina: A Market & Feasibility Assessment. University of South Carolina. https://scholarcommons.sc.edu/geog_facpub/231/

Examples of these include:

- **Lower business output**. 6 or more days above 90 degrees Fahrenheit decreases production in an average auto-manufacturing plant by 8% that week.[47]
- **Temporary business closures**. Due to climate impacts like flooding, businesses are expected to face an over 50% increase in closure days over the next 30 years.[48]
- **Lost wages and labor productivity declines**. Workers in sectors exposed to extreme heat, such as agriculture and tourism, are expected to lose over $1,500 in annual earnings by 2065.[49]
- **Infrastructure damage**. Statewide, roads, rail, bridges, and watersheds are expected to need billions of dollars in additional investment due to accelerating climate damages.[50]
- **Lost services**. Home insurance, which is required by many banks to obtain a mortgage, is getting more expensive across the country due to rising risk of climate impacts.[51] At least one home insurance provider has begun to withdraw from the Midlands market due in part to climate risk.

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47 Cachon, Gerard P and Gallino, Santiago and Olivares, Marcelo, Severe Weather and Automobile Assembly Productivity (December 14, 2012). Columbia Business School Research Paper No. 12/37, Available at SSRN: https://ssrn.com/abstract=2099798 or http://dx.doi.org/10.2139/ssrn.2099798

48 First Street Foundation. 2021. The 4th National Risk Assessment: Climbing Commercial Closures. https://firststreet.org/

49 Dahl, Kristina, Rachel Licker. 2021. Too Hot to Work: Assessing the Threats Climate Change Poses to Outdoor Workers. Cambridge, MA: Union of Concerned Scientists. *https://doi.org/10.47923/2021.14236*

50 Fleming, J. & Windsor, C. (2022). The Role of a Green Bank in South Carolina: A Market & Feasibility Assessment. University of South Carolina. https://scholarcommons.sc.edu/geog_facpub/231/. For further detail, see Martinich, J., Crimmins, A. Climate damages and adaptation potential across diverse sectors of the United States. Nat. Clim. Chang. 9, 397–404 (2019). *https://doi.org/10.1038/s41558-019-0444-6* ; Neumann, J.E., Chinowsky, P., Helman, J. et al. Climate effects on US infrastructure: the economics of adaptation for rail, roads, and coastal development. Climatic Change 167, 44 (2021). *https://doi.org/10.1007/s10584-021-03179-w* and Sias, J.E., Dave, E.V., Underwood, B.S. et al. Climate change impacts on roadways. Nat Rev Earth Environ 6, 555–573 (2025). *https://doi.org/10.1038/s43017-025-00711-9*.

51 U.S. Senate Budget Committee (2024). Next to Fall: The Climate-Driven Insurance Crisis is Here - And Getting Worse. Staff Report. https://www.budget.senate.gov/imo/media/doc/next_to_fall_the_climate-driven_insurance_crisis_is_here__and_getting_worse.pdf For an interactive story on insurance, see Flavelle, C. et al. (2024). As Insurers Around the U.S. Bleed Cash From Climate Shocks, Homeowners Lose. The New York Times. https://www.nytimes.com/interactive/2024/05/13/climate/insurance-homes-climate-change-weather.html. For an interactive story in coastal areas, see Bhatia, A. et al. (2023). 'A Beautiful Place That Has a Dragon': Where Hurricane Risk Meets Booming Growth. The New York Times. https://www.nytimes.com/interactive/2023/11/19/upshot/carolina-hurricanes.html

Public Health

Climate change is also a public health issue. Rising temperatures, extreme weather events, and air pollution create pathways for new diseases to create and worsen existing health conditions. Health impacts from climate change are not felt equally by all members of our community (see Chapters 3 and 7).

Climate actions, in addition to reducing greenhouse gas pollutants, in some cases also reduce other air pollutants that directly harm people. These are called criteria air pollutants and hazardous air pollutants. One example is the exhaust that comes out of gasoline or diesel vehicle tailpipes, which includes a mixture of greenhouse gases and criteria air pollutants. If a climate action in this plan also reduces these criteria or hazardous air pollutants, it is mentioned alongside the greenhouse gas reductions. However, all climate action may improve public health by addressing the broader issues mentioned here.

Key areas of concern include:

- **Heat Health:** Extreme heat is the largest weather and climate related killer in the United States.[52] Rising temperatures affects mortality[53] and can damage our bodies or worsen certain medical conditions (see Figure 1.14).[54] Heatwaves place stress on public health infrastructure like hospitals.[55] The number of heat-related deaths are rising, and the most at risk are seniors, children, and

52 National Weather Service (2025). Heat Safety Tips and Resources. https://www.weather.gov/safety/heat

53 Curriero FC, Heiner KS, Samet JM, Zeger SL, Strug L, Patz JA. Temperature and mortality in 11 cities of the eastern United States. Am J Epidemiol. 2002 Jan 1;155(1):80-7. doi: 10.1093/aje/155.1.80. PMID: 11772788. ||| Khatana SAM, Werner RM, Groeneveld PW. Association of Extreme Heat With All-Cause Mortality in the Contiguous US, 2008-2017. JAMA Netw Open. 2022;5(5):e2212957. doi:10.1001/jamanetworkopen.2022.12957

54 USGCRP, 2023: Fifth National Climate Assessment. Crimmins, A.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, B.C. Stewart, and T.K. Maycock, Eds. U.S. Global Change Research Program, Washington, DC, USA. *https://doi.org/10.7930/NCA5.2023*

55 For example, this paper discusses how a combined heatwave and utility grid blackout could quickly overwhelm the capacity of most cities' hospital systems to treat heat illness. Stone B Jr, Gronlund CJ, Mallen E, Hondula D, O'Neill MS, Rajput M, Grijalva S, Lanza K, Harlan S, Larsen L, Augenbroe G, Krayenhoff ES, Broadbent A, Georgescu M. How Blackouts during Heat Waves Amplify Mortality and Morbidity Risk. Environ Sci Technol. 2023 Jun 6;57(22):8245-8255. doi: 10.1021/acs.est.2c09588. Epub 2023 May 23. PMID: 37219950; PMCID: PMC10249403.

those with pre-existing conditions.[56] In the Midlands, extreme heat is a serious concern because our heat index values can often exceed 100 degrees Fahrenheit.

  - **Urban Heat Islands:** Certain urban areas in the Midlands can be up to 17 degrees Fahrenheit hotter than others at the exact same time, according to a heat mapping study conducted in 2022.[57] CMCOG and other community partners assisted the USC Department of Geography with an updated heat mapping study in 2025 (results forthcoming).

  - **Heat Inequity:** Heat does not affect everyone equally. Outdoor workers are especially at risk for heat stress or heat stroke, as physical labor exacerbates the health effects of heat. Indoor factories, businesses and homes should not exceed a temperature of 82 degrees Fahrenheit in order to avoid heat illness.[58]

- **Extreme Weather Events**

  - **Flooding:** Besides direct loss of life or other health impacts during or immediately following an extreme weather event, the addition of water into homes and other buildings can spread bacteria and fungal pathogens.[59] Standing water and high humidity can promote the growth of mold, which can harm people's health.

  - **Hurricanes:** Direct impacts can include deaths and strained healthcare systems, while indirect effects like failing infrastructure can persist long after a storm passes. Hurricane Helene (September 2024) became one of the state's deadlier

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56 Romanello, M., Walawender, M., Hsu, S. C., Moskeland, A., Palmeiro-Silva, Y., Scamman, D., ... & Costello, A. (2025). The 2025 report of the Lancet Countdown on health and climate change. *The Lancet*.

57 Capa Strategies (2022). Heat Watch Report - Columbia, South Carolina. Available at *https://cpac.columbiasc.gov/wp-content/uploads/2022/11/Summary-Report_Heat-Watch-Columbia-SC_111122.pdf*. Project data available at CAPA/NIHHIS. 2023. "Heat Watch Columbia SC." OSF. September 8. *osf.io/nqwyr*.

58 California Department of Industrial Relations (n.d.). Public law of the state of California, Title 8, Subchapter 7, Group 2, Article 10, §3396. Heat Illness Prevention in Indoor Places of Employment. https://www.dir.ca.gov/title8/3396.html

59 USGCRP, 2023: Fifth National Climate Assessment. Crimmins, A.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, B.C. Stewart, and T.K. Maycock, Eds. U.S. Global Change Research Program, Washington, DC, USA. https://doi.org/10.7930/NCA5.2023

hurricanes, responsible for 49 deaths.[60] The storm also damaged the riverwalk, a popular local park, and its closure for almost a full year decreased quality of life for residents seeking to improve their health via outdoor recreation.[61]

- **Vector-Borne Diseases**: Mosquitos, ticks and other vectors can carry and spread disease. Changing climatic conditions create favorable conditions for these vectors. For example, the mosquito season has expanded in the Midlands by over a week in the past few decades.[62]
- **Quality of Life**: Climate change and climate action can impact our health in many ways. These include, but are not limited to:
  - **Pollen Season:** More days above freezing are lengthening the allergy season.[63]
  - **Sleep Quality:** Warm overnight temperatures can reduce the quality of our sleep.[64]
  - **Indoor Pollutants:** Climate actions like electrification remove carcinogens and other harmful air pollutants in the home. One example is gas stoves used for home cooking, which are linked to 13% of childhood asthma cases in the U.S.[65] and release dangerous chemicals that harm people (such as benzene, which causes cancer).[66]

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60 Post and Courier (2024). Helene took the lives of nearly 50 people across South Carolina. Here's a look at the lives lost. https://www.postandcourier.com/hurricanewire/hurricane-helene-south-carolina-deaths-obituaries/article_c12ad978-81a9-11ef-8177-7f36ecac808e.html and The State (2024). Hurricane that ripped South Carolina left eye-opening statistics. Here's what agencies found. https://www.thestate.com/news/local/environment/article295992319.html

61 Hannah Wade (2025). Part of West Columbia riverwalk reopens. Where you can stroll by the Congaree. The State. https://www.thestate.com/news/local/article311520818.html

62 Climate Central (2023). Mosquito Days. https://www.climatecentral.org/climate-matters/mosquito-days-2023

63 W.R.L. Anderegg, J.T. Abatzoglou, L.D.L. Anderegg, L. Bielory, P.L. Kinney, & L. Ziska, Anthropogenic climate change is worsening North American pollen seasons, Proc. Natl. Acad. Sci. U.S.A. 118 (7) e2013284118, *https://doi.org/10.1073/pnas.2013284118* (2021).

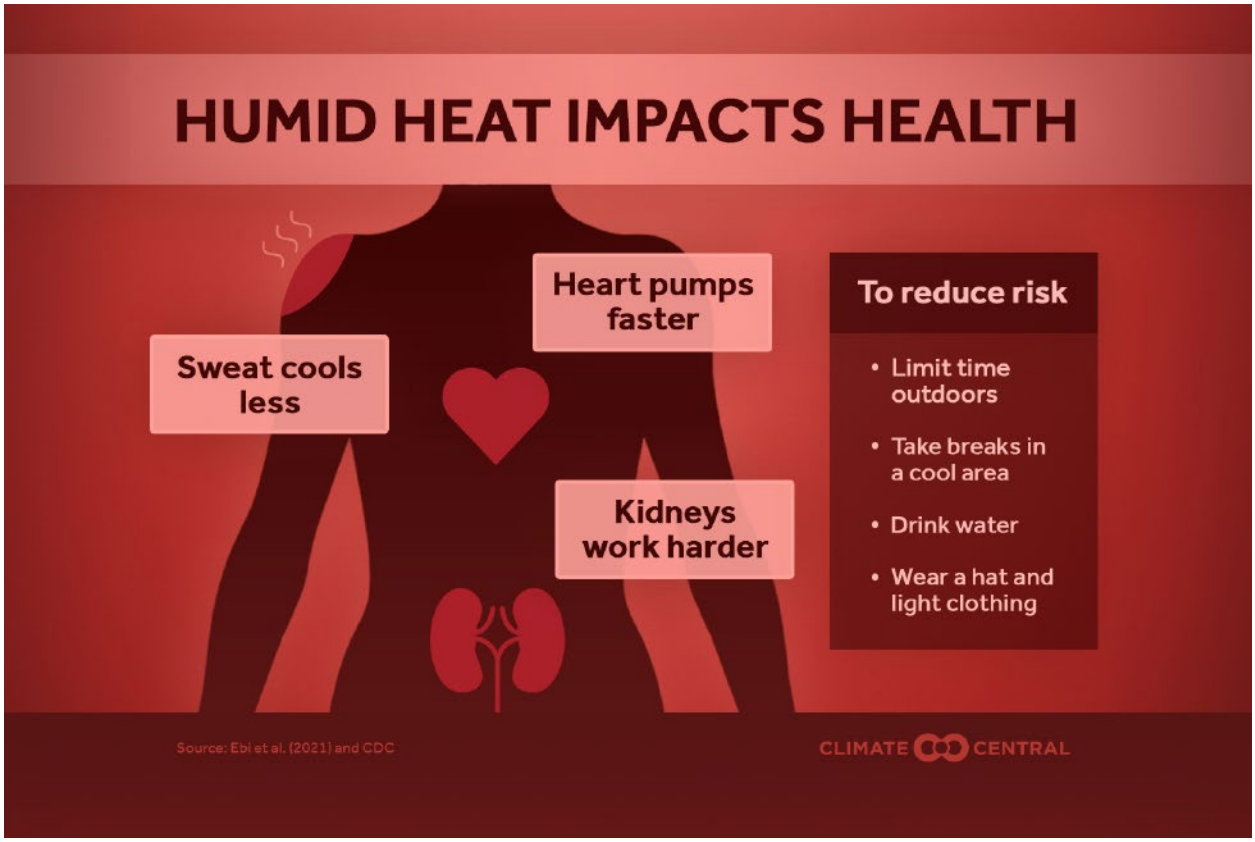
64 Minor, K., Bjerre-Nielsen, A., Jonasdottir, S.S. et al. (2022). Rising temperatures erode human sleep globally. One Earth, 5(5), 354-549. https://doi.org/10.1016/j.oneear.2022.04.008

65 Gruenwald, T., Seals, B. A., Knibbs, L. D., & Hosgood, H. D., III. (2023). Population Attributable Fraction of Gas Stoves and Childhood Asthma in the United States. International Journal of Environmental Research and Public Health, 20(1), 75. https://doi.org/10.3390/ijerph20010075

66 Kashtan, Y. S., Nicholson, M., Finnegan, C., Ouyang, Z., Lebel, E. D., Michanowicz, D. R., ... & Jackson, R. B. (2023). Gas and propane combustion from stoves emits benzene and increases indoor air pollution. Environmental Science & Technology, 57(26), 9653-9663. ||| Garg, A., Kashtan, Y., Nicholson, M., Finnegan, C. J., Lebel, E. D., Michanowicz, D. R., ... & Jackson, R. B. (2025). Exposure and health risks of benzene from combustion by gas stoves: A modelling approach in US homes. Journal of Hazardous Materials, 492, 137986.

– **Mental Health:** Witnessing environmental destruction and living through extreme climate impacts or accumulating financial costs (e.g., energy burdens) can cause stress and trauma that is temporary or becomes longer-lasting.[67] In this way, climate change can add to mental health burdens.

Figure 1.14.
A diagram of how heat and health are related.[68]



67 USGCRP, 2023: Fifth National Climate Assessment. Crimmins, A.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, B.C. Stewart, and T.K. Maycock, Eds. U.S. Global Change Research Program, Washington, DC, USA. https://doi.org/10.7930/NCA5.2023

68 Climate Central (2023). Health. https://www.climatecentral.org/topic/health

Nature

Nature in the Midlands faces many pressures from humans like habitat loss and land use, but climate change and other types of environmental pollution can also harm nature (see Figure 1.15). Globally, over 1 million species are at risk of extinction from human activities.[69] South Carolina recently updated the state wildlife action plan in 2025,[70] and the SC Department of Natural Resources and various non-profit and academic partners are tracking over 1,000 species through the South Carolina Heritage Trust Program.[71]

Many climate actions that are in this report can benefit animals, plants, and nature in addition to people and businesses. For example, intentional land use strategies can benefit nature and reduce greenhouse gases that cause climate change at the same time. In other cases, climate actions can intentionally attempt to foster biodiversity as a co-benefit.

Our communities can also take other actions that might benefit biodiversity and conservation, even if they do not directly affect greenhouse gas emissions. In general, there are not enough scientists in the Midlands to document and analyze how climate change and other changes in the environment are affecting nature. Anyone reading this report can address this gap in data and understanding of our landscapes by participating in citizen science projects and by notifying staff at CMCOG, local governments, universities, and non-profits of changes or problems that are observed in the Midlands.

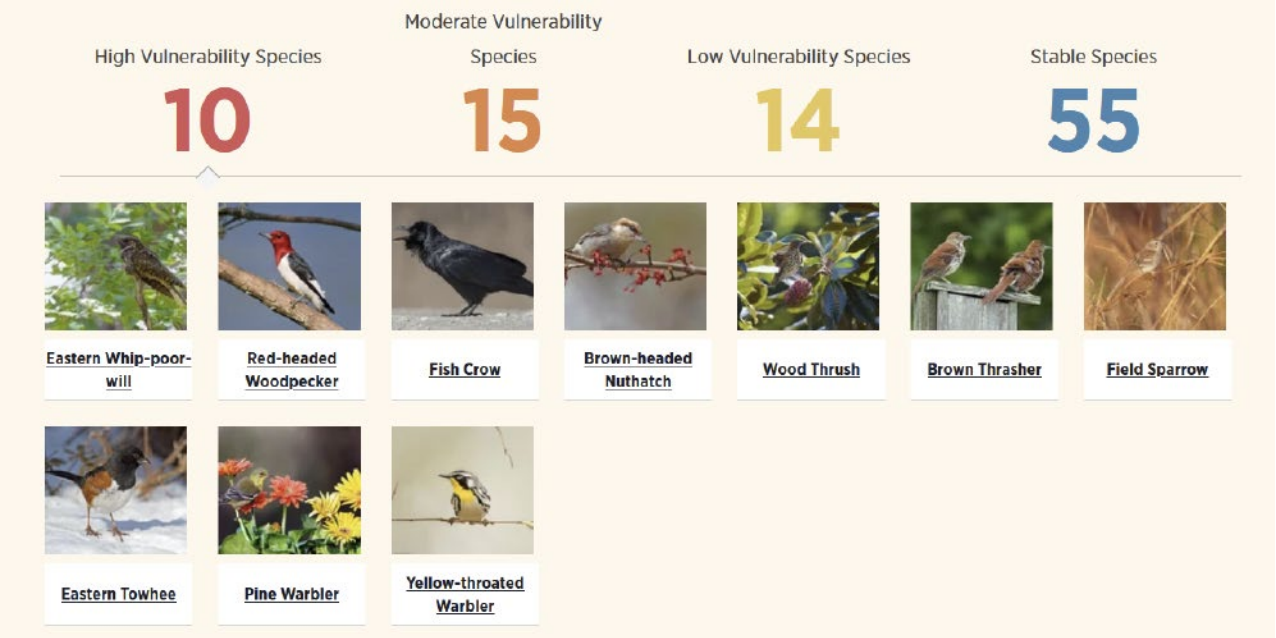
69 IPBES (2019): Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. E. S. Brondizio, J. Settele, S. Díaz, and H. T. Ngo (editors). IPBES secretariat, Bonn, Germany. 1148 pages. *https://doi.org/10.5281/zenodo.3831673*

70 SC DNR (2025). State Wildlife Action Plan. https://www.dnr.sc.gov/swap/index.html

71 SC Heritage Trust Program (2026). Tracking South Carolina's Species of Concern. https://natural-heritage-program-scdnr.hub.arcgis.com/

Figure 1.15.

A list of highly vulnerable birds that are expected to vanish from the Midlands in the summer season as a result of climate change.[72]



72 CMCOG entered the zip code for our offices, 29210, and copied the species listed as "high vulnerability species" for a 3 degree Celsius warming scenario in the summer season. Audubon Society (2025). Survival by Degrees: 389 Bird Species on the Brink. https://www.audubon.org/climate/survivalbydegrees/

2 Community Responses

Planning and Engagement

2.1 Local Government Planning

The City of Columbia is the only government in the Midlands that has a climate action plan. Created in 2006, its actions mainly focus on local government operations.[73] The Climate Protection Action Committee (CPAC) is a citizens advisory board that assists city staff and city council with lowering greenhouse gas emissions, exploring ways to increase sustainability, and improving quality of life in the Midlands. A regional urban heat island study completed in 2022, found that some areas of the city are up to 17 degrees Fahrenheit hotter than others.[74] Over the past few years, the city participated in the Smart Surface Coalition's Cities for Smart Surfaces Initiative and passed a Ready for 100 Resolution committing to energy efficiency and renewable energy goals by 2036.[75]

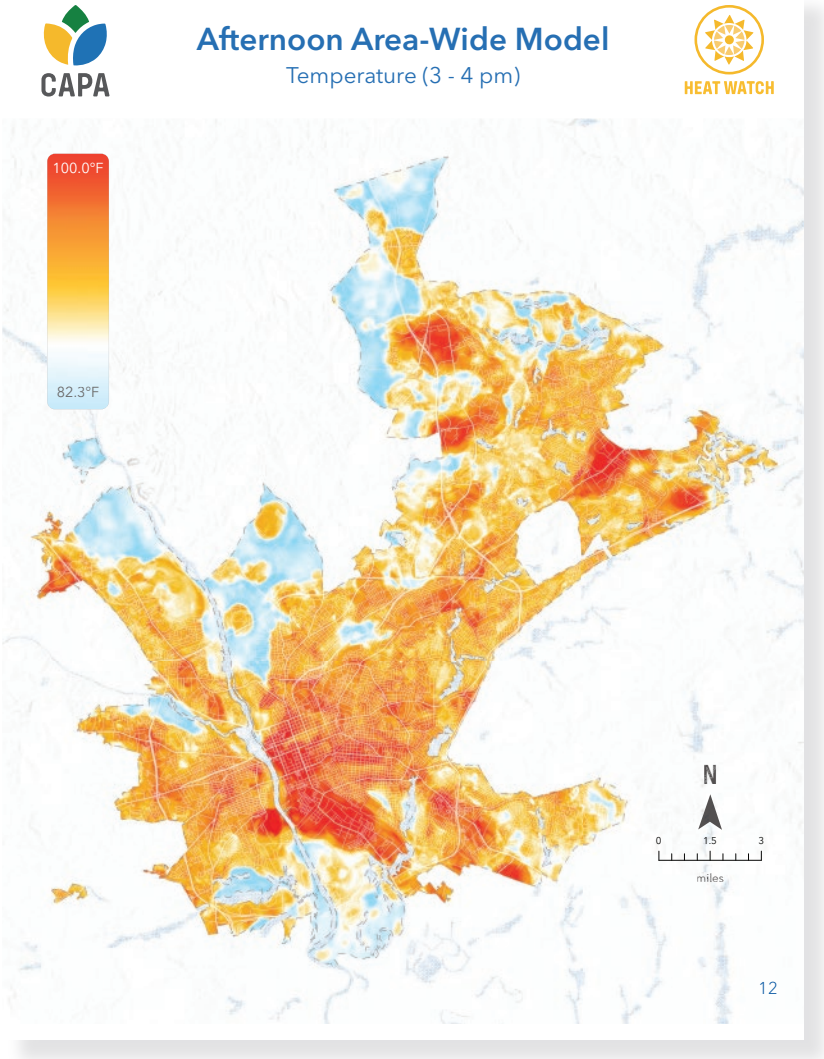


Figure 2.1.
A heat map from the Columbia Urban Heat Island Study.[76]

73 City of Columbia (2025). About CPAC. https://cpac.columbiasc.gov/about-cpac/

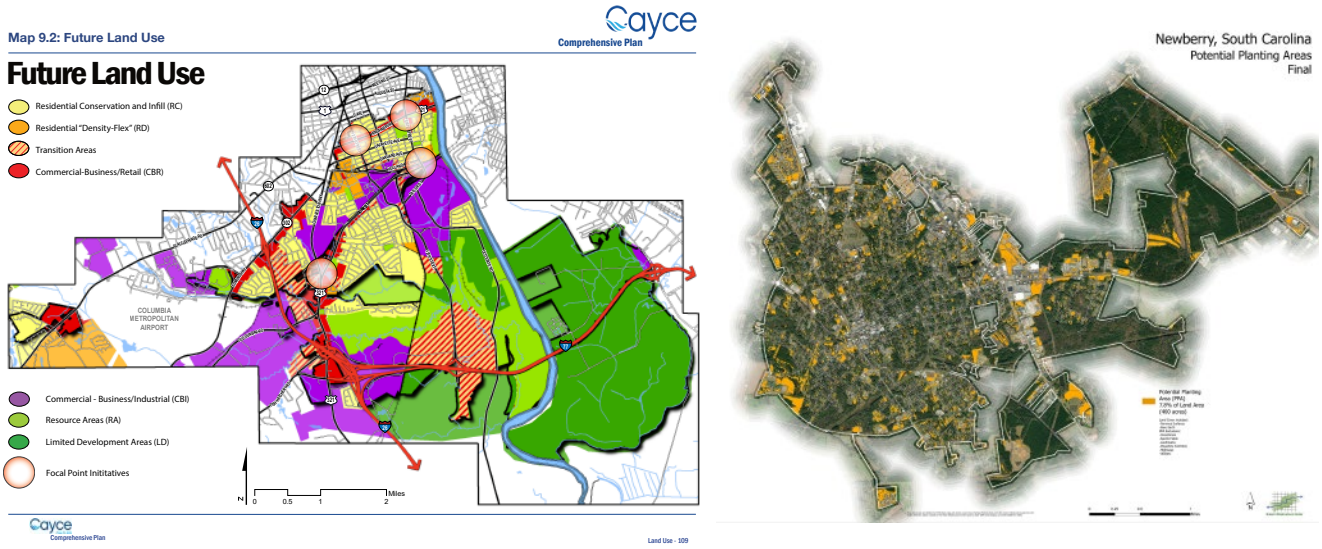
74 Capa Strategies (2022). Heat Watch Report - Columbia, South Carolina. Available at https://cpac.columbiasc.gov/wp-content/uploads/2022/11/Summary-Report_Heat-Watch-Columbia-SC_111122.pdf. Project data available at CAPA/NIHHIS. 2023. "Heat Watch Columbia SC." OSF. September 8. osf.io/nqwyr.

75 City of Columbia (2023). Resolution R-2023-053. City Council Archive. https://citycouncil.columbiasc.gov/download/resolution-no-r-2023-053/

76 Capa Strategies (2022). Heat Watch Report - Columbia, South Carolina. Available at https://cpac.columbiasc.gov/wp-content/uploads/2022/11/Summary-Report_Heat-Watch-Columbia-SC_111122.pdf. Project data available at CAPA/NIHHIS. 2023. "Heat Watch Columbia SC." OSF. September 8. osf.io/nqwyr.

Desire to address climate change is rising across the Midlands, especially when it intersects with other community concerns such as economic development, rising energy burdens, or urban heat islands. However, many local governments are just beginning to incorporate climate change mitigation into their community planning, and few have projects where the primary goal is to reduce emissions. Some urban forestry and tree planting initiatives reduce air pollution including greenhouse gases, even if they are not initiated as a climate action. Some municipalities and counties in the Midlands already incorporate sustainability, resilience, and other goals into local zoning or other decision-making processes (see Figure 2.2). Over time, local governments can play a large role in implementing or facilitating more climate action in the Midlands.

Figure 2.2.
Two examples of local planning in areas tied to air pollution reductions. Left - The City of Cayce's future land use map in their comprehensive plan.[77] Right - The City of Newberry's urban tree canopy assessment identifies areas for tree planting.[78]



77 City of Cayce (2020). Comprehensive Plan Update.
78 City of Newberry (2023). Urban Tree Canopy Assessment. SC Forestry Commission.

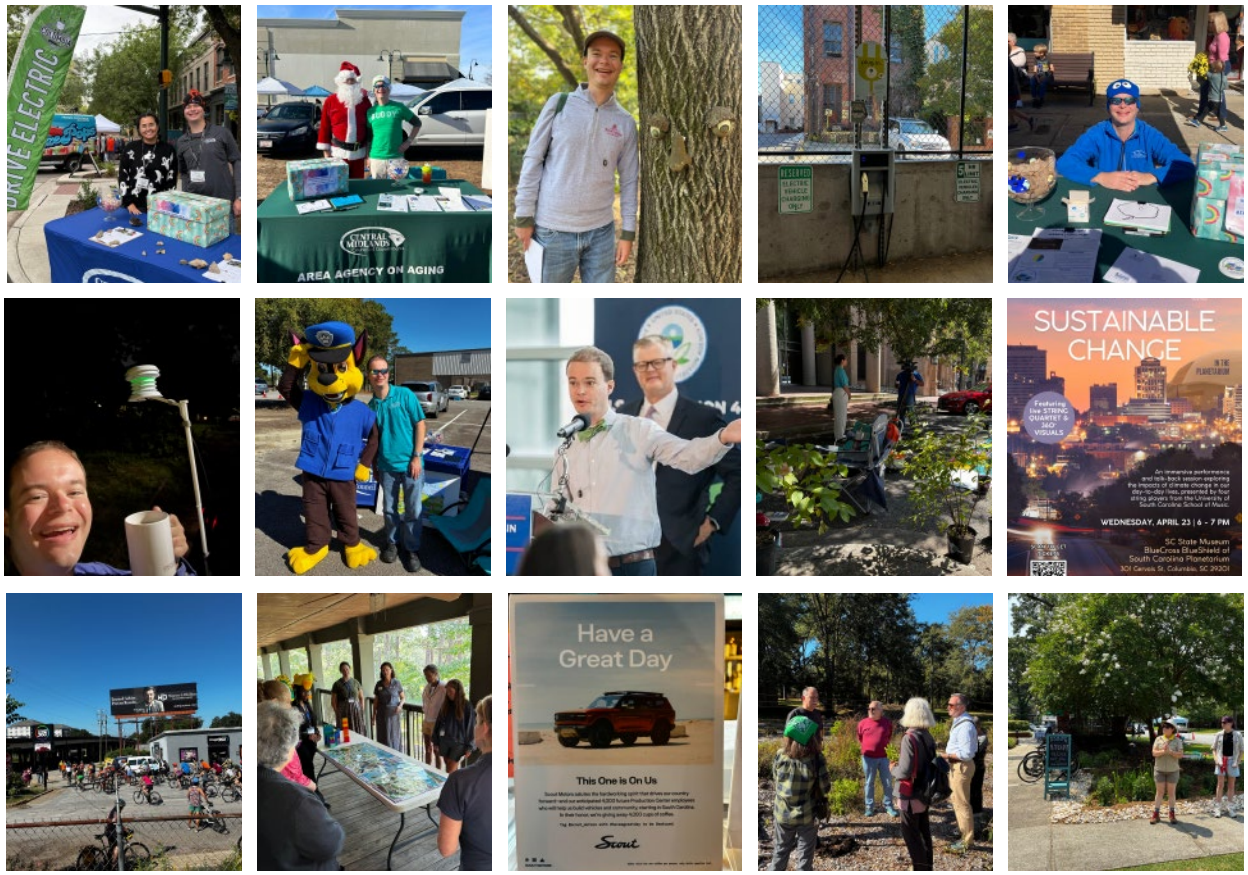
Local municipalities are now required to include resilience as an element of local comprehensive plans. Resilience is focused not on pollution reduction, but rather on adapting and responding to climate impacts that are increasing in frequency and severity in the Midlands (see Chapter 1). However, some actions that increase resilience can decrease greenhouse gas emissions as a secondary benefit. The South Carolina Office of Resilience's Strategic Statewide Resilience and Risk Reduction Plan offers data and analysis at a state-wide scale.[79] As municipalities increasingly respond to climate change in the Midlands, CMCOG can work collaboratively with local governments to translate climate science and scale both resilience and climate action over time.

2.2 Community Engagement

Over the development of this plan, the Central Midlands Council of Governments (CMCOG) adopted multiple approaches to engage the community (see Figure 2.3). Community ideas and perspectives are key to a regional climate action plan, because there are hundreds of possible actions that could be done to reduce air pollution over time. While the size of greenhouse gas emission reductions is important to consider, ultimately any climate action that reduces emissions is valuable and will limit the economic, social, health, and environmental harms from climate change. Community priorities shaped which actions were selected for this climate action plan and how they can be implemented.

79 South Carolina Office of Resilience (2024). South Carolina Strategic Statewide Resilience and Risk Reduction Plan. https://scor.sc.gov/resilience

Figure 2.3.
CMCOG staff collected data, observed climate actions already occurring, attended workshops and tours, participated in ongoing conversations, and used multiple methods to engage the community.



Through our community engagement strategy, CMCOG prioritized meeting the community where they are. The report's author attended events, tabled at a variety of locations around the Midlands, and intentionally sought out a diverse set of perspectives through one on one conversations with individuals, community organizations and businesses. CMCOG also set up the Climate Conversations Mini-Grant program to empower community-based organizations, schools and local governments in the Midlands that wanted to host conversations about climate change.

Summary of CMCOG Engagement Efforts

December 1, 2023 - December 1, 2025

- **Listening**: The report's author participated in 164 meetings, events or conversations. These included 46 events in the community, 58 conversations with local and state government partners, 35 conversations with businesses, NGOs, faith-based communities, or neighborhood groups, and 25 meetings of the Climate Protection Action Committee.
- **Surveys**: All of the South Carolina CPRG recipients collaborated on an online public survey to ask about climate action. 70 people who live in the Midlands responded to the survey. CMCOG also sent a detailed survey to regional water and wastewater utilities to gauge perspectives on climate action in their facilities, receiving 9 responses. CMCOG also evaluated survey data collected by others, including public surveys from the Climate Reality Project Midlands Chapter and polls from Sustain South Carolina and the Yale Program on Climate Change Communication.
- **Climate Conversations Mini-Grants**: CMCOG funded a total of 6 events that reached a combined 783 participants. CMCOG also funded virtual reality art installations on climate change impacts that have been viewed over 3,000 times since installation.
- **CPRG Coordination**: The report's author communicated closely with others across the state and Southeast doing climate action planning, including the South Carolina Office of Resilience, Charleston MSA, the Catawba Nation, and Raleigh MSA. Two CMCOG staff attended the nationwide CPRG conference held in Minneapolis where states and MSAs from across the country shared ideas.

Climate Conversations Mini-Grant

As part of its community engagement, CMCOG launched a mini-grant program to enable community partners to hold meaningful conversations and engage Midlands residents on climate action, air pollution, energy, resilience and other topics tied to regional climate planning. These ideas and events fostered collaboration and uplifted community voices that informed this climate plan.

University of South Carolina (February 21, 2025)

Students organized the university's first student sustainability summit, a student-led conference focused on climate action and sustainability. Over 70 students participated. Inspired by UNC Charlotte's summit, the event featured workshops, discussions, and service projects that promoted hands-on learning and collaboration. Emerging ideas included environmental justice and how to think about individual versus systemic actions to address climate change. Students organized and taught all of the sessions, with a goal to co-create community knowledge.

Figure 2.4.
Dialogue from a student-led workshop on how to talk to children about climate change.[80]

80 Photo provided by, and copyright of, the University of South Carolina.

Brookland Lakeview Empowerment Center (February 27, 2025)

A community center in West Columbia hosted an energy efficiency workshop, which featured guest speakers and organizations such as Dominion Energy, the Sustainability Institute, Solar United National, the Sierra Club, and the SC Energy Office. 72 people attended, mostly from neighborhoods nearby the community center. Topics discussed include home energy savings, weatherization services, clean energy, workforce development, and equitable community benefits. Community participants gained knowledge about energy efficiency, received energy efficiency kits, and learned practical ways to reduce energy costs and improve home comfort.

Figure 2.5.
Mitch, a building contractor from the Sustainability Institute, explains to residents how to use devices like caulk and insulation to save energy and reduce electricity bills.[81]

81 Photo provided by, and copyright of, the Sierra Club - Midlands Chapter.

One Columbia Arts and Culture (public art)

On Earth Day 2025, One Columbia celebrated the unveiling of augmented reality (AR) art at several locations across downtown Columbia. Signage informs participants about local climate impacts and invites participants to use their phones to view the art superimposed on real world spaces. The art installations focus on three local topics: heatwaves & the city's 2022 urban heat island study, the 2015 climate-driven flood disaster, and how climate changes are affecting synchronous fireflies (a locally charismatic species). According to data provided by the artist, the QR codes have been scanned over 3,000 times since their installation.

Figure 2.6.
One of the art installations, Deluge, highlights the 2015 flood event.[82]

82 Photo provided by, and copyright of, One Columbia Arts and Culture.

City of Columbia (April 26, 2025)

Columbia celebrated Earth Day with a climate action fair adjacent to the weekend farmer's market on Main Street. Over 500 residents attended the event, which featured 14 local community groups with interactive displays, a photo booth, and community activities. The grant enabled the city to restart a public event on Earth Day after the pandemic disrupted festival planning opportunities.

Figure 2.7.
Mascots from the SC Department of Environmental Services, City of Columbia, and the University of South Carolina led community activities during the event. The report's author is included in this photo.

Cola Town Bike Collective (May 6, 2025)

A local non-profit organized a film screening of *The Street Project* followed by a panel and community discussion with local transportation and planning leaders. 64 people attended the screening. The discussion focused on making streets safer through long-term planning, short-term improvements, and public engagement. The event connected the film's themes to ongoing transportation planning in Columbia, empowering attendees to see how community input can influence transportation decisions and infrastructure change.

Figure 2.8.
Local government officials from the SC Department of Transportation, SC Department of Public Health, City of Columbia, and Central Midlands Council of Governments (respectively, from left to right) facilitated a panel and community discussion on bicycle and pedestrian safety and infrastructure following the movie screening.[83]

83 Photo provided by, and copyright of, the Cola Town Bike Collective

Sustain SC (May 22, 2025)

Businesses, governments, utilities and academics (40 participants total) came together for a workshop on the economics of biodiversity and human health. The workshop focused on three main themes: understanding the importance of biodiversity, exploring how green spaces and healthy buildings support it, and examining the link between biodiversity, human health, and climate impacts in disadvantaged communities. Discussions highlighted the economic benefits of prioritizing biodiversity through improved health and business outcomes (employee retention, vibrant communities, etc.).

Figure 2.9.
Workshop participants discussing how workplaces can be sites of green infrastructure for climate action and employee wellness.[84]

84 Photo provided by, and copyright of, Sustain SC

CTW Community Council (October 4, 2025)

An energy and emergency preparedness workshop was held in Jenkinsville. The event focused on the connection between energy efficiency and emergency readiness, helping households weatherproof their homes, reduce energy costs, and prepare for severe weather. Representatives from the South Carolina Energy Office shared information on statewide energy-saving programs and home efficiency incentives, while Connections Workforce Development offered career resources, training, and guidance for those interested in energy and emergency management fields. 35 local residents attended and received weatherization kits. Experts from local utility companies shared how to use insulation, caulk, and other types of energy efficiency products.

Figure 2.10.
A local utility shares information on energy efficiency and reducing energy use.[85]

85 Photo provided by, and copyright of, CTW Community Council

Community Priorities

While the mini-grant program enabled the conversations of others, CMCOG's primary community engagement strategy involved going directly to communities and meeting people where they are. CMCOG attended meetings, events, and dialogues regularly. CMCOG also intentionally sought out and spoke individually with a cross-section of Midlands businesses, NGOs, and local governments. The report's author personally engaged in 164 such conversations over the two year period leading up to this climate action plan.

At a high level, climate impacts that are mentioned in Chapter 1 are driving growing concern among Midlands residents, with over two thirds of residents "worried about global warming" (a rate 4% higher than the national average).[86] Midlands residents think that all actors in society[87] should undertake climate actions, with a substantial majority in each case (ranging from 57% - 69% agreement, depending on which actor).[88] Additional surveys consulted, including the inter-agency CPRG program survey, highlight strong support for climate actions that increase land conservation, preserve working lands (e.g., agriculture or forestry), and for climate actions that have co-benefits (esp. ones that reduce public health concerns and utility bills).

Across our community engagement CMCOG consistently asked what community members' "vision for a climate friendly and resilient Midlands in 2050" would look like. Residents dropped cards in a "dream box" and expressed support for a wide variety of possible climate actions (Figure 2.11).

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86 Yale University - Climate Opinion Maps 2024. Trends over time from 2010–2020 are provided for 16 state-level climate opinions using data from Marlon et al. (2022). Estimates for 2021, 2022, 2023, and 2024 are generated using our conventional MRP model described in Howe et al. (2015). Marlon, J. R., Wang, X., Bergquist, P., Howe, P., Leiserowitz, A., Maibach, E., Mildenberger, M., and Rosenthal, S. "Change in US state-level public opinion about climate change: 2008–2020." *Environmental Research Letters 17, no. 12 (2022). 124046*. Howe, P., Mildenberger, M., Marlon, J., & Leiserowitz, A. (2015) "Geographic variation in opinions on climate change at state and local scales in the USA," Nature Climate Change 5. DOI: *10.1038/nclimate2583*.

87 The survey asks separately about state government, local government, private businesses, and citizens.

88 Yale University - Climate Opinion Maps 2024. Trends over time from 2010–2020 are provided for 16 state-level climate opinions using data from Marlon et al. (2022). Estimates for 2021, 2022, 2023, and 2024 are generated using our conventional MRP model described in Howe et al. (2015). Marlon, J. R., Wang, X., Bergquist, P., Howe, P., Leiserowitz, A., Maibach, E., Mildenberger, M., and Rosenthal, S. "Change in US state-level public opinion about climate change: 2008–2020." *Environmental Research Letters 17, no. 12 (2022). 124046*. Howe, P., Mildenberger, M., Marlon, J., & Leiserowitz, A. (2015) "Geographic variation in opinions on climate change at state and local scales in the USA," Nature Climate Change 5. DOI: *10.1038/nclimate2583*.

Figure 2.11.
A word cloud of 78 dreams submitted by Midlands residents of their vision for a climate friendly and resilient community.[89]

Greenhouse gases can be emitted by various economic activities, and halting global warming and climate impacts requires taking more than one action at a time. We received a large number of suggested actions from the public across multiple economic sectors. Residents, businesses and community groups frequently connected climate action to related co-benefits (e.g. public health, energy burden, economic development, aesthetics and beauty, etc.). Across all forms of our engagement, the following themes emerged. This synthesis incorporates all of the community engagement activities under this climate action plan.

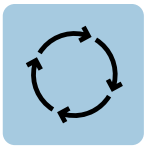
Energy Efficiency & Weatherization: These actions are seen not just as a way to reduce greenhouse gas emissions, but as an economic and public health necessity (particularly for low-income households). Existing programs are widely seen as insufficient in scale or containing barriers to access. Suggested fixes center around creating multiple widely available and large recurring rebates paired with developing community expertise to increase uptake and overcome education and trust gaps.

89 Not all words are shown, and comments were not edited to combine similar ideas.

Renewable Energy & Rising Energy Costs: The community sees widespread failure to contain rising electricity costs and air pollution tied to fossil-fuel power plants. A representative example is reported frustration among those visiting "less sunny" areas that see far more solar elsewhere than at home in SC, while knowing if they could access it affordably that solar could reduce their utility bills. Grid stability is an additional concern, with uncertainty as to why batteries and micro-grids are not being explored as a response to increasing extreme weather events that can lead to multi-day power outages.

Transportation Infrastructure: There is widespread recognition that the metropolitan area's transportation network has abnormally high greenhouse gas emissions and poor pedestrian and bicycle infrastructure. There is broad local consensus on investing in public transportation, but disagreement about which specific actions to pursue. The most common transportation actions mentioned to us were EV adoption and charger access, making the bus system more convenient and usable, additional public transit alternatives like trains, and increasing pedestrian and bicycle infrastructure to improve safety and create travel corridors (particularly in key areas such as downtown and around schools).

Land Use & Conservation: In local imaginations, climate actions often blend with concerns tied to land use and protection, particularly in rural areas. Perceptions of rural character are sometimes tied explicitly to land use (especially working lands) and to locally significant wildlife and plants. Rural communities desire higher density in urban areas in order to preserve more land in rural areas. Urban communities have high support for increasing tree canopy cover and in using green infrastructure to control climate impacts like flooding. Residents in both urban and rural communities feel that local governments are not developing or enforcing enough rules and are frustrated by land use changes that do not reflect their views (for example, lack of development rules that result in clear-cutting trees generates widespread anger).



Circular Economy: While the term itself is not used locally, residents frequently expressed ideas in this policy sector.[90] Ideas were often locally focused (e.g., on lack of composting options, their municipality's recycling program, etc.) but some were regional in scale (e.g., desire to limit future landfill growth, not accepting waste from other areas, taxing companies that produce lots of packaging waste, etc.).

Local Climate Impacts: The Midlands is already experiencing climate impacts. Most residents and businesses are aware of and have noticed their effects (whether on them or their communities). While flooding is a key concern, there is a growing concern with extreme heat and urban heat islands. Residents are increasingly understanding and thinking about climate change through a public health lens. There appears to be little consensus on how to respond to climate change or what the possible response options are.

90 Circular economy is a technical term for any actions or policies focused on material goods and items after their useful life, encompassing waste, recycling, & re-use, but also reducing the amount of materials used or consumed in the first place.

3 Low-Income and Disadvantaged Communities Benefits Analysis

3.1 What is Climate Justice?

Evaluating the distribution of climate benefits and harms is important because climate change does not affect all residents of the Midlands equally. Environmental changes like extreme heat and the urban heat island effect, extreme rainfall leading to flooding, and drought (particularly in agricultural communities) can harm some communities more than others. Risks associated with these climate impacts are not evenly distributed[91] and can create a range of economic, social, and health burdens.[92]

Climate justice often focuses on local impacts and experiences and benefits everyone in a community by helping those facing the most challenges.[93] This chapter describes where communities that are disadvantaged and facing the most challenges are located in the Midlands, key areas where harms are experienced, and how to begin responding to injustice.

Responding to Climate Injustices

All residents and actors (governments; businesses & community organizations) can be harmed by climate change in various ways, and the climate actions discussed in this plan can bring economic, social, and public health benefits. The actions we do or do not take can affect our neighbors in the Midlands, and some communities may need more or less support when responding to the climate impacts discussed in Chapter 1. This section shares two possible views of how to respond to climate injustice. Communities can respond to climate injustices in a variety of ways, and knowing how to help others or respond effectively is not always easy.

Figure 3.1 is a conceptual view of how vulnerability touches many parts of life and how this can translate into cascading impacts. Consider a hurricane:

- After the storm, someone without a personal vehicle may experience difficulty in accessing health care if public transit is temporarily shut down. In this situation, the storm (climate hazard) intersects with a vulnerability (lack of personal vehicle) to create a new problem (lack of health care).

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91 USGCRP, 2023: Fifth National Climate Assessment. Crimmins, A.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, B.C. Stewart, and T.K. Maycock, Eds. U.S. Global Change Research Program, Washington, DC, USA. *https://doi.org/10.7930/NCA5.2023*

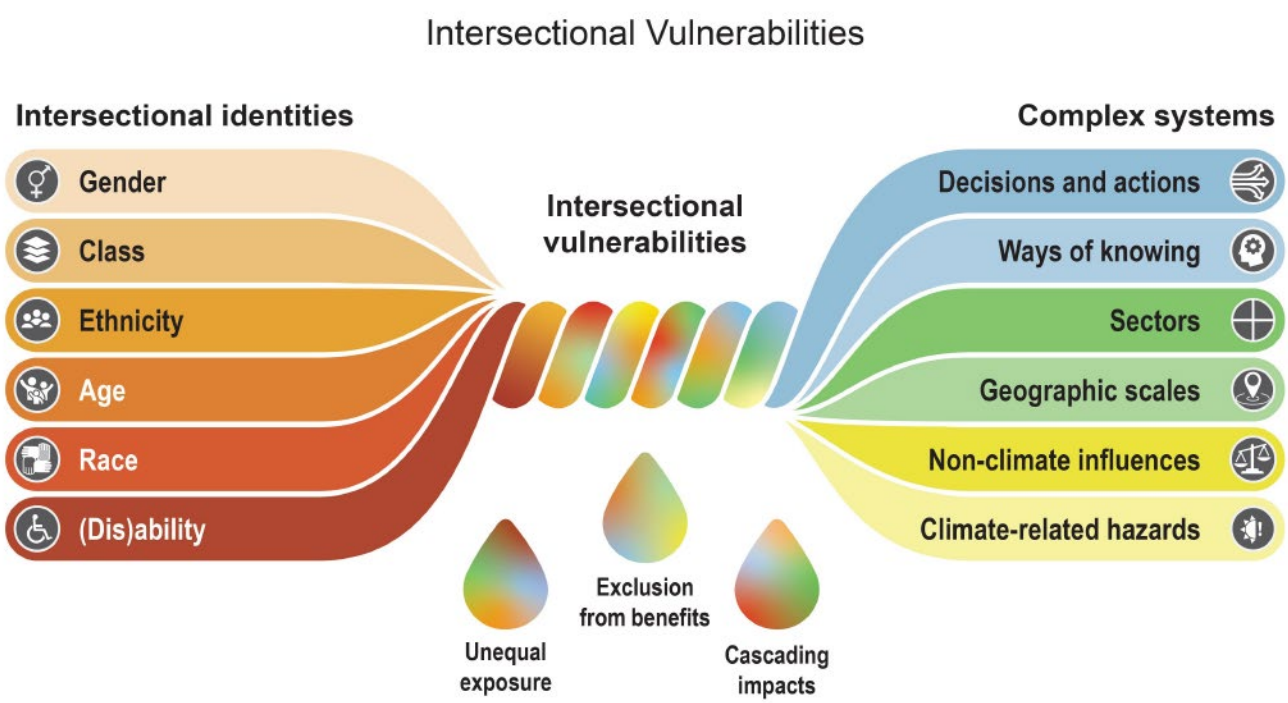
92 EPA. 2021. Climate Change and Social Vulnerability in the United States: A Focus on Six Impacts. U.S. Environmental Protection Agency, EPA 430-R-21-003.

93 Schlosberg, D., & Collins, L. B. (2014). From environmental to climate justice: climate change and the discourse of environmental justice. Wiley Interdisciplinary Reviews: Climate Change, 5(3), 359-374.

- If a household is low-income, it may be easier to repair a home damaged by the storm using only the funds available for recovery from insurance or public assistance. However, if the amount of funding is insufficient for all needed repairs, then water damage could potentially lead to new impacts later like mold growth. This would be an example of a cascading impact, where one problem now creates more problems later.

Conceptual frameworks like this can be used to guide decision-making, especially when leading organizations or creating programs. However, not all communities want to focus on vulnerability, and may prefer to focus on growing capabilities and becoming more resilient. Some communities may also find this conceptual view complicated.

Figure 3.1.
A conceptual diagram showing how a complex system merges many several socio-ecological drivers to differentially affect people within a given area.[94]



94 NCA Figure 18.2, "Intersectional Vulnerabilities". USGCRP, 2023: Fifth National Climate Assessment. Crimmins, A.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, B.C. Stewart, and T.K. Maycock, Eds. U.S. Global Change Research Program, Washington, DC, USA. https://doi.org/10.7930/NCA5.2023

Art and other expressions of local experience and knowledge (see Figure 3.2) can demonstrate how climate impacts affect daily life and how climate actions could benefit themselves or their communities. This second view of climate justice is equally important, because local knowledge and experience is valuable and technical analyses can de-emphasize the realities of everyday experiences. It can be easier to understand, and helps move scientific understanding to locally desirable actions that limit future harms.

Figure 3.2.
In order (clockwise, starting from the left):[95] *Deforestation by Kelly Curl records local land use impacts on forest and farms; Reflecting on What Could Be by Snow Dietrich highlights youth and visions of the real and reflected environment; Dish by Laura Tanner highlights social justice & food in the South; Redrawing the Earth by Ritika S. highlights our ability to change the future; Sunday in the Park with Climate Change by Mikaela R. merges everyday activities with wealth inequality and climate impacts.*

95 NCA "Art x Climate" Initiative. USGCRP, 2023: Fifth National Climate Assessment. Crimmins, A.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, B.C. Stewart, and T.K. Maycock, Eds. U.S. Global Change Research Program, Washington, DC, USA. https://doi.org/10.7930/NCA5.2023

Climate actions discussed in this plan (see Chapter 6) can sometimes help reduce inequality or injustice. In some cases, climate actions can unintentionally increase inequality if they are implemented poorly (see Chapter 7). Implementation pathways that use the recommended visionary framework (see Chapter 8) can incorporate climate justice concepts directly into decision criteria and outcomes tracking.

3.2 Low-Income and Disadvantaged Community Geography

The United States Environmental Protection Agency (EPA) established a geographically oriented definition of low-income and disadvantaged communities (LIDACs) for this regional climate action plan (see Figure 3.3). EPA defines an area as disadvantaged if a census tract is designated by the Council on Environmental Quality's Climate and Economic Justice Screening Tool or if a census block group meets the 90th percentile or above on any of the EPA's EJSCREEN supplemental indexes. Both metrics are quantitative indices that merge multiple environmental, health, and socio-economic datasets to assess harms and use percentile ranking to identify thresholds of harm. A quantitative approach to delineating communities or categorizing them has benefits and drawbacks for regional planning.[96]

LIDACs are an integral part of the Midlands economy and social fabric. LIDACs represent 76.7% of the Midlands by geographic area and include 44.1% of people residing here. LIDACs in the Midlands are geographically dispersed across all seven counties in the planning region. It is important to note that identifying community needs by geography presents some challenges. For example, some residents living in areas classified as "not disadvantaged" may be low-income, have a high energy burden, or experience harm from climate impacts. However, this quantitative approach also shows that many areas in the Midlands are currently experiencing more burdens than the majority of people living in the United States.

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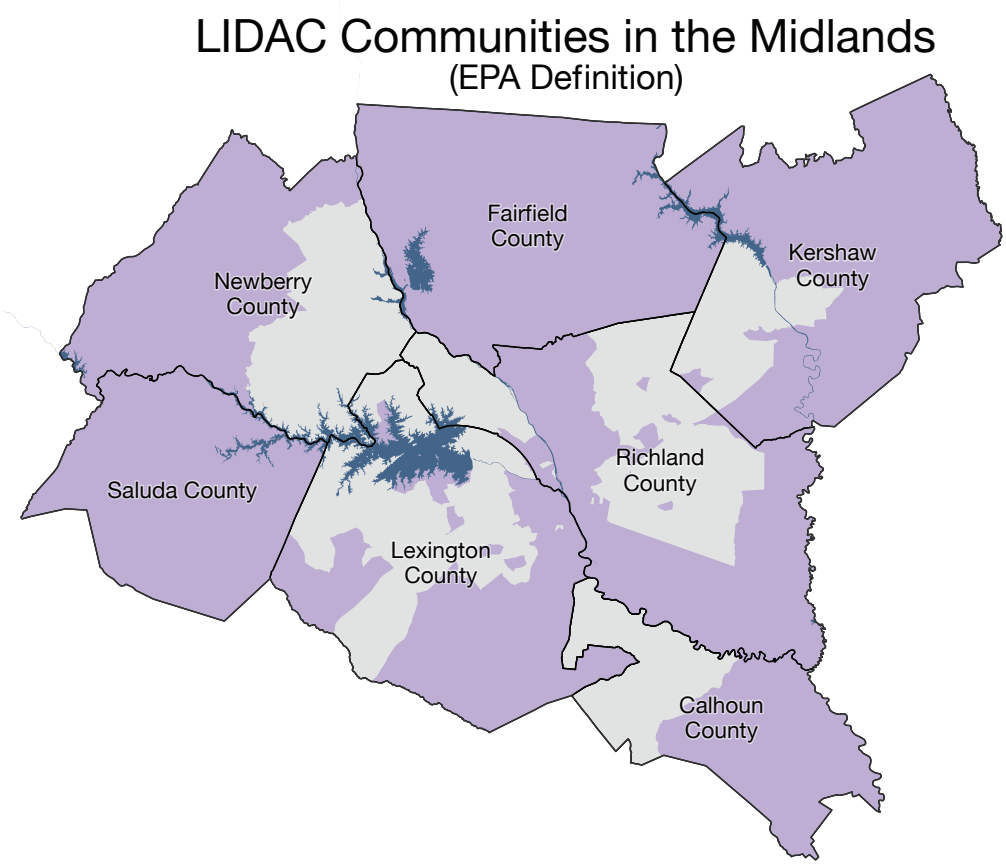
96 CMCOG notes that defining communities by geography, and using GIS data to do so, carries inherent methodological problems, and their use in this plan should not be taken to reference the views of our agency. In this plan, CMCOG followed EPA's guidance for merging both GIS layers and adopting a geographic and quantitative definition of LIDAC communities, as given in U.S. EPA (2023). Climate Pollution Reduction Grants Program: Technical Reference Document for States, Municipalities and Air Pollution Control Agencies. Benefits Analyses: Low-Income and Disadvantaged Communities. For information on the Climate and Economic Justice Screening Tool's methodology, see https://public-environmental-data-partners.github.io/j40-cejst-2/en/methodology. For more information on EJSCREEN methodology, see https://www.epa.gov/system/files/documents/2024-07/ejscreen-tech-doc-version-2-3.pdf.

Figure 3.3.
LIDACs (purple shaded areas) comprise a significant proportion of the Midlands by both geography and population.[97]



3.3 Climate Justice in the Midlands

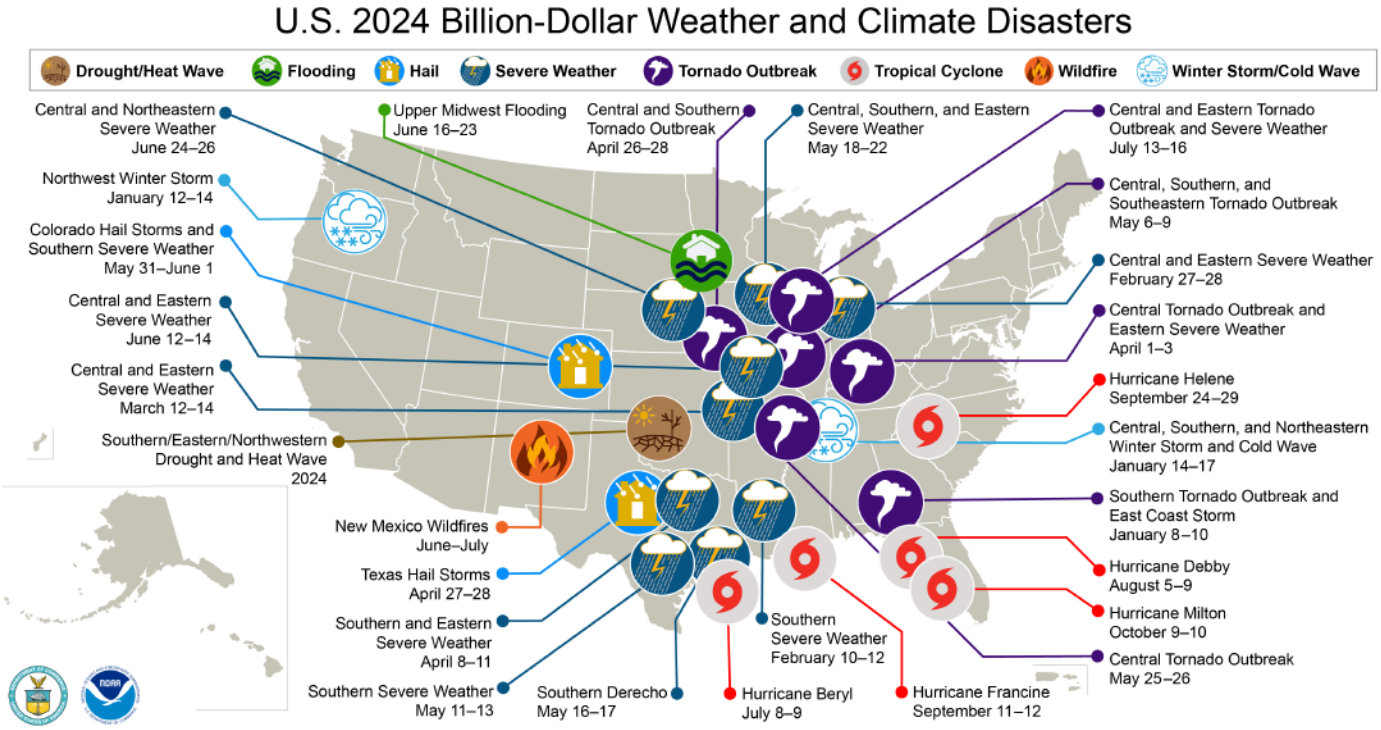
CMCOG's community engagement described in Chapter 2 included LIDACs directly as well as community-based groups operating in the Midlands that focus on environmental and energy justice. Many of the climate actions in this plan can dramatically improve life for disadvantaged communities and have co-benefits that address public health, economic, or social issues beyond reducing greenhouse gases and other types of air pollutants. This section summarizes key challenges that communities repeatedly raised. It is not an exhaustive list of all the ways that climate justice can or should be addressed in the Midlands.

97 U.S. EPA (2024). Low-Income & Disadvantaged Communities, version 2.0. [GIS data file]. https://www.epa.gov/inflation-reduction-act/about-cprg-planning-grant-information

Economic Inequality

Economic costs from climate change are often discussed in terms of extreme weather events that cause large damages (see Figure 3.4) or in terms of their impacts on the economy of the entire Midlands (see the discussion of economic losses in Chapter 1). Large damaging events are increasing in severity and frequency[98] and climate impacts are projected to lead to losses of nearly $1 out of every $10 generated in the Midlands economy by the end of the century.[99]

Figure 3.4.
In 2024, the United States experienced 27 separate weather or climate disasters that each resulted in at least $1 billion in damages.[100]



*This map denotes the approximate location for each of the **27 separate billion-dollar weather and climate disasters that impacted the United States in 2024.***

98 Climate Central (2026). U.S. Billion-Dollar Weather and Climate Disasters Database. https://www.climatecentral.org/climate-services/billion-dollar-disasters

99 Fleming, J. & Windsor, C. (2022). The Role of a Green Bank in South Carolina: A Market & Feasibility Assessment. University of South Carolina. https://scholarcommons.sc.edu/geog_facpub/231/

100 National Centers for Environmental Information (2025). 2024: An active year of U.S. billion-dollar weather and climate disasters. https://www.climate.gov/news-features/blogs/beyond-data/2024-active-year-us-billion-dollar-weather-and-climate-disasters

It can sometimes feel easier to rally support and respond to a huge damaging event. Yet in the day to day lives of residents in the Midlands, the small costs of climate change that are felt right now should not be dismissed. Recent research estimates that, in the Midlands, households are already losing ~$400 each year due to climate change[101] and experiencing a small reduction (~1%) to potential incomes.[102] The small costs include externalized costs of pollution, rising insurance costs, higher utility rates for energy, and more. While ~$35 a month may seem small, one's perspective varies by how much money you make (e.g. about 15% of Midlands households below the poverty line, see Table 1.1). For a household that is already restricting their spending and living paycheck to paycheck, this could mean using less air conditioning during the hottest days, avoiding a purchase at a local business, or other changes to daily life. As these small costs are anticipated to increase, climate change will increasingly affect more people in the Midlands economically even if they happen to avoid the next "billion dollar disaster" directly. Those with sufficient incomes can largely avoid these challenges, but many will not be able to and this may create new regional economic inequalities or exacerbate existing ones.

Lives & Living Landscapes

Living landscapes form an essential part of the day to day experience of people as they live, work, and move throughout their communities. These landscapes, and particularly plant life, help form deep attachments to places and shape daily life.[103] In the Midlands, tree canopy cover is not spatially distributed equally (see Figure 3.5). On average, rural areas of the Midlands have ~60% tree canopy coverage whereas urbanized areas have ~49% tree canopy coverage. LIDAC areas have ~2% less tree canopy coverage compared to non-LIDAC areas.[104]

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101 This value is specific to our area. The authors' spatial econometric model includes costs like energy bills, insurance, and public health impacts like mortality. The authors also note this is likely an underestimate, because they excluded many known economic costs that are more challenging to quantify for all areas of the country. Clausing, K., Knittel, C. & Wolfram, C. (2025). Who Bears the Burden of Climate Inaction? NBER Working Paper 345235. DOI: *10.3386/w34525*.

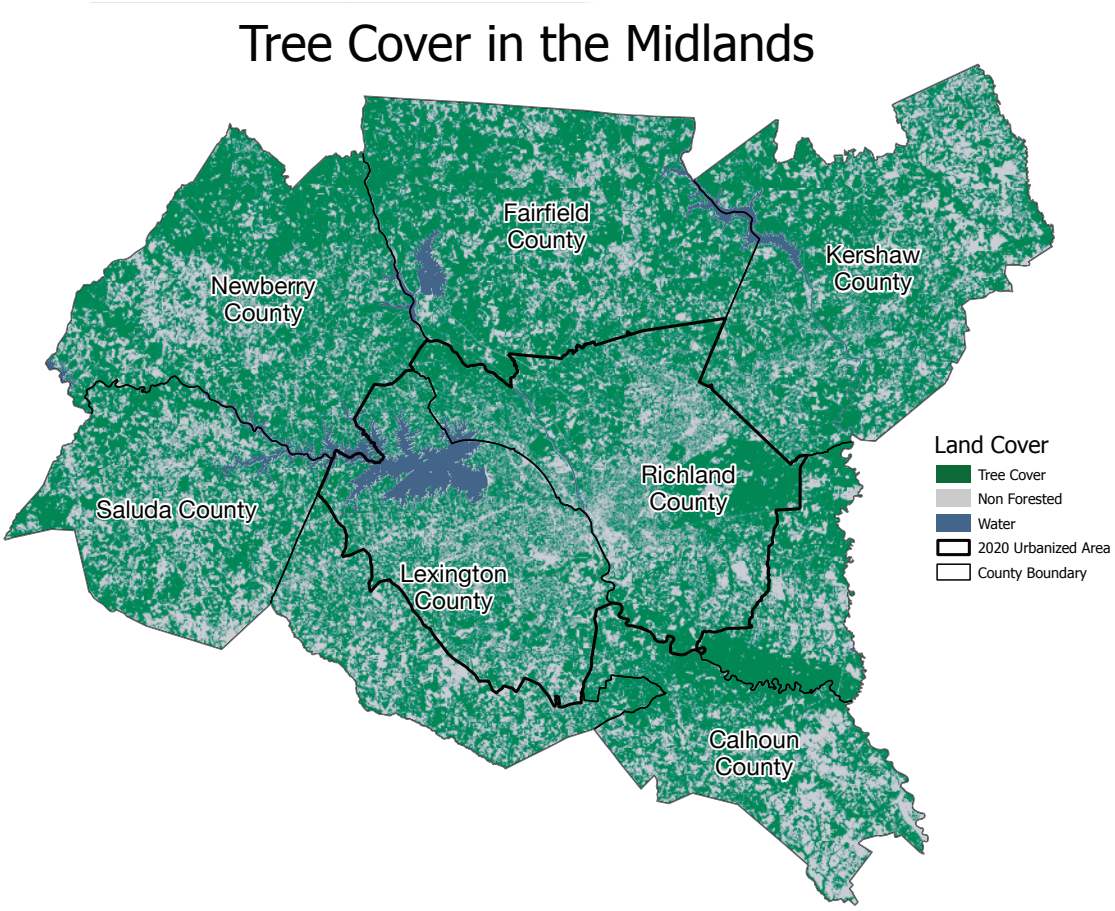
102 D. Lemoine, Climate change has already made the United States poorer, Proc. Natl. Acad. Sci. U.S.A. 122 (51) e2504376122, *https://doi.org/10.1073/pnas.2504376122* (2025).

103 Linda Joyce Forristal, Xinran Y. Lehto & Gyehee Lee (2014) The contribution of native species to sense of place, Current Issues in Tourism, 17:5, 414-433, DOI: *10.1080/13683500.2012.723679*

104 CMCOG analyzed urban and rural areas separately, because rural areas have higher tree canopy coverage. In both cases, LIDAC areas were relatively similar to nearby non-LIDAC areas when it came to relative percentage of tree canopy coverage.

Figure 3.5.

Trees (green shaded areas) cover 53% of the Midlands surface area, with the remaining surface area comprising water (blue shaded areas) and all other land use classes (gray shaded areas).[105]



While trees are often a focus of local governments and regional planning, smaller landscapes can also shape life in the region (see Figure 3.6). Changing the landscape can be done by local governments (left), community groups (right), or even individuals through shared spaces and in their yards. Both are examples of a climate action analyzed in this plan (see Section 6.3.7 - Protect Trees and Encourage Green Infrastructure). While they are small changes to the living landscape, both reduce greenhouse gas emissions and provide economic, social, and biodiversity co-benefits in areas like stormwater reductions, combating urban heat islands, and creating spaces that both people and wildlife can enjoy.

105 National Oceanic & Atmospheric Administration (2025). C-CAP High-Resolution Land Cover Data. NOAA Digital Coast & South Carolina Office of Resilience. *https://coast.noaa.gov/digitalcoast/data/ccaphighres.html*. Note that this figure is 3% lower than that reported in Section 1.3 due to differences in the cell size of the raster datasets used. This NOAA data is at a more detailed spatial scale.

Figure 3.6.
Left - A photo of a rain garden near Benedict College.[106] *Right - A photo of a pollinator garden at a local faith-based community.*[107]

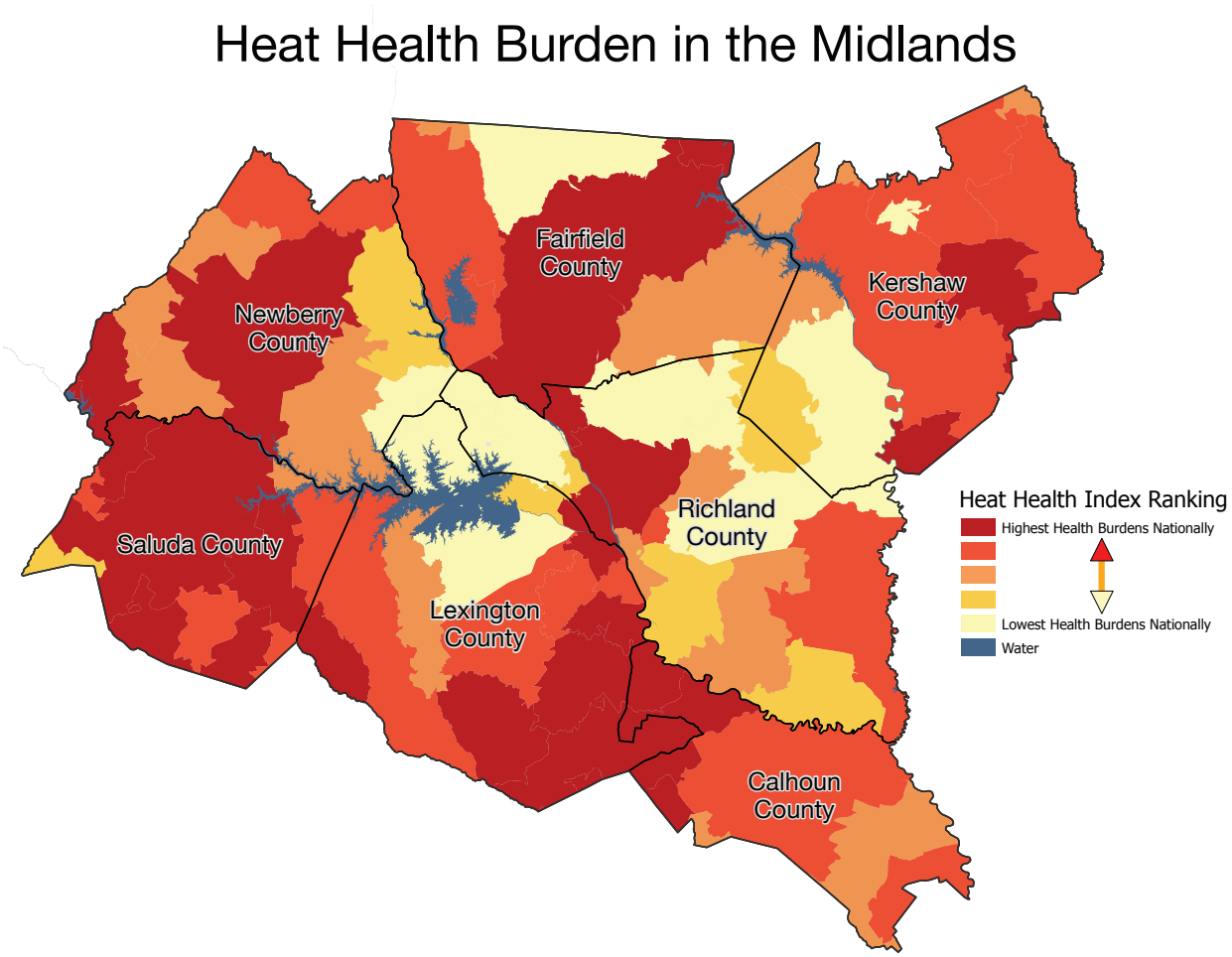
Heat Health & Equity

Although recent extreme floods in 2015 and storms in 2024 have captured the regional imagination, heat, health & equity is perhaps the most significant long-term issue for climate justice in the Midlands. Analysis from the Centers for Disease Control & Prevention shows that a number of areas of the Midlands face severe negative health outcomes from heat, with 31% of Midlands areas included among the most at-risk nationally (see Figure 3.7). The heat and health index evaluates vulnerability by examining historic health data, sensitivity, sociodemographics, and the natural & built environment.[108]

106 Photo provided by and copyright of Columbia Water / City of Columbia
107 CMCOG photo, used with permission
108 Agency for Toxic Substances and Disease Registry (2025). Heat & Health Index Fact Sheet. *https://atsdr.cdc.gov/place-health/media/pdfs/2025/09/CDC-ATSDR-HHI-Fact-Sheet-508.pdf*

Figure 3.7.

Over 30% of Midlands zip codes are among the nation's highest risk areas for heat health burdens.[109]



Responses to extreme heat can involve a variety of programs or services provided by local governments or community groups (e.g. cooling centers, infrastructure to reduce the urban heat island effect, etc.) but these responses often focus on heatwaves. Negative health outcomes can occur during both extreme heatwaves and when a household or business is unable to afford air conditioning. Nighttime temperatures are also rising, which can prevent a home from cooling down easily overnight and can lead

109 The percentile ranks are a nationwide comparison, showing the Midlands has significant heat health burdens. Agency for Toxic Substances and Disease Registry (2025). Place and Health - Geospatial Research Analysis, and Services Program. Heat & Health Index. https://atsdr.cdc.gov/place-health/php/hhi/index.html

to public health issues.[110] This can create an unjust heat health burden if no one responds to these slower injustices.[111]

For example, local utilities sometimes advise low-income customers to use less air conditioning by increasing their thermostat set point, which causes the air conditioner to run less and thus use less energy (see Figure 3.8). The flyer informs people that setting the thermostat to 82 degrees Fahrenheit would save the most money, but exposure at that level is considered a risk for heat illness by some.

For instance, growing research on heat health[112] has led to some areas regulating and setting "unsafe" temperatures for homes or workplaces. For example, California's Department of Industrial Relations sets 82 degrees Fahrenheit as a threshold for imposing requirements for worker safety in businesses, because exposure to this indoor temperature for more than 15 minutes was deemed likely to cause heat illness.[113]

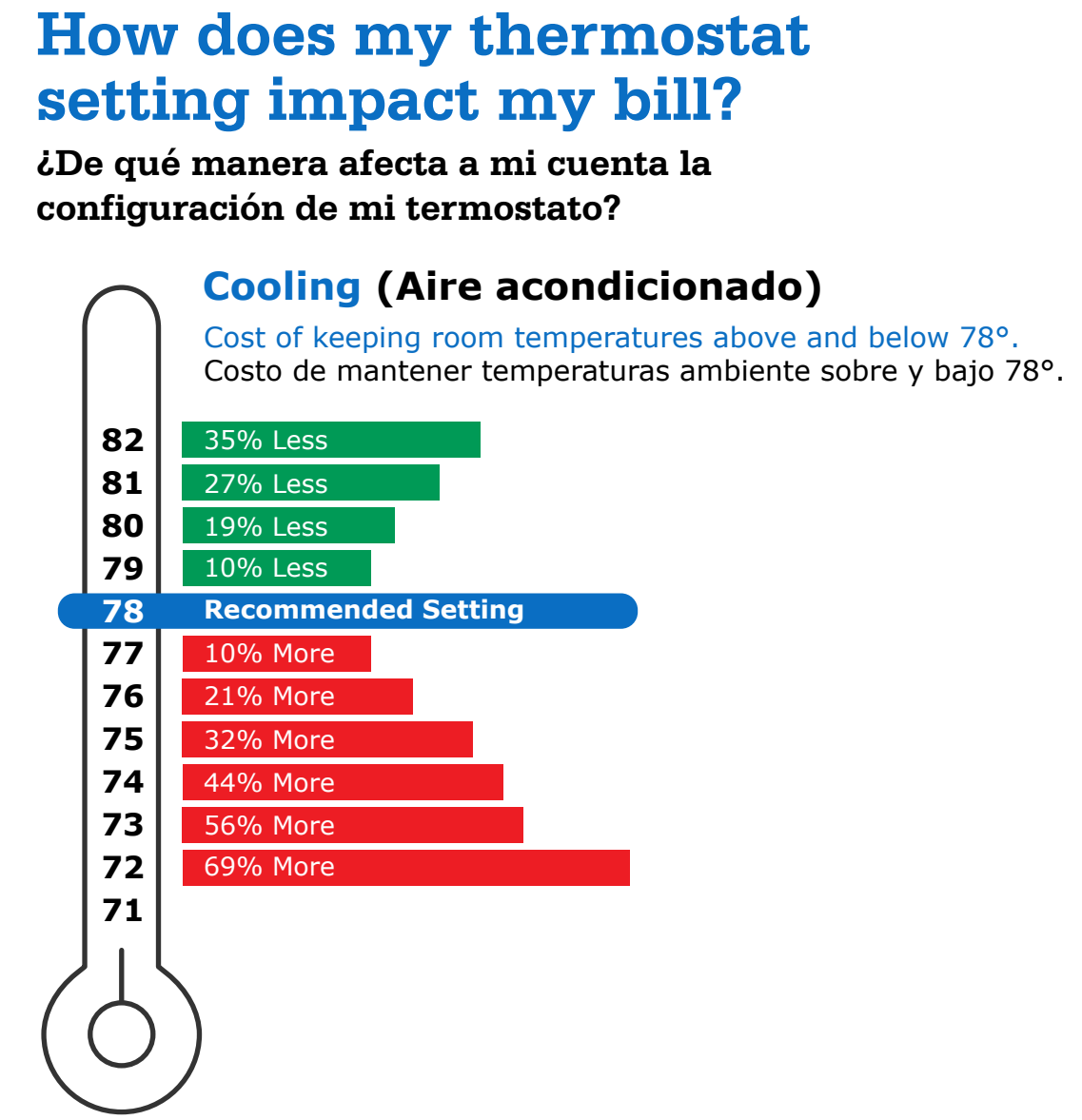
110 Examples include sleep quality and heat illness. Minor, K., Bjerre-Nielsen, A., Jonasdottir, S.S. et al. (2022). Rising temperatures erode human sleep globally. One Earth, 5(5), 354-549. https://doi.org/10.1016/j.oneear.2022.04.008 and He, C., Kim, H., Hashizume, M., Lee, W., Honda, Y., Kim, S. E., ... & Kan, H. (2022). The effects of night-time warming on mortality burden under future climate change scenarios: a modelling study. The Lancet Planetary Health, 6(8), e648-e657. *https://doi.org/10.1016/S2542-5196(22)00139-5*

111 Nixon, R. (2011). Slow Violence and the Environmentalism of the Poor. Harvard University Press. https://doi.org/10.2307/j.ctt2jbsgw

112 Romanello, M., Walawender, M., Hsu, S. C., Moskeland, A., Palmeiro-Silva, Y., Scamman, D., ... & Costello, A. (2025). The 2025 report of the Lancet Countdown on health and climate change. The Lancet.

113 California Department of Industrial Relations (n.d.). Public law of the state of California, Title 8, Subchapter 7, Group 2, Article 10, §3396. Heat Illness Prevention in Indoor Places of Employment. https://www.dir.ca.gov/title8/3396.html

Figure 3.8.
A flyer from a regional utility, collected by CMCOG at a community workshop, informs people how much money they could save by changing their thermostat set point.

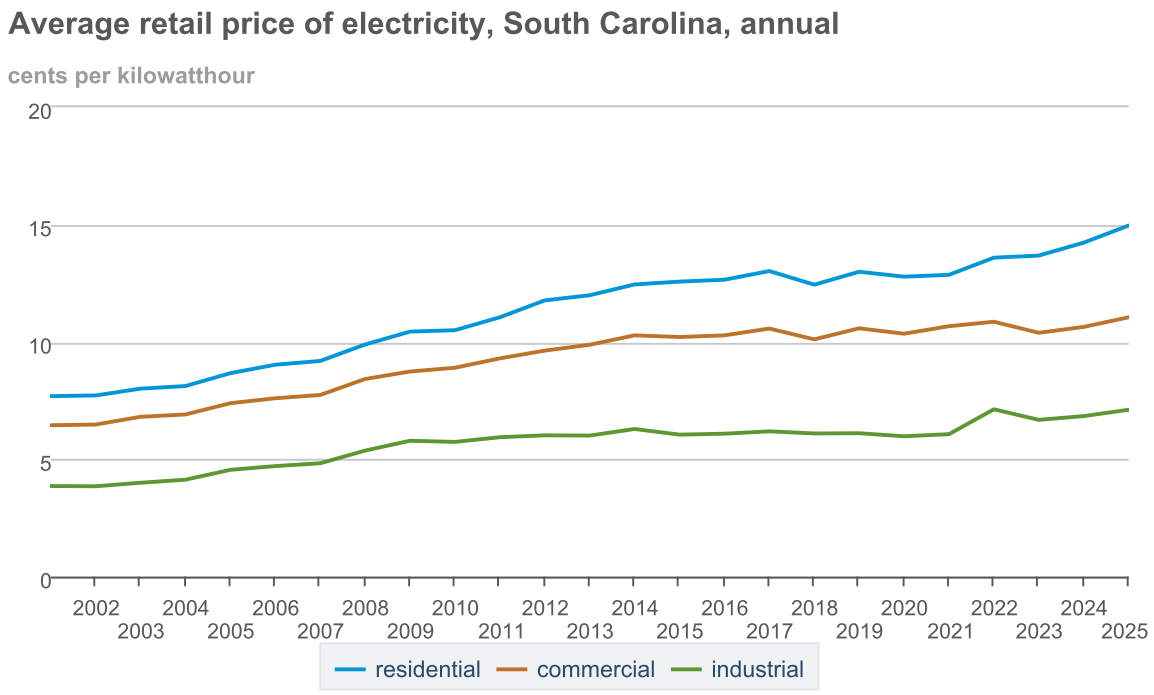


Prices for electricity in the Midlands have recently increased, and South Carolina has higher than average utility costs than some other states.[114] All customers do not necessarily pay the same amount for a unit of electricity, despite using the same utility provider (see Figure 3.9).

114 U.S. Department of Energy, Low-Income Household Energy Burden Varies Among States (Washington, DC: Office of Energy Efficiency and Renewable Energy, January 2019), https://www.energy.gov/sites/prod/files/2019/01/f58/WIP-Energy-Burden_final.pdf.

On average South Carolina's residential customers pay 30% more than commercial businesses and more than double what industrial customers pay.[115] Because everyone uses the same electricity grid, households are effectively subsidizing cheaper electricity for commercial and industrial customers. This rate setting practice is also employed in the Midlands, although not all local utilities price electricity the same way.

Figure 3.9.
Statewide average prices of electricity vary depending on what type of customer you are (residential, commercial and industrial).[116]



Data source: U.S. Energy Information Administration

In addition to the growing cost of air conditioning, it is often unjustly seen as a "luxury" despite an increase in heatwaves and rising overnight low temperatures in the summers. Hot daytime temperatures can rapidly heat a home, while warm nights can prevent a home from cooling down overnight. Landlords in South Carolina are not currently required to provide air

115 U.S. Energy Information Administration (2025). Electricity Data Browser - Average retail price of electricity, South Carolina, annual [data table 5.6]. https://www.eia.gov/electricity/data/browser

116 Figure generated from the EIA Electricity Data Browser. U.S. Energy Information Administration (2025). Electricity Data Browser - Average retail price of electricity, South Carolina, annual [data table 5.6]. https://www.eia.gov/electricity/data/browser

conditioning in rental housing.[117] Some climate action plans, including this one, do not include related actions because increasing air conditioning units does not lower greenhouse gas emissions.[118] However, that doesn't mean that policy changes regarding air conditioning should not be considered as a response that benefits the community in important ways and helps neighborhoods adapt to a changing climate.

Energy Justice & Energy Burden

Energy burden refers to when households spend a large percentage of their monthly take-home income on the utility bill. A household faces a high energy burden when it spends more than 6% of its income on energy and a severe energy burden when it spends more than 10% of its income on energy.[119] The most recent available data, for 2022, shows that energy burden is a major concern in the Midlands.[120]

In the Midlands, the average household has an energy burden of 3.1%, but households earning less than 60% of the median income have an energy burden of 10.6% and the lowest income households (earning less than 30% of the median income) have an energy burden of 26.7%.[121] Figure 3.10 shows the difference in energy burden between the lowest income households and the average of all households nearby. While this varies spatially, it does not correlate well with EPA's LIDAC geographies. Low-income households in both LIDAC and non-LIDAC areas have an energy burden about 23% higher than the average household in the same area. This indicates that energy burden is a common problem for low-income households in the Midlands. There are estimated to be approximately 45,000 households in the Midlands (~13% of households) that face these highest energy burdens. Energy burden is further discussed in Chapter 7.

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117 South Carolina Appleseed Legal Justice Center (2024). Is your Landlord Required to Fix your A/C? https://www.scjustice.org/is-your-landlord-required-to-fix-your-a-c/

118 The U.S. EPA requires all climate actions in this plan to lower air pollution which prevents actions like this one from being included.

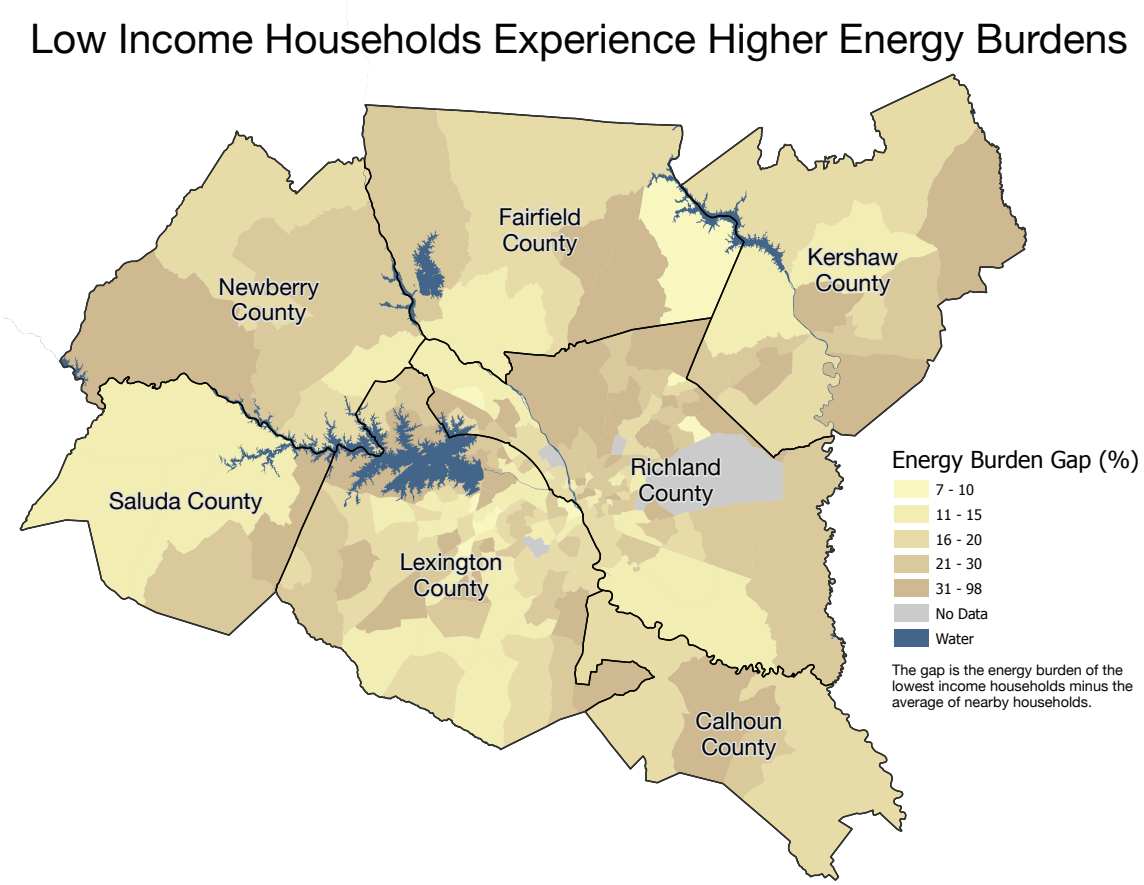
119 Ariel Drehobl, Lauren Ross, and Roxana Ayala, How High Are Household Energy Burdens? An Assessment of National and Metropolitan Energy Burdens across the United States (Washington, DC: American Council for an Energy-Efficient Economy, September 2020), 4, https://www.aceee.org/sites/default/files/pdfs/u2006.pdf.

120 For additional information about the dataset used here to analyze energy burden, see U.S. Department of Energy (2024). Low-income Energy Burden (LEAD) Tool - Factsheet. https://www.energy.gov/sites/default/files/2024-07/lead-tool-factsheet_072624.pdf

121 All figures are averages based on income percentile groups, meaning an individual household in that income percentile group may have higher or lower energy burden. See U.S. Department of Energy (2025). Low-Income Energy Affordability Data (LEAD). https://www.energy.gov/scep/low-income-energy-affordability-data-lead-tool

Figure 3.10.

Low-income households pay ~23% more for energy than the average households nearby.[122]



122 CMCOG's spatial analysis compared the energy burden of each area's lowest income households to the average energy burden of all households in the same area. The LEAD data contains additional details, including building type and fuel type, that were not separately evaluated here. U.S. Department of Energy (2025). Low-income Energy Affordability Data (LEAD). https://www.energy.gov/scep/low-income-energy-affordability-data-lead-tool

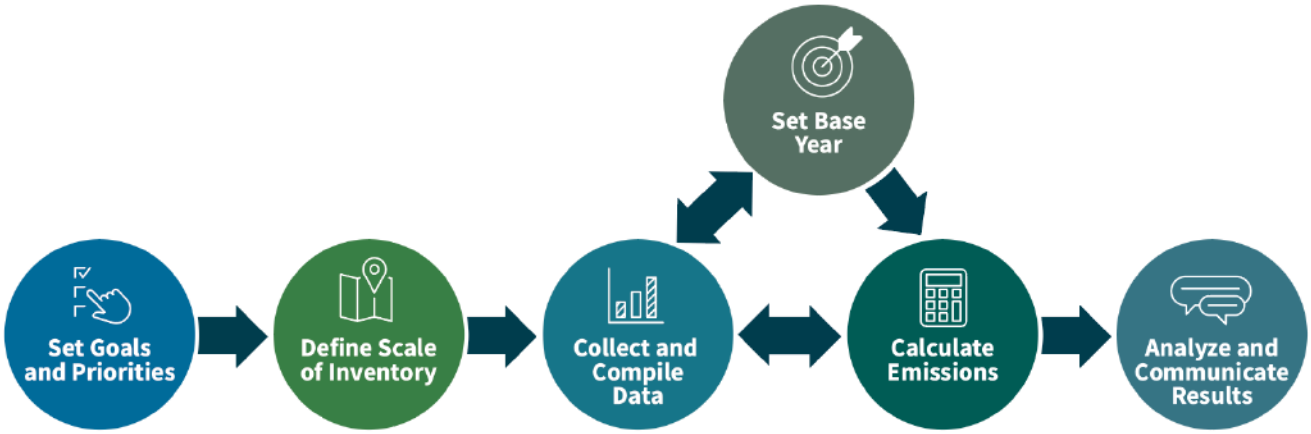
4 Greenhouse Gas Inventory

4.1 What is an Inventory? Why is it useful?

The purpose of creating a greenhouse gas inventory is to identify sources and quantify the amounts of greenhouse gases being released directly from a community or organization, or as a result of their activities. A greenhouse gas inventory should include all direct and indirect sources and sinks of these gases. Greenhouse gases are air pollutants contributing to global warming. They include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and fluorinated gases (F-gases) including hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF6).

The steps involved in creating a greenhouse gas inventory are shown in Figure 4.1.

Figure 4.1.
Overview of key steps of a greenhouse gas Inventory.[123]



123 Figure copied from EPA's User's Guide to Incorporating Existing GHG Inventories sent to CPRG grant recipients in 2024.

Identifying where greenhouse gas emissions are coming from is the first step in informing a community of what they will need to do to reduce those emissions. Climate change is a large air pollution problem, but the solution is the same as other pollution problems. Stopping the pollution will begin to stop and eventually reverse the problems.[124]

4.2 Prior Inventories

The City of Columbia has previously completed two greenhouse gas inventories, one in 2007 and another in 2019. Both inventories use a local government operations protocol and are not community-scale inventories. They show how the Midland's largest city can prioritize and focus on different operations to reduce greenhouse gas emissions in the future. The 2019 inventory analyzed sectors such as buildings, streetlights, water delivery, wastewater treatment, vehicle fleet, and employee commute. In 2019, notable emissions were observed from wastewater facilities and the vehicle fleet.

A local government operations inventory only accounts for the emissions produced directly by a city government. To CMCOG's knowledge, there has never been a comprehensive regional greenhouse gas inventory specific to the Midlands that accounts for all sources and sinks of greenhouse gases.[125]

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124 Greenhouse gases are part of the planetary carbon cycle. In fact, greenhouse gases enable a warmer planet that supports human and non-human life. But humans burning fossil fuels and some other actions (such as land use changes) artificially put more greenhouse gases into the atmosphere and cause global warming. But if humans stop emitting greenhouse gases, global warming is expected to eventually stop getting worse and return to its previous levels. It's important to know that different greenhouse gases behave differently in the atmosphere, with some gases being short-lived pollutants and others being long-lived pollutants. This is also interwoven with the geophysical system where "tipping points" could lead to further warming even if humans suddenly stopped emitting greenhouse gases tomorrow. For more discussion, see Myles, A. (2017). *Climate metrics under ambitious mitigation*. Oxford Martin School. https://www.oxfordmartin.ox.ac.uk/publications/climate-metrics-under-ambitious-mitigation and the Summary for Policy Makers of IPCC AR6, Working Group 3 https://www.ipcc.ch/report/ar6/wg3/

125 Greenhouse gas accounting at regional or national levels has occurred in various scientific analyses. Comprehensive efforts like the U.S. National Greenhouse Gas Inventory would account for greenhouse gas emissions produced in the Midlands, but the analysis is not specific to our region.

4.3 Inventory Methodology

This plan provides a comprehensive greenhouse gas inventory for the Midlands[126], for the calendar year 2022. This was the most recent year in which complete data were available while this report was being written.

This plan used the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC), Version 1.1.[127] This protocol provides a rigorous and vetted methodology, and is one of the most commonly used protocols for regional comprehensive greenhouse gas inventories around the world. It also aligns with the IPCC guidelines for emissions reporting.

The GHG inventory presented for CMCOG in this plan reports to GPC BASIC+ standard, and also provides an estimate of the region's Other Scope 3 emissions. The inventory includes all direct greenhouse gas emissions occurring in the Midlands, as well as emissions associated with changes in land-use, emissions occurring during energy transmission and distribution, and those that occur due to the consumption of goods and services produced outside our region but transported into it. The GPC protocol groups greenhouse gas emissions based on which economic sector they come from:

- **Stationary Energy** — This category refers to emissions from building systems in commercial, residential, industrial/ manufacturing, institutional, energy-generation, and agricultural buildings. It includes:
  - Use of electricity inside buildings;
  - Use of fuels other than electricity in residential, commercial, manufacturing, construction, and in industrial furnaces, generators or other stationary combustion equipment; and,
  - Emissions from transmission and distribution losses from grid-supplied energy, and emissions from fugitive emissions within the project area.
- **Transportation** — This category includes emissions from fuel and energy sources used to move people, freight and equipment within the community. These sources include:

126 As previously noted, the geographic area included in CMCOG's climate action plan includes the counties of Richland, Lexington, Kershaw, Newberry, Fairfield, Saluda and Calhoun in the U.S. state of South Carolina.

127 Greenhouse Gas Protocol. Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC). Version 1.1 https://ghgprotocol.org/ghg-protocol-cities

  - On-road passenger travel (including public transportation), freight motor vehicle travel and energy used to move waste;
  - Freight and passenger rail;
  - Waterborne transportation within the region;
  - Aviation; and,
  - Off-road vehicles and equipment.
- **Waste** — This category includes emissions from energy used to treat waste and wastewater, and emissions produced during the decomposition of solid waste and wastewater. Examples include:
  - Solid waste deposited in landfills, incinerated or composted; and,
  - Energy used in wastewater pumping and treatment processes, including filtering and aeration and chemical, UV and other treatments.
- **Industrial Processes and Product Use (IPPU)** — These are emissions produced through the use of particular products, and as a result of industrial processes. They include greenhouse gases that are produced during chemical reactions occurring in industrial facilities. In the Midlands, this category includes emissions of carbon dioxide (CO_2), methane (CH_4), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF6).[128]
- **Agriculture, Forestry and Land Use (AFOLU)** — This category includes greenhouse gases that are emitted from livestock, crops, and land, as well as carbon sequestered in trees and natural ecosystems as vegetation grows.
- **Other Scope 3** — These include consumption-based emissions produced as a result of purchases of goods and services that were produced outside the region and possibly transported into the area. The GPC protocol requires reporting of BASIC+ emissions totals (which include the categories identified above) and Other Scope 3 separately from each other, and to not include the Other Scope 3 emissions in the BASIC+ total; accordingly, this plan presents the BASIC+ total and the Other Scope 3 emissions separately.

Wherever possible, activity data was used to produce this inventory. Data sources and CMCOG's assessment of data quality for each source is included in Appendix A. As required by the EPA under the CPRG grant, all greenhouse gases are included in the inventory and are reported by GPC code separately in Appendix A.

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128 HFCs, PFCs and SF6 are included in a group of gases called F-gases.

As required by the GPC protocol, greenhouse gas emissions are also differentiated by scope in Section 4.5, with additional details in Appendix A. Scope 1 emissions refers to GHG emissions from sources located within the Midlands., scope 2 emissions refers to GHG emissions occurring as a consequence of the use of grid-supplied electricity, heat, steam and/or cooling within the Midlands, and scope 3 emissions refers to all other GHG emissions that occur outside the Midlands as a result of activities taking place within the Midlands.[129]

In most cases, this plan reports greenhouse gas emissions reductions in units of metric tons (MT) of carbon dioxide equivalents (CO_2e), a unit conversion that allows for a single number that encompasses all greenhouse gases based on their global warming potential value (GWP).[130] We used IPCC 5th Assessment Report (AR5) Global Warming Potentials, 100 year time horizon values to perform these conversions.

4.4 Greenhouse Gas Inventory Results

The calculations completed for CMCOG's climate action plan indicate that in 2022, the Midlands total gross emissions (i.e. all BASIC+ emissions, not including sequestration nor Other Scope 3 emissions) totalled 13,733,187 MT CO_2e. Unless otherwise specified, this will be referred to as the Midlands' 2022 total gross emissions in the rest of this document.

Figure 4.2 and Table 4.1 display the Midlands 2022 total gross emissions, as well as the amount of CO_2e sequestered in the region in 2022 (4,240,959 MT CO_2e), and Other Scope 3 emissions (3,022,859 MT CO_2e) for which the region was responsible in the same year.

129 Greenhouse Gas Protocol. Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC). Version 1.1 https://ghgprotocol.org/ghg-protocol-cities

130 A GWP is a unit conversion tool. Each gas that alters Earth's radiation budget is evaluated and given a number that allows all gases to be compared to carbon dioxide, the main human-emitted greenhouse gas. For example, methane's value of 28 means that each tonne of that gas has the same impact on global warming as 28 tonnes of carbon dioxide.

Figure 4.2.
GHG emissions by sector in the Midlands, 2022.

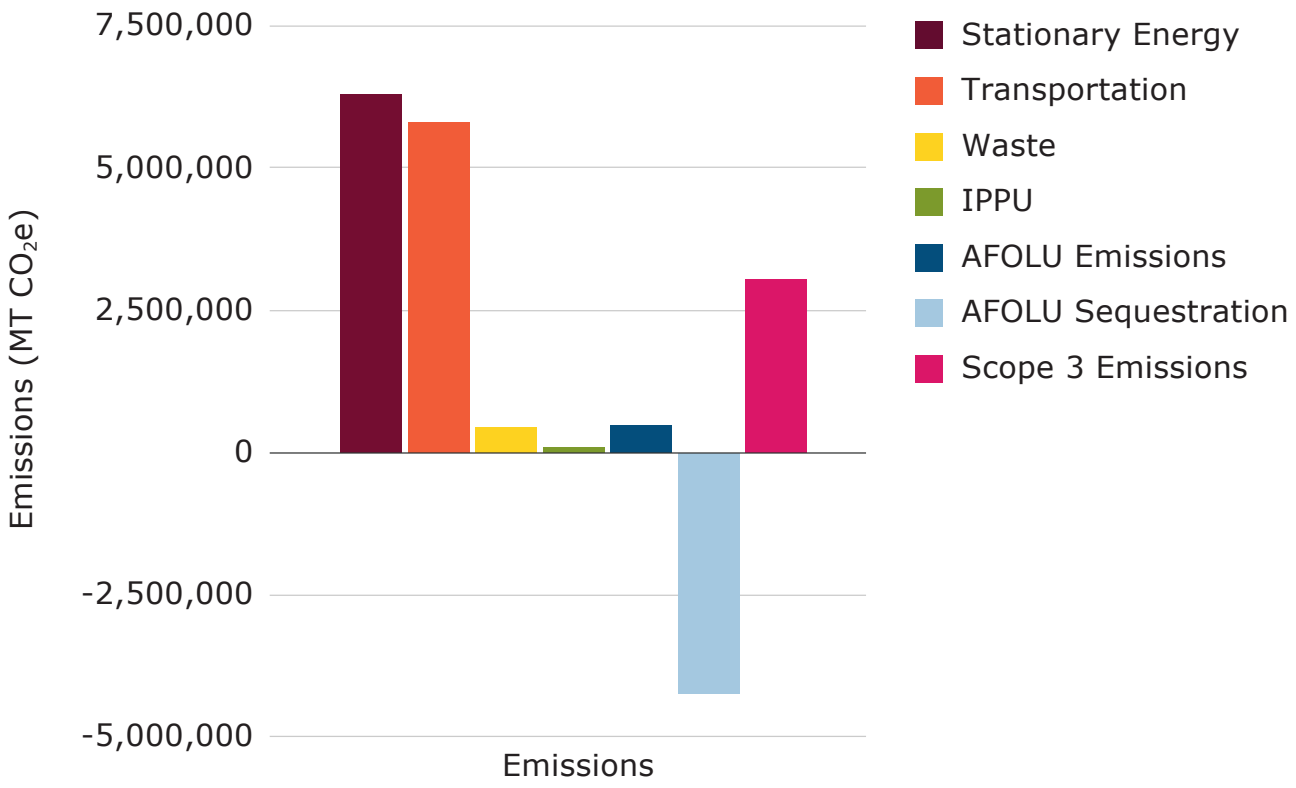


Table 4.1.
The Midlands' community GHG emissions by scope in 2022.

Sector	Total by Scope (tCO_2e)				Total by community-induced reporting level (tCO_2e)		Net Emissions
	Scope 1	Scope 2	Scope 3	Other Scope 3	BASIC	BASIC+	
Stationary Energy	1,607,071	4,462,064	214,293		6,069,135	6,283,428	6,283,428
Transportation	5,696,714	8,397	119,826		5,705,111	5,824,937	5,824,937
Waste	446,722		0		446,722	446,722	446,722
IPPU	741,662					741,662	741,662
AFOLU emissions	476,438					476,438	476,438
AFOLU sequestration	-4,240,959						-4,240,959
Other Scope 3				3,022,859			3,022,859
Total	**8,968,607**	**4,470,461**	**334,119**	**3,022,859**	**12,220,968**	**13,733,187**	**12,555,087**
	(All Scope 1 (Territorial) emissions, excluding sequestration)				*(All BASIC emissions)*	*(All BASIC+ emissions, excluding sequestration)*	*(All emission sources & sinks)*

Key Insights from the Inventory

- Our gross emissions per person are slightly higher than the national average. With a population in 2022 of approximately 870,000 people[131], per capita emissions in the same year were approximately 15.7 MT CO_2e.[132] For comparison, the national per capita emissions in 2022[133] were 15.6 MT CO_2e.
- Our forests, plants, soils and wetlands provide important carbon storage. In 2022 alone, over 4.2 million MT of CO_2e were extracted from the air by plants growing in the Midlands, and converted to carbon in the form of vegetative growth. This represents sequestration of 31% of the total greenhouse gases released in the region annually. It will not be possible to sequester all of the region's greenhouse gas emissions, and these emissions should not be hidden using carbon credits or other policies that obscure gross emissions (see Chapter 6 - Additional Policy Considerations).
- While stationary energy use constitutes our largest source of emissions (at 50%), our second-largest source is the transportation sector. Because our region is geographically spread out, we travel a lot, particularly in vehicles. As a result, greenhouse gas emissions from vehicles are very high - specifically, the combustion of gasoline and diesel fuel in on and off-road vehicles produced 5.5 million MT CO_2e in 2022 (approximately 40% of gross emissions).

Comparison to Overall U.S. Greenhouse Gas Emissions

Figure 4.3 shows results from the national greenhouse gas inventory. Note that the sectors do not align because a nationwide inventory uses a different protocol. The most notable difference is in the transportation sector. This sector is 46% of our greenhouse gas emissions according to this inventory. This aligns with external analyses, which have identified the Midlands as the 3rd worst area in the nation on a per-capita basis for

131 U.S. Census Bureau (2024). American Community Survey, 5-year estimates for 2022. *https://data.census.gov*

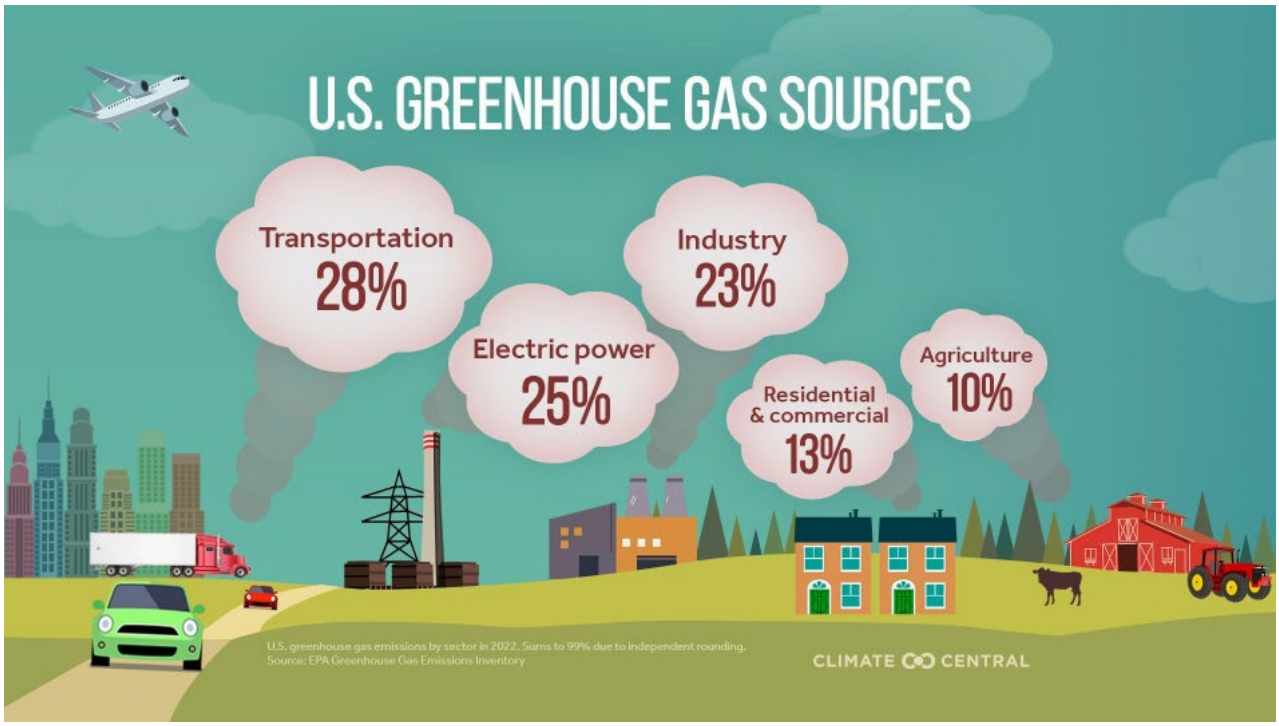
132 These are the estimated per capita gross emissions - that is, not including the CO_2 sequestered.

133 "Data Page: Per capita CO2 emissions," part of the following publication: Hannah Ritchie, Pablo Rosado, and Max Roser (2023) - "CO2 and Greenhouse Gas Emissions". Data adapted from Global Carbon Project, Various sources. Retrieved from *https://ourworldindata.org/grapher/co-emissions-per-capita*

transportation emissions.[134] Conversely, the emissions associated with our electric power grid are lower than in some communities in the U.S. due to the high percentage of nuclear power generation in South Carolina.

Figure 4.3.

These percentages come from the U.S. National Greenhouse Gas Emissions Inventory for the same year (2022) as our regional inventory.[135]



134 Streetlight Data (2024). Transportation Climate Impact Index. https://learn.streetlightdata.com/transportation-emissions-climate-impact-index-2024. For local discussion of this report, see Archote, J. (2024). Car-centric Columbia among nation's worst for commuter miles and vehicle emissions. Post and Courier. https://www.postandcourier.com/columbia/news/emissions-climate-transportation-columbia-midlands/article_64c22eb2-f82d-11ee-80e0-c71faae6cb91.html

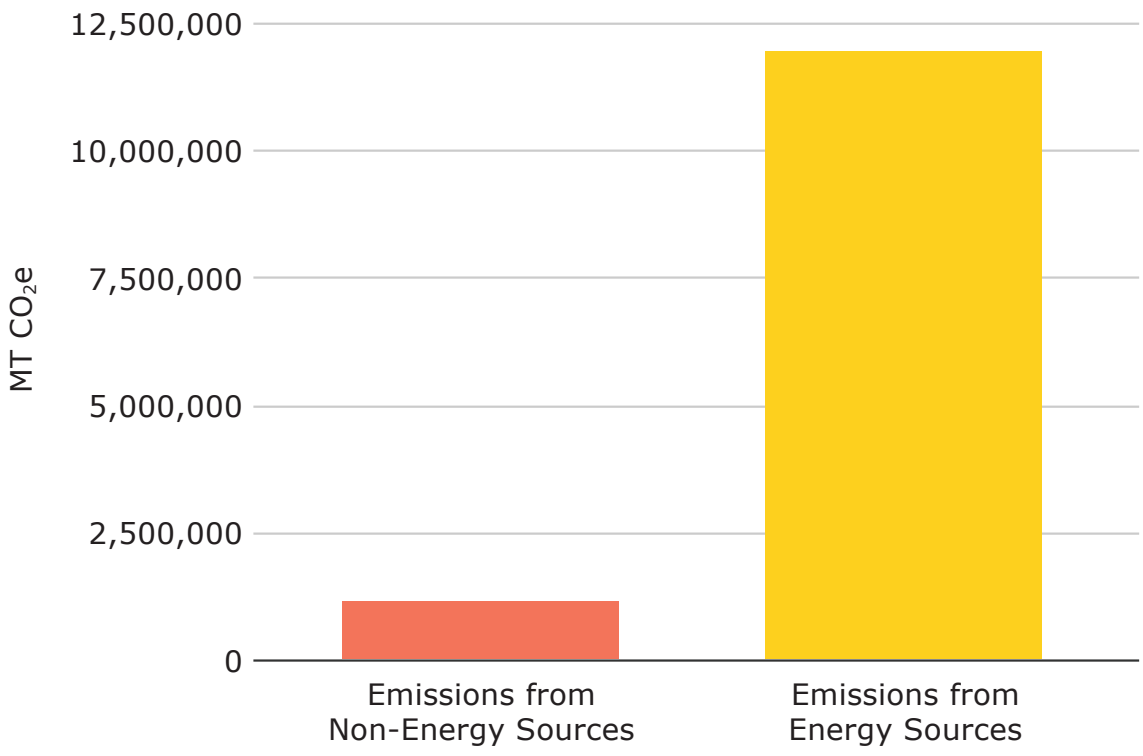
135 Image copied from, and copyright of, Climate Central. Climate Central (2024). Heat-Trapping Pollution. https://www.climatecentral.org/climate-matters/heat-trapping-pollution-2024

Energy vs. Non-Energy Emissions

In the Midlands, over 90% of all emissions come from burning fossil fuels. The remaining emissions come from the decomposition of organic matter in landfills and the natural environment, as well as from chemical reactions occurring during industrial processes.

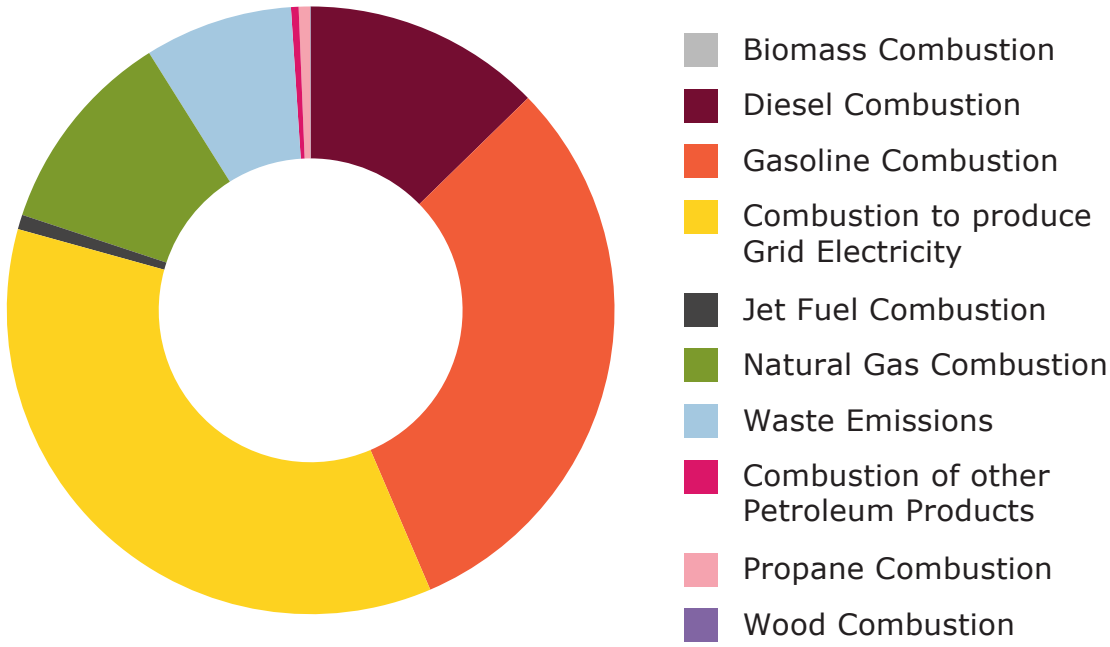
Figure 4.4 illustrates this split between energy and non-energy-based emissions in 2022. The region will need to transition away from fossil fuels to eliminate greenhouse gas emissions.

Figure 4.4.
Energy and non-energy BASIC+ emissions in 2022 in the Midlands.



A more detailed summary of the Midlands' specific fuels and non-energy sources of emissions is shown in Figure 4.5 below.

Figure 4.5.
GHG emissions by fuel or non-energy related source in the Midlands, 2022.

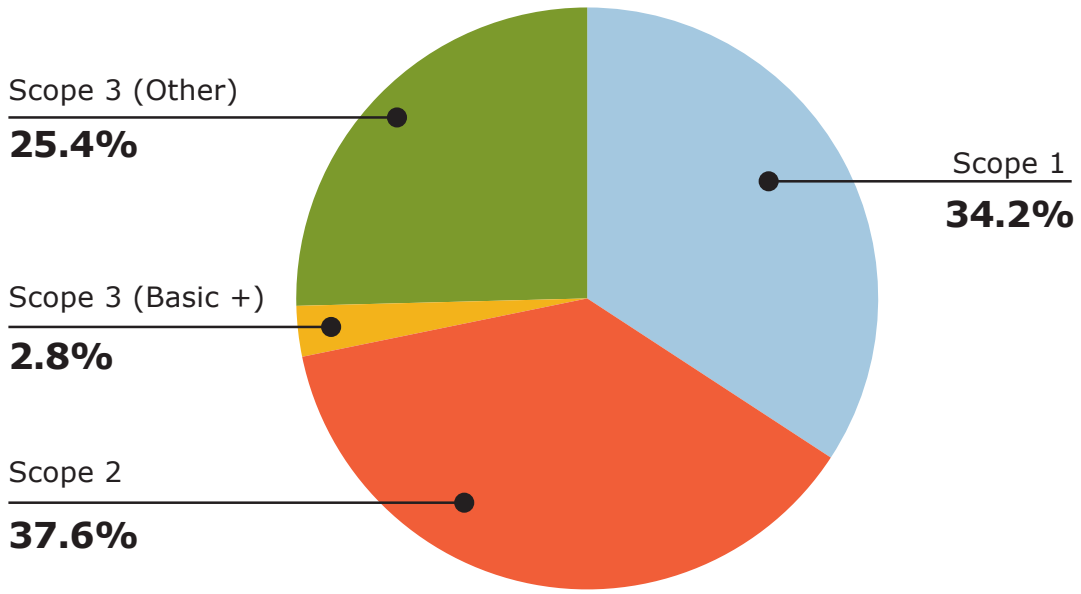


4.5 Other Scope 3 (Consumption-based GHG Emissions)

Figure 4.6 illustrates the proportions of the Midlands' total 2022 emissions that were scopes 1, 2 and 3, and subdivides the scope 3 emissions into those included in the BASIC+ inventory, and those considered 'Other Scope 3' emissions.

In this document, Other Scope 3 emissions are also referred to as consumption-based emissions.

Figure 4.6.
2022 GHG emissions in the Midlands, by scope.



The total emissions reported in the Midlands' 2022 BASIC+ inventory include scope 3 emissions totalling 334,119 MT CO_2e. The region is also responsible for a further 3,022,859 MT CO_2e of Other Scope 3 (or consumption-based) emissions from the purchase of goods and services.[136]

The GPC protocol requires reporting BASIC+ and Other Scope 3 emissions separately. This is because the former categories are all economic activities that are occurring in our region or can be explicitly tied to our region (like the purchase and use of electricity). However, consumption-based emissions are harder to quantify, and so for this inventory CMCOG has used an estimate from U.C. Berkeley.[137] Unlike the BASIC+ inventory, people in the Midlands do not always have the ability to lower these emissions because decisions about the production of goods or delivery of services are being made outside the Midlands. These goods and services are however, only produced and shipped as a result of demand for them from within the

136 Christopher M. Jones and Daniel M. Kammen, Spatial Distribution of U.S. Household Carbon Footprints Reveals Suburbanization Undermines Greenhouse Gas Benefits of Urban Population Density. Environ. Sci. Technol., 2014, 48 (2), pp 895–902, dx.doi.org/10.1021/es4034364

137 Christopher M. Jones and Daniel M. Kammen, Spatial Distribution of U.S. Household Carbon Footprints Reveals Suburbanization Undermines Greenhouse Gas Benefits of Urban Population Density. Environ. Sci. Technol., 2014, 48 (2), pp 895–902, dx.doi.org/10.1021/es4034364

Midlands, so steps taken to lower consumption-based emissions are also valuable climate actions. Therefore, emissions generated from them are considered to be the responsibility of the Midlands for emissions reporting frameworks.

The two climate actions described in the Reduce Consumption-based Carbon Impact strategy) affect consumption-based emissions. All of the remaining climate actions in this plan affect the BASIC+ category.

5 GHG Reduction Targets and Future Projections

5.1 Regional GHG Targets

CMCOG has set a target, based on scientific recommendations and community input, to reduce greenhouse gas emissions region-wide by 46% by 2035,[138] and to become a net-zero emitter of greenhouse gases by 2050[139]. This target is a science-based goal that aligns with the guidance of the IPCC.[140] These goals can often align with other targets, such as local cities[141] pursuing clean energy or statewide air pollution[142] and waste reduction[143] planning. But most importantly, our community is already dealing with climate change here and now. Achieving these regional greenhouse gas reduction targets will result in less harm to communities in the Midlands. Further information on GHG targets can be found in Appendix B.

5.2 What if we take no action?

What would the Midlands's greenhouse gas emissions be in 2035 and 2050 if we don't change anything about the way we live? We modelled a **business as planned (BAP)** scenario in which changes in demographics, employment, climate, and sectors of our economy like land use, energy and transportation continue onwards as they would reasonably be expected to change without any climate action. This is a useful reference to compare against a **low-carbon (LC) scenario** where this climate action plan is implemented.

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138 Relative to a 2022 baseline.

139 This means that while the Midlands may still emit some greenhouse gases, these will be offset by removals of greenhouse gases [mostly from natural sequestration in our forests].

140 M. Pathak, R. Slade, P.R. Shukla, J. Skea, R. Pichs-Madruga, D. Ürge-Vorsatz,2022: Technical Summary. In: Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [P.R. Shukla, J. Skea, R. Slade, A. Al Khourdajie, R. van Diemen, D. McCollum, M. Pathak, S. Some, P. Vyas, R. Fradera, M. Belkacemi, A. Hasija, G. Lisboa, S. Luz, J. Malley, (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA. doi: 10.1017/9781009157926.002.

141 For example, City of Columbia Resolution No: R-2023-053. *https://citycouncil.columbiasc.gov/download/resolution-no-r-2023-053/*

142 Palmetto Air Quality Collaborative. 'DRAFT South Carolina Priority Climate Action Plan'. 2024. https://scor.sc.gov/sites/scor/files/Documents/SC_PCAP_Draft_Version_1.0_ForWeb.pdf

143 South Carolina. '61-62.5 Standard No. 3 Waste Combustion and Reduction Regulation'. 2016. *https://des.sc.gov/sites/des/files/Library/Regulations/R.61-62.5_Std.3.pdf*

For projecting both scenarios, we used modeling software called ScenaCommunity.[144] This software used geographic, demographic, transportation, energy, and building stock data specific to the Midlands, as well as standard emissions factors and forecast costs in combination with different sets of assumptions about what will occur in the future to model scenarios of what the future may look like in the Midlands. To understand more about how this modeling works, and the data used, please refer to the separate Data, Methods and Assumptions Manual.

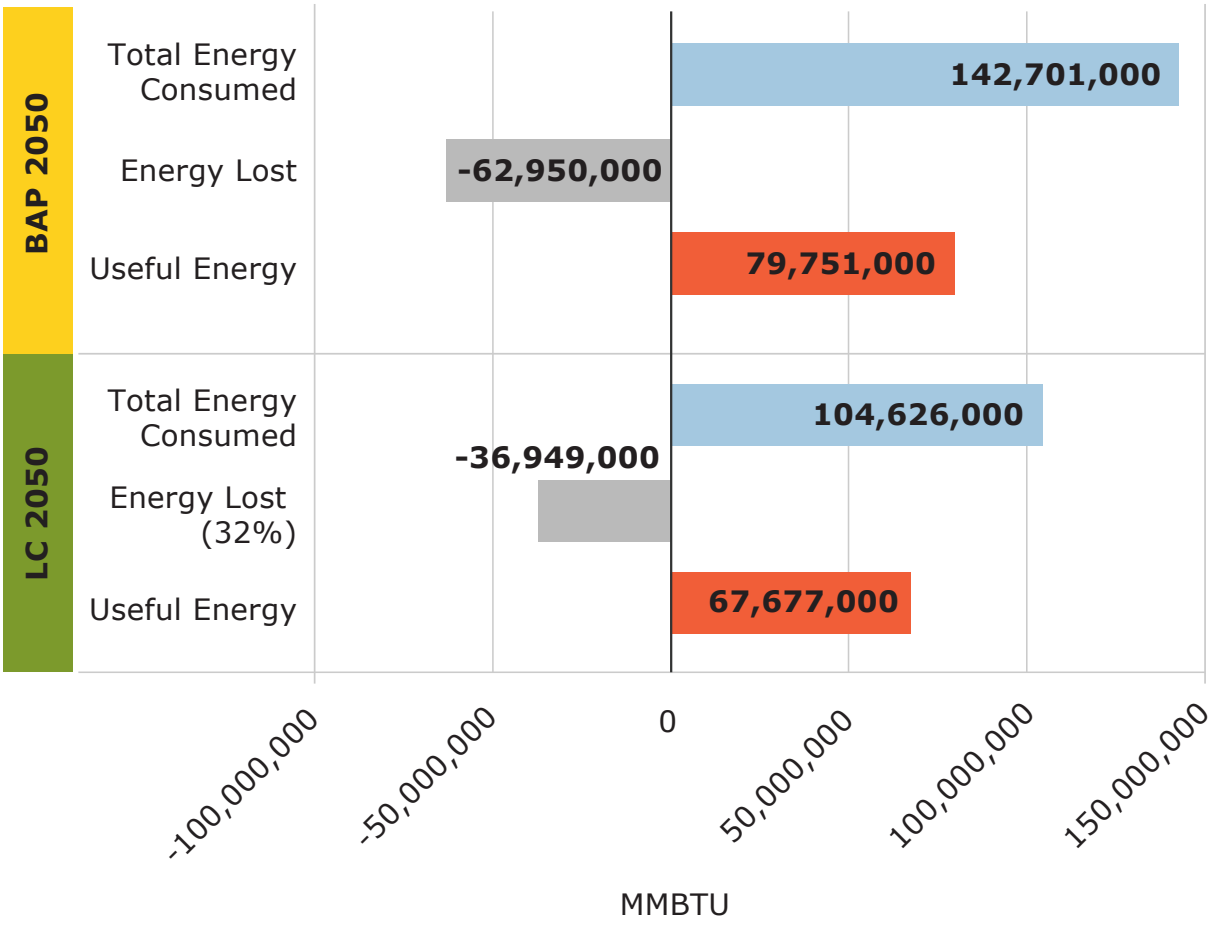
A third scenario, a business as usual (BAU) scenario, is a forecast with fewer assumptions and based primarily on current air pollution data. The results for the BAU scenario are provided in the Data, Methods and Assumptions Manual.

Impacts to Total Energy Consumed, and Energy that is Lost

The first thing to notice in this case is the difference in total energy consumed between the two scenarios. The amount of energy consumed in the Midlands will be significantly lower by 2050 in the LC than in the BAP scenario. Figure 5.1 illustrates two important elements of this difference.

144 Sustainability Solutions Group. ScenaCommunity web page. https://ssg.coop/tools/scenacommunity/ Accessed March 7, 2026.

Figure 5.1.
Proportion of Total Energy Consumed in the BAP and LC Scenarios that is Lost vs. Useful, in the year 2050.



Firstly, the total amount of energy consumed in 2050 will be 27% lower in the LC scenario than the BAP, despite the fact that the population has grown and economic development has continued. This reflects the improved energy efficiency in technologies that draw less energy (such as LED lighting), better insulated buildings, and greater proportions of trips taken by active and shared modes of transportation in the LC scenario.

Secondly, the amount of energy that is lost or wasted is 41% lower in the LC scenario than in the BAP scenario. This reflects the benefits of technologies such as heat exchange systems (or heat pumps) and electric vehicles, both of which do not lose energy transformed into heat during combustion, as their fossil fuel counterparts do.

If the actions that cause these reductions in energy use are not made, the following risks would increase in both likelihood and severity:

- Demand for traditional sources of energy would increase in proportion to the growth in population and economic development, placing increasing strain on all fuel and energy sources.
- Continued reliance on imported fossil fuels would extend the unpredictable costs of these fuels into the future.
- A direct result of using less energy is having to pay for less energy. Conversely, if energy consumption is not reduced, consumers will need to keep paying for as much as they use.

Furthermore, if the community does not improve energy efficiency, but instead chooses to shift simply to electrification, the risk of exceeding the electricity grid's capacity increases.

Impacts to Emissions

The pollution forecast for the BAP scenario (including both BASIC+ emissions and consumption-based), and for the low-carbon scenario (reflecting the impact of all climate actions, including the two actions targeting consumption-based emissions), are shown in Figures 5.2 and 5.3, and in Table 5.1 below.

Figure 5.2.
Projected GHG emissions (BASIC+ and Consumption-based) in the BAP and LC scenarios, 2022-2050.

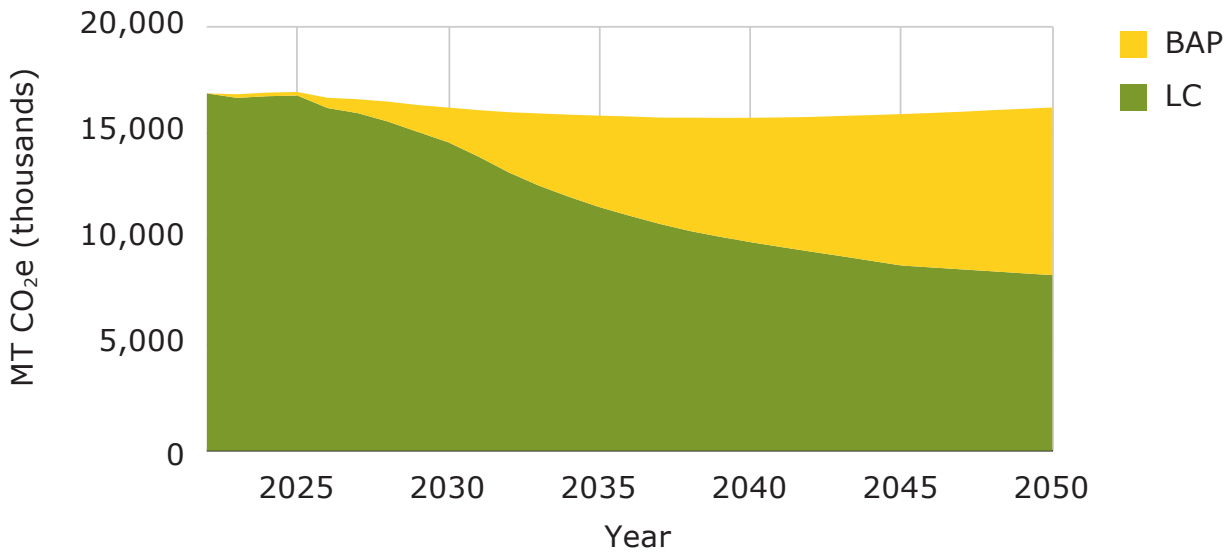
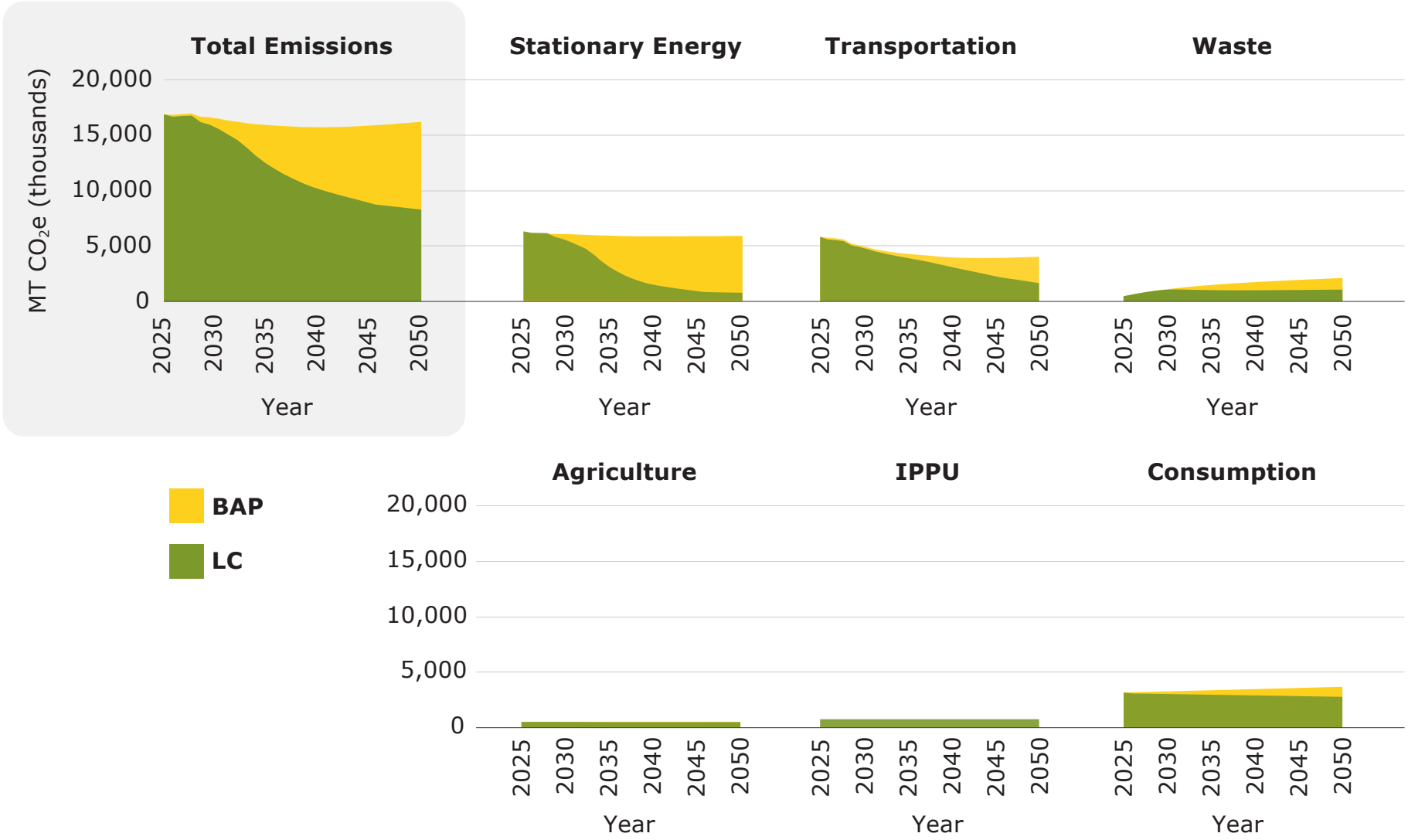


Figure 5.3 below shows the projected GHG emissions in the BAP and LC scenarios, for each sector.

Figure 5.3.
Projected GHG emissions (BASIC+ and Consumption-based) by Sector in the BAP and LC scenarios, 2022-2050.



CMCOG's total emissions in the BAP and LC scenarios are broken out by sector in Table 5.1.

Table 5.1.
Total GHG emissions by scenario and sector.

Sector	BAP Scenario			LC Scenario	
	2022 (Base Year)	2035	2050	2035	2050
STATIONARY					
Residential	2,255,740	1,881,233	1,730,854	561,484	156,155
Commercial and Institutional	2,288,213	2,303,323	2,500,662	956,444	51,389
Manufacturing and Industry	1,683,635	1,688,670	1,652,974	956,000	566,050
Agriculture, Forestry and Fishing	25,320	28,508	30,000	19,430	11,183
Fugitive	30,519	28,787	31,707	18,076	11,789
TRANSPORTATION	5,824,937	4,181,305	4,030,100	3,673,000	1,641,000
WASTE	446,722	1,115,420	1,321,780	977,077	1,043,416
IPPU	741,662	741,662	741,662	741,662	741,662
AFOLU	476,438	476,438	476,438	472,702	467,534
TOTAL BASIC+	13,773,186	12,445,346	12,516,177	8,375,875	4,690,178
% change over base year	n/a	-10%	-9%	-40%	-66%
OTHER SCOPE 3	3,098,077	3,367,910	3,679,255	2,963,676	2,775,021
TOTAL incl. Other Scope 3	16,871,263	15,813,236	16,195,432	11,339,551	7,465,199
% change over base year	n/a	-6%	-4%	-33%	-56%

6 Climate Actions for a Low Carbon Future

The business as planned (BAP) scenario results demonstrate that existing policies, regulations, market trends and efficiency improvements in the Midlands will only lower emissions by 10% by 2035 and by 9% by 2050. This is significantly short of the region's targets. More ambitious efforts will be required especially in the next 5 years to achieve a 46% reduction by 2035.

In the low-carbon (LC) scenario, a series of climate actions were selected that will reduce greenhouse gas emissions from the sources found in the Midlands, and bridge the gap between the BAP scenario and the targets. The actions that were selected and the timeline on which they are scheduled are a combination of best practices (i.e. the most efficient and effective, proven actions currently available), and local expertise and community input.

The climate actions are grouped into ten "strategies" each of which focuses on either a big source of greenhouse gas emissions or reflects key community priorities.

Climate Action Strategies

1. **Design Buildings for Life**
2. **Reimagine Transportation in the Midlands**
3. **Expand Renewable Energy Generation**
4. **Advance Low-carbon Transformation in Industry**
5. **Scale-up Waste Reduction and Diversion Initiatives**
6. **Optimize Water and Wastewater Operations**
7. **Protect Trees and Encourage Green Infrastructure**
8. **Enhance Agriculture and Soil Management Practices**
9. **Intentional Land Use**
10. **Reduce Consumption-Based Carbon Impact**

All of the actions were scheduled on a timeline that has been designed to maximize the depth and speed of change, reduce overall energy use, avoid the loss or waste of energy, and minimize investment and maintenance costs. The combined impact of these actions was modeled, producing the results provided in this section of the plan.

> **When implemented as laid out in this plan, these actions will reduce the Midlands's total annual GHG emissions from the Midlands by 39% by 2035 and by 66% by 2050. However, any climate action that reduces greenhouse gas emissions will benefit the Midlands. Even if it is a small action, every tonne of greenhouse gases reduced makes a difference.**

The scale and timing of the actions in this plan are ambitious in order to reach towards the region's targets, and to show how much is possible.

Individual communities and different participants each have different ways in which they can move these actions forwards. Information on how different actors can advance this work is found in Chapter 8 of this document, which is focused on implementation.

Working together and coordinating our efforts will reduce greenhouse gas emissions. It will also provide benefits beyond reducing greenhouse gases. Additional information and calculations about these co-benefits are found in Chapter 7.

6.1 Climate Action Strategies

The ten strategies include 43 emissions reduction actions which are described in Table 6.1. The actions in the first nine strategies reduce emissions in the BASIC+ inventory. The final strategy contains actions that reduce consumption-based, or 'Other Scope 3' emissions.

Table 6.1.
The strategies and actions in the low-carbon scenario.

Strategies	Actions	Description
Commercial and Residential Buildings		
Design Buildings for Life	**High Performance New Residential Buildings**	▪ Update building and energy efficiency code for new residential buildings to IECC 2021 beginning in 2027. ▪ Every four years thereafter, upgrade the building and energy efficiency code to align with the latest IECC code, until 2040 at which time, new residential buildings will be built to a net-zero standard.
	High Performance New Non-residential Buildings	▪ Update building and energy efficiency code for new non-residential buildings to IECC 2021 beginning in 2027. ▪ Every four years thereafter, upgrade the building and energy efficiency code to align with the latest IECC code, until 2040 at which time, new non-residential buildings will need to be built to a net-zero standard.
	Residential Energy Efficiency Improvements: **Level 1 - Weatherization**	▪ All homes built before 2020 will undergo energy efficiency retrofits. Level 1 of residential retrofits will consist of 'weatherization' measures only - i.e. adding insulation and sealing air leaks. ▪ In the first year (2028) 2% of existing pre-2020 homes will undergo these improvements. The proportion of homes undergoing these measures will increase each year to ensure all homes undergo these improvements by 2045.

Strategies	Actions	Description
Design Buildings for Life	**Residential Energy Efficiency Improvements:** **Level 2 - Enhanced Energy Efficiency**	▪ Level 2 of residential retrofits will consist of measures such as foundation floor and wall insulation that will increase the energy efficiency beyond basic weatherization levels but not to deep energy retrofits. ▪ Each year's group of homes that have Level 1 measures completed will undergo Level 2 improvements 2 years after the Level 1 measures. That is, the first year of Level 2 retrofits will be 2030, and in this year the 2% of homes that underwent Level 1 measures in 2028 will undergo Level 2 improvements. The last cohort of homes will undergo Level 2 retrofits in 2047.
	Residential Energy Efficiency Improvements: **Level 3 - Deep Retrofits**	▪ Level 3 of residential retrofits will reduce each home's energy consumption to 50% below what it was before Level 1 retrofits - deep energy retrofits. ▪ Each year's group of homes that have Level 1 measures completed will undergo Level 3 measures 5 years after the Level 1 measures. That is, the first year of Level 3 retrofits will be 2033, and in this year the 2% of homes that underwent Level 1 measures in 2028 will undergo Level 3 improvements. ▪ All pre-2020 homes will have Level 3 retrofits completed on them by 2050.

Strategies	Actions	Description
Design Buildings for Life	**Non-residential Energy Efficiency Improvements:** **Level 1 - Weatherization**	▪ All non-residential buildings built before 2020 will undergo energy efficiency retrofits. Level 1 of these retrofits will consist of 'weatherization' measures only - i.e. adding insulation and sealing air leaks. ▪ In the first year (2028) 2% of existing pre-2020 non-residential buildings will undergo these improvements. The proportion of buildings undergoing these measures will increase each year to ensure all pre-2020 non-residential buildings undergo these improvements by 2045.
	Non-residential Energy Efficiency Improvements: **Level 2 - Enhanced Energy Efficiency**	▪ Level 2 of non-residential retrofits will consist of measures such as foundation floor and wall insulation that will increase the energy efficiency beyond basic weatherization levels but not to deep energy retrofits. ▪ Each year's group of buildings that have Level 1 measures completed will undergo Level 2 improvements 2 years after the Level 1 measures. That is, the first year of Level 2 retrofits will be 2030, and in this year the 2% of buildings that underwent Level 1 measures in 2028 will undergo Level 2 improvements. The last cohort of non-residential buildings will undergo Level 2 retrofits in 2047.

Strategies	Actions	Description
Design Buildings for Life	**Non-residential Energy Efficiency Improvements:** **Level 3 - Deep Energy Retrofits**	▪ Level 3 of non-residential retrofits will reduce each building's energy consumption to 50% below what it was before Level 1 retrofits. ▪ Each year's group of buildings that have Level 1 measures completed will undergo Level 3 measures 5 years after the Level 1 measures. That is, the first year of Level 3 retrofits will be 2033, and in this year the 2% of non-residential homes that underwent Level 1 measures in 2028 will undergo Level 3 improvements. ▪ All pre-2020 non-residential buildings will have Level 3 retrofits completed in 2050.
	Heat Pumps for Water Heating	▪ For new buildings (residential and non-residential): Beginning in 2030, all new construction uses air source heat pumps for water heating. ▪ For existing buildings (residential and non-residential): Immediately after Level 3 retrofits are completed, all water heating systems will be replaced with air source heat pumps.
	Heat Pumps for Space Heating & Cooling	▪ For new buildings (residential and non-residential): Beginning in 2030, all new construction uses air source heat pumps for space heating and cooling. ▪ For existing buildings (residential and non-residential): Immediately after Level 3 retrofits are completed, all fossil-fuel space heating and cooling systems would be replaced with air source heat pumps.

Strategies	Actions	Description
Transportation		
Reimagine Transportation in the Midlands	**Increase Active Transportation**	▪ Gradually increase the portion of trips taken by either walking or cycling: – For all trips of 1 mile or less in distance, gradually increase the proportion that are walked until by 2040, 60% of trips of this length are walked. – For all trips of 5 miles or less in distance, gradually increase the proportion that are biked until by 2040, 60% of trips of this length are biked.
	Increase Transit Ridership	▪ Increase transit ridership from 0.5% to 2% of total trips by 2040, region-wide where there is transit. ▪ Increase carpooling in places where there is no transit.
	Reduce vehicle-miles-travelled (VMT) in Columbia	▪ Within Columbia, the total VMT will be reduced by 5% by 2030. After this it will remain constant at this level.
	Shift Personal Vehicle Travel to Rail Travel	▪ Increase train and tram ridership as follows: – By 2045, shift 40,000 personal vehicle trips between Columbia and Charlotte, NC to (a new) electric, inter-city passenger rail service.; and, – By 2040, shift 7.5% of personal vehicle trips that fall within the census tracts of the old tram lines to electric tram trips.
	Replace Transit Buses and Shuttles with Electric Models	▪ All transit vehicles, including buses and shuttles will gradually be switched from diesel and compressed natural gas (CNG) to battery-electric vehicles by 2040.

Strategies	Actions	Description
Reimagine Transportation in the Midlands	**Electrify Personal and Commercial Light-duty Vehicles**	▪ Sales of new personal and commercial light-duty vehicles will be increasingly electric, according to the following schedule: – By 2036, 52% will be electric; – By 2040, 68% will be electric; – By 2045, 80% will be electric; and – By 2050, 100% will be electric.
	Replace Municipal and County Fleet Vehicles with Electric Vehicles	▪ Within all municipal and county fleets: – All new LDVs are EVs by 2030; – All new MDVs are EVs by 2033; and – All new HDVs are ZEVs by 2040.
	Replace Commercial Medium and Heavy-duty Vehicles with Electric Models	▪ Sales of new medium- and heavy-duty vehicles will be increasingly zero-emissions, according to the following schedule: – By 2030, 35% will be ZEV; – By 2035, 45% will be ZEV; – By 2040, 55% will be ZEV; – By 2045, 75% will be ZEV; and – By 2050, 100% will be ZEV.
	Transport more Freight by Rail rather than by Truck	▪ Shift 5% of freight currently transported by trucks to rail by 2035, 10% by 2040 and 20% by 2050.

Strategies	Actions	Description
Reimagine Transportation in the Midlands	**Replace Diesel Freight Train Engines with Hybrid Diesel/ Electric Engines**	▪ Shift diesel freight train engines to diesel/ electric hybrid engines at the following rate: – By 2030, 1% are hybrid; – By 2035, 5% are hybrid; – By 2040, 25% are hybrid; and – By 2050, 85% are hybrid.
Electricity Generation		
Expand Renewable Energy Generation	**Utilities Switch to Renewable Energy Sources to Generate Grid Electricity**	▪ The grid's emissions will be reduced by 85% by 2045.
	Rooftop Solar PV outside Columbia	▪ Residential, commercial, institutional and industrial buildings gradually add rooftop solar until there are 3,000 MW of capacity on these buildings by 2038 according to the following schedule: – 2025-2031: 1 GW ; – 2032-2033: 2 GW (cumulatively); – 2034-2038: 3 GW (cumulatively).
	Rooftop Solar PV in Columbia	▪ The community of the City of Columbia installs 817 MW of rooftop solar on businesses and homes in Columbia by 2036.
	Restart Columbia Canal Hydro	▪ Restart the Columbia Canal Hydro Facility in 2027 at full capacity (5 MW), providing as much power as possible to the adjacent water station pumping facility, and the remainder to the grid.

Strategies	Actions	Description
Expand Renewable Energy Generation	**Canopy Solar on Parking Lots in Downtown Columbia**	▪ Install canopy solar over all significant parking areas in downtown Columbia by 2045.
Industry		
Advance Low-carbon Transformation in Industry	**Industrial Efficiency Improvements**	▪ The industrial sector's overall energy consumption is reduced by 5% between 2025 and 2028, by 10% by 2030, and by 20% by 2035.
	Solar on Industrial Buildings	▪ Beginning in 2030: – All new facilities have on-site solar PV (rooftop or ground mount) to meet 40% of their required power. – Existing facilities gradually install on-site solar to meet 30% of their required power. By 2050, 95% of existing facilities have solar installations.
Waste and Materials Management		
Scale Up Waste Reduction and Diversion Initiatives	**Reduce Waste Generation**	▪ All counties will gradually reduce total waste disposal per person to: – 3.25 pounds per person per day by 2030 – 3 pounds per person per day by 2050

Strategies	Actions	Description
Scale Up Waste Reduction and Diversion Initiatives	**Divert Organic Waste from Landfills**	▪ Divert organic waste from landfills to composting by the following amounts: – 60% by 2030 – 90% by 2050
Optimize Water and Wastewater Operations	**Anaerobic Digestion at all Wastewater Treatment Plants**	▪ By 2035, anaerobic digestion will be added to all WWTPs that are not already using it. This will be assumed to reduce wastewater emissions by 90%.
	Improve Efficiency of Water and Wastewater Treatment Assets	▪ Energy consumption in water and wastewater treatment facilities is reduced by 5% between 2025 and 2028, 10% by 2030, and 20% by 2035.
	Install Solar at Wastewater Treatment Plants	▪ Beginning in 2030: – All new wastewater treatment facilities have on-site solar PV (rooftop or ground mount) to meet 40% of their required power. – By 2050, 95% of existing facilities have added on-site solar to meet 30% of their power needs.
	Reduce Water Consumption	▪ Reduce per capita water consumption: – by 20% by 2028, – by 30% by 2030, and – by 35% by 2035.

Strategies	Actions	Description
Optimize Water and Wastewater Operations	**Replace Septic Systems with Connections to Wastewater Treatment Plants**	▪ By 2045, 10% of residents currently on septic systems shift to being handled by wastewater treatment facilities.
Natural and Working Lands		
Protect Trees and Encourage Green Infrastructure	**Increase and Maintain Healthy Urban Trees**	▪ Plant 1,890,000 trees between 2025 and 2050 across the region (75,600 annually).
	Reforestation	▪ Plant climate-resilient and native trees to reforest 675,562 acres of land between 2025 and 2050.

Strategies	Actions	Description
Protect Trees and Encourage Green Infrastructure	**Add Green Infrastructure**	Install the following three types of green infrastructure within the urbanized core of the Midlands. Between 2025 and 2030: – Part 1: Replace impermeable surfaces covering an area equal to 248 acres with light-colored permeable pavers. – Part 2: Add bioswales to 476 acres of built-up land area. – Part 3: Add rain gardens to 53 acres of landscaped areas in the immediate vicinity of approximately 800 buildings. Between 2031 and 2040: – Part 1: Replace a further 248 acres of impermeable surfaces in the city with light-colored permeable pavers. – Part 2: Add bioswales to a further 476 acres of built-up land area. – Part 3: Add rain gardens to a further 53 acres of landscaped areas next to an additional 800 buildings (approximately).
Enhance Agriculture and Soil Management Practices	**Climate Smart Commodities**	▪ Reduce use of Nitrogen fertilizer by: – 25% on corn crops in Lexington, Calhoun and Newberry – 25% on cotton crops in Calhoun – 25% on peanut crops in Calhoun – 50% on soybean crops in Newberry and Calhoun. – Through gradual change, by 2050, all agricultural land that is currently intensively tilled is converted to no-till farming.

Strategies	Actions	Description
Enhance Agriculture and Soil Management Practices	**Agrivoltaics**	▪ Agrivoltaics will gradually increase until by 2050 it is installed on 10% of all agricultural land in the region.
Intentional Land Use	**Smart Growth**	▪ New developments shift to medium-intensity development, with increased infill, denser residential buildings and more mixed use buildings. This will include new apartments in downtown Columbia, and slightly increased density on the riverfront in West Columbia & Cayce. In smaller communities, this shift will include reducing the size of residential lots in some areas, and opting for more row houses, townhouses, or small vertical mixed-use buildings (2-3 floors) in some areas. ▪ Limit growth outside existing local community boundaries, either by freezing the boundary or by adding a small buffer to it to reduce 'sprawl'. Move the development that would have been outside these boundaries inside, making communities more compact.

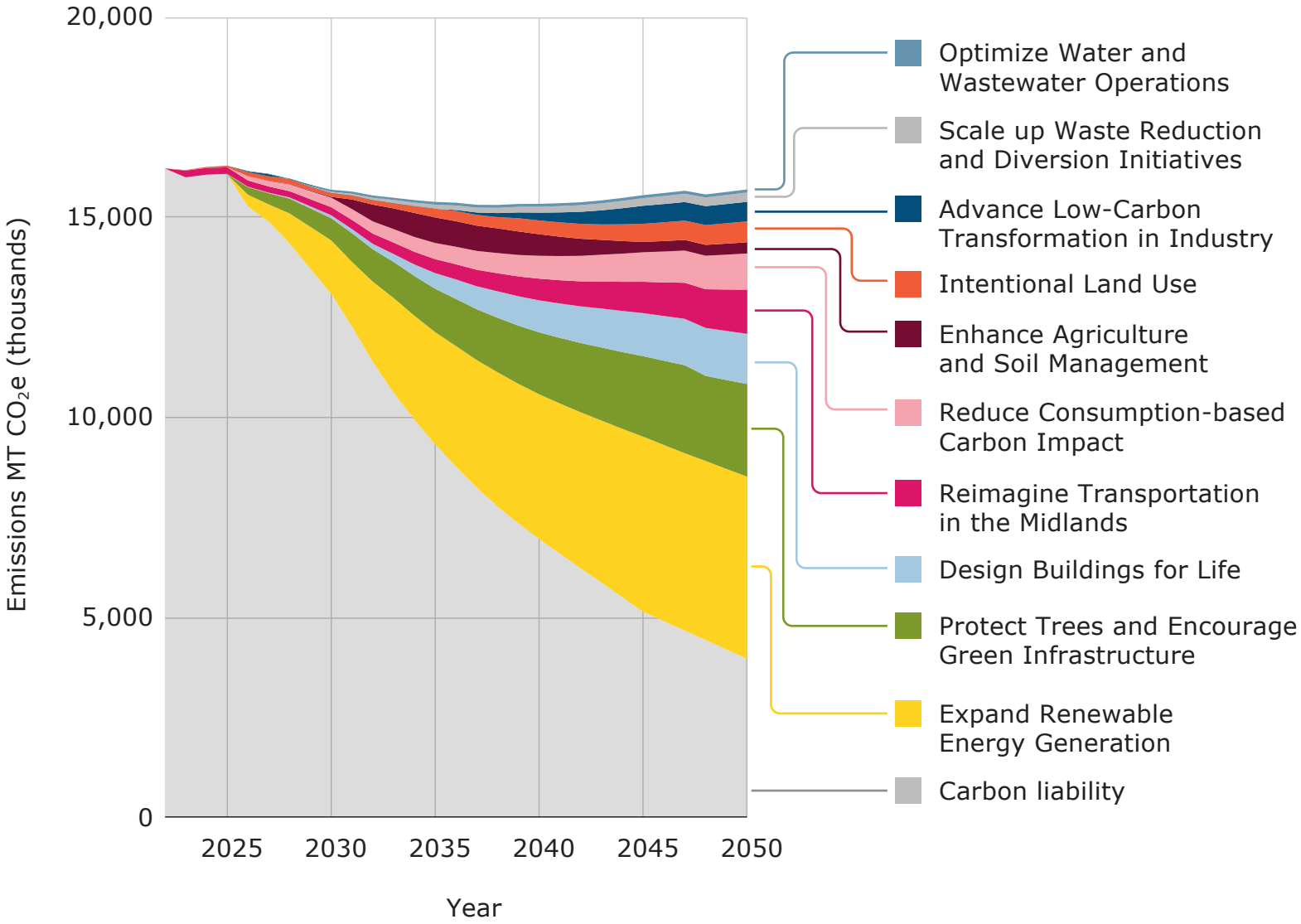
Strategies	Actions	Description
Intentional Land Use	**Install Reflective Surfaces**	▪ Part 1 – Between 2025 and 2030, cool roofs are installed on 39,300 (17% of) existing homes and non-residential buildings in the urbanized core of the Midlands. – Between 2031 and 2040, cool roofs are installed on a further 76,200 (33% of) existing homes and non-residential buildings in the urbanized core of the Midlands. ▪ Part 2 – Between 2025 and 2030, cool pavement is installed on 5% of road surfaces in the urbanized core of the Midlands.. This amounts to converting the surfaces of 600 lane miles of roadway over 5 years. – Between 2031 and 2040, cool pavement is installed on a further 10% of road surfaces or 1,300 miles of roadway in the urbanized core of the Midlands.
Reduce Consumption-based Carbon Impact	**Increase Circular Economy**	▪ Gradually increase the amount of material that gets re-used and reduce the amount of goods purchased, reducing the scope 3 emissions required to acquire new raw materials. Increase from avoiding 100,000 MT of scope 3 emissions in 2026 to 900,000 MT in 2050.
	Plant-based Meals at Cafeterias	▪ Beginning in 2026, change from including meat in all meals provided at high-volume cafeterias like schools and hospitals across the region to having one day a week (20% of meals) on which these meals are all plant-based. This will mean 100,000 meals become meat-free each week. Continue at the same rate until 2050.

6.2 Low-Carbon (LC) Scenario Projections

In the low-carbon scenario, CMCOG's total annual GHG emissions are projected to decrease by 43% by 2035 and by 70% by 2050. This decrease is a result of the combined impact of the LC actions all working together and proceeding in a specific order. For example, lowering the emissions from the electricity grid will accelerate the emissions reductions from all actions that use electricity (such as powering electric vehicles and heating homes with heat pumps). However, when it comes to individuals and organizations, every climate action that lowers air pollution is important, and each tonne of greenhouse gas removed lowers the probability of severe weather, ecosystem impacts, and other mechanisms where global warming harms the Midlands.

Figure 6.1 illustrates the impact over time of each strategy (group of actions) in the LC scenario.

Figure 6.1.
Wedge diagram of emissions reductions by strategy in the low-carbon scenario, 2022-2050.



A wedge diagram allows us to see what climate action and a future with no climate action look like in one graph:

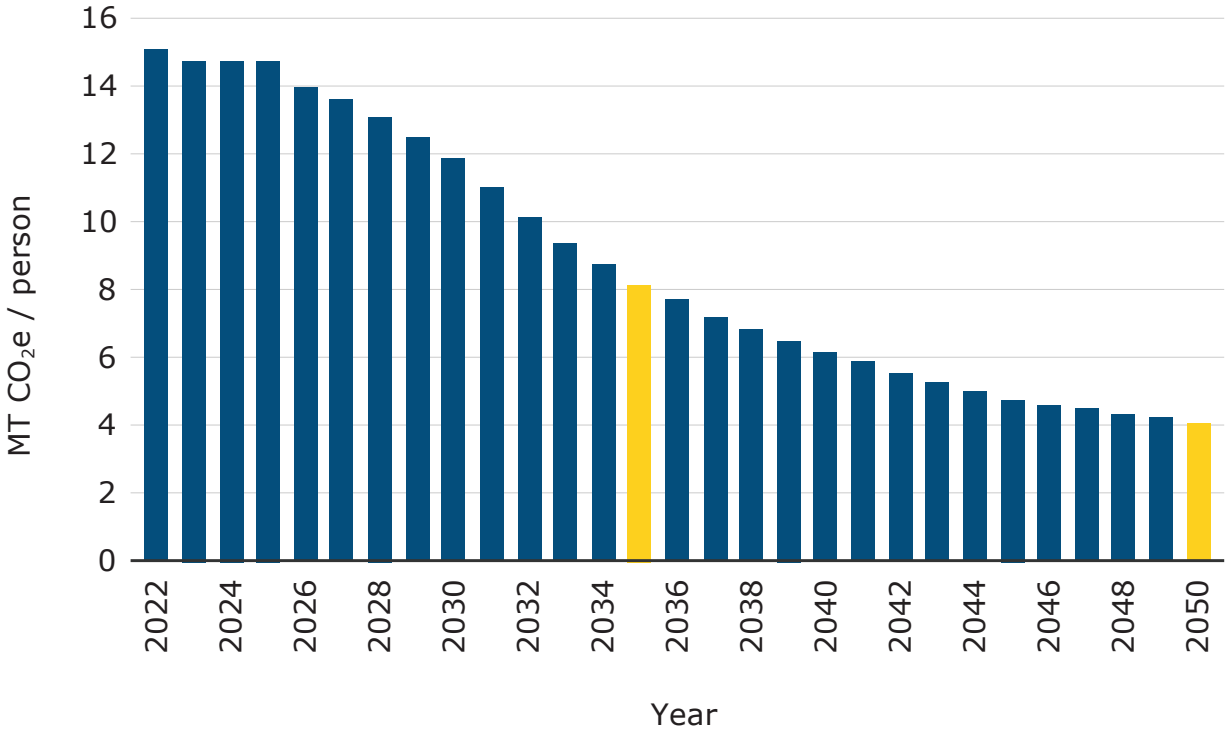
- The top horizontal line (the top line of 'Optimize Water and Wastewater Operations') represents future emissions in the BAP scenario - if the region takes no action.
- The bottom of the lowest colored wedge, that falls from the upper left to the lower right corner of the graph, represents projected reduction in regional emissions if all the actions in the LC scenario are implemented on schedule.
- The grey wedge at the bottom of the graph represents 'residual emissions' - or the total greenhouse gas emissions that will still be emitted within the region over time, as the low-carbon actions are implemented. This wedge gradually decreases, but does not reach zero by 2050.
- Each colored wedge above the residual emissions represents the impact of one strategy, or group of actions from the LC scenario.

> **The wedge diagram shows us that no one or two strategies alone will achieve the majority of the region's climate goals. Instead, a broad range of strategies will need to be prioritized and implemented together.**

As time progresses, the impact of many strategies grows significantly. This emphasizes that the sooner this work begins, the sooner beneficial impacts will be realized. It is also true that the sooner the work begins, the less it will cost to reduce greenhouse gas emissions. This is discussed more in Chapters 7 and 8 of this document.

Per capita emissions in the low-carbon scenario are projected to decrease by 46% by 2035 and by 73% in 2050. Figure 6.2 displays the projected per capita greenhouse gas emissions in the Midlands in the low-carbon scenario.

Figure 6.2.
Projected per capita emissions in the LC Scenario, 2022-2050. The highlighted bars show target years (2035 & 2050).



6.3 Ten Strategies to Decarbonize the Midlands

6.3.1 Design Buildings for Life

The energy consumed in 2022 in buildings in the Midlands produced 48% of the region's total emissions for the year. This was 30% higher than buildings' share of total national emissions in the same year.[145] Many of the conditions causing this are also responsible for high rates of energy burden in the state.

145 National Renewable Energy Laboratory. 'New Residential Construction Carbon Emissions'. 2023. https://docs.nrel.gov/docs/fy23osti/83049.pdf

This presents the Midlands with an opportunity to address two crises with coordinated and ambitious efforts to reduce energy consumption and emissions, and to prioritize support for those with high energy burdens.

The actions in the Design Buildings for Life strategy[146] are a suite of ten changes that together, will reduce annual household energy use by 48% by 2050, and eliminate a total of 15,366,000 MT CO_2e between the present and 2050. This represents 10% of the total reductions achieved in the low-carbon scenario.

In the Midlands, as in most American communities, reducing energy use and emissions in the building sector requires three major shifts:

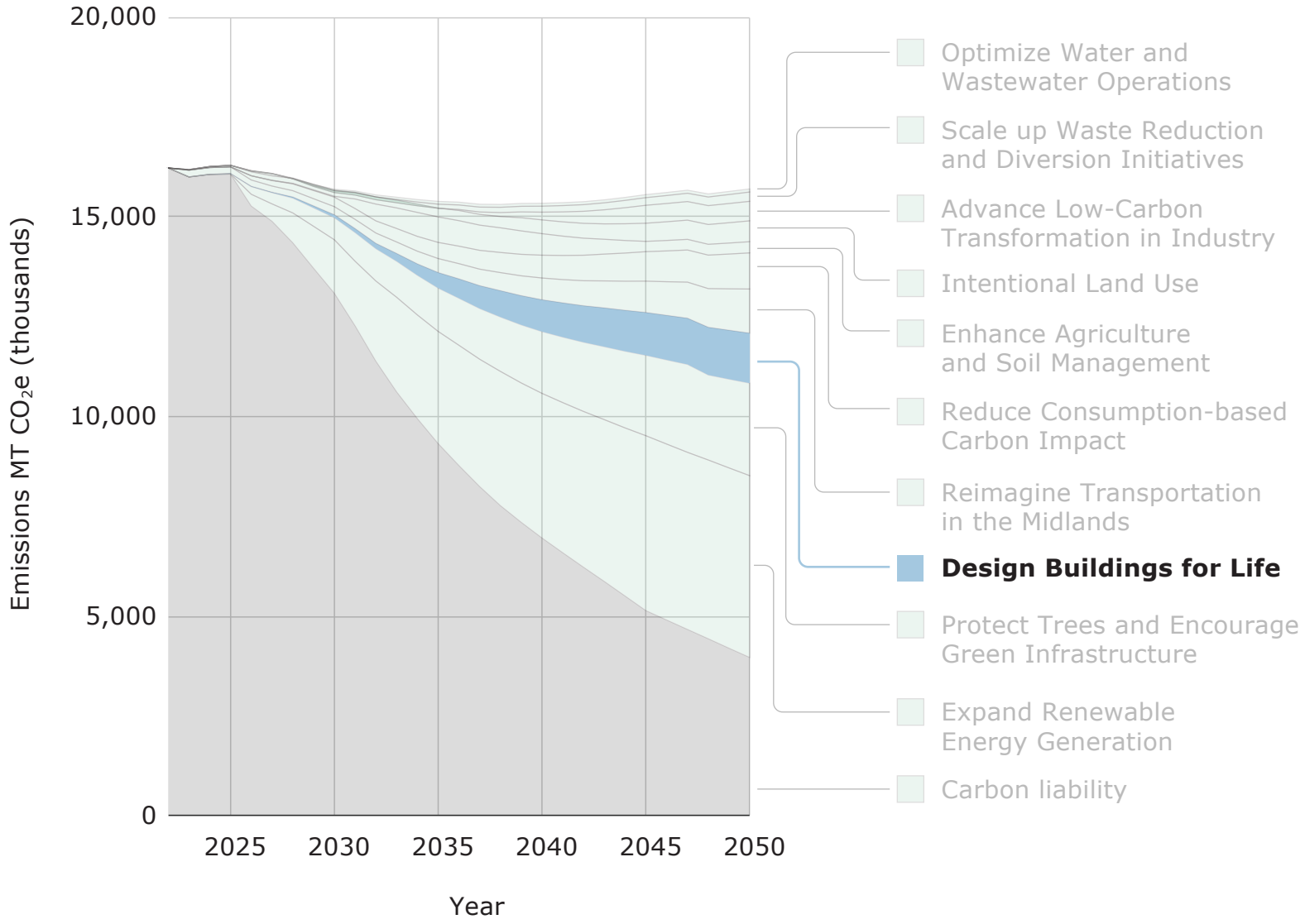
1. Major energy efficiency improvements in all buildings, achieved by retrofitting existing buildings and significantly improving energy efficiency standards for new buildings.
2. Switching from fossil fuels to electricity for space and water heating and for appliances.
3. Finally, the electricity grid powering these changes should have low or no greenhouse gas emissions, which is achieved by both the utilities and community relying on clean energy sources to power the grid.

The Design Buildings for Life strategy includes a combination of actions that are fundamental to achieving net-zero emissions, and that illustrate how the depth of building retrofits affects not only the amount of emissions and other pollution eliminated, but how much energy burden is reduced. The actions have been designed and modeled specifically for new and existing buildings, and with variations across building types.

The total impact of all of the Design Buildings for Life actions on greenhouse gas emissions is shown as the light blue wedge in Figure 6.3.

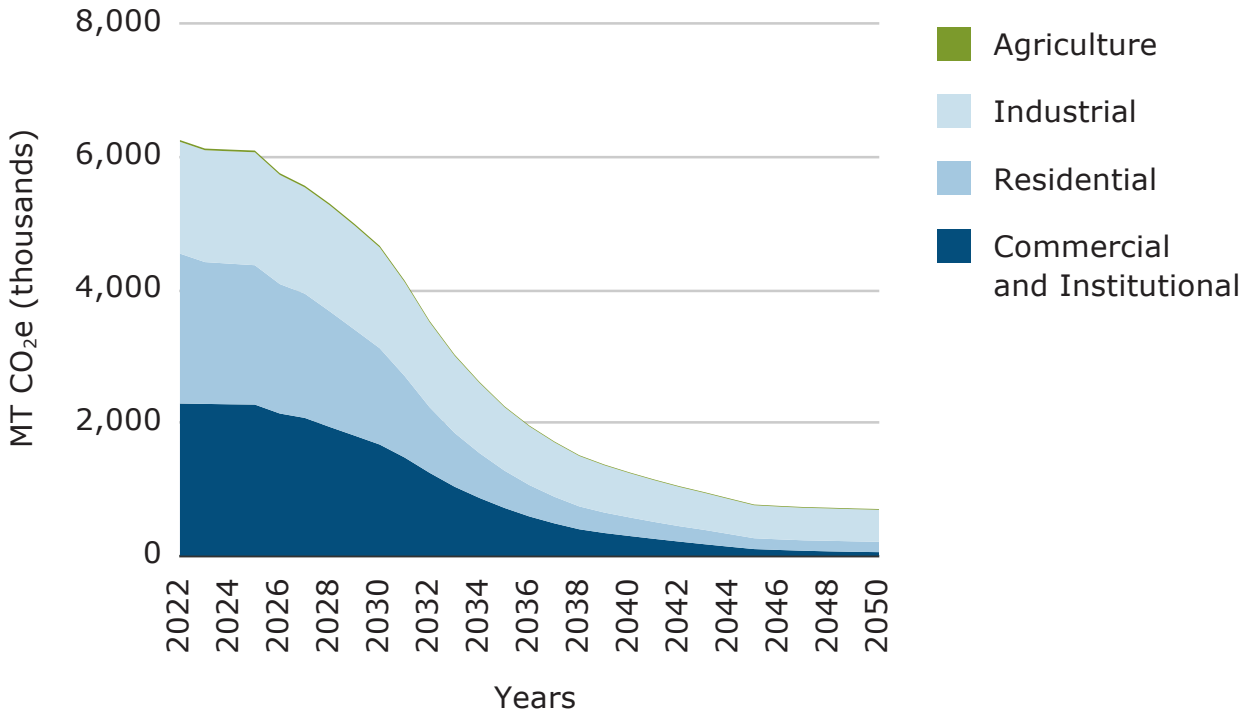
146 See Table 6.1 for the individual action details.

Figure 6.3.
Projected emissions reductions for the Design Buildings for Life Strategy in the LC scenario, 2022-2050.



The total emissions reductions that are achieved by the actions in this strategy are shown by building type, in Figure 6.4 below.

Figure 6.4.
Projected building sector GHG emissions in the LC scenario by Building Type, 2022-2050.



Each of the individual actions in the Design Buildings for Life Strategy are described below, along with their impact on short and long-term emissions and criteria air pollutants, and their costs and savings.

High Performance New Residential Buildings

Dramatically improving the energy efficiency standards required for new homes reduces the energy required to keep them at comfortable temperatures year-round. New homes in the Midlands are currently only required to be built to the 2009 International Energy Conservation Code (IECC), which is less stringent than the current code, 2021 IECC. Transitioning the region from its current standard to net-zero homes was modeled on a timeline of three phases.

Modeled Action and Timeline

Initially, the building energy code is brought up to current standards. During the second period, the code is updated regularly, and new housing stock becomes increasingly energy-efficient over time. Finally, once the building industry and workforce have become familiar with higher and regularly-updated standards, in 2040, a final change is made to require that all homes from this point on are built to a net-zero standard.

The action's timeline is as follows:

- **January 1, 2027:** The IECC 2021 building and energy efficiency code for new residential buildings goes into effect for all types of new home construction in the Midlands.
- **January 1, 2031:** The residential building and energy efficiency code is updated to the latest IECC standard.
- **January 1, 2035:** The residential building and energy efficiency code is updated to the latest IECC standard.
- **January 1, 2039:** The residential building and energy efficiency code is updated to the latest IECC standard.
- **January 1, 2040:** A net-zero emissions building standard goes into effect for all new residential buildings. All homes that begin construction after this date will be required to produce net-zero emissions.

Pathways to Implementation

New homes represent a key area to prevent future energy burden in the Midlands. When people buy a new home, many assume it has the best available insulation and other "built in" features that will lead to lower energy use and utility bills. The most effective action is a pathway that directly requires improvements to be made, such as building energy codes or other forms of building standards (e.g., a net-zero building standard).

The most immediate implementation pathway for residential buildings is updating building codes.[147] The South Carolina state legislature sets these codes in state law, and can update this law at any time when it is in session. For long-term implementation, the legislature should delegate routine and regular updating of building energy codes to a cognizant state agency, such as the SC Energy Office or the SC Department of Labor, Licensing and Regulation.

147 U.S. Department of Energy (2025). Building Energy Codes Program - South Carolina. https://www.energycodes.gov/status/states/south-carolina

While Midlands actors have no implementation pathway for building energy codes absent a change in state law, they could require that all new home or rental sales adequately inform buyers about expected energy costs and relative building energy efficiency. The SC Energy Office is currently piloting a residential energy labeling/sticker disclosure program.[148]

- Key Implementing Organizations: SC state legislature (building energy codes); municipalities (labeling); building developers.
- Geographic Area Impacted: Region-wide.
- Applicable Funding Sources: None needed - updating building codes requires no funding.
- Implementation Authority: Building codes must be updated by an act of state law (or, an act of state law may set a new mechanism for updating building energy codes). Municipalities can currently implement building labeling or other related policies. Developers can build net-zero buildings even if they are not required to do so.

Low-carbon Scenario Impacts

Table 6.2.
Low-carbon Scenario Impacts of High Performance New Residential Buildings

Low-carbon Scenario Metrics		
Greenhouse Gas Reduction Impact		
Cumulative greenhouse gas reduction from 2025-2035 (MT CO_2e)		117,000 MT CO_2e
Cumulative greenhouse gas reduction from 2025-2050 (MT CO_2e)		735,000 MT CO_2e
Cumulative Criteria Air Pollution Reduction	2025-2030	2025-2050
Total CO reduction (lbs)	18,968	366,960
Total HC reduction (lbs)	0	0
Total NOx reduction (lbs)	34,338	650,455

148 SC Energy Office (2025). Building Codes and Labeling Recommendations. https://energy.sc.gov/focus-area/energy-efficiency/building-ee-homes/building-codes-and-labeling-recommendations

Low-carbon Scenario Metrics		
Total PM10 reductions (lbs)	3,988	82,046
Total PM2.5 reduction (lbs)	3,342	68,748
Total SO2 reduction (lbs)	12,528	258,806
Total VOC reduction (lbs)	1,749	32,682
Financial Impact		
Incremental Cost (USD)[149]		$4,727,603,430
Incremental Savings (USD)[150]		$704,215,569
Net Cost/ Savings (USD)		Net Cost of $4,023,387,860
Marginal abatement Cost/ Savings (USD/ $MTCO_2e$)		$5,475 / MT

High Performance New Non-residential Buildings

This action applies to all non-residential buildings, including commercial, institutional, industrial, manufacturing, and municipal and public buildings. As with new homes, improving the energy efficiency standards of these buildings significantly reduces the energy required to keep them at comfortable temperatures. Highly efficient non-residential buildings can then be connected to zero-emissions systems (sometimes referred to as district energy systems) in high density areas. For example, a factory may consider heat "wasted energy" but this heat could be utilized by neighboring buildings if it can be effectively transported.

Modeled Action and Timeline

This action has three phases. Initially, the building code is brought up to current standards. During the second phase, the code is updated regularly. And in 2040, a final change is made to require that all new non-residential

149 Incremental cost includes capital, maintenance, operations, and energy costs relative to the BAP scenario.

150 Incremental savings includes all avoided capital, maintenance, operations and energy costs as well as revenue, relative to the BAP scenario.

buildings constructed from this point on are built to a net-zero standard. The action's timeline is as follows:

- **January 1, 2027:** The IECC 2021 building and energy efficiency code for new non-residential buildings goes into effect for all types of new non-residential construction in the Midlands.
- **January 1, 2031:** The non-residential building and energy efficiency code(s) is updated to the latest IECC standard.
- **January 1, 2035:** The non-residential building and energy efficiency code(s) is updated to the latest IECC standard.
- **January 1, 2039:** The non-residential building and energy efficiency code(s) is updated to the latest IECC standard.
- **January 1, 2040:** A net-zero emissions building standard goes into effect for all new non-residential buildings. All buildings that begin construction after this date will be required to produce net-zero emissions.

Pathways to Implementation

The implementation pathways are identical for commercial building energy codes and residential building energy codes. Labeling programs are less applicable to newly constructed commercial and industrial buildings.

For public or institutional buildings (local governments, schools, etc.), targets or goals are often effective to ensure new buildings are built with a long-term view of energy efficiency and use. Such targets can be easily applied during procurement and contracting for new buildings. A prior initiative on state building performance standards ("20 by 20") successfully achieved its 20% energy reduction goal by the year 2020.[151] This program was for existing buildings, but provides useful data if justification is needed to design new public buildings to be energy efficient above the outdated requirements for commercial buildings. Some utilities in the Midlands offer preferential or discounted energy to public buildings, but local governments should also expect rate increases given the current energy policy landscape in South Carolina.

- Key Implementing Organizations: SC state legislature (building energy codes); municipalities (labeling); building developers.

151 Weiss, J. South Carolina Energy Efficiency Roadmap. NI R 21-02. Durham, NC: Duke University. *https://energy.sc.gov/focus-area/energy-efficiency/energy-efficiency-roadmap*

- Geographic Area Impacted: Region-wide.
- Applicable Funding Sources: None needed - updating building codes requires no funding.
- Implementation Authority: Building codes must be updated by an act of state law (or, an act of state law may set a new mechanism for updating building energy codes). Municipalities, schools, etc. can require energy efficient buildings through procurement and contracting as they are being constructed.

Low-carbon Scenario Impacts

Table 6.3.
Low-carbon Scenario Impacts of High Performance New Non-residential Buildings

Low-carbon Scenario Metrics		
Greenhouse Gas Reduction Impact		
Cumulative greenhouse gas reduction from 2025-2035 (MT CO_2e)	359,105 MT CO_2e	
Cumulative greenhouse gas reduction from 2025-2050 (MT CO_2e)	2,690,946 MT CO_2e	
Cumulative Criteria Air Pollution Reduction	2025-2030	2025-2050
Total CO reduction (lbs)	40,998	1,200,362
Total HC reduction (lbs)	0	0
Total NOx reduction (lbs)	61,321	1,873,301
Total PM10 reductions (lbs)	9,037	319,855
Total PM2.5 reduction (lbs)	7,569	268,003
Total SO2 reduction (lbs)	28,802	1,019,149
Total VOC reduction (lbs)	2,943	87,812
Financial Impact		
Incremental Cost (USD)[152]	$32,917,765,136	

152 Incremental cost includes capital, maintenance, operations, and energy costs relative to the BAP scenario.

Low-carbon Scenario Metrics	
Incremental Savings (USD)[153]	$4,512,756,731
Net Cost/ Savings (USD)	Net Cost of $28,405,008,405
Marginal abatement Cost/ Savings (USD/ $MTCO_2e$)	$10,555 / MT

Residential Energy Efficiency Improvements: Levels 1, 2 and 3

Much of the Midlands' existing housing will continue to be occupied for years to come. However, many of these buildings are not energy-efficient and some are in need of basic maintenance. Improving the condition of these homes is an important first step in reducing emissions from buildings. The National Renewable Energy Laboratory (NREL) indicated that South Carolina energy consumption in single-family homes could be reduced by 30% through cost-effective improvements.[154] NREL subsequently conducted a study specific to Columbia that found homeowners could save over $1,300 a year on average by implementing several key energy efficiency improvements.[155]

Improving residential energy efficiency can be done in many ways, some of which are highly impactful and others which are less so., But even starting small can provide benefits that quickly multiply:

Many home owners **start by sealing leaks and replacing weather stripping around doors.** These simple changes will prevent conditioned air from being lost to the outdoors, and this will immediately reduce energy costs for the home owner. It will also make the home more comfortable, with less variation in temperature when the weather changes, and with better indoor air quality.

153 Incremental savings includes all avoided capital, maintenance, operations and energy costs as well as revenue, relative to the BAP scenario.

154 National Renewable Energy Laboratory (NREL). ResStock. 'South Carolina Residential Energy Efficiency Potential'. 2017. https://resstock.nrel.gov/factsheets/SC

155 Liu, Lixi, Jes Brossman, and Yingli Lou. 2023. "ResStock Communities Local Energy Action Program (Communities LEAP) Pilot Residential Housing Analysis." NLR Data Catalog. Golden, CO: National Laboratory of the Rockies. Last updated: January 16, 2025. DOI: 10.7799/2222487.

With more stable temperatures in the home, when it comes time for a new heating or cooling system, new HVAC systems can be smaller and less expensive than they would have had to be in the original home. **If furnaces and air conditioning are replaced with heat pumps, the new systems will be at least 3 - 4 times as efficient as the systems being replaced.** Again, this will reduce the total energy consumed in the home and reduce energy bills for the household.

> **For the community, this will mean more energy is available to be used elsewhere, improving energy reliability and resilience for the whole community.**

For the purposes of this plan, **three levels of residential energy efficiency improvements were modeled**. Each level builds on the one before it, to illustrate the increasing value realized with each additional level of retrofits. Together they clarify how much energy consumption, household energy costs and GHG emissions have the potential to be reduced depending on the depth of retrofits made.

Level 1
Weatherization → **Level 2**
Enhanced Energy Efficiency → **Level 3**
Deep Retrofits

Pathways to Implementation

As a multi-stage action, implementation pathways are similar and a well-designed program could implement more than one stage at a time. Conducting energy efficiency improvements in existing buildings is one of the most difficult actions because it is necessary to tackle a large portion of buildings within an area (particularly in the Midlands, where the NREL C-LEAP study found a high percentage of very inefficient, older buildings). However this action also has significant community co-benefits, and each resident benefits immensely and immediately from energy savings.

According to the American Council for an Energy-Efficient Economy (ACEEE), South Carolina ranked 40th out of 50 states in 2025, in terms of state-level policies and programs to advance energy efficiency.[156] While there are a variety of possible programs, there are three common pathways

156 American Council for an Energy-Efficient Economy (ACEEE). '2025 State Energy Efficiency Scorecard.' 2025. https://www.aceee.org/state-policy/scorecard. Accessed December 2, 2025.

to implementing residential energy efficiency programs. Across all of them, they will be most successful if they are designed to scale and have uncapped funding (i.e., are not arbitrarily limited to serving a set number of people per year).

1) State & Local Governments: States and local governments can implement a wide variety of programs. A simple rebate for energy efficient improvements would lower the cost barrier for residents to take actions independently and is effective for single family homes. For larger residential buildings (apartments, multi-family housing) building performance standards could be implemented by municipalities[157] and several other areas have already done so.[158] Most implementations only apply to large buildings where the building generates substantial profits. Reduced standards can be designed for other types of rented housing (single family homes; duplexes, etc.). These standards require building owners to meet minimum energy efficiency targets which increase over time, and typically involve both penalties and rebates for effective implementation.

   a) Municipal utilities in the Midlands (Town of Prosperity, City of Camden, City of Newberry, and Town of Winnsboro) are electric utilities and can design and execute energy efficiency programs. In these places, local control offers unique opportunities and technical assistance from CMCOG or other regional partners can help implement energy audits, rebates, on-bill finance, or direct weatherization or insulation programs.

2) Utilities: Utilities can run a variety of rebate and on-bill finance programs to increase energy efficiency improvements in residential buildings. Utility energy efficiency programs can be difficult to access; have arbitrary caps or limits, or have other design policy barriers that can easily be removed. Utility demand side programs (which can include energy efficiency, as well as other programs like virtual power plants) have benefits for grid resiliency. Two utilities in the Midlands (Duke and Dominion) score among the bottom half in the United States for their energy savings programs, according

157 According to guidance received from a legal academic. Home rule would indicate this is possible, but to the authors' knowledge has not been attempted yet in South Carolina.

158 Climate XChange (2025). Building Performance Standards. State Climate Policy Dashboard. https://www.climatepolicydashboard.org/policies/buildings-efficiency/building-performance-standards

to a comprehensive study most recently conducted in 2023.[159] On-bill finance programs (either utility only or in partnership with a green bank) are underutilized, with only one* program potentially active in the Midlands.[160]

3) Community groups: Non-profits can organize energy efficiency programs. One example from SC is the Sustainability Institute, which runs a home weatherization program using grant & philanthropic funds combined with an AmeriCorps program.[161] Churches, community centers, and other sites can be hubs for similar programs or information sharing. Individuals can also be a community resource by receiving training in energy efficiency.[162] It can be difficult to understand why utility bills are high and what potential options are available to lower it, and important decisions like HVAC improvements are infrequent. Neighbors who are knowledgeable can be a community resource to help with understanding why a higher efficiency technology could save a lot of money after it is installed (for example).

- Key Implementing Organizations: Various. More than one organization is optimal, with a coordinated one-stop shop ideal.
- Geographic Area Impacted: Region-wide.
- Applicable Funding Sources: The SC Energy Office is expected to release HEAR and HOMES funds as soon as 2026.[163] Several Midlands utilities run active energy efficiency programs. The SC Office of Economic Opportunity, via community action agencies, runs the state's weatherization assistance program.[164] The Clean Energy Fund of the Carolinas (SC's green bank) is expanding its available finance for energy efficiency improvements into the state.[165]
- Implementation Authority: Most organizations have pre-existing authority to design, fund and implement programs in this area.

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159 ACEEE (2023). The Utility Energy Efficiency Scorecard. https://www.aceee.org/utility-scorecard

160 The Electric Co-Ops run an on-bill finance program called "Help My House", but at time of publication the status of the program was not able to be fully ascertained and existing uptake is low. *https://ecsc.org/help-my-house*. * Additional on-bill finance programs are being explored or considered by other utilities in the Midlands.

161 The Sustainability Institute (2025). Weatherization & Critical Home Repair. https://sustainabilityinstitutesc.org/programs/weatherization-and-critical-home-repair/

162 Rewiring America (2025). Electric Coaches. https://www.rewiringamerica.org/go-electric/electric-coaches

163 SC Energy Office (2025). South Carolina Home Energy Rebates. *https://energy.sc.gov/rebates*

164 SC Office of Economic Opportunity (2025). Weatherization Assistance Program. https://oeo.sc.gov/managedsites/prd/oeo/weatherization.html

165 Clean Energy Fund of the Carolinas (2025). Homepage. *https://cefcarolinas.org/*

Level 1 - Weatherization

The first step to significantly reducing the emissions from these homes is improving their energy efficiency through basic 'weatherization' retrofits. Changes included in this level of retrofits include the types of repairs provided by the South Carolina Weatherization Assistance Program (WAP), such as adding insulation and making minor repairs to windows and doors.

Modeled Action and Timeline

- **2028 calendar year:** 2% of all pre-2020 homes in the region will undergo energy efficiency retrofits that consist of basic weatherization measures such as adding insulation and sealing air leaks.
- **Each year from 2029 to 2045:** A portion of all pre-2020 homes in the region will undergo basic weatherization retrofits. The portion will gradually increase to ensure that by 2045 all homes built before 2020 have received these upgrades.

Low-carbon Scenario Impacts

Table 6.4.
Low-carbon Scenario Impacts of Residential Energy-Efficiency Improvements: Level 1 - Weatherization

Low-carbon Scenario Metrics		
Greenhouse Gas Reduction Impact		
Cumulative greenhouse gas reduction from 2025-2035 (MT CO_2e)	264,568 MT CO_2e	
Cumulative greenhouse gas reduction from 2025-2050 (MT CO_2e)	1,875,473 MT CO_2e	
Cumulative Criteria Air Pollution Reduction	2025-2030	2025-2050
Total CO reduction (lbs)	17,955	932,967
Total HC reduction (lbs)	0	0
Total NOx reduction (lbs)	31,895	1,663,432
Total PM10 reductions (lbs)	4,165	214,464
Total PM2.5 reduction (lbs)	3,495	179,986

Low-carbon Scenario Metrics		
Total SO2 reduction (lbs)	12,875	662,089
Total VOC reduction (lbs)	1,585	82,868
Financial Impact		
Incremental Cost (USD)[166]		$5,766,429,378
Incremental Savings (USD)[167]		$1,766,302,657
Net Cost/ Savings (USD)		Net Cost of $3,990,126,721
Marginal abatement Cost/ Savings (USD/ $MTCO_2e$)		$2,128 / MT

Level 2 - Enhanced Energy Efficiency

This action involves adding further energy efficiency improvements to homes that have already received Level 1 weatherization. Upgrades included in the Enhanced Energy Efficiency level of retrofits would include adding insulation throughout the home (walls, attic and the basement or crawlspace), switching all lighting to LEDs, and replacing some doors or windows. These changes will further reduce energy consumption relative to Level 1 retrofits.

Modeled Action and Timeline

- 2030-2031: All homes that had Level 1 measures completed in 2028 (which was 2% of total housing stock built before 2020) will undergo Level 2 improvements.
- Each year from 2032 to 2047: Each subsequent cohort of homes with Level 1 retrofits completed will undergo Level 2 retrofits two years after they complete Level 1. The total number of homes being retrofitted will gradually increase to ensure that by 2047 all homes built before 2020 have received these upgrades.

Low-carbon Scenario Impacts

166 Incremental cost includes capital, maintenance, operations, and energy costs relative to the BAP scenario.

167 Incremental savings includes all avoided capital, maintenance, operations and energy costs as well as revenue, relative to the BAP scenario.

Table 6.5.
Low-carbon Scenario Impacts of Residential Energy-Efficiency Improvements: Level 2 - Enhanced Energy Efficiency

Low-carbon Scenario Metrics		
Greenhouse Gas Reduction Impact		
Cumulative greenhouse gas reduction from 2025-2035 (MT CO_2e)	22,720 MT CO_2e	
Cumulative greenhouse gas reduction from 2025-2050 (MT CO_2e)	224,679 MT CO_2e	
Cumulative Criteria Air Pollution Reduction	2025-2030	2025-2050
Total CO reduction (lbs)	282	111,848
Total HC reduction (lbs)	0	0
Total NOx reduction (lbs)	501	199,556
Total PM10 reductions (lbs)	65	25,620
Total PM2.5 reduction (lbs)	55	21,500
Total SO2 reduction (lbs)	202	79,140
Total VOC reduction (lbs)	25	9,951
Financial Impact		
Incremental Cost (USD)[168]	$259,048,389	
Incremental Savings (USD)[169]	$220,451,674	
Net Cost/ Savings (USD)	Net Cost of $38,596,715	
Marginal Abatement Cost/ Savings (USD/ $MTCO_2e$)	Cost of $172 / MT	

168 Incremental cost includes capital, maintenance, operations, and energy costs relative to the BAP scenario.

169 Incremental savings includes all avoided capital, maintenance, operations and energy costs as well as revenue, relative to the BAP scenario.

Level 3 - Deep Retrofits

Ultimately, to reach the region's emissions targets, existing pre-2020 buildings including homes, will require 'deep energy retrofits'. This term refers to making sufficient changes to a building's envelope, insulation, windows, doors, and roof, and sealing all leaks, so as to reduce energy consumption by at least 50% relative to what it was before any retrofits were completed.

Modeled Action and Timeline

- **2033:** All homes that had Level 1 measures completed in 2028 (which was 2% of total housing stock built before 2020) and Level 2 measures completed in 2030 will undergo Level 3 improvements.
- **Each year from 2034 to 2050:** Each subsequent cohort of homes with Level 1 and Level 2 retrofits completed will undergo Level 3 retrofits five years after Level 1 retrofits. The total number of homes being retrofitted will gradually increase to ensure that by 2050 all homes built before 2020 have received all three levels of upgrades.

Low-carbon Scenario Impacts

Table 6.6.
Low-carbon Scenario Impacts of Residential Energy-Efficiency Improvements: Level 3 - Deep Energy Retrofits

Low-carbon Scenario Metrics		
Greenhouse Gas Reduction Impact		
Cumulative greenhouse gas reduction from 2025-2035 (MT CO_2e)	79,249 MT CO_2e	
Cumulative greenhouse gas reduction from 2025-2050 (MT CO_2e)	2,049,833 MT CO_2e	
Cumulative Criteria Air Pollution Reduction	2025-2030	2025-2050
Total CO reduction (lbs)	0	1,016,534
Total HC reduction (lbs)	0	0
Total NOx reduction (lbs)	501	199,556
Total PM10 reductions (lbs)	65	25,620

Low-carbon Scenario Metrics		
Total PM2.5 reduction (lbs)	55	21,500
Total SO2 reduction (lbs)	202	79,140
Total VOC reduction (lbs)	25	9,951
Financial Impact		
Incremental Cost (USD)[170]		$15,149,943,219
Incremental Savings (USD)[171]		$2,012,195,949
Net Cost/ Savings (USD)		Net Cost of $13,137,747,270
Marginal Abatement Cost/ Savings (USD/ $MTCO_2e$)		Cost of $6,409 / MT

Non-residential Energy Efficiency Improvements: Levels 1, 2 and 3

Energy efficiency improvements provide similar benefits to non-residential building owners as they do to home owners. There are unique challenges for some building archetypes. For example, it can be challenging to reduce energy loss in buildings with large garage doors that are often open, such as fire stations. However, there are also additional benefits that can be gained from economies of sale that can be realized in larger buildings.

Similar to the actions for residences, three levels of retrofits were also modeled for non-residential buildings.

Pathways to Implementation

Utility programs are often the most relevant initial pathway to implementing energy efficiency improvements in commercial buildings. Larger utilities in particular often incentivize bigger buildings to reduce their energy use or to shift load away from peak demand times, and many businesses could benefit from changing rates or programs like utility energy audits. Several

170 Incremental cost includes capital, maintenance, operations, and energy costs relative to the BAP scenario.

171 Incremental savings includes all avoided capital, maintenance, operations and energy costs as well as revenue, relative to the BAP scenario.

Midlands businesses also offer Building Performance Institute certified energy auditors capable of assessing commercial buildings. Energy audits, whether from a utility or a local business, should provide actional and data-driven steps tied to a particular building.

- Key Implementing Organizations: Building owners.
- Geographic Area Impacted: Region-wide.
- Applicable Funding Sources: Apart from direct investment by the owner, green banks and other mission-driven financial institutions are key sources of funding for either concessionary loans or facilitating financialization (loan loss reserves, etc.). Most grants do not allow private firms to apply.
- Implementation Authority: Existing building owners generally have the ability to implement these improvements, with some exceptions for historic buildings or other atypical cases. Many business owners rent commercial space or buildings, which creates a split incentive issue that is not resolvable by implementation authority, but rather by ownership incentives.

Level 1 - Weatherization

The first level of non-residential retrofits includes completing basic weatherization measures such as adding insulation and making basic repairs.

Modeled Action and Timeline

- **2028:** 2% of all non-residential buildings constructed before 2020 will undergo basic weatherization measures such as adding attic insulation and sealing leaks.
- **Each year from 2029 to 2045:** Each year, an increasing proportion of pre-2020 non-residential buildings will undergo weatherization retrofits, such that by 2045 all of these buildings have received these improvements.

Low-carbon Scenario Impacts

Table 6.7.
Low-carbon Scenario Impacts of Non-Residential Energy-Efficiency Improvements: Level 1 - Weatherization

Low-carbon Scenario Metrics		
Greenhouse Gas Reduction Impact		
Cumulative greenhouse gas reduction from 2025-2035 (MT CO_2e)		102,831 MT CO_2e
Cumulative greenhouse gas reduction from 2025-2050 (MT CO_2e)		752,784 MT CO_2e
Cumulative Criteria Air Pollution Reduction	2025-2030	2025-2050
Total CO reduction (lbs)	8,874	481,907
Total HC reduction (lbs)	0	0
Total NOx reduction (lbs)	12,335	668,421
Total PM10 reductions (lbs)	1,081	57,856
Total PM2.5 reduction (lbs)	1,292	69,141
Total SO2 reduction (lbs)	4,111	219,903
Total VOC reduction (lbs)	617	33,479
Financial Impact		
Incremental Cost (USD)[172]		$315,827,581
Incremental Savings (USD)[173]		$1,192,070,283
Net Cost/ Savings (USD)		Net Savings of $876,242,701
Marginal Abatement Cost/ Savings (USD/ $MTCO_2e$)		Savings of $1,164 / MT

172 Incremental cost includes capital, maintenance, operations, and energy costs relative to the BAP scenario.

173 Incremental savings includes all avoided capital, maintenance, operations and energy costs as well as revenue, relative to the BAP scenario.

Level 2 - Enhanced Energy Efficiency

The second level of retrofits for non-residential buildings will include changes such as adding insulation as required throughout the building, switching lighting to LEDs and possibly replacing a door or window. These changes will further reduce energy consumption relative to Level 1 retrofits but total reductions will still be less than 50% of total thermal energy and total light and plug use.

Modeled Action and Timeline

- 2030: All non-residential buildings that had Level 1 measures completed in 2028 (which was 2% of this group of buildings) will undergo Level 2 improvements.
- Each year from 2032 to 2047: Each subsequent cohort of buildings with Level 1 retrofits completed will undergo Level 2 retrofits two years after they complete Level 1. The total number of buildings retrofitted annually will gradually increase to ensure that by 2047 all non-residential buildings built before 2020 have received these upgrades.

Low-carbon Scenario Impacts

Table 6.8.
Low-carbon Scenario Impacts of Non-Residential Energy-Efficiency Improvements: Level 2 - Enhanced Energy Efficiency

Low-carbon Scenario Metrics		
Greenhouse Gas Reduction Impact		
Cumulative greenhouse gas reduction from 2025-2035 (MT CO_2e)	51,371 MT CO_2e	
Cumulative greenhouse gas reduction from 2025-2050 (MT CO_2e)	529,824 MT CO_2e	
Cumulative Criteria Air Pollution Reduction	2025-2030	2025-2050
Total CO reduction (lbs)	734	339,400
Total HC reduction (lbs)	0	0
Total NOx reduction (lbs)	1,020	470,633

Low-carbon Scenario Metrics		
Total PM10 reductions (lbs)	107	48,605
Total PM2.5 reduction (lbs)	89	40,672
Total SO2 reduction (lbs)	340	154,588
Total VOC reduction (lbs)	51	23,576
Financial Impact		
Incremental Cost (USD)[174]		$315,827,581
Incremental Savings (USD)[175]		$863,526,469
Net Cost/ Savings (USD)		Net Savings of $547,698,887
Marginal Abatement Cost/ Savings (USD/ $MTCO_2e$)		Savings of $1,034 / MT

Level 3 - Deep Retrofits

The third level of energy efficiency retrofits for non-residential buildings will be deep energy retrofits. These will include comprehensive changes to a building's envelope, insulation, windows and doors, roof, etc. so as to reduce the building's total energy consumption by at least 50% relative to what it was before retrofits.

Modeled Action and Timeline

- **2033:** All buildings that had Level 1 measures completed in 2028 (which was 2% of total housing stock built before 2020) and Level 2 measures completed in 2030 will undergo Level 3 improvements.
- **Each year from 2034 to 2050:** Each subsequent cohort of buildings with Level 1 and Level 2 retrofits completed will undergo Level 3 retrofits five years after Level 1 retrofits. The total number of buildings being retrofitted will gradually increase to ensure that by 2050 all non-residential buildings constructed before 2020 have received all three levels of upgrades.

174 Incremental cost includes capital, maintenance, operations, and energy costs relative to the BAP scenario.

175 Incremental savings includes avoided capital, maintenance, operations and energy costs as well as revenue, relative to the BAP scenario.

Low-carbon Scenario Impacts

Table 6.9.
Low-carbon Scenario Impacts of Non-Residential Energy-Efficiency Improvements: Level 3 - Deep Energy Retrofits

Low-carbon Scenario Metrics		
Greenhouse Gas Reduction Impact		
Cumulative greenhouse gas reduction from 2025-2035 (MT CO_2e)		73,501 MT CO_2e
Cumulative greenhouse gas reduction from 2025-2050 (MT CO_2e)		2,571,313 MT CO_2e
Cumulative Criteria Air Pollution Reduction	2025-2030	2025-2050
Total CO reduction (lbs)	0	1,647,705
Total HC reduction (lbs)	0	0
Total NOx reduction (lbs)	0	2,284,502
Total PM10 reductions (lbs)	0	235,751
Total PM2.5 reduction (lbs)	0	197,272
Total SO2 reduction (lbs)	0	749,799
Total VOC reduction (lbs)	0	114,451
Financial Impact		
Incremental Cost (USD)[176]		$8,060,621,943
Incremental Savings (USD)[177]		$4,252,891,888
Net Cost/ Savings (USD)		Net Cost of $3,807,730,055
Marginal Abatement Cost/ Savings (USD/ $MTCO_2e$)		Cost of $1,481 / MT

176 Incremental cost includes capital, maintenance, operations, and energy costs relative to the BAP scenario.

177 Incremental savings includes avoided capital, maintenance, operations and energy costs as well as revenue, relative to the BAP scenario.

Heat Pumps for Water Heating

In order for buildings to reach net-zero emissions, they must become electrified. Water heating is usually the 2nd largest source of energy used in homes, and water heaters sometimes use fossil fuels that release air pollutants into the home and environment.

Heat pump water heaters use electricity, which reduces greenhouse gas emissions and saves money. This action assumes that as older water heaters are replaced, the new one will be the cheaper and less polluting heat pump water heater. This would occur in both new builds and retrofits of existing buildings.

The National Renewable Energy Laboratory specifically analyzed cost savings for the Midlands, and found that the average single family home would save $128 per year and the average multi-family home would save $99 per year by switching to a heat pump water heater.[178] Less commonly, an electric resistance water heater may make more sense in a particular home.[179]

While other alternatives to water heating can also be sustainable, like district heating, in the Midlands our weather conditions are optimal for air source heat pump water heaters. These systems are often simple to implement, because in most cases they can directly replace an old water heater without needing any large modifications to the building.

Modeled Action and Timeline

- 2030 on: All newly constructed buildings - both residential and non-residential - will use air source heat pumps for domestic water heating.
- Each year from 2034 to 2050: As Level 3 retrofits are completed in both residential and non-residential buildings, old water heaters will be replaced with heat pump water heaters.

Pathways to Implementation

These products are already available in the SC market, and prices are falling (especially as they are increasingly built into new housing developments).

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178 Liu, Lixi, Jes Brossman, and Yingli Lou. 2023. "ResStock Communities Local Energy Action Program (Communities LEAP) Pilot Residential Housing Analysis." NLR Data Catalog. Golden, CO: National Laboratory of the Rockies. Last updated: January 16, 2025. DOI: 10.7799/2222487.

179 One example is where the existing water heater location receives insufficient air flow for a heat pump, and a new location is unfeasible or expensive. Plumbing companies that have previously installed heat pump water heaters are usually best situated to advise customers.

Local plumbers already have the skills needed to install them. To increase the speed of their uptake, two implementation strategies are recommended:

1) Neighbors, especially those who have one in their home, can share this information with their friends, colleagues and neighbors. Many people do not know that these water heaters are more efficient and will save money on utility bills, because water heaters are not frequently replaced nor are they a common topic of conversation. Information on how to talk about these topics is available from different organizations, including Rewiring America.[180]

2) Rebates or other incentives are highly effective, especially when they make the more efficient water heater cost-comparable to the cheapest one (which is almost always less efficient and more expensive in the long run). Utilities[181] or governments at any level (local, state, federal) can run these programs.

- Key Implementing Organizations: Utilities, governments, building owners and homeowners.
- Geographic Area Impacted: Region-wide.
- Applicable Funding Sources: None identified. The recent federal government tax credit was eliminated in 2025.
- Implementation Authority: None needed.

Low-carbon Scenario Impacts

Table 6.10.
Low-carbon Scenario Impacts of replacing domestic water heating systems with heat pumps

Low-carbon Scenario Metrics	
Greenhouse Gas Reduction Impact	
Cumulative greenhouse gas reduction from 2025-2035 (MT CO_2e)	37,902 MT CO_2e

180 Rewiring America (2025). Electric Coaches. https://www.rewiringamerica.org/go-electric/electric-coaches

181 Incentive programs should not disallow fuel switching. Utilities can also benefit from virtual power plant (VPP) programs designed to interface with smart heat pump water heaters. Customers should be financially rewarded for such programs as they can aid the utility with shaving peak power demand. If the water heater is at least at half capacity, many customers may be open to a voluntary VPP program that reduces hot water heating during peak hours.

Low-carbon Scenario Metrics		
Cumulative greenhouse gas reduction from 2025-2050 (MT CO_2e)		608,391 MT CO_2e
Cumulative Criteria Air Pollution Reduction[182]	2025-2030	2025-2050
Total CO reduction (lbs)	399	418,000
Total HC reduction (lbs)	0	0
Total NOx reduction (lbs)	1,070	655,952
Total PM10 reductions (lbs)	-63	40,393
Total PM2.5 reduction (lbs)	-53	33,796
Total SO2 reduction (lbs)	-213	124,890
Total VOC reduction (lbs)	68	35,021
Financial Impact		
Incremental Cost (USD)[183]		$2,145,753,729
Incremental Savings (USD)[184]		$1,614,759,197
Net Cost/ Savings (USD)		Net Cost of $530,994,532
Marginal Abatement Cost/ Savings (USD/ $MTCO_2e$)		Cost of $873 / MT

Heat Pumps for Space Heating and Cooling

In order for buildings to reach net-zero emissions, they must become electrified. Space heating and cooling is usually the largest source of energy used in homes, and they sometimes use fossil fuels that release air pollutants into the home and environment.

182 Negative numbers indicate an increase in this pollutant.

183 Incremental cost includes capital, maintenance, operations, and energy costs relative to the BAP scenario.

184 Incremental savings includes avoided capital, maintenance, operations and energy costs as well as revenue, relative to the BAP scenario.

Air source pumps are essentially air conditioners that can also operate in reverse to heat a building. Heat pumps use electricity, which reduces greenhouse gas emissions and saves money. The financial savings are realized in several ways:

- Firstly, heat pumps convert a single unit of electricity into 3-4 units of heating or cooling. This means that their energy efficiency is 300-400% which is much more efficient than even a high-efficiency furnace, which is approximately 96% efficient. The result is you need to pay for much less energy to keep a building at a healthy and comfortable temperature when using a heat pump.
- Secondly, heat pumps provide both heating and cooling within a single unit. This means owners only have to pay for the purchase, maintenance and energy costs for one highly-efficient unit rather than two, less efficient systems. As the annual average temperature and the number of heat waves continue to increase, energy efficient HVAC will become increasingly important to limit spikes in utility bills as air conditioning is used more frequently. .
- Furthermore, maximizing opportunities to improve energy efficiency in buildings before installing heat pumps, will reduce the size of heat pump required, reducing the initial cost of a heat pump.

In 2020, South Carolina already had one of the highest adoption rates of heat pumps, with 41% of homes relying on a heat pump as the primary source of heat.[185] The National Renewable Energy Laboratory specifically analyzed cost savings for the Midlands, and found that the average single family home would save $948 per year by switching to a high-efficiency heat pump or $463 per year with a cheaper heat pump.[186] Businesses similarly save money by using air source heat pumps to heat and cool larger commercial buildings. The Midlands region even manufactures commercial scale heat pumps in Newberry (at Trane's facility).

The weather conditions in the Midlands are optimal for air source heat pumps. These heat pumps effectively heat homes at temperatures well below zero degrees Fahrenheit, but they use less energy at milder temperature

185 IEA (2020). Residential Energy Consumption Survey. https://www.eia.gov/consumption/residential/data/2020/index.php?view=state and https://www.eia.gov/consumption/residential/data/2020/index.php?view=state

186 Liu, Lixi, Jes Brossman, and Yingli Lou. 2023. "ResStock Communities Local Energy Action Program (Communities LEAP) Pilot Residential Housing Analysis." NLR Data Catalog. Golden, CO: National Laboratory of the Rockies. Last updated: January 16, 2025. DOI: 10.7799/2222487.

ranges.[187] Our winters in particular are mild, with daytime temperatures rarely dropping below freezing for long periods of time. A cold-weather rated heat pump is sufficient on its own for our lowest ever recorded temperature (1 degree Fahrenheit), but cheaper heat pumps that perform best in temperatures above freezing can be backed up by electric heat strips or a small gas furnace.[188] Geothermal heat pumps are not optimal for our region, because they are less commonly installed and repairs may thus be more expensive (and our climate is nearly perfect for the cheaper and more common air source heat pumps).

With a combination of ease to implement, regional suitability, and high impact (in terms of greenhouse gas emissions reduction potential), switching buildings to heat pumps is perhaps the best available climate action in the Midlands.

Pathways to Implementation

These products are already widely available and competitive in the SC market. Local HVAC companies already have the skills needed to install them. Residents should know that some HVAC companies may only present options identical to the prior installation, but nearly all homes in the Midlands are suitable for heat pumps. To increase the speed of their uptake, two implementation strategies are recommended:

1. Neighbors, especially those who have a heat pump in their home, can share information with their friends, colleagues and neighbors. HVAC replacements can be intimidating, and people often need to make a decision rapidly if their previous one broke down. Information on how to talk about these topics is available from different organizations, including Rewiring America.[189]
2. Rebates or other incentives are highly effective, especially when they make the more efficient heat pump cost-comparable to the cheapest one. Utilities[190] or governments at any level (local, state, federal) can run these programs.

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187 Between ~30 degrees and ~85 degrees Fahrenheit

188 While these backup systems are more expensive to fuel, they should rarely kick on in our mild winters. Residents should ensure that more expensive backup heat systems (gas furnaces or electric heat strips) are programmed to come on only when the cheaper heat pump is unable to heat the house on its own. Most thermostats have a setting to separately control such backup systems with rules (for example, do not turn on backup heat while the outdoor temperature is above freezing).

189 Rewiring America (2025). Electric Coaches. https://www.rewiringamerica.org/go-electric/electric-coaches

190 Incentive programs should not disallow fuel switching.

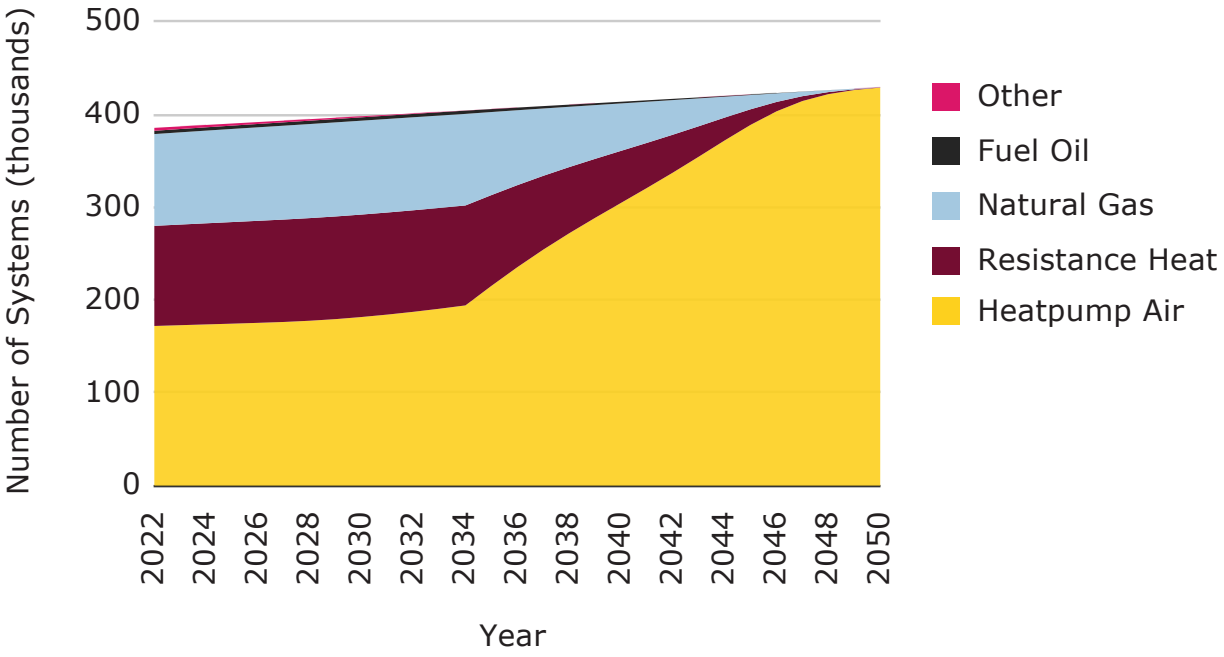
- Key Implementing Organizations: HVAC companies; governments (local, state, federal); utilities.
- Geographic Area Impacted: Region-wide.
- Applicable Funding Sources: The recently available federal tax credit was eliminated in 2025. The SC Energy Office is expected to release HEAR and HOMES funds as soon as 2026.[191] Several area utilities have rebate programs that can include heat pumps.
- Implementation Authority: None needed.

Modeled Action and Timeline

- **2030 on:** All newly constructed buildings - both residential and non-residential - use air source heat pumps for domestic space heating and cooling.
- **Each year from 2034 to 2050:** As Level 3 retrofits are completed in both residential and non-residential buildings, old space heating systems will be replaced with air source heat pumps.

The share of different types of heat systems over time, as modeled for this action is shown in Figure 6.5 below.

Figure 6.5.
Shares of heating systems in buildings in the LC scenario, 2022-2050.



191 SC Energy Office (2025). South Carolina Home Energy Rebates. https://energy.sc.gov/rebates

Low-carbon Scenario Impacts

Table 6.11.
Low-carbon Scenario Impacts of replacing existing systems with heat pumps for space heating and cooling

Low-carbon Scenario Metrics		
Greenhouse Gas Reduction Impact		
Cumulative greenhouse gas reduction from 2025-2035 (MT CO_2e)	217,312 MT CO_2e	
Cumulative greenhouse gas reduction from 2025-2050 (MT CO_2e)	3,448,187 MT CO_2e	
Cumulative Criteria Air Pollution Reduction	2025-2030	2025-2050
Total CO reduction (lbs)	3,632	2,942,699
Total HC reduction (lbs)	0	0
Total NOx reduction (lbs)	5,601	3,858,040
Total PM10 reductions (lbs)	274	102,768
Total PM2.5 reduction (lbs)	230	85,446
Total SO2 reduction (lbs)	808	308,198
Total VOC reduction (lbs)	301	208,867
Financial Impact		
Incremental Cost (USD)[192]	$5,318,536,391	
Incremental Savings (USD)[193]	$4,859,261,816	
Net Cost/ Savings (USD)	Net Cost of $459,274,575	
Marginal Abatement Cost/ Savings (USD/ $MTCO_2e$)	Cost of $133 / MT	

192 Incremental cost includes capital, maintenance, operations, and energy costs relative to the BAP scenario.

193 Incremental savings includes avoided capital, maintenance, operations and energy costs as well as revenue, relative to the BAP scenario.

6.3.2 Reimagine Transportation in the Midlands

The actions that constitute the Reimagine Transportation in the Midlands strategy[194] eliminate a total of 12,954,000 MT CO_2e between the present and 2050. This represents 8.3% of the total reductions achieved in the low-carbon scenario.

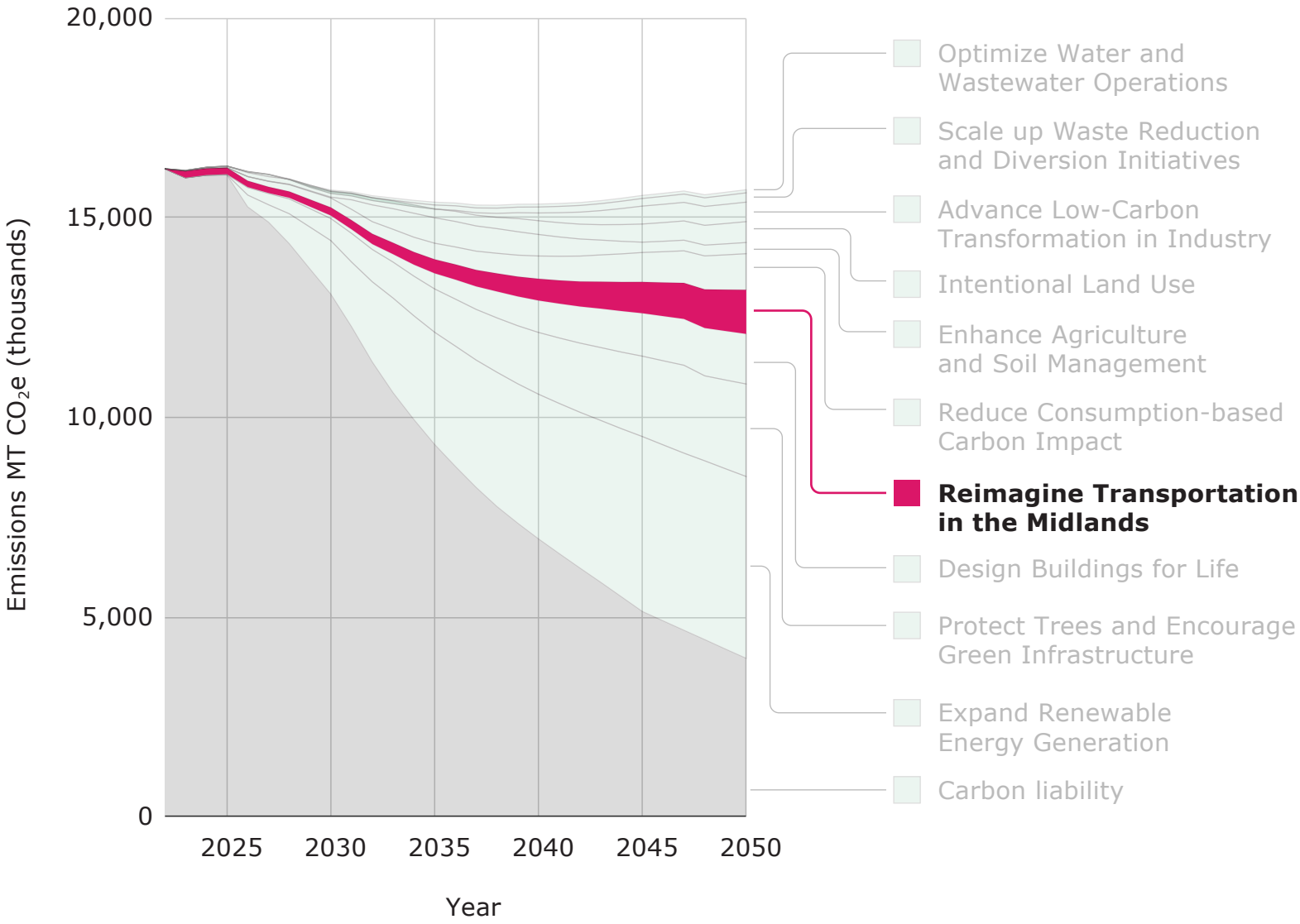
Reducing transportation emissions relies on the combination of two approaches:

1. Reducing the amount of travel taken in personal-use vehicles. This can be achieved by increasing walking and cycling, increasing transit and train ridership, and designing communities with more destinations within walking, cycling, or transit distances.
2. Switching vehicles to rely on electricity as a fuel. This encompasses all types of vehicles in the Midlands from diesel and gasoline cars to heavy-duty trucks and equipment and freight trains.

The combined impact on emissions of the actions in this strategy are shown in Figure 6.6.

194 See Table 6.1 for the individual action details.

Figure 6.6.
Projected emissions reduction from the Reimagine Transportation in the Midlands strategy, 2022-2050.



Each of the individual actions that constitute the Reimagine Transportation for Life Strategy are described below, along with their impact on short and long-term emissions and criteria air pollutants, and their costs and savings.

Increase Active Transportation

Active transportation refers to forms of non-motorized travel modes like walking, cycling and other micromobility options like scooters, skateboards, rollerblades, and tricycles. Every time someone chooses to walk or bike instead of driving their car, there's one less gasoline or diesel powered vehicle on the road. Since most transportation emissions come from burning gasoline or diesel, even short trips shifted to active modes cut air pollution.

Modeled Action and Timeline

This action focuses on regular commutes, such as to work and school, for short distances less than 5 miles.

- For all trips of 1 mile or less in distance, gradually increase the proportion that are walked until by 2040, 60% of trips of this length are walked.
- For all trips of 5 miles or less in distance, gradually increase the proportion that are biked until by 2040, 60% of trips of this length are biked.

Pathways to Implementation

In our public engagement, the lack of pedestrian and bicycle infrastructure and related safety concerns were prominent. These concerns are backed up by data, as our state is one of the worst in the nation for pedestrian and bicyclist fatalities.[195] Even when infrastructure is available, it is sometimes viewed as unsafe.[196] The best available solution is pedestrian paths and bike lanes that are physically separated from vehicle traffic (either permanently or at minimum with standing sticks or bollards, see Figure 6.7). Bike lanes with a substantial painted buffer are less optimal, but also strongly preferred to bike lanes with no buffer that place vehicles dangerously close to bicyclists.

195 SCDOT (2022). Bicycle & Pedestrian Safety. https://www.scdot.org/projects/bikeped-safety.html

196 One local mapping initiative labels bike routes by perceived safety. Cola Town Bike Collective (2025). Columbia Regional Bike Map. *https://cola.bike/*

Implementation of protected infrastructure should be based on areas where pedestrian and bicycle use is already high. Examples of successful data collection that can guide local planning include the City of Columbia's bicycle and pedestrian counts (usually conducted biannually). Municipalities can also conduct single point in time studies and generate local walk and bike plans.[197]

Figure 6.7.
A photo of the only (mostly) protected bike lane in the Midlands, on S. Main St. in Columbia.

197 At the time of this plan's writing, CMCOG was aware of 5 Midlands municipalities with Bike Ped Master Plans (City of Columbia, City of Cayce, City of West Columbia, Town of Springdale, and Town of Chapin), and more were considering it due to available funding from SCDOT.

Local (or state) governments can also set up e-bike[198] rebate programs to encourage active transportation. These programs typically provide funds to local bike shops on a monthly or quarterly basis for each e-bike sold. These programs have positive environmental and economic benefits, and can also support local small businesses (e.g. by limiting the rebate to bikes physically sold in the region).[199]

Finally, greenways represent a strategic opportunity for larger regional scale planning (e.g., separate from individual useful sidewalks or bike lanes). Greenways offer opportunities for a larger variety of use-cases beyond commuting, such as recreation and tourism. CMCOG's planning department has been analyzing greenway potential and pursuing related grants for several decades, and more greenways are emerging in the region. Examples include the Palmetto Trail and the 3 Rivers Greenway. When they become large enough to facilitate movement between areas, they may be more attractive for travel and aid in increasing active transportation. Sidewalks or bike lanes that connect to regional greenways can amplify this possibility.

- Key Implementing Organizations: Municipalities, SC Department of Transportation
- Geographic Area Impacted: Region-wide, but focused on areas with high population density and high known pedestrian and bicycle activity (e.g., even within small towns or rural areas, identifying key locations for infrastructure is important)
- Applicable Funding Sources: State funding is available on a variable basis through various state and federal programs, such funding often routes through SCDOT or CMCOG. Occasional grants from the federal government can also fund these projects.
- Implementation Authority: None needed. South Carolina already has a framework for transportation infrastructure spending. Local or state governments can start e-bike rebate programs at any time.

198 E-bikes have a small electric battery and motor to provide partial movement of a bicycle without pedaling. They are popular among many bicyclists that commute, as they can speed travel times and help when encountering elevations to make a trip easier to undertake.

199 For data analysis and examples, see Grynwald, B. et al. (2025) E-Bike Environment and Economics Impact Assessment Calculator. https://rmi.org/insight/e-bike-environment-and-economics-impact-assessment-calculator/

Low-carbon Scenario Impacts

Table 6.12.
Low-carbon Scenario Impacts of Increasing Active Transportation

Low-carbon Scenario Metrics		
Greenhouse Gas Reduction Impact		
Cumulative greenhouse gas reduction from 2025-2035 (MT CO_2e)	402,242 MT CO_2e	
Cumulative greenhouse gas reduction from 2025-2050 (MT CO_2e)	2,378,823 MT CO_2e	
Cumulative Criteria Air Pollution Reduction	2025-2030	2025-2050
Total CO reduction (lbs)	1,761,227	80,473,751
Total HC reduction (lbs)	119,772	5,451,868
Total NOx reduction (lbs)	102,915	5,174,249
Total PM10 reductions (lbs)	43,852	1,660,272
Total PM2.5 reduction (lbs)	4,003	303,642
Total SO2 reduction (lbs)	4,153	444,106
Total VOC reduction (lbs)	112,059	5,123,545
Financial Impact		
Incremental Cost (USD)	$224,999,990	
Incremental Savings (USD)	$2,815,846,734	
Net Cost/ Savings (USD)	Savings of $2,590,846,743	
Marginal Abatement Cost/ Savings (USD/ MT CO_2e)	Savings of $1,089 / MT CO_2e	

Increase Transit Ridership

Helping more people access and use buses, ride-sharing, rail and other forms of transit options, reduces air pollution by moving many people at once rather than by individual cars. For instance, a single bus replaces dozens of car trips, cutting fuel consumption which is the main driver of greenhouse gas emissions in the transportation sector.

Modeled Action and Timeline

Currently, the primary transit service in the Midlands region is offered by COMET. Its services, in the form of buses, vans and ride-sharing, are concentrated within the City of Columbia and surrounding areas across Richland and Lexington counties. This action assumes that as the bus transit network and services improve, transit ridership will increase from 0.5% in 2025 to reach 2% of total trips by 2040 regionwide. Carpools are included to fill-in the gap for areas with limited access to bus networks.

Pathways to Implementation

Bus routes between locations in the Midlands can sometimes be inconvenient. Depending on nearby routing, it is not uncommon for a 20 minute car trip to take an hour or more by COMET. To some degree, the region's extreme sprawl and lack of strict urban planning in many areas make a traditional fixed route system difficult to implement. While there are a variety of possible ways to improve the existing transit system, the following recommendations may be useful to consider:

1) Free to Ride: With no changes to the existing system, making it free to ride immediately helps community members who use it now, and this policy is likely to increase ridership. Free bus systems have been implemented successfully in multiple U.S. cities of varying sizes, including Boston, Iowa City, Chapel Hill, Richmond, and Kansas City. Beyond ridership increases, additional observed benefits have included reduced traffic on roadways and increased public safety on the transit system. These benefits have been found to outweigh the loss of ticket revenues.[200]

200 Streetsblog Mass. (2025). MeVa Study Finds Benefits of Axing Fares 'Far Exceed' Lost Revenue. https://mass.streetsblog.org/2025/02/06/meva-study-finds-benefits-of-axing-fares-far-exceed-lost-revenue

2) Bus Rapid Transit: These systems prioritize a limited number of routes with extremely high frequency, often less than 15 minutes or even less than 5 minutes, and usually paired with dedicated bus lanes. If it is possible to walk or bike to stops along the route, bus rapid transit can significantly reduce route times. The Charleston metro area is currently implementing the first such mass transit system in South Carolina, which could be a model as population density in the Midlands increases.[201]

3) Distributed Transit: Rather than a fixed route system with large buses, complete system redesigns are possible and usually have examples in other locations to draw data from. One possibility is the use of a large number of regular vehicles and small vans (e.g. public ride-sharing).

- Key Implementing Organizations: COMET
- Geographic Area Impacted: COMET system geography (centered on City of Columbia).
- Applicable Funding Sources: Local funding, mixed with occasional grants from the federal government.
- Implementation Authority: None needed.

Low-carbon Scenario Impacts

Table 6.13.
Low-carbon Scenario Impacts of Increasing Transit Ridership

Low-carbon Scenario Metrics		
Greenhouse Gas Reduction Impact		
Cumulative greenhouse gas reduction from 2025-2035 (MT CO_2e)		47,617 MT CO_2e
Cumulative greenhouse gas reduction from 2025-2050 (MT CO_2e)		381,839 MT CO_2e
Cumulative Criteria Air Pollution Reduction	2025-2030	2025-2050
Total CO reduction (lbs)	159,939	12,829,010

201 Low Country Rapid Transit (2025). https://lowcountryrapidtransit.com/. CMCOG also evaluated BRT in a prior report. Central Midlands Council of Governments (2006). Commuter Rail Feasibility Study. *https://centralmidlands.org/transportation/document_center/index.php*

Low-carbon Scenario Metrics		
Total HC reduction (lbs)	10,876	868,941
Total NOx reduction (lbs)	9,350	829,170
Total PM10 reductions (lbs)	3,976	262,175
Total PM2.5 reduction (lbs)	364	49,514
Total SO2 reduction (lbs)	379	73,176
Total VOC reduction (lbs)	10,176	816,823
Financial Impact		
Incremental Costs (USD)	Not calculated[202]	
Incremental Savings (USD)	$453,740,753	
Incremental Net Costs/ Savings (USD)	Savings of $453,740,753	
Marginal Abatement Cost (USD / MT CO_2e)	Savings of $1,188 / MT CO_2e	

Reduce Vehicle Miles Traveled in Columbia

Designing more mixed-use development in urban areas enables people to meet most of their daily needs without having to drive far. Having amenities like schools, groceries, dining options, parks, recreation centers and healthcare closer together to where people live also makes it easier to walk or bike instead of using a car for every trip.

Modeled Action and Timeline

This action focuses on trips within the City of Columbia in the short-term, anticipating that total miles travelled by vehicles will decrease by 5% by 2030.

202 Incremental costs for this action will vary depending on the approaches taken and changes made. As a result, costs were not calculated for this action.

Pathways to Implementation

Urban planning and design is the most applicable implementation pathway. Municipalities have the ability through zoning to enable mixed-use development and encourage density. It is often helpful to utilize a planning framework. For example, the 15 minute-city concept is the idea that the most commonly visited places (such as grocery stores, pharmacies, etc.) should be within a 15 minute walking radius of where someone lives.[203] This model would functionally require interspersing mixed use developments and light commercial zones within residential neighborhoods, rather than limiting commercial businesses to a single street that everyone needs to drive to.

- Key Implementing Organizations: Municipalities.
- Geographic Area Impacted: Urbanized areas.
- Applicable Funding Sources: None needed. Zoning is a structural change that encodes itself on the landscaspe over time.
- Implementation Authority: None needed for areas falling underneath a municipality that currently does zoning.

Low-carbon Scenario Impacts

Table 6.14.
Low-carbon Scenario Impacts of Reducing Vehicle Miles Traveled in Columbia

Low-carbon Scenario Metrics		
Greenhouse Gas Reduction Impact		
Cumulative greenhouse gas reduction from 2025-2035 (MT CO_2e)		648,618 MT CO_2e
Cumulative greenhouse gas reduction from 2025-2050 (MT CO_2e)		1,145,109 MT CO_2e
Cumulative Criteria Air Pollution Reduction	2025-2030	2025-2050
Total CO reduction (lbs)	14,601,566	38,768,378
Total HC reduction (lbs)	993,552	2,631,652
Total NOx reduction (lbs)	841,927	2,375,663

203 Moreno, C. (2024). The 15-Minute City: A Solution to Saving Our Time & Our Planet. Wiley. ISBN 9781394228140.

Low-carbon Scenario Metrics		
Total PM10 reductions (lbs)	425,179	934,600
Total PM2.5 reduction (lbs)	30,440	116,435
Total SO2 reduction (lbs)	32,448	154,613
Total VOC reduction (lbs)	929,054	2,467,521
Financial Impact		
Incremental Costs (USD)	Not calculated[204]	
Incremental Savings (USD)	$1,145,429,261	
Incremental Net Costs/ Savings (USD)	Savings of $1,145,429,261	
Marginal Abatement Cost (USD / MT CO_2e)	Savings of $1,127 / MT CO_2e	

Shift Personal Vehicle Travel to Rail Travel

Similar to the action on transit, this action involves replacing trips currently taken in personal vehicles with rail and tram services. Two specific opportunities were identified and incorporated into the modeling for this plan.

Electric, Inter-City Passenger Rail: The first is an opportunity to provide convenient and direct electric inter-city passenger rail service between Columbia and Charlotte, North Carolina. Based on current vehicle counts between the two cities, it was estimated that such a service could eliminate 40,000 trips currently taken in personal vehicles.

Revitalize Historic Tram Lines: The second opportunity would be to re-establish or re-imagine a new version of the City of Columbia's historic tram lines as they were in the late 19th and early 20th century,[205] to provide an electric tram service for short-distance trips within the city.

204 Incremental costs for this action will vary depending on the approaches taken and changes made. As a result, costs were not calculated for this action.

205 Background information was taken from: 'South Carolina Railroads - Street Railways - Columbia.' https://www.carolana.com/SC/Transportation/railroads/sc_street_railways_columbia.html and McQuillan, D.C. (1975). The Street Railway and the Growth of Columbia, South Carolina, 1882-1936. University of South Carolina Theses - Geography.

Modeled Action and Timeline

- **By 2045:** 40,000 trips between Columbia and Charlotte, NC that would currently be taken in personal vehicles will be taken instead on electric, inter-city, passenger rail.
- **By 2030:** Re-establish electric tram service, and begin shifting short distance vehicle trips to tram service.
- **By 2040:** 7.5% of short distance trips within the areas served by the trams that would previously have been taken in personal vehicles will be taken on the trams.

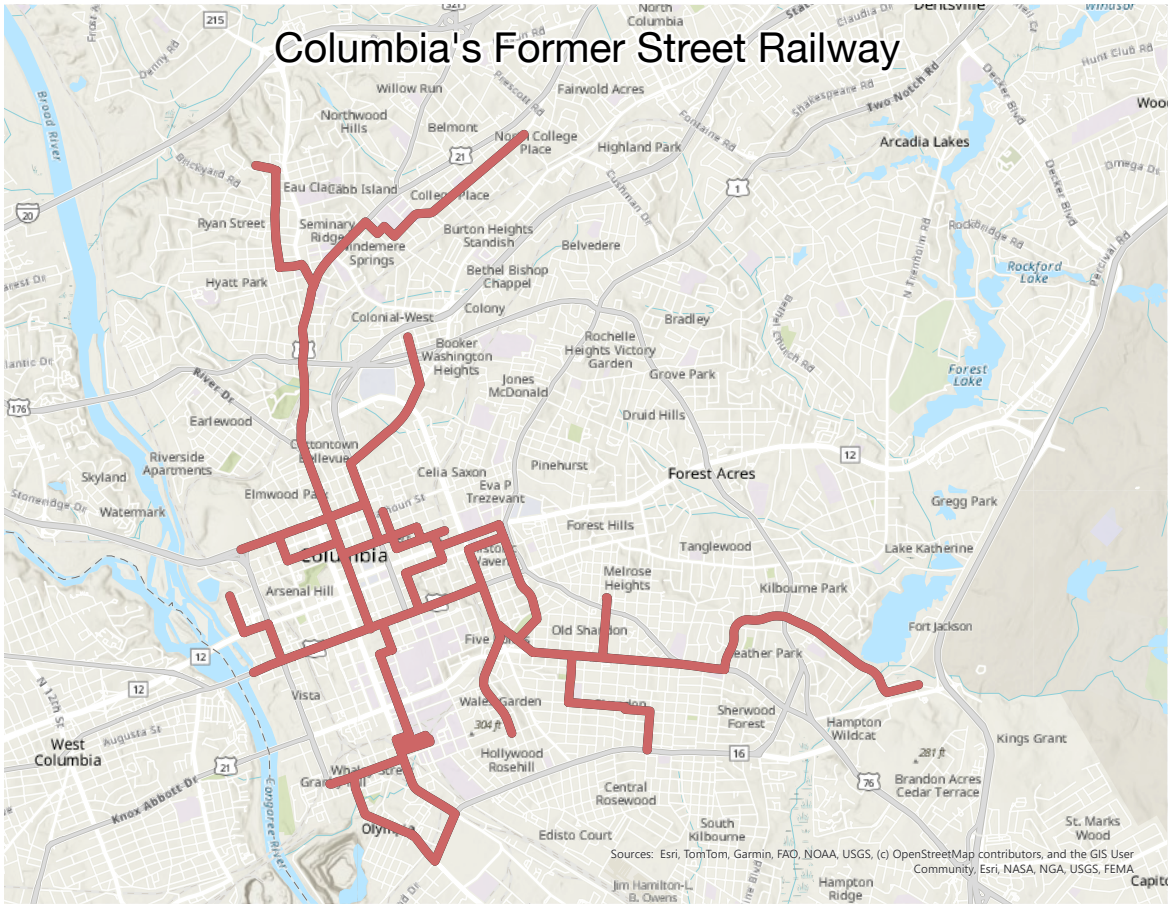
Pathways to Implementation

In the early 20th century, Columbia had a vibrant tram system, which encompassed most of the urban area at the time. It also extended beyond it, and led to the creation of new neighbourhoods and parks. The tram was not just a cheap and convenient way to move around the city, but also a driver of economic development. It was ripped out to make more room for cars on roads. CMCOG re-created the routes in GIS using historical geography research from a USC research project, shown in Figure 6.8.[206] Re-creating this tram system, with a few changes to better reflect current population distributions, would be a highly effective way to increase public transit options in the urban core of the metropolitan area.[207] Many students and professionals transit into and out of the center of the city for school or work.

206 McQuillan, D.C. (1975). The Street Railway and the Growth of Columbia, South Carolina, 1882-1936. University of South Carolina Theses - Geography.

207 In addition to the tram system, similar ideas are discussed in a prior CMCOG report. Central Midlands Council of Governments (2006). Commuter Rail Feasibility Study. *https://centralmidlands.org/transportation/document_center/index.php*

Figure 6.8.
A map of Columbia's former trolley system overlaid on modern streets.[208]



South Carolina once had perhaps the best passenger rail network in the world, starting with the longest continuous railroad line of 136 miles opening in 1833.[209] By the late 19th century, nearly the entire state was serviced by train routes, with many towns having multiple departure times throughout the day (see Figure 6.9).[210] Recreating larger train routes, such as the Greenville-Columbia-Charleston train route, would reduce 1.8 MMT of CO_2

208 CMCOG's GIS team georectified original data from McQuillan, and overlaid this on the modern street grid in Columbia. See McQuillan, D.C. (1975). The Street Railway and the Growth of Columbia, South Carolina, 1882-1936. University of South Carolina Theses - Geography.

209 Cochran, B. (2025). Revitalizing Passenger Rail: A Sustainable Solution to Environmental and Public Health Challenges in South Carolina. University of South Carolina Theses - Environmental Health Science.

210 Mewborne, M., Austin, C., Fleming, J. & Bentley, E. (2025). The Atlas of South Carolina (3rd edition). University of South Carolina Press. ISBN: 9781643366265 and Cochran, B. (2025). Revitalizing Passenger Rail: A Sustainable Solution to Environmental and Public Health Challenges in South Carolina. University of South Carolina Theses - Environmental Health Science.

annually.[211] In our community engagement, residents mentioned a shorter route to Charlotte as a priority, and CMCOG has previously analyzed this. The sole current passenger rail service operates from the Columbia, SC Amtrak station, but at inconvenient once daily times of ~4:30am (northbound) or ~12:30am (southbound), see Figure 6.9. Currently, a state-supported Amtrak route is the most viable option for passenger rail. North Carolina has successfully partnered with Amtrak for state-supported routes recently.

Figure 6.9.
Left - A map showing major passenger rail routes circa 1925.[212] Right - A photo of the report's author at the Columbia Amtrak station, close to the train's once daily north-bound boarding time.

- Key Implementing Organizations: SCDOT, Amtrak [inter-city passenger rail]; SCDOT, local municipalities, CMCOG [intra-city trams or other forms of commuter rail]
- Geographic Area Impacted: Metropolitan Planning Organization (MPO) boundary [trams], train route stops [e.g. along a Columbia - Charlotte Amtrak route]

211 Cochran, B. (2025). Revitalizing Passenger Rail: A Sustainable Solution to Environmental and Public Health Challenges in South Carolina. University of South Carolina Theses - Environmental Health Science.

212 Map copied from the Atlas of South Carolina, copyright University of South Carolina. Mewborne, M., Austin, C., Fleming, J. & Bentley, E. (2025). The Atlas of South Carolina (3rd edition). University of South Carolina Press. ISBN: 9781643366265

- Applicable Funding Sources: None identified at the moment.
- Implementation Authority: No new authority needed, but planning for either scenario envisioned here would involve multiple levels of government planning and other necessary steps prior changing land-use surfaces (such as city roads, updating current or laying new rail tracks, etc.).

Low-carbon Scenario Impacts

Table 6.15.
Low-carbon Scenario Impacts of Shifting Personal Vehicle Travel to Rail

Low-carbon Scenario Metrics		
Greenhouse Gas Reduction Impact		
Cumulative greenhouse gas reduction from 2025-2035 (MT CO_2e)		9,938 MT CO_2e
Cumulative greenhouse gas reduction from 2025-2050 (MT CO_2e)		29,680 MT CO_2e
Cumulative Criteria Air Pollution Reduction	2025-2030	2025-2050
Total CO reduction (lbs)	1	1,105,633
Total HC reduction (lbs)	0	75,125
Total NOx reduction (lbs)	0	65,829
Total PM10 reductions (lbs)	0	26,117
Total PM2.5 reduction (lbs)	0	3,586
Total SO2 reduction (lbs)	0	3,180
Total VOC reduction (lbs)	0	70,342
Financial Impact		
Incremental Costs (USD)		$211,269,500
Incremental Savings (USD)		$48,704,643
Incremental Net Costs/ Savings (USD)		Savings of $162,564,858
Marginal Abatement Cost/ Savings (USD /MT CO_2e)		Cost of $5,477 / MT CO_2e

Replace Transit Buses and Shuttles with Electric Models

Public transit buses in the Midlands are currently mostly fueled by diesel or compressed natural gas. Switching these vehicles to electric will eliminate greenhouse gases and other air pollution. Electric buses are also quieter and more efficient than gas or diesel engines. They are also likely to save transit operators money on both fuel and maintenance.

Modeled Action and Timeline

- Between 2025 and 2040, transit buses and shuttles will gradually be replaced with battery-electric models. By 2040, 100% of the fleet will be battery-electric.[213]

Pathways to Implementation

COMET has already begun piloting fleet options to transition away from polluting diesel buses (see Figure 6.10). In 2025, the COMET used two sources of grant funds to purchase both zero-emission buses[214] and hybrid electric buses.[215] The COMET's recent use of hybrid vehicles lowers greenhouse gas emissions and has significant public health benefits,[216] but as soon as possible, only battery electric vehicles should be purchased in order to limit technological lock-in to fleet assets that would still emit heavily polluting diesel over the lifetime of the new buses.[217]

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213 Hybrid vehicles have become a temporary transition, aka a mid-point in between diesel and battery electric vehicles. This type of more complex transition pathway was not modeled here.

214 COMET (2025). In Celebration of Earth Day, the COMET Rolls Out New Zero-Emission Buses Funded by $2.9M Federal Grant. https://catchthecometsc.gov/in-celebration-of-earth-day-the-comet-rolls-out-new-zero-emission-buses-funded-by-2-9m-federal-grant/. Both battery-electric and hydrogen buses were purchased, but hydrogen fuel is less suitable for the Midlands strategically (see policy considerations section later in this chapter).

215 COMET (2025). The COMET Awarded $15.75 Million Federal Grant To Replace Diesel Buses with Hybrid-Electric Fleet. https://catchthecometsc.gov/the-comet-awarded-15-75-million-federal-grant-to-replace-diesel-buses-with-hybrid-electric-fleet/

216 Hybrid engines would be expected to emit less air pollutants near bus stops as the electric battery is used more frequently at a standstill or low speeds, lowering the use of the diesel engine near sites of highest exposure to air pollutants that harm public health. For further information, see Lajunen, A., & Lipman, T. (2016). Lifecycle cost assessment and carbon dioxide emissions of diesel, natural gas, hybrid electric, fuel cell hybrid and electric transit buses. Energy, 106, 329-342. & Wang, J., & Rakha, H. A. (2016). Modeling Fuel Consumption of Hybrid Electric Buses: Model Development and Comparison with Conventional Buses. Transportation Research Record: Journal of the Transportation Research Board, 2539(1), 94-102.

217 There is active debate about whether "transitionary" technologies like hybrid buses result in less air pollution over the entire time horizon of a fleet conversion project. However, it remains true that to eliminate air pollution, zero emission buses are eventually required. For further information, see Arabi, M., Oke, T., Baker, E., & Oke, J. (2025). Harnessing hybrid buses in the near term leads to faster transit decarbonization. Iscience, 28(10). https://doi.org/10.1016/j.isci.2025.113567

Figure 6.10.
A photo of one of COMET's new zero-emissions buses.[218]

- Key Implementing Organizations: COMET, regional counties [outside COMET area]
- Geographic Area Impacted: Mainly COMET service area (centered around the urban core of Columbia, SC and surrounding municipalities). Other counties in the planning area that are outside of COMET's service area run shuttles or van service for particular communities, such as elderly residents or disabled residents.
- Applicable Funding Sources: COMET has successfully used grants from the U.S. Department of Transportation to fund purchases of zero-emission vehicles. No current grant funding sources are noted at this time.
- Implementation Authority: None needed.

218 Photo provided by, and copyright of, Central Midlands Regional Transit Authority.

Low-carbon Scenario Impacts

Table 6.16.
Low-carbon Scenario Impacts of Replacing Transit Vehicles with Electric Buses

Low-carbon Scenario Metrics		
Greenhouse Gas Reduction Impact		
Cumulative greenhouse gas reduction from 2025-2035 (MT CO_2e)		12,139 MT CO_2e
Cumulative greenhouse gas reduction from 2025-2050 (MT CO_2e)		63,850 MT CO_2e
Cumulative Criteria Air Pollution Reduction[219]	2025-2030	2025-2050
Total CO reduction (lbs)	-277[220]	-15,272
Total HC reduction (lbs)	0	-3
Total NOx reduction (lbs)	-442	-24,356
Total PM10 reductions (lbs)	929	87,429
Total PM2.5 reduction (lbs)	-180	-10,683
Total SO2 reduction (lbs)	-178	-7,708
Total VOC reduction (lbs)	-21	-1,131
Financial Impact		
Incremental Costs (USD)		$35,186,163
Incremental Savings (USD)		$26,956,291
Incremental Net Costs/ Savings (USD)		Cost of $8,229,872
Marginal Abatement Cost/ Savings (USD /MT CO_2e)		Cost of $129 / MT CO_2e

219 Negative values in this table indicate an increase.

220 In this action, we see increases in a number of criteria air pollutants. One reason for this is the fact that electric buses are heavier than ICE buses, meaning they cause more wear on their tires than ICE models. The result is an increase in some air pollutants including particulate matter.

Electrify Personal and Commercial Light-duty Vehicles

This action applies to light-duty vehicles. Electric vehicles do not burn gasoline or diesel, and thus do not produce tailpipe emissions. Electric vehicles that connect to a "dirty" power grid still emit less compared to conventional cars as these vehicles are more efficient and run on less energy.[221] In South Carolina, the high percentage of nuclear energy on the grid (which produces no greenhouse gases) means switching to electric vehicles is a high impact climate action.

Many people severely underestimate the health risks of breathing in harmful pollutants emitted from gasoline and diesel vehicles, which can cause cardio-vascular harm and even lead to premature deaths.[222] Public health harms are disproportionately high in the Midlands, because we have one of the worst per capita rates of transportation air pollution nationwide.[223] In addition to significant environmental and public health benefits that arise from completely eliminating a major source of air pollution, EVs also have additional quality of life benefits (such as a large reduction in noise).

This action also provides vehicle owners with dramatic cost savings on both fuel and maintenance relative to owning an internal combustion engine (ICE) vehicle. In fact, these savings are substantial enough that an electric vehicle purchased in South Carolina in 2025 can be expected to pay for itself in 4 to 7 years.[224] And although the initial purchase cost of some EVs are currently higher than an equivalent ICE vehicle, the cost of electric LDVs is expected to reach parity with ICE light-duty vehicles by 2030, and medium-duty vehicles should reach parity by 2035. The relative sprawl of the Midlands and current costs of electricity means that cost savings from EVs are slightly higher than other parts of the country.

Similarly to personal vehicles, commercial businesses that use light-duty

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221 Smith, E., Woody, M., Wallington, T. J., Hitt, C., Kim, H. C., Taub, A. I., & Keoleian, G. A. (2025). Greenhouse gas reductions driven by vehicle electrification across powertrains, classes, locations, and use patterns. Environmental Science & Technology, 59(37), 19768-19780. https://doi.org/10.1021/acs.est.5c05406

222 Pan, S., Yu, W., Fulton, L. M., Jung, J., Choi, Y., & Gao, H. O. (2023). Impacts of the large-scale use of passenger electric vehicles on public health in 30 US. metropolitan areas. Renewable and Sustainable Energy Reviews, 173, 113100.

223 Archote, J. (2024). Car-centric Columbia among nation's worst for commuter miles and vehicle emissions. Post and Courier. https://www.postandcourier.com/columbia/news/emissions-climate-transportation-columbia-midlands/article_64c22eb2-f82d-11ee-80e0-c71faae6cb91.html

224 Based on analysis from the following sources: U.S. DoE Office of Energy Efficiency and Renewable Energy.. 'Vehicle Cost Calculator' web page. https://afdc.energy.gov/calc/; and AAA. 'True Cost of Electric Vehicles' web page. https://afdc.energy.gov/calc/

vehicles benefit from cost savings. The main additional consideration is that small businesses, agribusinesses, ride share drivers, and others often rely more on public fast chargers during the workday.

Modeled Action and Timeline

With decreasing prices, increasing availability and the presence of electric vehicle manufacturing facilities in the Midlands, this action assumes more new personal and commercial light-duty vehicles sold each year will be electric vehicles. The transition of light-duty personal and commercial vehicles was modeled as follows:

- Beginning in 2036, 52% of all new light-duty personal and commercial vehicles sold will be electric;
- By 2040, this will have increased to 68% of all new light-duty personal and commercial vehicles cars sold;
- By 2045, this will increase to 80% of all new light-duty personal and commercial vehicles cars sold; and,
- By 2050, 100% of all new cars sold will be electric.

Notes:

1. The BAP and LC scenarios both assume that electric vehicles will constitute 39% of all new personal and commercial vehicle sales by 2030, and rise to 51% by 2035. The two scenarios begin to diverge in 2036, when the LC scenario sees EVs constitute 52% of new sales, vs. 51% in the BAP scenario. The results thus show no emissions reductions from this action relative to the BAP scenario until 2036.
2. It was assumed that existing conventional vehicles will be retired on average after 15 years, so in this scenario there will still be diesel and gasoline vehicles in operation in 2050. Mitigating this would mean a faster transition of vehicles is necessary.

Pathways to Implementation

Subsidies are likely not needed for electric vehicles, due to the large consumer savings in both fuel and maintenance.[225] Larger macroeconomic policies or decision-making of particular businesses pose a risk in the Midlands that cheap EVs will not be available here. For example, there

225 EVs need almost no regular maintenance compared to gasoline or diesel vehicles, and have fewer mechanical failure points.

are currently EVs manufactured in other countries that are cheap[226] and are barred from sale in the U.S.. Some car dealers in the Midlands are not stocking the cheapest EVs currently available in the U.S. market on their lots.[227]

EV growth in South Carolina is beginning to turn exponential, likely because it is significantly cheaper to own and maintain an EV here.[228] As more people transition over time, enabling infrastructure is likely the optimal implementation pathway. This means a combination of both fast chargers (sometimes called level 3 chargers) and slow chargers (sometimes called level 2 chargers). Many have access to a slow charger either where they live or where they work, which is sufficient for day to day EV refueling. However for those who do not, access to public or semi-public chargers is important. Public chargers, particularly fast chargers, are also important for tourists, businesses, and people who travel intensively for recreation or employment (ride-share drivers, etc.).

Private firms have sufficient economic incentives to install adequate charging stations within areas of highest density of EV ownership, within wealthy areas, and along Interstate routes near larger cities. There is a regional planning risk that areas that do not meet these criteria will be underprioritized by the private market (e.g. rural areas, smaller towns, and high traffic roads that are not adjacent to Interstates). Local municipalities and counties can play a key role (whether through grants, local policies, etc.) in ensuring that all residents of the Midlands have access to EV chargers.

CMCOG has begun planning for EV charger infrastructure in the Midlands. First, we used a model from the U.S. Department of Energy to evaluate transition needs, finding that by 2050 the Midlands needs an additional ~500 fast charging stations and ~7,500 places where slow charging is available.[229] Second, we did a spatial analysis of all current high-quality fast charging stations in late 2024. The results are shown in Figure 6.11.[230]

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226 If they were sold in the U.S., their MSRP would likely be under $20,000.

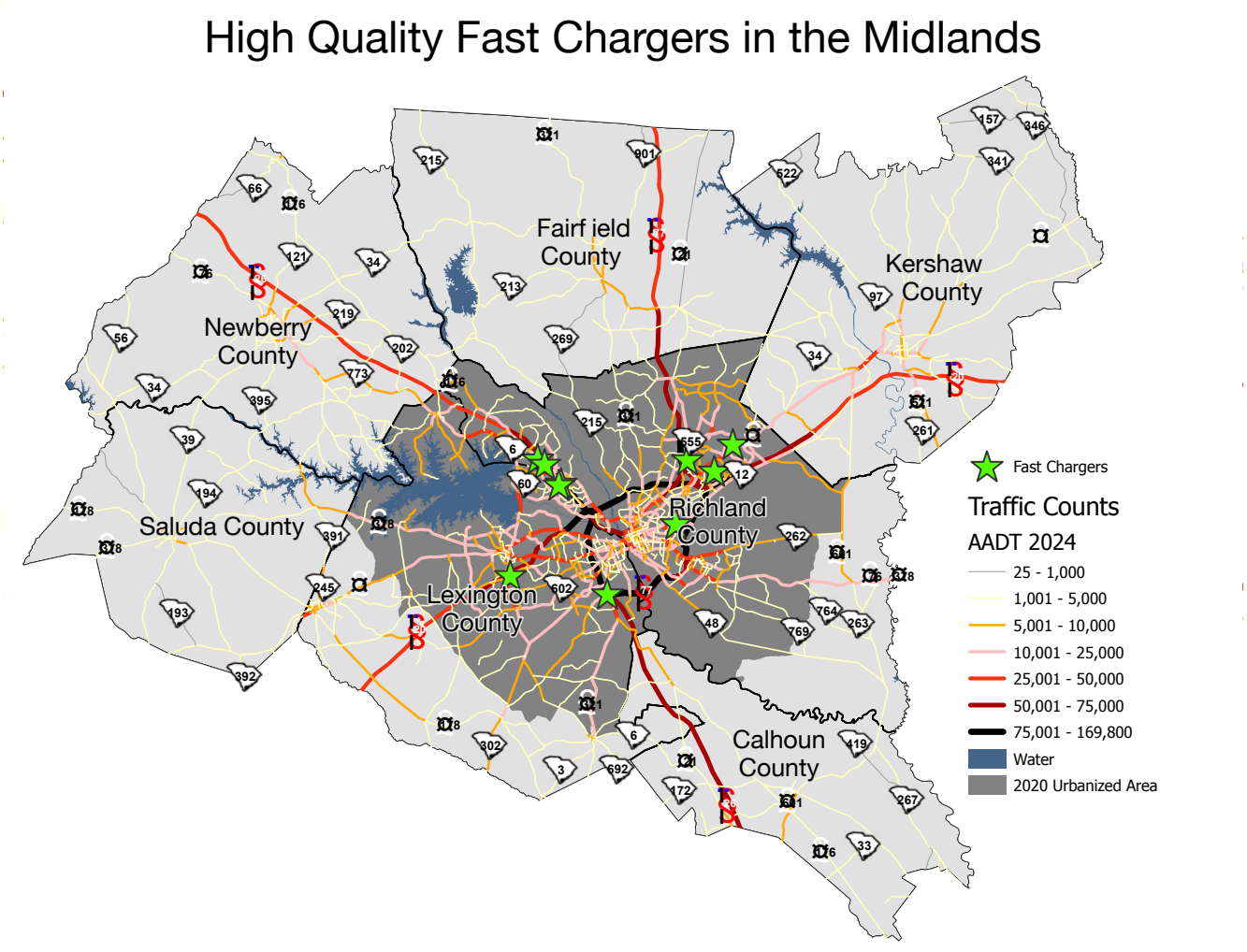
227 At one point during this planning process multiple major brands were sold out of all of the cheapest model EVs available from their manufacturer on their lots in the area.

228 Southern Alliance for Clean Energy (2025). Transportation Electrification in the Southeast - 6th Annual Report. *https://cleanenergy.org/resource/transportation-electrification-in-the-southeast-sixth-annual-report/*

229 We used the National Laboratory of the Rockies EVI-X Toolbox (https://www.nlr.gov/transportation/evi-x). We evaluated a scenario in 2050, where 700,000 EVs and hybrids are on the road. We expect this would be about ~65% of light-duty vehicles (accounting for continued population growth). The number of stations assume that, on average, fast charger locations can charge 5 vehicles simultaneously and slow charger locations can charge 6 vehicles simultaneously.

230 Special thanks to Nikhil Vaishnav, Connor Rourk, and Liam Ogden who partnered with CMCOG on this spatial analysis as part of their Geography Senior Capstone Project at the University of South Carolina.

Figure 6.11.
A map of high-quality fast charger stations in the Midlands, showing high traffic roads and the urban core.231



- Key Implementing Organizations: CMCOG [planning], local municipalities [public level 2 chargers], large institutional/commercial sites [level 2 chargers], private firms (often gas stations or fast charger networks) [fast chargers]

231 This analysis was conducted in late 2024, but is still reflective of fast charging station geography in the Midlands. We manually determined "high quality" stations to be commercial operators that had at least two ports, and were not at locations that controlled access (like car dealers, hotels, etc.). Only Interstates, U.S. Highways, and SC Highways are shown, where "traffic" refers to average annual daily traffic count estimates. The metropolitan planning organization boundary defines the urban core for transportation planning. U.S. Department of Energy (2024). Alternative Fuels Data Center. *https://afdc.energy.gov/fuels/electricity-stations* & SC Department of Transportation (2024). 2023 Statewide Traffic Lines. https://info2.scdot.org/GISMapping/Pages/GIS.aspx & Central Midlands Council of Governments (2024). MPO Boundary GIS Layer.

- Geographic Area Impacted: Region-wide
- Applicable Funding Sources: No new funds available at this time. The SCDOT recently regained funds for fast chargers along interstates through the National Electric Vehicle Infrastructure program, with potential implementation in 2026.
- Implementation Authority: None needed.

Low-carbon Scenario Impacts

Table 6.17.
Low-carbon Scenario Impacts of Electrifying Personal and Commercial Light-Duty Vehicles

Low-carbon Scenario Metrics		
Greenhouse Gas Reduction Impact		
Cumulative greenhouse gas reduction from 2025-2035 (MT CO_2e)		0 MT CO_2e
Cumulative greenhouse gas reduction from 2025-2050 (MT CO_2e)		961,643 MT CO_2e
Cumulative Criteria Air Pollution Reduction	2025-2030	2025-2050
Total CO reduction (lbs)	0	179,821,437
Total HC reduction (lbs)	0	12,319,964
Total NOx reduction (lbs)	0	8,662,063
Total PM10 reductions (lbs)	0	2,754,597
Total PM2.5 reduction (lbs)	0	-50,469[232]
Total SO2 reduction (lbs)	0	-731,023
Total VOC reduction (lbs)	0	11,441,449
Financial Impact		
Incremental Costs (USD)		$3,054,694,473

232Negative values indicate an increase in the pollutant.

Low-carbon Scenario Metrics	
Incremental Savings (USD)	$2,006,101,988
Incremental Net Costs/ Savings (USD)	Costs $1,048,592,485
Marginal abatement cost ($/tCO$_2$e)	Costs $1,090 / MT CO$_2$e

Replace Municipal and County Fleet Vehicles with Electric Vehicles

This action involves replacing vehicles and equipment fueled by gasoline and diesel that are operated by local municipalities with electric vehicles as they reach their end of life after an average of 15 years. This would begin with replacing light-duty vehicles and equipment such as cars, trucks and lawn mowers, and expand over time to include specialized heavy-duty vehicles like fire engines, waste transportation vehicles, and school buses.

Modeled Action and Timeline

Within all municipal and county fleets, vehicles and equipment will be replaced according to the following schedule:

- **2026:** Replacements of light-duty vehicles will begin to switch over to battery electric models. Wherever possible, plans to replace or purchase medium and heavy-duty vehicles and equipment will also begin to be budgeted for and replaced with electric models.
- **January 1, 2030:** All new light-duty vehicles and equipment that are purchased either to replace existing fleet vehicles/ equipment or to grow the fleet are battery electric;
- **January 1, 2033:** All new medium-duty fleet vehicles that are purchased are battery electric; and
- **January 1, 2040:** All new heavy-duty vehicles (such as fire engines, waste transportation vehicles and school buses) purchased are battery electric vehicles.

Note that it was assumed that existing conventional vehicles will be retired on average after 15 years, so in this scenario there will still be diesel and gasoline vehicles in operation in 2050. Mitigating this would require a faster conversion to electric vehicles, with a goal to have no polluting vehicles in the fleet by 2050.

Pathways to Implementation

Local governments can be leaders in clean transportation. Fleet vehicles offer a good opportunity to lower ongoing fuel and maintenance costs, because fleet vehicles often have high annual mileage and thus any marginal savings on fuel are amplified. There are several local examples of fleet conversions (see Figure 6.12). Some projects also include EV chargers, but many municipalities have fast chargers within a short distance that can be used until chargers are installed on-site. If the South Carolina State Fleet obtains EVs for leasing, local governments can use this as a mechanism to trial EVs before embarking on a fleet conversion project.

Local fleets often include a wide range of vehicles. Charleston, SC recently began a program focused on landscaping vehicles & equipment.[233] South Carolina school districts, including Richland 1, received electric school buses from an EPA Grant in 2023-2024.[234] Buses that emit diesel are a particularly severe public health concern for children. Specialized heavy-duty vehicles (beyond buses, such as fire trucks, waste transportation vehicles, etc.) are sometimes more expensive or otherwise difficult to transition as new models have emerged only recently. Cary, NC recently purchased the first electric fire truck on the east coast, for example.[235]

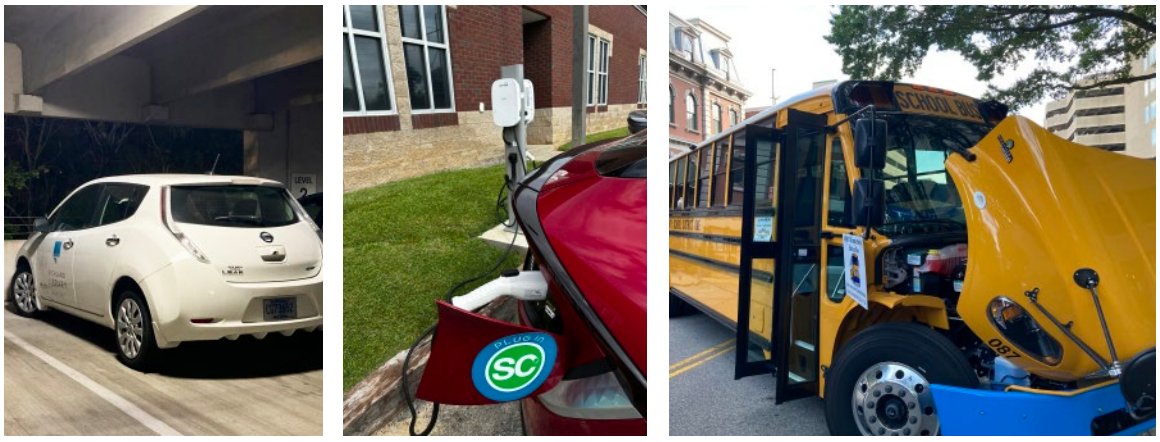
Local governments should immediately transition all new light-duty vehicle purchases to electric, as these are proven to save money over the vehicle's lifetime and are thus the most cost-effective for taxpayer funds (assuming the fleet vehicle is not expected to be returned or disposed of within 5-10 years). Similarly, local landscaping and forestry departments can also begin replacing equipment with electric motor equivalents as new purchases are needed. After 2030, electric models for heavy-duty vehicles will likely be more widely available with lower up-front costs. In the interim, local governments can strategically install charging infrastructure to enable a faster fleet transition later.

233 Schatz & Kerns (2024). Interactive map of lawn mower and leaf blower policies. PIRG. https://pirg.org/resources/interactive-map-of-lawn-mower-and-leaf-blower-policies/

234 SC Department of Education (2022). South Carolina Receives $58M from EPA for Electric School Buses. *https://ed.sc.gov/newsroom/news-releases/south-carolina-receives-58m-from-epa-for-electric-school-buses/*

235 Cary, NC. (2025). Cary Leads the East Coast with Field-Proven First Electric Fire Truck. *https://www.carync.gov/Home/Components/News/News/16719/715*

Figure 6.12.
A photo of electric fleet vehicles from (from left to right) Richland County Library, Central Midlands Council of Governments, and Richland School District 1.



- Key Implementing Organizations: Local governments
- Geographic Area Impacted: Region-wide
- Applicable Funding Sources: None needed. Light duty EVs are already the most cost-effective for fleets (assuming that the vehicle's lifetime cost is used, not solely upfront purchase price). Small grants can enable charging infrastructure installations on municipal buildings, a key annually recurring funding source here is the SC Energy Office's Mini-Grant.
- Implementation Authority: None needed.

Low-carbon Scenario Impacts

Table 6.18.
Low-carbon Scenario Impacts of replacing municipal and county fleet vehicles and equipment with electric models

Low-carbon Scenario Metrics	
Greenhouse Gas Reduction Impact	
Cumulative greenhouse gas reduction from 2025-2035 (MT CO_2e)	3,035 MT CO_2e
Cumulative greenhouse gas reduction from 2025-2050 (MT CO_2e)	31,154 MT CO_2e

Low-carbon Scenario Metrics		
Cumulative Criteria Air Pollution Reduction	2025-2030	2025-2050
Total CO reduction (lbs)	55,755	2,538,300
Total HC reduction (lbs)	3,824	188,966
Total NOx reduction (lbs)	4,785	628,796
Total PM10 reductions (lbs)	1,098	69,604
Total PM2.5 reduction (lbs)	44	10,197
Total SO2 reduction (lbs)	-266[236]	-15,101
Total VOC reduction (lbs)	3,574	179,595
Financial Impact		
Incremental Costs (USD)		$8,625,037
Incremental Savings (USD)		$48,441,697
Incremental Net Costs/ Savings (USD)		Savings of $39,816,660
Marginal abatement cost (USD/ MT CO_2e)		Savings of $1,278 / MT CO_2e

Replace Commercial Medium and Heavy-duty Vehicles with Electric Models

This action involves replacing commercial medium and heavy-duty vehicles after an average of 15 years of use with electric models. At the time of writing, all types of medium and heavy-duty vehicles are available in at least one mode that produces zero-emissions; however, to allow for an increase in selection and to accommodate high demand, the timeline for this action is slightly later than the timeline modeled for light-duty vehicles.

236 Negative values indicate an increase in the pollutant.

Modeled Action and Timeline

New medium- and heavy-duty commercial vehicles will increasingly be replaced with battery electric models, based on the following schedule:

- 2026: New medium and heavy-duty commercial vehicles will begin to be replaced with battery electric models;
- By 2030, 35% of all new medium and heavy-duty vehicles registered in the region will be battery electric models;
- By 2035, this will increase to 45%;
- By 2040, this will increase to 55%;
- By 2045, this will increase to 75%; and
- By 2050, 100% of all new medium and heavy-duty vehicles registered in the region will be battery electric vehicles.

Pathways to Implementation

Commercial medium and heavy-duty vehicles would categorically exclude small businesses (which would mainly use light-duty trucks or vans to transport equipment or goods to market). Large vehicles, such as semi-trucks, use larger volumes of diesel that disproportionately contribute to air pollution that causes public health damages. One optimal implementation pathway to curb damages is to tax the activity causing the harm.[237] South Carolina already collects taxes on diesel fuel sold in the state. A policy to raise diesel fuel taxes over time would automatically incentivize private firms to transition fleets over time (as fuel costs rise and EV vehicles fall in price). The legislature should thus enable an exponentially rising diesel fuel tax for all diesel sold over a small threshold volume.[238]

- Key Implementing Organizations: Private firms, SC State Legislature
- Geographic Area Impacted: Region-wide
- Applicable Funding Sources: None needed.
- Implementation Authority: State legislation [diesel tax].

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237 Annika Stechemesser, Nicolas Koch, Ebba Mark, Elina Dilger, Patrick Klösel, Laura Menicacci, Daniel Nachtigall, Felix Pretis, Nolan Ritter, Moritz Schwarz, Helena Vossen, Anna Wenzel (2024): Climate policies that achieved major emission reductions: Global evidence from two decades. Science. DOI: 10.1126/science.adl6547

238 A threshold that is small (e.g., 5 gallons) would partially exclude light-duty vehicles that use diesel and have smaller tanks. Alternatively, light-duty diesel vehicles also emit air pollution and could thus be included in a tax applied to all fuel sales.

Low-carbon Scenario Impacts

Table 6.19.
Low-carbon Scenario Impacts of replacing commercial medium and heavy-duty vehicles with electric models

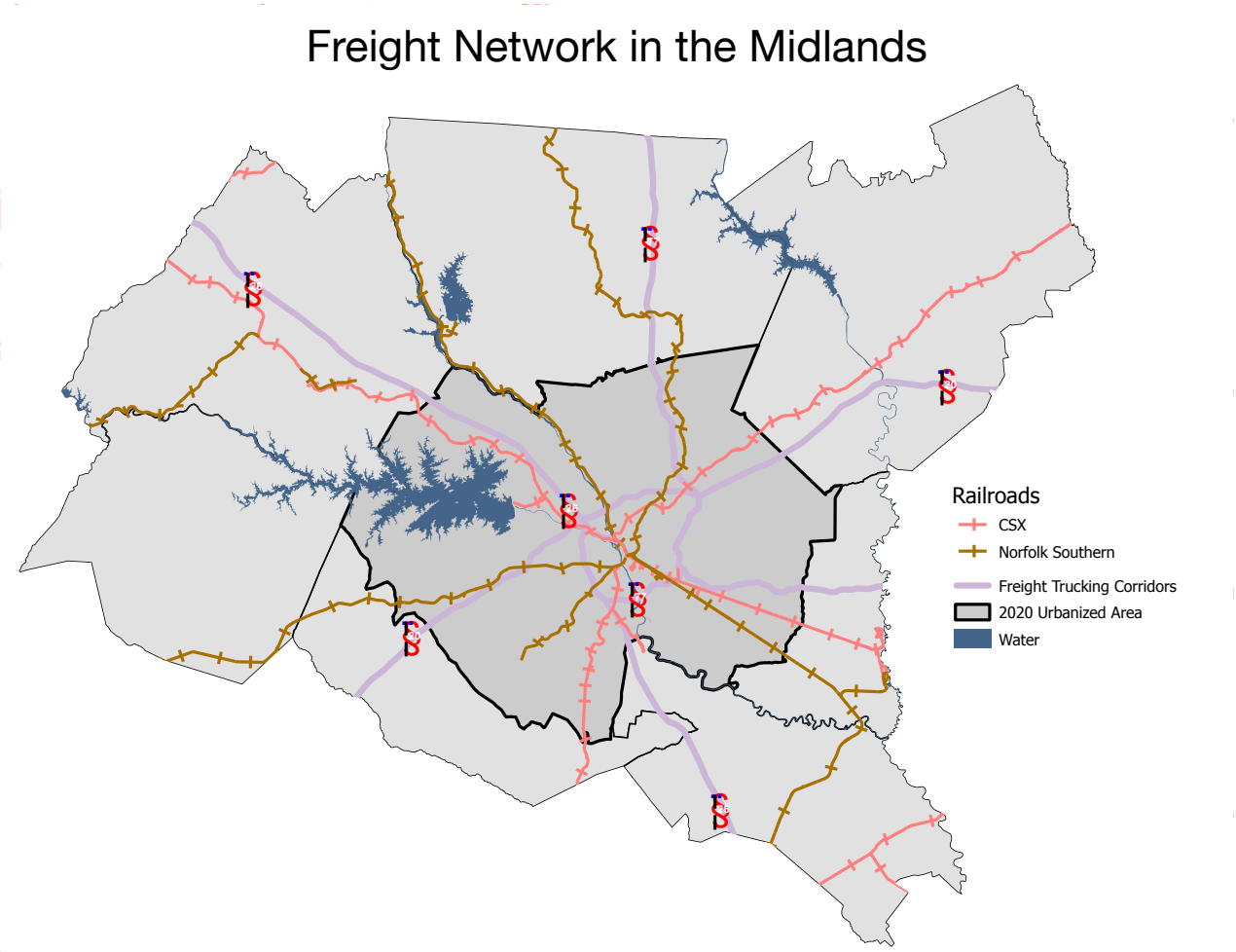
Low-carbon Scenario Metrics		
Greenhouse Gas Reduction Impact		
Cumulative greenhouse gas reduction from 2025-2035 (MT CO_2e)		1,434,947 MT CO_2e
Cumulative greenhouse gas reduction from 2025-2050 (MT CO_2e)		7,000,838 MT CO_2e
Cumulative Criteria Air Pollution Reduction	2025-2030	2025-2050
Total CO reduction (lbs)	3,068,132	62,236,603
Total HC reduction (lbs)	363,345	7,464,363
Total NOx reduction (lbs)	3,520,806	67,662,780
Total PM10 reductions (lbs)	594,844	10,018,873
Total PM2.5 reduction (lbs)	95,493	1,159,543
Total SO2 reduction (lbs)	37,319	-1,037,865[239]
Total VOC reduction (lbs)	366,035	7,370,029
Financial Impact		
Incremental Costs (USD)		$6,232,660,295
Incremental Savings (USD)		$13,635,702,963
Incremental Net Costs/ Savings (USD)		Savings of $7,403,042,668
Marginal Abatement Cost (USD/ MT CO_2e)		Savings of $1,090 / MT CO_2e

239 Negative values indicate an increase in the pollutant.

Transport more Freight by Rail rather than by Truck

The Midlands region is a shipping hub in South Carolina with freight travelling into, through, and out of the area. Figure 6.13 illustrates the trucking and rail routes by which freight is currently carried through the region. At present, about 68% of this freight is transported by truck, 32% by rail and the rest by air. Transportation of freight by rail is much more energy-efficient than by truck. This is partly because a single rail engine can pull many railcars containing freight whereas trucks generally pull a maximum of 2-3 trailers at a time. Transitioning freight to rail has additional co-benefits, particularly reductions in vehicle traffic and damage to roadways.

Figure 6.13.
Freight networks and railroads in the Midlands.[240]



240 Central Midlands Council of Governments. (2021) Moving the Midlands: 2045 Long Range Transportation Plan. Pg. 125, Fig 11.1

Modeled Action and Timeline

The modeled action reflected a small shift of freight that is currently transported by truck to rail based on the following schedule:

- Beginning in 2026, freight that is currently transported by truck will gradually be switched to existing rail service.
- By 2035: 5% of freight that in 2022 was transported into, through or out of the region by truck will be transported by rail instead.
- By 2040: 10% of freight that in 2022 was transported into, through or out of the region by truck will be transported by rail instead.

Pathways to Implementation

One key pathway to implementation is ensuring that industrial parks have access to freight rail networks for moving goods produced on-site to market, or to receive parts and supplies. Local economic development projects and plans should prioritize rail spurs at new and existing industrial parks, as well as incentivize companies with single manufacturing sites to build rail spurs. Further analysis is available in CMCOG's Regional Freight Mobility Plan, completed in 2017.[241]

South Carolina Ports "in-land port" Greer location is a successful example of how rail can interconnect with local manufacturing and improve supply-chain logistics. While technically outside of this plan's geography, the junction of Interstates 26 and 95 is a potential location for a second "in-land port" that could further increase rail utilization for freight.

- Key Implementing Organizations: Local governments [economic development], CMCOG [regional planning], South Carolina Ports [possible 2nd in-land port site]
- Geographic Area Impacted: Specific industrial parks or manufacturing sites within the Midlands.
- Applicable Funding Sources: None currently available.
- Implementation Authority: None needed.

241 CMCOG (2017). Regional Freight Mobility Final Plan. *https://centralmidlands.org/transportation/document_center/index.php*

Low-carbon Scenario Impacts

Table 6.20.
Low-carbon Scenario Impacts of transporting more freight by rail rather than by truck.

Low-carbon Scenario Metrics		
Greenhouse Gas Reduction Impact		
Cumulative greenhouse gas reduction from 2025-2035 (MT CO_2e)		213,275 MT CO_2e
Cumulative greenhouse gas reduction from 2025-2050 (MT CO_2e)		726,811 MT CO_2e
% of total emissions eliminated in LC Scenario		0.5%
Cumulative Criteria Air Pollution Reduction	2025-2030	2025-2050
Total CO reduction (lbs)	187,329	3,749,797
Total HC reduction (lbs)	22,177	441,862
Total NOx reduction (lbs)	215,781	4,327,110
Total PM10 reductions (lbs)	35,396	672,958
Total PM2.5 reduction (lbs)	5,963	135,354
Total SO2 reduction (lbs)	2,495	63,276
Total VOC reduction (lbs)	22,367	446,945
Financial Impact		
Incremental Costs (USD)		$90,000,000
Incremental Savings (USD)		$764,315,929
Incremental Net Costs/ Savings (USD)		Savings of $674,315,929
Marginal Abatement Cost (USD/ MT CO_2e)		Savings of $928 / MT CO_2e

Replace Diesel Freight Train Engines with Hybrid Diesel / Electric Engines

This action involves replacing diesel-powered freight train engines with hybrid diesel/ electric engines. The intent is for this action to begin with replacing the engines used at rail yards to move rail cars from one track to another within the yard. Over time this would expand to replace up to 85% of all freight rail engines with hybrids.

Modeled Action and Timeline

Diesel train engines used to transport freight in the Midlands would gradually be replaced with diesel electric hybrid engines according to the following schedule:

- 2030: 1% of all freight engines used in the region - predominantly those used within rail yards - are diesel/ electric hybrid engines.
- 2035: The number of diesel/ electric hybrid engines has increased to 5% of all freight engines used in the region.
- 2040: Diesel / electric hybrid engines constitute 25% of all freight engines used in the region.
- 2050: Diesel/ electric hybrid engines constitute 85% of all freight engines used in the region.

Pathways to Implementation

Note that this action will not be sufficient to eliminate the greenhouse emissions from freight rail engines in the Midlands. To achieve this, the engines will need to transition to zero-emissions alternatives such as engines powered by electricity. While this would also improve the economics of freight, it would take both time and money. Electrified freight rail networks require extensive and expensive infrastructure investments.

Hybrid engines (that use a battery and electric motor that operate during low speeds to move the train and at high speeds to improve fuel efficiency) are currently available for diesel train engines.[242] Similar to diesel fuel use in commercial medium and heavy-duty vehicles, an exponentially rising diesel fuel tax will encourage transition to hybrid train engines (and

242 Popovich, N.D., Rajagopal, D., Tasar, E. et al. Economic, environmental and grid-resilience benefits of converting diesel trains to battery-electric. Nat Energy 6, 1017–1025 (2021). https://doi.org/10.1038/s41560-021-00915-5

eventually, electrified rail lines). A diesel tax is an efficient policy because a transitionary technology (hybrid engines) is already available and requires no infrastructure change or business process changes within the existing freight rail industry in the state.[243]

- Key Implementing Organizations: Private firms. SC State Legislature [diesel tax].
- Geographic Area Impacted: Areas adjacent to freight rail lines.
- Applicable Funding Sources: None needed.
- Implementation Authority: None needed. SC State Legislature [diesel tax].

Low-carbon Scenario Impacts

Table 6.21.
Low-carbon Scenario Impacts of replacing diesel locomotive engines with hybrid diesel electric engines

Low-carbon Scenario Metrics		
Greenhouse Gas Reduction Impact		
Cumulative greenhouse gas reduction from 2025-2035 (MT CO_2e)		7,186 MT CO_2e
Cumulative greenhouse gas reduction from 2025-2050 (MT CO_2e)		569,447 MT CO_2e
Cumulative Criteria Air Pollution Reduction	2025-2030	2025-2050
Total CO reduction (lbs)	10,967	3,952,685
Total HC reduction (lbs)	0	0
Total NOx reduction (lbs)	54,025	18,798,599
Total PM10 reductions (lbs)	1,218	475,027
Total PM2.5 reduction (lbs)	1,211	463,189

243 Annika Stechemesser, Nicolas Koch, Ebba Mark, Elina Dilger, Patrick Klösel, Laura Menicacci, Daniel Nachtigall, Felix Pretis, Nolan Ritter, Moritz Schwarz, Helena Vossen, Anna Wenzel (2024): Climate policies that achieved major emission reductions: Global evidence from two decades. Science. DOI: 10.1126/science.adl6547

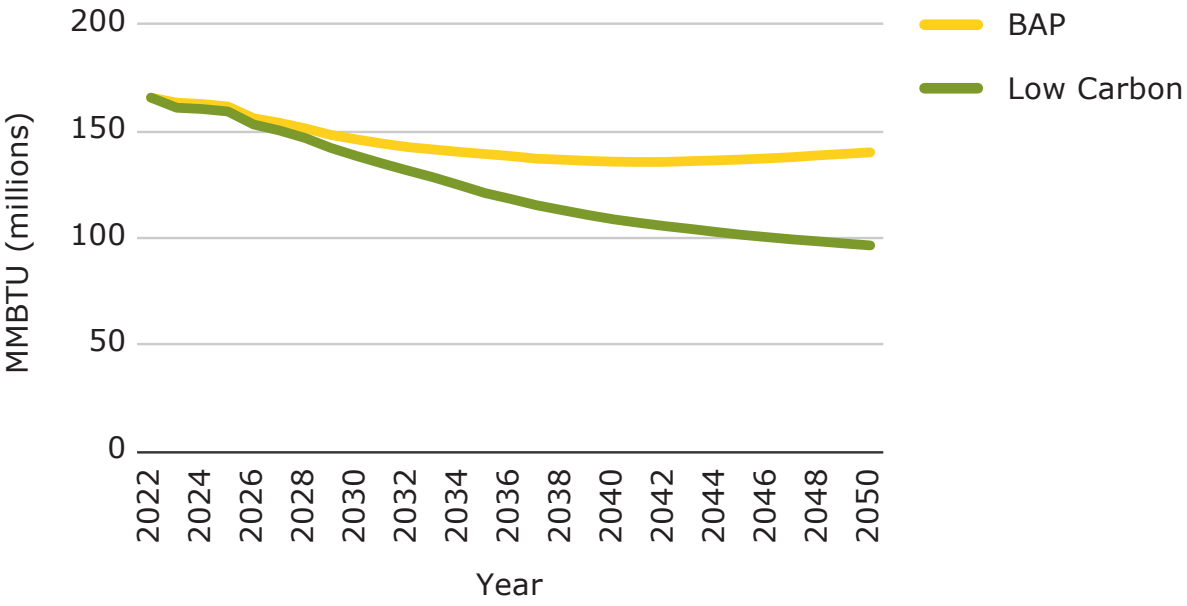
Low-carbon Scenario Metrics		
Total SO2 reduction (lbs)	-674	-44,012
Total VOC reduction (lbs)	2,243	782,036
Financial Impact		
Incremental Costs (USD)		$183,600,008
Incremental Savings (USD)		$175,031,622
Incremental Net Costs/ Savings (USD)		Net Cost of $8,568,386
Marginal Abatement Cost (USD/ MT CO_2e)		Cost of $15 / MT CO_2e

6.3.3 Expand Renewable Energy Generation

In the low-carbon scenario, the Midlands makes two significant energy transitions.

Firstly, despite population growth, by 2050, the total amount of energy required annually in the region is projected to decrease by over 69 million MMBTU. Figure 6.14 illustrates this decrease in total energy consumption in the scenario relative to the BAP scenario.

Figure 6.14.
Energy sources and consumption in the LC Scenario, 2022 and 2050.



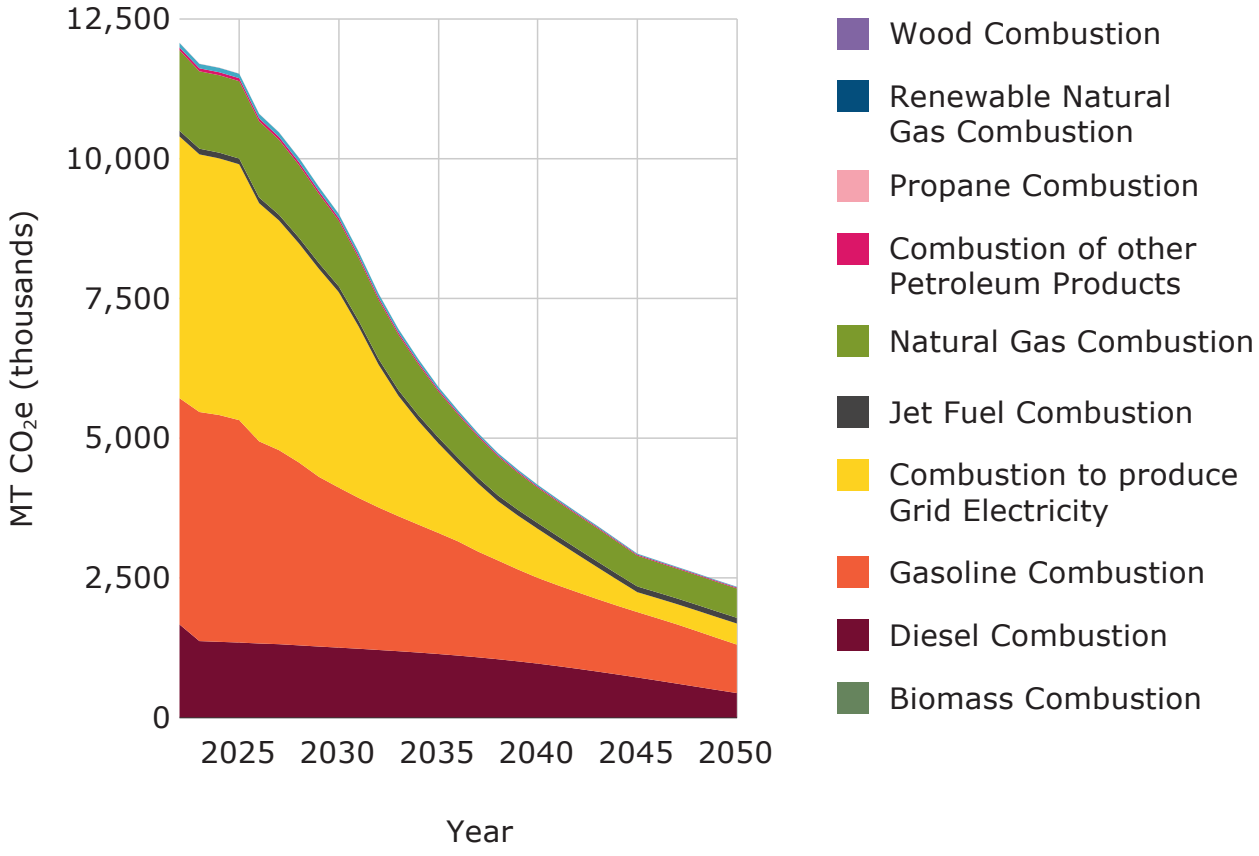
This decrease reflects the impacts of first improving energy efficiency in buildings and industry, and then switching to much more efficient technologies such as heat pumps and EVs. It also includes a reduction in electricity losses wherever electricity is produced locally rather than having to be distributed across the grid.

All of these changes translate into less energy consumption overall, and in turn, lower energy bills for residents, business owners, and municipalities. It also improves the region's resilience to a warming climate, because energy

demand will be less extreme during heat waves for example than it would be in the business-as-planned scenario.

The second part of the Midlands' energy transition is a result of shifting from fossil fuels (90% of energy use in 2022) to getting the majority of its energy from renewable or alternative sources (67% of energy use) by 2050. Figure 6.15 illustrates this reduction over time.

Figure 6.15.
Projected emissions from energy sources, by fuel type in the LC Scenario, 2022-2050.



The actions related to switching to renewable and alternative energy sources constitute the Expanding Renewable Energy strategy. Together these actions eliminate a total of 74,498,000 MT CO_2e between the present and 2050, or 48% of the total emissions reductions achieved in the low-carbon scenario.

The Expand Renewable Energy strategy contains actions related to decarbonization of the electricity grid, increasing the use of on-site solar PV across the region, and restarting an existing hydro power facility in Columbia.

Utilities Switch to Renewable Energy Sources to Generate Grid Electricity

Dominion Energy, like many power utilities, is already transitioning away from fossil fuels to emissions-free energy sources due to economic and market incentives. According to the company's 2025 Integrated Resource Plan Update, they plan to increase renewable generation capacity, focusing on solar facilities and energy storage, and also giving consideration to small modular nuclear facilities as well as both onshore and offshore wind power.

This action achieves over 36% of the total emissions reductions achieved in this plan.

Modeled Action and Timeline

This action reflects a modeled case from Dominion Energy's 2025 update to their Integrated Resource Plan in which they reduce total emissions from their electricity generation by 85% by 2045.[244]

Pathways to Implementation

As discussed in Chapter 1, there is a patchwork of utility providers in the Midlands. Larger utilities serving the Midlands file Integrated Resource Plans with the SC Energy Office and the SC Public Service Commission, and this action involves the largest Midlands utility following one of the options in its own plan.[245] Many actors lack an effective way to influence utility decision-making, because there is no way for a resident, business or government to choose another utility provider. State law effectively prohibits many actors from pursuing some types of climate actions that produce electricity, such as community solar. However, local stakeholders can communicate with their utility and utility regulators, while large institutions can signal desired changes (for example, cities through clean energy goals and large companies through clean energy targets & preferences).[246]

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244 Dominion Energy (2025). "Integrated Resource Plan 2025 Update." pp 95-96. Retrieved from https://cdn-dominionenergy-prd-001.azureedge.net/-/media/pdfs/global/company/irp/sc/desc-integrated-resource-plan-2025.pdf?rev=03470c4dd404485895763e093b4a4482

245 The emissions pathway selected is only one of several that are presented and analyzed in their IRP. Any (or even all) IRP pathway(s) may or may not be implemented by the utility and/or change as part of future IRP planning processes.

246 Many large firms, particularly those headquartered abroad, have market or regulatory incentives to purchase energy that emits no air pollution. In fact, it is likely that South Carolina's existing grid emission factor (which is lower than some other states, primarily due to nuclear power comprising nearly half of grid generation) has been a draw for recent manufacturing investments from European firms including Volkswagen (Scout Motors), as well as data centers.

To ensure that utilities reduce air pollution over time, targets would need to be directly encoded into regulatory frameworks by the SC State Legislature. With electricity production, updating regulatory frameworks to prioritize lowering households' average bills would likely result in clean energy power plants (particularly solar & batteries).[247] Finally, state legislators should require larger utilities to enable virtual power plants.[248]

- Key Implementing Organizations: Utilities
- Geographic Area Impacted: Region-wide.
- Applicable Funding Sources: None needed.
- Implementation Authority: None needed [for utilities to follow their own plans]. New legislation is optimal.

Low-carbon Scenario Impacts

Table 6.22.
Low-carbon Scenario Impacts of reducing grid emissions by 85% by 2045.

Low-carbon Scenario Metrics		
Greenhouse Gas Reduction Impact		
Cumulative greenhouse gas reduction from 2025-2035 (MT CO_2e)		7,832,374 MT CO_2e
Cumulative greenhouse gas reduction from 2025-2050 (MT CO_2e)		58,602,454 MT CO_2e
Cumulative Criteria Air Pollution Reduction	2025-2030	2025-2050
Total CO reduction (lbs)	611,489	27,471,167
Total HC reduction (lbs)	0	0

247 This can be accomplished in a variety of ways. Currently, utilities are not incentivized to achieve the lowest possible electric utility rates for residential customers in the Midlands.

248 Virtual power plants involve electricity customers (usually each metered household) sending electricity back to the grid, but at times that the utility controls. This enables a home to be both a consumer of electricity and functionally a tiny power plant. Utilities, by networking hundreds or even thousands of homes, can thus effectively eliminate the need for building a new power plant. This most often involves small batteries in homes (either a solar/battery system or electric vehicle) or demand-side management (e.g., controlling thermostats for a limited window of time). Customers are usually rewarded with a lower electricity rate in return for directly benefitting the utility. Virtual power plants have been implemented elsewhere, and they can be particularly effective at eliminating peak demand. See Fitch, T. et al. (2024). How Virtual Power Plants Unlock Cleaner, More Affordable Electricity Systems. Rocky Mountain Institute. *https://rmi.org/insight/power-shift*

Low-carbon Scenario Metrics		
Total NOx reduction (lbs)	974,167	43,764,477
Total PM10 reductions (lbs)	177,034	7,953,271
Total PM2.5 reduction (lbs)	148,356	6,664,900
Total SO2 reduction (lbs)	564,055	25,340,200
Total VOC reduction (lbs)	45,155	2,028,595
Financial Impact		
Incremental Costs (USD)	Not calculated[249]	
Incremental Savings (USD)	$39,041,545,585	
Incremental Net Costs/ Savings (USD)	Not calculated.	
Marginal Abatement Cost (USD/ MT CO_2e)	Not calculated.	

Rooftop Solar PV outside Columbia

In areas outside the City of Columbia, an action was modeled to gradually add rooftop solar on residential, commercial, and institutional buildings between 2026 and 2038 such that by the end of 2038 they constitute 3 GW of capacity. In the context of South Carolina's current policies around solar PV installations, virtually all of this capacity will be added behind the meter. It will provide energy savings to the households and businesses that install solar, and they will place less strain on the electricity grid when the sun is shining and these buildings do not need to draw as much power from the grid.

Modeled Action and Timeline

- 2026-2031: Install a total of 1 GW of solar PV capacity on buildings outside Columbia.
- 2032-2033: Install a further 1 GW of solar PV capacity outside Columbia (for a cumulative total of 2 GW); and,

249 Incremental costs were not available for this analysis.

- 2034-2038: Install a further 1 GW of solar PV capacity outside Columbia (for a cumulative total of 3 GW).

These systems will be divided among the residential, commercial and institutional rooftops based on the portion of suitable rooftops available.

Pathways to Implementation

South Carolina is among the best places in the country to generate energy from solar panels (see Figure 6.16). South Carolina currently has enabling policies, including solar net metering.[250] Despite this, the state has an extremely low adoption rate for rooftop solar, with the residential and commercial solar sectors comprising less than one-ninth of solar generation overall (e.g., utility companies have the vast majority of solar panels).[251] There are two key barriers limiting rooftop solar PV uptake in the Midlands.

- Up front cost: System costs of $15,000 or higher make the cost-savings from solar less accessible to low or middle income households or smaller businesses.
- Split incentive problem: Renters (whether residents or small businesses) have no financial incentive to improve a landlord's building. Similarly, since they rarely pay the utility bill, landlords have no incentive to install rooftop solar PV.

There are many policies, at various levels of government, that can help more people save money with solar. Rooftop solar systems are essentially tiny money printing machines, and pay for themselves in well under a decade in our climate. With the regional focus of this climate action plan, three implementation pathways are recommended:

1. Local governments or community-based organizations can organize (either alone or in partnership with green banks) solarize campaigns. The organizer recruits multiple residents and businesses to enter into a bulk/group agreement, and procure solar on their behalf.[252] This enables a trusted organizer to use its staff expertise in vetting contractors, while residents benefit from lower prices and better financing because an installer is bidding on a larger project.

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250 SC Energy Office (2025). Solar Financing. https://solar.sc.gov/financing-system/tax-credits-incentives-and-net-metering

251 *SC Energy Office – Energy Data Portal*. Data are from Table 3, 2023 Cumulative Capacity by Sector, kW AC. Data pulled and analyzed in Summer 2024.

252 For one example, see here from Asheville NC. https://www.ashevillenc.gov/news/office-of-sustainability-shares-results-of-solarize-asheville-buncombe-campaign/

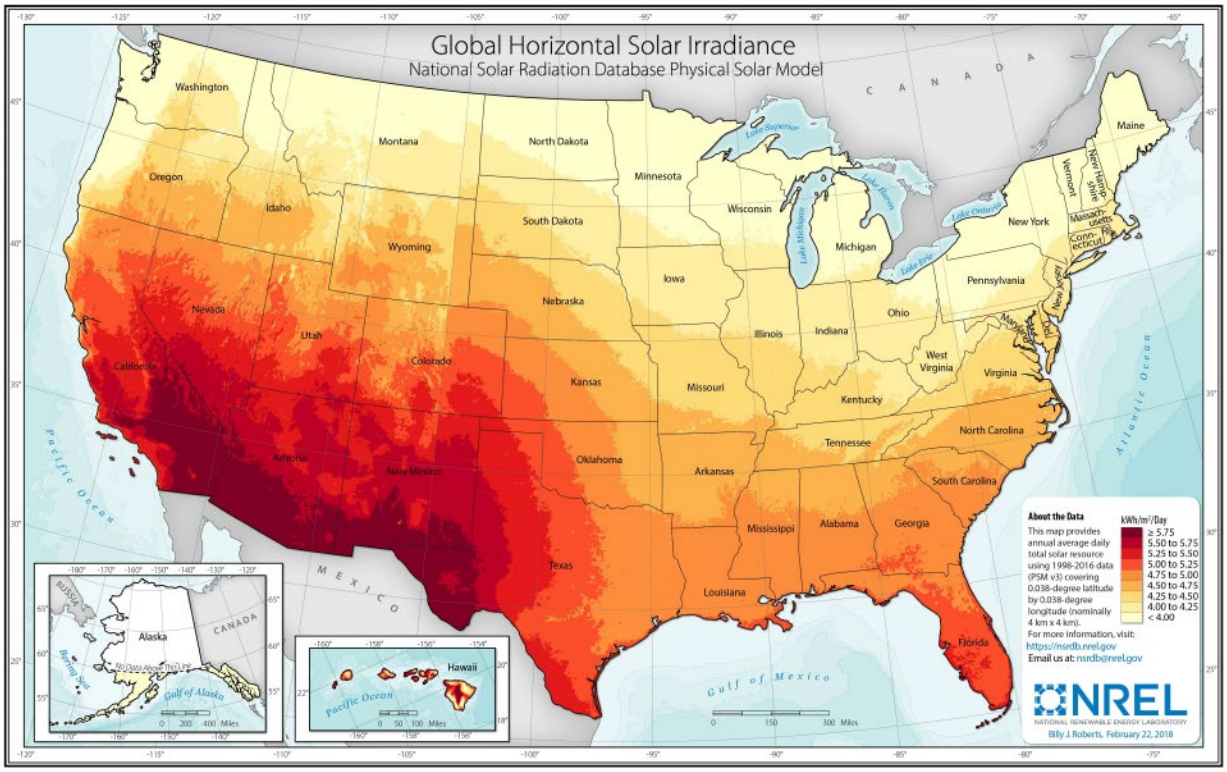
2. Community solar is often used for split incentive problems (e.g. renters) or those who cannot afford a standard rooftop solar installation. In SC, policy barriers to community solar mean it is functionally impossible. This can be resolved by updating state legislation to either enable non-utility programs or by requiring that utility programs must be available to customers.[253]
3. Plug-in solar (cheaper solar panels that are portable and plug into a standard wall outlet) has been widely available in other countries for years, with increasing U.S. market availability recently.[254] Expanding plug-in solar is recommended to increase the affordability and accessibility of solar in the Midlands. This is discussed further under Additional Policy Considerations at the end of Chapter 6.

253 Community solar programs in SC cannot build solar panels at another location and provide the power to residents located anywhere else, because the utility is empowered to block the transmission. This can be updated by state legislation to force utilities to not indirectly prohibit such traditional community solar programs. Currently, state legislation encourages, but does not require, utilities to offer community solar programs and does not require that such programs are actually available to customers. As a result, regional utilities have typically made small community solar pilot programs that have been fully subscribed for years and no announced plans for expanding or re-opening them.

254 O'Malley, I. (2025). Solar panels that fit on your balcony or deck are gaining traction in the US. Associated Press. *https://apnews.com/article/balcony-plug-solar-climate-energy-renewable-trump-c162abf520da0fa155dc971270b8684a*

Figure 6.16.

A map of solar energy potential. The Southeastern region is the 2nd highest in the nation.[255]



- Key Implementing Organizations: All actors.
- Geographic Area Impacted: Region-wide, not including City of Columbia
- Applicable Funding Sources: None available at the moment.
- Implementation Authority: None needed for traditional rooftop solar systems.[256] New state legislation, particularly to enable community solar and to enable plug-in solar, are needed.

255 Map copied from and copyright of NREL. National Renewable Energy Lab (2018). Annual solar global horizontal irradiance. https://www.nlr.gov/gis/solar-resource-maps

256 Exceptions exist in atypical cases, such as some historic buildings. Some homeowners associations also have the authority to prohibit or restrict rooftop solar systems.

Low-carbon Scenario Impacts

Table 6.23.
Low-carbon Scenario Impacts of installing rooftop solar outside Columbia.

Low-carbon Scenario Metrics		
Greenhouse Gas Reduction Impact		
Cumulative greenhouse gas reduction from 2025-2035 (MT CO_2e)		5,937,994 MT CO_2e
Cumulative greenhouse gas reduction from 2025-2050 (MT CO_2e)		12,717,864 MT CO_2e
Cumulative Criteria Air Pollution Reduction	2025-2030	2025-2050
Total CO reduction (lbs)	995,399	5,961,773
Total HC reduction (lbs)	0	0
Total NOx reduction (lbs)	1,585,776	9,497,736
Total PM10 reductions (lbs)	288,181	1,726,013
Total PM2.5 reduction (lbs)	241,498	1,446,412
Total SO2 reduction (lbs)	918,185	5,499,313
Total VOC reduction (lbs)	73,505	440,244
Financial Impact		
Incremental Costs (USD)		$5,544,713,960
Incremental Savings (USD)		$25,332,147,394
Incremental Net Costs/ Savings (USD)		Net Savings of $19,787,433,434
Marginal Abatement Cost (USD/ MT CO_2e)		Savings of $1,556 / MT CO_2e

Rooftop Solar PV in Columbia

The City of Columbia has set goals to increase or procure renewable energy, and to become 100% renewable by 2036.[257] This action supports this goal by modeling the impact of ambitiously installing rooftop solar PV on homes and businesses over the next 11 years.

Modeled Action and Timeline

- 2026: Begin installation of solar PV systems on residential and non-residential rooftops deemed appropriate for solar, rapidly increasing the total solar capacity installed each year.
- December 31, 2035: Complete the installation of 817 MW of solar PV systems on rooftops across the city.

Pathways to Implementation

Note - this action is listed separately because the City of Columbia has a renewable energy target (and this enabled modeling specific to this existing policy). Implementation pathways are broadly similar to the prior action. If this action is implemented on time, the City of Columbia would need to see at least 4,000 - 9,000 solar rooftop systems installed each year on homes and businesses.[258]

Low-carbon Scenario Impacts

Table 6.24.
Low-carbon Scenario Impacts of installing rooftop solar in Columbia.

Low-carbon Scenario Metrics	
Greenhouse Gas Reduction Impact	
Cumulative greenhouse gas reduction from 2025-2035 (MT CO_2e)	1,348,937 MT CO_2e
Cumulative greenhouse gas reduction from 2025-2050 (MT CO_2e)	3,010,941 MT CO_2e

257 City of Columbia. 'Columbia Resolution 100.' 2023. https://citycouncil.columbiasc.gov/download/resolution-no-r-2023-053/?wpdmdl=975598&refresh=6742515fc44521732399455

258 This is a simple calculation that divides the 817 MW total in 2036 by 10 years (since there has been limited progress to date), and provides a high range using an expected average ~10 kW system size and a low range using an expected average ~20 kW system size. If the City of Columbia or other partners install a large system, such a system would require less installations. For instance, a 2 MW solar panel project is the same as ~200 small household rooftop projects.

Low-carbon Scenario Metrics		
Cumulative Criteria Air Pollution Reduction	2025-2030	2025-2050
Total CO reduction (lbs)	173,147	1,411,444
Total HC reduction (lbs)	0	0
Total NOx reduction (lbs)	275,841	2,248,579
Total PM10 reductions (lbs)	50,128	408,632
Total PM2.5 reduction (lbs)	42,008	342,437
Total SO2 reduction (lbs)	159,715	1,301,957
Total VOC reduction (lbs)	12,786	104,227
Financial Impact		
Incremental Costs (USD)		$1,646,622,633
Incremental Savings (USD)		$6,083,533,679
Incremental Net Costs/ Savings (USD)		Net Savings of $4,436,911,046
Marginal Abatement Cost (USD/ MT CO_2e)		Savings of $1,474 / MT CO_2e

Restart Columbia Canal Hydro

This action modeled the impact of restarting the Columbia Canal Hydro Facility to power the adjacent water pumping station, and provide residual power to the grid.

Modeled Action and Timeline

- 2027: The Columbia Canal Hydro Facility begins operation at its normal capacity (5 MW).[259] The power generated goes primarily to the adjacent water pumping station. Residual power is fed to the grid.

259 Note that while the nameplate capacity of the facility is higher, on an annualized average its generation is about 5MW capacity. [Information provided by City of Columbia].

- 2028 on: The facility continues operating until after 2050 at the same capacity, and with the same portions of behind and in-front-of-the-meter electricity consumption.

Pathways to Implementation

The city owns a hydroelectric plant along the drinking water canal (see Figure 6.17). The plant was first built in the late 1800s, but was severely damaged in the climate-fueled flood disaster in 2015.[260] The city has secured funding from the Federal Emergency Management Administration to rebuild the plant. The plant is expected to come back online in 2027.

Figure 6.17.
A photo of the City of Columbia's hydropower plant, adjacent to the canal along the Congaree River.[261]

260 Columbia Water (2026). Columbia Canal Recovery Project. https://columbiascwater.net/columbiacanalproject/

261 Photo provided by, and copyright of, City of Columbia / Columbia Water.

- Key Implementing Organizations: City of Columbia, Dominion Energy.[262]
- Geographic Area Impacted: City of Columbia.
- Applicable Funding Sources: Secured from FEMA as part of disaster recovery funding.
- Implementation Authority: None needed.

Low-carbon Scenario Impacts

Table 6.25.
Low-carbon Scenario Impacts of restarting Columbia Canal Hydro.

Low-carbon Scenario Metrics		
Greenhouse Gas Reduction Impact		
Cumulative greenhouse gas reduction from 2025-2035 (MT CO_2e)		106,920 MT CO_2e
Cumulative greenhouse gas reduction from 2025-2050 (MT CO_2e)		166,996 MT CO_2e
Cumulative Criteria Air Pollution Reduction	2025-2030	2025-2050
Total CO reduction (lbs)	25,874	78,283
Total HC reduction (lbs)	0	0
Total NOx reduction (lbs)	41,219	124,713
Total PM10 reductions (lbs)	7,491	22,664
Total PM2.5 reduction (lbs)	6,277	18,993
Total SO2 reduction (lbs)	23,866	72,211
Total VOC reduction (lbs)	1,911	5,781
Financial Impact		
Incremental Costs (USD)		$10,000,000[263]

262 The City of Columbia is not able to utilize all of the power produced by the plant, and so excess power would need to be sent to Dominion Energy. (Similarly to the previous agreement between the two parties).

263 Costs to restart the facility are expected to be $10 million. Estimate provided by the City of Columbia.

Low-carbon Scenario Metrics	
Incremental Savings (USD)	$115,762,594
Incremental Net Costs/ Savings (USD)	Net Savings of $105,762,594
Marginal Abatement Cost (USD/ MT CO_2e)	Savings of $633 / MT CO_2e

Canopy Solar on Parking Lots in Downtown Columbia

Installing canopy solar PV systems over parking areas is an excellent way of realizing more benefits from high-value land in the heart of the city, that is otherwise used only for parking. This means firstly that this land is generating less economic value for the community (through property taxes and business revenue) than it would if it contained homes and businesses. It also means that people are less likely to walk, bike or take the bus in the downtown area and more likely to drive because they expect parking to be plentiful.

Modeled Action and Timeline

- 2025-2045: Gradually install canopy solar systems over all significant parking areas in downtown Columbia such that by 2045, 9 MW of power generation capacity has been added to these areas.

Pathways to Implementation

Canopy solar systems are elevated so that cars can park underneath them (see Figure 6.18). Communities have found other creative uses of the additional space they create, including gardening or to provide shade for pedestrians. They are otherwise similar to traditional ground mounted or rooftop solar systems (e.g., the electricity would be used to power nearby adjacent buildings). Recent work by the Parking Reform Network indicates that in 2024 approximately 37% of downtown Columbia was covered in parking lots.[264] This action was designed to add at least one additional layer

264 J.A. Jarchote. The Post and Courier. 'Paved paradise? Parking lots plague 37% of downtown Columbia, one of worst in nation.' 2024. https://www.postandcourier.com/columbia/parking-columbia-downtown-charleston-climate-development/article_da31b592-b09c-11ee-8f6d-67181ad34315.html

of value to these parking lots, by generating power that can be used in the local area. This will also help the City of Columbia make progress towards its goal of becoming 100% renewable by 2036.

Figure 6.18.
A photo of a canopy solar project over parking spaces in Georgetown, SC.[265]

- Key Implementing Organizations: Parking lot owners.
- Geographic Area Impacted: City of Columbia (primarily), but other less densely urbanized areas could also install them.
- Applicable Funding Sources: None needed. (These systems are similarly cost-effective, with payback times increased by only a few years).
- Implementation Authority: None needed.

265 Photo provided by, and copyright of, Brad Leon (SUN Energy Solutions).

Low-carbon Scenario Impacts

Table 6.26.
Low-carbon Scenario Impacts of canopy solar on parking lots in downtown Columbia.

Low-carbon Scenario Metrics		
Greenhouse Gas Reduction Impact		
Cumulative greenhouse gas reduction from 2025-2035 (MT CO_2e)		11,489 MT CO_2e
Cumulative greenhouse gas reduction from 2025-2050 (MT CO_2e)		31,734 MT CO_2e
Cumulative Criteria Air Pollution Reduction	2025-2030	2025-2050
Total CO reduction (lbs)	1,475	14,876
Total HC reduction (lbs)	0	0
Total NOx reduction (lbs)	2,349	23,699
Total PM10 reductions (lbs)	427	4,307
Total PM2.5 reduction (lbs)	358	3,609
Total SO2 reduction (lbs)	1,360	13,722
Total VOC reduction (lbs)	109	1,099
Financial Impact		
Incremental Costs (USD)		$10,622,842
Incremental Savings (USD)		$73,419,653
Incremental Net Costs/ Savings (USD)		Net Savings of $62,796,811
Marginal Abatement Cost (USD/ MT CO_2e)		Savings of $1,979 / MT CO_2e

6.3.4 Advance Low-Carbon Transformation in Industry

The actions modeled to reduce emissions from industry in the Midlands eliminate a total of 3,334 MT CO_2e by 2050. Figure 6.19 illustrates the total 'wedge' of emissions reductions associated with the Advance Low-Carbon Transformation in Industry strategy.

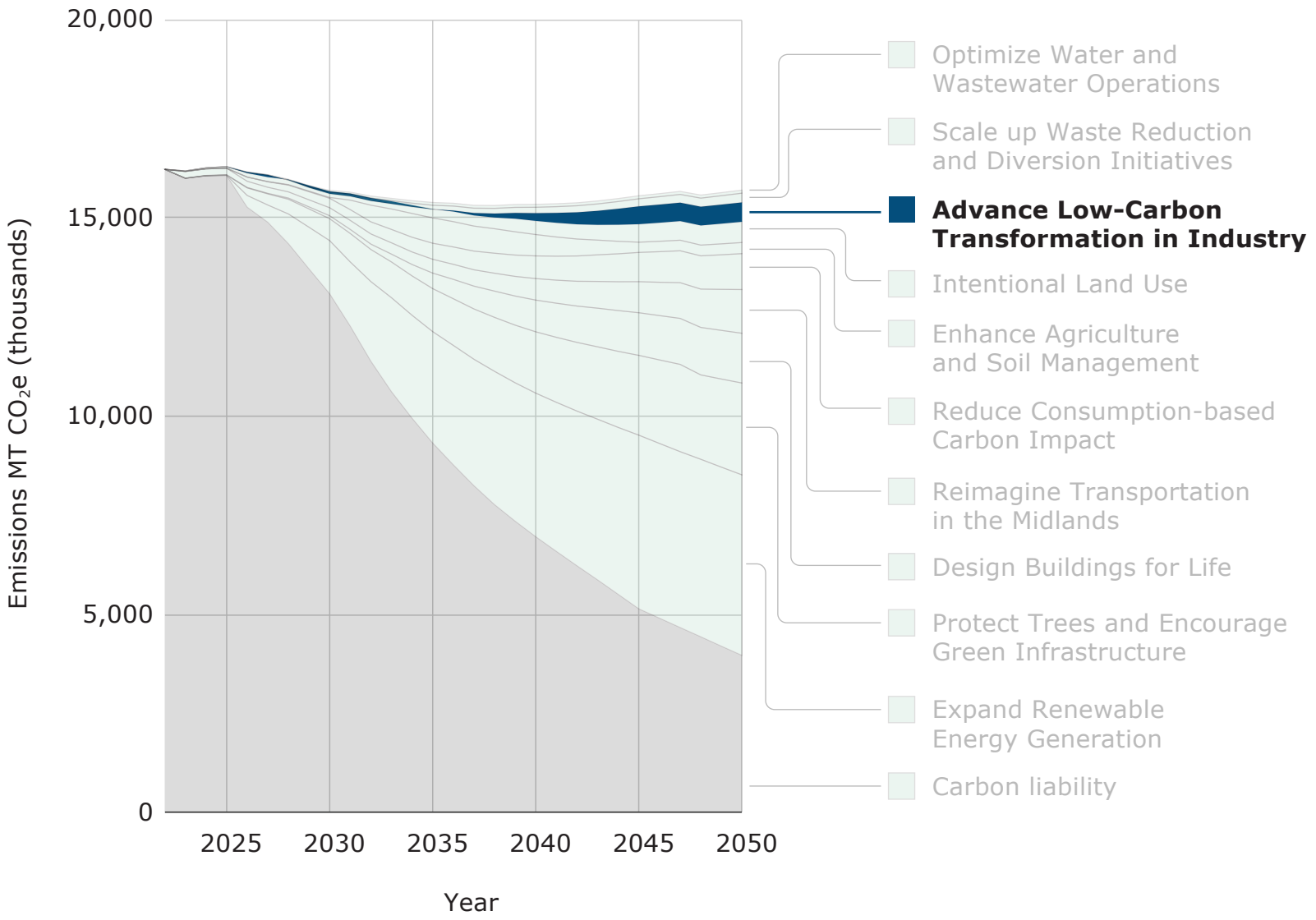
This climate action plan proposes fewer actions that reduce emissions in the industrial sector. Larger actors, such as state governments, have additional policy tools and funding potential to work alongside the industrial sector to reduce emissions or to enforce rules & regulations that reduce emissions.

Industry is complex, the ways energy is consumed or fuel is burned varies widely. Within industry, there are generally two main avenues for transformation.

1) Build new industrial facilities with more sustainable technologies or processes. One example is the CMC Steel Plant in Cayce, which uses an electric arc furnace. This technology produces less air pollution than a blast furnace (which requires direct coal combustion). If the plant had a blast furnace, it would likely be prohibitively expensive to switch it (or even impossible). For these types of changes in particular, regulatory or tax incentives are often necessary to ensure new industrial sites in the state create less air pollution, and the state government is better placed to do so.

2) If an industrial process or building is already constructed, there are likely ways to reduce its marginal emissions on-site. The two main ways to do this (at a high level) are included in this plan. For these types of changes, there are more possible avenues for collaboration with local governments, universities or community groups with a local or regional focus.

Figure 6.19.
Projected emissions reduction from the Advance Low-Carbon Transformation in Industry strategy, 2022-2050.



Industrial Efficiency Improvements

Energy efficiency improvements in industry can be achieved in many ways. They range from replacing old, inefficient equipment with improved models, and switching to variable speed motors and fans, to turning off machinery and lighting when a facility is not operational, and many more. The specifics of this action will likely include some changes that are common across many operations, and others that will be specific to the manufacturing or industrial processes within each facility.

Modeled Action and Timeline

- 2026-2028: Total energy consumption by industry is reduced by 5%.
- 2029-2030: Total energy consumption by industry is reduced by 10% (i.e. a further 5% after 2028).
- 2031-2035: Total energy consumption by industry is reduced by 20% (i.e. a further 10% after 2030).

Pathways to Implementation

Different industrial facilities utilize energy in different ways, so it can be difficult or impossible to generate recommendations that would be universally applicable. Such recommendations can end up being extremely specific. For example, according to a recent analysis, South Carolina (including the Midlands counties) is perhaps the 3rd best location in the country for energy reductions using electrified boilers.[266]

For industrial sites in the Midlands looking to reduce their energy use over time and receive guidance specific to their facility,, the University of North Carolina at Charlotte's Industrial Assessment Center offers energy assessments as a mechanism to identify ways a facility is losing money on energy and evaluate potential solutions.[267] For firms seeking to finance energy-saving upgrades, specialized finance through green banks may be a viable and profitable pathway to implement projects.

- Key Implementing Organizations: Private firms.
- Geographic Area Impacted: Region-wide.

266 Schoeneberger, C., Zhang, J., McMillan, C., Dunn, J. B., & Masanet, E. (2022). Electrification potential of US industrial boilers and assessment of the GHG emissions impact. Advances in Applied Energy, 5, 100089.

267 UNC Charlotte (2026). CC-ITAC. https://itac.university/center/CC

- Applicable Funding Sources: The UNC Charlotte Technical Assessment Center's technical assistance is typically free, via funding from the U.S. Department of Energy.
- Implementation Authority: None needed.

Low-carbon Scenario Impacts

Table 6.27.
Low-carbon scenario impacts of industrial efficiency improvements.

Low-carbon Scenario Metrics		
Greenhouse Gas Reduction Impact		
Cumulative greenhouse gas reduction from 2025-2035 (MT CO_2e)	2,030,975 MT CO_2e	
Cumulative greenhouse gas reduction from 2025-2050 (MT CO_2e)	5,737,099 MT CO_2e	
Cumulative Criteria Air Pollution Reduction	2025-2030	2025-2050
Total CO reduction (lbs)	422,652	4,568,478
Total HC reduction (lbs)	0	0
Total NOx reduction (lbs)	323,599	3,726,764
Total PM10 reductions (lbs)	266,604	2,780,955
Total PM2.5 reduction (lbs)	229,647	2,393,628
Total SO2 reduction (lbs)	113,492	1,399,251
Total VOC reduction (lbs)	18,496	208,339
Financial Impact		
Incremental Costs (USD)	$198,741,000	
Incremental Savings (USD)	$9,231,821,000	
Incremental Net Costs/ Savings (USD)	Net Savings of $9,033,080,000	
Marginal Abatement Cost (USD/ MT CO_2e)	Savings of $1,575 / MT CO_2e	

Solar on Industrial Buildings

To reduce emissions that will continue to be produced by the grid, and to reduce operational costs, this action modeled the impact of installing solar on industrial facilities in the region.

Modeled Action and Timeline

Beginning in 2030:

- All new industrial facilities will have on-site rooftop or ground mounted solar systems that are sufficient to meet 40% of their required electricity.
- Existing industrial facilities will gradually install on-site solar systems that are sufficient to meet 30% of their required electricity. By 2050, 95% of existing industrial facilities will have solar PV installations providing them with at least 30% of their required electricity.

Pathways to Implementation

Industrial facilities often have a building suitable for rooftop solar, or land available adjacent to a building suitable for ground mounted solar. When paired with batteries, solar can enable a facility to save money on utility time of use rates and recoup investment costs.

Solar and battery projects at sites with high electricity also benefit the grid by reducing peak demand and improving grid resilience. State or local governments could work to encourage equitable cost distribution and increase grid resilience via policy.[268]

- Key Implementing Organizations: Private firms; utilities, SC Public Service Comission, & SC state legislature [incentives or regulation]
- Geographic Area Impacted: Region-wide

268 As discussed in Chapter 1, some utilities in the Midlands heavily subsidize industrial electricity prices at the expense of commercial and residential customers. See Additional Policy Considerations later in this chapter for further discussion about policy options available for large energy industrial sites.

- Applicable Funding Sources: None needed [these projects have a positive and relatively rapid simple rate of return already][269]
- Implementation Authority: None needed. For changes in incentives or regulation, policy signals to the SC Public Service Commission via the SC state legislature may be needed if local governments cannot institute certain policies via zoning.

Low-carbon Scenario Impacts

Table 6.28.
Low-carbon scenario impacts of installing solar on industrial buildings.

Low-carbon Scenario Metrics		
Greenhouse Gas Reduction Impact		
Cumulative greenhouse gas reduction from 2025-2035 (MT CO_2e)	236,988 MT CO_2e	
Cumulative greenhouse gas reduction from 2025-2050 (MT CO_2e)	1,027,514 MT CO_2e	
Cumulative Criteria Air Pollution Reduction	2025-2030	2025-2050
Total CO reduction (lbs)	8,770	481,669
Total HC reduction (lbs)	0	0
Total NOx reduction (lbs)	13,971	767,350
Total PM10 reductions (lbs)	2,539	139,450
Total PM2.5 reduction (lbs)	2,128	116,860
Total SO2 reduction (lbs)	8,089	444,306
Total VOC reduction (lbs)	648	35,569

269 There can be a variety of reasons firms then do not implement these projects. The most common is that given extra capital, there are typically even more profitable ways to re-deploy that capital into the business. CAPEX rarely outcompetes on time vs. other investment categories within a business strategy that is short-term focused. For more, see Fleming, J. & Windsor, C. (2022). The Role of a Green Bank in South Carolina: A Market & Feasibility Assessment. University of South Carolina. https://scholarcommons.sc.edu/geog_facpub/231/

Low-carbon Scenario Metrics	
Financial Impact	
Incremental Costs (USD)	$889,185,000
Incremental Savings (USD)	$2,753306,000
Incremental Net Costs/ Savings (USD)	Savings of $1,864,120,000
Marginal Abatement Cost (USD/ MT CO_2e)	Savings of $1,814 / MT CO_2e

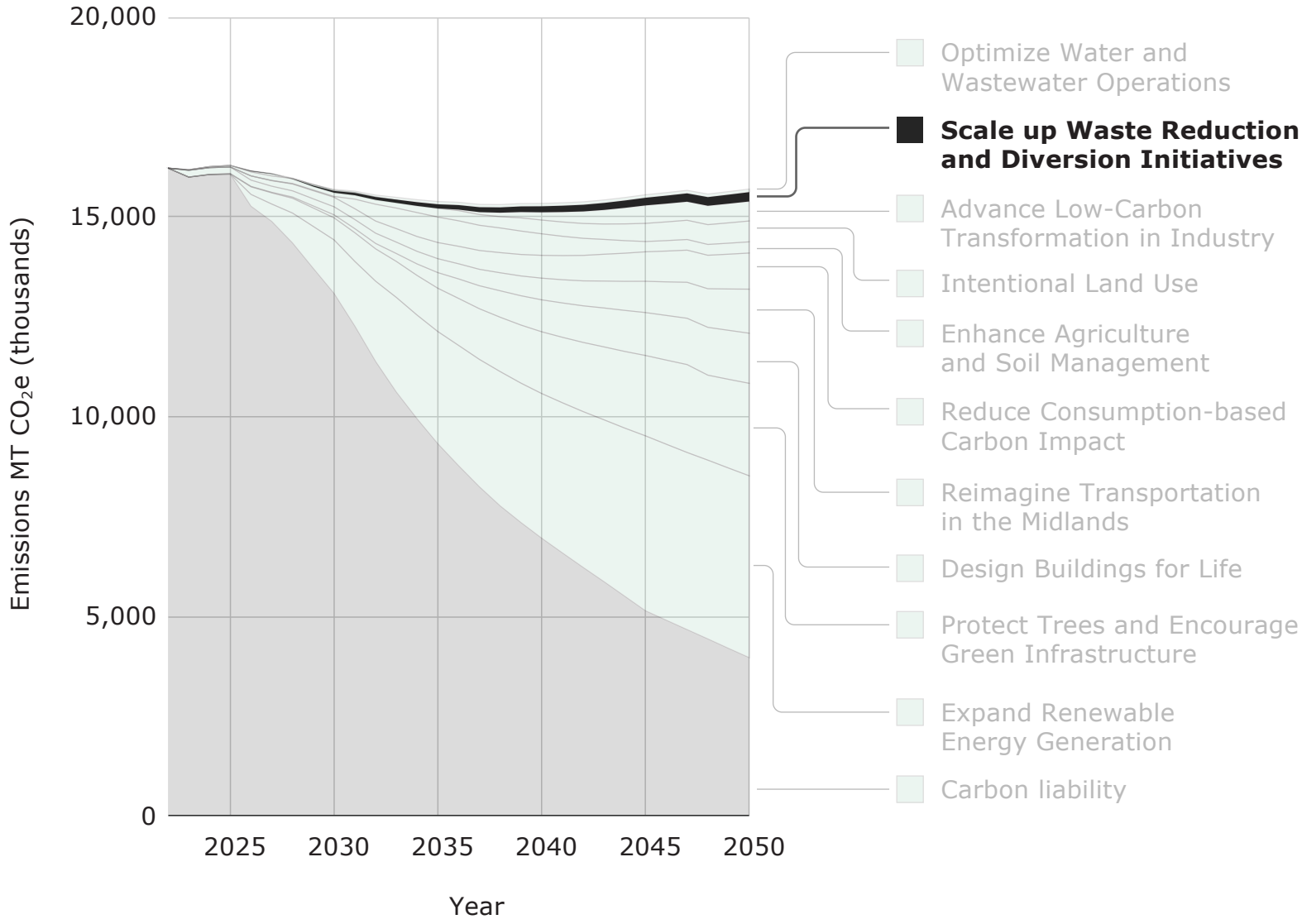
6.3.5 Scale Up Waste Reduction and Diversion Initiatives

The primary greenhouse gas from waste is methane, which comes from the natural breakdown of organic matter in landfills over time. This includes things like food scraps, yard trimmings, paper towels, leaves, and other biodegradable materials. The methane produced by this decomposition is a powerful greenhouse gas. Alternatives such as composting or treating organic waste in an anaerobic digester keep the methane from escaping into the atmosphere, and allow us to convert it into natural gas, which can be sold to industries requiring fuels that produce particularly high-temperatures. The main MSW Richland County Landfill already captures some methane emissions and converts it into usable natural gas.

The most effective strategy to address waste emissions requires a combination of reducing the amount of waste generated, re-using and transforming 'waste' into new raw materials (known as developing a circular economy), and finally, capturing all methane in anaerobic digesters, and upgrading this to renewable natural gas. Other approaches also offer benefits. For example at a small scale, composting is an affordable way to reduce emissions from waste; although it is not as effective at this as anaerobic digestion, it is an improvement over sending organic waste to landfills.

The actions modeled for this plan to eliminate waste emissions draw on several of these approaches. This could eliminate a total of 3,066,000 MT CO_2e between present time and 2050, representing 2% of the total reductions achieved in the low-carbon scenario (see Figure 6.20).

Figure 6.20.
Projected emissions reduction from the Scale Up Waste Reduction and Diversion Initiatives strategy, 2022-2050.



Reduce Waste Generation

In 2021, South Carolina announced a state-wide goal to reduce the state's average per capita disposal to 3.25 pounds per person per day (p/p/d). Out of the seven counties in the Midlands region, both Kershaw and Calhoun are already below this target while Fairfield, Newberry, and Lexington generated more than double the waste goal per capita rate in 2023 at 7.96, 7.19, and 6.69 p/p/d respectively. Richland and Saluda are in the middle, with 3.71 and 3.65 p/p/d respectively.[270]

Modeled Action and Timeline

- 2026: All counties will introduce or enhance initiatives to reduce waste;
- By 2030, all counties will achieve an average total annual waste disposal rate of no more than 3.25 pounds per day per person; and,
- By 2050, all counties will achieve an average total annual waste disposal rate of no more than 3 pounds per day per person.

Counties that are already below the goal were assumed to maintain their 2023 rate throughout the modelling timeline.

Pathways to Implementation

The best pathways to implementation for local governments and community organizations are to align their activities or augment existing state programs. Waste management policy choices can benefit local businesses like Sonoco Recycling (which accepts the City of Columbia's recycling collection streams). SC Department of Environmental Services' waste management staff can offer technical assistance and currently track data on progress towards the state waste reduction target.

Local governments contribute to waste management decisions, primarily through landfills for municipal solid waste. As population growth increases in the Midlands, limiting or preventing out of boundary waste from being shipped into the Midlands will lower greenhouse gas emissions and limit the need for new landfills.

Several local governments in the Midlands run active recycling collection or recycling drop-off programs, but none are currently meeting the state's

270 SC DES (2024). South Carolina Solid Waste Management Annual Report for Fiscal Year 2023 *https://des.sc.gov/sites/des/files/media/document/OR-2508.pdf*

targets for recycling rates.[271] Available community education resources like the Waste/Recycling Wizard can be a good first step towards achieving waste reduction goals.[272] Local governments can also consider directly incentivizing waste reduction by implementing "pay as you throw" programs.[273]

Higher government levels, such as state or federal governments, can also effectively incentivize waste reduction. Ultimately, a portion of the responsibility for waste that ends up in local landfills rests with companies that operate or do business within the state. These firms currently have no economic incentive to limit the volume of packaging waste that ends up in landfills (as just one example). States can utilize taxes or other policy instruments to create such incentives where they do not currently exist.

- Key Implementing Organizations: SC Department of Environmental Services, local governments
- Geographic Area Impacted: Region-wide.
- Applicable Funding Sources: None identified. Existing grant funding for waste management has been variable in this sector in the past.
- Implementation Authority: None needed for local policies or programs.

Low-carbon Scenario Impacts

Table 6.29.
Low-carbon scenario impacts of reducing waste generation.

Low-carbon Scenario Metrics	
Greenhouse Gas Reduction Impact	
Cumulative greenhouse gas reduction from 2025-2035 (MT CO_2e)	1,353 MT CO_2e

271 SC DES (2024). South Carolina Solid Waste Management Annual Report for Fiscal Year 2023 https://des.sc.gov/sites/des/files/media/document/OR-2508.pdf

272 City of Columbia Public Works (2026). Waste Wizard. https://publicworks.columbiasc.gov/waste-wizard/

273 Rather than a flat fee collected via taxes, a pay as you throw program charges differential fees to households based on how much waste is discarded and picked up by waste collection vehicles. These policies also typically result in more accurate and stable funding for local public works departments, because then increases in waste disposal that result in higher costs (through tipping fees etc.) are recouped automatically. Local residents then have an economic incentive to reduce the amount of waste created. These policies can be modified based on additional considerations, such as adjusting for household size and a fee reduction for households with young children.

Low-carbon Scenario Metrics		
Cumulative greenhouse gas reduction from 2025-2050 (MT CO_2e)		66,360 MT CO_2e
Cumulative Criteria Air Pollution Reduction	2025-2030	2025-2050
Total CO reduction (lbs)	0	108,910
Total HC reduction (lbs)	0	0
Total NOx reduction (lbs)	0	31,734
Total PM10 reductions (lbs)	0	20,273
Total PM2.5 reduction (lbs)	0	8,457
Total SO2 reduction (lbs)	0	7,529
Total VOC reduction (lbs)	0	28,208
Financial Impact		
Incremental Costs (USD)		Not calculated[274]
Incremental Savings (USD)		
Incremental Net Costs/ Savings (USD)		
Marginal Abatement Cost (USD/ MT CO_2e)		

274 Financial costs and savings were not calculated for this measure because there are no mandatory capital costs, and the programmatic costs will vary depending on how communities choose to encourage this change.

Divert Organic Waste from Landfills

The US EPA estimates that about 30-40% of the American food supply is never eaten, and most of that food waste ends up in landfills.[275] The most effective way to reduce food waste is preventing waste in the first place, as described in the previous action. When waste does occur, diverting it from landfills is key to preventing potent methane gas release into the atmosphere. Diverting it into composting facilities is a relatively inexpensive way to reduce the emissions produced, and also produce valuable compost which can be used to fertilize gardens in the local community.

Modeled Action and Timeline

- 2026: All counties introduce or enhance initiatives to help residents, industry, commercial properties and institutions divert organic waste from the volumes transported to landfills;
- By 2030, all counties will be diverting at least 60% of all organic waste to composting facilities; and,
- By 2050, all counties will be diverting at least 90% of all organic waste to composting facilities.

Pathways to Implementation

The SC Department of Environmental Services currently (as of 2026) is running a "Don't Waste Food SC" campaign which targets this area of waste disposal.[276] Local governments and community organizations can augment this existing program or share it within the Midlands.

As part of the planning process, CMCOG did not identify any composting bin collection programs in the Midlands. Some local governments run limited composting operations. For example, the City of Columbia picks up yard waste from the street in residential areas and several municipalities run street collections once a year for Christmas trees (see Figure 6.21). Counties, often through their soil and water conservation districts, have subsidized composting bins sold to local residents.[277]

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275 US EPA. "United States 2030 Food Loss and Waste Reduction Goal." Updated August 20, 2025. Retrieved from https://www.epa.gov/sustainable-management-food/united-states-2030-food-loss-and-waste-reduction-goal

276 SC DES (2025). Don't Waste Food SC. *https://des.sc.gov/community/recycling-waste-reduction/dont-waste-food-sc*

277 One example is Richland County Soil & Water Conservation District, which has run a subsidized composting bin sale annually for several years.

Figure 6.21.
A photo of yard waste collection in Columbia, which diverts organic waste from the landfill to a composting center.[278]

Street collection of food waste can be expensive, and its effectiveness often increases with population density. One potential solution is to focus food composting efforts on large institutions with larger volumes of food waste (e.g., cafeterias), restaurants, and grocery stores. Local governments that can subsidize the movement of food waste from large disposal sites to local composting operations and could help those local businesses scale. This presents a policy alternative that may be cheaper than creating an entirely new composting operation run by the municipality. For example, local composters like ReSoil offer an avenue for composting residential food waste (it just needs to have a mechanism to reach their facility). Local governments or community groups could facilitate this transfer.

278 Photo provided by, and copyright of, City of Columbia / Public Works Department / The Recycling Wizard.

Local organizations can also compost and use it on site (e.g., through community garden or neighborhood compost bins). In these cases, the availability of small grants or subsidized compost bins can support the initial start-up costs and work to uplift smaller-scale and community-oriented composting projects in residential areas.

- Key Implementing Organizations: All actors that dispose of food waste (ideally). Starting with the largest disposal sites. Local governments.
- Geographic Area Impacted: Region-wide.
- Applicable Funding Sources: None identified at this stage.
- Implementation Authority: None needed. SC Department of Environmental Services has existing rules and procedures for commercial & municipal composting operations (which receive their own designation class as a specialized landfill). Composting residential food waste (e.g. a composting bin in the backyard) typically needs no additional authorization in the Midlands.

Low-carbon Scenario Impacts

Table 6.30.
Low-carbon scenario impacts of diverting organic waste from landfills to composting.

Low-carbon Scenario Metrics		
Greenhouse Gas Reduction Impact		
Cumulative greenhouse gas reduction from 2025-2035 (MT CO_2e)		454,289 MT CO_2e
Cumulative greenhouse gas reduction from 2025-2050 (MT CO_2e)		2,999,372 MT CO_2e
Cumulative Criteria Air Pollution Reduction	2025-2030	2025-2050
Total CO reduction (lbs)	119,652	873,788
Total HC reduction (lbs)	0	0
Total NOx reduction (lbs)	34,864	254,605
Total PM10 reductions (lbs)	22,273	162,653

Low-carbon Scenario Metrics		
Total PM2.5 reduction (lbs)	9,291	67,851
Total SO2 reduction (lbs)	8,271	60,404
Total VOC reduction (lbs)	30,990	226,314
Financial Impact		
Incremental Costs (USD)		Not calculated[279]
Incremental Savings (USD)		
Incremental Net Costs/ Savings (USD)		
Marginal Abatement Cost (USD/ MT CO_2e)		

279 Financial costs and savings were not calculated for this measure because there are no mandatory capital costs, and the programmatic costs will vary depending on how communities choose to encourage this change.

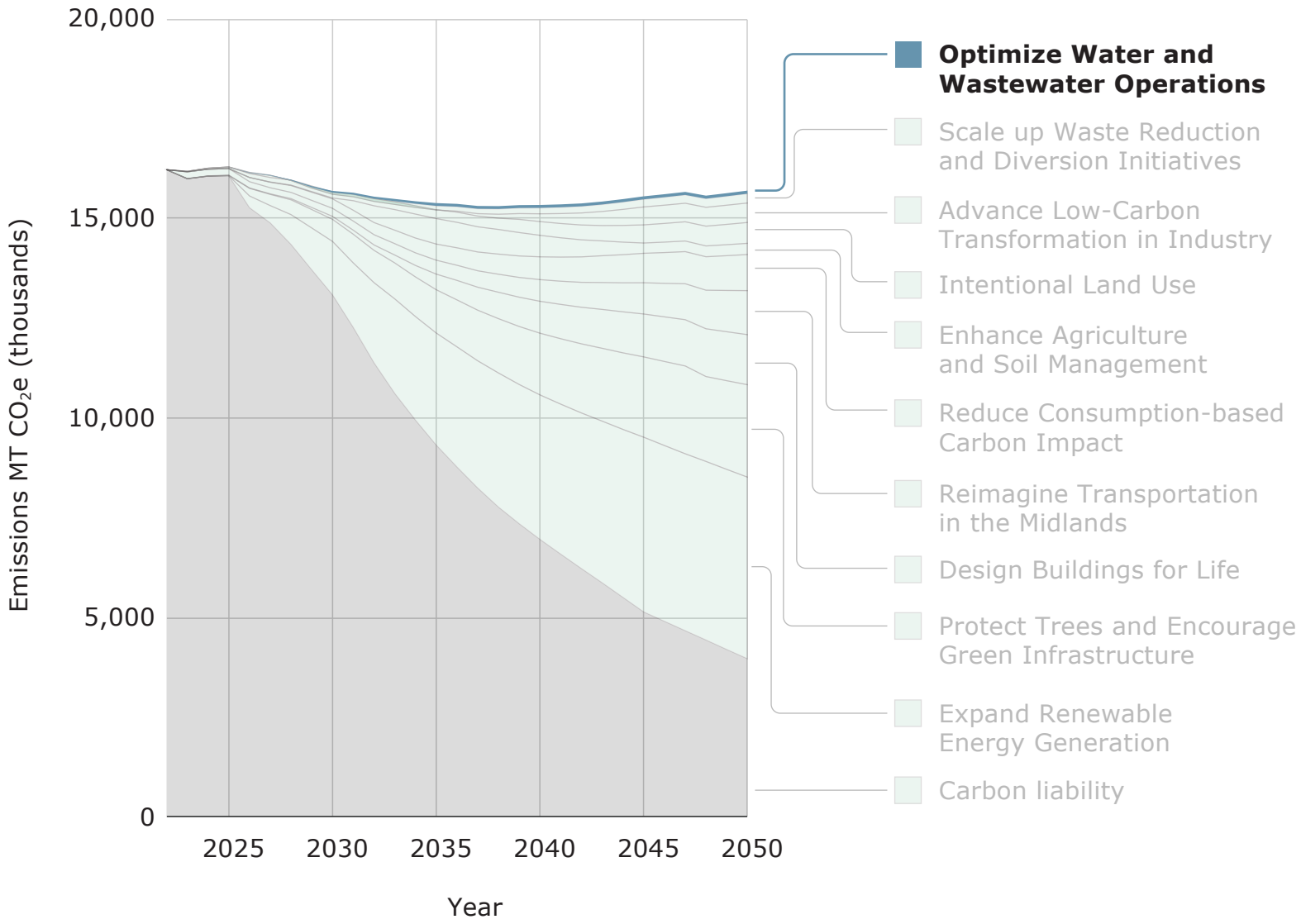
6.3.6 Optimize Water and Wastewater Operations

Water and wastewater systems comprise the network of treatment plants, pipes and pumps that supply clean potable water and safely treat wastewater (i.e. sewage) before releasing it back into the environment. These systems use a lot of energy for pumping, heating and treatment. Wastewater treatment processes can produce methane and nitrous oxide, both potent greenhouse gases. Reducing emissions in this activity sector requires a combination of actions aimed at reducing the system's energy demands and capturing the methane generated from sewage treatment.

In the low-carbon scenario, the set of actions under the Optimize Water and Wastewater Operations strategy could deliver 1,483 MT CO_2e reduction in emissions from now through 2050, accounting for 1% of the total reductions realized in this scenario.

Figure 6.22 illustrates the wedge of emissions that are eliminated over time by the Optimize Water and Wastewater Operations strategy.

Figure 6.22.
Projected emissions reduction from the Optimize Water and Wastewater Operations strategy, 2022-2050.



Each of the actions in this strategy and their impacts are described below.

Anaerobic Digestion at all Wastewater Treatment Plants

Anaerobic digestion is a process that makes use of bacteria to break down organic materials in the absence of oxygen to produce biogas and digestate.[280] The process occurs within sealed chambers, ensuring that no methane escapes into the atmosphere. The gas that it produces can be sold directly as relatively inexpensive biogas, or upgraded to natural gas. It can also be used at a facility in some cases. For instance, the City of Columbia metropolitan wastewater treatment facility uses a portion of captured biogas for boilers (heat production) and flares the remainder.

Modeled Action and Timeline

- By 2035: Anaerobic digesters will have been added to all eight wastewater treatment plants in the Midlands region. In facilities in which aerobic processes are currently used, they will be replaced with anaerobic digesters.
- 2035 on: Gas produced at these facilities will be injected into the natural gas pipeline, supplementing the fossil fuel natural gas supply.
- 2025- 2050: The City of Columbia's metropolitan wastewater treatment facility, which is already equipped with five anaerobic digesters,[281] will continue operating at full capacity throughout the modeled period.

Pathways to Implementation

This action has a straightforward implementation pathway. For facilities that currently use aerobic digesters, the end of a system's useful life is the most convenient time to swap to anaerobic digestion. Facility upgrades or expansions are also logical times.

Anaerobic digestion can open new revenue streams for a wastewater facility. In these cases, cooperation from regional utilities is required (to either buy or transfer the natural gas to other locations). The SC state legislature can, via policy signals, encourage or require the SC Public Service Commission and

280 US EPA. "How Does Anaerobic Digestion Work?". Last updated on December 31, 2024. Retrieved from https://www.epa.gov/agstar/how-does-anaerobic-digestion-work

281 M.B.Khan. Columbia Metro WWTP Anaerobic Digesters Rehab & Improvements. Retrieved from https://www.mbkahn.com/project/metro-waste-water-treatment/

utilities to beneficially re-use captured natural gas from wastewater facilities. This would directly benefit investments made in the Midlands instead of directing economic investment towards out of state firms where fossil fuel natural gas originates.

- Key Implementing Organizations: Wastewater treatment plant owners (mostly municipalities in our region).
- Geographic Area Impacted: At specific sites, although a reasonably large portion of wastewater is sent to these facilities across urban areas. [Rural areas are more likely to use septic tanks].
- Applicable Funding Sources: None needed.
- Implementation Authority: None needed.

Low-carbon Scenario Impacts

Table 6.31.
Low-carbon scenario impacts of installing anaerobic digestion at all wastewater treatment plants.

Low-carbon Scenario Metrics		
Greenhouse Gas Reduction Impact		
Cumulative greenhouse gas reduction from 2025-2035 (MT CO_2e)	274,832 MT CO_2e	
Cumulative greenhouse gas reduction from 2025-2050 (MT CO_2e)	1,129,801 MT CO_2e	
Cumulative Criteria Air Pollution Reduction	2025-2030	2025-2050
Total CO reduction (lbs)	16,466	219,490
Total HC reduction (lbs)	0	0
Total NOx reduction (lbs)	24,653	356,441
Total PM10 reductions (lbs)	132	1,923
Total PM2.5 reduction (lbs)	109	1,589
Total SO2 reduction (lbs)	152	2,215
Total VOC reduction (lbs)	1,393	20,318

Low-carbon Scenario Metrics	
Financial Impact	
Incremental Costs (USD)	$225,134,000
Incremental Savings (USD)	$576,800,000[282]
Incremental Net Costs/ Savings (USD)	Net savings of $351,666,000
Marginal Abatement Cost (USD/ MT CO_2e)	Savings of $637 / MT CO_2e

Improve Efficiency of Water and Wastewater Treatment Assets

Similar to the action to improve industrial energy efficiency, improving the efficiency of machinery like pumping (in water treatment facilities) and aeration (in wastewater treatment facilities) can significantly reduce the total energy required in what are otherwise very energy-intensive processes. This in turn reduces costs for the operators. Some mechanisms that lead to higher energy use or greenhouse gas emissions are complex. For example, stormwater that infiltrates sewer pipes increases treatment costs.

Modeled Action and Timeline

- 2025-2028: Total energy consumption in all water and wastewater treatment facilities is reduced by 5%;
- By 2030: Total energy consumption at these facilities is reduced by 10% - i.e. 5% more than the level reached in 2028;
- By 2035: Total energy consumption at these facilities is reduced by 30% - i.e. 20% more than the level reached in 2030.

282 The financial savings shown here assume that all natural gas produced from the digesters is injected into the natural gas line, and facility operators are paid the retail price for this gas.

Pathways to Implementation

CMCOG surveyed water and wastewater utilities as part of this planning process, and asked for perceptions of various efficiency improvements at facilities.[283] The following were the top 5 favored actions:

1) High-efficiency \ variable speed pumps
2) Optimizing the pump station network[284]
3) Reducing stormwater infiltration[285]
4) Reducing septic system use adjacent to or within wastewater networks [broken out into a separate action in this plan]
5) Solar PV at facilities [broken out into a separate action in this plan]

Among operator's top 3 favored actions, high-efficiency pumps are the easiest to implement. When an existing facility replaces an outdated or broken pump, long-term investments in high-efficiency pumps are both economical and reduce emissions. These pumps often would not require changes at the facility. The next 2 actions are more complex, but also have several additional co-benefits beyond greenhouse gas emissions reductions.

- Key Implementing Organizations: Wastewater treatment plant owners (mostly municipalities in our region).
- Geographic Area Impacted: At specific sites, although a reasonably large portion of wastewater is sent to these facilities across urban areas. [Rural areas are more likely to use septic tanks].
- Applicable Funding Sources: None noted at this time.
- Implementation Authority: None needed.

283 Thanks to the 9 facility operators who completed this survey. [Nearly all large water/wastewater utilities in the Midlands are included within survey responses].

284 Due to system expansions or consolidations over time, some infrastructure is now not optimally positioned or duplicative (e.g. two pumping stations from formerly separate networks are now combined and located close together). This action in particular would need prior regional planning, and collaboration among regional utilities to consider future system needs and expected population growth.

285 Sewer infrastructure is expensive to repair or replace. Stormwater getting into sewer pipes and sent to wastewater treatment plants raises their costs & energy use. In the Midlands, all stormwater systems are MS4s, meaning they direct water to local waterways. See SC DES overview here - *https://des.sc.gov/programs/bureau-water/stormwater/stormwater-management/municipal-storm-sewer-systems-ms4s*

Low-carbon Scenario Impacts

Table 6.32.
Low-carbon scenario impacts of improving efficiency at all water and wastewater treatment plants.

Low-carbon Scenario Metrics		
Greenhouse Gas Reduction Impact		
Cumulative greenhouse gas reduction from 2025-2035 (MT CO_2e)		23,981 MT CO_2e
Cumulative greenhouse gas reduction from 2025-2050 (MT CO_2e)		47,438 MT CO_2e
Cumulative Criteria Air Pollution Reduction	2025-2030	2025-2050
Total CO reduction (lbs)	3,437	23,347
Total HC reduction (lbs)	0	0
Total NOx reduction (lbs)	5,433	36,458
Total PM10 reductions (lbs)	965	6,240
Total PM2.5 reduction (lbs)	809	5,229
Total SO2 reduction (lbs)	3,073	19,857
Total VOC reduction (lbs)	253	1,708
Financial Impact		
Incremental Costs (USD)		Not calculated.[286]
Incremental Savings (USD)		$99,333,000
Incremental Net Costs/ Savings (USD)		Not calculated.
Marginal Abatement Cost (USD/ MT CO_2e)		Not calculated.

286 Costs for this measure were not calculated because they will vary depending on the measures implemented. However there are many simple and inexpensive measures that significantly reduce energy consumption. Net savings from this action are likely.

Install Solar at Wastewater Treatment Plants

As discussed in the context of earlier actions, water and wastewater facilities are high energy consumers, and as a result they are expensive to operate. Reducing those costs can make a significant difference to overall budgets of local water utilities. Installing solar PV systems on these buildings is an extremely effective way to reduce energy costs, in addition to reducing greenhouse gas emissions.

Modeled Action and Timeline

- From 2030 on: All new wastewater facilities must have solar PV systems (rooftop or canopy) installed at them that have enough capacity to meet 40% of their total required power; and,
- 2026-2050: Existing wastewater facilities gradually begin to add solar PV systems (rooftop or canopy) at their properties such that by 2050, 95% of all existing wastewater treatment facilities have enough solar capacity on-site to meet 30% of their total required power.

Pathways to Implementation

Similar to industrial sites, wastewater facilities often have adjacent land that would be suitable for small or moderately sized canopy solar PV. Wastewater facilities are often one of the most expensive electric bills for any local government, and solar systems would be particularly effective at reducing these expenses over time.

- Key Implementing Organizations: Wastewater treatment plant owners (mostly municipalities in our region).
- Geographic Area Impacted: At specific sites, although a reasonably large portion of wastewater is sent to these facilities across urban areas. [Rural areas are more likely to use septic tanks].
- Applicable Funding Sources: None needed [solar PV is cost-effective and would have a simple payback period of less than 10 years for most facilities].
- Implementation Authority: None needed.

Low-carbon Scenario Impacts

Table 6.33.
Low-carbon scenario impacts of installing solar PV systems at all wastewater treatment plants.

Low-carbon Scenario Metrics		
Greenhouse Gas Reduction Impact		
Cumulative greenhouse gas reduction from 2025-2035 (MT CO_2e)		807 MT CO_2e
Cumulative greenhouse gas reduction from 2025-2050 (MT CO_2e)		1,631 MT CO_2e
Cumulative Criteria Air Pollution Reduction	2025-2030	2025-2050
Total CO reduction (lbs)	37	765
Total HC reduction (lbs)	0	0
Total NOx reduction (lbs)	59	1,218
Total PM10 reductions (lbs)	11	221
Total PM2.5 reduction (lbs)	9	186
Total SO2 reduction (lbs)	34	705
Total VOC reduction (lbs)	3	56
Financial Impact		
Incremental Costs (USD)		$780,000
Incremental Savings (USD)		$3,351,000
Incremental Net Costs/ Savings (USD)		Savings of $2,571,000
Marginal Abatement Cost (USD/ MT CO_2e)		Savings of $1,576/ MT CO_2e

Reduce Water Consumption

Reducing water consumption both reduces the amount of energy required (and so also the emissions generated to produce that energy), and has a co-benefit for increasing water availability (reducing water use).

Modeled Action and Timeline

This modeled action did not specify how to achieve the reductions, but rather left it up to the water treatment plants to determine what combination of measures will most effectively help their customers to reduce their consumption to the levels described below.

- By 2028: Per capita water consumption region-wide is reduced by 20% relative to 2022 levels;
- By 2030: Per capita water consumption region-wide is reduced by 30% relative to 2022 levels; and,
- By 2035: Per capita water consumption region-wide is reduced by 35% relative to 2022 levels.

Pathways to Implementation

There are many ways in which water consumption can be reduced - ranging from installing inexpensive tap aerators on all water taps in public buildings, to requiring industrial facilities to only use grey water for cooling purposes, or to using recycled wastewater for irrigation.

- Key Implementing Organizations: Water utilities (public education programs or incentives); water consumers.
- Geographic Area Impacted: Region-wide.
- Applicable Funding Sources: None noted at this time.
- Implementation Authority: None needed.

Low-carbon Scenario Impacts

Table 6.34.
Low-carbon scenario impacts of reducing water consumption

Low-carbon Scenario Metrics		
Greenhouse Gas Reduction Impact		
Cumulative greenhouse gas reduction from 2025-2035 (MT CO_2e)		51,403 MT CO_2e
Cumulative greenhouse gas reduction from 2025-2050 (MT CO_2e)		108,800 MT CO_2e
Cumulative Criteria Air Pollution Reduction	2025-2030	2025-2050
Total CO reduction (lbs)	7,567	33,828
Total HC reduction (lbs)	0	0
Total NOx reduction (lbs)	12,055	53,892
Total PM10 reductions (lbs)	2,191	9,794
Total PM2.5 reduction (lbs)	1,836	8,207
Total SO2 reduction (lbs)	6,980	31,204
Total VOC reduction (lbs)	559	2,498
Financial Impact		
Incremental Costs (USD)		$2,086,000
Incremental Savings (USD)		$150,346,000
Incremental Net Costs/ Savings (USD)		Savings of $148,260,000
Marginal Abatement Cost (USD/ MT CO_2e)		Savings of $1,363 / MT CO_2e

Replace Septic Systems with Connections to Wastewater Treatment Plants

Septic systems, especially older, poorly maintained, or overloaded systems, can leak methane into the atmosphere. Septic systems make economic sense for rural homes on large lots or areas without sewer expansion. Switching individual septic systems to a centralized sewer network enables methane to be captured and controlled, thereby eliminating the release of this potent greenhouse gas. Septic systems that are not properly maintained may also leak and contaminate groundwater.

Modeled Action and Timeline

- 2025: 30% of the residents within the Midlands region rely on septic systems to treat their wastewater.
- By 2045, 10% of households currently using septic systems (i.e. 3% of total households) are connected to wastewater treatment networks.

Pathways to Implementation

CMCOG estimates that 30% of the communities in the Midlands rely on septic systems to treat their wastewater. As local municipalities expand their wastewater networks, these residents can be connected to extended sewer networks. Subsidies or grants to defray the costs of switching from a septic system to municipal wastewater connection would be helpful as utility expansions occur.

- Key Implementing Organizations: Wastewater treatment plant owners (mostly municipalities in our region).
- Geographic Area Impacted: Region-wide.
- Applicable Funding Sources: None identified at this time. Grants can eliminate the initial cost of tie-ing into a wastewater network.
- Implementation Authority: None needed.

Low-carbon Scenario Impacts

Table 6.35.
Low-carbon scenario impacts of replacing septic systems with connections to wastewater treatment facilities

Low-carbon Scenario Metrics		
Greenhouse Gas Reduction Impact		
Cumulative greenhouse gas reduction from 2025-2035 (MT CO_2e)		29,980 MT CO_2e
Cumulative greenhouse gas reduction from 2025-2050 (MT CO_2e)		195,144 MT CO_2e
Cumulative Criteria Air Pollution Reduction	2025-2030	2025-2050
Total CO reduction (lbs)	16,466	219,490
Total HC reduction (lbs)	0	0
Total NOx reduction (lbs)	24,653	356,441
Total PM10 reductions (lbs)	132	1,923
Total PM2.5 reduction (lbs)	109	1,589
Total SO2 reduction (lbs)	152	2,215
Total VOC reduction (lbs)	1,393	20,318
Financial Impact		
Incremental Costs (USD)		$126,423,000
Incremental Savings (USD)		$1,039,743,000
Incremental Net Costs/ Savings (USD)		Net savings of $913,321,000
Marginal Abatement Cost (USD/ MT CO_2e)		Savings of $4,680 / MT CO_2e

6.3.7 Protect Trees and Encourage Green Infrastructurve

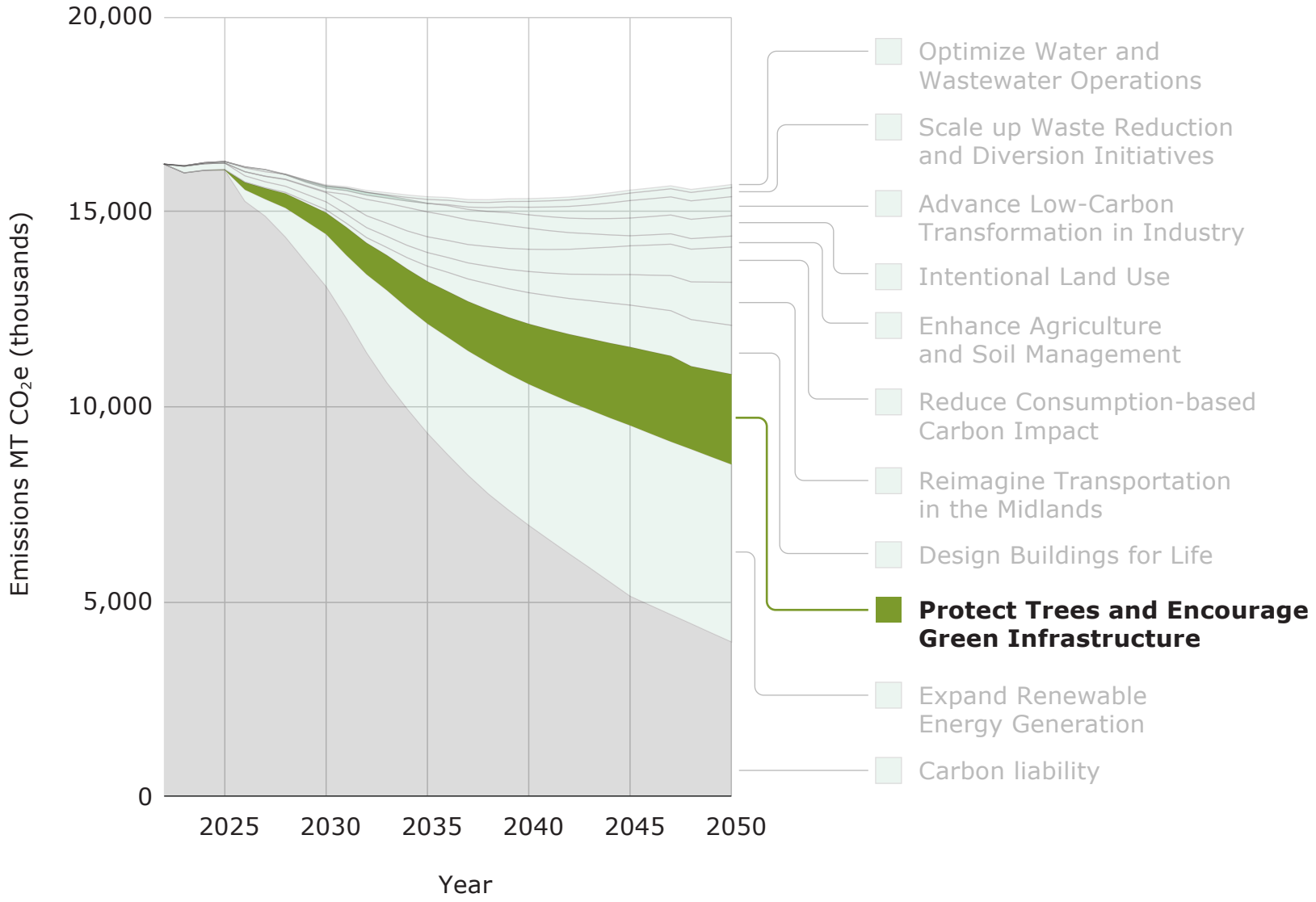
Natural vegetation in the Midlands sequestered an estimated total of 4,241,000 MT of CO_2 in 2022. The actions in this section build upon this capacity for natural sequestration, reducing air pollution, protecting communities from extreme heat, and saving local governments money. It will also help to mitigate the biodiversity crisis that is threatening the survival of many plant and animal species globally.[287]

The actions modeled for the Protect Trees and Encourage Green Infrastructure strategy will eliminate 29,961,000 MT of CO_2 that would otherwise be emitted in the Midlands between 2022 and 2050. This constitutes 19% of the total reductions achieved in the low-carbon scenario, and makes this strategy the second most impactful in this plan, after Expand Renewable Energy Generation.

Figure 6.23 illustrates the impact of this strategy on greenhouse gas emissions in the Midlands over time.

287 IPBES (2019): Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. S. Díaz, J. Settele, E. S. Brondízio, H. T. Ngo, M. Guèze, J. Agard, A. Arneth, P. Balvanera, K. A. Brauman, S. H. M. Butchart, K. M. A. Chan, L. A. Garibaldi, K. Ichii, J. Liu, S. M. Subramanian, G. F. Midgley, P. Miloslavich, Z. Molnár, D. Obura, A. Pfaff, S. Polasky, A. Purvis, J. Razzaque, B. Reyers, R. Roy Chowdhury, Y. J. Shin, I. J. Visseren-Hamakers, K. J. Willis, and C. N. Zayas (eds.). IPBES secretariat, Bonn, Germany. 56 pages. https://doi.org/10.5281/zenodo.3553579

Figure 6.23.
Wedge Diagram of Emissions Reductions from Protect Trees and Encourage Green Infrastructure strategy in the LC Scenario, 2022-2050.



Increase and Maintain Healthy Urban Trees

This action builds on a number of commitments in the region to increase tree coverage in urban areas by planting almost 2 million additional trees and creating long-term care plans that ensure the vast majority survive past 2050.

Modeled Action and Timeline

- *Every year from 2026 to 2050: In large and small communities across the region, 75,600 trees will be planted. These trees will be maintained sufficiently to ensure a high rate of survival at least until 2050.*
- *By 2050: A total of 1,890,000 additional trees will have been planted, covering more than 8,039 additional acres of 'urban' land with tree canopy, and increasing the total area of the region that has tree cover to 49%.*

For the purposes of this plan, this action assumed an equal number of each of the following species[288] were planted each year:

1. White Oak: *Quercus alba*
2. Black Gum: *Nyssa sylvatica*
3. Poplar or Tulip Tree: *Liriodendron tulipifera*

Pathways to Implementation

Tree species selected for planting should be resilient to a changing climate and able to withstand conditions such as drought or flooding depending on expected conditions where they are planted. It is also important to plant a diversity of tree species, especially native or endemic species that can contribute to improved biodiversity and ecosystem services. Planting a variety of species can bring additional aesthetic benefits or increase biodiversity. Maximizing greenhouse gas emissions reductions should not be the primary driver of selecting which species to plant, as all urban trees will capture carbon.

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288 Note - limiting the number of species simplified our air pollution modeling for this climate action. These three species are all native to our region and currently used by urban forestry programs in the Midlands. They are not the only species suitable for urban tree programs (and in fact, a larger variety of species can be both aesthetically pleasing and lead to better ecosystem services). While hardwoods are often preferred for urban forestry, coniferous trees can also be used. For more, see U.S. Forest Service (2026). Urban Forest Inventory & Analysis Program. https://research.fs.usda.gov/programs/urbanfia

The Midlands region has several local governments that are currently exploring or actively implementing urban forestry campaigns or programs. Cross-regional sharing can improve the outcomes of these programs over time, and CMCOG can work with municipalities or community-based organizations in this area. A few implementation notes to highlight include:

1) "Urban" should refer to small towns in addition to larger cities.
2) Tree plantings in areas where people congregate are especially valuable (parks, schools, main streets, business districts, etc.). Programs should ensure no communities are left out, and should evaluate current tree canopy levels by geography if funding or capacity is limited.
3) Grant funds can help start a program, but ideally urban tree programs are continuous. It is generally better to maintain smaller levels of planting continually because in the future older trees will need to be replaced.[289]

Besides direct planting programs, local governments can also enforce change over time via zoning requirements (particularly in commercially zoned areas).[290] Other actors can also contribute to urban forestry in various ways. Community-based organizations (either alone on their properties, or in partnership with local governments) can aid or co-run tree planting programs. One example recently is the "Beat the Heat" program.[291] Businesses, especially those with large campuses, can intentionally create green spaces and partially or fully open these to the public.[292] Within areas with mostly residentially zoned properties, local organizing can increase the tree canopy cover in neighborhoods over time by encouraging property owners to plant trees or through zoning.[293]

- Key Implementing Organizations: All actors, but especially local governments.

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289 Climate driven disasters like hurricanes that fell large numbers of trees at once would be an exception here.

290 For instance, the Smart Surfaces Coalition has recently published a zoning guide for cities. Smart Surfaces Coalition (2026). Smart Surfaces Policy Memo: Zoning and Building Codes. https://smartsurfacescoalition.org/analysis

291 A partnership between an NGO (Columbia Green) and a local government (City of Columbia). *https://columbiagreen.org/beattheheat*

292 While outside the Midlands, one example in South Carolina is the Milliken Arboretum. https://www.sctrails.net/trails/trail/milliken-arboretum

293 For example, Ocean Spring MS has a citizen-led tree planting program focused on residential properties. WLOX News (2026). First of 500 trees planted in Ocean Springs Tree Canopy Renewal Project. https://www.wlox.com/2026/02/09/first-500-trees-planted-ocean-springs-tree-canopy-renewal-project/

- Geographic Area Impacted: Urban areas across the Midlands
- Applicable Funding Sources: The SC Forestry Commission regularly runs grant programs and provides technical assistance. Technical assistance is often available from multiple sources, including universities and NGOs. CMCOG can also advise or collaborate on grant applications.
- Implementation Authority: None needed [in some cases, policy changes may assist this action. CMCOG has not completed a comparative zoning code analysis as part of this plan].

Low-carbon Scenario Impacts

Table 6.36.
Low-carbon scenario impacts of planting almost 2 million trees in urban areas.

Low-carbon Scenario Metrics		
Greenhouse Gas Reduction Impact		
Cumulative greenhouse gas reduction from 2025-2035 (MT CO_2e)	236,584 MT CO_2	
Cumulative greenhouse gas reduction from 2025-2050 (MT CO_2e)	1,398,000 MT CO_2	
Cumulative Criteria Air Pollution Reduction[294]	2025-2030	2025-2050
Total CO reduction (lbs)	Not calculated.[295]	
Total HC reduction (lbs)		
Total NOx[296] reduction (lbs)	77,411	219,442
Total PM10 reductions (lbs)	Not calculated148	
Total PM2.5 reduction (lbs)	25,781	73,084
Total SO2 reduction (lbs)	10,075	28,561

294 Cumulative criteria air pollutant calculations for this action were done using the i-Tree Planting Calculator found at: https://planting.itreetools.org/.

295 The i-Tree tool does not provide calculations of CO, HC or PM10 reductions.

296 The values here are for NO_2 only, because this is the only NOx reduction that the i-Tree tool calculates.

Low-carbon Scenario Metrics		
Total VOC reduction (lbs)	2,307	6,541
Financial Impact		
Incremental Costs (USD)		$285,706,000
Incremental Savings (USD)		$400,308,000
Incremental Net Costs/ Savings (USD)		Savings of $114,601,000
Marginal Abatement Cost (USD/ MT CO_2e)		Savings of $82 / MT CO_2

Reforestation

This action involves returning lands that were previously forested, back to a forested state. Afforestation is the term used if the land has not been forested for some time, while reforestation is the term used if the land was more recently forest. Both focus more on restoring larger areas as species-rich natural habitats than on simply adding trees to a small area like urban forestry. The result will be an increase in Midlands areas that are natural spaces capable of supporting a wide variety of plant and animal species. This action also encourages economic development in rural communities, as pristine ecosystems (particularly restored areas that were in a formerly degraded state) can increase local recreation opportunities, tourism, or be integrated into or amidst working lands.

Modeled Action and Timeline

- 2025-2050: Climate resilient trees, shrubs and other plants will be planted and maintained across the Midlands gradually over time, such that by 2050, 675,562 acres of land will be restored to diversely populated forested, natural areas.

For the purposes of this plan, this action assumed an equal number of each of the following species[297] were planted each year:

297 Note - limiting the number of species simplified our air pollution modeling for this climate action. These three species are all native to our region. For reforestation in particular, a large variety of species is critical and would change based on the ecosystem type (e.g. bottomland hardwood forest vs. longleaf pine forest).

1. Loblolly Pine: *Pinus taeda*
2. Bald Cypress: *Taxodium distichum*
3. Water oak: *Quercus nigra*

Pathways to Implementation

Existing research indicates that reforestation in the Midlands would likely have high environmental and biodiversity benefits[298] and would be cost-effective.[299]

Spatial planning can be complex, with large sites and regional connectivity posing challenges. Different state agencies maintain useful data but propose "priority" areas that may not align. Examples include the SC Conservation Bank[300], SC DNR/Forestry Commission[301], and the SC Office of Resilience.[302] The SC Governor's office has recently attempted to merge several GIS layers under a unified umbrella and set a goal to conserve 10 million acres.[303] CMCOG has engaged in prior land planning analyses[304], but is working to develop updated guidance based on recent developments in order to aid local communities in the Midlands to interconnect with future funding tied to the state's goals and programs.

Forest ecosystems in the Midlands like bottomland hardwood forests and longleaf pine forests are incredibly biodiverse. For instance, longleaf pine ecosystems rival rainforests along some metrics of biodiversity, supporting a wide variety of animals, insects, and plants.[305] While spatial planning for

298 See Cook-Patton, S.C., Leavitt, S.M., Gibbs, D. et al. Mapping carbon accumulation potential from global natural forest regrowth. Nature 585, 545–550 (2020). https://doi.org/10.1038/s41586-020-2686-x and Fesenmyer, K.A., Poor, E.E., Terasaki Hart, D.E. et al. Addressing critiques refines global estimates of reforestation potential for climate change mitigation. Nat Commun 16, 4572 (2025). https://doi.org/10.1038/s41467-025-59799-8

299 See Cook-Patton, S. C., Gopalakrishna, T., Daigneault, A., Leavitt, S. M., Platt, J., Scull, S. M., ... & Fargione, J. E. (2020). Lower cost and more feasible options to restore forest cover in the contiguous United States for climate mitigation. One Earth, 3(6), 739-752. and Busch, J., Bukoski, J.J., Cook-Patton, S.C. et al. Cost-effectiveness of natural forest regeneration and plantations for climate mitigation. Nat. Clim. Chang. 14, 996–1002 (2024). https://doi.org/10.1038/s41558-024-02068-1

300 Prioritizing new land parcels via an index against currently protected parcels, see https://www.sccbank.sc.gov/sccb-statewide-priorities.

301 Both agencies prioritize against biodiversity and/or habitats, see https://www.dnr.sc.gov/swap/index.html or https://heritagetrust.dnr.sc.gov/

302 Prioritizing a mix of flood resilience benefits or carbon sequestration potential, see https://www.maps.tnc.org/resilientland/

303 See more about Governor McMaster's Land Conservation Plan here: https://experience.arcgis.com/experience/2bedb49e42904257880336ec17ed172b

304 See our prior work with the SC Forestry Commission, https://www.scfc.gov/management/urban-forestry/sc-green-infrastructure-plan-2023/

305 Earley, L. S. (2004). Looking for longleaf: the fall and rise of an American forest. Univ of North Carolina Press.

restoration at a regional scale is crucial to form interconnected networks or oases of habitat, much of the work of afforestation or reforestation happens at individual sites in the Midlands (see Figure 6.24). Implementing reforestation or afforestation over time involves a variety of actors. State and local governments can assist via policy (zoning, etc.), providing funds, or creation of parks. Businesses and residents can employ working lands that are forests or intermix natural forests on a portion of property adjacent to working lands. Conservation easements or other policy options can provide tax benefits to landowners in some cases.

Figure 6.24.
A photo of longleaf pine restoration in progress at a community site in the Midlands. The site is actively managed, including enabling a natural fire regime to regenerate a longleaf ecosystem.[306]

- Key Implementing Organizations: State and local governments, community-based organizations, and other actors.
- Geographic Area Impacted: Previously forested rural areas across the Midlands
- Applicable Funding Sources: None identified at this time.
- Implementation Authority: None needed [in some cases, policy changes may assist this action. For example, CMCOG has not completed a comparative zoning code analysis as part of this plan but this may inform development pathways].

306 Photo provided by a community partner and used with permission. The photo is soon after a fire, the top of the longleaf pine is green and the tree will likely thrive after the burn.

Low-carbon Scenario Impacts

Table 6.37.
Low-carbon scenario impacts of reforesting areas of the Midlands.

Low-carbon Scenario Metrics		
Greenhouse Gas Reduction Impact		
Cumulative greenhouse gas reduction from 2025-2035 (MT CO_2e)		4,835,099 MT CO_2
Cumulative greenhouse gas reduction from 2025-2050 (MT CO_2e)		28,562,807 MT CO_2
Cumulative Criteria Air Pollution Reduction[307]	2025-2030	2025-2050
Total CO reduction (lbs)		Not calculated[308]
Total HC reduction (lbs)		
Total NOx reduction (lbs)[309]	15,941,746	79,708,729
Total PM10 reductions (lbs)		Not calculated
Total PM2.5 reduction (lbs)	4,340,682	21,703,409
Total SO2 reduction (lbs)	6,170,053	30,850,267
Total VOC reduction (lbs)	-14,577	-72,884
Financial Impact		
Incremental Costs (USD)		$327,566000
Incremental Savings (USD)		$8,180,011,000
Incremental Net Costs/ Savings (USD)		Net Savings of $$7,852,445,000
Marginal Abatement Cost (USD/ MT CO_2e)		Savings of $275 / MT CO_2

307 Cumulative criteria air pollutant calculations for this action were done using the i-Tree Planting Calculator found at: https://planting.itreetools.org/ . Accessed March 7, 2026.

308 The i-Tree tool does not provide calculations of CO, HC or PM10 reductions.

309 The values here are for NO_2 only, because this is the only NOx reduction that the i-Tree tool calculates.

Add Green Infrastructure

The following three-part, green infrastructure action was modeled for this plan using the Smart Surfaces Benefit-Cost Analysis Tool.[310] As heavy rain and flood events increase, green infrastructure is a way for local governments to respond that makes adjacent areas more resilient. Green infrastructure – such as rain gardens, bioswales, permeable pavements, and green roofs – capture and treat stormwater by mimicking natural systems. Green infrastructure strategies are lower-cost alternatives to concrete "grey" infrastructure that manage stormwater while also providing a host of social and financial benefits and ecosystem services.

Modeled Action and Timeline

All of the following action components are carried out within the urbanized core of the Midlands.

1. Between 2025 and 2030:
   - Part 1: Replace impermeable surfaces covering an area equal to 248 acres with light-colored permeable pavers.
   - Part 2: Add bioswales to 476 acres of built-up land area.
   - Part 3: Add rain gardens to 53 acres of landscaped areas in the immediate vicinity of approximately 800 buildings.
2. Between 2031 and 2040:
   - Part 1: Replace a further 248 acres of impermeable surfaces with light-colored permeable pavers.
   - Part 2: Add bioswales to a further 476 acres of built-up land area.
   - Part 3: Add rain gardens to a further 53 acres of landscaped areas next to an additional 800 buildings (approximately).

Pathways to Implementation

Local governments are well-situated to lead implementation of green infrastructure projects and programs. Easements adjacent to roadways or in road medians are often ideal candidates for small-scale projects that would amplify stormwater benefits due to the adjacent impervious road surfaces.

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310 The City of Columbia participated in the Smart Surface Coalition's Cities for Smart Surfaces initiative from 2023 - 2026. As part of this initiative, a model of the urban core area of the City of Columbia and adjacent areas was analyzed. The Smart Surface Coalition's work involved several NGO and academic experts. The results are available here - *https://bca.smartsurfacescoalition.org/*

Community-based organizations can also be a key pathway for implementation. For example, the Gills Creek Watershed Association has been installing rain gardens and teaching others how to do so as well (see Figure 6.25), while the SC Public Health Association has been providing technical assistance and micro-grants in this area.[311]

While green infrastructure is often considered from an engineering perspective that emphasizes reductions in pollution or resilience benefits, green infrastructure can be construed more broadly to mean various types of intentional plantings that produce co-benefits. For example, pollinator gardens are simple installations that support wildlife, mitigate urban heat and stormwater runoff, and enhance neighborhood aesthetics.[312] Local community groups like the SC Native Plant Society, local gardening clubs, etc. often play a key role in disseminating knowledge about these types of green infrastructure projects and local governments can collaborate to utilize the expertise of these groups (see Figure 6.25).

Figure 6.25.
Left - A photo of the rain garden installed by Gills Creek Watershed Association at the Richland Library: Wheatley Branch. Right - A photo of bees pollinating an apple tree at a local community garden.[313]

- Key Implementing Organizations: Local governments, community-based organizations, businesses & residents.

311 SC Public Health Association (2025). Smart Surfaces. https://www.scpha.com/smart-surfaces

312 For instance, the Smart Surfaces Coalition has recently published an urban meadows guide. Smart Surfaces Coalition (2026). Smart Surfaces Policy Guidance: Urban Meadows. https://smartsurfacescoalition.org/analysis

313 Both are CMCOG photos. The photo from the community garden is used with permission.

- Geographic Area Impacted: urban core of the Midlands
- Applicable Funding Sources: None identified at this time.
- Implementation Authority: None needed [typically].

Low-carbon Scenario Impacts

Table 6.38.
Low-carbon scenario impacts of adding green infrastructure to the Midlands.

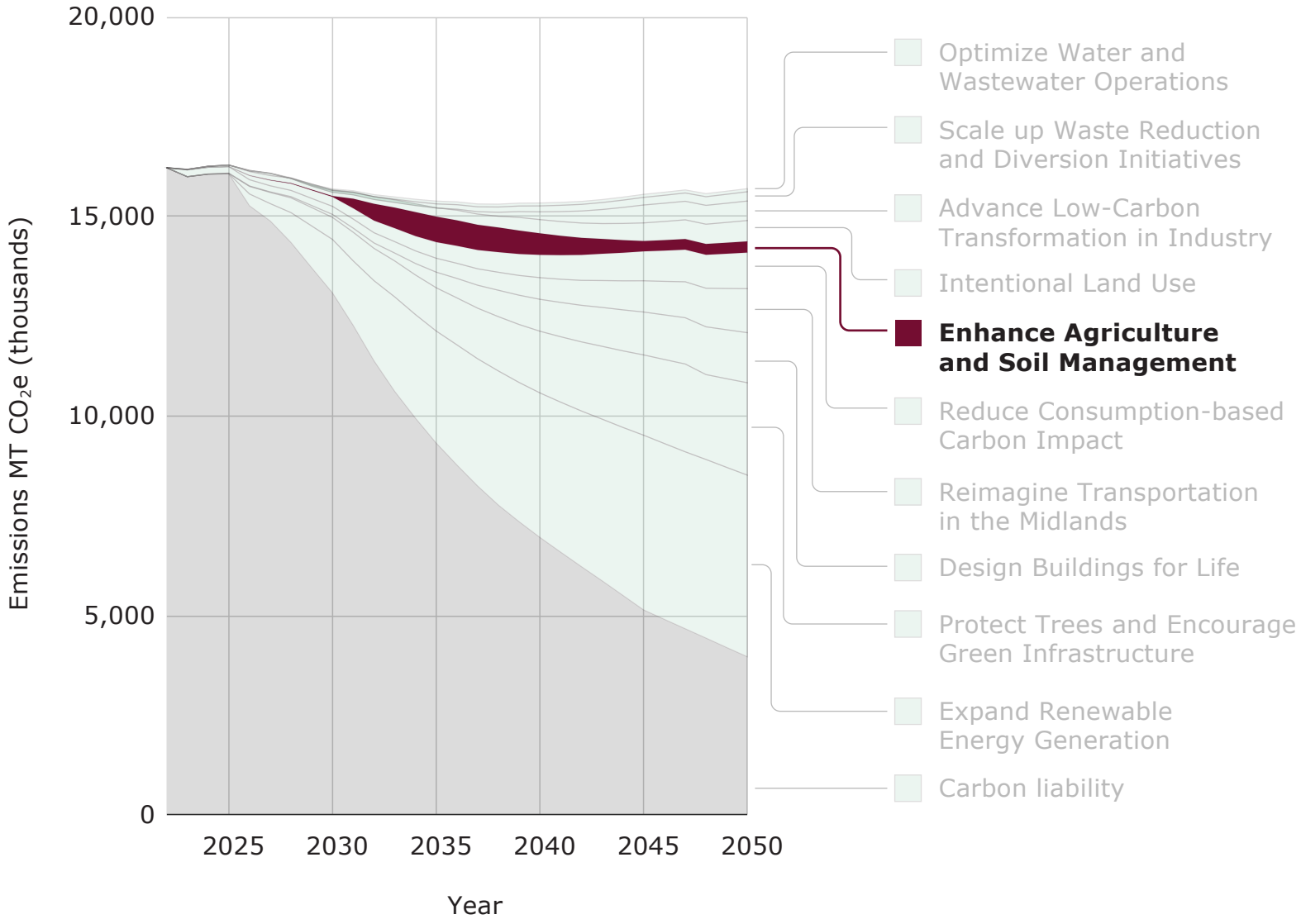
Low-carbon Scenario Metrics		
Greenhouse Gas Reduction Impact		
Cumulative greenhouse gas reduction from 2025-2035 (MT CO_2e)		16,000 MT CO_2
Cumulative greenhouse gas reduction from 2025-2050 (MT CO_2e)		32,000 MT CO_2
Cumulative Criteria Air Pollution Reduction	2025-2030	2025-2050
Total CO reduction (lbs)	Not calculated for this action.[314]	
Total HC reduction (lbs)		
Total NOx reduction (lbs)		
Total PM10 reductions (lbs)		
Total PM2.5 reduction (lbs)		
Total SO2 reduction (lbs)		
Total VOC reduction (lbs)		
Financial Impact		
Incremental Costs (USD)		$1,797,730000
Incremental Savings (USD)		$4,610,680,000
Incremental Net Costs/ Savings (USD)		Net Savings of $2,812,950,000
Marginal Abatement Cost (USD/ MT CO_2e)		Savings of $87,905 / MT CO_2

314 The Smart Surfaces Benefit-Cost Analysis Tool does not provide estimates for reductions in criteria air pollutants.

6.3.8 Enhance Agriculture and Soil Management Practices

Figure 6.26 highlights the emissions reductions achieved by the actions in the Enhance Agriculture and Soil Management strategy of the low-carbon scenario in 2022 and 2050.

Figure 6.26.
Wedge Diagram of Emissions Reductions from Enhance Agriculture and Soil Management in the LC Scenario, 2022-2050.



Climate Smart Commodities

This action was designed to provide a quantification of selected actions from the Climate Smart Commodities program[315] - specifically, the benefits associated with reducing tillage and reducing fertilizer use on crops. Clemson recently conducted an extensive evaluation of climate smart agricultural practices and their applicability to agribusinesses in South Carolina.[316] Clemson recommended analyzing two agricultural actions for the statewide climate action plan, and we downscaled them to the Midlands here. There are a variety of on-farm practices that can reduce air pollutants (including greenhouse gases), and these actions are not an exhaustive list of beneficial actions.[317]

Modeled Action and Timeline

3. 2025-2050: Through gradual change, the use of nitrogen fertilizer will be reduced by the following amounts by 2050:
    - 25% reduction of nitrogen fertilizer used on corn crops in Lexington, Calhoun and Newberry counties;
    - 25% reduction of nitrogen fertilizer on cotton crops in Calhoun county;
    - 25% reduction of nitrogen fertilizer on peanut crops in Calhoun county;
    - 50% reduction of nitrogen fertilizer on soybean crops in Newberry and Calhoun counties.
4. 2025-2050: Through gradual change, all land that is currently identified as 'intensively tilled' will be converted to 'no-till' practices. (Other intensities of tilling will not be changed.)

315 USDA (2024). Partnership for Climate Smart Commodities. https://www.usda.gov/climate-solutions/climate-smart-commodities

316 Clemson University (2022). USDA Investing $70M in Clemson / South Carolina State Climate Smart Commodities project - the largest single award from a federal agency in the history of both universities. *https://news.clemson.edu/usda-investing-70m-in-clemson-south-carolina-state-climate-smart-commodities-project/*

317 USDA (2024). NRCS Climate Smart Mitigation Activities. https://www.usda.gov/climate-solutions/climate-smart-commodities

Pathways to Implementation

Clemson University, one of the state's land grant colleges, runs an agricultural extension program with technical assistance available to all farms and agribusinesses in the Midlands.

- Key Implementing Organizations: Clemson University (extension services); Agribusinesses
- Geographic Area Impacted: Agricultural areas across the Midlands
- Applicable Funding Sources: None identified at this time.
- Implementation Authority: None needed.

Low-carbon Scenario Impacts

Table 6.39.
Low-carbon scenario impacts of adopting practices from the Climate Smart Commodities initiative.

Low-carbon Scenario Metrics		
Greenhouse Gas Reduction Impact		
Cumulative greenhouse gas reduction from 2025-2035 (MT CO_2e)		199,733 MT CO_2e
Cumulative greenhouse gas reduction from 2025-2050 (MT CO_2e)		996,389 MT CO_2e
Cumulative Criteria Air Pollution Reduction	2025-2030	2025-2050
Total CO reduction (lbs)		Not calculated.[318]
Total HC reduction (lbs)		
Total NOx reduction (lbs)		
Total PM10 reductions (lbs)		
Total PM2.5 reduction (lbs)		
Total SO2 reduction (lbs)		
Total VOC reduction (lbs)		

318 Calculations of reductions in criteria air pollutants were not completed for this action.

Low-carbon Scenario Metrics	
Financial Impact	
Incremental Costs (USD)	$0[319]
Incremental Savings (USD)	$228,355,000
Incremental Net Costs/ Savings (USD)	Savings of $228,355,000
Marginal Abatement Cost (USD/ MT CO_2e)	Savings of $287 / MT CO_2e

Agrivoltaics

Agrivoltaics refer to a process in which solar PV systems are installed on agricultural land in such a way that the land can continue to be used for agricultural production (as opposed to just a solar project adjacent to farmland). The solar panels are installed with gaps between them that have been optimized to ensure that sufficient sunlight and rain will still reach the underlying crops. Installations can also be elevated to allow livestock grazing or small tractors to pass underneath, or to create space for shade tolerant crops to grow underneath the solar panels. Agrivoltaics are especially beneficial for livestock, for instance a sheep can graze while being partially shaded from heat. Their grazing also keeps the grasses low in height and from shading the solar panels.

Modeled Action and Timeline

1. 2025-2050: Agrivoltaic systems will be installed across the region, starting with relatively small installations in the early years. Adoption will gradually increase in size and number until by 2050 agrivoltaic systems are installed on 10% of all agricultural land in the region.

319 No incremental costs were calculated for this action; however it is noted that costs may be present, as discussed in the following reference: https://www.usda.gov/sites/default/files/documents/Marginal-Abatement-Cost-Curve-Estimate-Methodology-Report.pdf

Pathways to Implementation

Agrivoltaics can be a key to preserving working lands by offering an avenue to generate additional revenue and offset business costs. General reports can provide guidance and analysis to inform farmers.[320] However it can often be helpful to connect directly with farmers who tried agrivoltaics. CMCOG is not aware of an active agrivoltaics site in the Midlands, although several farms have utilized solar effectively.[321] The inSPIRE Agrivoltaics map lists several sites in surrounding states.[322]

- Key Implementing Organizations: Clemson University [extension], agribusinesses
- Geographic Area Impacted: Agricultural areas across the Midland region
- Applicable Funding Sources: The U.S. Department of Agriculture regularly runs grant programs for farms, some of which allow energy as an eligible improvement category or that focus on energy use on farms. For example, the Rural Energy for America Program offers concessionary loan funds, and occasionally grants, that can fund solar projects on farms.
- Implementation Authority: None needed. Solar systems on farms are treated by regional utilities like a small-scale project on other commercial sites. Legislative policy changes that may require state legislation, particularly enabling traditional community solar arrangements, would empower farms specifically if they are able to sell excess solar power to other consumers instead of the utility.

320 Lamb, B. & Pederson, B. (2021). Agrivoltaics: Producing Solar Energy While Protecting Farmland. *American Farmland Trust.* https://farmlandinfo.org/publications/agrivoltaics-producing-solar-energy-while-protecting-farmland/

321 For an example, see Branham, J. et al. (2024). CHASING ZERO A CASE STUDY OF CITY ROOTS FARM COLUMBIA, SC. From Seed to Sustainability: Achieving Net-Zero Energy Usage for an Organic Leafy Greens Farm. Branham Group. https://branham-group.com/wp-content/uploads/2024/06/Case-Study_City-Roots-2_compressed.pdf

322 OpenEI (2025). Agrivoltaics map. https://openei.org/wiki/InSPIRE/Agrivoltaics_Map

Low-carbon Scenario Impacts

Table 6.40.
Low-carbon Scenario Impacts of installing agrivoltaics

Low-carbon Scenario Metrics		
Greenhouse Gas Reduction Impact		
Cumulative greenhouse gas reduction from 2025-2035 (MT CO_2e)		2,271,479 MT CO_2e
Cumulative greenhouse gas reduction from 2025-2050 (MT CO_2e)		7,692,574 MT CO_2e
Cumulative Criteria Air Pollution Reduction	2025-2030	2025-2030
Total CO reduction (lbs)	0	3,606,060
Total HC reduction (lbs)	0	0
Total NOx reduction (lbs)	0	5,744,836
Total PM10 reductions (lbs)	0	1,044,003
Total PM2.5 reduction (lbs)	0	874,882
Total SO2 reduction (lbs)	0	3,326,335
Total VOC reduction (lbs)	0	266,288
Financial Impact		
Incremental Costs (USD)		$11,031,750,000
Incremental Savings (USD)		$18,015,987,000
Incremental Net Costs/ Savings (USD)		Savings of $6,984,237,000
Marginal Abatement Cost (USD/ MT CO_2e)		Savings of $908 / MT CO_2e

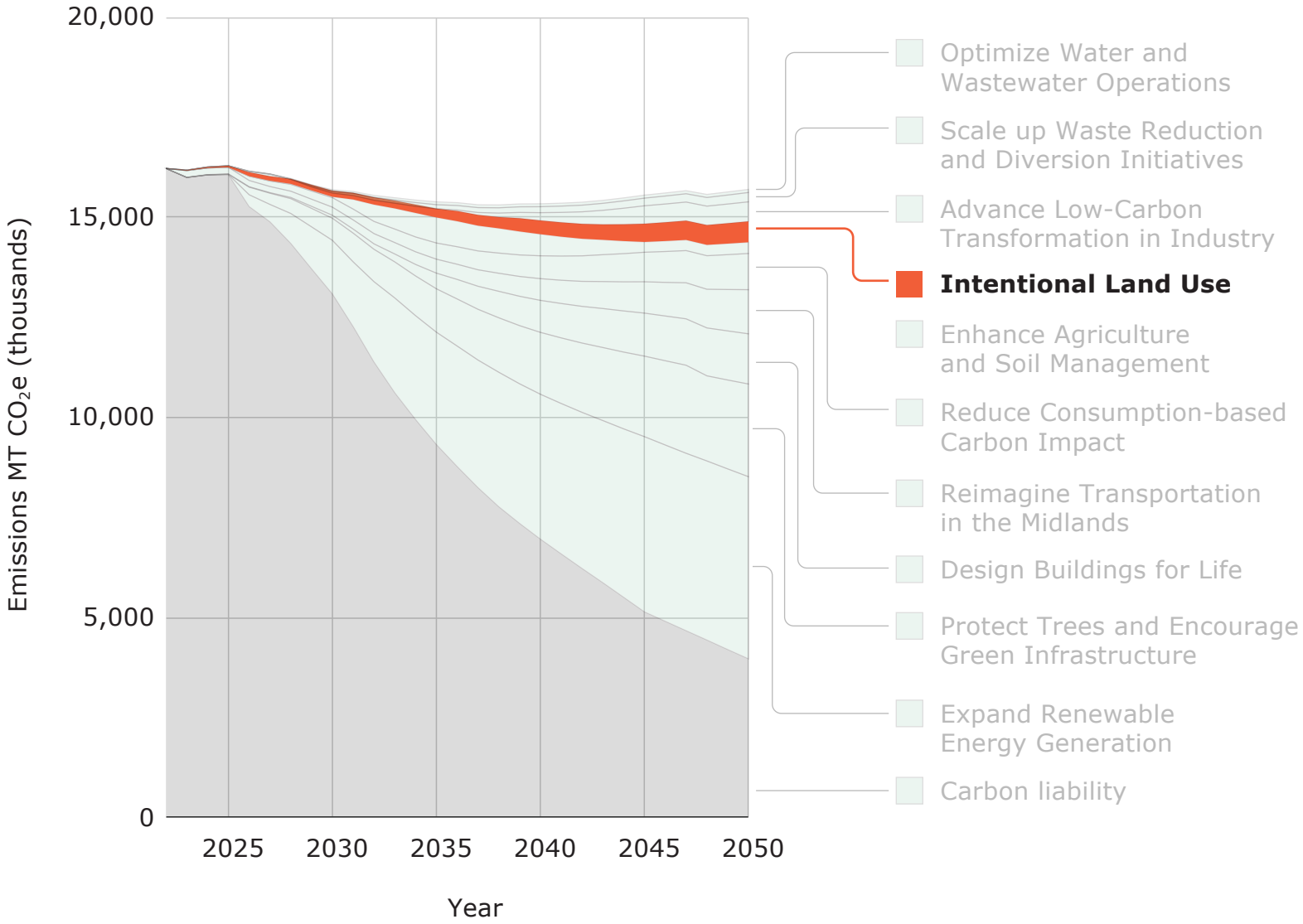
6.3.9 Intentional Land Use

There are two ways in which the Intentional Land Use Strategy helps to reduce emissions:

- More compact and mixed-use development, where homes, schools, shops, and jobs are built closer together, reduces how far and how often people need to drive. Compact areas also support more efficient transit service and reduce the need for new roads and utility lines, which means fewer emissions from construction and infrastructure. In many places, mixed use development means 2 - 4 story buildings that create an intentional neighborhood zone with a medium population density and high access to small businesses and amenities.
- Town homes have smaller space while attached homes (like rowhouses) and multi-family homes (like apartments) have shared walls. Compared to single-family, detached homes, these types of dwellings require less energy for space heating and cooling. They are also typically more affordable types of housing.

Figure 6.27 highlights the emissions reductions achieved by the actions in the Intentional Land Use strategy of the LC Scenario between 2022 and 2050.

Figure 6.27.
Wedge Diagram of Emissions Reductions from Intentional Land Use in the LC Scenario, 2022-2050.



Smart Growth

Modeled Action and Timeline

The first part of this action focuses on increasing community density to 'medium-density development':

- 2025-2050: Over the period, new developments will shift to medium-intensity development, with increased infill, denser residential building archetypes, and more mixed-use buildings. This will include new apartments in downtown Columbia, and slightly increased density on the riverfront in West Columbia. In smaller communities, this shift will include reducing the size of residential lots, and opting for more row houses and fewer single-family dwellings.

The second part of this action limits growth outside of existing community boundaries, either by freezing the boundary or adding a small buffer to reduce sprawl.

- 2025-2050: During this time period, new developments that would have taken place outside of existing municipal boundaries under other scenarios, are moved to make the communities more compact in the low-carbon scenario.

Pathways to Implementation

CMCOG's planning department has previously used building permit applications to track growing sprawl in the Midlands region (see Figure 6.28). The Midlands area is already extremely sprawled, which leads to high transportation air pollution and traffic. Until recently, lack of mixed use development has led to residential areas that have no easy access to nearby essential commerce (grocery stores, pharmacies, etc.) or small businesses and amenities (parks, cultural sites, etc.). For many residents in the Midlands, businesses and amenities are more than a 10 minute drive away, and are not safely accessible by walking or biking. It also has a large impact on working lands, including farmland, which has spurred recent spatial analysis efforts seeking to identify solutions to loss of working lands.[323]

323 See the recent Palmetto 2040 project by the American Farmland Trust, which is tracking farmland at risk starting in Lexington County. American Farmland Trust (2023). New Partnership Will Identify Threats to South Carolina's Farmland. *https://farmland.org/blog/new-partnership-will-identify-threats-to-south-carolinas-farmland*

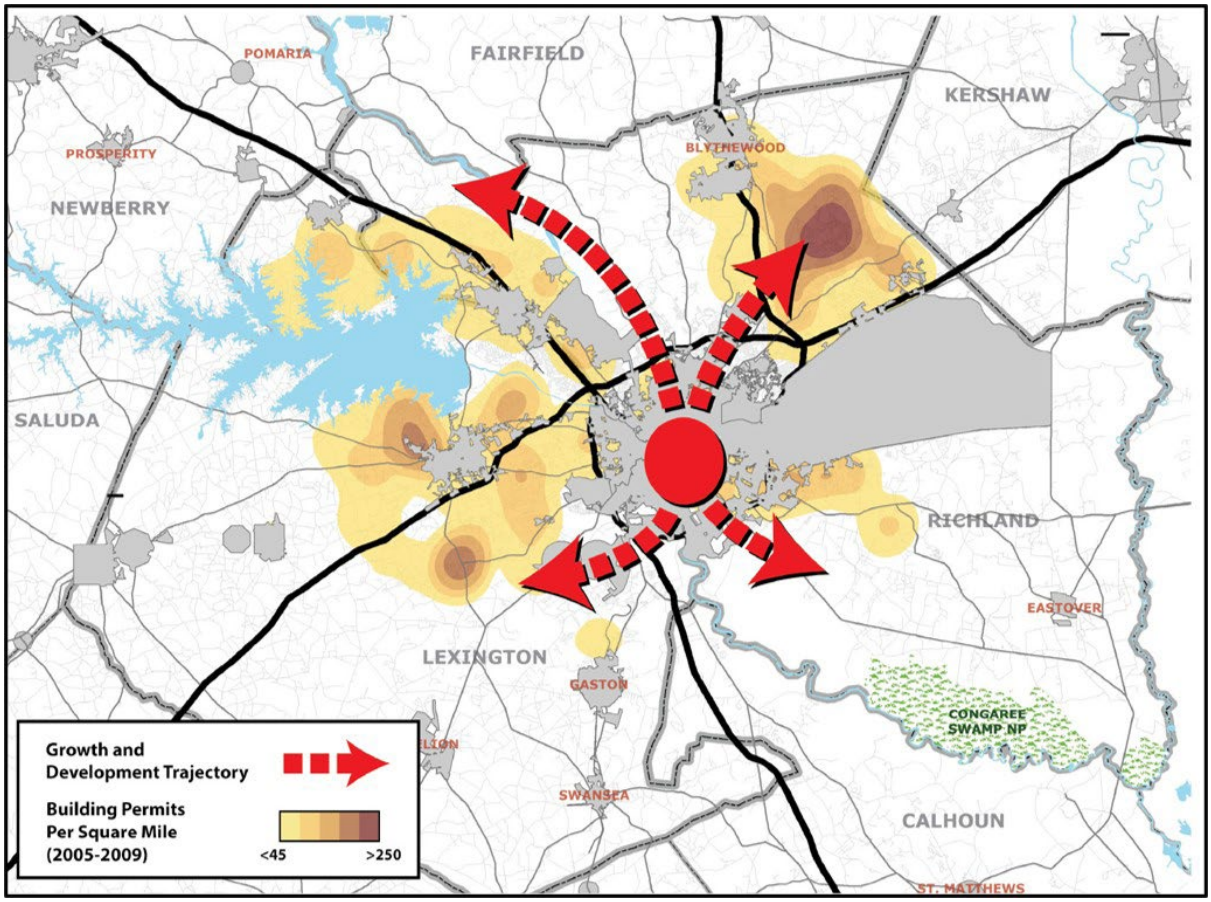
Local community groups, including the Climate Protection Action Committee, are exploring smart growth as a mechanism to merge sustainability and economic development in the Midlands. Smart growth is a set of policy recommendations that encourage higher economic output by using land more intentionally.[324] The 10 basic principles of smart growth are to:

1. Mix land uses.
2. Take advantage of compact building design.
3. Create a range of housing opportunities and choices.
4. Create walkable neighborhoods.
5. Foster distinctive, attractive communities with a strong sense of place.
6. Preserve open space, farmland, natural beauty and critical environmental areas.
7. Strengthen and direct development towards existing communities.
8. Provide a variety of transportation choices.
9. Make development decisions predictable, fair and cost effective.
10. Encourage community and stakeholder collaboration in development decisions.

The use of zoning by local governments is the most currently applicable pathway to implementation, alongside related land-use policy changes in both urban and rural areas. For example, vacant land in urban areas is not effectively penalized via tax policy, while in some cases large economic incentives exist for expansive style suburban developments that pass on hidden future costs to local governments (e.g. infrastructure maintenance).

324 EPA (2025). Smart Growth. https://www.epa.gov/smartgrowth

Figure 6.28.
Spatial development patterns inferred from building permit applications to local governments.[325]



- Key Implementing Organizations: Local governments
- Geographic Area Impacted: Region-wide.
- Applicable Funding Sources: None needed.
- Implementation Authority: None needed.

325 CMCOG's research, planning and development department has tracked building permits as a mechanism to perform spatial analyses of projected expansions to the municipality boundaries and areas of anticipated population density. CMCOG (2024). Building Permits by County. [GIS Data File].

Low-carbon Scenario Impacts

Table 6.41.
Low-carbon Scenario Impacts of Smart Growth

Low-carbon Scenario Metrics		
Greenhouse Gas Reduction Impact		
Cumulative greenhouse gas reduction from 2025-2035 (MT CO_2e)		1,214,983 MT CO_2e
Cumulative greenhouse gas reduction from 2025-2050 (MT CO_2e)		5,487,889 MT CO_2e
Cumulative Criteria Air Pollution Reduction	2025-2030	2025-2050
Total CO reduction (lbs)	-1,015,235	-7,858,642
Total HC reduction (lbs)	-69,326	-535,604
Total NOx reduction (lbs)	-52,419	-427,007
Total PM10 reductions (lbs)	-25,874	-155,343
Total PM2.5 reduction (lbs)	-1,373	-19,278
Total SO2 reduction (lbs)	805	-6,979
Total VOC reduction (lbs)	-64,517	-499,390
Financial Impact		
Incremental Costs (USD)		$265,476,000
Incremental Savings (USD)		$1,710,787,000
Incremental Net Costs/ Savings (USD)		Savings of $1,445,310,000
Marginal Abatement Cost (USD/ MT CO_2e)		Savings of $625 / MT CO_2e

Install Reflective Surfaces

Smart surfaces refers to changes to land use or surface materials to reduce greenhouse gas emissions (see Figure 6.29), and smart surface policies can encompass other climate actions in this plan. This action specifically refers to reflective or "cool" roof and road surfaces that are specifically designed to both reduce greenhouse gas emissions and to protect communities from the impacts of a changing climate. In this action, we used the Smart Surfaces Benefit-Cost Analysis Tool[326] to quantify the potential benefits of adding 'cool roofs' and 'cool pavement' to a portion of the rooftops and roadways in Columbia.

Note that this action does not reduce the actual quantity of CO_2e in the atmosphere. Its impact can be quantified in terms of CO_2e using a metric called the Global Warming Potential of Albedo. (See Table 6.39 for these calculations.) However, currently the GPC protocol only accommodates quantifications of emissions, not other types of changes that may reduce radiative forcing. As a result, this action is not included in the wedge diagrams in this plan. Reflective surfaces provide co-benefits beyond slowing global warming, including reducing the urban heat island effect and reducing lifecycle costs for road and roof infrastructure.

Modeled Action and Timeline

The first part of this action involves gradually converting 50% of the rooftops in the urbanized core of the Midlands to 'cool roofs' - that is, roofs with surfaces and colors that reflect more of the sunlight and absorb less heat than traditional dark roofs. This keeps these buildings' internal temperatures cooler, reducing the energy required to operate air conditioning, and also reducing concentrated, outdoor, urban heat.

- Between 2025 and 2030, cool roofs are installed on 39,300 (17% of) existing homes and non-residential buildings.
- Between 2031 and 2040, cool roofs are installed on a further 76,200 (33% of) existing homes and non-residential buildings.

326 Smart Surfaces Benefit - Cost Analysis Tool. *https://bca.smartsurfacescoalition.org/*

The second part of this action consisted of gradually converting 15% of road surfaces in the urbanized core of the Midlands to 'cool pavements'. Similar to cool roofs, these are road surfaces that reflect more sunlight than conventional surfaces, lowering the surface temperature of the road and reducing outdoor air temperatures. Application is gradual as roads are replaced or paved, and do not necessarily require full road reconstruction.

- Between 2025 and 2030, cool pavement is installed on 5% of road surfaces. This amounts to converting the surfaces of 600 lane miles of roadway over 5 years.
- Between 2031 and 2040, cool pavement is installed on a further 10% of road surfaces or 1,300 miles of roadway.

Pathways to Implementation

The City of Columbia has been participating in the Cities for Smart Surfaces Initiative, receiving technical assistance and networking with other cities. CMCOG has worked with the Smart Surfaces Coalition, and can direct local municipalities or community-based organizations to additional resources on smart surfaces.[327] The SC Public Health Association also has expertise in this area.[328] While in this climate action plan, smart-surface actions are limited to cool roofs and pavements, the policy term can refer to other types of land use changes that are included here but under different actions (see Figure 6.29).

327 For instance, the coalition has recently published a zoning guide for cities. Smart Surfaces Coalition (2026). Smart Surfaces Policy Memo: Zoning and Building Codes. https://smartsurfacescoalition.org/analysis

328 SC Public Health Association (2025). Smart Surfaces. https://www.scpha.com/smart-surfaces

Figure 6.29.
Examples of different types of modifications to the surface of the land under the smart surfaces umbrella.[329]

In many cases, there are already existing options in the marketplace for cool roofs (and increasingly for cool pavements). Low-slope roofs can use white elastomeric coatings and white single-ply membranes. Residential buildings can use light-colored asphalt shingles, light-colored tiles, and light-colored metal roofs to increase solar reflectance.

As part of CMCOG's ongoing CPRG Implementation Grant, the city intends to trial cool pavements in certain areas of downtown with a high urban heat island effect. Many commercial buildings in the Midlands already deploy cool roofs to lower energy costs, but their use in residential housing is low and can be accelerated by city policies that require or incentivize their use. Green roofs are not common locally, and pilot projects in this area would be helpful to kickstart a process of local learning.

The Smart Surfaces Coalition is a resource hub that enables communities to see implemented projects and policies from other areas, such as zoning changes or best practices for projects.[330]

329 Photo courtesy and copyright of the Smart Surfaces Coalition.

330 For example, the Smart Surfaces Coalition maintains a policy tracker (https://smartsurfacespolicy.org/policies/) and a best practices hub (https://smartsurfacespolicy.org/best-practices/).

- Key Implementing Organizations: Local governments, community-based organizations.
- Geographic Area Impacted: Urban areas of the Midlands.
- Applicable Funding Sources: None identified at this time.
- Implementation Authority: Local municipalities have existing authority to implement various policies through zoning.

Low-carbon Scenario Impacts

Table 6.42.
Low-carbon scenario impacts of Reflective Surfaces

Low-carbon Scenario Metrics		
Greenhouse Gas Reduction Impact		
Cumulative greenhouse gas reduction from 2025-2035 (MT CO_2e)		461,000 MT CO_2e
Cumulative greenhouse gas reduction from 2025-2050 (MT CO_2e)		2,130,000 MT CO_2e
Cumulative Criteria Air Pollution Reduction	2025-2030	2025-2050
Total CO reduction (lbs)		Not calculated.[331]
Total HC reduction (lbs)		
Total NOx reduction (lbs)		
Total PM10 reductions (lbs)		
Total PM2.5 reduction (lbs)		
Total SO2 reduction (lbs)		
Total VOC reduction (lbs)		

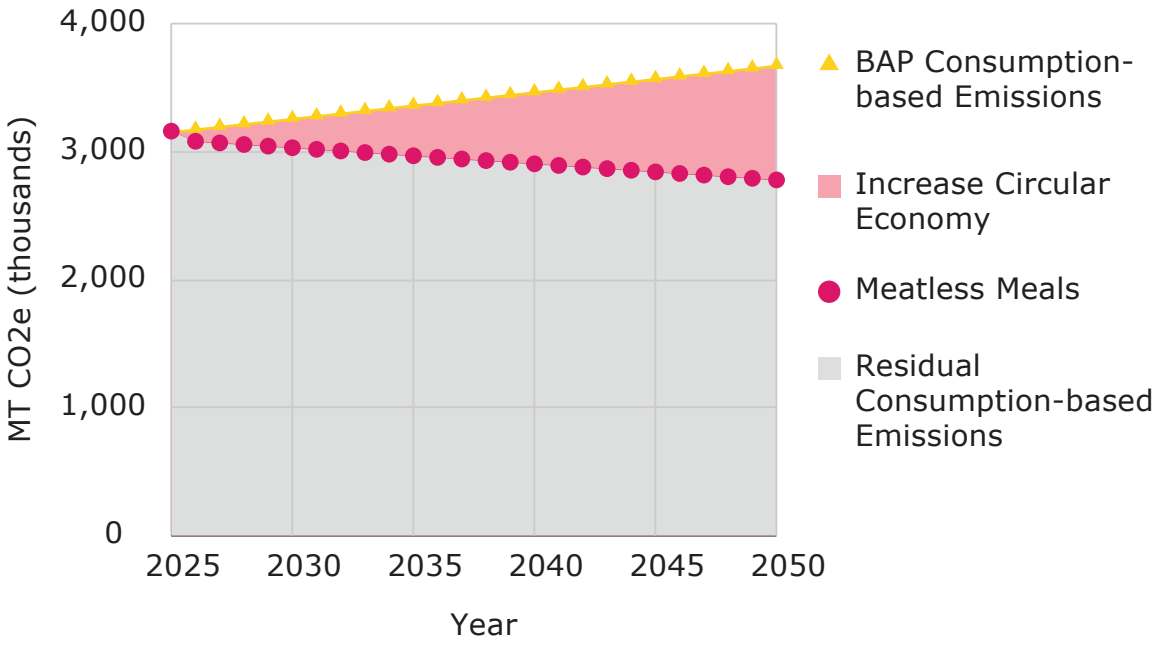
331 These benefits could not be calculated with the Smart Surfaces Benefit Cost Analysis Tool.

Low-carbon Scenario Metrics	
Financial Impact	
Incremental Costs (USD)	$179,700,000
Incremental Savings (USD)	$436,790,000
Incremental Net Costs/ Savings (USD)	Savings of $257,090,000
Marginal Abatement Cost (USD/ MT CO_2e)	Savings of $121 / MT CO_2e

6.3.10 Reduce Consumption-based Carbon Impact

Consumption-based emissions are scope 3 emissions that do not fall within the GPC BASIC+ inventory protocol. These emissions refer to greenhouse gas emissions generated as a result of demand for goods and services within the Midlands. These emissions are generated from supply chains, outside the boundary of our area, and are also typically someone else's emissions depending on the protocol used. While multiple areas play a role in these emissions, actions taken to reduce them still matter equally for reducing global warming as any other climate actions. Figure 6.30 is a wedge diagram of the Midlands consumption-based emissions with the impact of the two actions in this strategy shown as yellow and pink wedges.

Figure 6.30.
Wedge Diagram of Reduce Consumption-based Emissions actions, 2025-2050.



Increase Circular Economy

Increasing the circular economy of the Midlands refers to redirecting product components at the end of a product's life back into the production stream as raw materials, rather than disposing them as waste. In this way, rather than having to continually extract more natural resources, we use the same materials repeatedly. A circular economy also focuses on reducing the amount of resources that enter the economic system and need to be extracted in the first place.

The benefits of this action include reduced transportation of raw materials, less waste in landfills, and less harvesting of increasingly scarce resources. All of these benefits themselves result in fewer emissions.

Modeled Action and Timeline

This action was designed to reduce the region's scope 3 emissions. It specifically aims to reduce the need to ship products into the Midlands from raw materials that are grown, harvested, or manufactured outside the region. The action's modeled timeline is as follows

- 2026: Re-use enough materials to reduce the Midlands' scope 3 emissions (from the production and transportation of goods imported to the region) by 100,000 MT CO_2e.
- 2027 - 2049: Each year, gradually increase the total materials that are re-used such that the total scope 3 emissions avoided continues to increase.
- By 2050: Re-use enough materials to reduce the Midlands' scope 3 emissions by 900,000 MT CO_2e.

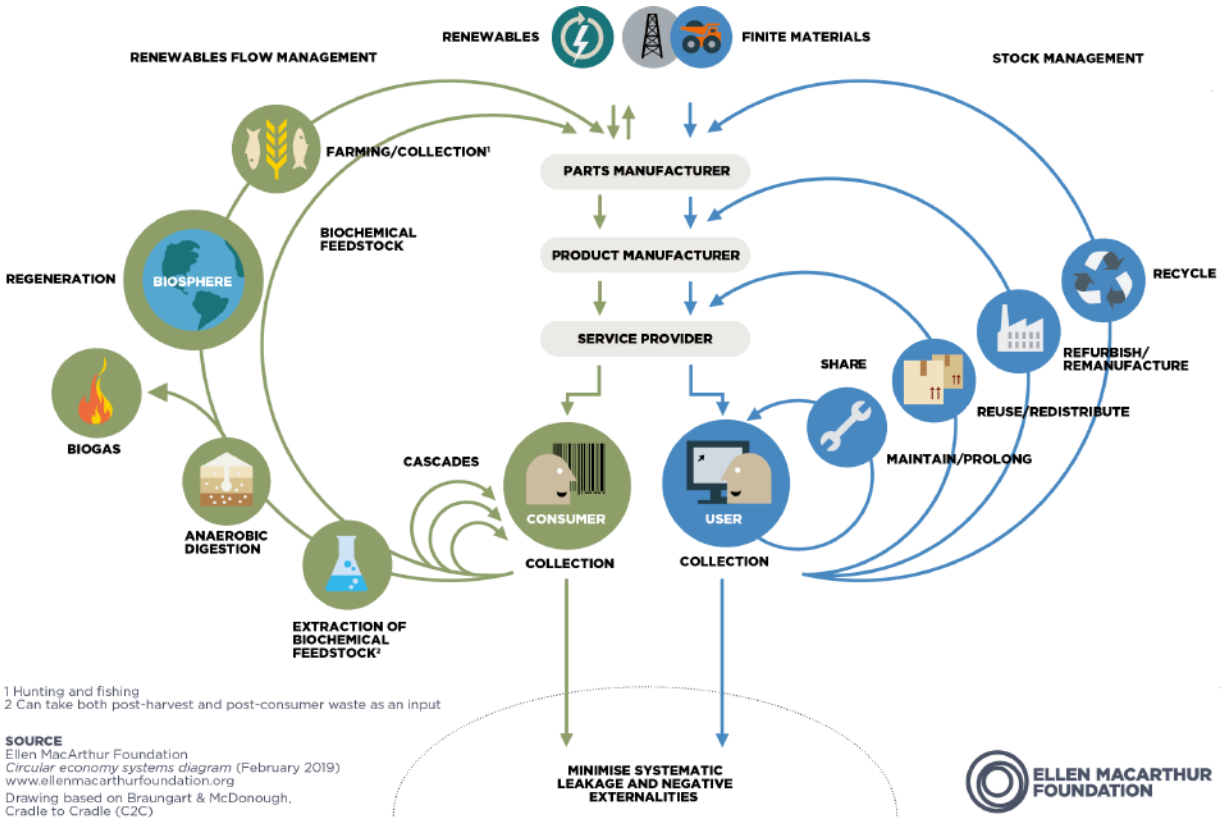
Pathways to Implementation

This action can be implemented by any actor in the Midlands, in various ways. The best way to start is to learn more about the circular economy concept, which includes recycling but also goes further to consider how resources are used in the economy and why (see Figure 6.31).[332] Depending on the scenario, the most applicable actions revolve around either reducing/consolidating material inputs or purchases, or in productively recycling and reusing materials after their initial use case is complete.

332 Ellen Macarthur Foundation (2025). The Circular Economy - Definition & Model Explained. https://www.ellenmacarthurfoundation.org/topics/circular-economy-introduction/overview

Figure 6.31.

A conceptual diagram of the circular economy policy framework.[333]



- Key Implementing Organizations: All actors.
- Geographic Area Impacted: Region-wide.
- Applicable Funding Sources: None identified at this time.
- Implementation Authority: None needed [for many circular economy actions or decisions].

333 Figure copied from and copyright of Ellen Macarthur Foundation (2026). Circular Economy Butterfly Diagram. https://www.ellenmacarthurfoundation.org/circular-economy-diagram

Low-carbon Scenario Impacts

Table 6.43.
Low-carbon scenario impacts of increasing the circular economy.

Low-carbon Scenario Metrics		
Greenhouse Gas Reduction Impact		
Cumulative greenhouse gas reduction from 2025-2035 (MT CO_2e)		2,50,000 MT CO_2e
Cumulative greenhouse gas reduction from 2025-2050 (MT CO_2e)		12,500,000 MT CO_2e
Cumulative Criteria Air Pollution Reduction	2025-2030	2025-2050
Total CO reduction (lbs)		Not calculated[334]
Total HC reduction (lbs)		
Total NOx reduction (lbs)		
Total PM10 reductions (lbs)		
Total PM2.5 reduction (lbs)		
Total SO2 reduction (lbs)		
Total VOC reduction (lbs)		
Financial Impact		
Incremental Costs (USD)		Not calculated[335]
Incremental Savings (USD)		
Incremental Net Costs/ Savings (USD)		
Marginal Abatement Cost (USD/ MT CO_2e)		

334 Criteria air pollutant reductions were not calculated for this measure because the ways in which this will be achieved will vary significantly, and these variations will affect the amount of criteria air pollutants produced.

335 Financial costs and savings were not calculated for this measure.

Plant-based Meals at Cafeterias

The raising of animals, and producing and transporting meat for food can be a carbon-intensive practice. Overall, agriculture and raising livestock is responsible for approximately one third of global greenhouse gas emissions.[336] For those with access to sufficient food,[337] eating less meat can reduce these emissions while also carrying potential improvements to health.[338] Reducing meat consumption would also allow more land to be used in different ways. For example, an acre of land used to grow crops can feed more people than an acre of land used to raise livestock. Further land could be used for development, recreation, or for conservation.

A recent analysis found that the average person in the Midlands emits 1,153 kilograms of CO_2e per year from eating 80 kilograms (177 pounds) of meat.[339] Greenhouse gas emissions tied to meat consumption in our area are higher than the national average. This action illustrates how shifting only 20% of meals served in the region's high-volume cafeterias to plant-based meals would reduce these emissions. This action does not entail eliminating meat consumption. In most cases, simply eating the dietarily recommended amount of meat reduces greenhouse gas emissions by a substantial degree.

Modeled Action and Timeline

This action involves replacing 20% of meat-based meals served every year in high-volume cafeterias in the region with plant-based meals. If cafeterias at area schools, universities and hospitals were included, this would amount to changing an estimated 5.2 million meals from meat to plant-based options every year, region-wide.

Note that because much of the meat eaten in the Midlands is raised elsewhere and transported into the region for consumption, this action reduces the community's scope 3 emissions.

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336 Xu, X., Sharma, P., Shu, S. et al. Global greenhouse gas emissions from animal-based foods are twice those of plant-based foods. Nat Food 2, 724–732 (2021). https://doi.org/10.1038/s43016-021-00358-x

337 This action is not intended to suggest that those living with hunger should reduce their meat consumption.

338 P. West. Project Drawdown. 'Four climate solutions with surprising benefits for biodiversity and human well-being.' 2025. https://drawdown.org/insights/four-climate-solutions-with-surprising-benefits-for-biodiversity-and-human-well-being

339 Goldstein, B.P., Pelton, R.E.O., Gounaridis, D. et al. The carbon hoofprint of cities is shaped by geography and production in the livestock supply chain. Nat. Clim. Chang. 15, 1190–1197 (2025). https://doi.org/10.1038/s41558-025-02450-7

Pathways to Implementation

One example of how to do so is to adopt "Meatless Mondays". This action is straightforward to implement for most high volume cafeterias, which already change menus regularly.

- Key Implementing Organizations: Hospitals, schools, universities, and workplaces with cafeterias.
- Geographic Area Impacted: Specific sites across the Midlands.
- Applicable Funding Sources: None needed [plant-based meals are often cheaper].
- Implementation Authority: None needed.

Low-carbon Scenario Impacts

Table 6.44.
Low-carbon scenario impacts of reducing the amount of meat consumed in high-volume cafeterias.

Low-carbon Scenario Metrics		
Greenhouse Gas Reduction Impact		
Cumulative greenhouse gas reduction from 2025-2035 (MT CO_2e)		42,340 MT CO_2e
Cumulative greenhouse gas reduction from 2025-2050 (MT CO_2e)		105,850 MT CO_2e
Cumulative Criteria Air Pollution Reduction	2025-2030	2025-2050
Total CO reduction (lbs)		Not calculated[340]
Total HC reduction (lbs)		
Total NOx reduction (lbs)		
Total PM10 reductions (lbs)		
Total PM2.5 reduction (lbs)		

340 Criteria air pollutant reductions were not calculated for this measure because the ways in which this will be achieved will vary significantly, and these variations may or may not affect the amount of criteria air pollutants produced.

Low-carbon Scenario Metrics	
Total SO2 reduction (lbs)	
Total VOC reduction (lbs)	
Financial Impact	
Incremental Costs (USD)	Not calculated[341]
Incremental Savings (USD)	
Incremental Net Costs/ Savings (USD)	
Marginal Abatement Cost (USD/ MT CO_2e)	

341 Financial costs and savings were not calculated for this measure.

6.4 Additional Policy Considerations

The following are additional factors that should be taken into consideration for climate action in the Midlands.

Regional Planning Considerations

This climate action plan for the Midlands region responds to a certain set of EPA requirements. In particular, this plan has a strong focus on tracking greenhouse gas emissions and suggesting means to eliminate air pollution over time. This may not reflect the lived everyday experience of the Midlands when it comes to climate change. The environmental, health and economic harms that climate change already poses to the Midlands might be considered more pressing. For example, if local governments in the Midlands have limited resources, it is challenging to decide whether to prioritize limiting these harms now (adaptation/resilience) or limiting future harms (greenhouse gas emissions reductions).[342]

Like many regional plans, the analyses here are technical and rely on quantification to inform decision-making. Quantified outputs of models should not be the sole consideration for actors in the Midlands deciding which climate actions to pursue, although they can be informative and useful for strategic thinking.

A focus on multiple economic sectors and thus many climate action solutions can obscure the fact that ultimately, any reduction in greenhouse gas emissions is beneficial. It can also obscure the fact that the extraction and burning of fossil fuels is responsible for the majority of global warming. Some research suggests that blunt policy instruments with a focus on regulating or taxing fossil fuels is an effective approach (although this is largely not implementable by local actors in the Midlands).[343]

Model Considerations

The climate actions in this plan were mainly modeled in ScenaCommunity, a systems dynamics model that adopts an integrated and spatialized approach to estimating greenhouse gas emissions reductions from changes to energy

342 Although some climate actions that reduce greenhouse gas emissions also have resilience co-benefits.

343 Annika Stechemesser et al. Climate policies that achieved major emission reductions: Global evidence from two decades. Science385,884-892(2024). DOI:*10.1126/science.adl6547*

consumption, infrastructure, behaviors, and building, HVAC, vehicle and other types of inventory over time. The assumptions used for the modeling in this plan may be different from those made in other studies, leading to different results.

- Due to the benefits of an integrated approach for complex planning, ScenaCommunity was used when possible to model all actions even if alternatives were available for specific climate actions. More information about modeling for each action, including whether ScenaCommunity or an alternative method was used for quantification, is available in the separate Data, Methods & Assumptions Manual.
- While ScenaCommunity or other methods used in this plan to quantify air pollution reductions usually report results to the single units (e.g. tons of gases), all models include error and assumptions. The quantifications here are generally beyond EPA's minimal requirements and are well suited for regional planning, but more complete or detailed technical analyses may be needed depending on how the data will be used. For more information on model or data source precision, accuracy & bias, see the separate Data, Methods & Assumptions Manual.
- This plan model's timeframe ends at 2050, which was set by the EPA for this plan but is also somewhat arbitrary. In many cases, climate actions in this plan have benefits beyond 2050, and these are not modeled or reported.

For more information about the modeling, data sources, and technical assumptions in this plan's analyses, please refer to the separate Data, Methods & Assumptions Manual.

Methane Capture at Landfills & Closed Landfills

The main municipal solid waste (MSW) Richland County Landfill already captures some methane emissions and converts it into usable natural gas.[344] This is why a related climate action is not listed in this plan. Any new MSW landfills in the region should similarly incorporate methane capture and beneficial re-use.

Closed landfills can also emit methane over time, even after they are capped or sealed. For this climate action plan, no actions were proposed here but this problem should be considered in future planning efforts. This plan's greenhouse gas inventory does not consider methane emissions from closed landfill sites.[345] Tracking data from satellites is making it increasingly feasible to evaluate this source of methane for future planning efforts.

Embodied Carbon

Embodied carbon refers to the greenhouse gas emissions released during the lifecycle of certain products used in construction and building materials like cement and steel.[346] These products can be produced more or less sustainably. While not modeled as a climate action here, local governments can use their purchasing power to preferentially use building materials (e.g. in local government buildings) that were produced more sustainably.

Large Energy Industrial Sites

Industrial sites, manufacturing facilities, and data centers can also be drivers of economic development in the Midlands. However, such facilities can also be large consumers of energy. Directly burning coal, oil, natural gas, diesel, or other fossil fuels emits greenhouse gases and other air pollutants harmful to public health. Facilities that use large amounts of electricity can stress the utility grid and impose costs on other utility customers (see Chapter 3). Policies in this area can be complex. For example, the CMC Steel Plant in Cayce uses an electric arc furnace. While this furnace design uses a lot of electricity, it also has significant public health benefits compared to older blast furnace designs, which require using large amounts of coal and which may emit toxic pollutants into surrounding communities.

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344 See EPA (2025). LMOP National Map. https://www.epa.gov/lmop/lmop-national-map and other EPA landfill program data.

345 According to the GPC Protocol, these emissions are a grey area. The waste sector focuses on tracking in-boundary waste management and disposal for the current inventory year.

346 Rocky Mountain Institute (2023). Embodied Carbon 101. https://rmi.org/embodied-carbon-101/

More recently, large data centers are emerging as a particular concern due to their incredibly high usage of water and electricity (compared to other industrial sites of similar size) combined with their low contributions to local jobs.[347] Environmental resource use can be unexpected - e.g. a data center comparable to moderately sized manufacturing plant may occupy as much as 1 gigawatt or more of continuous electricity generation, which is as much as an entire nuclear reactor. CMCOG's GIS department has begun tracking data centers in the Midlands.[348] Recent analyses have found that the Southeastern U.S. (including SC) is attractive to data centers because of subsidized electricity costs for industry, lax regulatory requirements, limits on utilities' abilities to impose sector-specific requirements, and a high percentage of clean energy (nuclear or renewables) on local utility grids.[349]

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347 A typical large data center may only require on the order of low hundreds or even just dozens of FTE staff for 24 hour operation A similarly sized manufacturing plant may employ high hundreds to thousands of FTE jobs. After initial construction ends, they are generally not considered by most experts to be job creators. On-site jobs mainly include server maintenance and site security. The economic value derived from a data center can be anywhere in the world, and the highest-paid AI engineers at tech firms are generally based outside the Midlands.

348 For instance, see the following two GIS aggregators for data center locations. https://www.datacentermap.com/ and *https://cleanview.co/public/data-centers/us*

349 For more information on data center impacts, CMCOG recommends consulting the following reports. 1) Mateo, Patrick, Connor, Aiden, & Hanah (2025). Energy & Resource Efficient AI. University of South Carolina - Moore School of Business. 2) American Edge Project (2025). America's AI Surge: Powering Investment, Jobs, and Growth in Every State. /edge. *https://americanedgeproject.org/wp-content/uploads/2025/12/Americas-AI-Surge-Powering-Growth-in-Every-State.pdf* 3) Lovins, A. & Locke, J. (2026). AI: Does not compute. Canary Media. https://www.canarymedia.com/articles/data-centers/ai-does-not-compute 4) Rosner-Uddin et. al. (2025). The power crunch threatening America's AI ambitions. Financial Times. https://ig.ft.com/ai-power/

State and local governments should attempt to regulate large energy industrial customers, especially large data centers or other sites that have limited job creation. Multiple emerging policies are available, both at the state level and at the local level. These include requiring data centers to build solar & battery systems on-site, to shift power demand to limit or prevent electricity use during times of the grid's peak demand, and even directly investing in lowering electricity use in the community by funding energy efficiency upgrades in local homes & businesses.[350]

Governments in South Carolina should explore these policies in order to benefit economically from industry while also avoiding large increases to regional greenhouse gas emissions or increasing electricity prices for residents and other electricity customers (small businesses, farmers, institutions like schools, etc.). Local governments should attempt to coordinate with CMCOG or the Municipal Association of South Carolina in order to eliminate spatial zoning arbitrage.[351] Large energy industrial sites can bring jobs and tax revenues, but lack of regulation can shift utility costs to residences and other businesses. The following policies are recommended:

State Government

- Data Reporting: all sites consuming energy or environmental resources over a certain threshold (e.g., 75 MW of electricity or 1 million gallons of water per day) should report usage to a state agency, and this agency should release the data publicly. The data is

350 For more information on data center policy options, CMCOG recommends contacting its technical experts and consulting the following initial sources for examples. 1) Ross, M. T., and J. Ewing. 2026. Data Centers and Generation Capacity over the Next Decade: Potential Benefits of Flexibility. NI 26-04. Durham, NC: Nicholas Institute for Energy, Environment & Sustainability, Duke University. https://nicholasinstitute.duke.edu/publications/data-centers-and-generation-capacity-over-next-decade 2) Wyent, C., Verma, M., & Kanj, W. (2025). Homegrown energy: How household upgrades can meet 100 percent of data center demand growth. Hyperscalers should pay for heat pumps, rooftop solar, and storage to get the capacity they need on the grid now, while setting us up for an affordable, reliable, and clean energy future. Rewiring America. https://www.rewiringamerica.org/research/homegrown-energy-report-ai-data-center-demand 3) John, J. (2026). How states are trying to keep AI data centers off your power bill. Canary Media. https://www.canarymedia.com/articles/data-centers/how-states-are-trying-keep-ai-off 4) Sierra Club (2026). Data Center State Policies, 2026. https://www.sierraclub.org/sites/default/files/2026-01/policies-for-data-centers-2026.pdf 5) Abbot, S. et al. (2025). Lightening the Load: Scaling Clean Solutions for Data Centers and Communities. Rocky Mountain Institute. *https://rmi.org/insight/lightening-the-load/* & *https://rmi.org/lightening-the-load-graphic/*.

351 Spatial zoning arbitrage is when a firm moves the location of a proposed facility to avoid zoning requirements. For example, see this story about how one firm moved from county land to a small town when the county imposed new requirements on data centers. Beamer, A. (2026). Google's Response to an Iowa County's New Data Center Requirements? Annex the Land. https://insideclimatenews.org/news/04032026/google-attempts-to-annex-iowa-county-land-for-data-center/

most useful if the location is known, and the data is reported at the highest time frequency at which the electricity or water meter can collect it.

- Avoiding Peak Demand: utilities must plan to have adequate power stations to supply the expected peak demand in each season. To prevent the need for expensive new power plants, one or more policies could be pursued. For example,
- The industrial site could be required to pay for a substantial majority of this otherwise unplanned utility grid cost OR to empower utilities with tools like large load rates, ability to force intermittent disconnection or power consumption reductions during peak hours, etc. to limit or fully prevent industrial sites from overtaxing grids during peak demand hours.
- An industrial site could be required to have a certain amount of on-site energy generation and to use this to avoid consuming energy at peak demand times. Solar and battery systems would reduce the most air pollution. Diesel generators or coal combustion both have significant public health harms and should be avoided.
- An industrial site could instead fund utility energy efficiency programs that seek to limit the peak demand from other energy consumers on the grid. Utility programs can be designed to benefit the community members and businesses that would otherwise face higher costs.

Local Government

- Transparency: local governments should not enter non-disclosure agreements or prevent their residents from obtaining information pertaining to proposed large energy industrial sites, because these decisions are likely to impact all residents within their jurisdiction irrespective of proximity to the facility (e.g., electric rate hikes by a utility affect all residential and business customers in the entire service territory of that utility).
- Water Utilities and Fire Management: if the local government controls water and sewer utilities, they should ensure that any new industrial sites anticipated to use a large amount of water are properly analyzed. In particular, an external estimate should be sought for anticipated average and maximum water usage of a proposed facility. If a proposed facility places additional burdens on local fire departments, these costs should be assessed to the facility and not spread to residents and other businesses.

- Zoning and Model Ordinances: local governments can consider encoding various specific best practices like additional setbacks, noise limits, pollution limits, energy generation and storage, etc. through zoning or ordinances.

Hydrogen

Some prior attempts at hydrogen fuel deployments in the Midlands have not been successful. In general, suitable infrastructure for large scale deployment of hydrogen as a transitionary or clean fuel source is not available here. Electrified alternatives are available, and are generally more economic and suitable here. One example is hydrogen fuel cell vehicles vs. electric vehicles. Electricity is available via current utility grids at nearly all locations in the Midlands, hydrogen fuel pipelines are not.

There are also industrial challenges to producing hydrogen fuel without creating further greenhouse gas emissions as part of its manufacturing process. Using non clean hydrogen fuel would create more greenhouse gas emissions (either here or in another location).

F-Gases

Fluorinated gases (or F-gases) are powerful greenhouse gases that are associated with a variety of economic activities, but these are always relatively specific. Examples include types of refrigerants used in HVAC systems or as outputs of industrial processes or manufacturing.[352] F-gases associated with product use (such as refrigerants) are included in our region's greenhouse gas inventory; and there are no industrial sites in the Midlands that produce enough F-gases to necessitate mandated reporting to the EPA.[353] Because we do not directly produce them in our region, local governments in the Midlands have limited ability to affect F-gas emissions here. Regulation is the most effective tool for eliminating these emissions and to handle proper disposal of waste that could otherwise emit F-gases (e.g. refrigerant collection and disposal). State and federal levels of government are usually the source of these policy changes, and so this climate action plan has no specific actions proposed for F-gases in the Midlands.

352 EPA (2025). Fluorinated Greenhouse Gas Emissions and Supplies Reported to the GHGRP. https://www.epa.gov/ghgreporting/fluorinated-greenhouse-gas-emissions-and-supplies-reported-ghgrp

353 EPA's FLIGHT database was reviewed during this planning process. This means, specifically, that no facilities emit enough F-gases to require mandated reporting, not necessarily that none are produced from any industrial site in the Midlands.

Sale of Carbon Credits or Carbon Offsets

Selling or purchasing carbon credits or offsets are practices that are fraught with difficulties. Some organizations purchase offsets because they are often less costly than making the changes required to reduce their own emissions. Another problem is that not all offsets or credits are comprehensively managed to ensure that emissions reductions are never claimed by more than one entity. Carbon credits or offsets allow another actor elsewhere to emit more air pollution, which is harmful and delays the change we really need. As a result of these and other difficulties, the purchase of offsets is inconsistent with this regional climate action plan's intent. This planning standard reflects the integrity and data transparency necessary to implement this regional climate action plan.

Reduction of Emissions from the Electricity Grid

Many actions in this plan rely on increasing the use of electricity. In these cases, unless the electricity is being provided by a renewable electricity system on-site or locally, the emissions reductions that will be achieved will be constrained by the electricity grid. Dominion Energy South Carolina is the load balancing utility for the Midlands, and currently uses a range of power plants (some of which do, and others that do not produce greenhouse gas emissions or other air pollutants). In South Carolina broadly, the extremely high percentage of nuclear power electricity generation means our starting point is ahead of many other states (nuclear power generation emits no greenhouse gases). However our state has several coal plants with no set retirement date, and plans for new gas plants risk socio-technical lock in.[354]

In the low-carbon scenario, it was assumed that grid emissions will continue to decrease until by 2045, they have fallen by 85% relative to 2022.[355] If emissions from the grid are not reduced at this rate, the total emission reductions in this plan will not be as rapid as is described here. Increasing local renewable energy generation will mitigate the severity of this risk if it does occur.

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354 In other words, once expensive infrastructure is built it tends to stay operating for its useful life, regardless of economic or environmental harms.

355 This reflects Dominion Energy's Integrated Resources Plan 2025 Update. Source: *http://www.dominionenergy.com/-/media/content/about/our-company/irp/pdfs/desc-integrated-resource-plan-2025.pdf?rev=9d7524cb48e54da4a40cce4ff18c4db0*

Municipal Utilities

While noted when discussing some individual climate actions above, municipalities that serve as the electric utility provider have broad authority to implement a variety of climate actions that would have substantial climate benefits and also reduce residents' electricity bills. There are currently 4 municipal electric utilities in the Midlands - Town of Prosperity, City of Camden, City of Newberry, and Town of Winnsboro.

Ideas that focus on lowering their customers energy bills include:

- Rebates for energy efficiency upgrades or high efficiency heat pumps.
- Virtual power plants, municipally owned solar/battery systems, or other programs that shift demand locally and allow for arbitrage when purchasing electricity from a larger load balancing utility.
- On-bill financing programs, where energy saving improvements are zero cost to residents and savings exceed finance costs.

Utility Grid Transmission

Utility grids are often large and interconnected, with load balancing utilities sending electricity to adjacent utility grids, and even between regions of the country. Improving the transmission connections between utilities can lead to tremendous savings across very large areas because the supply of and demand for electricity is not the same in different places at different times. However, for various reasons grid transmission projects are complex and utilities are not always well incentivized to explore them. Utilities in the Midlands should be required to present the levelized cost of equivalent demand side management programs and utility grid transmission improvements alongside levelized cost proposals of any new power plant for consideration by regulators. This policy idea, or others in this space, are not considered in this plan because utility policy is controlled by the state and local actors in the Midlands have no authority to implement separate actions.

Plug-in Solar

Plug-in solar (cheaper solar panels that are portable and plug into a standard wall outlet) has been widely available in other countries for years, with increasing U.S. market availability recently.[356] Based on legal guidance sought by CMCOG in 2025, such systems could potentially be treated as at-home generators based on current state law. However, it is stabilizing for markets if the state legislature clarifies their status. Utah was the first state to do so, in 2025.[357] SC should pass a law that clarifies plug-in solar in a similar way, with key policy points including:

- Use a reasonable and simple definition of "plug-in solar", such as any system that plugs into a standard household 120 volt electrical outlet and/or by setting a maximum system wattage.
- Exempt net metering for plug-in solar to support utilities. Having a clear exemption from net metering grants utilities certainty that they will not be required to install bidirectional meters or financially compensate customers in the rare cases where plug-in solar may send small amounts of electricity back to the grid.
- Eliminate utility interconnection, local government solar permits, or other local or state regulations that are designed for and only applicable to larger solar installations. Legislation should clearly and directly prohibit utilities from having any requirements, paperwork, communication, fees, or any other forms of impositions on customers (in the same way that utilities cannot currently require anything from a household that intends to plug in a new appliance that increases their electricity usage).

Any additional included policies should be carefully evaluated, because they could be unnecessary or increase costs. In other countries, these small solar systems are widely available at local stores at prices of $1,000 or less. While these systems also produce electricity from the sun, they are not like a large typical rooftop solar system. They do not require an electrician to install (because there arguably is no installation), and they are significantly cheaper. They also produce much less electricity than a larger traditional solar system, and while they cannot fully power a home they can still meaningfully lower

356 O'Malley, I. (2025). Solar panels that fit on your balcony or deck are gaining traction in the US. Associated Press. *https://apnews.com/article/balcony-plug-solar-climate-energy-renewable-trump-c162abf520da0fa155dc971270b8684a*

357 Public law of the state of Utah, enabled by H.B. 340 - Solar Power Amendments. https://le.utah.gov/~2025/bills/static/HB0340.html

power bills. Plug-in solar is especially valuable to those living in rental housing, because it eliminates the split incentive problem.[358] When they move, they simply unplug the small solar panel and take it with them.

Local Zoning

In South Carolina, local municipalities have varying levels of ability to influence decision-making because of home rule. The South Carolina Home Rule Act of 1975 set up the local government system largely in place today, and gave local governments the power over local decisions in many cases.[359] For instance, many climate actions can be partially or mostly implemented through local zoning. Local government ordinances can also play a role in enabling or facilitating different types of climate actions.

Opportunities for local governments to consider zoning changes are included in implementation pathway notes for some climate actions in this chapter. Going forward, CMCOG will continue evaluating ways to support local governments in the Midlands with implementing this regional plan. In particular, successful zoning changes or municipal ordinances from other communities in the United States or other countries can provide examples or data to inform similar ideas in the Midlands. While local rules can sometimes slow-down development projects, they are also an effective mechanism to encode and thus realize key community priorities. This can be valuable when decisions will affect a community for several decades.

358 This problem means that a renter does not wish to pay to install solar on their landlord's roof, and the landlord does not wish to pay to lower their renter's utility bill. Exceptions can arise when the landlord also pays for utilities, but in the Midlands most renters pay for utilities.

359 Municipal Association of South Carolina (2012). Home Rule: turning point for local governments. Uptown - June 2012. https://www.masc.sc/sites/default/files/uploads/home_rule_uptown.pdf

7 Benefits Analysis

Many of the actions that reduce GHG emissions have many other benefits, including financial savings. This section explores the benefits and the costs of the climate actions in this plan. It begins with a discussion of financial costs and savings and then moves into other co-benefits such as improved public health, more good jobs, reduced energy costs, greater resilience to extreme weather, and improved affordability for all members of the community. This section describes the broad societal impacts of the climate action plan measures for the people in CMCOG in general, as well as for low-income and disadvantaged communities in particular.

7.1 Social Cost of Carbon

Climate change creates both economic and health costs for people and businesses in the Midlands today. If pollution does not fall meaningfully in the future, those costs will rise. The longer action is delayed, the greater that cost will become. It is also important to consider that GHG emissions often produce economic benefits for the people or businesses that are producing them. The social cost of carbon incorporates these benefits.

The social cost of carbon (SCC) is a method used to estimate key costs of climate change impacts. For example, it typically includes costs associated with changes in net agricultural productivity, human health, property and public infrastructure damage from extreme weather events, and energy cost fluctuations. The social cost of carbon is higher in the future because climate change costs will rise. This type of analysis is also commonly used for other gases considered air pollutants, often with an emphasis on public health. Economists can use this value to try to estimate an appropriate tax, if polluters were asked to pay for the harm they cause. It usually considers only people (i.e., damages to landscapes and non-human life may be excluded).

A simpler way to define the social cost of carbon is that it tries to find a single dollar number to sum up all of the costs and benefits from greenhouse gas emissions in order to show how it harms people.

The U.S. government estimates a decade ago evaluated a range of costs, from as low as $14 to as high as $138 per tonne of CO_2 in 2025.[360] In order to limit global warming below 2 degrees Celsius, Barrage and Nordhaus advise a social

360 EPA (2016). Social Cost of Carbon. EPA Fact Sheet. https://www.epa.gov/sites/default/files/2016-12/documents/social_cost_of_carbon_fact_sheet.pdf

cost of carbon of $89 in 2025 and $213 by 2050.[361] An analysis of multiple methods indicate that today's social cost of carbon should be approximately $250 per tonne CO_2 on average,[362] with some estimates over $500 per tonne of CO_2. Increasingly, scientists and other concerned parties such as insurance companies are advocating for the social cost of carbon to include more of the costs expected and more realistic projections of those costs.[363]

The social cost of carbon was included in the economic analyses and financial calculations reported in this plan. The values that we used came from Resources for the Future's Social Cost of Carbon Explorer (see Table 7.1).[364] Please refer to the Data, Methods & Assumptions Manual to see all of the values used to calculate the social cost of carbon each year between 2025 and 2050.

Table 7.1.
The social cost of carbon values for four of the key dates in the Midlands Climate Action Plan

2025	2030	2040	2050
$210 / MT CO_2e	$229.70 / MT CO_2e	$269.60 / MT CO_2e	$329 / MT CO_2e

7.2 Financial Analysis

Financial Summary

To implement all of the actions in this climate action plan on our proposed timeline will:

- Require a total incremental investment of $118 billion over the next 25 years, or an average of $4.7 billion / year or 8.1% of the region's 2023 GDP.

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361 L. Barrage & W. Nordhaus, Policies, projections, and the social cost of carbon: Results from the DICE-2023 model, Proc. Natl. Acad. Sci. U.S.A. 121 (13) e2312030121, *https://doi.org/10.1073/pnas.2312030121* (2024).

362 Tol, R.S.J. Social cost of carbon estimates have increased over time. Nat. Clim. Chang. 13, 532–536 (2023). *https://doi.org/10.1038/s41558-023-01680-x*

363 AFP. "Experts back more robust US estimates of social cost of carbon". *https://www.rfi.fr/en/health-and-lifestyle/20230213-experts-back-more-robust-us-estimates-of-social-cost-of-carbon* (2023)

364 The values used were those with a 2% discounting rate. Source: Resources for the Future, 2022. 'Social Cost of Carbon Explorer', https://www.rff.org/publications/data-tools/scc-explorer/ (linear extrapolation between decades). Settings included: RFF-SPs, temperature-fair, sea level rise-BRICK, ocean PH- Fung, Damages- aggregate, Howard & Stern, Discounting- 2%.

- Generate savings of $157 billion over the next 25 years, or an average of $6.3 billion / year.

This is a net savings of $39 billion between 2025 and 2050, at a marginal abatement savings of -$250 / MT CO_2e.[365] The financial analysis here considers the social cost of carbon and all of the modeled investments and savings of taking the climate actions discussed in Chapter 6. The financial analysis of this plan does not discount the future[366], but the cost projections used incorporate the impacts of inflation. For more information on the methodology and data sources used, please consult the Data, Methods & Assumptions Manual.

Table 7.2 below shows the financial analysis results for the entire climate action plan. Following this, you will find a breakdown that shows a financial assessment of households and of the 10 key strategies for climate action identified in Chapter 6.

Table 7.2.
Total Investment and Return[367] for the Midlands Climate Action Plan

	Total (2025-2050)	Annual Average
Total Investment Required	$118,706,332,894	$4.748 billion / year
Total Savings	$157,741,035,285	$6.309 billion / year
Total Net Value	Savings of $39,034,702,391	Savings of $1.561 billion / year
Emissions Eliminated	170,619,200 MT CO_2e	6,824,768 MT / year
Marginal Abatement Cost	Savings of $250 per MT CO_2e eliminated.	

365 In climate planning, abatement cost refers to the total costs of the climate actions minus the total savings expected from them, divided by the greenhouse gas emissions avoided. This can be negative, meaning that the savings exceed the cost. By expressing marginal abatement as a value per tonne of air pollution reduced, this reframes the financial analysis to answer the question "what is the cost or savings from reducing 1 unit of air pollution?".

366 The calculations that produced these totals have not had a discount rate applied to them. Economic discounting means that the environment, people and economy of the future are less valuable than the present. This does not align with the goals of this regional plan. That is, the discount rate used in this plan, 0%, implies that future generations are not less valuable than we are.

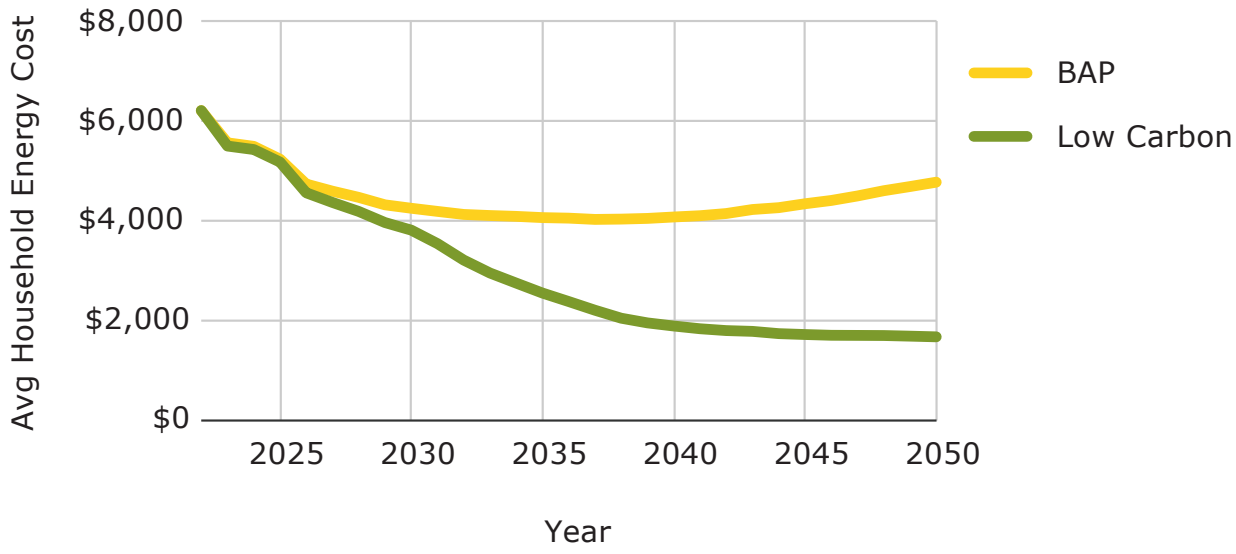
367 The financials presented in this plan are incremental to the BAP scenario.

Household Financial Summary

One of the most important benefits of the actions in this plan is that they will significantly reduce household costs for residents of the Midlands. This is due firstly to the overall improved energy efficiency of the low carbon actions. As homes are made more energy efficient and switched to highly-efficient heat pumps, they will need less energy. Secondly, sources of renewable energy such as solar generate electricity for a lower cost than fossil fuels. This means renewable electricity will cost households less than what they currently pay. These changes mean that households in the Midlands, in a low carbon future, will have lower energy bills, and also pay less for transportation.

As shown in Figure 7.1, the combined impact of all the low carbon actions will reduce the average household's annual home energy costs by 73% by 2046 relative to 2022 and also relative to the costs expected in 2050 in the BAP Scenario.

Figure 7.1.
Annual Average Household Home Energy Costs in the BAP and LC scenarios, 2025-2050.



The investments in this work will come from multiple sources. For example, it will likely be home owners who pay up-front to add insulation or replace a furnace with a heat pump in their homes; however, they may be supported financially in doing this with rebates or other incentives from governments and community agencies.

Similarly, the savings resulting from these actions will also be realized by different parts of the community. While home owners will generally be the ones who benefit from investments in improving their home energy efficiency, municipal governments that convert their vehicle fleets to electric vehicles will be the ones who experience savings (in avoided costs for fuel and vehicle maintenance). Other climate actions are more complex. For example, a more efficient electricity grid creates savings for all people and businesses who buy electricity, while investments in green infrastructure or waste management are public goods.

Costs and Savings for the low-carbon scenario

This section outlines the financial costs and savings[368] associated with each of the low-carbon strategies modeled for the Midlands. To calculate these values, costs and savings were first calculated for the BAP scenario. The low-carbon scenario costs and savings were then calculated relative to those of the BAP scenario. This means that all of these values are incremental to the BAP scenario.

At a high level, the values presented here include each of the categories shown in Table 7.3 of both costs and savings.[369]

Table 7.3.
Categories of Costs and Savings

Category of Cost or Savings
Purchase/ Replacement Costs/ Savings - for equipment, materials, vehicles, construction services, etc.
Operations and Maintenance Costs/ Savings - regular maintenance of furnaces, heat pumps, oil changes in ICE vehicles, etc.
Energy Costs/ Savings - electricity, gasoline, diesel, natural gas, propane, fuel oil, etc.
Social Cost of Carbon - infrastructure or building repairs, new healthcare costs, etc. all occurring as a result of the impacts of climate change

368 For the purposes of this document, the term 'savings' refers to all of the following: decreased or avoided costs for things like fuel and maintenance, lower or less frequent replacement capital costs, and revenue from sources like transit fares, the sale of energy, offsets or credits, services and products.

369 In the detailed financial data provided as part of this project, it is further separated into costs and savings for residents, commercial entities, and municipal/ county/ other governments.

Design Buildings for Life

The Design Buildings for Life strategy requires the largest incremental investment and has the highest marginal abatement cost per MT of CO_2e eliminated of the strategies included in this plan. However, these actions are responsible for eliminating over 15 million MT of CO_2e between 2025 and 2050, which is 8.6% of the total emissions eliminated by all actions in the low-carbon scenario.

Table 7.4.
Total Investment and Return for the Design Buildings for Life actions

	Total (2025-2050)	Annual Average
Investment Required	$75,362,401,805	$3.014 billion / year
Total Savings	$22,008,432,233	$880 million / year
Total Net Value	Cost of $53,353,952,672	Cost of $2.134 billion / year
Emissions Eliminated	15,365,551 MT CO_2e	614,622 MT CO_2e / year
Marginal Abatement Cost	Cost of $3,472 / MT CO_2e eliminated.	

Reimagine Transportation in the Midlands

The Reimagine Transportation in the Midlands strategy will save residents a total of $11,079,236,362 between 2025 and 2050 mostly in avoided fuel and maintenance costs. At the same time it will also eliminate almost 13 million MT of CO_2e between 2025 and 2050, or 7.2% of the total emissions eliminated by all actions in the low-carbon scenario. This scenario is highly effective at reducing emissions while also making life more affordable in the region.

Table 7.5.
Total Investment and Return for the Reimagine Transportation in the Midlands actions

	Total (2025-2050)	Annual Average
Investment Required	$10,041,035,517	$402 million / year
Total Savings	$21,120,271,880	$845 million / year
Total Net Value	Savings of $11,079,236,362	Savings of $443 million / year

	Total (2025-2050)	Annual Average
Emissions Eliminated	12,954,155 MT CO_2e	518,166 MT CO_2e / year
Marginal Abatement Cost	Savings of $855 / MT CO_2e eliminated.	

Expand Renewable Energy Generation

The Expand Renewable Energy Generation Strategy provides the single greatest reduction in emissions of all the strategies in the Plan (74,529,989 MT CO_2e or 41% of all emissions eliminated), an impressive return on investment, and significant savings per MT of CO_2e eliminated.

Table 7.6.
Total Investment and Return for the Expanding Renewable Energy actions

	Total (2025-2050)	Annual Average
Investment Required	$7,211,959,435	$288 million / year
Total Savings	$70,646,408,905	$2.825 billion / year
Total Net Value	Savings of $63,434,449,469	Savings of $2.637 billion / year
Emissions Eliminated	74,529,989MT CO_2e	2,981,200T CO_2e / year
Marginal Abatement Cost	Savings of $851 / MT CO_2e eliminated.	

Advance Low-carbon Transformation in Industry

The Advance Low-carbon Transformation in Industry Strategy is one of only two strategies in this plan that require a net investment for each MT of emissions eliminated. In this case, the investment required is $61 / MT of emissions eliminated. However, these actions do still provide over $13.5 billion in savings, primarily in the form of reduced long-term energy costs for industrial businesses between now and 2050.

The actions in this strategy eliminate 3% of the total emissions eliminated in the low-carbon scenario.

Table 7.7.
Total Investment and Return for the Advance Low-Carbon Transformation in Industry actions

	Total (2025-2050)	Annual Average
Investment Required	$13,826,032,447	$553,041,298 / year
Total Savings	$13,560,901,658	$542,436,066 / year
Total Net Value	Cost of $265,130,789	Cost of $10,605,232 / year
Emissions Eliminated	4,354,526 MT CO_2e	174,181 MT CO_2e / year
Marginal Abatement Cost	Cost of $61 / MT CO_2e eliminated.	

Scale Up Waste Reduction and Diversion Initiatives

The Scale Up Waste Reduction and Diversion Initiatives Strategy includes two actions. The first involves reducing the total amount of solid waste being disposed of, and the second involves increasing composting over time. Costs and savings were not calculated for these actions, because these actions can be implemented in a wide variety of ways, and the cost and scale of different approaches have very different costs.

This strategy eliminates just under 2% of the total emissions reduced in the low-carbon scenario.

Table 7.8.
Total Investment and Return for the Scale Up Waste Reduction and Diversion Initiatives actions

	Total (2025-2050)	Annual Average
Investment Required	Not calculated	Not calculated
Total Savings	Not calculated	Not calculated
Total Net Value	Not calculated	Not calculated
Emissions Eliminated	3,065,732 MT CO_2e	122,629 MT CO_2e / year
Marginal Abatement Cost	Not calculated	Not calculated

Optimize Water and Wastewater Operations

The actions in this strategy eliminate 0.9% of the total emissions eliminated in the low-carbon scenario. However, of all the strategies in this plan, the Optimize Water and Wastewater Operations Strategy provides the second-largest savings per MT of emissions eliminated: $1,022 / MT CO_2e. This represents a significant reduction in operating costs for the owners of these facilities, which are nearly all owned and operated by local governments here in the Midlands. When these facilities are publicly-owned, the savings can translate into community benefits like reduced water/sewer fees, re-allocating funds for repairs, or to provide additional services.

Table 7.9.
Total Investment and Return for the Optimize Water and Wastewater Operations actions

	Total (2025-2050)	Annual Average
Investment Required	$354,422,240	$14,176,890
Total Savings	$1,869,572,861	$74,782,914
Total Net Value	Savings of $1,515,150,622	Savings of $60,606,025 / year
Emissions Eliminated	1,483,813 MT CO_2e	59,313 MT CO_2e / year
Marginal Abatement Cost	Savings of $1,022 / MT of CO_2e eliminated.	

Protect Trees and Encourage Green Infrastructure

The Protect Trees and Encourage Green Infrastructure Strategy is responsible for 18.8% of all greenhouse gas emissions eliminated in the low-carbon scenario, which is second only to the Expand Renewable Energy Generation Strategy for the most emissions eliminated by a single strategy. This amounts to a total of 32,090,807 MT of CO_2e eliminated.

Table 7.10.
Total Investment and Return for the Protect Trees and Encourage Green Infrastructure actions

	Total (2025-2050)	Annual Average
Investment Required	$613,271,693	$24,530,868 / Year
Total Savings	$8,580,318,380	$343,212,735 / Year
Total Net Value	Savings of $7,967,046,688	Savings of $318,681,868 / Year
Emissions Eliminated	29,960,807 MT CO_2e	1,198,432 MT CO_2e / Year
Marginal Abatement Cost	Savings of $266 / MT CO_2e eliminated	

Enhance Agriculture and Soil Management Practices

The Enhance Agriculture and Soil Management Practices Strategy provides the greatest savings per MT of CO_2e eliminated of all the strategies in this plan. This is partially because two of the three actions require no capital investment but saves millions, particularly in fertilizer costs.

Table 7.11.
Total Investment and Return for the Enhance Agriculture and Soil Management Practices actions

	Total (2025-2050)	Annual Average
Investment Required	$11,031,750,240	$441.3 million / year
Total Savings	$18,244,342,604	$729.8 million / year
Total Net Value	Savings of $7,212,592,364	Savings of $288.5 million / year
Emissions Eliminated	8,688,964 MT CO_2e	347,559 MT CO_2e / year
Overall Cost/ Savings per MT of CO_2e eliminated	Savings of $1,195 / MT CO_2e eliminated	

Intentional Land Use

The Intentional Land Use Strategy's actions do not require significant capital investment to eliminate emissions. Rather, they focus on making land use and infrastructure decisions that result in more compact community layouts with surfaces that reduce the concentrated heating effect of greenhouse gases already present. This strategy requires a relatively low level of investment and provides savings for every MT of CO_2e eliminated. It should be noted that strictly speaking, 2,130,000 MT CO_2e (from the ReflectiveSurfaces action) is achieved through a reduction in the albedo effect that is considered equivalent to eliminating this amount of greenhouse gases, although it does not involve actually eliminating them from the atmosphere.[370]

Table 7.12.
Total Investment and Return for the Intentional Land Use actions

	Total (2025-2050)	Annual Average
Investment Required	$265,476,416	$10.6 million / year
Total Return on Investment (including avoided costs, savings, and revenue)	$1,710,786,763	$68.4 million / year
Total Net Value	Savings of $1,445,310,348	Savings of $57.8 million / year
Emissions Eliminated	5,480,818 MT CO_2e	219,233 MT CO_2e / year
Marginal Abatement Cost	Savings of $265 / MT CO_2e eliminated	

Reduce Consumption-based Carbon Impact

The actions to reduce consumption-based emissions were defined at a high level for this plan. As a result, specific costs and savings for these actions were not calculated. Intuitively, switching to meatless meals should produce cost savings as vegetarian options are generally less expensive than meat. Similarly, increasing the use of locally sourced materials should reduce costs associated with transporting materials into the community, resulting in net savings for manufacturers.

370 Based on the current version of the GPC, reductions in albedo effect, although equivalent to physical reductions in greenhouse gases, cannot currently be included in a GHG inventory. Therefore the impact of this action is included in the Plan's totals but it should not be included in future GHG inventories.

7.3 Co-Pollutants Analysis

Some climate actions, in addition to greenhouse gas reductions, also reduce criteria or harmful air pollutants that do not contribute to climate change but harm people's health. When feasible, we calculated co-pollutant reductions associated with climate actions in this plan. These estimates are listed alongside each action (see Chapter 6). A complete co-pollutants inventory for the base year is included for this plan in Appendix C.

The transition to a low-carbon future is projected to reduce not only GHG emissions but also co-pollutants including particulate matter, NOx and VOCs. Table 7.13 provides the expected levels of key criteria air pollutants projected to occur under the different scenarios modeled as part of this analysis, including through the business as planned (BAP), business as usual (BAU), and low-carbon (LC) scenarios in 2050 as compared to the base year. The values provided for the low-carbon scenario assume all of the actions are implemented on schedule. Compared to the BAU and BAP scenarios, the low-carbon scenarios show substantial declines in fossil fuel use and associated co-pollutants, especially PM2.5 and NOx, which are major contributors to air-related health conditions. The quantified public health benefits associated with these co-pollutant reductions are discussed in Section 7.5 Co-Benefits and Co-Harms: Health.

Table 7.13.
Criteria Air Pollutants in the Base Year, and in 2050 for the BAU, BAP and LC Scenarios.

Criteria Air Pollutants (MT)	Base Year (2022)	BAU (2050)	BAP (2050)	LC (2050)
CO	83,031	95,789	66,164	43,031
HC	13,273	15,379	13,631	5,417
Particulate matter released (PM2.5)	1,094	1,187	1,141	0
Particulate matter released (PM10)	3,536	2,879	2,317	841
NOx released	13,273	15,379	13,631	0
SO2 released	1,259	1,314	1,257	0

Criteria Air Pollutants (MT)	Base Year (2022)	BAU (2050)	BAP (2050)	LC (2050)
VOCs released	6,527	7,406	5,494	0

7.4 Introducing the Co-Benefits Analysis

What Are Co-Benefits and Co-Harms?

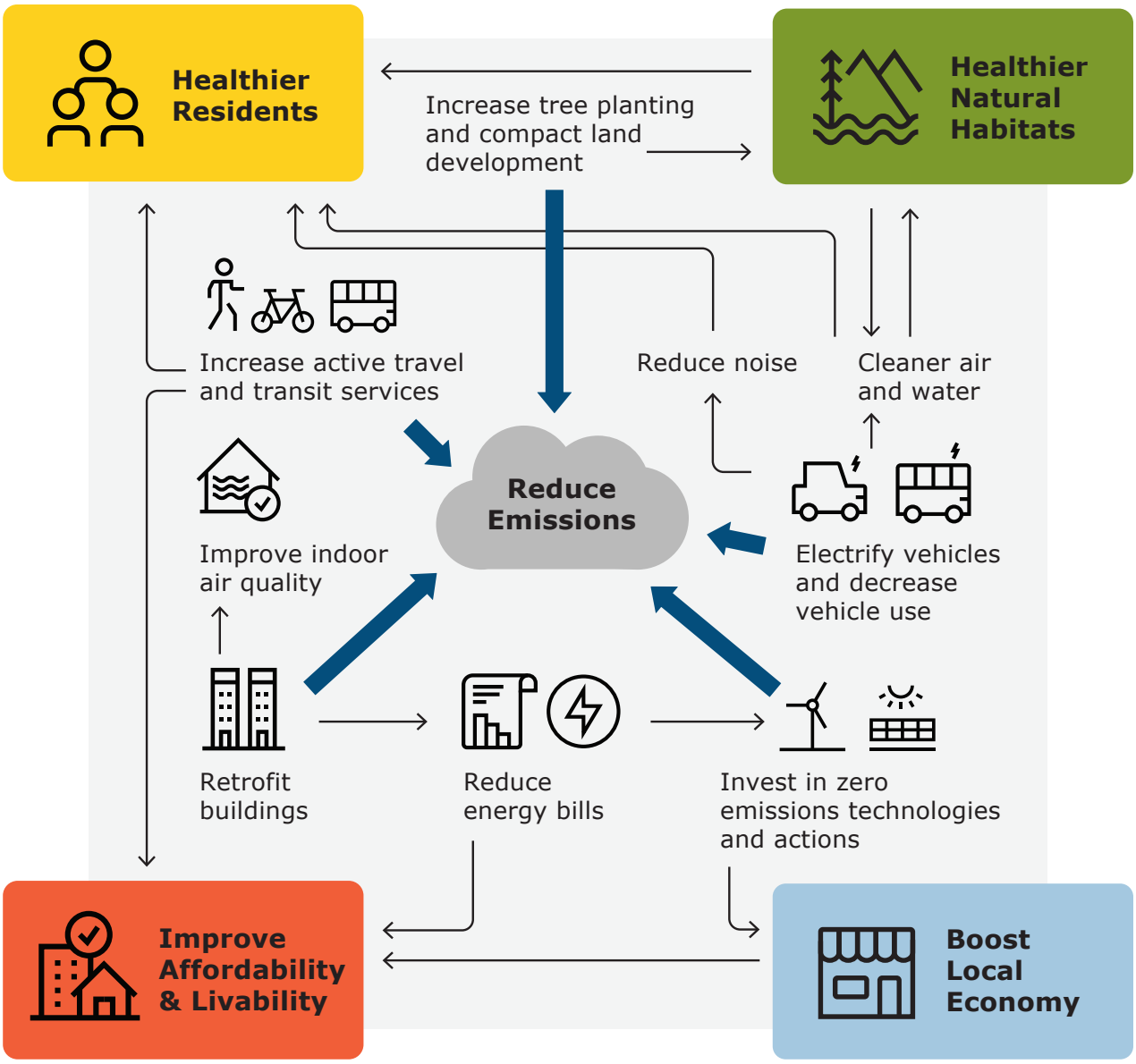
A co-benefit is an additional positive impact of a climate action beyond its impact on reducing GHG emissions.[371] In many cases, climate actions can create vibrant cities and towns, improve public health, reduce municipal and state operating and capital costs, and support innovation. One review of more than a dozen studies on climate actions found that the co-benefits of reduced air pollution often equaled or exceeded the benefit of the GHG reduction itself.[372]

Appendix D contains a summary of co-benefits and co-harms for each climate action, whereas the remaining sections of Chapter 7 summarizes and discusses key co-benefits by considering all climate actions in this plan.

371 The IPCC defines co-benefits as "the positive effects that a policy or measure aimed at one objective might have on other objectives, irrespective of the net effect on overall social welfare" in its Fifth Assessment Report (2014). The term co-benefits and its corollary, co-harms, have a variety of synonyms, including "ancillary effects" and "ancillary benefits and costs."

372 OECD, Ancillary Benefits and Costs of Greenhouse Gas Mitigation (OECD Publishing, 2000).

Figure 7.2.
Actions that reduce emissions can also support healthier residents and natural habitats, boost local economies, create local jobs and improve affordability and livability.



While many GHG reduction measures have positive effects they can also have co-harms, or negative impacts. For example:

- Compact urban development reduces emissions, but without careful design, people, including children and the elderly, may be exposed to elevated levels of air pollutants as they walk or cycle in close proximity to traffic.

- Energy-efficiency retrofits in low-income neighborhoods can lead to rising rents and property values, causing gentrification and unintended changes to neighborhood affordability.
- Increased costs in urban centers may result in increased lower-cost housing at the edge of cities or outside of their boundaries, leading to an increase in transportation emissions and congestion.
- Some climate actions can lead to job displacement or changes in the types of work available. As certain industries grow and others shrink, certain roles may decline while new ones emerge. Ensuring access to retraining, upskilling, and fair transition support can help workers adapt and share in the benefits of a low-carbon economy.

The positive — or negative — effects are often unintentional and specific to local contexts, but governments can intentionally implement GHG reduction actions in ways that increase positive co-benefits and mitigate or avoid negative co-harms.

Evaluating Co-Benefits and Co-Harms

Assessment Criteria

Not all co-benefits or co-harms are equal. It is helpful to identify and prioritize criteria for evaluating co-benefits. These criteria include:[373]

- **Synergies:** Many emissions-reduction actions have multiple socio-economic benefits, including improving transit, energy efficiency, and compact urban design.
- **Urgency:** Some emissions-reduction actions, such as promoting compact communities that require less car use, require time to realize their effects, making immediate implementation paramount. These actions must be implemented with a higher degree of urgency in order to avoid loss of inertia on action already taken, lock-in effects,[374] or deferred costs.
- **Costs:** Taking action earlier is generally cheaper than taking

373 Adapted from Fay et al., (2015). Decarbonizing development: three steps to a zero-carbon future. Washington, DC: World Bank Group.

374 Lock-in effects describe situations in which implementation of a strategy or action improves performance of an object or activity in the short term but is prohibitive to future emissions reductions. Lock-in effects may refer to building upgrades or land-use decisions that "lock in" a set level of emissions in the long term. For example, building retrofits that provide limited energy efficiency improvements can create a situation in which no additional improvements in the equipment installed can be expected over the course of its lifetime without considerable additional expense. In this way, lower levels of energy reductions can be locked in for a long period.

action later, particularly because delayed action involves ongoing investments in infrastructure, activities and utilities that are higher emitting than low-emissions solutions. Examples include investments in renewable energy infrastructure, transit and energy efficiency.

- **Longevity:** Related to urgency, the longevity of some investment decisions locks society into their effects for decades, if not centuries.
- **Distribution effects:** Actions designed to reduce emissions have different impacts on different people, including different income groups, future generations, and disadvantaged communities.

Analytical Methods

Co-benefits and co-harms were quantified or assessed qualitatively for the region as a whole for the low-carbon scenario. Co-benefits and co-harms affecting low-income and disadvantaged communities are woven throughout the assessment.

A summary of the assessment and analytical method used to assess co-benefits and co-harms is described in Table 7.14 and in the Data, Methods & Assumptions report.

Table 7.14.
Overview of co-benefits and co-harms categories, specific impacts and indicators and the analytical method used.

Category	Impact Overview	Indicators	Analytical Method
Health impacts			
Outdoor air quality	Improvement in outdoor air quality	▪ Avoided mortality and incidence of disease ▪ Dollar value of total health benefits	▪ Calculated using air pollutants from modeling inputted into EPA's Co-Benefits Risk Assessment (COBRA) tool
Physical and emotional well-being	Increased physical activity, increased mental well-being	▪ Walking miles traveled; cycling miles traveled ▪ Number of vehicles per household	▪ Relationship between vehicle miles traveled and indicators of physical and mental health
Occupant comfort	Improvement in occupant comfort inside homes and businesses	▪ Number of homes using electric appliances ▪ Total square footage of non-residential buildings using electric appliances ▪ Number of homes/floor area of workplaces retrofit	▪ Correlation between retrofits, improved indoor air quality and health and social benefits

Category	Impact Overview	Indicators	Analytical Method
Economy impacts			
Employment	New employment opportunities are created. Existing employment opportunities are lost.	▪ Jobs created/lost by sector	▪ Employment multipliers for every dollar spent on decarbonization
Household savings	Energy efficiency will reduce household and transportation costs	▪ Household energy and travel expenditures	▪ Calculated in the ScenaCommunity model (change in expenditures on transportation and housing)[375]
Resiliency impacts			
Passive survivability	Populations are able to withstand extreme weather events and power outages	▪ Number of buildings with deep retrofits ▪ Number of batteries installed alongside renewable energy systems ▪ Number of electric vehicles	▪ Calculated in the ScenaCommunity model
Urban heat island effect	Planting trees for shade and expanding green infrastructure reduces urban heat island effect	▪ Number of trees planted or acres of landscape restored	▪ Calculated in the ScenaCommunity model and correlated with reductions in local temperature

375 See the Data, Methods, and Assumptions (DMA) Manual for more information about SSG's ScenaCommunity model.

Category	Impact Overview	Indicators	Analytical Method
Water and soil health	Improvement in water and soil health	▪ Number of trees planted or acres of landscape restored ▪ Number of septic tanks replaced	▪ Relationship between canopy cover and water quality ▪ Relationship between agricultural and water services management and soil health

7.5 Co-Benefits and Co-Harms: Health

Air Quality

One of the most beneficial and immediate health co-benefits of reducing GHG emissions is improved air quality. Cleaner air reduces the risk of adverse health effects, such as aggravated asthma, decreased lung function, heart attacks, neurological disorders, and premature death.[376]

Climate change will increase the likelihood of conditions that exacerbate poor air quality.[377] Burning fossil fuels such as gasoline, diesel and natural gas additionally releases air pollutants of public health concern as well as greenhouse gases. These pollutants include particulate matter (PM), carbon monoxide (CO), hydrocarbons (HC), sulfur dioxide (SO_2), nitrogen oxides (NOx), mercury (Hg), and volatile organic compounds (VOCs). All have negative impacts on human health.

Air pollution damages the lungs, heart, brain, skin and other organs, and causes disease, disability, and death.[378] Air pollution from fossil fuels has been linked to the development of neurological disorders including Parkinson's disease, Alzheimer's disease and other dementias, acute bronchitis in children, asthma and other respiratory illnesses, heart disease, stroke, and cancer.[379] Among air pollutants, PM2.5 often serves as a key indicator of outdoor air quality. The EPA also uses the Air Quality Index, which monitors unhealthy levels of 5 major air pollutants and reports this information to the public using a color-based system to denote times when any of them exceeds certain health thresholds.[380]

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376 Buonocore, J. J., Reka, S., Y., D., Chang, C., Roy, A., Thompson, T., ... & Arunachalam, S. (2023). Air pollution and health impacts of oil & gas production in the United States. Environmental Research: Health, 1(2), 021006. and National Institute of Environmental Health Sciences, Air Pollution and Your Health, accessed June 20, 2025, https://www.niehs.nih.gov/health/topics/agents/air-pollution

377 U.S. Environmental Protection Agency. Climate Change Impacts on Air Quality. Last modified June 6, 2023. https://www.epa.gov/climateimpacts/climate-change-impacts-air-quality & First Street Foundation (2024). 10th National Risk Assessment | Atrocious Air. https://firststreet.org/research-library/atrocious-air

378 Shilpa S. Shetty, Deepthi D, Harshitha S, Shipra Sonkusare, Prashanth B. Naik, Suchetha Kumari N, and Harishkumar Madhyastha, "Environmental Pollutants and Their Effects on Human Health," Heliyon 9, no. 9 (August 25, 2023): e19496, *https://doi.org/10.1016/j.heliyon.2023.e19496*

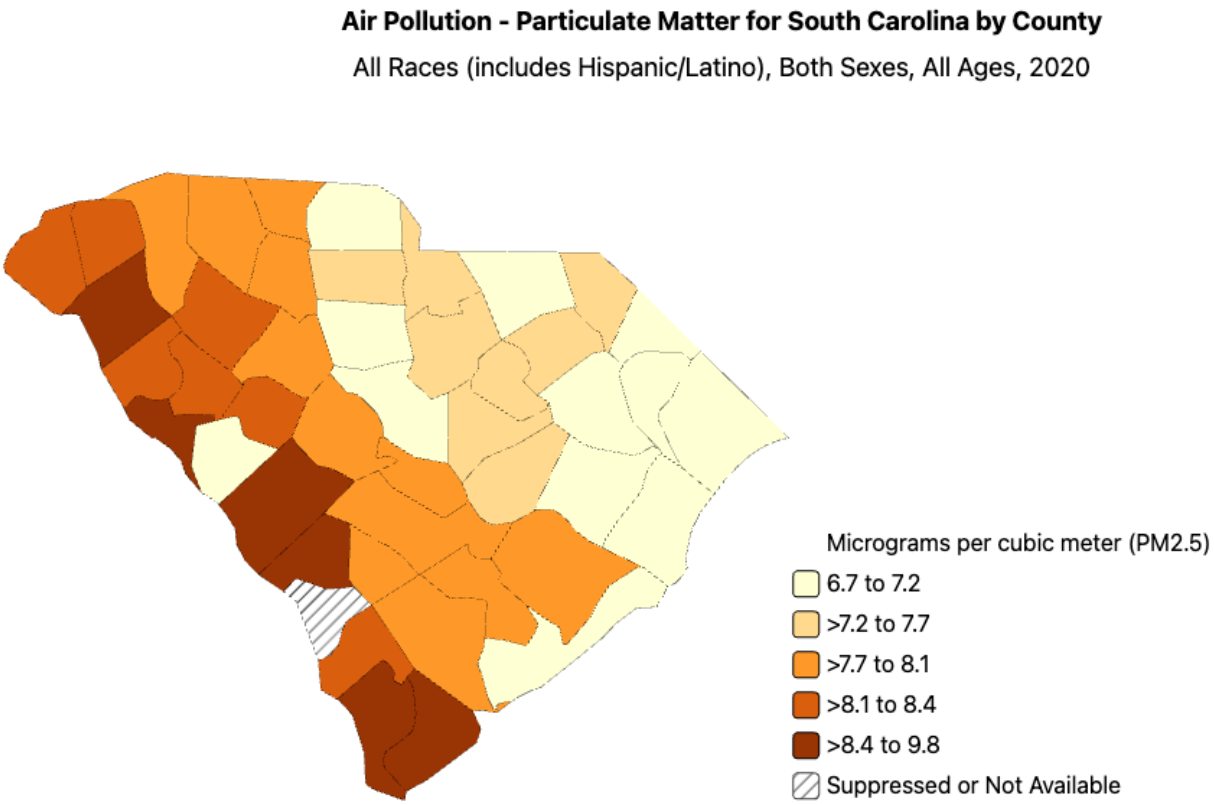
379 Shilpa S. Shetty, Deepthi D, Harshitha S, Shipra Sonkusare, Prashanth B. Naik, Suchetha Kumari N, and Harishkumar Madhyastha, "Environmental Pollutants and Their Effects on Human Health," Heliyon 9, no. 9 (August 25, 2023): e19496, *https://doi.org/10.1016/j.heliyon.2023.e19496*

380 EPA (2025). Air Quality Index Basics. https://www.airnow.gov/aqi/aqi-basics/

Outdoor Air Quality in the Midlands

According to World Health Organization guidelines, annual average concentrations of PM2.5 should not exceed 5 micrograms per cubic meter.[381] In 2020, South Carolina exceeded this threshold with an average PM2.5 concentration for all counties of 7.8 micrograms per cubic meter. This average is higher than the national average of 7.3 micrograms per cubic meter.[382] All of the state's individual counties also exceeded this limit, as shown in Figure 7.3. Amongst the seven counties in the Midlands, Saluda County had the highest PM2.5 concentration at 8.2 micrograms per cubic meter.

Figure 7.3.
Average daily density of fine particulate matter in micrograms per cubic meter for South Carolina by county, 2020.[383]



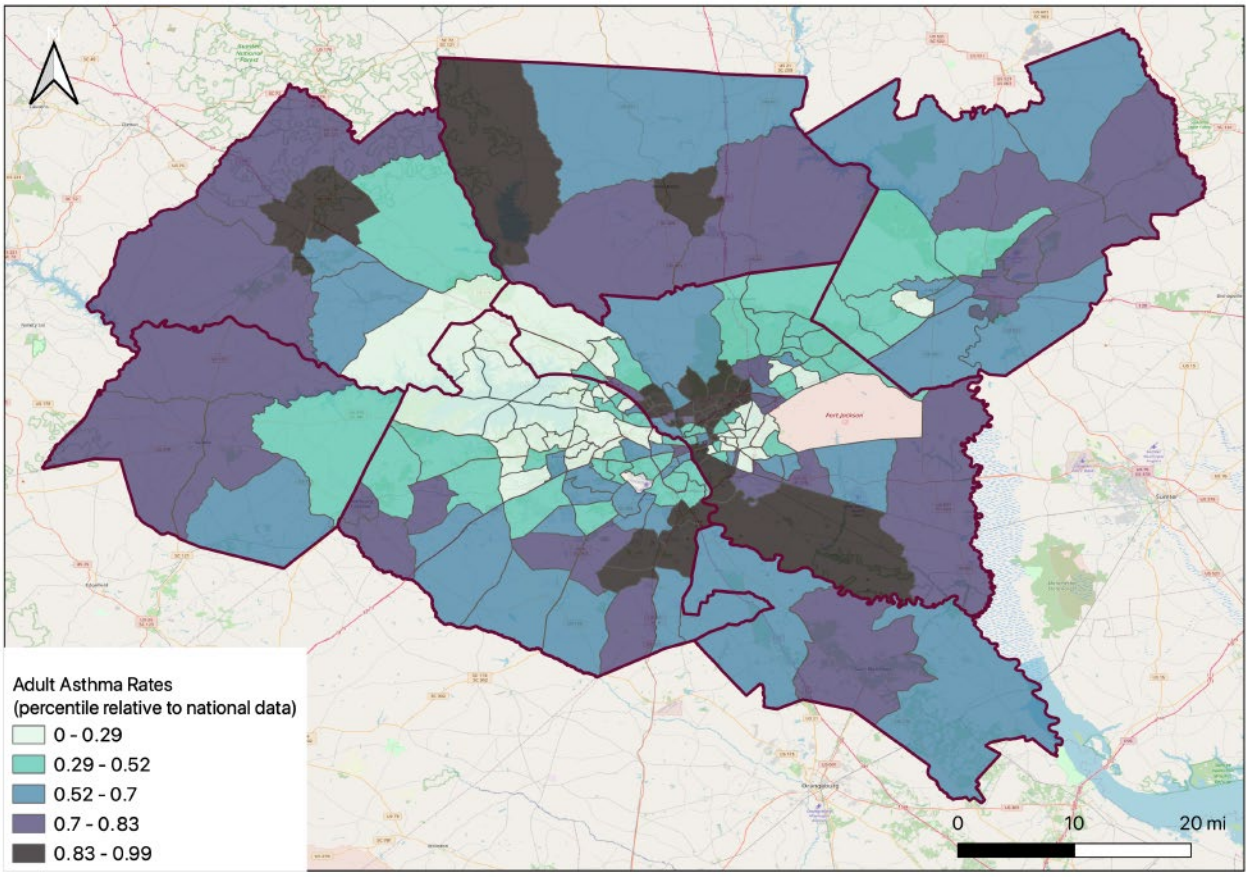
381 World Health Organization, "WHO air quality guidelines," C40 Knowledge Hub, Sept. 2021, https://www.c40knowledgehub.org/s/article/WHO-Air-Quality-Guidelines?language=en_US.

382 National Institute on Minority Health and Health Disparities, "Air Pollution - Particulate Matter for South Carolina by County," HD Pulse: An Ecosystem of Minority Health and Health Disparities Resources. (February 11, 2025). Available from https://hdpulse.nimhd.nih.gov/data-portal/home

383 National Environmental Public Health Tracking Network from the CDC. Average daily density of fine particulate matter in micrograms per cubic meter (PM2.5). https://hdpulse.nimhd.nih.gov/data-portal/physical/map.

Air pollution does not impact everyone equally. Farmers and outdoor workers are particularly at risk of exposure to air pollutants from transportation and industrial activities. As of 2021, an average of 9.3% of the adult population in the Midlands region (ranging from 8.3% in Newberry to 9.6% in Lexington, Richland and Fairfield) reported having asthma (see Figure 7.4), making them more sensitive to poor air quality.[384]

Figure 7.4.
Adult asthma rates in the Midlands, relative to national percentiles.



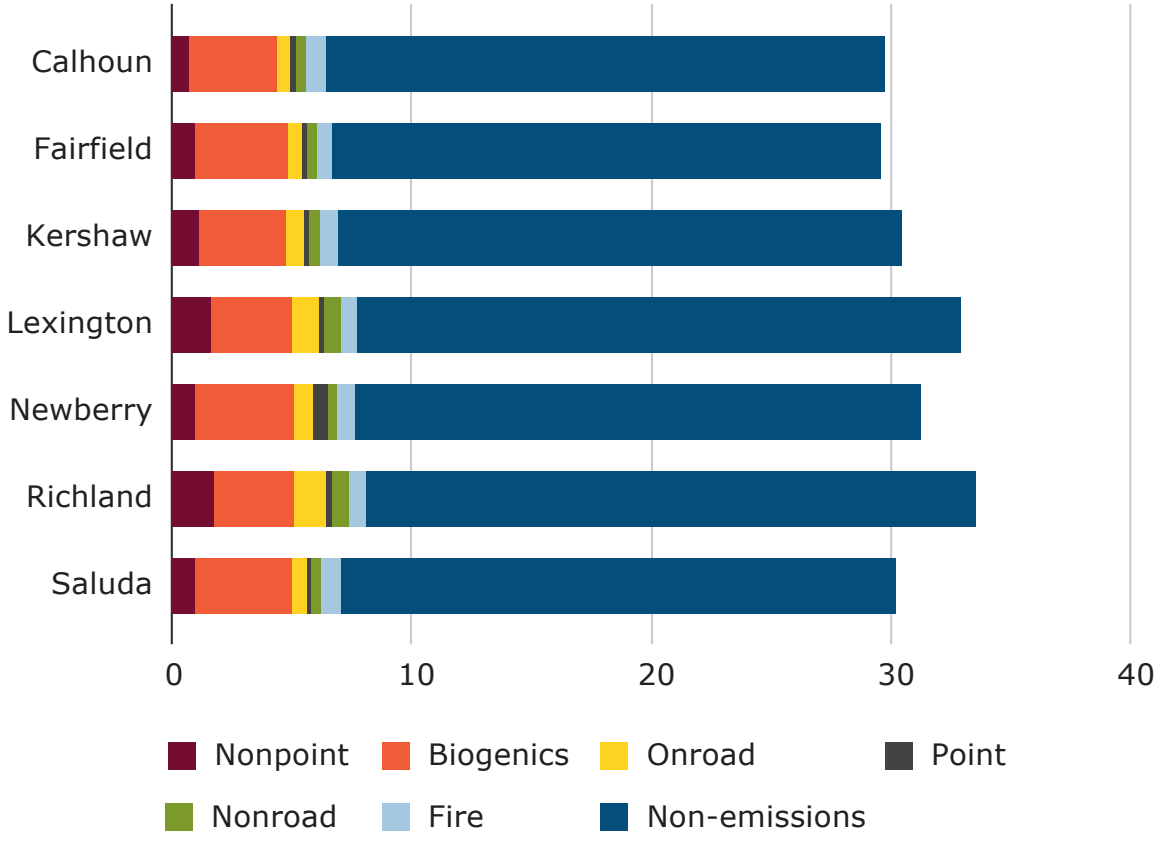
Air pollution also increases the risk for certain cancers. The EPA's 2020 Air Toxics Screening Assessment identified which air toxins may pose health risks across the country. Figure 7.5 highlights the projected cancer risk per

384 PLACES Local Data for Better Health, County Data 2024 release. https://data.cdc.gov/500-Cities-Places/PLACES-Local-Data-for-Better-Health-County-Data-20/swc5-untb/about_data

million by air pollution source by county.[385] The largest share (about 75-78% for each county) is from non-emissions, which refers to pollutants that are not directly emitted into the air but are formed through chemical reactions in the atmosphere (e.g., secondary pollutants) or existing background levels. These are often beyond local control, but still influence public health.

Biogenic emissions can be notable. These are natural emissions from trees and vegetation when used by humans or combusted naturally. Examples include fire-related emissions from wildfires or prescribed burns, residential wood combustion and solvent use. Other notable sources include industrial plants, power stations, and on-road emissions from vehicles operating on highways and local streets.

Figure 7.5.
Cancer risk (per million) in the Midlands by air pollution source group.[386]

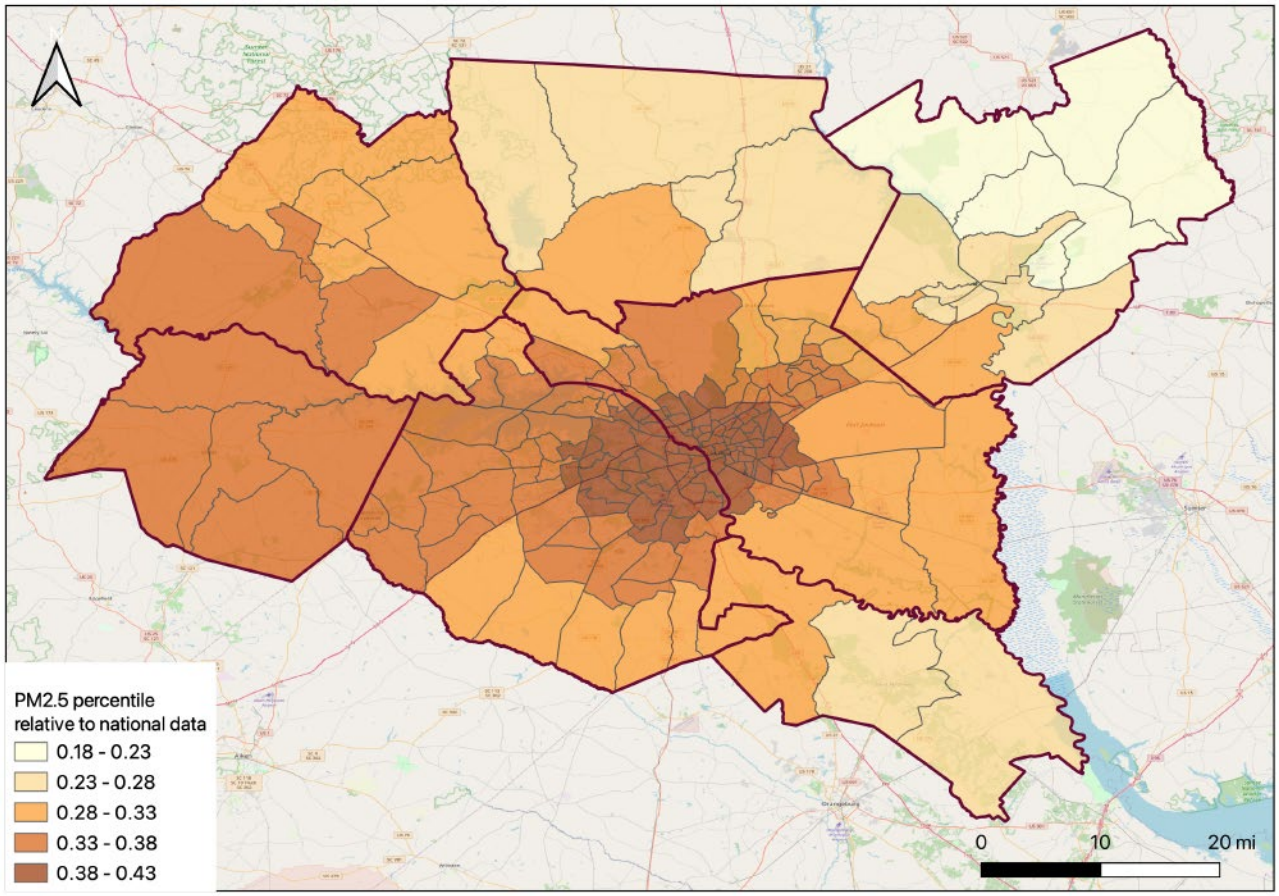


385 Cancer sources that were not emissions groups, including background and secondary sources, are not included in this figure. Source: https://www.epa.gov/AirToxScreen/2020-airtoxscreen-assessment-results

386 U.S. Environmental Protection Agency, "2020 AirToxScreen," EPA, last updated May 22, 2025, accessed February 23, 2026, https://www.epa.gov/AirToxScreen/2020-airtoxscreen.

Figure 7.6 illustrates census tracts in the project area that have higher rates of PM2.5 exposure.[387] As expected, exposure is more concentrated around urban areas with higher traffic and close to high emitting facilities like power stations and industrial sites.

Figure 7.6.
PM2.5 exposure in the Midlands, as a percentile of national PM2.5 levels.



Indoor Air Quality in the Midlands

In addition to outdoor air pollution, indoor air pollution can be a concern within people's homes or apartments if they use certain devices or appliances that burn fossil fuels. Direct burning of fossil fuels releases harmful air pollutants into the home. Pollutant loads are higher without active ventilation to the exterior. One example is gas stoves used for home cooking, which

387 Climate and Economic Justice Screening Tool. https://screeningtool.geoplatform.gov/en/#7.91/42.353/-83.616. Accessed January 9, 2024.

are linked to 13% of childhood asthma cases in the U.S.[388] and release dangerous chemicals that harm people such as benzene, which causes cancer.[389] Certain climate impacts also directly or indirectly alter indoor air quality. During an active wildfire, wind-blown smoke can enter homes and lower indoor air quality (especially particulate matter).[390] With repeated exposure to flooding or heavy rain, mold can proliferate in the interior of a home and cause health problems.[391]

Impacts

A total of 33 actions in the buildings, energy, waste and transportation sectors will reduce the amount of fossil fuels burned and reduce outdoor air pollution in the Midlands. Some actions, especially home electrification, will reduce indoor air pollution. The full list of actions are included in Appendix D: Summary of Co-benefits by Climate Action.

The actions in the climate action plan focus on the reduction of GHG emissions, and by consequence also include measures to improve energy efficiency, reducing the overall energy demand. Because of this, all measures directly or indirectly improve outdoor air quality.

Removing fossil-fuel burning appliances and equipment from homes, businesses, industries, and roadways directly reduces a variety of GHGs. Reducing the overall demand for energy reduces the need for electricity generation from fossil fuels while utilities transition to a zero-emissions grid.

Reducing outdoor air pollution not only improves public health but also delivers significant economic benefits by reducing medical expenses and minimizing productivity losses. To estimate these benefits, the EPA Co-Benefits Risk Assessment (COBRA) model was used to quantify health-related cost savings associated with the criteria air pollution reductions under the low-carbon scenario (see Table 7.13).

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388 Gruenwald, T., Seals, B. A., Knibbs, L. D., & Hosgood, H. D., III. (2023). Population Attributable Fraction of Gas Stoves and Childhood Asthma in the United States. International Journal of Environmental Research and Public Health, 20(1), 75. https://doi.org/10.3390/ijerph20010075

389 Kashtan, Y. S., Nicholson, M., Finnegan, C., Ouyang, Z., Lebel, E. D., Michanowicz, D. R., ... & Jackson, R. B. (2023). Gas and propane combustion from stoves emits benzene and increases indoor air pollution. Environmental Science & Technology, 57(26), 9653-9663. ||| Garg, A., Kashtan, Y., Nicholson, M., Finnegan, C. J., Lebel, E. D., Michanowicz, D. R., ... & Jackson, R. B. (2025). Exposure and health risks of benzene from combustion by gas stoves: A modelling approach in US homes. Journal of Hazardous Materials, 492, 137986.

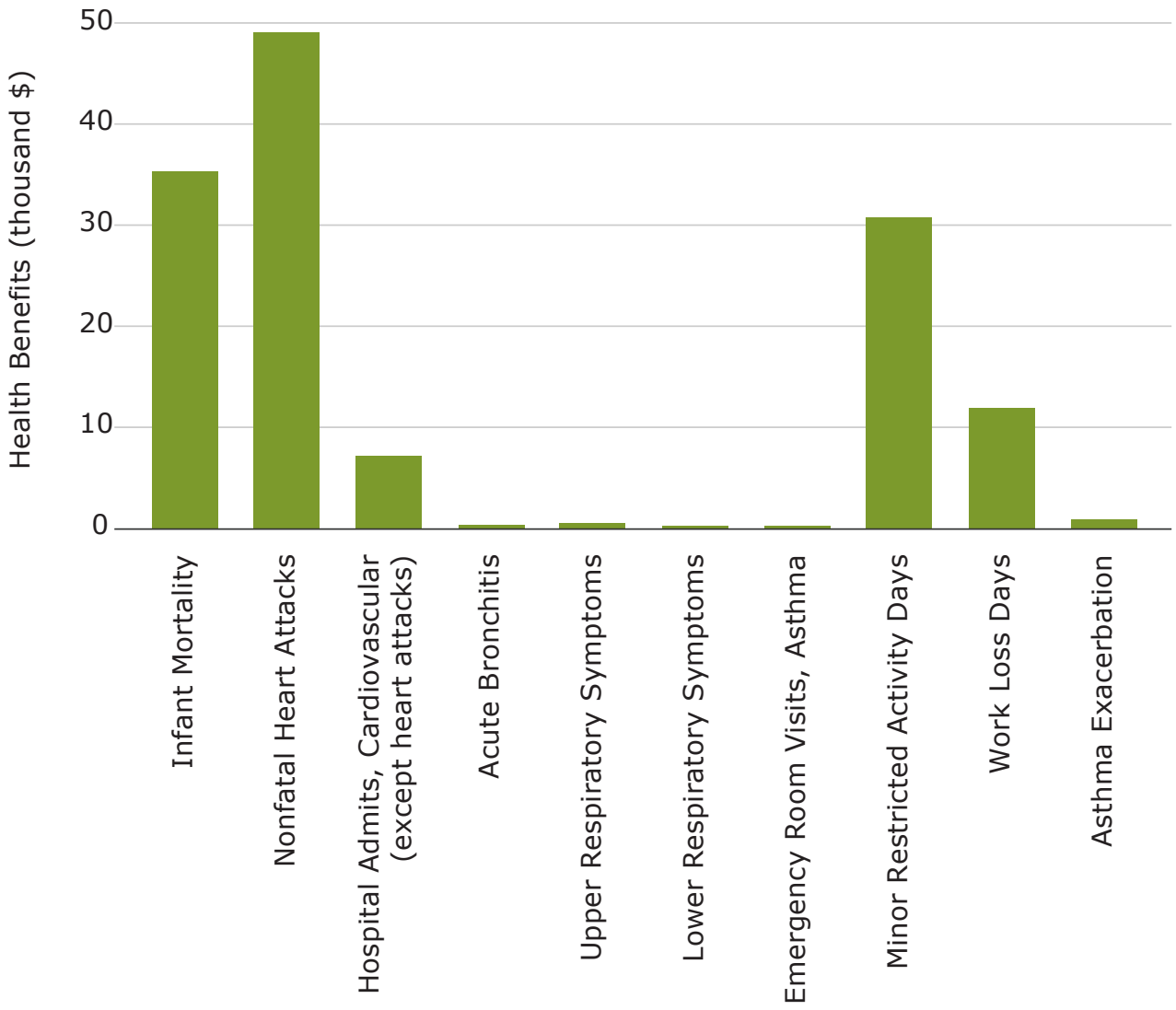
390 First Street Foundation (2024). 10th National Risk Assessment | Atrocious Air. https://firststreet.org/research-library/atrocious-air

391 Fretwell, S. (2020). Hurricanes repeatedly devastate this SC town, leaving a stinking threat behind: Mold. The State. *www.thestate.com/news/local/environment/article246392770.html*

The modeling estimates approximately $10 million in annual benefits by 2050 from avoided premature deaths, fewer asthma-related emergency room visits, reduced respiratory symptoms, and fewer missed work and school days. Among these outcomes, reduced asthma incidence and fewer lost school days represent particularly large health gains for residents in the Midland region.

These health improvements are especially important in areas where outdoor air pollution is most severe. Figure 7.7 below illustrates how modelled air quality improvements are expected to benefit these same areas.

Figure 7.7.
Annual health benefits in dollars by health-related indicators in the low-carbon scenario, 2050.



Physical and Emotional Well-Being

Regular physical activity improves overall health and fitness, reduces the risk of premature mortality and many chronic diseases, and contributes to happiness and reduced anxiety.

People living in cities and neighborhoods with more compact urban forms and robust public transportation are less likely to experience hypertension.[392] When people switch from driving to using public transit, their physical activity is likely to increase by eight to 33 minutes per day.[393] Studies have shown that children who walk or bike to school are more fit than those who travel by car or bus.[394]

Getting around on foot or by bike can also reduce the risk of premature death. Studies have shown that the relative risk of premature mortality was 30-40% less among those who used active transportation compared to those who did not get similar amounts of leisure time exercise.[395] Similarly, studies have found that cycling to work would also reduce all-cause mortality rates by 40%.[396]

Increasing access to green spaces and parks also increases community levels of physical activity. Residents in neighborhoods with ample green space are three times more likely to be physically active and 40% less likely to be overweight than those in neighborhoods with limited green space.[397] Seniors living in neighborhoods with walkable green spaces nearby may live longer on average.[398]

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392 Ewing, R., L. Frank, and R. Freutzer. (2006). Understanding the Relationship Between Public Health and the Built Environment. A Report Prepared for the LEED-ND Core Committee.

393 Rissel, C., Curac, N., Greenaway, M., & Bauman, A. (2012). Physical Activity Associated with Public Transport Use—A Review and Modelling of Potential Benefits. International Journal of Environmental Research and Public Health, 9(7), 2454–2478.

394 Voss C, Sandercock G. (2010). Aerobic fitness and mode of travel to school in English schoolchildren. Med Sci Sports Exerc. 2010 Feb;42(2):281-7.

395 Andersen LB, Schnohr P, Schroll M, Hein HO. All-cause mortality associated with physical activity during leisure time, work, sports, and cycling to work. Arch Intern Med 2000;160:1621-8. and Matthews CE, Jurj AL, Shu XO, Li HL, Yang G, Li Q, et al. Influence of exercise, walking, cycling, and overall nonexercise physical activity on mortality in Chinese women. Am J Epidemiol 2007;165:1343-50.

396 Andersen LB, Schnohr P, Schroll M, Hein HO. All-Cause Mortality Associated With Physical Activity During Leisure Time, Work, Sports, and Cycling to Work. Arch Intern Med. 2000;160(11):1621-1628.

397 [CABE] Commission for Architecture and the Built Environment (n.d.). Future Health: Sustainable places for health and well-being. London, U.K.: CABE

398 Bray, R., C. Vakil, and D. Elliot. (2005). Report on Public Health and Urban Sprawl in Ontario: A review of the pertinent literature. Ontario College of Family Physicians

The COVID-19 pandemic temporarily shifted transportation mode patterns. Many people no longer had to commute long distances by car and could spend more time walking or biking closer to home. These shifts, even if temporary, revealed that latent demand for active transportation modes may be higher than previously assumed. During our community engagement for this plan, CMCOG found high levels of community support for infrastructure that enables active transportation (such as sidewalks and protected bike lanes).

If such latent demand is met, residents may experience relief or even joy. People who walk and bike to work are happier with their commutes; those who travel by car or transit in heavily congested areas are less happy with their commutes.[399] Giving up a car can have a positive effect on feelings of life satisfaction and joy, two positive indicators of subjective well-being, for up to three years after the event.[400]

Potential Co-Harms

Active travel, through cycling and walking, is beneficial for health due to increased physical activity but may also expose people to higher levels of air pollution. However, a recent study has shown that the benefits of physical activity far outweigh risks from air pollution, even under the most extreme levels of active travel.[401] Additionally, planting a tall vegetation barrier along busy roads can significantly mitigate increased exposure to air pollution, as plants can capture air pollution particulates on their leaves.[402] Furthermore, the more people who walk and cycle, the more drivers become accustomed to looking out for them. Researchers have found that doubling the number of people who walk in a given area would reduce the risk of injury to each individual walker by approximately one-third.[403]

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399 Oliver Smith, "Commute Well-Being Differences by Mode: Evidence from Portland, Oregon, USA," *Journal of Transport & Health* 4 (March 1, 2017): 246–54, https://doi.org/10.1016/j.jth.2016.08.005.

400 Ann-Kathrin Hess, "The Relationship between Car Shedding and Subjective Well-Being," *Transportation Research Interdisciplinary Perspectives* 15 (September 1, 2022): 100663, https://doi.org/10.1016/j.trip.2022.100663.

401 Tainio, Marko, Audrey J. de Nazelle, Thomas Götschi, Sonja Kahlmeier, David Rojas-Rueda, Mark J. Nieuwenhuijsen, Thiago Hérick de Sá, Paul Kelly, and James Woodcock. "Can Air Pollution Negate the Health Benefits of Cycling and Walking?" Preventive Medicine 87 (June 2016): 233–36. doi:10.1016/j.ypmed.2016.02.002.

402 "Plants By School Playgrounds Protect Kids From Road Pollution, Study Finds," accessed October 3, 2022, *https://nextcity.org/urbanist-news/plants-by-school-playgrounds-protect-kids-from-road-pollution-study-finds*. and ORD US EPA, "Living Close to Roadways: Health Concerns and Mitigation Strategies," Overviews and Factsheets, January 10, 2017, https://www.epa.gov/sciencematters/living-close-roadways-health-concerns-and-mitigation-strategies.

403 Jacobsen, P. L. (2003). Safety in numbers: more walkers and bicyclists, safer walking and bicycling. Injury Prevention, 9(3), 205–209.

Impacts

Two actions in the transportation sector and one action related to urban trees will help reduce the amount of fossil fuels burned and improve physical and emotional well-being in the Midlands. The full list of actions are included in Appendix D: Summary of Co-benefits by Climate Action.

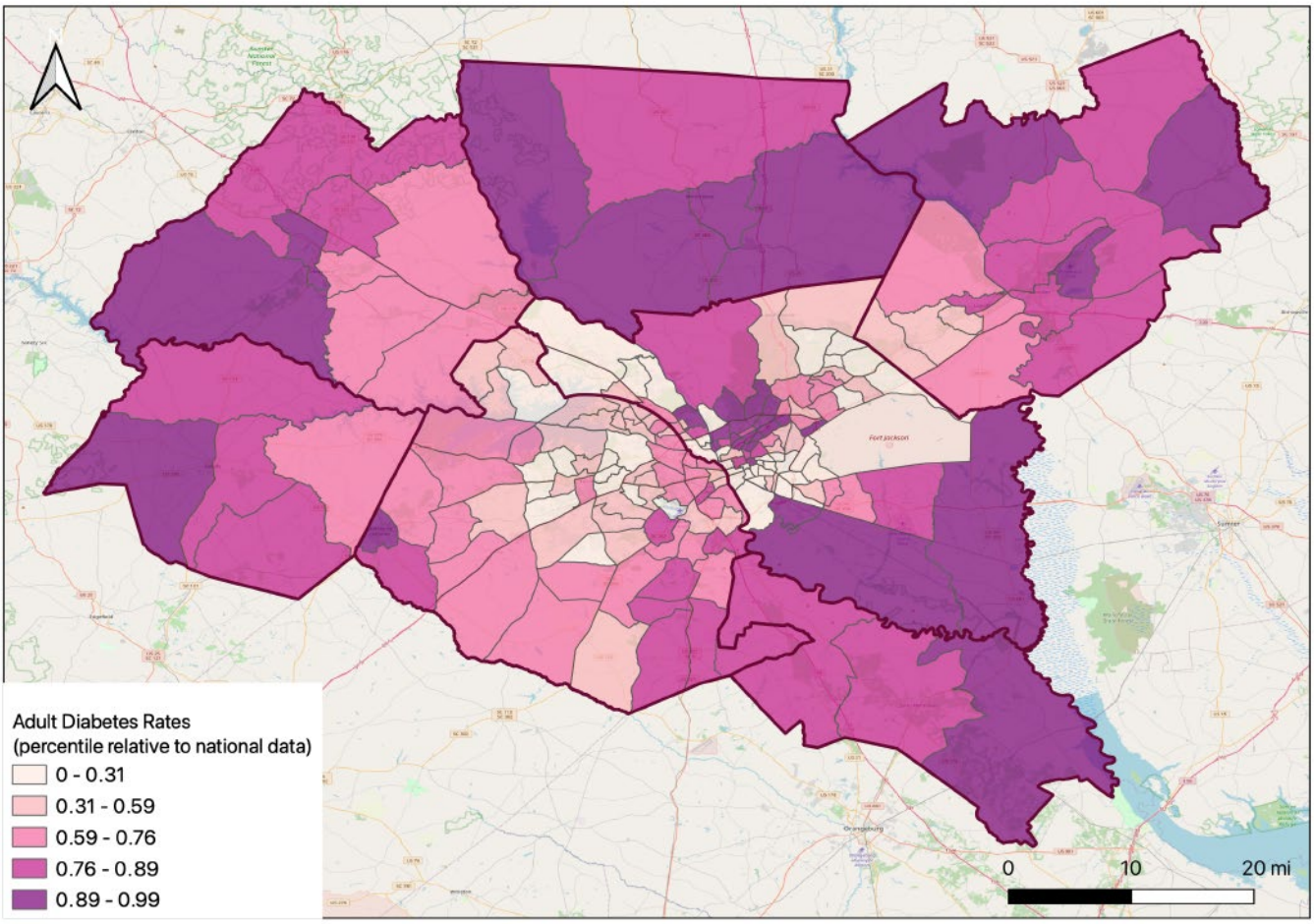
Residents in Midlands are projected to experience significant increases in active transportation under the low-carbon scenario compared to BAU and BAP. By 2050, the total number of active miles traveled annually, including both walking and biking, is expected to reach nearly 1,520 million miles, more than four times the projected total under BAU. This includes over 500 million hours spent walking and 35 million hours spent cycling each year, reflecting a 415% increase in active miles from the BAU baseline. These shifts are driven by land use, transit, and infrastructure investments that make walking, biking, and transit more accessible and appealing across the region (see Table 7.15).

Table 7.15.
Indicators of physical and emotional well-being in the climate action plan Scenarios.

Indicator	BAU	BAP	LCS
Yearly active miles (2050)	294	740	1,520
% Improvement from BAU	-	152%	416%
Annual number of hours spent walking million)	102	243	502
Annual number of hours spent cycling (million)	5	17	35

Figures 7.8 (below) and 7.4 (earlier) show areas in the Midlands with a high percentile of people experiencing diabetes and asthma. Understanding where health burdens are prevalent can help guide investments in walking, biking, and transit infrastructure to support public health benefits where they may be most impactful.

Figure 7.8.
Adult diabetes rates in the Midlands, relative to national percentiles. Data source: CEJST.



Occupant Comfort

Collectively, the conditions we experience inside buildings are known as "occupant comfort." As we typically spend 90% of our time indoors,[404] indoor health conditions are an important consideration.

The phenomenon of "sick building syndrome," prevalent in the 1980s and 1990s and continuing today, as well as the COVID-19 pandemic, helped to identify indoor air quality as a major health-influencing factor. Improvements in ventilation systems and less toxic building materials (e.g., insulation,

404 U.S. Environmental Protection Agency (EPA). 1989. Report to Congress on Indoor Air Quality — Vol. II: Assessment and Control of Indoor Air Pollution. EPA/400/1-89/001C. Washington, D.C.: US EPA. Available at tinyurl. com/CCN-2013-R017E

wall paneling) improve indoor air quality, often while reducing energy use. Improving energy efficiency can also affect health directly by influencing indoor temperatures, energy use and cost (with indirect effects on financial choices for low-income families) and the emission of toxic pollutants to the local environment.[405] Buildings with more stable and comfortable indoor environments have been found to reduce the risk of deaths from cold and hot spells and indirectly reduce absenteeism from school in children.[406]

Benefits of improved energy efficiency and tighter building envelopes include reduced mold, which has been found to directly reduce depression, arthritis and rheumatism, injuries and death, allergies, and symptoms of respiratory disease.[407] Energy-efficient buildings with opportunities for occupant control, such as windows that open and adjustable blinds, provide an increased sense of control, which reduces stress and improves mood.[408]

Potential Co-Harms

Meeting global greenhouse gas mitigation goals by 2035 could result in the health benefits described above if mechanical ventilation heat recovery systems with particle filtering are installed in retrofitted and new buildings. If such systems are not installed, operated, and maintained correctly, buildings could wind up with poor indoor air quality.[409] There may also be tradeoffs between preserving historic and heritage buildings and increasing occupant comfort. Reducing the severity of these tradeoffs means documenting current and historic energy use and creating detailed energy models for such buildings.[410]

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405 Milner, J., Davies, M., & Wilkinson, P. (2012). Urban energy, carbon management (low carbon cities) and co-benefits for human health. Current Opinion in Environmental Sustainability, 4(4), 398–404.

406 *International Energy Agency, "Capturing the Multiple Benefits of Energy Efficiency" (Paris, France, 2014), http://www.iea.org/publications/freepublications/publication/Captur_the_MultiplBenef_ofEnergyEficiency.pdf.*

407 *International Energy Agency.* 'Did it work: Evaluating the multiple benefits of energy efficiency'. https://iea.blob.core.windows.net/assets/imports/events/610/Buildings.8_Evaluating_multiple_benefits.pdf Accessed March 7, 2026.

408 *Uteuova, A. "'It's a Sanctuary'"* The Guardian. https://www.theguardian.com/environment/2022/feb/24/passive-building-energy-efficiency-affordable-housing-new-york . Accessed March 7, 2026.

409 Wilkinson P, Smith KR, Davies M, Adair H, Armstrong B, Barrett M, Bruce N, Haines A, Hamilton I, Oreszczyn T et al.: Public health benefits of strategies to reduce greenhouse-gas emissions: household energy. Lancet 2009, 374:1917-1929.

410 *Larissa Ide et al., "Balancing Trade-Offs between Deep Energy Retrofits and Heritage Conservation: A Methodology and Case Study,"* International Journal of Architectural Heritage *16, no. 1 (January 2, 2022): 97–116, https://doi.org/10.1080/15583058.2020.1753261.*

Impacts

A total of eleven actions in the commercial, residential and industrial building sectors will help reduce the amount of fossil fuels burned and improve occupant comfort in the Midlands. The full list of actions are included in Appendix D: Summary of Co-benefits by Climate Action.

Retrofitting homes and businesses can improve occupant comfort by creating more stable and healthier indoor environments. Under the low-carbon scenario, 5,469,000 dwellings and 4,978 million square footage of non-residential buildings will be upgraded from 2022 to 2050. Occupants of these upgraded buildings will experience less drafts and noise, more consistent temperatures, and overall improved air quality.

Lower-income households and communities of color are more likely to live in older, smaller homes with poor ventilation; share the home with more people (higher occupant density); lack adequate stove top ventilation; and have higher rates of asthma and other respiratory diseases due to other sources of pollutants. These households are also less likely to have the resources to undertake costly efficiency upgrades, therefore requiring targeted financial and technical assistance to overcome upfront costs and access barriers.

Measures that reduce the combustion of fuels in the home such as stoves, water heaters, and furnaces can reduce indoor air pollution, which in turn improves occupant's comfort. Transitioning to electric systems, particularly induction stoves and heat pumps, eliminates these combustion-related emissions.

7.6 Co-Benefits and Co-Harms: Economic Prosperity

Actions that reduce emissions can play a major role in revitalizing local economies across the Midlands. GHG reduction actions like improving energy efficiency create jobs and often lower energy costs.

Employment

The Columbia MSA is on an upward economic trajectory with high employment and population gains. The resident population went up 1.3%

from 859,158 in 2023 to 870,193 in 2024.[411] Similarly, as reported by the U.S. Bureau of Labor Statistics, employment increased by 1.7% from July 2024 to reach 432,458 workers in July 2025.[412] The South Carolina Department of Employment and Workforce (SC DEW) projects that an additional 45,000 workers will be added to the region by 2032.[413]

In general, the transition to a low-emissions economy is expected to have four categories of impacts on labor markets:

- **Jobs created:** Additional jobs will be created in emerging sectors, such as electric vehicles and renewable energy manufacturing.
- **Jobs shifted:** Some employment will be shifted, for example, from fossil fuel production and distribution to renewables.
- **Jobs phased-down:** Certain skillsets will be less in demand over time as equipment stock turns over. Examples include gas boiler servicing and petrol vehicle maintenance.
- **Jobs transformed:** Many existing jobs will be transformed and redefined, with some employment opportunities emerging that are not yet possible to anticipate.[414]

Transitioning to a low-emissions future will require massive investments in infrastructure — from vehicles to district energy, from manufacturing to energy efficiency. This mobilization of public and private finance — of up to $3.2 billion per city in one estimate[415] — will create many new jobs . For example, the Rocky Mountain Institute estimates that from January 2021 to January 2025, a total of $295 billion was invested in clean energy,

411 U.S. Census Bureau. Resident Population in Columbia, SC (MSA) [CBAPOP], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/CBAPOP, November 2, 2025.

412 U.S. Bureau of Labor Statistics. Economy at a Glance: Columbia, SC. Retrieved from https://www.bls.gov/eag/eag.sc_columbia_msa.htm#eag_sc_columbia_msa.f.3, November 2, 2025.

413 Stalnaker, Lainey. "Employment Projections: How many people will be working in South Carolina in 2032?" South Carolina Department of Employment and Workforce. March 24, 2025. *https://dew.sc.gov/labor-market-information-blog/2025-03/employment-projections-how-many-people-will-be-working-south*

414 Martinez-Fernandez, C., Hinojosa, C., & Miranda, G. (2010). Green jobs and skills: the local labour market implications of addressing climate change. Working Document, OECD. Retrieved from http://www.oecd.org/regional/leed/44683169.pdf

415 Gouldson, A., Colenbrander, S., McAnulla, F., Sudmant, A., Kerr, N., Sakai, P., … Kuylenstierna, J. (2014). The economic case for low carbon cities. A New Climate Economy. Retrieved from http://eprints.whiterose.ac.uk/82868/

which created over 349,000 clean energy jobs.[416] The Natural Resources Defense Council projected that stricter emissions standards for electricity generation could net 210,000 national jobs over a seven-year time period.[417] The American Clean Power reports that clean energy manufacturing not only creates jobs, but creates high paying jobs with average salaries above national median wage. Furthermore, the organization also estimates that every clean manufacturing job generates three additional jobs in the broader economy, boosting suppliers, contractors and local businesses.[418]

Investments in active travel and public transit create ample employment opportunities. Implementing policies to increase walking, biking, and public transit has been found to increase GDP, total employment, and employment in the transportation sector.[419] One assessment estimated that $1 billion dollars of spending on public transportation generated over 36,000 jobs, $3.6 billion dollars of output, and $1.8 billion dollars of GDP annually.[420] Additionally, spending on transit generates 70% more job hours than spending the same amount on highway projects.[421]

Potential Co-Harms

South Carolina's economy has grown steadily since the pandemic, adding jobs in manufacturing, construction, transportation, and clean energy. However, according to the Economic Policy Institute (EPI), most workers have not seen improvements in pay or job quality. Nearly one in five workers earn less than $15 an hour, and fewer than half of the fastest-growing occupations pay above the state's median wage of $20.30 an hour. Job growth has been strongest in metropolitan areas like Columbia, leaving rural communities behind. Black and Latino workers also face greater barriers to good jobs, reflecting persistent racial and geographic inequities.

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416 RMI (2025) Trillion Dollar Win: Clean Energy investment Benefits Growth and Jobs in All States. Retrieved from https://rmi.org/trillion-dollar-win-clean-energy-investment-benefits-growth-and-jobs-in-all-states/

417 Stanton, E., Comings, T., Takahaski, K., Knight, P., Vitolo, T., & Hausman, E. (2013). Economic impacts of the NRDC carbon standard. Retrieved from https://www.nrdc.org/sites/default/files/ene_13070101a.pdf

418 American Clean Power. The State of Clean Energy Manufacturing. May 2025. Retrieved from https://cleanpower.org/resources/america-builds-power/

419 Doll, C.,Hartwig, J. (2012). Clean, safe and healthy mobility through non-technical measures - Linking individual and public decision levels. Transportation Demand Management - mobil.TUM2012 International Scientific Conference on Mobility and Transport, Munich, Institute of Transportation, Technische Universitaet Muenchen

420 Reno, A.,Weisbrod, G. (2009). Economic Impact of Public Transportation Investment. Transit Cooperative Research Program. Rérat, P. (2012). "The new demographic growth of cities: The case of reurbanisation in Switzerland." Urban Studies 49(5): 1107- 1125.

421 SGA (2011). Recent lessons from the stimulus: Transportation Funding and Job Creation, Smart Growth America.

Most workers lack access to basic benefits such as health insurance or paid sick leave. The state also has the lowest union coverage rate in the country.[422] Ensuring an economically just transition includes investing in jobs that support unions and worker organizing, comply with or exceed mandatory labor standards, and maximize training and apprenticeship programs.[423]

Policy and implementation design are key to realizing the benefits of the new jobs created during the low-emissions transition, as well as mitigating the negative impacts of job losses. Workers in industries that will be phased out or where technologies are changing — gasoline and diesel automotive vehicle maintenance and repair, natural gas furnaces and water heating — need to be provided with the tools and resources necessary to transition their work. These could include transition assistance (financial or otherwise), investment in workforce training, and economic development assistance. For more detail, see the workforce analysis section of this report.

Impacts

A total of 31 of the actions in this Plan will produce new, good jobs in the Midlands. Specific job numbers are provided in Table 9.1.

Investments in the low-carbon scenario represent opportunities for existing and new businesses in the Midlands. These include businesses directly implementing elements of climate action, such as contractors, HVAC suppliers, construction companies, appliance manufacturers, renewable energy developers, car dealerships[424] and bike shops, as well as businesses supporting them, such as banks and credit unions, engineering firms, architects and designers, and insurance companies.

The creation of new industries and jobs provides opportunities to address inequities related to housing, income and rural-urban disparities without the pressure of excessive growth. For example, jobs created by climate change mitigation strategies could help reduce unemployment for marginalized groups and low-income and disadvantaged communities.

Dramatically Lower Energy Costs for Households

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422 Summarized from Childers, C, Mast, N, and Cohn, E (March 24, 2025). The State of Working South Carolina. *Economic Policy Institute*. Retrieved from https://www.epi.org/publication/state-of-working-south-carolina/

423 *"Solidarity for Climate Action" (San Francisco, CA, US: BlueGreen Alliance), accessed October 5, 2022, http://www.bluegreenalliance.org/wp-content/uploads/2022/07/Solidarity-for-Climate-Action-vFINAL.pdf.*

424 Car dealerships may benefit from increased EV sales, but may lose revenue due to decreased maintenance needs of EVs.

In South Carolina, energy costs account for a higher share of household spending than in many other states due to higher outdoor temperatures, widespread use of air-conditioning, and the prevalence of outdated appliances and inadequate insulation.[425]

The costs, particularly of natural gas and electricity in the Midlands, are expected to continue rising in the future. In addition, imported fossil fuel prices can easily rise or fall as a result of factors outside the control of local authorities. When the prices for these fuels rise as they did when Russia invaded Ukraine, the impact is felt directly by all households that still use these fuels.

According to the U.S. Department of Energy, actions that improve building and appliance energy efficiency have the potential to reduce energy use by 13-31%. The actions modeled for this plan confirm that there are significant savings to be realized here. Combining energy retrofits with renewable generation, through rooftop solar, community solar gardens, or the development of microgrids, reduce energy costs even further for everyone, and also help communities remain resilient during electricity disruptions and extreme weather events.

Impacts

A total of 14 actions across all sectors will help reduce emissions and energy costs, as they reduce the costs of fuel for transportation, electricity and heating and cooling buildings. The full list of actions are included in Appendix D: Summary of Co-benefits by Climate Action.

In the low-carbon scenario, average annual household spending on home energy (heating and cooling, lights and other electricity) and transportation falls 73% - from almost $6,194 to $1,673. This is shown in Figure 7.9.

- Making homes more energy effective and generally efficient through installing electric appliances and replacing heating/cooling systems with exceptionally efficient heat pumps will immediately increase savings. **By 2030, household costs have dropped by 39% to an average of $3,804 annually.**
- At the same time, better transit service, improved sidewalks and cycling infrastructure, and more compact communities means

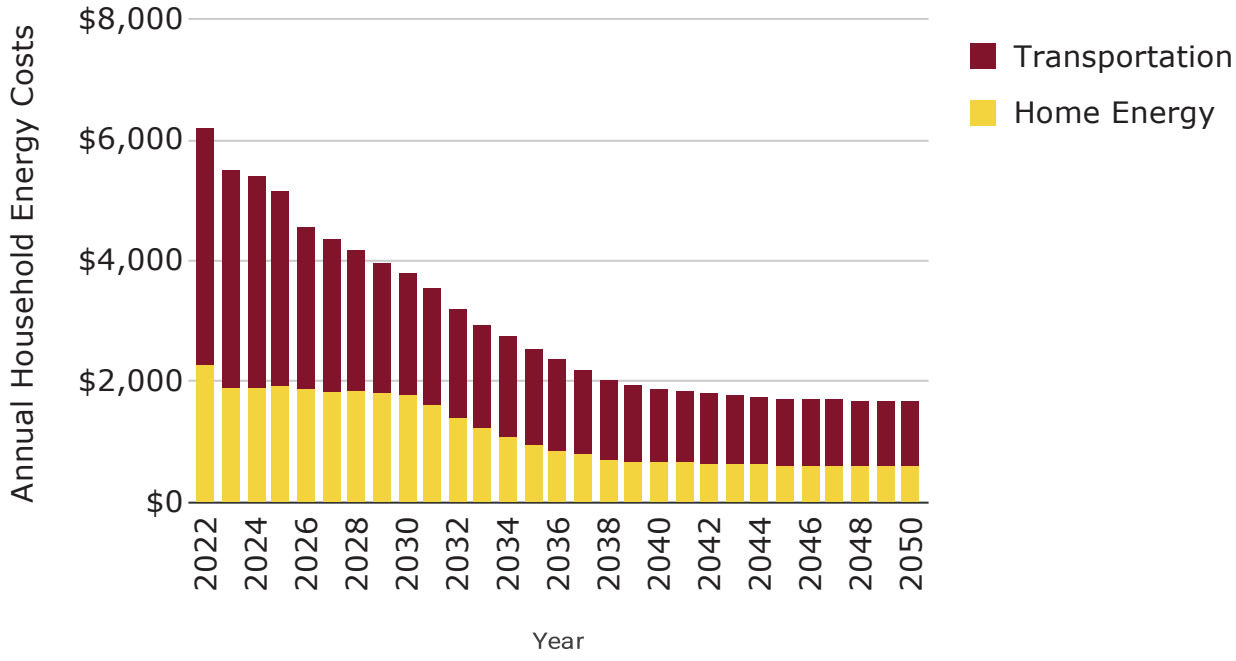
425 US Department of Energy. "Low-Income Household Energy Burden Varies Among States-Efficiency can Help in All of Them." Retrieved from https://www.energy.gov/sites/prod/files/2019/01/f58/WIP-Energy-Burden_final.pdf

people take more short-distance trips on the bus, or walking or cycling. It becomes feasible to live in more communities without owning a car. **By 2040, average household costs have fallen by 70% to $1,889 annually.**

- EVs make up an ever-increasing proportion of all personal vehicles. For households, this translates into dramatic savings in annual fuel and maintenance costs.
- **By 2050, households will save an average of US$ 2,865 per year on energy in their home** (driven by better insulation, tighter envelopes, and electric heat pumps for both space heating and cooling and water heating) **and about US$ 225 per year on transportation** (from taking more trips by walking, cycling, or transit, and from the lower operating costs of electric vehicles).

Together, these shifts protect residents from the price swings inherent to imported natural gas, gasoline and diesel, and free up more of the household budget for other needs.

Figure 7.9.
Average annual household spending on home energy and transportation in the LC scenario, 2022-2050.



Help for Energy Burden

Chapter 3 highlights how energy burden is a key issue facing many households in the Midlands. Low-income households face higher energy burdens partly because their homes are more likely to be older, drafty, and poorly insulated, which makes them less energy efficient. The U.S. Department of Energy notes that cost-effective improvements—such as better insulation and more efficient appliances—could reduce energy use by 13 to 31 percent.[426] In addition, pairing energy retrofits with renewable energy—through rooftop solar, community solar gardens, or microgrid development—can lower household energy costs even further. Renters that face energy burden encounter a split incentive problem, where any upgrades benefit the landlord. In some cases, renters may be limited or even prohibited from taking certain steps to try to lower their utility bills since they do not own the property.

Several programs, like the U.S. Department of Energy's Weatherization Assistance Program, provide assistance to thousands of households, but the need is far greater than the sum of existing programs and funding sources. The state legislature in May 2025 adopted a resolution to declare an energy burden crisis.[427]

Potential Co-Harms

Although cost savings are a benefit of many climate actions, some can lead to unintended negative consequences if not designed carefully.

For example, energy efficiency programs must be carefully designed to prevent households from having higher total energy costs after installing a heat pump. Heat pumps are far more efficient than furnaces for example, so they will use less energy (in the form of electricity) than a furnace (which may use natural gas or fuel oil). However, if electricity is considerably more expensive than natural gas, it is still possible for a household switching from gas to an electric heat pump to see an increase in their total monthly energy bills as a result, despite using less energy overall. To avoid this, programs for lower income residents should include measures such as installing free solar PV onto the home before switching

426 U.S. Department of Energy, Low-Income Household Energy Burden Varies Among States—Efficiency Can Help in All of Them, Office of Energy Efficiency and Renewable Energy, January 2019, https://www.energy.gov/sites/prod/files/2019/01/f58/WIP-Energy-Burden_final.pdf.

427 SC General Assembly. "H.4498 SC Energy Burden Crisis and Energy Justice Day." Retrieved from https://www.scstatehouse.gov/sess126_2025-2026/bills/4498.htm

the furnace to a heat pump, or long-term subsidies of their electricity costs to ensure that efficiency improvements translate into savings.[428]

Another potential risk comes from the possibility of gentrification. By increasing access to transit, walkable communities, and highly efficient homes, communities that were intended to be made more affordable become more attractive to higher-income earners. When this drives up housing costs, lower-income residents may be forced to relocate to areas which are often farther from job centers and essential services. This effectively redirects the benefits of affordable housing away from those who need it most while also potentially making their lives even more challenging.[429]

A third example is sometimes called 'renoviction'. This is a situation in which landlords evict tenants in order to make major retrofits to the building. When the renovations are finished, they significantly increase the rent for the same units, making them unaffordable for the original residents. To address this, some municipalities require that landlords freeze their rent for a period of time in order to qualify for energy efficiency rebates.

Finally, while clean energy and efficiency measures often lower long-term costs, they generally require upfront investments. LIDACs may be unable to access rebates or tax incentives, or face barriers to participating in retrofit programs. Targeted financial support, including income-tested grants and subsidies, and flexible financing mechanisms through entities like green banks, are crucial to addressing this. These types of programs can ensure that vulnerable households can access energy upgrades and clean energy technologies, reduce their energy burden, and realize the benefits of moving to a sustainable energy system.

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428 U.S. Department of Energy, "Most Americans Can Save on Energy Bills with the Right Heat Pump System," *Energy.gov*, accessed December 15, 2025, https://www.energy.gov/policy/articles/most-americans-heat-pump-can-lower-bills-right-now and American Council for an Energy Efficient Economy, *The Cost Effectiveness of Residential Heat Pumps in Different Fuel Price Scenarios* (Washington, DC: ACEEE, 2021), https://www.aceee.org/research-report/u2102.

429 Gaigné, C., Riou, S., & Thisse, J.-F. (2012). Are compact cities environmentally friendly? Journal of Urban Economics, 72(2), 123–136.

7.7 Co-Benefits and Co-Harms: Resilience

Passive Survivability

Passive survivability is "the ability to maintain safe indoor conditions in the event of extended energy outage or loss of energy supply. In practice, passive survivability enables safe indoor thermal conditions, relying on building design measures that require no energy. As a measure of a building's thermal performance, passive survivability offers an integrated assessment of both energy efficiency and resilience."[430]

Increasing the passive survivability of homes, community buildings, and essential infrastructure allows communities to withstand major events like power outages, heatwaves, and cold snaps. Design strategies for passive survivability aim to reduce dependency on mechanical systems through measures like better insulation and air-tightness, on-site power generation, natural ventilation through operable windows and vents, natural cooling with shading devices and reflective surfaces. Passive survivability enables buildings to maintain livable temperatures through design alone, even during power outages or grid disruptions. This capability becomes increasingly important as climate-driven hazards (e.g., extreme heat, wildfires, and air quality events) become more frequent and severe.

In the Midland region, where summer temperatures can reach well over 100 degrees Fahrenheit (°F), passive survivability is a critical resilience consideration. It can reduce reliance on energy-intensive cooling and backup power sources during emergencies, offering life-saving protection for medically vulnerable individuals, children, and seniors, especially in LIDACs, where residents may be more exposed to heat and less likely to have access to air conditioning, alternative cooling options, or power backup. For instance, landlords in SC are not required to provide air conditioning to renters.[431]

Impacts

A total of twelve actions in the building sector will help reduce emissions and improve passive survivability in the Midlands. The full list of actions are included in Appendix D: Summary of Co-benefits by Climate Action.

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430 U.S. Department of Energy. Energy Resilience. Retrieved from https://www.energycodes.gov/energy-resilience

431 South Carolina Appleseed Legal Justice Center (2024). Is your Landlord Required to Fix your A/C? https://www.scjustice.org/is-your-landlord-required-to-fix-your-a-c/

These climate actions increase energy efficiency and resilience to grid outages. Net-zero buildings, in particular, often incorporate airtight construction, high-performance windows, insulation, and shading, which are strategies that improve thermal stability and reduce dependence on active cooling or backup power systems. Solar power installations and battery-electric vehicles enhance resilience by providing back-up power during power outages.

Investing in passive survivability offers multiple resilience and public health benefits, particularly in the face of rising temperatures, energy insecurity, and extreme weather events. In the Midland regions, where prolonged heat waves are increasingly common, passive design features can help maintain safe indoor conditions during power outages, improve indoor air quality, and reduce peak energy demand. These strategies reduce reliance on mechanical cooling and backup power, which may be unavailable or unaffordable for many households.

By extending the amount of time buildings remain habitable without active cooling, passive survivability can prevent heat-related illness, reduce strain on emergency services, and enable safer shelter-in-place conditions during climate emergencies. Vulnerable populations, including older adults, children, people with chronic illnesses, and residents of LIDACs, stand to gain the most from such protections. Additionally, passive strategies (e.g., insulation, shading, and natural ventilation) can reduce household energy bills, offering long-term economic savings alongside climate resilience.

Reduction of Urban Heat Island Effect

The built environment greatly impacts the average temperature fluctuations of an area. Spaces that are heavily vegetated or treed or are near water bodies are typically cooler than those with hard, dry surfaces. Buildings, roads, sidewalks, and parking lots absorb heat from the sun and reflect it back, concentrating heat in densely developed areas. These areas, known as urban heat islands, are pockets of the landscape with elevated temperatures that are worsened by human activities, such as driving or air conditioning, that release more heat into the environment. Urban heat islands have elevated average temperatures; an issue of particular concern during heat events.

While areas with lots of vegetation and natural cooling may be within a safe temperature range for humans during a heat wave, urban heat islands are pushed into an unsafe range, increasing the risk of serious health impacts on people within those locations. Therefore, areas with high population densities are more likely to be impacted by the urban heat island effect.

Locations with less tree cover experience a greater urban heat island effect, which could be mitigated by increasing tree cover in these areas, as well as working to increase overall vegetation in denser neighborhoods across the region.

Between 2020 and 2023, the number of emergency department visits for heat related illness in South Carolina jumped by 20% from 1,514 to 1,828. Out of the 1,828 visits in 2023, approximately 13% were in the Midlands region.[432]

Outdoor workers, children, older adults, individuals with chronic illness, and other residents in LIDACs face elevated risk. These groups often live in neighborhoods with higher levels of impervious surfaces, less access to green infrastructure, and limited access to air conditioning or cooling centers.

Impacts

A total of twelve actions across all sectors will help reduce emissions and urban heat island impact in the Midlands. The full list of actions are included in Appendix D: Summary of Co-benefits by Climate Action.

The low-carbon scenario assumes a total 1,891,200 urban trees will be planted in cities and towns in the Midlands region from 2025 to 2050. These additional trees, alongside increased green infrastructure like bioswales, rain gardens and green roofs will reduce surface and air temperatures, thus lowering cooling demand and improving comfort and health for urban residents, especially during heat waves.

Water and Soil Health

Human activities—including intensive agriculture, urban development, deforestation, and industrial operations—have profound impacts on water and soil health. Excessive use of fertilizers and pesticides contaminates waterways and soils,[433] leading to nutrient runoff and harmful algal blooms. Deforestation and land clearing increase soil erosion and reduce the land's

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432 S.C. Department of Public Health. Tracking Heat Related Illness Dashboard. Retrieved from https://dph.sc.gov/professionals/public-health-data/sc-tracking/tracking-heat-related-illness-dashboard

433 Khan M.N., Mobin M., Abbas Z.K. and Alamri S.A. (2018) "Fertilizers and Their Contaminants in Soils, Surface and Groundwater." The Encyclopedia of the Anthropocene, vol. 5, p. 225-240. Oxford: Elsevier.

natural capacity to retain water,[434] while urbanization and impermeable surfaces decrease groundwater recharge and amplify flood risks.[435] Industrial discharges and improper waste management further degrade both soil and water quality, undermining ecosystem services that communities rely on for food production, drinking water, and flood regulation.

Climate action measures can address these pressures while producing additional co-benefits. For example, reforestation and adopting responsible agriculture practices improve carbon sequestration, enhance soil fertility, and reduce nutrient runoff into rivers and lakes. Green infrastructure, such as permeable pavements and rain gardens, not only mitigates urban heat and stormwater flooding but also improves water infiltration and soil health.

Potential Co-Harms

Some measures can also introduce unintended harms if not carefully designed. Poorly sited solar farms may compete with food production. Poorly designed composting or other waste diversion programs may produce leachate or run-off that contaminates local soil and water.

Effective climate strategies therefore require integrated planning that maximizes co-benefits for soil and water while minimizing negative environmental impacts. By aligning emission reductions with sustainable land and water management, communities can strengthen ecosystem resilience, support long-term agricultural productivity, and safeguard essential water resources.

Impacts

A total of eleven actions will help reduce emissions and improve water and soil health in the Midlands. The full list of actions are included in Appendix D: Summary of Co-benefits by Climate Action.

Trees planted in urban areas, modelled to be 1,891,200 in urban areas from 2025 to 2050, and 676,000 reforested areas outside the urban core, will be the main contributor to improving soil health and water systems in the Midlands. Both actions work to restore ecological functions degraded by land clearing and intensive land use. Better water and agricultural

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434 Nyasha, S. (2021). "Effects of deforestation on soil functions and how reforestation can reverse them." International Journal of Agricultural Sciences and Veterinary Medicine, vol. 9 (1), p. 36-40.

435 Sharp, J.M. (2010). "The Impacts of Urbanization on Groundwater Systems and Recharge." AQUAMundi Vol.1. P.51-56. Retrieved from https://web.archive.org/web/20170808220546id_/http://www.acquesotterranee.it/sites/default/files/Am01008.pdf

management amplifies these gains by reducing runoff, improving irrigation efficiency, and supporting soil conservation practices that combine with reforestation to protect waterways and sustain long-term land productivity. Finally, connecting the 30% of households currently using septic tanks to the sewage network will eliminate the tanks' leakages, improving local soil and water health.

8 Implementing & Funding the Climate Action Plan

The speed and scale of the change described in this Climate Action Plan is transformative. Implementing this plan effectively requires cooperation across multiple entities. Whenever an actor in the Midlands is uncertain about how to move forward as an individual or an organization, they can reach out to staff experts at CMCOG or other organizations in the community to receive technical assistance. However, the best thing to do is simply get started with any action known to reduce greenhouse gas emissions. This chapter thus presents one suggested implementation pathway for each major type of actor in our community.

The chapter concludes by discussing an intersection of this plan with other funding and summarizing the key implementation notes associated with each climate action listed in this plan. Chapter 6 contains implementation pathway notes that are specific to each climate action, and further discussion of available implementation and funding pathways can be found in the separate Additional Guidance on the Implementation of Climate Actions Memo.

8.1 Getting Started

Setting a Visionary Framework

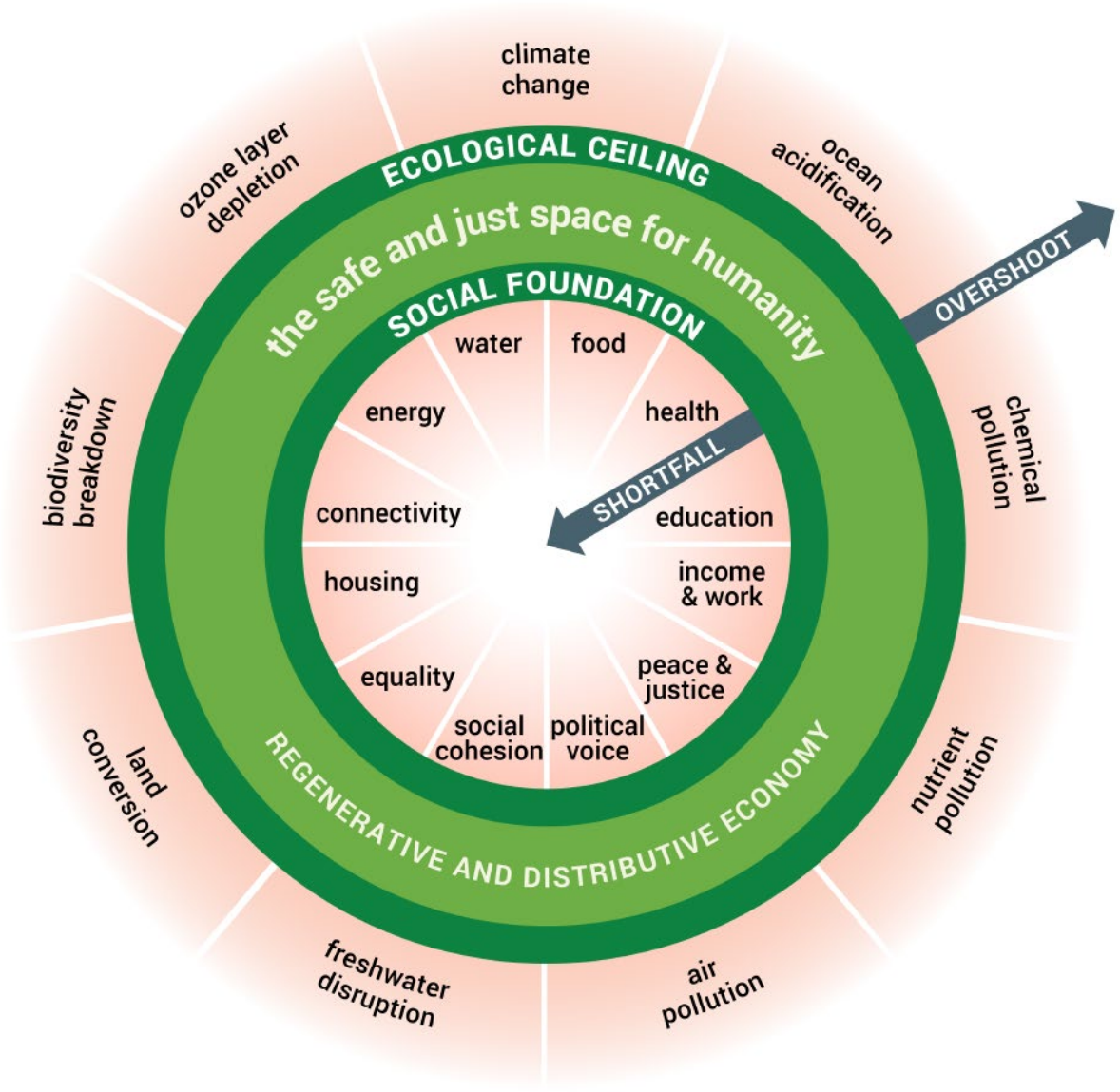
This plan sets a target for net-zero greenhouse gas emissions by 2050. To implement this plan, the Midlands can utilize the donut framework (see Figure 8.1). This tool is a reference that enables more effective climate action by reminding all stakeholders:

- Both human and ecological flourishing are the key outcomes of effective climate action.
- A flourishing environment is not possible without a social foundation that supports all people in the Midlands.
- A flourishing community is not possible if it pressures the planet and ecosystems in the Midlands too much.

The donut is a widely used tool for ecological and economic decision-making. CMCOG can advise organizations in the Midlands on how to adopt this framework and integrate it into decision-making.

Figure 8.1.

The donut framework. This tool sets an overall vision for a community and for individuals and organizations to guide how they make decisions.[436]



436 Raworth, K. (2017). A Doughnut for the Anthropocene: humanity's compass in the 21st century. The lancet planetary health, 1(2), e48-e49. [original source] and Raworth, K (2025). The Evolving Doughnut, Doughnut Economics Action Lab, Oxford. https://doi.org/10.64981/XGRX2738 [image source]. Learn more from Fanning, A.L., Raworth, K. Doughnut of social and planetary boundaries monitors a world out of balance. Nature 646, 47–56 (2025). https://doi.org/10.1038/s41586-025-09385-1 and at https://doughnuteconomics.org/tools/the-evolving-doughnut

Local Governments - Collect and Spend Money on Climate Action

Local governments can prioritize spending on climate actions that directly benefit their residents. The suggested action is to collect and spend money every year on climate action. A good metric to use as a minimum recommended funding level is about $10 per person per year. These funds should be pre-allocated and collected using a recurring and permanent funding stream. This allows for climate action to scale over time.

Local governments can pick any of the climate actions in this plan (or any others that verifiably reduce greenhouse gas emissions), and begin implementing them. Additional actions can be added over time, until the local government is acting to reduce greenhouse gas emissions across all sectors.

For example, collecting $1 per month on utilities via a franchise fee would lead to approximately this level of minimum funding and a surprising amount of climate action. One analysis found that if all cities nationwide implemented this policy to start reliably funding climate action, it could create 10,000 times more solar installations that were put in across the entire United States in 2024.[437]

Grants or other small and irregular funding streams will not eliminate the air pollution problem in the Midlands and relying solely on occasional grant projects cannot scale up climate action to the levels needed to reach this plan's targets. Table 8.1 recommends a funding minimum for each local government in the Midlands. This table provides the 2023 population for each local government in the Midlands[438] and then assumes that each spends $10 per person.

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437 Cook, J. J., Grunwald, B. U., Holm, A., & Aznar, A. (2020). Wait, cities can do what? Achieving city energy goals through franchise agreements. Energy Policy, 144, 111619. | CMCOG divided the potential estimate from the policy by the total U.S. solar capacity installed in 2024.

438 U.S. Census Bureau (2025). 2023 Population Values, ACS 5-Year Estimates. *https://data.census.gov* | Note that CMCOG subtracted the population totals of cities and towns that fall within a county from that county's population total, so that each person in the Midlands is only counted once.

Table 8.1.

Recommended local government annual funding levels for climate action

Local Government	2023 Population	Annual Climate Action Funding Minimum
Richland County	252,541	$2,525,410
Lexington County	226,066	$2,260,660
Columbia	138,019	$1,380,190
Kershaw County	56,302	$563,020
Newberry County	24,162	$241,620
Lexington	24,132	$241,320
West Columbia	17,723	$177,230
Fairfield County	16,274	$162,740
Saluda County	15,370	$153,700
Cayce	13,718	$137,180
Calhoun County	12,073	$120,730
Irmo	11,799	$117,990
Newberry	10,733	$107,330
Forest Acres	10,491	$104,910
Camden	8,025	$80,250
Blythewood	5,309	$53,090
Batesburg-Leesville	4,935	$49,350
Winnsboro	3,332	$33,320
Saluda	3,095	$30,950
Springdale	2,727	$27,270
Pine Ridge	2,709	$27,090
Elgin	2,176	$21,760

Local Government	2023 Population	Annual Climate Action Funding Minimum
Gaston	2,026	$20,260
South Congaree	1,918	$19,180
St. Matthews	1,626	$16,260
Chapin	1,410	$14,100
Whitmire	1,241	$12,410
Prosperity	1,198	$11,980
Pelion	1,147	$11,470
Ridge Spring	848	$8,480
Arcadia Lakes	843	$8,430
Swansea	700	$7,000
Summit	596	$5,960
Eastover	566	$5,660
Gilbert	563	$5,630
Cameron	451	$4,510
Little Mountain	446	$4,460
Bethune	421	$4,210
Ward	284	$2,840
Ridgeway	240	$2,400
Monetta	209	$2,090
Silverstreet	160	$1,600
Pomaria	103	$1,030
Peak	78	$780
Jenkinsville	47	$470

Businesses - Lower Pollution Directly or Indirectly

As discussed in chapter 9, some businesses in the Midlands manufacture products that directly reduce greenhouse gas emissions. However, even businesses whose core products or services are not tied directly to climate change have a role to play in climate action, because almost all businesses emit greenhouse gases either directly (e.g., fossil fuel use or energy use) or indirectly (e.g., through the purchase of goods and services). The suggested implementation action for businesses is to lower greenhouse gas emissions either directly or indirectly.

Small Businesses

There are varying definitions of small businesses, but they generally have fewer than 500 employees and/or have less than $10 million in annual revenue, and are more likely to be local to the Midlands. Smaller businesses often emit greenhouse gases at their business, such as by using electricity or using vehicles that produce greenhouse gas emissions. Small businesses can strive to reduce direct greenhouse gas emissions they are responsible for whenever possible. Examples include reducing energy use or purchasing an electric vehicle that emits no greenhouse gas emissions.

Lowering greenhouse gas emissions directly may not always be possible, such as when a business rents a building and has no authority to modify it to reduce energy use. In these cases, small businesses can act indirectly to lower greenhouse gas emissions. The most common two mechanisms to do so are:

1) Purchasing Power - when possible, apply a purchasing preference for more sustainable goods and services.

2) Funding Climate Action for Others - regularly fund climate actions done by others. Several existing certifications, like 1% For the Planet, recognize businesses of all sizes that annually fund climate action. In the past, the Midlands and South Carolina have also had sustainable business programs or other ways to contribute to local efforts. Such programs often enable a business to be recognized for the funding.

Large Businesses & Industry

There are varying definitions of large businesses, but they generally have more than 500 employees and/or exceed $10 million in annual revenue. These businesses are more likely to emit larger amounts of greenhouse gas emissions directly, and are also more likely to own the assets producing the pollution (such as buildings and equipment). These businesses can act to reduce emissions in the Midlands directly as soon as possible. Indirect actions like providing funding for the climate actions of others should be in addition to direct action to lower the businesses' scope 1 and scope 2 emissions.

As they seek to reduce direct greenhouse gas emissions as fast as possible, large businesses and industry in the Midlands should:

- At minimum, track all scope 1 and scope 2 emissions on a regular basis, or at least every 5 years, to identify how much greenhouse gas emissions they are releasing in the Midlands.
- As needed, seek technical assistance to identify steps to reduce the direct greenhouse gas emissions sources identified. Several sources of free guidance and support exist, such as the University of North Carolina, Charlotte Industrial Assessment Center (CC-ITAC), if the business or manufacturer is uncertain how to proceed.
- Once the solution is identified, eliminate the source of greenhouse gas emissions.

Residents - Talk to Others

Individuals and households, particularly those that are middle or high income, can make several important decisions that result in lower greenhouse gas emissions. The top two areas are:

1) Home Energy Use & Daily Travel: Lowering greenhouse gas emissions in the home and in the daily method of personal/work travel can have a meaningful impact when scaled up. The option that lowers greenhouse gas emissions (electric vehicle, heat pump HVAC, etc.) often costs slightly more up front but has large monetary savings over its lifetime as well as public health benefits, as described elsewhere in this plan. If a resident or household has the monetary means to save money and lower greenhouse gas emissions, they can do so.

2) Lifestyle Choices: Thoughtful decision-making about diet, air travel, the consumption of goods produced outside the Midlands, and more can all have greenhouse gas emissions reductions of varying sizes.

However, the number one climate action a resident in the Midlands can take is to communicate with others about climate change.[439] This is something everyone can do, regardless of income or other personal circumstances. While counterintuitive, it rests on the premise that while individual choices are important, other actors in the community have a comparatively large influence. The suggested action for residents is thus to talk to others about climate change.

One estimate for a "household carbon footprint" in the Midlands is about 50 MT of CO_2e per year.[440] By comparison, if the state of South Carolina updated the energy efficiency building code which is over 15 years out of date, it would save 841 MMT of CO_2e as a total greenhouse gas emissions reduction.[441] Thus, if the Midlands household eliminated all of its emissions, it would take that household 16.8 million years to have the same relative impact as updating our building code statewide (which can be done within the course of a few weeks, anytime the state legislature is in session).[442]

This example is not meant to reduce the meaningful contribution of an individual's choice to reduce their own greenhouse gas emissions. Rather, it is to show how large actors like government and private businesses have a large impact. Their choices shape the impacts of others. If the electricity grid emits no greenhouse gas emissions, then all electricity users emit no greenhouse gas emissions from consuming electricity. Actions within each view offer different relative strengths and weaknesses, but emerging theory suggests that striving for systemic change is routinely undervalued in many people's minds.[443]

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439 Ettinger, J., McGivern, A., Spiegel, M. P., King, B., Shawoo, Z., Chapin, A., & Finnegan, W. (2023). Breaking the climate spiral of silence: lessons from a COP26 climate conversations campaign. Climatic Change, 176(3), 22.

440 Christopher M. Jones and Daniel M. Kammen, Spatial Distribution of U.S. Household Carbon Footprints Reveals Suburbanization Undermines Greenhouse Gas Benefits of Urban Population Density. Environ. Sci. Technol., 2014, 48 (2), pp 895–902, dx.doi.org/10.1021/es4034364

441 Athalye et al. (2016). Impacts of Model Building Energy Codes - South Carolina. Pacific Northwest National Laboratory. U.S. Department of Energy, Document #PNNL-25611 Rev. 1. https://www.energycodes.gov/status/states/south-carolina

442 In South Carolina, energy efficiency building codes are set by state law, and can be updated during any state legislative session via an update to state law.

443 Chater, N., & Loewenstein, G. (2023). The i-frame and the s-frame: How focusing on individual-level solutions has led behavioral public policy astray. Behavioral and Brain Sciences, 46, e147. doi:10.1017/S0140525X22002023

Residents can change their communities by talking about what is important to them with their families, friends, co-workers, and community leaders in government and business. Conversations build on one another, and can lead to a community change that drives climate action for decades to come and at large scales.

Community Based Groups, Educational Institutions, and Other Actors - Provide Technical Assistance

The Midlands is home to a vibrant group of universities and colleges, non-profits and community based groups, churches & other religious centers, and more. These organizations often employ experts to conduct research, science, or policy work. In many cases, climate actions can be confusing and access to expertise and knowledge can be valuable. Thus, the suggested action for these groups is to provide technical assistance.

For example, when an HVAC unit breaks, a homeowner may seek out information about energy efficiency and how to reduce energy use in order to save money, but the loss of air conditioning or heating means that any information or technical assistance is needed quickly. A neighborhood group, faith community, or non-profit organization can help that homeowner understand which alternatives would be environmentally friendly, save energy, and lower costs over time.

Another example is that community actors may have ideas for climate action, but do not have access to data, lack data analysis capacity, or may need science translation. Experts at educational institutions can provide these services directly, partner on grant applications, and ensure their research addresses community needs in the Midlands.

While it is easy to discount technical assistance, the metropolitan area contains less than 1 million people and subject matter experts with knowledge in energy, environmental science, public health, conservation, etc. are currently limited in the Midlands.

8.2 Intersection with Other Funding Availability

Achieving CMCOG's climate goals will require sustained and strategic investment across public, private and philanthropic sectors. Implementation will hinge on the ability to mobilize and manage funding effectively. Climate action will rely on funding sources and financing mechanisms. Funding sources include financial resources such as federal grants, state general funds, taxes or private finance. Financing mechanisms can include revolving loan funds, public-private partnerships, and on-bill financing.

Funding should be pursued in the following strategic priority order:

1) Organizations funding their own climate action. This is particularly important for businesses and local governments. It is not possible to implement this plan without direct funding. Local governments should begin at a funding level of $10 per capita, and businesses should begin at a funding level of 1% of annual gross revenues.

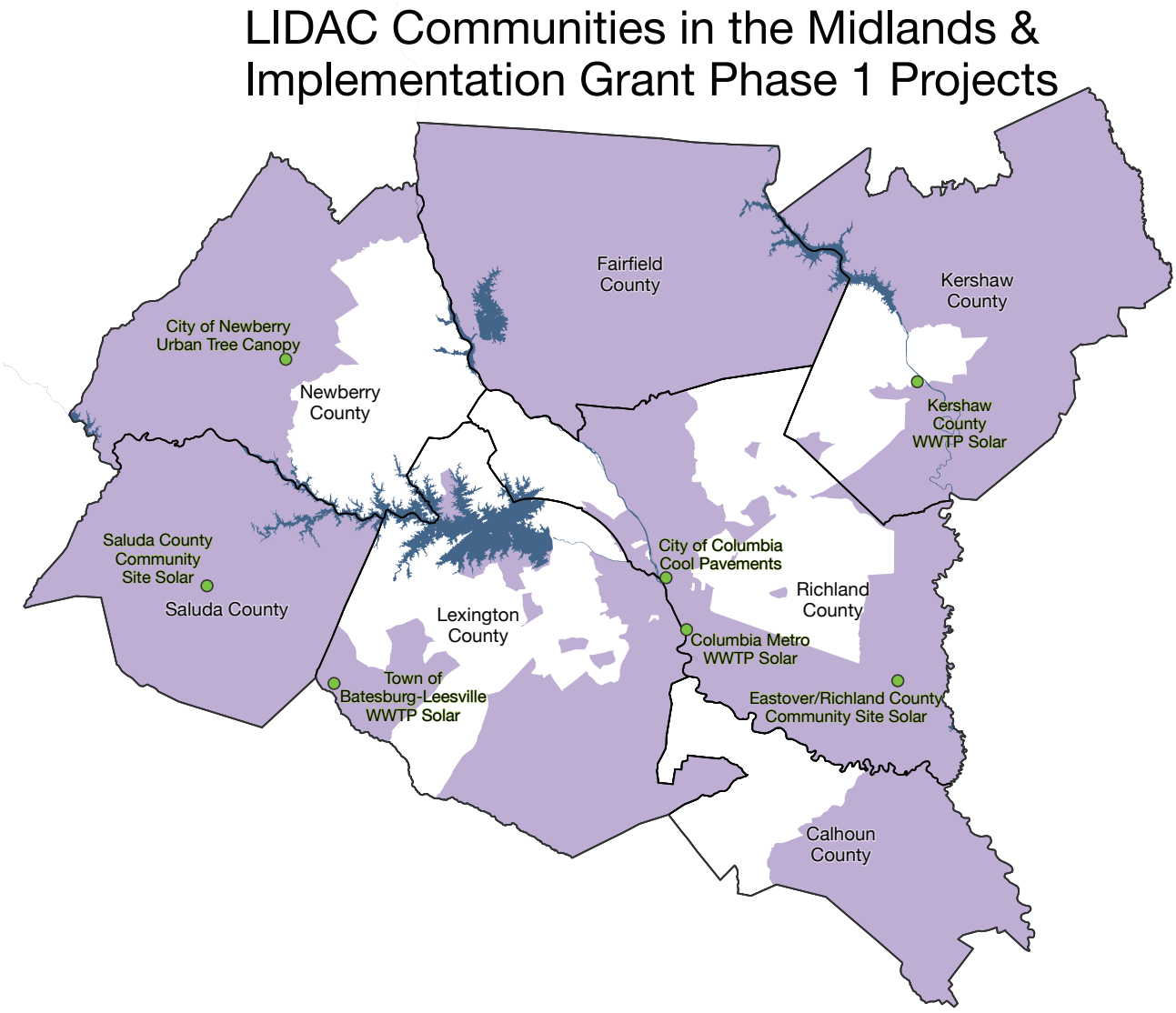
2) Mission-aligned finance. Certain institutions, like green banks, are non-profit finance sources that seek to drive progress on climate actions where projected savings over time enable certain financial mechanisms. This can be helpful when the sole cause of inaction is a lack of upfront investment capital and when financialization is viable. South Carolina currently has one capitalized and operating green bank - The Clean Energy Fund of the Carolinas.

3) Local and regional philanthropic funds. These groups are more likely to be accessible to organizations in the Midlands, and may be more willing to invest in scaling climate action programs over time rather than single-time investments in pilot projects.

4) Grants from federal or state governments. These sources of funds can be unreliable, often impose rules that make them resource intensive to manage, and can be highly competitive. Grant project periods also have a defined end date, and it is nearly impossible to scale climate action using grants. Grants should mainly be pursued for pilot projects that jumpstart action or when a particular source of greenhouse gas emissions can be completely eliminated with a single grant project.

The Central Midlands Council of Governments is a hub of technical assistance and can advise on potential climate action project economics or applications to green banks philanthropic funders. In some cases, our agency directly coordinates grant coalitions in the Midlands. One example is the CPRG Implementation Grant, where CMCOG coordinated with several local governments and was awarded $8.7 million to implement smart surface pilot projects.[444]

Figure 8.2.
Anticipated project sites funded under CMCOG's CPRG Implementation Grant.



444 U.S. EPA (2024). Central Midlands Council of Governments (South Carolina). CPRG Implementation Grant. https://www.epa.gov/inflation-reduction-act/central-midlands-council-governments-south-carolina

8.3 Climate Action Implementation Measures

This section provides CMCOG with a list of possible implementation measures for each action in the low-carbon scenario. It also indicates which actors would likely be able to implement the measure, and suggests key performance indicators to monitor in order to track the effectiveness of the measure and broader progress on the plan's goals.

Table 8.2.
The Strategies, Actions and Corresponding Implementation Measures in the low-carbon scenario.

Strategies	Actions	Implementation Measures
Commercial and Residential Buildings Sector		
Design Buildings for Life	**High Performance New Residential Buildings**	▪ Adopt and enforce updated energy efficiency building codes at the state level ▪ Introduce Home Energy Score and commercial building benchmarking programs ▪ Capacity building for developers, builders and designers (incentivized training, partnership with ed institutions & industry associations, mentorship, knowledge exchange platform)
	High Performance New Non-residential Buildings	

Strategies	Actions	Implementation Measures
Commercial and Residential Buildings Sector		
Design Buildings for Life	**Residential Energy Efficiency Improvements:** **Level 1 Weatherization** **Residential Energy Efficiency Improvements:** **Level 2 Enhanced Energy Efficiency** **Residential Energy Efficiency Improvements:** **Level 3 Deep Retrofits**	▪ Expand the Weatherization Assistance Program ▪ Introduce Deep Retrofit Programs ▪ Introduce Home Energy Score program ▪ Encourage utilities and electric cooperatives to enhance demand-side management programs and introduce distributed energy resources programs focused on residential sector ▪ Capacity building for contractors and equipment installers (incentivized training - subsidies & stipends, accreditation & QA programs, apprenticeship, technical guides, partnership with trades and unions)

Strategies	Actions	Implementation Measures
Commercial and Residential Buildings Sector		
Design Buildings for Life	**Non-residential Energy Efficiency Improvements:** **Level 1 Weatherization** **Non-residential Energy Efficiency Improvements:** **Level 2 Enhanced Energy Efficiency** **Non-residential Energy Efficiency Improvements:** **Level 3 Deep Energy Retrofits**	▪ Introduce building benchmarking & tune-up program ▪ Offer deep retrofit incentives ▪ Encourage utilities and electric cooperatives to enhance demand-side management programs and introduce distributed energy resources programs focused on non-residential sector ▪ Capacity building for contractors and equipment installers ▪ Partner with Chambers of Commerce and other business associations to build awareness

Strategies	Actions	Implementation Measures
Commercial and Residential Buildings Sector		
Design Buildings for Life	**Heat Pumps for Water Heating** **Heat Pumps for Space Heating & Cooling**	▪ Introduce financial support initiatives like – Rebates and discounts – Leasing programs – Bulk purchase programs ▪ Incorporate into Green Building Standards ▪ Promote EnergyStar appliances ▪ Phase out fossil fuel appliances after 2030 - both new and used. ▪ Encourage utilities to create programs that replace old appliances with electric versions. ▪ Create a program that will provide emergency electric heating for free when someone's furnace fails until a heat pump can be installed.

Strategies	Actions	Implementation Measures
Transportation Sector		
Reimagine Transportation in the Midlands	**Increase Active Transportation**	▪ Introduce initiatives to reduce motorized commuting for work and school: – Work-from-home – Transit coupons – Safe Routes to School programs – Work with businesses to eliminate free parking perks for employees, and replace them with payment or bonuses for commuting actively. – Create a micro-offsets program that provides people with cash for miles walked or biked. – Make the regional bus system free-to-ride ▪ Implement congestion & parking charges ▪ Encourage ridesharing services ▪ Improve innercity and intercity connections with busses and rail ▪ Improve linear assets, including protected bike lanes, walkways ▪ Introduce on-demand transit
	Increase Transit Ridership	
	Reduce vehicle-miles-travelled (VMT) in Columbia	
	Replace Transit Buses and Shuttles with Electric Models	▪ Establish bulk purchasing programs with municipalities within the Midlands. ▪ Introduce joint upskilling programs for municipal drivers and mechanics

Strategies	Actions	Implementation Measures
Transportation Sector		
Reimagine Transportation in the Midlands	**Electrify Personal and Commercial Light-duty Vehicles**	Measures that encourage desired behaviors: – Introduce enabling EV policies (land-use, zoning, building) that allow/ streamline installation of charging infrastructure networks, esp in apartment buildings and commercial areas – Develop EV incentive programs – Collaborate with car dealerships on awareness programs Measures that discourage behaviors that are not desired: – Introduce charges for residential street parking in which high-emitting vehicles are charged a fee annually per MT of emissions released from each vehicle parked on the street. This action has proven effective at stimulating earlier transitions to EVs, and at reducing the number of vehicles owned per household. – Introduce congestion charges or downtown parking charges in which high emissions vehicles pay the most, and their fees rise quickly. Exempt vehicles that emit no air pollution and vehicles modified for disabled residents.

Strategies	Actions	Implementation Measures
Transportation Sector		
Reimagine Transportation in the Midlands	**Replace Municipal and County Fleet Vehicles with Electric Vehicles**	▪ Availability of EVs from State Fleet for local government leasing. ▪ Establish bulk purchasing programs with EV distributors to add leverage to price negotiations and encourage on-schedule delivery. Include municipalities, utilities, institutions, logistic companies, and other large fleet owners. ▪ Introduce joint upskilling programs for drivers and mechanics ▪ New diesel taxes.
	Replace Commercial Medium and Heavy-duty Vehicles with Electric Models	
	Transport More Freight by Rail rather than by Truck	▪ Upgrade rail infrastructure and vehicles for efficiency and capacity ▪ Integrate multi-modal planning to improve inter and intra-regional connectivity for both freight and passenger services, and to integrate train travel with transit and active transportation routes (for passenger services) and with last-mile connectivity alternatives for freight. ▪ Encourage rail spurs in economic development projects & planning. ▪ New diesel taxes.
	Shift Personal Vehicle Travel to Rail Travel	
	Shift diesel freight train engines to lower-emissions engines	

Strategies	Actions	Implementation Measures
Electricity Sector		
Expand Renewable Energy Generation	**Rooftop Solar PV in Columbia** **Rooftop Solar PV outside Columbia** **Restart Columbia Canal Hydro** **Canopy Solar on Parking Lots in Downtown Columbia** **Utilities Switch to Renewable Energy Sources to Generate Grid Electricity**	▪ Work with utilities and local governments to streamline permitting, siting, and interconnection processes ▪ Enable plug-in solar that enable renters to benefit from solar ▪ Introduce financial support incentives like grants, discounts, rebates and tax credits ▪ Establish green financing mechanisms like green banks, low-interest loans and revolving funds ▪ Support community aggregation and cooperative projects, like community solar programs or bulk purchasing programs like solarize campaigns. ▪ Encourage local governments to source a percentage of power from renewable energy or place solar directly on/adjacent to buildings. ▪ Capacity building for electricians, technicians and engineers for renewable energy systems design, installation and maintenance

Strategies	Actions	Implementation Measures
Industrial Sector		
Advance Low-carbon Transformation in Industry	**Industrial Efficiency Improvements**	▪ Introduce programs to support or incentivize energy efficiency in industrial sector, for measures like envelope improvements, waste heat recovery, high efficiency equipment, regular energy audits, and strategic energy management practices ▪ Develop strategic collaboration between industrial sector, municipal governments, academia to support innovation, establish performance standards, and accelerate adoption of proven efficiency measures ▪ Capacity building and workforce training for engineers, operators, and maintenance staff on energy management, efficient operations, and emerging clean technologies.
	Solar on Industrial Buildings	▪ Introduce financial support incentives like grants, discounts, rebates and tax credits ▪ Technical assistance as required

Strategies	Actions	Implementation Measures
Waste and Materials Management		
Scale Up Waste Reduction and Diversion Initiatives	**Reduce Waste Generation**	▪ Expand existing awareness and educational programs ▪ Conduct waste audit every 3-5 years and tailor programs to target largest waste sources
	Divert Organic Waste from Landfills	▪ Continue compost bulk buy programs for urban areas ▪ Collect organics from high volume sites and deliver to large composting operations
Optimize Water and Wastewater Operations	**Anaerobic Digestion at all Water and Wastewater Treatment Plants**	▪ Support water/wastewater utilities in seeking funding and low-interest loans for upgrading facilities and assets. ▪ Strategic planning and research for prioritizing efficiency upgrades, and grant applications. ▪ Facilitate collaboration between water/ wastewater utilities to have joint training and knowledge sharing on latest technologies and best practices, and to share implementation data regionally.
	Improve Efficiency of Water and Wastewater Treatment Assets	
	Install Solar at Wastewater Treatment Plants	▪ Introduce financial support incentives like grants, discounts, rebates and tax credits ▪ Technical assistance as required

Strategies	Actions	Implementation Measures
Waste and Materials Management		
Optimize Water and Wastewater Operations	**Reduce Water Consumption**	▪ Introduce awareness and educational programs ▪ Work with local governments and water utilities to develop rebate programs for installing low-flow fixtures ▪ Promote high-efficiency fixtures through development standards and retrofit programs ▪ Encourage water reuse and recycling like graywater for non-potable use, xeriscaping, and rainwater harvesting
	Replace Septic Systems with Connections to Wastewater Treatment Plants	▪ Develop targeted incentive programs
Natural and Working Lands		
Protect Trees and Encourage Green Infrastructure	**Increase and Maintain Healthy Urban Trees**	▪ Accelerate urban tree planting programs via a mix of government funding, grants, and community involvement ▪ Develop guidelines for selecting and maintaining urban trees, tailored to biodiversity, aesthetics, and climate resilience ▪ Revisit zoning requirements

Strategies	Actions	Implementation Measures
Natural and Working Lands		
Protect Trees and Encourage Green Infrastructure	**Reforestation**	▪ Promote federal and state forestry programs ▪ Partner with local landowners and non-profits to coordinate large-scale reforestation or afforestation projects ▪ Encourage agroforestry and silvopasture systems that combine tree planting with agricultural production
	Add Green Infrastructure	▪ Uplift stories of success, share data for completed projects regionally ▪ Revisit zoning requirements
Enhance Agriculture and Soil Management Practices	**Climate Smart Commodities** **Agrivoltaics**	▪ Support the Climate-Smart Commodities Initiative and promotes its outcomes ▪ Provide financial incentives and technical training for farmers to transition to climate-smart practices via Clemson Extension ▪ Utilize grants or other finance mechanisms for Agrivoltaics, similar to other solar related climate actions
Intentional Land Use	**Smart Growth**	▪ Encourage in-fill development, multi-use development, and increased density via zoning and incentives ▪ Limit growth outside existing local community boundaries, and consider available policy tools (e.g., zoning) or regional planning as mechanisms to define a boundary to freeze in order to prioritize in-fill development
	Install Reflective Surfaces	▪ Revisit zoning requirements

Strategies	Actions	Implementation Measures
Natural and Working Lands		
Reduce Consumption-based Carbon Impact	Increase Circular Economy	▪ Develop a region-wide circular economy strategy that focuses on the idea of zero-landfill waste. Strategies can include Buy Nothing Groups, Take-it or Leave-it Centers, Repair Cafes.
	Plant-based Meals at Cafeterias	▪ Use "Meatless Mondays" or another means to create a regional campaign ▪ Share experiences and cost/benefit data regionally

9 Workforce Analysis and Planning

The Midlands is one of several larger metropolitan areas in South Carolina. Our economic and workforce development needs parallel the wider state, and the Midlands Workforce Development Board works locally to provide assistance to businesses that have identified workforce needs. As climate action expands in the midlands, this local agency is available to provide additional analyses and services for businesses seeking to expand their workforce footprint and hire. At the state level, the SC Department of Employment and Workforce provides additional data, policy support, and strategy.

9.1 Clean Economy in the Midlands

The Midlands has recently seen an increase in the variety of businesses engaged in the clean economy, meaning that the products they produce help households or other businesses reduce air pollution. These manufacturing businesses include:

- Clean Transportation: including Scout Motors in Blythewood (EVs), ABB E-Mobility in West Columbia (EV Chargers), and Cirba Solutions in Columbia (EV battery recycling)
- Clean Energy: including Enphase in West Columbia (solar inverters) and Phenogy in Columbia (utility/facility batteries)
- Energy Efficiency: including Trane in Newberry (heat pumps)

According to the Clean Investment Monitor Database, clean economy manufacturers have invested (or are currently deploying) a total of $2.47 billion in CAPEX spending in the Midlands through Q3 2025.[445] Clean energy facilities currently deployed in the Midlands have a combined CAPEX footprint of $874 million.[446] Collectively, the clean economy is driving an increasing share of economic growth in the Midlands.

445 Rhodium Group (2025). Clean Investment Monitor. Rhodium Group & Massachusetts Institute of Technology. https://www.cleaninvestmentmonitor.org/ [Data provided via an access agreement with the Central Midlands Council of Governments].

446 Rhodium Group (2025). Clean Investment Monitor. Rhodium Group & Massachusetts Institute of Technology. https://www.cleaninvestmentmonitor.org/ [Data provided via an access agreement with the Central Midlands Council of Governments].

Economic development has not always been a success. For example, $15 million of CAPEX was lost in Camden when macroeconomic policies at the nationwide level in 2025 changed[447], the failure of the V.C. Summer Nuclear expansion wasted $8.18 billion in CAPEX and caused utility bill challenges for residents,[448] and Scout Motors recently passed over Columbia for Charlotte in selecting a location for its headquarters with hundreds of high paying jobs.[449] These examples represent how job losses and economic hardship may relate to governments not deploying the most effective economic development policies, strategies, or land/tax/infrastructure agreements with firms.

9.2 Workforce Development Highlights and Priorities in the Midlands

In this section of the plan, we provide estimates of the number of jobs that will be created as a result of implementing the climate actions in this plan. We have also incorporated the South Carolina Office of Resilience's climate action workforce analysis (provided as Appendix E) to provide additional context from a statewide scale. Both analyses can help local residents benefit from the new, long-term, good jobs that will be created in the Midlands by an initial assessment of where changes in the labor market are anticipated.

Summary

The following key points highlight the tremendous job growth that is projected to occur as a result of implementing this plan:

- Overall, implementing this plan is projected to create a total of **519,209 additional person years of work** between 2026 and 2050.

447 Rhodium Group (2025). Clean Investment Monitor. Rhodium Group & Massachusetts Institute of Technology. https://www.cleaninvestmentmonitor.org/ [Data provided via an access agreement with the Central Midlands Council of Governments].

448 Rhodium Group (2025). Clean Investment Monitor. Rhodium Group & Massachusetts Institute of Technology. https://www.cleaninvestmentmonitor.org/ [Data provided via an access agreement with the Central Midlands Council of Governments].

449 John McDermott. (2025). EV-maker Scout will move its headquarters near, but not in, SC. Post and Courier. https://www.postandcourier.com/business/industry/sc-scout-motors-columbia-charlotte/article_44c7c95d-99aa-45a4-ba36-35e6d025a036.html

- On average, there will be **20,768 additional jobs each year in the Midlands** relating to climate action implementation between 2026 and 2050.
- **The building construction sector has the potential to provide 390,784 good, new jobs** as a result of implementing the climate actions described in the Design Buildings for Life strategy.

How do Climate Actions Create Jobs?

The strategies and actions in this plan require significant changes to many of the fundamental aspects of life in the Midlands. The buildings we live and work in will need to be insulated and our heating and cooling systems replaced. The ways we travel and the ways we move freight and goods will need to switch to zero-emissions vehicles. Our farmers will be able to spend less on fertilizers, and increase their income sources with agrivoltaics and anaerobic digesters.

All of these changes will require people to make them happen. Midlands manufacturers like the ones above are already supporting this shift and bringing new jobs to the area.

The sectors in which we can expect to see the most new, good jobs are those where there is significant skilled, manual labor required, and the work is time-consuming. A good example is the work that will be required to weatherize and significantly reduce energy consumption in all existing residences in the Midlands. (See the actions in the Design Buildings for Life strategy.) This is work that will require education not only in basic construction skills, but also in new construction standards and technologies. And the number of buildings requiring retrofits will mean many workers will be required over many years.

Job Creation by Strategy and Action

This section describes the strategies and actions from this plan that are expected to provide the Midlands with the most new, good jobs. The numbers provided here include direct jobs only. Direct jobs are those that are created directly by the companies manufacturing and carrying out the actions. In addition, there will be increases in indirect jobs - those that support this work with supplies, transportation, etc.

Design Buildings for Life

Between 2026 and 2050, the actions in the Design Buildings for Life strategy are expected to create 390,784 person-years of employment.

These jobs will be primarily in building planning, renovation and construction, and HVAC installation and maintenance. Builders in the Midlands will need to understand not only basic construction practices, but also how to build and retrofit to highly energy-efficient standards. They will also need to understand the construction standards used in the region in the past, principles of building energy efficiency (e.g. thermal bridging, passive heating and cooling, and internal heat exchange), and new technologies (such as integrated heat exchange in external building cladding).

Local governments who partner with community colleges and trades schools can work with CMCOG and national non-profits specializing in net zero buildings to ensure that these skills are included in all relevant programs as soon as possible. This will ensure that local residents are the ones who benefit from these new jobs, and who are then able to do the work required to improve the buildings in which they live and work.

Reimagine Transportation in the Midlands

Between 2026 and 2050, the actions in the Reimagine Transportation in the Midlands strategy are expected to create 70,725 person-years of employment. These jobs will range from additional transit and train operators to jobs in manufacturing electric vehicles, batteries, and rail rolling stock, to positions in vehicle and parts dealerships.

It should be noted that electric vehicles require significantly less maintenance than ICE vehicles. As a result, as more people and fleets switch to EVs, the demand for ICE vehicle mechanics will fall, and be replaced by fewer EV mechanic positions. However, this decrease is reflected in the projection of 70,725 new jobs, so the sector will still experience significant net growth overall.

Enhanced Agriculture and Soil Management

Between 2026 and 2050, the actions in the Enhanced Agriculture and Soil Management strategy are expected to create 36,405 person-years of employment. This number reflects the job growth specifically required to install and maintain agrivoltaic systems on 10% of agricultural land in the region by 2050.

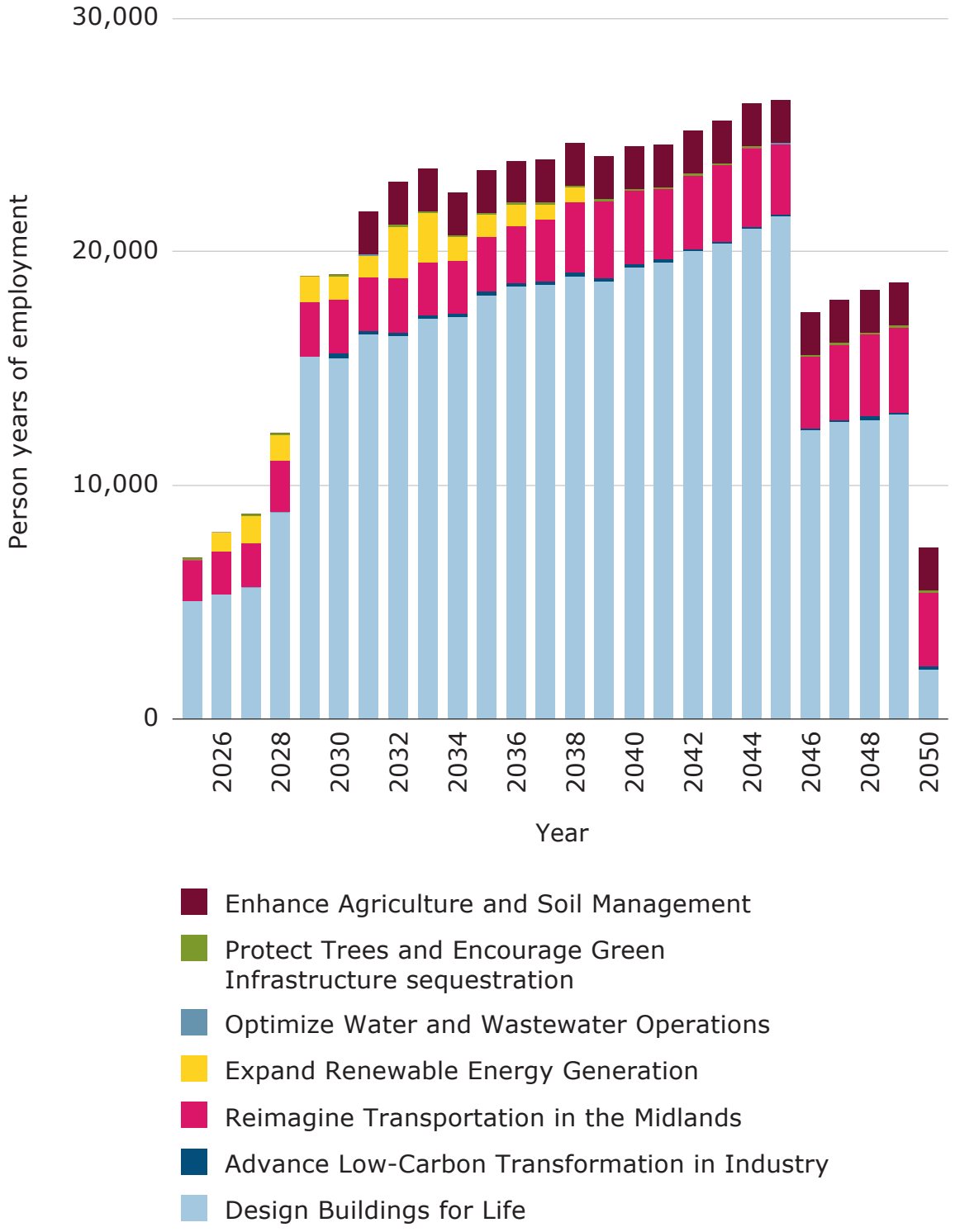
Expand Renewable Energy Generation

Between 2026 and 2050, the actions in the Expand Renewable Energy Generation strategy are expected to create 14,670 person-years of employment. These jobs will be related to the installation and maintenance of renewable energy systems, including rooftop and canopy solar installations, but also anaerobic digester implementation, and restarting the Columbia Canal Hydro Plant.

Job creation is also expected in almost all of the other strategies in this plan. Figure 9.1 illustrates the number of new jobs expected to be created to implement the actions in this plan, grouped by strategy.[450]

450 Strategies not included in this diagram (e.g. Waste Reduction and Diversion) either did not have capital costs calculated for them in this plan, or are not expected to generate additional jobs.

Figure 9.1.
Jobs Created in the Midlands, by Strategy, 2025-2050



The numbers presented in Table 9.1 below provide the total number of person years of employment are expected for each of the climate actions in this plan. All of these jobs are in addition to what is expected to occur in the Business as Planned scenario.[451]

Table 9.1.
Total Number of Additional Job Years expected in the Midlands by Climate Action.

Strategy and Actions	Additional Direct Person Years of Employment between 2026 and 2050
Design Buildings for Life	
High performance new residential buildings	26,002
High performance new non-residential buildings	181,048
Existing residential buildings energy performance: Level 1 - Weatherization	31,715
Existing residential buildings energy performance: Level 2 - Enhanced Energy Efficiency	1,425
Existing residential buildings energy performance: Level 3 - Deep Retrofits	83,325
Existing non-residential buildings energy performance: Level 1 - Weatherization	1,737
Existing non-residential buildings energy performance: Level 2 - Enhanced Energy Efficiency	1,737
Existing non-residential buildings energy performance: Level 3 - Deep Energy Retrofits	44,333
Heat pumps for water heating	4,768

451 Job creation in this plan has been calculated using industry-based job multipliers sourced from the Economic Policy Institute: *https://files.epi.org/pdf/160282.pdf*. See the Data, Methods and Assumptions Manual provided to CMCOG as part of this project for more detail.

Strategy and Actions	Additional Direct Person Years of Employment between 2026 and 2050
Heat pumps for space heating & cooling	14,694
Reimagine Transportation in the Midlands	
Increase active transportation	1,237
Increase transit ridership	0[452]
Reduce vehicle-miles-travelled (VMT) in Columbia	0
Shift personal vehicle travel to rail travel	546
Replace transit buses and shuttles with electric models	222
Electrify personal and commercial light-duty vehicles	22,605
Replace municipal and county fleet vehicles with electric vehicles	64
Replace commercial medium and heavy-duty vehicles with electric models	46,122
Transport more freight by rail rather than by truck	-420[453]
Replace diesel freight train engines with hybrid diesel/ electric engines	349
Expand Renewable Energy Generation	
Rooftop solar installation in Columbia	3,346
Rooftop solar installation outside Columbia	11,293
Restart Columbia Canal Hydro	11

452 Actions with 0 jobs either did not have capital costs calculated for them in this plan, or are not expected to generate additional jobs.

453 Actions with a negative number of jobs are projected to experience a reduction in person-years of employment.

Strategy and Actions	Additional Direct Person Years of Employment between 2026 and 2050
Canopy solar on parking lots in downtown Columbia	21
Utilities switch to renewable energy sources to generate grid electricity	0338
Advance Low-carbon Transformation in Industry	
Industrial efficiency improvements	636[454]
Solar on industrial buildings	1,909
Scale Up Waste Reduction and Diversion Initiatives	
Reduce waste generation	0338
Divert organic waste from landfills	0338
Optimize Water and Wastewater Operations	
Anaerobic digestion at all wastewater treatment plants	56
Improve efficiency of water and wastewater treatment assets	0338
Install solar at wastewater treatment plants	2
Reduce water consumption	0338
Replace septic systems with connection to wastewater treatment plants	88
Protect Trees and Encourage Green Infrastructure	
Increase and maintain healthy urban trees	743

454 The projected number of new jobs shown for the Industrial efficiency improvements action includes 636 jobs associated with Industrial efficiency improvements, and also 106 jobs associated with industrial electrification, which is a recommendation of this plan, but which was not modeled as a separate action.

Strategy and Actions	Additional Direct Person Years of Employment between 2026 and 2050
Reforestation	852
Add green infrastructure	1,258
Enhance Agriculture and Soil Management Practices	
Climate Smart Commodities	0338
Agrivoltaics	36,405
Intentional Land Use	
Smart Growth	-12340
Install reflective surfaces	988
Reduce Consumption-based Carbon Impact	
Increase Circular Economy	0338
Plant-based Meals at Cafeterias	0338

Appendices

Appendix A: GPC BASIC+ GHG Inventory

Inventory Characteristics

This inventory encompasses all greenhouse gases and includes all emissions and sinks by emission source

and sink category. Results are reported in metric tons, by gas, and converted to CO_2e by using the IPCC AR5, 100-year time horizon GWP values.

The inventory base year is 2022, the most recent year with high quality data available during the planning period. As discussed in Chapter 1, the inventory region is the following counties in the U.S. state of South Carolina: Richland, Lexington, Kershaw, Fairfield, Newberry, Saluda, and Calhoun. The land area of the region is 11,605 square kilometers. As of 2022 there are 869,831 people living in the region according to the Census Bureau (16.9% of the state's population), representing 343,776 households with a median household income of $57,184.[455] In 2022 the combined Gross Domestic Product of the region was $55.8 billion according to the U.S. Bureau of Economic Analysis.[456]

This inventory followed the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC), Version 1.1.[457] The inventory was completed to the BASIC+ level and also reports additional Scope 3 emissions data where available.

455 U.S. Census Bureau (2024). American Community Survey, 5-year estimates for 2022. https://data.census.gov

456 U.S. Bureau of Economic Analysis (2022). Gross Domestic Product, county-level estimates for 2022. https://www.bea.gov/data/gdp/gdp-county-metro-and-other-areas

457 Greenhouse Gas Protocol. Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC). Version 1.1 https://ghgprotocol.org/ghg-protocol-cities

What does it mean to produce a GPC BASIC+ Inventory for data comparability?

Greenhouse gas inventories using the same method are designed to be directly compared. However, by doing the BASIC+ inventory, our inventory "reflects more challenging data collection and calculation procedures" than those opting for a BASIC inventory (GPC Protocol page 39).

All communities that produce a GPC BASIC GHG Inventory are expected to report on the same key categories and sources of emissions. As a result, it is reasonable to compare them to each other and to aggregate them. Those producing a GPC BASIC+ GHG Inventory are reporting on more sources of emissions than they would in a GPC BASIC, so the total emissions of BASIC+ inventories should not be compared directly with total emissions of GPC BASIC inventories. However, each of the individual lines of the inventory that are included in both inventory methods (for example, II.1.1, "Emissions from fuel combustion for on-road transportation occurring within the city boundary") can be more readily compared.

					Gases (in MT)							Total CO_2e	Data Quality		Explanatory Comments
GPC ref No.	Scope	GHG Emissions Source	Notation Keys	Reason for exclusion (if applicable)	CO_2	CH_4	N_2O	HFC	PFC	SF6	NF3		AD	EF	
I		**STATIONARY ENERGY SOURCES**													
I.1		**Residential buildings**													
I.1.1	1	Emissions from fuel combustion within the city boundary			333,254	6	1	0	0	0	0	333,609	H	H	*Natural Gas:* Dominion CMCOG Utility GHG Inventory data request (8-23-24).xlsx (via CMCOG data request) *Other Fossil Fuels:* Initial estimates of building stocks that consume other fossil fuels were determined using Residential Energy Consumption Survey, and then adjusted to meet known natural gas consumption and fuel shares for the region. recsData_spcHeat.csv, *EIA Residential Consumption Survey (RECS)*

					Gases (in MT)							Total CO_2e	Data Quality		Explanatory Comments
GPC ref No.	Scope	GHG Emissions Source	Notation Keys	Reason for exclusion (if applicable)	CO_2	CH_4	N_2O	HFC	PFC	SF6	NF3		AD	EF	
I.1.2	2	Emissions from grid-supplied energy consumed within the city boundary			1,827,099	99	16	0	0	0	0	1,834,050	H	H	*Grid Supplied Energy:* Dominion Energy: Source: Dominion CMCOG Utility GHG Inventory data request (8-23-24).xlsx (via CMCOG data request) Duke Energy and Electricity Co-ops: Consumption was estimated by downscaling from total sales via number of customers. Source for Total Sales: Sales_Ult_Cust_2022.xlsx, *EIA Annual Electric Power Industry Report* The number of utility customers by county were provided by the SC Department of Emergency Management.

					Gases (in MT)								Data Quality		
GPC ref No.	Scope	GHG Emissions Source	Notation Keys	Reason for exclusion (if applicable)	CO_2	CH_4	N_2O	HFC	PFC	SF6	NF3	Total CO_2e	AD	EF	Explanatory Comments
I.1.3	3	Emissions from transmission and distribution losses from grid-supplied energy consumption			87,747	5	1	0	0	0	0	88,081	H	M	Grid loss factor was calculated from total energy losses over net supply for utilities in the Midlands. Source: f861_Operational_Data_2022.csv,*EIA Annual Electric Power Industry Report*
I.2		**Commercial and institutional buildings/facilities**													
I.2.1	1	Emissions from fuel combustion within the city boundary			328,880	8	1	0	0	0	0	329,405	H	H	*Natural Gas:* Data source as described in I.1.1 *Other Fuels:* Initial estimates of building stocks that consume other fossil fuels were determined using Commercial Buildings Energy Consumption Survey (*EIA Commercial Buildings Consumption Survey (CBECS)*, then adjusted to meet known natural gas consumption and fuel shares for the region.

GPC ref No.	Scope	GHG Emissions Source	Notation Keys	Reason for exclusion (if applicable)	Gases (in MT)							Total CO_2e	Data Quality		Explanatory Comments
					CO_2	CH_4	N_2O	HFC	PFC	SF6	NF3		AD	EF	
I.2.2	2	Emissions from grid-supplied energy consumed within the city boundary			1,861,963	101	16	0	0	0	0	1,869,047	H	H	Data source as described in I.1.2.
I.2.3	3	Emissions from transmission and distribution losses from grid-supplied energy consumption			89,422	5	1	0	0	0	0	89,762	H	M	Data source as described in I.1.3.
I.3		**Manufacturing industry and construction**													

					Gases (in MT)							Total CO_2e	Data Quality		Explanatory Comments
GPC ref No.	Scope	GHG Emissions Source	Notation Keys	Reason for exclusion (if applicable)	CO_2	CH_4	N_2O	HFC	PFC	SF6	NF3		AD	EF	
I.3.1	1	Emissions from fuel combustion within the city boundary			886,786	66	19	0	0	0	0	893,663	H	H	*General Industry:* Data source as described in I.2.1 *Heavy Emitters* *EPA FLIGHT Tool*
I.3.2	2	Emissions from grid-supplied energy consumed within the city boundary			750,914	41	6	0	0	0	0	753,771	H	H	Data source as described in I.1.2.
I.3.3	3	Emissions from transmission and distribution losses from grid-supplied energy consumption			36,063	2	0	0	0	0	0	36,200	H	M	Data source as described in I.1.3.
I.4		**Energy industries**													

					Gases (in MT)							Total CO_2e	Data Quality		Explanatory Comments
GPC ref No.	Scope	GHG Emissions Source	Notation Keys	Reason for exclusion (if applicable)	CO_2	CH_4	N_2O	HFC	PFC	SF6	NF3		AD	EF	
I.4.1	1	Emissions from energy used in power plant auxiliary operations within the city boundary	**NE**	District energy is in use at the University of South Carolina for steam-based heating, no energy is sent out beyond the campus. Emissions or energy use associated with these auxiliary operations are not estimated. No other auxiliary operations are known to CMCOG.											
I.4.2	2	Emissions from grid-supplied energy consumed in power plant auxiliary operations within the city boundary	**IE**	Same as I.4.1. Energy to power the network would be included under I.2.2.											
I.4.3	3	Emissions from transmission and distribution losses from grid-supplied energy consumption in power plant auxiliary operations	**IE**	Same as 1.4.1. Energy to power the network would be included under I.2.3.											

					Gases (in MT)							Total CO_2e	Data Quality		Explanatory Comments
GPC ref No.	Scope	GHG Emissions Source	Notation Keys	Reason for exclusion (if applicable)	CO_2	CH_4	N_2O	HFC	PFC	SF6	NF3		AD	EF	
I.4.4	1	Emissions from energy generation supplied to the grid	**NE**	Not required for BASIC+											
I.5		**Agriculture, forestry and fishing activities**													
I.5.1	1	Emissions from fuel combustion within the city boundary			19,803	1	0					19,875	H	H	Data Source as described in I.2.1
I.5.2	2	Emissions from grid-supplied energy consumed within the city boundary			5,176	0	0	0	0	0	0	5,196	H	H	Data Source as described in I.1.2
I.5.3	3	Emissions from transmission and distribution losses from grid-supplied energy consumption			249	0	0.0022	0	0	0	0	250	H	M	Data Source as described in I.1.3
I.6		**Non-specified sources**													
I.6.1	1	Emissions from fuel combustion within the city boundary	**NO**	All fuel combustion known is assigned a source in this inventory.											

					Gases (in MT)							Total CO_2e	Data Quality		Explanatory Comments
GPC ref No.	**Scope**	**GHG Emissions Source**	**Notation Keys**	**Reason for exclusion (if applicable)**	**CO_2**	**CH_4**	**N_2O**	**HFC**	**PFC**	**SF6**	**NF3**		**AD**	**EF**	
I.6.2	2	Emissions from grid-supplied energy consumed within the city boundary	**NO**	All grid energy known is assigned a source in this inventory.											
I.6.3	3	Emissions from transmission and distribution losses from grid-supplied energy consumption	**NO**	All transmission and distribution losses known are assigned a source in this inventory.											
I.7		**Fugitive emissions from mining, processing, storage, and transportation of coal**													
I.7.1	1	Emissions from fugitive emissions within the city boundary	**NO**	Coal is not mined in the Midlands.											

					Gases (in MT)							Total CO_2e	Data Quality		Explanatory Comments
GPC ref No.	Scope	GHG Emissions Source	Notation Keys	Reason for exclusion (if applicable)	CO_2	CH_4	N_2O	HFC	PFC	SF6	NF3		AD	EF	
I.8		**Fugitive emissions from oil and natural gas systems**													
I.8.1	1	Emissions from fugitive emissions within the city boundary			12	1,090	0	0	0	0	0	30,519	L	M	Table 4.2.4 from 2006 IPCC Guidelines, Volume 2, Chapter 4, Fugitive Emissions.
II		**TRANSPORTATION**													
II.1		**On-road transportation**													

					Gases (in MT)							Total CO_2e	Data Quality		Explanatory Comments
GPC ref No.	Scope	GHG Emissions Source	Notation Keys	Reason for exclusion (if applicable)	CO_2	CH_4	N_2O	HFC	PFC	SF6	NF3		AD	EF	
II.1.1	1	Emissions from fuel combustion for on-road transportation occurring within the city boundary			5,054,550	272	131	0	0	0	0	5,097,002	M	H	*Vehicle Miles Travelled:* SCDOT 2022 VMT by county.pdf provided by SC Department of Transportation via a data request. *Vehicle Stock:* *South Carolina License Plates* *Vehicle Engine Shares:* *South Carolina Energy Landscape, 2023 Vehicle Data* *Origin-Destination Trip Purposes:* Provided by CMCOG via a data request.
II.1.2	2	Emissions from grid-supplied energy consumed within the city boundary for on-road transportation			8,366	0.45	0.07	0	0	0	0	8,397	H	H	Data source as described in II.1.1.

					Gases (in MT)								Data Quality		
GPC ref No.	Scope	GHG Emissions Source	Notation Keys	Reason for exclusion (if applicable)	CO_2	CH_4	N_2O	HFC	PFC	SF6	NF3	Total CO_2e	AD	EF	Explanatory Comments
II.1.3	3	Emissions from portion of transboundary journeys occurring outside the city boundary, and transmission and distribution losses from grid-supplied energy consumption			34,243	2	0	0	0	0	0	34,400	M	H	Data source as described in II.1.1
II.2		**Railways**													
II.2.1	1	Emissions from fuel combustion for railway transportation occurring within the city boundary			102,033	8	3	0	0	0	0	102,945	L	M	*Freight*: *Go Rail South Carolina* downscaled to the Midlands based on population.
II.2.2	2	Emissions from grid-supplied energy consumed within the city boundary for railways	**NO**	There are no known electrified passenger or freight rail in the Midlands.											
II.2.3	3	Emissions from portion of transboundary journeys occurring outside the city boundary, and transmission and distribution losses from grid-supplied energy consumption			213	0	0.005	0	0	0	0	215	M	H	*Passenger:* *Amtrak Estimated Diesel Us per Mile* downscaled to the Midlands using miles of track.

					Gases (in MT)							Total CO_2e	Data Quality		Explanatory Comments
GPC ref No.	Scope	GHG Emissions Source	Notation Keys	Reason for exclusion (if applicable)	CO_2	CH_4	N_2O	HFC	PFC	SF6	NF3		AD	EF	
II.3		**Water-borne navigation**													
II.3.1	1	Emissions from fuel combustion for waterborne navigation occurring within the city boundary			67,519	6	2	0	0	0	0	68,174	M	M	Columbia-Newberry CSA PCAP - Transportation.xlsx. Original data from EPA's 2020 National Emissions Inventory.
II.3.2	2	Emissions from grid-supplied energy consumed within the city boundary for waterborne navigation	**IE**	All waterborne navigation is recreational and believed to use fuel combustion. There may be a small number of electric or hybrid boat motors, but those emissions would be included elsewhere under I.1.2											

					Gases (in MT)							Total CO_2e	Data Quality		Explanatory Comments
GPC ref No.	Scope	GHG Emissions Source	Notation Keys	Reason for exclusion (if applicable)	CO_2	CH_4	N_2O	HFC	PFC	SF6	NF3		AD	EF	
II.3.3	3	Emissions from portion of transboundary journeys occurring outside the city boundary, and transmission and distribution losses from grid-supplied energy consumption	**NO**	The rivers running through the Midlands are not used for transboundary journeys.											
II.4		**Aviation**													
II.4.1	1	Emissions from fuel combustion for aviation occurring within the city boundary			16,707	0	1					16,846	M	M	Transportation_ NEI_2020_ PointAirports_ minusCAE.xlsx. Original data from EPA's 2020 National Emissions Inventory. [Note - aviation from all airports not including CAE was assumed to be entirely within the region boundary]

GPC ref No.	Scope	GHG Emissions Source	Notation Keys	Reason for exclusion (if applicable)	Gases (in MT)							Total CO_2e	Data Quality		Explanatory Comments
					CO_2	CH_4	N_2O	HFC	PFC	SF6	NF3		AD	EF	
II.4.2	2	Emissions from grid-supplied energy consumed within the city boundary for aviation	**IE**	There are no known electric or hybrid airplanes in the Midlands. If there are any, emissions would be included elsewhere under I.2.2.											
II.4.3	3	Emissions from portion of transboundary journeys occurring outside the city boundary, and transmission and distribution losses from grid-supplied energy consumption			84,473	2	3	0	0	0	0	102,058	H	H	CMCOG Airport Data Request CAE_6-21-24.doc Original data provided by Columbia Metropolitan Airport. [Note - activity data captures all fuel provided at CAE, and does not differentiate between inbound and outbound planes].
II.5		**Off-road**													

					Gases (in MT)								Data Quality		
GPC ref No.	**Scope**	**GHG Emissions Source**	**Notation Keys**	**Reason for exclusion (if applicable)**	**CO_2**	**CH_4**	**N_2O**	**HFC**	**PFC**	**SF6**	**NF3**	**Total CO_2e**	**AD**	**EF**	**Explanatory Comments**
II.5.1	1	Emissions from fuel combustion for off-road transportation occurring within the city boundary			368,661	1,485	6	0	0	0	0	411,747	L	M	*Gasoline*: Federal Highway Administration - Private and Commercial Nonhighway Use of Gasoline - 2022 *Diesel:* US Census of Agriculture and US Department of Agriculture - downscaled from federal data
II.5.2	2	Emissions from grid-supplied energy consumed within the city boundary for off-road transportation	**IE**	No off-road transportation electricity use is known to be occurring. If there are any, emissions would be included elsewhere under I.2.2 I											
III		**WASTE**													
III.1		**Solid waste disposal**													

					Gases (in MT)							Total CO_2e	Data Quality		Explanatory Comments
GPC ref No.	Scope	GHG Emissions Source	Notation Keys	Reason for exclusion (if applicable)	CO_2	CH_4	N_2O	HFC	PFC	SF6	NF3		AD	EF	
III.1.1	1	Emissions from solid waste generated within the city boundary and disposed in landfills or open dumps within the city boundary			0	12,661	0	0	0	0	0	354,501	H	M	South Carolina Solid Waste Management Annual Report - 2022. The First Order Decay method was used to estimate emissions from solid waste.
III.1.2	3	Emissions from solid waste generated within the city boundary but disposed in landfills or open dumps outside the city boundary	**NO**	SC Department of Environmental Services informed CMCOG that to their best available knowledge, no MSW waste generated here is disposed outside the region boundary.											
III.1.3	1	Emissions from waste generated outside the city boundary and disposed in landfills or open dumps within the city boundary	**IE**	Included under III.1.1. We did not find suitable data for waste disposal by landfill by geographic source, only by total disposal in the region's landfills.											

					Gases (in MT)							Total CO_2e	Data Quality		Explanatory Comments
GPC ref No.	Scope	GHG Emissions Source	Notation Keys	Reason for exclusion (if applicable)	CO_2	CH_4	N_2O	HFC	PFC	SF6	NF3		AD	EF	
III.2		**Biological treatment of waste**													
III.2.1	1	Emissions from solid waste generated within the city boundary that is treated biologically within the city boundary			0	372	22	0	0	0	0	16,311	H	M	South Carolina Solid Waste Management Annual Report - 2022.
III.2.2	3	Emissions from solid waste generated within the city boundary but treated biologically outside of the city boundary	**NO**	To our knowledge and available reporting from SC DES, if solid waste from the region is composted, it is done within the boundary.											
III.2.3	1	Emissions from waste generated outside the city boundary but treated biologically within the city boundary	**IE**	We did not find suitable data for composting landfills to differentiate material by its geographic origin, so these emissions are included under III.2.1											

GPC ref No.	Scope	GHG Emissions Source	Notation Keys	Reason for exclusion (if applicable)	Gases (in MT)							Total CO_2e	Data Quality		Explanatory Comments
					CO_2	CH_4	N_2O	HFC	PFC	SF6	NF3		AD	EF	
III.3		**Incineration and open burning**													
III.3.1	1	Emissions from solid waste generated and treated within the city boundary	**NO**	As reported by SC DES, no waste incineration sites exist in the Midlands.											
III.3.2	3	Emissions from solid waste generated within the city boundary but treated outside of the city boundary	**NO**	As reported by SC DES, no waste incineration exists in the Midlands.											
III.3.3	1	Emissions from waste generated outside the city boundary but treated within the city boundary	**NO**	As reported by SC DES, no waste incineration exists in the Midlands.											
III.4		**Wastewater treatment and discharge**													

					Gases (in MT)								Data Quality		
GPC ref No.	Scope	GHG Emissions Source	Notation Keys	Reason for exclusion (if applicable)	CO_2	CH_4	N_2O	HFC	PFC	SF6	NF3	Total CO_2e	AD	EF	Explanatory Comments
III.4.1	1	Emissions from wastewater generated and treated within the city boundary			0	2,433	29	0	0	0	0	75,911	L	M	*Volume:* *South Carolina Department of Environmental Sciences Bureau of Water* *Proportions of septic vs central wastewater treatment*: CMCOG planning department estimation, based on regional knowledge [no official data available].
III.4.2	3	Emissions from wastewater generated within the city boundary but treated outside of the city boundary	**NO**	To the best of our knowledge, wastewater is not sent beyond the boundary for treatment.											
III.4.3	1	Emissions from wastewater generated outside the city boundary	**NO**	To the best of our knowledge, no wastewater from beyond the boundary is sent into the boundary for treatment.											

GPC ref No.	Scope	GHG Emissions Source	Notation Keys	Reason for exclusion (if applicable)	Gases (in MT)							Total CO_2e	Data Quality		Explanatory Comments
					CO_2	CH_4	N_2O	HFC	PFC	SF6	NF3		AD	EF	
IV		**INDUSTRIAL PROCESSES AND PRODUCT USE (IPPU)**													
IV.1	1	Emissions from industrial processes occurring within the city boundary			84,427	0	0	0	0	0	0	84,427	M	H	*EPA FLIGHT Tool*

GPC ref No.	Scope	GHG Emissions Source	Notation Keys	Reason for exclusion (if applicable)	Gases (in MT)							Total CO_2e	Data Quality		Explanatory Comments
					CO_2	CH_4	N_2O	HFC	PFC	SF6	NF3		AD	EF	
IV.2	1	Emissions from product use occurring within the city boundary			0	0	0	334	0.026	1.1	0	657,235	M	M	*F-gas data source:* EPA's State Level Greenhouse Gas Inventory[458] for 2021. SF6 down-scaled from state total based on the proportion of electricity consumed by the Midlands. Other F-gases down-scaled from the state based on population. Note that EPA's data reports only in CO_2e, and combines some HFCs and PFCs into groups whose chemical formulas, and thus GWPs, are unknown. The totaled CO_2e column tonnage is thus more accurate than the split into individual tonnage by gas.

458 EPA (2021). Greenhouse Gas Inventory Data. https://cfpub.epa.gov/ghgdata/inventoryexplorer/

					Gases (in MT)							Total CO_2e	Data Quality		Explanatory Comments
GPC ref No.	Scope	GHG Emissions Source	Notation Keys	Reason for exclusion (if applicable)	CO_2	CH_4	N_2O	HFC	PFC	SF6	NF3		AD	EF	
V		**AGRICULTURE, FORESTRY AND LAND USE (AFOLU)**													
V.1	1	Emissions from livestock within the city boundary			0	9,188	165	0	0	0	0	300,976	M	M	*US Department of Agriculture Livestock Counts by County*
V.2	1	Emissions from land within the city boundary			-4,240,959	0	0	0	0	0	0	-4,240,959	M	M	Source: Hasler, Natalia; Williams, Christopher A. 2025. National Forest Carbon Monitoring System (NFCMS) version 3.0 - Carbon stocks and potential sequestration over conterminous U.S. forests. Fort Collins, CO: Forest Service Research Data Archive. *https://doi.org/10.2737/RDS-2025-0019*
V.3	1	Emissions from aggregate sources and non-CO2 emission sources on land within the city boundary			0	0	662	0	0	0	0	175,462	L	M	
VI		**OTHER SCOPE 3**													

					Gases (in MT)							Total CO_2e	Data Quality		Explanatory Comments
GPC ref No.	Scope	GHG Emissions Source	Notation Keys	Reason for exclusion (if applicable)	CO_2	CH_4	N_2O	HFC	PFC	SF6	NF3		AD	EF	
VI.1	3	Other Scope 3			N/A	N/A	N/A	N/A	N/A	N/A	N/A	3,098,077	L	L	Data is modeled consumption-based emissions for goods and services in units of CO_2e for the county level. These emissions are from the year 2013. As required by GPC, Other Scope 3 are not included in BASIC+ totals or inventory percentages in this report. Source: Christopher M. Jones and Daniel M. Kammen, Spatial Distribution of U.S. Household Carbon Footprints Reveals Suburbanization Undermines GHG Benefits of Urban Popn Density. Environ. Sci. Technol., 2014, 48 (2), pp 895–902, dx.doi.org/10.1021/es4034364

Appendix B: Additional Detail on GHG Targets

Why Set GHG Reduction Targets?

At a basic level, targets provide us with guidance when making decisions and investments, and with metrics against which we can measure our progress.

Setting a GHG reduction target and creating a supportive framework of policies, incentives and regulations also sends a message to investors, businesses and residents. It communicates a commitment to sustainable land use, deployment of renewable energy technology, and prioritization of renewed and resilient infrastructure. This invites residents, businesses and governments to see themselves as participants in and beneficiaries of the change. It may also drive capital to the investments required to reach a long-term goal.

In the context of climate planning, setting a target for emissions reductions helps us visualize how rapidly and how dramatically we need to implement change. Current global emissions trends are pushing temperatures toward a 3°C increase, far above the safe 1.5-2.0°C threshold.[459] This can make the challenge seem overwhelming, but we can then create interim targets to help us transform a daunting end-goal into a series of more manageable steps.

These interim targets also provide us with regular and frequent points at which to check on our progress. Comparing our progress to interim targets allows us to regularly revisit and improve our programs, regulations, education, etc.

The Basis for Targets

Alignment with National Targets

The 2050 target contained in CMCOG's climate action plan aligns with the U.S. national goal for 2050; however the region's 2035 goal is less ambitious than the national goal.

The U.S. national emissions reduction goals are described in the 2024 U.S. Nationally-Determined Contribution (NDC), which was developed as part of

459 "Climate Change 2022 Mitigation of Climate Change: Summary for Policy Makers," IPCC, https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_SummaryForPolicymakers.pdf.

U.S. participation in the Paris Agreement.[460] It sets a target of reducing U.S. GHG emissions by 61-66% below 2005 levels by 2035 and achieving net-zero emissions by 2050.[461]

Alignment with International Targets

The Paris Agreement was a commitment made at the 21st United Nations Climate Change Conference in Paris, France, on December 12, 2015 by 196 nations to to hold "the increase in the global average temperature to well below 2°C above pre-industrial levels" and pursue efforts "to limit the temperature increase to 1.5°C above pre-industrial levels."[462] The thresholds of 1.5°C (2.7°F) and 2°C (3.6°F) are based on the latest scientific evidence on anticipated climate impacts.[463]

Countries set national targets according to a mechanism in the Paris Agreement called the nationally determined contributions (NDCs). The target and actions committed to by each country are determined by that country and submitted to the United Nations.

Alignment With Science

The main goal in the race against climate change is limiting damage and costs from human emissions of greenhouse gases. This should be based on the most up-to-date scientific understanding of the level and speed of change that is required.

Recent Global Target-Setting Guidance

The Paris Agreement provided nations with an initial set of targets grounded in scientific evidence of what was necessary to avoid large damages from climate change. New guidance is published in reports from the UNFCCC.[464] The most recent of these reports - The State of the Global Climate 2024 Report - provided the following updates:

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460 The United States of America, 2024, Nationally Determined Contribution. Accessed April 2025, https://unfccc.int/sites/default/files/2024-12/United%20States%202035%20NDC.pdf. Note that on January 20th, 2025, President Trump began the process of withdrawing from the Paris Agreement. The earliest the withdrawal will take effect will be January 27, 2026.

461 "The Long-term Strategy of the United States: Pathways to Net-Zero Greenhouse Gas Emissions by 2050," U.S. Department of State, accessed November 2024, https://www.whitehouse.gov/wp-content/uploads/2021/10/US-Long-Term-Strategy.pdf

462 "The Paris Agreement," United Nations Framework Convention on Climate Change, accessed in November 2024, https://unfccc.int/sites/default/files/resource/parisagreement_publication.pdf.

463 "The Sixth Assessment Report of the Intergovernmental Panel on Climate Change: Physical Science Basis," IPCC, accessed in November 2024. https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_SPM_final.pdf#page=33

464 UNFCC. "Climate Action: Reports." https://www.un.org/en/climatechange/reports

- 2024 was the warmest year ever in the 175-year observational record. It was 1.55 °C warmer than the 1850-1900 average.
- At the end of 2024, global long-term warming (averaged over decades) came closer to but remained below 1.5°C.
- The oceans continued to warm, and are anticipated to continue warming for hundreds of years.
- The long-term rate of sea-level rise has increased from 2.1 mm/year between 1993-2002 to 4.7 mm/year between 2015-2024.

In 2021, a review of scientific evidence presented at the 26th United Nations Conference of Parties resulted in the creation of a new target to rapidly and dramatically reduce methane emissions. 159 nations (including the United States) adopted the Global Methane Pledge[465], and in 2024, the U.S. included its commitment to reduce anthropogenic methane emissions by at least 35% by 2035 in its NDC.

Incorporating 'Fair Share' and 'Completeness'

Developing targets based on scientific evidence and guidance helps different types of jurisdictions to understand what and how much they need to change to achieve a stable atmosphere globally.[466]

Over time, the parties to the Paris Agreement have agreed that two other factors must also be considered when selecting targets. The first is the 'fair share' aspect of target-setting, which refers to the following: The development of targets should reflect historical contributions to the current climate crisis, and the fact that different countries have different amounts of resources with which to address climate change. Jurisdictions with more resources and with high historical and current emissions need to take responsibility for reducing a greater amount of emissions and fast, to account for their historical emissions and because they have greater resources to draw to make these changes. For example, the World Resources Institute recommends that areas with a high GDP per capita and a developed economy should aim to eliminate 70-75% of their total emissions by 2030, even though global emissions need to be reduced by only 52% by this date. Correspondingly, areas with low per capita GDP and virtually no

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465 Global Methane Pledge. "Global Methane Pledge" website. https://www.globalmethanepledge.org/

466 "Results of the assessment of greenhouse gas emission reduction target setting methodologies for cities," Science Based Targets Network, July 20202, accessed in November 2024, *https://c40.my.salesforce.com/sfc/p/#36000001Enhz/a/1Q000000gRNm/mv_WQOpWyZYubeKGUJytOUA8r60bwnynPcfUv3wOQjs*

emissions should not be required to reduce their already low emissions as dramatically.[467] From 2030 to 2050 however, this distinction is removed; all regions of the world must work to completely eliminate their emissions.

The second principle is 'completeness'. This refers simply to the fact that communities must track, develop targets, and implement measures to reduce all greenhouse gas emissions that are released within their community or as a result of activities within their communities. Protocols such as the Global Protocol for Community Greenhouse Gas Emissions,[468] or GPC (which was used for this plan) provide details on what this means, but it can be summarized as follows:

1. At the most basic level, communities must track and reduce emissions of CO_2, N_2O and CH4 that are either released directly from within the community, or outside its geographic boundary but occurring as a result of activities inside the boundary. The majority of anthropogenic emissions fall into this group, meaning that initially focussing on eliminating these emissions is an effective way to make good progress on reducing the impacts of climate change.
2. As soon as possible after a community has the basic level in hand, it should expand its focus to also include emissions of a) other types of greenhouse gases (such as HFCs), and b) emissions caused by our consumption of products that are produced in other jurisdictions and then transported to us.[469]

467 "Science-based Climate Targets: A Guide for Cities," November 2020, accessed in November 2024, https://sciencebasedtargetsnetwork.org/wp-content/uploads/2021/04/SBTs-for-cities-guide.pdf

468 "Global Protocol for Community-Scale Greenhouse Gas Emission Inventories," Greenhouse Gas Protocol, accessed in November 2024, https://ghgprotocol.org/sites/default/files/2022-12/GPC_Executive_Summary_1.pdf

469 Stockholm Environment Institute. "Estimating consumption-based greenhouse gas emissions at the city scale". https://www.c40knowledgehub.org/s/article/Estimating-consumption-based-greenhouse-gas-emissions-at-the-city-scale?language=en_US

Appendix C: Criteria and Hazardous Air Pollutant Inventory

As required by the U.S. EPA for the CPRG program, when feasible we have estimated air pollutant reductions for criteria and hazardous air pollutants whenever a climate action is expected to reduce these air pollutants in addition to greenhouse gases. These co-pollutant reductions are reported alongside greenhouse gas emissions reductions in the Climate Action & low-carbon scenario Chapter, where the action's relevant section lists the quantified reductions of co-pollutants for each one feasible to model.

These co-pollutant reductions would be removed from the Midland's total emissions of these air pollutants. The EPA regularly collects these data as part of the National Emissions Inventory, and the S.C. Department of Environmental Services regulates and monitors these air pollutants for our state. We have analyzed the National Emissions Inventory Data available for 2020, the most recent year where data was easily available, for this co-pollutant baseline inventory. These data are reported originally at county level. S.C. Department of Environmental Services and U.S. EPA also collects and reports air pollution data from individual facilities and reports this information to the public. These facility emissions are included in the National Emissions Inventory, alongside other sources of these air pollutants where relevant. Here we present a total for the Midlands region in this inventory, divided by sector and reported by gas. The units are U.S. short ton (907.18 kilograms).

Co-Pollutant Emissions (U.S. Short Tons)

SC-Midlands

PM10 Primary (Filt + Cond)	PM10 Filterable	PM2.5 Primary (Filt + Cond)	PM2.5 Filterable	Nitrogen Oxides	
CAP	CAP	CAP	CAP	CAP	Type
347.758752	334.452576	338.485759	325.179583	321.907659	Residential - Stationary Fuel Combustion
542.510180	49.803144	503.300989	10.593790	232.906250	Commercial - Stationary Fuel Combustion
1648.042814	1592.617903	1410.448571	1355.023272	787.453867	Industrial - Stationary Fuel Combustion
595.036324	0.000000	269.032347	0.000000	9224.936630	Transportation - On Road
1334.093772	1150.256395	288.438870	115.025639	1287.842776	Transportation - Off Road/Mobile
7.779557	0.000000	7.546170	0.000000	300.306923	Transportation - Rail
15.489930	0.000000	14.364557	0.000000	494.115379	Transportation - Waterborne
0.000000	0.000000	0.000000	0.000000	0.000000	Solid Waste - Landfills
0.000000	0.000000	0.000000	0.000000	0.000000	Solid Waste -Composting
0.000000	0.000000	0.000000	0.000000	0.000000	Water/Wastewater - Wastewater Treatment
639.331870	639.331870	79.916479	79.916479	0.000000	Process & Fugitive - IPPU
0.000000	0.000000	0.000000	0.000000	0.000000	Process & Fugitive - Oil & Gas Processes
1624.552550	1532.135660	359.198267	306.427100	1809.852880	AFOLU - Crop
1494.613516	1494.613516	205.383253	205.383253	0.000000	AFOLU - Livestock
2138.238661	865.307111	1867.711815	788.956396	407.901716	AFOLU - Forestry
0.000000	0.000000	0.000000	0.000000	0.000000	AFOLU - Trees
15235.305357	15235.305357	2256.471627	2256.471627	68.511587	Activity Not Included in a Standard GHGI

Co-Pollutant Emissions (U.S. Short Tons)

SC-Midlands

PM Condensible	Carbon Monoxide	Ammonia	Sulfur Dioxide	
CAP	CAP	CAP	CAP	Type
13.305252	2338.680052	66.259775	7.951328	Residential - Stationary Fuel Combustion
492.706005	398.321281	1.189968	6.254991	Commercial - Stationary Fuel Combustion
55.424836	1960.578540	24.546073	178.441858	Industrial - Stationary Fuel Combustion
0.000000	59370.198743	318.415239	31.747583	Transportation - On Road
0.000000	26486.885604	3.428771	1.601844	Transportation - Off Road/Mobile
0.000000	65.029783	0.203629	0.229541	Transportation - Rail
0.000000	6195.651568	0.920169	0.472830	Transportation - Waterborne
0.000000	0.000000	0.000000	0.000000	Solid Waste - Landfills
0.000000	0.000000	34.387593	0.000000	Solid Waste -Composting
0.000000	0.000000	0.000000	0.000000	Water/Wastewater - Wastewater Treatment
0.000000	0.000000	0.000000	0.000000	Process & Fugitive - IPPU
0.000000	0.000000	0.000000	0.000000	Process & Fugitive - Oil & Gas Processes
0.000000	505.232097	2683.324416	10.392294	AFOLU - Crop
0.000000	0.000000	5613.747895	0.000000	AFOLU - Livestock
0.000000	18830.127370	688.675364	182.836406	AFOLU - Forestry
0.000000	10441.992000	0.000000	0.000000	AFOLU - Trees
0.000000	998.967635	13.087863	11.945932	Activity Not Included in a Standard GHGI

Co-Pollutant Emissions (U.S. Short Tons)

SC-Midlands

1-Methylnaphthalene	Formaldehyde	Volatile Organic Compounds	
HAP	HAP	CAP	Type
0.226815	27.042964	348.397017	Residential - Stationary Fuel Combustion
0.000000	9.633533	103.660164	Commercial - Stationary Fuel Combustion
0.041230	4.589452	57.816908	Industrial - Stationary Fuel Combustion
0.000000	42.046364	4211.036512	Transportation - On Road
0.000000	38.290705	1707.531920	Transportation - Off Road/Mobile
0.000000	2.768079	12.412909	Transportation - Rail
0.000000	9.153516	1235.984748	Transportation - Waterborne
0.000000	0.000000	0.000000	Solid Waste - Landfills
0.000000	0.000000	243.318270	Solid Waste -Composting
0.000000	0.000000	0.000000	Water/Wastewater - Wastewater Treatment
0.000000	0.000000	0.000000	Process & Fugitive - IPPU
0.000000	0.000000	1888.118962	Process & Fugitive - Oil & Gas Processes
0.000000	4.451323	345.075018	AFOLU - Crop
0.000000	0.000000	449.099833	AFOLU - Livestock
0.000000	193.655005	3294.099314	AFOLU - Forestry
0.000000	1490.499500	121558.860000	AFOLU - Trees
0.000000	7.898698	7428.765965	Activity Not Included in a Standard GHGI

2-Methylnaphthalene	1,3-Butadiene	1-Methylphenanthrene			
HAP	HAP	HAP	Type	SC-Midlands	Co-Pollutant Emissions (U.S. Short Tons)
0.322387	2.651483	0.042906	Residential - Stationary Fuel Combustion		
0.000000	0.614895	0.000000	Commercial - Stationary Fuel Combustion		
0.058344	0.455083	0.008446	Industrial - Stationary Fuel Combustion		
0.000000	8.787643	0.000000	Transportation - On Road		
0.000000	7.678672	0.000000	Transportation - Off Road/Mobile		
0.000000	0.023088	0.000000	Transportation - Rail		
0.000000	4.983076	0.000000	Transportation - Waterborne		
0.000000	0.000000	0.000000	Solid Waste - Landfills		
0.000000	0.000000	0.000000	Solid Waste -Composting		
0.000000	0.000000	0.000000	Water/Wastewater - Wastewater Treatment		
0.000000	0.000000	0.000000	Process & Fugitive - IPPU		
0.000000	0.000000	0.000000	Process & Fugitive - Oil & Gas Processes		
0.000000	0.681162	0.000000	AFOLU - Crop		
0.220813	0.000000	0.000000	AFOLU - Livestock		
0.000000	29.260714	0.000000	AFOLU - Forestry		
0.000000	0.000000	0.000000	AFOLU - Trees		
0.151460	2.511555	0.000000	Activity Not Included in a Standard GHGI		

Acenaphthylene	Acenaphthene	2-Methylphenanthrene		SC-Midlands	Co-Pollutant Emissions (U.S. Short Tons)
HAP	HAP	HAP	Type		
0.404472	0.039336	0.035045	Residential - Stationary Fuel Combustion		
0.002224	0.000000	0.000000	Commercial - Stationary Fuel Combustion		
0.072347	0.007685	0.007076	Industrial - Stationary Fuel Combustion		
0.380524	0.129200	0.000000	Transportation - On Road		
0.262417	0.095895	0.000000	Transportation - Off Road/Mobile		
0.005498	0.004009	0.000000	Transportation - Rail		
0.147600	0.034442	0.000000	Transportation - Waterborne		
0.000000	0.000000	0.000000	Solid Waste - Landfills		
0.000000	0.000000	0.000000	Solid Waste -Composting		
0.000000	0.000000	0.000000	Water/Wastewater - Wastewater Treatment		
0.000000	0.000000	0.000000	Process & Fugitive - IPPU		
0.000000	0.000000	0.000000	Process & Fugitive - Oil & Gas Processes		
0.000000	0.000000	0.000000	AFOLU - Crop		
0.000000	0.000000	0.000000	AFOLU - Livestock		
0.000000	0.000000	0.000000	AFOLU - Forestry		
0.000000	0.000000	0.000000	AFOLU - Trees		
0.130077	0.011404	0.000000	Activity Not Included in a Standard GHGI		

Anthracene	Acrolein	Acetophenone	Acetaldehyde		SC-Midlands	Co-Pollutant Emissions (U.S. Short Tons)
HAP	HAP	HAP	HAP	Type		
0.071210	1.357613	0.080606	38.090749	Residential - Stationary Fuel Combustion		
0.000257	0.001464	0.000000	8.970068	Commercial - Stationary Fuel Combustion		
0.013380	0.245045	0.015169	6.627880	Industrial - Stationary Fuel Combustion		
0.122131	3.287218	0.000000	32.709037	Transportation - On Road		
0.040150	2.606005	0.000000	15.152899	Transportation - Off Road/Mobile		
0.000000	0.198607	0.000000	0.971931	Transportation - Rail		
0.025511	0.473221	0.000000	4.829125	Transportation - Waterborne		
0.000000	0.000000	0.000000	0.000000	Solid Waste - Landfills		
0.000000	0.000000	0.000000	0.340645	Solid Waste -Composting		
0.000000	0.000000	0.000000	0.000000	Water/Wastewater - Wastewater Treatment		
0.000000	0.000000	0.000000	0.000000	Process & Fugitive - IPPU		
0.000000	0.000000	0.000000	0.000000	Process & Fugitive - Oil & Gas Processes		
0.000000	0.000000	0.000000	8.164071	AFOLU - Crop		
0.000000	0.000000	0.000000	0.421315	AFOLU - Livestock		
0.286111	37.035195	0.000000	74.239990	AFOLU - Forestry		
0.000000	0.000000	0.000000	1120.133100	AFOLU - Trees		
0.023164	0.473979	0.083392	7.810393	Activity Not Included in a Standard GHGI		

Ethyl Benzene	Cresol/Cresylic Acid (Mixed Isomers)	Catechol	Benzene		SC-Midlands	Co-Pollutant Emissions (U.S. Short Tons)
HAP	HAP	HAP	HAP	Type		
0.506478	10.125200	6.726966	9.012708	Residential - Stationary Fuel Combustion		
0.064022	0.011738	0.007603	0.496924	Commercial - Stationary Fuel Combustion		
0.089072	1.826553	1.213555	1.490836	Industrial - Stationary Fuel Combustion		
62.298083	0.000000	0.000000	71.758551	Transportation - On Road		
30.269742	0.000000	0.000000	49.277649	Transportation - Off Road/Mobile		
0.047666	0.000000	0.000000	0.279290	Transportation - Rail		
19.752666	0.000000	0.000000	32.127789	Transportation - Waterborne		
0.000000	0.000000	0.000000	0.000000	Solid Waste - Landfills		
0.000000	0.000000	0.000000	0.000000	Solid Waste -Composting		
0.000000	0.000000	0.000000	0.000000	Water/Wastewater - Wastewater Treatment		
0.000000	0.000000	0.000000	0.000000	Process & Fugitive - IPPU		
1.458522	0.000000	0.000000	7.875097	Process & Fugitive - Oil & Gas Processes		
0.108635	0.000000	0.000000	0.969169	AFOLU - Crop		
0.000000	0.000000	0.000000	1.964169	AFOLU - Livestock		
2.030031	0.000000	0.000000	33.032188	AFOLU - Forestry		
0.000000	0.000000	0.000000	0.000000	AFOLU - Trees		
37.796874	1.223259	0.000000	17.514185	Activity Not Included in a Standard GHGI		

m-Xylene	Hydroquinone	Fluorene	Fluoranthene			
HAP	HAP	HAP	HAP	Type	SC-Midlands	Co-Pollutant Emissions (U.S. Short Tons)
1.299906	0.369956	0.095679	0.063482	Residential - Stationary Fuel Combustion		
0.040882	0.000000	0.000000	0.003398	Commercial - Stationary Fuel Combustion		
0.233376	0.066901	0.017270	0.011863	Industrial - Stationary Fuel Combustion		
0.000000	0.000000	0.268406	0.238830	Transportation - On Road		
0.000000	0.000000	0.165402	0.069396	Transportation - Off Road/Mobile		
0.000000	0.000000	0.005875	0.000261	Transportation - Rail		
0.000000	0.000000	0.068411	0.044378	Transportation - Waterborne		
0.000000	0.000000	0.000000	0.000000	Solid Waste - Landfills		
0.000000	0.000000	0.000000	0.000000	Solid Waste -Composting		
0.000000	0.000000	0.000000	0.000000	Water/Wastewater - Wastewater Treatment		
0.000000	0.000000	0.000000	0.000000	Process & Fugitive - IPPU		
0.000000	0.000000	0.000000	0.000000	Process & Fugitive - Oil & Gas Processes		
0.000000	0.000000	0.000000	0.000000	AFOLU - Crop		
0.000000	0.000000	0.000000	0.000000	AFOLU - Livestock		
0.000000	0.000000	0.000000	0.385105	AFOLU - Forestry		
0.000000	0.000000	0.000000	0.000000	AFOLU - Trees		
35.754652	0.000000	0.053189	0.049269	Activity Not Included in a Standard GHGI		

Phenol	Phenanthrene	o-Xylene	Naphthalene			
HAP	HAP	HAP	HAP	Type	SC-Midlands	Co-Pollutant Emissions (U.S. Short Tons)
11.319692	0.349184	0.402665	4.965418	Residential - Stationary Fuel Combustion		
0.013123	0.014939	0.063954	0.097151	Commercial - Stationary Fuel Combustion		
2.042040	0.061067	0.070402	0.882939	Industrial - Stationary Fuel Combustion		
0.000000	0.574935	0.000000	5.552304	Transportation - On Road		
0.000000	0.378004	0.000000	2.567895	Transportation - Off Road/Mobile		
0.000000	0.013872	0.000000	0.033887	Transportation - Rail		
0.000000	0.176957	0.000000	1.642807	Transportation - Waterborne		
0.000000	0.000000	0.000000	0.000000	Solid Waste - Landfills		
0.000000	0.000000	0.000000	1.216591	Solid Waste -Composting		
0.000000	0.000000	0.000000	0.000000	Water/Wastewater - Wastewater Treatment		
0.000000	0.000000	0.000000	0.000000	Process & Fugitive - IPPU		
0.000000	0.000000	0.000000	0.043566	Process & Fugitive - Oil & Gas Processes		
0.000000	0.000000	0.000000	0.000000	AFOLU - Crop		
1.148639	0.000000	0.000000	0.000000	AFOLU - Livestock		
4.863611	0.286111	2.875208	23.010568	AFOLU - Forestry		
0.000000	0.000000	0.000000	0.000000	AFOLU - Trees		
2.263238	0.094439	43.135513	14.351591	Activity Not Included in a Standard GHGI		

Co-Pollutant Emissions (U.S. Short Tons)

SC-Midlands

Toluene	Pyrene	Propionaldehyde	Type
HAP	HAP	HAP	
3.455334	0.037760	6.119744	Residential - Stationary Fuel Combustion
0.257610	0.004194	3.864024	Commercial - Stationary Fuel Combustion
0.614556	0.007114	0.991847	Industrial - Stationary Fuel Combustion
447.111195	0.299175	2.479324	Transportation - On Road
159.931989	0.080939	3.075594	Transportation - Off Road/Mobile
0.266878	0.000354	0.479139	Transportation - Rail
115.342713	0.050936	0.488751	Transportation - Waterborne
0.000000	0.000000	0.000000	Solid Waste - Landfills
0.000000	0.000000	0.000000	Solid Waste -Composting
0.000000	0.000000	0.000000	Water/Wastewater - Wastewater Treatment
0.000000	0.000000	0.000000	Process & Fugitive - IPPU
29.003178	0.000000	0.000000	Process & Fugitive - Oil & Gas Processes
0.710821	0.000000	1.338319	AFOLU - Crop
1.326793	0.000000	0.000000	AFOLU - Livestock
22.937406	0.531903	0.000000	AFOLU - Forestry
0.000000	0.000000	0.000000	AFOLU - Trees
298.323108	0.056575	2.001938	Activity Not Included in a Standard GHGI

Xylenes (Mixed Isomers)	Hexane	2,2,4-Trimethylpentane		SC-Midlands	Co-Pollutant Emissions (U.S. Short Tons)
HAP	HAP	HAP	Type		
0.000000	0.054279	0.013715	Residential - Stationary Fuel Combustion		
0.000000	0.257202	0.065437	Commercial - Stationary Fuel Combustion		
0.000000	0.000000	0.000000	Industrial - Stationary Fuel Combustion		
234.814334	107.423573	100.603048	Transportation - On Road		
110.047470	21.428308	121.987059	Transportation - Off Road/Mobile		
0.203572	0.034632	0.088380	Transportation - Rail		
72.375299	25.649394	93.048092	Transportation - Waterborne		
0.000000	0.000000	0.000000	Solid Waste - Landfills		
0.000000	0.000000	0.000000	Solid Waste -Composting		
0.000000	0.000000	0.000000	Water/Wastewater - Wastewater Treatment		
0.000000	0.000000	0.000000	Process & Fugitive - IPPU		
12.221294	36.877594	17.395603	Process & Fugitive - Oil & Gas Processes		
0.276702	0.764753	0.023440	AFOLU - Crop		
0.000000	4.085921	0.000000	AFOLU - Livestock		
9.148607	1.407787	0.000000	AFOLU - Forestry		
0.000000	0.000000	0.000000	AFOLU - Trees		
133.212198	31.954410	0.000000	Activity Not Included in a Standard GHGI		

Co-Pollutant Emissions (U.S. Short Tons)

SC-Midlands

Benzo[g,h,i,] Perylene	Benzo[a] Pyrene	Arsenic	Styrene	
HAP	HAP	HAP	HAP	Type
0.000000	0.009971	0.000000	0.000000	Residential - Stationary Fuel Combustion
0.000000	0.000000	0.000000	0.000000	Commercial - Stationary Fuel Combustion
0.000000	0.000000	0.000000	0.000000	Industrial - Stationary Fuel Combustion
0.067549	0.034604	0.021653	1.614168	Transportation - On Road
0.121409	0.042739	0.000000	4.439200	Transportation - Off Road/Mobile
0.000000	0.000000	0.007508	0.000000	Transportation - Rail
0.016042	0.005800	0.000000	2.965357	Transportation - Waterborne
0.000000	0.000000	0.000000	0.000000	Solid Waste - Landfills
0.000000	0.000000	0.000000	0.000000	Solid Waste -Composting
0.000000	0.000000	0.000000	0.000000	Water/Wastewater - Wastewater Treatment
0.000000	0.000000	0.000000	0.000000	Process & Fugitive - IPPU
0.000000	0.000000	0.000000	0.000000	Process & Fugitive - Oil & Gas Processes
0.000000	0.000000	0.000000	0.105587	AFOLU - Crop
0.000000	0.000000	0.000000	0.000000	AFOLU - Livestock
0.290689	0.084531	0.000000	8.924151	AFOLU - Forestry
0.000000	0.000000	0.000000	0.000000	AFOLU - Trees
0.023164	0.024946	0.000000	43.351082	Activity Not Included in a Standard GHGI

Benz[a] Anthracene	Nickel	Manganese	Indeno[1,2,3-c,d]Pyrene		SC-Midlands	Co-Pollutant Emissions (U.S. Short Tons)
HAP	HAP	HAP	HAP	Type		
0.001470	0.000000	0.000000	0.000000	Residential - Stationary Fuel Combustion		
0.000000	0.001488	0.000000	0.000000	Commercial - Stationary Fuel Combustion		
0.000000	0.000000	0.000000	0.000000	Industrial - Stationary Fuel Combustion		
0.060078	0.014211	0.084035	0.024579	Transportation - On Road		
0.021170	0.000332	0.000000	0.043135	Transportation - Off Road/Mobile		
0.000000	0.030166	0.016913	0.000000	Transportation - Rail		
0.006202	0.000000	0.000000	0.005672	Transportation - Waterborne		
0.000000	0.000000	0.000000	0.000000	Solid Waste - Landfills		
0.000000	0.000000	0.000000	0.000000	Solid Waste -Composting		
0.000000	0.000000	0.000000	0.000000	Water/Wastewater - Wastewater Treatment		
0.000000	0.000000	0.000000	0.000000	Process & Fugitive - IPPU		
0.000000	0.000000	0.000000	0.000000	Process & Fugitive - Oil & Gas Processes		
0.000000	0.000000	0.000000	0.000000	AFOLU - Crop		
0.000000	0.000000	0.000000	0.000000	AFOLU - Livestock		
0.354778	0.000000	0.000000	0.195128	AFOLU - Forestry		
0.000000	0.000000	0.000000	0.000000	AFOLU - Trees		
0.026728	0.000000	0.000000	0.022541	Activity Not Included in a Standard GHGI		

Ethylene Glycol	Chrysene	Benzo[k] Fluoranthene	Benzo[b] Fluoranthene			
HAP	HAP	HAP	HAP	Type	SC-Midlands	Co-Pollutant Emissions (U.S. Short Tons)
0.000000	0.001389	0.000577	0.001479	Residential - Stationary Fuel Combustion		
0.000000	0.000000	0.000000	0.000000	Commercial - Stationary Fuel Combustion		
0.000000	0.000000	0.000000	0.000000	Industrial - Stationary Fuel Combustion		
0.000000	0.039075	0.016466	0.018140	Transportation - On Road		
0.000000	0.019215	0.023185	0.023185	Transportation - Off Road/Mobile		
0.000000	0.000000	0.000000	0.000000	Transportation - Rail		
0.000000	0.006341	0.005673	0.005673	Transportation - Waterborne		
0.000000	0.000000	0.000000	0.000000	Solid Waste - Landfills		
0.000000	0.000000	0.000000	0.000000	Solid Waste -Composting		
0.000000	0.000000	0.000000	0.000000	Water/Wastewater - Wastewater Treatment		
0.000000	0.000000	0.000000	0.000000	Process & Fugitive - IPPU		
0.000000	0.000000	0.000000	0.000000	Process & Fugitive - Oil & Gas Processes		
0.000000	0.000000	0.000000	0.000000	AFOLU - Crop		
0.000000	0.000000	0.000000	0.000000	AFOLU - Livestock		
0.000000	0.354778	0.148778	0.000000	AFOLU - Forestry		
0.000000	0.000000	0.000000	0.000000	AFOLU - Trees		
284.129581	0.032074	0.011939	0.032965	Activity Not Included in a Standard GHGI		

Methylene Chloride	Methyl Isobutyl Ketone	Methanol	Glycol Ethers		SC-Midlands	Co-Pollutant Emissions (U.S. Short Tons)
HAP	HAP	HAP	HAP	Type		
0.000000	0.000000	0.000000	0.000000	Residential - Stationary Fuel Combustion		
0.002256	0.000000	0.012930	0.000000	Commercial - Stationary Fuel Combustion		
0.000000	0.000000	0.000000	0.000000	Industrial - Stationary Fuel Combustion		
0.000000	0.000000	0.000000	0.000000	Transportation - On Road		
0.000000	0.000000	0.000000	0.000000	Transportation - Off Road/Mobile		
0.000000	0.000000	0.000000	0.000000	Transportation - Rail		
0.000000	0.000000	0.000000	0.000000	Transportation - Waterborne		
0.000000	0.000000	0.000000	0.000000	Solid Waste - Landfills		
0.000000	0.000000	31.120400	0.000000	Solid Waste -Composting		
0.000000	0.000000	0.000000	0.000000	Water/Wastewater - Wastewater Treatment		
0.000000	0.000000	0.000000	0.000000	Process & Fugitive - IPPU		
0.000000	0.000000	0.000000	0.000000	Process & Fugitive - Oil & Gas Processes		
0.000000	0.000000	3.243525	0.000000	AFOLU - Crop		
0.073604	6.262856	27.887303	0.000000	AFOLU - Livestock		
0.000000	0.000000	113.879270	0.000000	AFOLU - Forestry		
0.000000	0.000000	6308.743600	0.000000	AFOLU - Trees		
7.752542	15.008273	39.605679	56.940902	Activity Not Included in a Standard GHGI		

Triethylamine	Polycyclic aromatic compounds (includes 25 specific compounds)	Phenyl Cellosolve			
HAP	HAP	HAP	Type	SC-Midlands	Co-Pollutant Emissions (U.S. Short Tons)
0.000000	0.000000	0.000000	Residential - Stationary Fuel Combustion		
0.000000	0.013575	0.000000	Commercial - Stationary Fuel Combustion		
0.000000	0.000000	0.000000	Industrial - Stationary Fuel Combustion		
0.000000	0.000000	0.000000	Transportation - On Road		
0.000000	0.000000	0.000000	Transportation - Off Road/Mobile		
0.000000	0.000000	0.000000	Transportation - Rail		
0.000000	0.000000	0.000000	Transportation - Waterborne		
0.000000	0.000000	0.000000	Solid Waste - Landfills		
0.000000	0.000000	0.000000	Solid Waste -Composting		
0.000000	0.000000	0.000000	Water/Wastewater - Wastewater Treatment		
0.000000	0.000000	0.000000	Process & Fugitive - IPPU		
0.000000	0.000000	0.000000	Process & Fugitive - Oil & Gas Processes		
0.000000	0.000000	0.000000	AFOLU - Crop		
0.000000	0.000000	0.000000	AFOLU - Livestock		
0.000000	0.000000	0.000000	AFOLU - Forestry		
0.000000	0.000000	0.000000	AFOLU - Trees		
0.279057	21.188904	2.470752	Activity Not Included in a Standard GHGI		

Trichloroethylene	Diethanolamine	Vinyl Acetate	p-Xylene		SC-Midlands	Co-Pollutant Emissions (U.S. Short Tons)
HAP	HAP	HAP	HAP	Type		
0.000000	0.000000	0.000000	0.006942	Residential - Stationary Fuel Combustion		
0.000000	0.000000	0.000000	0.034539	Commercial - Stationary Fuel Combustion		
0.000000	0.000000	0.000000	0.000000	Industrial - Stationary Fuel Combustion		
0.000000	0.000000	0.000000	0.000000	Transportation - On Road		
0.000000	0.000000	0.000000	0.000000	Transportation - Off Road/Mobile		
0.000000	0.000000	0.000000	0.000000	Transportation - Rail		
0.000000	0.000000	0.000000	0.000000	Transportation - Waterborne		
0.000000	0.000000	0.000000	0.000000	Solid Waste - Landfills		
0.000000	0.000000	0.000000	0.000000	Solid Waste -Composting		
0.000000	0.000000	0.000000	0.000000	Water/Wastewater - Wastewater Treatment		
0.000000	0.000000	0.000000	0.000000	Process & Fugitive - IPPU		
0.000000	0.000000	0.000000	0.000000	Process & Fugitive - Oil & Gas Processes		
0.000000	0.000000	0.000000	0.000000	AFOLU - Crop		
0.000000	0.000000	0.000000	0.070858	AFOLU - Livestock		
0.000000	0.000000	0.000000	0.000000	AFOLU - Forestry		
0.000000	0.000000	0.000000	0.000000	AFOLU - Trees		
1.178207	2.607535	1.293047	13.394068	Activity Not Included in a Standard GHGI		

Co-Pollutant Emissions (U.S. Short Tons)

SC-Midlands

Type	Methyl Chloroform	Tetrachloroethylene	Phthalic Anhydride	Methyl Methacrylate
HAP	HAP	HAP	HAP	HAP
Residential - Stationary Fuel Combustion	0.000000	0.000000	0.000000	0.000000
Commercial - Stationary Fuel Combustion	0.000000	0.000000	0.000000	0.000000
Industrial - Stationary Fuel Combustion	0.000000	0.000000	0.000000	0.000000
Transportation - On Road	0.000000	0.000000	0.000000	0.000000
Transportation - Off Road/Mobile	0.000000	0.000000	0.000000	0.000000
Transportation - Rail	0.000000	0.000000	0.000000	0.000000
Transportation - Waterborne	0.000000	0.000000	0.000000	0.000000
Solid Waste - Landfills	0.000000	0.000000	0.000000	0.000000
Solid Waste -Composting	0.000000	0.000000	0.000000	0.000000
Water/Wastewater - Wastewater Treatment	0.000000	0.000000	0.000000	0.000000
Process & Fugitive - IPPU	0.000000	0.000000	0.000000	0.000000
Process & Fugitive - Oil & Gas Processes	0.000000	0.000000	0.000000	0.000000
AFOLU - Crop	0.000000	0.000000	0.000000	0.000000
AFOLU - Livestock	0.000000	0.000000	0.000000	0.000000
AFOLU - Forestry	0.000000	0.000000	0.000000	0.000000
AFOLU - Trees	0.000000	0.000000	0.000000	0.000000
Activity Not Included in a Standard GHGI	0.989889	3.908267	0.340828	0.970063

Co-Pollutant Emissions (U.S. Short Tons)

SC-Midlands

Dimethyl Phthalate	Acrylic Acid	Dibutyl Phthalate	Cumene	Type
HAP	HAP	HAP	HAP	
0.000000	0.000000	0.000000	0.000000	Residential - Stationary Fuel Combustion
0.000000	0.000000	0.000000	0.000000	Commercial - Stationary Fuel Combustion
0.000000	0.000000	0.000000	0.000000	Industrial - Stationary Fuel Combustion
0.000000	0.000000	0.000000	0.000000	Transportation - On Road
0.000000	0.000000	0.000000	0.000000	Transportation - Off Road/Mobile
0.000000	0.000000	0.000000	0.000000	Transportation - Rail
0.000000	0.000000	0.000000	0.000000	Transportation - Waterborne
0.000000	0.000000	0.000000	0.000000	Solid Waste - Landfills
0.000000	0.000000	0.000000	0.000000	Solid Waste -Composting
0.000000	0.000000	0.000000	0.000000	Water/Wastewater - Wastewater Treatment
0.000000	0.000000	0.000000	0.000000	Process & Fugitive - IPPU
0.000000	0.000000	0.000000	0.216258	Process & Fugitive - Oil & Gas Processes
0.000000	0.000000	0.000000	0.006928	AFOLU - Crop
0.000000	0.000000	0.000000	0.000000	AFOLU - Livestock
0.000000	3.352359	0.000000	0.518079	AFOLU - Forestry
0.000000	0.000000	0.000000	0.000000	AFOLU - Trees
0.050610	0.404512	58.885360	0.738714	Activity Not Included in a Standard GHGI

Methyl Bromide	Carbaryl	Captan	2,4-Dichlorophenoxy Acetic Acid			
HAP	HAP	HAP	HAP	Type	SC-Midlands	Co-Pollutant Emissions (U.S. Short Tons)
0.000000	0.000000	0.000000	0.000000	Residential - Stationary Fuel Combustion		
0.000000	0.000000	0.000000	0.000000	Commercial - Stationary Fuel Combustion		
0.000000	0.000000	0.000000	0.000000	Industrial - Stationary Fuel Combustion		
0.000000	0.000000	0.000000	0.000000	Transportation - On Road		
0.000000	0.000000	0.000000	0.000000	Transportation - Off Road/Mobile		
0.000000	0.000000	0.000000	0.000000	Transportation - Rail		
0.000000	0.000000	0.000000	0.000000	Transportation - Waterborne		
0.000000	0.000000	0.000000	0.000000	Solid Waste - Landfills		
0.000000	0.000000	0.000000	0.000000	Solid Waste -Composting		
0.000000	0.000000	0.000000	0.000000	Water/Wastewater - Wastewater Treatment		
0.000000	0.000000	0.000000	0.000000	Process & Fugitive - IPPU		
0.000000	0.000000	0.000000	0.000000	Process & Fugitive - Oil & Gas Processes		
1.698519	0.115466	0.743587	6.415261	AFOLU - Crop		
0.000000	0.000000	0.000000	0.000000	AFOLU - Livestock		
0.000000	0.000000	0.000000	0.000000	AFOLU - Forestry		
0.000000	0.000000	0.000000	0.000000	AFOLU - Trees		
0.000000	0.000000	0.000000	0.000000	Activity Not Included in a Standard GHGI		

Dibenzo(a,h) Anthracene	Bis(2-Ethylhexyl) Phthalate	Dibenzofuran	Trifluralin			
HAP	HAP	HAP	HAP	Type	SC-Midlands	Co-Pollutant Emissions (U.S. Short Tons)
0.000000	0.000000	0.000000	0.000000	Residential - Stationary Fuel Combustion		
0.000000	0.000000	0.000000	0.000000	Commercial - Stationary Fuel Combustion		
0.000000	0.000000	0.000000	0.000000	Industrial - Stationary Fuel Combustion		
0.000000	0.000000	0.000000	0.000000	Transportation - On Road		
0.000000	0.000000	0.000000	0.000000	Transportation - Off Road/Mobile		
0.000000	0.000000	0.000000	0.000000	Transportation - Rail		
0.000000	0.000000	0.000000	0.000000	Transportation - Waterborne		
0.000000	0.000000	0.000000	0.000000	Solid Waste - Landfills		
0.000000	0.000000	0.000000	0.000000	Solid Waste -Composting		
0.000000	0.000000	0.000000	0.000000	Water/Wastewater - Wastewater Treatment		
0.000000	0.000000	0.000000	0.000000	Process & Fugitive - IPPU		
0.000000	0.000000	0.000000	0.000000	Process & Fugitive - Oil & Gas Processes		
0.000000	0.000000	0.000000	0.684305	AFOLU - Crop		
0.000000	0.000000	0.000000	0.000000	AFOLU - Livestock		
0.000000	0.000000	0.285474	0.000000	AFOLU - Forestry		
0.000000	0.000000	0.000000	0.000000	AFOLU - Trees		
0.004811	0.423196	0.067115	0.000000	Activity Not Included in a Standard GHGI		

Co-Pollutant Emissions (U.S. Short Tons)

SC-Midlands

Mercury	Isophorone	Hydrogen Cyanide	Hydrochloric Acid		
HAP	HAP	HAP	HAP	Type	
0.000000	0.000000	0.000000	0.000000	Residential - Stationary Fuel Combustion	
0.000000	0.000000	0.000000	0.000000	Commercial - Stationary Fuel Combustion	
0.000986	0.000000	0.000000	0.000000	Industrial - Stationary Fuel Combustion	
0.000000	0.000000	0.000000	0.000000	Transportation - On Road	
0.000000	0.000000	0.000000	0.000000	Transportation - Off Road/Mobile	
0.000000	0.000000	0.000000	0.000000	Transportation - Rail	
0.000000	0.000000	0.000000	0.000000	Transportation - Waterborne	
0.002161	0.000000	0.000000	0.000000	Solid Waste - Landfills	
0.000000	0.000000	0.000000	0.000000	Solid Waste -Composting	
0.000000	0.000000	0.000000	0.000000	Water/Wastewater - Wastewater Treatment	
0.000000	0.000000	0.000000	0.000000	Process & Fugitive - IPPU	
0.000000	0.000000	0.000000	0.000000	Process & Fugitive - Oil & Gas Processes	
0.000000	0.000000	0.000000	0.000000	AFOLU - Crop	
0.000000	0.000000	0.000000	0.000000	AFOLU - Livestock	
0.000000	0.000000	0.000000	0.000000	AFOLU - Forestry	
0.000000	0.000000	0.000000	0.000000	AFOLU - Trees	
0.017225	0.164824	7.799287	5.426330	Activity Not Included in a Standard GHGI	

Acetamide	Chlorobenzene	1,4-Dichlorobenzene	Methyl Chloride			
HAP	HAP	HAP	HAP	Type	SC-Midlands	Co-Pollutant Emissions (U.S. Short Tons)
0.000000	0.000000	0.000000	0.000000	Residential - Stationary Fuel Combustion		
0.000000	0.000000	0.000000	0.000000	Commercial - Stationary Fuel Combustion		
0.000000	0.000000	0.000000	0.000000	Industrial - Stationary Fuel Combustion		
0.000000	0.000000	0.000000	0.000000	Transportation - On Road		
0.000000	0.000000	0.000000	0.000000	Transportation - Off Road/Mobile		
0.000000	0.000000	0.000000	0.000000	Transportation - Rail		
0.000000	0.000000	0.000000	0.000000	Transportation - Waterborne		
0.000000	0.000000	0.000000	0.000000	Solid Waste - Landfills		
0.000000	0.000000	0.000000	0.000000	Solid Waste -Composting		
0.000000	0.000000	0.000000	0.000000	Water/Wastewater - Wastewater Treatment		
0.000000	0.000000	0.000000	0.000000	Process & Fugitive - IPPU		
0.000000	0.000000	0.000000	0.000000	Process & Fugitive - Oil & Gas Processes		
0.000000	0.000000	0.000000	0.000000	AFOLU - Crop		
2.760547	0.004410	0.068064	0.000000	AFOLU - Livestock		
0.000000	0.000000	0.000000	7.360256	AFOLU - Forestry		
0.000000	0.000000	0.000000	0.000000	AFOLU - Trees		
0.000000	0.000417	0.000000	2.902677	Activity Not Included in a Standard GHGI		

Co-Pollutant Emissions (U.S. Short Tons)

SC-Midlands

o-Cresol	Ethyl Chloride	Chloroform	Carbon Disulfide	Acetonitrile	
HAP	HAP	HAP	HAP	HAP	Type
0.000000	0.000000	0.000000	0.000000	0.000000	Residential - Stationary Fuel Combustion
0.000000	0.000000	0.000000	0.000000	0.000000	Commercial - Stationary Fuel Combustion
0.000000	0.000000	0.000000	0.000000	0.000000	Industrial - Stationary Fuel Combustion
0.000000	0.000000	0.000000	0.000000	0.000000	Transportation - On Road
0.000000	0.000000	0.000000	0.000000	0.000000	Transportation - Off Road/Mobile
0.000000	0.000000	0.000000	0.000000	0.000000	Transportation - Rail
0.000000	0.000000	0.000000	0.000000	0.000000	Transportation - Waterborne
0.000000	0.000000	0.000000	0.000000	0.000000	Solid Waste - Landfills
0.000000	0.000000	0.000000	0.000000	0.000000	Solid Waste -Composting
0.000000	0.000000	0.000000	0.000000	0.000000	Water/Wastewater - Wastewater Treatment
0.000000	0.000000	0.000000	0.000000	0.000000	Process & Fugitive - IPPU
0.000000	0.000000	0.000000	0.000000	0.000000	Process & Fugitive - Oil & Gas Processes
0.000000	0.000000	0.000000	0.000000	0.000000	AFOLU - Crop
5.429776	1.140869	0.920056	1.251276	3.239041	AFOLU - Livestock
0.000000	0.000000	0.000000	0.000000	4.205322	AFOLU - Forestry
0.000000	0.000000	0.000000	0.000000	0.000000	AFOLU - Trees
0.000000	0.000000	0.000000	0.000000	0.000000	Activity Not Included in a Standard GHGI

Co-Pollutant Emissions (U.S. Short Tons)

SC-Midlands

Benzofluoranthenes	Benzo[e] Pyrene	Benzo(c) phenanthrene	Benzo(a) Fluoranthene	Type
HAP	HAP	HAP	HAP	
0.000000	0.001181	0.000000	0.000000	Residential - Stationary Fuel Combustion
0.000000	0.000000	0.000000	0.000000	Commercial - Stationary Fuel Combustion
0.000000	0.000000	0.000000	0.000000	Industrial - Stationary Fuel Combustion
0.000000	0.000000	0.000000	0.000000	Transportation - On Road
0.000000	0.000000	0.000000	0.000000	Transportation - Off Road/Mobile
0.000000	0.000000	0.000000	0.000000	Transportation - Rail
0.000000	0.000000	0.000000	0.000000	Transportation - Waterborne
0.000000	0.000000	0.000000	0.000000	Solid Waste - Landfills
0.000000	0.000000	0.000000	0.000000	Solid Waste -Composting
0.000000	0.000000	0.000000	0.000000	Water/Wastewater - Wastewater Treatment
0.000000	0.000000	0.000000	0.000000	Process & Fugitive - IPPU
0.000000	0.000000	0.000000	0.000000	Process & Fugitive - Oil & Gas Processes
0.000000	0.000000	0.000000	0.000000	AFOLU - Crop
0.000000	0.000000	0.000000	0.000000	AFOLU - Livestock
0.294122	0.152211	0.223167	0.148778	AFOLU - Forestry
0.000000	0.000000	0.000000	0.000000	AFOLU - Trees
0.000000	0.000000	0.000000	0.000000	Activity Not Included in a Standard GHGI

Co-Pollutant Emissions (U.S. Short Tons)

SC-Midlands

Methylchrysene	Methylbenzopyrene	Methylanthracene	Type
HAP	HAP	HAP	
0.000000	0.000000	0.000000	Residential - Stationary Fuel Combustion
0.000000	0.000000	0.000000	Commercial - Stationary Fuel Combustion
0.000000	0.000000	0.000000	Industrial - Stationary Fuel Combustion
0.000000	0.000000	0.000000	Transportation - On Road
0.000000	0.000000	0.000000	Transportation - Off Road/Mobile
0.000000	0.000000	0.000000	Transportation - Rail
0.000000	0.000000	0.000000	Transportation - Waterborne
0.000000	0.000000	0.000000	Solid Waste - Landfills
0.000000	0.000000	0.000000	Solid Waste -Composting
0.000000	0.000000	0.000000	Water/Wastewater - Wastewater Treatment
0.000000	0.000000	0.000000	Process & Fugitive - IPPU
0.000000	0.000000	0.000000	Process & Fugitive - Oil & Gas Processes
0.000000	0.000000	0.000000	AFOLU - Crop
0.000000	0.000000	0.000000	AFOLU - Livestock
0.452318	0.169378	0.471212	AFOLU - Forestry
0.000000	0.000000	0.000000	AFOLU - Trees
0.000000	0.000000	0.000000	Activity Not Included in a Standard GHGI

Co-Pollutant Emissions (U.S. Short Tons)

SC-Midlands

Ethylene Dichloride	2,4-Toluene Diisocyanate	Lead	Carbonyl Sulfide	
HAP	HAP	CAP/HAP	HAP	Type
0.000000	0.000000	0.000000	0.000000	Residential - Stationary Fuel Combustion
0.000000	0.000000	0.000877	0.000000	Commercial - Stationary Fuel Combustion
0.000000	0.000000	0.000000	0.000000	Industrial - Stationary Fuel Combustion
0.000000	0.000000	0.000000	0.000000	Transportation - On Road
0.000000	0.000000	0.000000	0.000000	Transportation - Off Road/Mobile
0.000000	0.000000	0.000000	0.000000	Transportation - Rail
0.000000	0.000000	0.000000	0.000000	Transportation - Waterborne
0.000000	0.000000	0.000000	0.000000	Solid Waste - Landfills
0.000000	0.000000	0.000000	0.000000	Solid Waste -Composting
0.000000	0.000000	0.000000	0.000000	Water/Wastewater - Wastewater Treatment
0.000000	0.000000	0.000000	0.000000	Process & Fugitive - IPPU
0.019867	0.000000	0.000000	0.000000	Process & Fugitive - Oil & Gas Processes
0.000000	0.000000	0.000000	0.000000	AFOLU - Crop
0.000000	0.000000	0.000000	0.000000	AFOLU - Livestock
0.000000	0.000000	0.008363	0.029723	AFOLU - Forestry
0.000000	0.000000	0.000000	0.000000	AFOLU - Trees
0.000000	0.175261	0.001355	0.000000	Activity Not Included in a Standard GHGI

Co-Pollutant Emissions (U.S. Short Tons)

SC-Midlands

1,2,4-Trichlorobenzene	Cyanide	2,4,6-Trichlorophenol	
HAP	HAP	HAP	Type
0.000000	0.000000	0.000000	Residential - Stationary Fuel Combustion
0.000000	0.000000	0.000000	Commercial - Stationary Fuel Combustion
0.000000	0.003601	0.000000	Industrial - Stationary Fuel Combustion
0.000000	0.000000	0.000000	Transportation - On Road
0.000000	0.000000	0.000000	Transportation - Off Road/Mobile
0.000000	0.000000	0.000000	Transportation - Rail
0.000000	0.000000	0.000000	Transportation - Waterborne
0.000000	0.000000	0.000000	Solid Waste - Landfills
0.000000	0.000000	0.000000	Solid Waste -Composting
0.000000	0.000000	0.000000	Water/Wastewater - Wastewater Treatment
0.000000	0.000000	0.000000	Process & Fugitive - IPPU
0.000000	0.000000	0.000000	Process & Fugitive - Oil & Gas Processes
0.000000	0.000000	0.000000	AFOLU - Crop
0.000000	0.000000	0.000000	AFOLU - Livestock
0.000000	0.000000	0.000000	AFOLU - Forestry
0.000000	0.000000	0.000000	AFOLU - Trees
0.001149	0.000000	0.003143	Activity Not Included in a Standard GHGI

Hydrogen Fluoride	Benzyl Chloride	Polychlorinated Biphenyls		SC-Midlands	Co-Pollutant Emissions (U.S. Short Tons)
HAP	HAP	HAP	Type		
0.000000	0.000000	0.000000	Residential - Stationary Fuel Combustion		
0.000000	0.000000	0.000000	Commercial - Stationary Fuel Combustion		
0.000000	0.000787	0.000000	Industrial - Stationary Fuel Combustion		
0.000000	0.000000	0.000000	Transportation - On Road		
0.000000	0.000000	0.000000	Transportation - Off Road/Mobile		
0.000000	0.000000	0.000000	Transportation - Rail		
0.000000	0.000000	0.000000	Transportation - Waterborne		
0.000000	0.000000	0.000000	Solid Waste - Landfills		
0.000000	0.000000	0.000000	Solid Waste -Composting		
0.000000	0.000000	0.000000	Water/Wastewater - Wastewater Treatment		
0.000000	0.000000	0.000000	Process & Fugitive - IPPU		
0.000000	0.000000	0.000000	Process & Fugitive - Oil & Gas Processes		
0.000000	0.000000	0.000000	AFOLU - Crop		
0.000000	0.000000	0.000000	AFOLU - Livestock		
0.000000	0.000000	0.000000	AFOLU - Forestry		
0.000000	0.000000	0.000000	AFOLU - Trees		
0.001248	0.000000	0.001703	Activity Not Included in a Standard GHGI		

Appendix D:
Summary of Co-benefits by Climate Action

Table D.1.

Overview of GHG reduction measures in CMCOG Climate Action Plan and their associated co-benefits and co-harms.

✓ denotes direct benefits; Ω denotes indirect benefits; X denotes co-harms.

Measure	Outdoor Air Quality	Occupant Comfort	Physical and Emotional Well-being	Job Creation	Household Savings	Passive Survivability	Urban Heat Island Effect	Water and Soil Health
Design Buildings for Life								
High performance new residential buildings	Ω	✓		✓	✓	✓	Ω	
High performance new non-residential buildings	Ω	✓		✓		✓	Ω	
Existing residential buildings energy performance: Level 1 - Weatherization	Ω	✓		✓	✓			

Measure	Outdoor Air Quality	Occupant Comfort	Physical and Emotional Well-being	Job Creation	Household Savings	Passive Survivability	Urban Heat Island Effect	Water and Soil Health
Existing residential buildings energy performance: Level 2 - Enhanced Energy Efficiency	Ω	✓		✓	✓			
Existing residential buildings energy performance: Level 3 - Deep Retrofits	Ω	✓		✓	✓			
Existing non-residential buildings energy performance: Level 1 - Weatherization	Ω	✓		✓				
Existing non-residential buildings energy performance: Level 2 - Enhanced Energy Efficiency	Ω	✓		✓				
Existing non-residential buildings energy performance: Level 3 - Deep Energy Retrofits	Ω	✓		✓				

Measure	Outdoor Air Quality	Occupant Comfort	Physical and Emotional Well-being	Job Creation	Household Savings	Passive Survivability	Urban Heat Island Effect	Water and Soil Health
Heat pumps for water heating	✓	✓		✓	✓		Ω	
Heat pumps for space heating & cooling	✓	✓		✓	✓		Ω	
Reimagine Transportation in the Midlands								
Increase active transportation			✓		✓			
Increase transit ridership			Ω		✓			
Reduce vehicle-miles-travelled (VMT) in Columbia	✓							
Shift personal vehicle travel to rail travel	✓			✓ / X	✓			
Replace transit buses and shuttles with electric models	✓			✓ / X		✓		
Electrify personal and commercial light-duty vehicles	✓			✓ / X		✓	✓	

Measure	Outdoor Air Quality	Occupant Comfort	Physical and Emotional Well-being	Job Creation	Household Savings	Passive Survivability	Urban Heat Island Effect	Water and Soil Health
Replace municipal and county fleet vehicles with electric vehicles	✓					✓	✓	
Replace commercial medium and heavy-duty vehicles with electric models	✓			✓ / X		✓	✓	
Transport more freight by rail rather than by truck	✓						✓	
Replace diesel freight train engines with hybrid diesel/electric engines	✓						✓	
Expand Renewable Generation								
Rooftop solar installation in Columbia	Ω			✓	✓	✓		
Rooftop solar installation outside Columbia	Ω			✓	✓	✓		
Restart Columbia Canal Hydro	Ω							

Measure	Outdoor Air Quality	Occupant Comfort	Physical and Emotional Well-being	Job Creation	Household Savings	Passive Survivability	Urban Heat Island Effect	Water and Soil Health
Canopy solar on parking lots in downtown Columbia	Ω			✓		✓		
Utilities switch to renewable energy sources to generate grid electricity	Ω			✓				
Advance Low-carbon Transformation in Industry								
Industrial efficiency improvements		✓		✓				
Solar on industrial buildings	Ω			✓		✓		
Scale Up Waste Reduction and Diversion Initiatives								
Reduce waste generation	✓			✓				✓
Divert organic waste from landfills				✓				✓
Optimize Water and Wastewater Operations								
Anaerobic digestion at all wastewater treatment plants	✓			✓				✓

Measure	Outdoor Air Quality	Occupant Comfort	Physical and Emotional Well-being	Job Creation	Household Savings	Passive Survivability	Urban Heat Island Effect	Water and Soil Health
Improve efficiency of water and wastewater treatment assets				✓				Ω
Install solar at wastewater treatment plants	Ω			✓		✓		
Reduce water consumption					Ω			✓
Replace septic systems with connection to wastewater treatment plants	✓			✓				✓
Protect Trees and Encourage Green Infrastructure								
Increase and maintain healthy urban trees	✓		✓	✓			✓	✓
Reforestation	✓			✓				✓
Add green infrastructure	✓			✓			✓	✓

Measure	Outdoor Air Quality	Occupant Comfort	Physical and Emotional Well-being	Job Creation	Household Savings	Passive Survivability	Urban Heat Island Effect	Water and Soil Health
Enhance Agriculture and Soil Management Practices								
Climate Smart Commodities	✓			✓				✓
Agrivoltaics	Ω			✓		✓		✓
Intentional Land Use								
Smart Growth			✓		Ω			
Install reflective surfaces				✓			✓	
Reduce Consumption-based Carbon Impact								
Increase Circular Economy				Ω	Ω			
Plant-based Meals at Cafeterias			✓		Ω			Ω

Appendix E:
Statewide Workforce Analysis

The project archive at the Open Science Framework (DOI: *10.17605/OSF.IO/VZEPC*) contains a copy of the South Carolina Office of Resilience's statewide climate action plan's workforce analysis. Many businesses operate across multiple counties, and the Midlands is interconnected with other parts of the state's economy as a function of our geographic location in the middle of the state. The statewide analysis thus provides important additional information to refer to in addition to Chapter 9 of this regional plan. The Midlands' total population is approximately 17% of the statewide total population. This can be used as an initial way to downscale certain numbers or figures presented for the entire state (e.g., multiply the number by 0.17 to derive a first order approximation of a similar number for the Midlands).

Climate Action Plan

FOR THE MIDLANDS REGION
OF SOUTH CAROLINA

April 22nd, 2026