Knoxville, TN Metropolitan Statistical Area

Priority Climate Action Plan

March 1, 2024

This project has been funded wholly or in part by the United States Environmental Protection Agency (EPA) under assistance agreement 02D56823 to the City of Knoxville. The contents of this document do not necessarily reflect the views and policies of the EPA, nor does the EPA endorse trade names or recommend the use of commercial products mentioned in this document.

Acknowledgements

This Priority Climate Action Plan (PCAP) was developed to meet deliverable requirements for Phase 1 of the U.S. Environmental Protection Agency (EPA) Climate Pollution Reduction Grant (CPRG) program. The Knoxville MSA's PCAP was coordinated by staff from the City of Knoxville and the Knoxville Regional Transportation Planning Organization (TPO), which serves as the transportation division of Knoxville-Knox County Planning. The PCAP was also informed by stakeholders across the region.

Staff responsible for CPRG program deliverables include:

- Dawn Michelle Foster - Deputy Director, City of Knoxville Office of Sustainability
- Grace Levin - Sustainability Coordinator, City of Knoxville Office of Sustainability
- Amy Brooks - Executive Director, Knoxville-Knox County Planning
- Ally Ketron - Strategic Planning & Communications Manager, Knoxville-Knox County Planning
- Aubrey Weiland - Research Associate, Knoxville-Knox County Planning
- Emily Jackson - AmeriCorps Service Member, Knoxville-Knox County Planning

The project team would like to thank the members of the Advisory Committee:

- Mayor Indya Kincannon - City of Knoxville
- Mayor Tanya Martin - City of Alcoa
- Randy Hemann - City Manager, City of Oak Ridge
- Brian Boone - Director of Engineering & Public Works, City of Maryville
- Evie Braude - City of Knoxville Mayor's Youth Council
- Chris Carnevale - Climate Advocacy Director, Southern Alliance for Clean Energy
- Dr. Jay Clark - Director of Environmental & Sustainability Initiatives, Maryville College
- Erin Gill - Vice President of Sustainability & Government Relations, Knoxville Utilities Board
- Stan Johnson - Executive Director, Socially Equal Energy Efficient Development
- Skip Markham - Senior Manager of Regulatory Affairs, Tennessee Valley Authority
- Kent Minault – Vice Chair, Sierra Club Harvey Broome Group
- Nancy Nabors - Director of Regional Enhancement, Knoxville Chamber
- Daniel Odle - Vice President, LawlerWood, LLC
- Cortney Piper - Executive Director, Tennessee Advanced Energy Business Council
- Dr. Peter Thornton - Director of Climate Change Science Institute, Oak Ridge National Laboratory

The team also appreciates the many individuals who contributed project ideas, attended meetings, or otherwise supported the planning process, including Liz Albertson, Bruce Applegate, Megan Brooks, Aaron Browning, Rob Cheesman, Tom Clabo, Jeff DeSalu, Dr. Amy Fitzgerald, Mayor Terry Frank, Dakota Gentry, Chasity Hobby, Angie Luckie, Amy Nolan, Dr. Kevin Parks, David Powell, Jeffrey Vincent, Kelsey Vincent, Don Walker, and Jennifer Williams.

Finally, the project team acknowledges the invaluable contributions of ICF and Three[3], whose staff worked closely with the City of Knoxville and TPO to develop this PCAP.

Table of Contents

Figures

Tables

Acronyms and Abbreviations

AEO	Annual Energy Outlook
AFV	Alternative fueled vehicle
BAU	Business-as-usual
BEV	Battery electric vehicle
BIPOC	Black, Indigenous, and People of Color
CAC	Climate action committee
CBO	Community-based organizations
CCAP	Comprehensive Climate Action Plan
CMAQ	Congestion Mitigation and Air Quality
CPRG	Climate Pollution Reduction Grant
DER	Distributed Energy Resources
DOE	Department of Energy
EIA	Energy Information Administration
EPA	Environmental Protection Agency
EV	Electric vehicle
EWG	Equity Working Group
FCEV	Fuel cell electric vehicle
FHWA	Federal Highway Administration
FLIGHT	Facility-Level Information on Greenhouse gases Tool
FTA	Federal Transit Administration
HUD	Housing and Urban Development
GHG	Greenhouse gas
ICEV	Internal combustion engine vehicle
IRA	Inflation Reduction Act
IRS	Internal Revenue Service
KAT	Knoxville Area Transit
KTA	Knoxville Transportation Authority
LDV	Light-duty vehicle
LIDAC	Low Income Disadvantaged Community
LMOP	Landfill Methane Outreach Program
MHDV	Medium and heavy-duty vehicles
MSA	Metropolitan Statistical Area
MSW	Municipal solid waste
NAPEE	National Action Plan for Energy Efficiency
NGO	Non-governmental organizations
NOAA	National Oceanic and Atmospheric Administration
NREL	National Renewable Energy Laboratory
PCAP	Priority Climate Action Plan
PHEV	Plug-in hybrid electric vehicle
PPA	Power purchase agreements
SIT	State Inventory Tool
STBG	Surface Transportation Block Grant
TA	Transportation Alternatives
TDEC	Tennessee Department of Environment and Conservation
TDOT	Tennessee Departments of Transportation
TPO	Transportation Planning Organization
TVA	Tennessee Valley Authority
VMT	Vehicle miles traveled
WARM	Waste Reduction Model
ZEV	Zero-emission vehicles

Definitions

Greenhouse Gas (GHG)	The air pollutants carbon dioxide, hydrofluorocarbons, methane, nitrous oxide, perfluorocarbons, and sulfur hexafluoride.
GHG Inventory	A list of emission sources and sinks and the associated emissions quantified using standard methods.
GHG Reduction Measure	Policies, programs, actions, or projects that reduce GHG emissions or enhance carbon removal. Measures that enhance "carbon removal" are those that increase the removal of carbon dioxide from the atmosphere through, for example, the uptake of carbon and storage in soils, vegetation, and forests.
Co-Benefits	Positive effects beyond the stated goal of a GHG reduction measure (e.g., improved public health outcomes, economic benefits, increased climate resilience).
Low Income Disadvantaged Community (LIDACs)	Communities with residents that have low incomes, limited access to resources, and disproportionate exposure to environmental or climate burdens.

1 Introduction

The City of Knoxville developed the Knoxville Metropolitan Statistical Area's (MSA) Priority Climate Action Plan (PCAP) to meet the requirements of the Environmental Protection Agency's (EPA) Climate Pollution Reduction Grant (CPRG) program. The CPRG program provides funding to states, local governments, tribes, and territories to develop and implement plans for reducing greenhouse gas (GHG) emissions and other harmful air pollutants.

The City of Knoxville, as the lead organization representing the Knoxville MSA, was awarded a CPRG planning grant on August 1, 2023, and will use those funds to develop planning deliverables, including this PCAP. The funds will also be used to develop a Comprehensive Climate Action Plan (CCAP) in 2025 and a CCAP Status Report in 2027.

1.1 CPRG Program Overview

The Inflation Reduction Act (IRA), signed into law on August 16, 2022, directs federal funding to reduce carbon emissions, lower healthcare costs, fund the Internal Revenue Service (IRS), and improve taxpayer compliance. The IRA contains provisions that directly or indirectly address issues related to climate change, including reduction of GHG emissions and promotion of adaptation and resilience to climate change impacts.[1] The law represents the largest investment toward addressing climate change in United States history, investing approximately $369 billion for climate and clean energy programs over ten years.[2]

The CPRG program, authorized under Section 60114 of the IRA, provides $5 billion in grants to states, local governments, tribes, and territories to develop and implement plans for reducing GHG emissions and other harmful air pollutants. The CPRG program consists of two phases: planning and implementation. The planning phase provides $250 million in noncompetitive grants to state and local agencies to develop emissions inventories and identify emissions reduction measures. The implementation phase provides $4.6 billion in competitive grants to eligible applicants to implement GHG reduction measures identified in a PCAP developed under a CPRG planning grant.[3]

[1] CRS. "Inflation Reduction Act of 2022 (IRA): Provisions Related to Climate Change," October 3, 2022. https://crsreports.congress.gov/product/pdf/R/R47262.
[2] U.S. Department of Energy. "The Inflation Reduction Act Drives Significant Emissions Reductions and Positions America to Reach Our Climate Goals." August 2022. https://www.energy.gov/sites.
[3] US EPA. "Climate Pollution Reduction Grants." January 18, 2023. https://www.epa.gov/inflation-reduction-act/climate-pollution-reduction-grants.

1.2 PCAP Overview and Scope

Because including a GHG reduction measure in a PCAP is a prerequisite for organizations to compete for the CPRG Phase 2 implementation grant, the measures identified in this PCAP are designed to be broad enough to encompass local and regional priorities for addressing climate pollution. To that end, the geographic scope of this PCAP covers the entirety of the Knoxville MSA, which consists of the following nine counties: Anderson, Blount, Campbell, Grainger, Knox, Loudon, Morgan, Roane, and Union (see Figure 1-1).

Figure 1-1 PCAP Geographic Scope

This PCAP includes a focused list of near-term, high priority, implementation-ready measures to reduce GHG pollution throughout the Knoxville MSA region and aims to provide 40% of the benefits of these measures to low-income and disadvantaged communities (LIDACs) to further advance the goals of the federal Justice40 Initiative as set forth in Executive Order 14008. Table 1-1 summarizes the information provided within this PCAP, in accordance with EPA's CPRG Planning guidance.[4]

Table 1-1: Summary of PCAP Elements and Location within Report

PCAP Element	Document Location
GHG Inventory and Projections	Section 2.1
Quantified GHG Reduction Measures	Section 3
LIDACs Benefits Analysis	Section 2.2 and Section 3
Review of Authority to Implement for Each Measure	Section 3

1.3 Approach to Developing the PCAP

To identify, prioritize, and analyze GHG reduction measures, the City of Knoxville followed the approach outlined in Figure 1-2. As part of this process, the City of Knoxville with support from the Knoxville Regional Transportation Planning Organization (TPO) continuously engaged stakeholders to seek feedback on priorities and discuss key implementation information. A summary of engagement efforts that were undertaken to support PCAP development are detailed in Section 1.4.

[4] US EPA. "Climate Pollution Reduction Grants Program: Formula Grants for Planning," March 1, 2023. https://www.epa.gov/system/files/documents/2023-02/EPA%20CPRG%20Planning%20Grants%20Program%20Guidance%20for%20States-Municipalities-Air%20Agencies%2003-01-2023.pdf

Figure 1-2. The City of Knoxville's Approach to Developing the PCAP

Step 1: Review climate plans and related resources

As the first step in the development of the PCAP, the City of Knoxville compiled and reviewed existing plans and other relevant resources from throughout the MSA to assess already-identified priorities for reducing GHG emissions across the region. Key documents reviewed included but were not limited to:

- Tennessee Department of Transportation Carbon Reduction Strategy
- Knoxville Regional Transportation Planning Organization 2045 Mobility Plan
- Knox County, City of Knoxville, and Town of Farragut Multi-Jurisdictional Local Hazard Mitigation Plan
- Knoxville Area Transit Decarbonization Plan
- City of Knoxville 2021 Energy & Sustainability Work Plan
- City of Knoxville Green Fleet Policy
- City of Knoxville Vision Zero Action Plan
- City of Knoxville Downtown Circulation & Mobility Study
- City of Knoxville Sidewalk Study
- City of Knoxville State of the Urban Forest Report
- City of Knoxville Urban Tree Canopy Report
- City of Knoxville Urban Forest Management Plan

Next, the City of Knoxville compiled additional information on project ideas and regional priorities. The project team distributed a survey to the member organizations of the regional Advisory Committee, requesting details of existing and planned projects and programs. The team also made phone calls and emails to an additional 14 city and county governments throughout the MSA to ensure thorough representation of governing bodies.

Step 2: Compile ideas and develop GHG reduction measures

The City then reviewed the documents and stakeholder feedback and identified over 140 relevant policies, goals, and actions. These items were then consolidated into an initial measure list through the following steps:

1. Categorize policies, goals, and actions by sectors.
2. Group policies, goals, and actions into similar topics and with similar needs/audiences/approaches for implementation.
3. Review groups and develop overall measures.

Step 3: Prioritize GHG reduction measures

Following compilation of the initial list of measures, the City of Knoxville reviewed each measure against screening criteria to prioritize the list of measures. Criteria included GHG reduction potential, impacts to LIDACs, air pollution benefits, authority to implement, and identification and experience of a lead implementer. Initial measures were also compared to the State of Tennessee's draft PCAP measures. The City of Knoxville then presented the draft list of seven priority measures to the Advisory Committee to identify potential gaps and build regional consensus. Using their feedback, the City of Knoxville finalized the list of GHG reduction measures presented in this PCAP.

Step 4: Assess GHG reduction measures

After finalizing the list of priority measures, the City of Knoxville collected information for each measure using existing resources and incorporating feedback from stakeholders to complete this PCAP. Where required information for the PCAP was not available, the City of Knoxville worked with internal and external stakeholders to develop it. Along with the references cited, Appendix A provides further detail on the methodological approaches and information used to analyze and quantify GHG reductions from each measure.

Step 5: Prepare PCAP

Using information developed in steps 1-4, the City of Knoxville prepared this PCAP. The City of Knoxville worked internally with its consultants and with other local governments and stakeholders to develop the other required information for each measure, such as authority to implement, LIDAC benefits analysis, and other information (e.g., available funding and key implementors).

1.4 Stakeholder Engagement

Advisory Committee

The City of Knoxville assembled an Advisory Committee of regional leaders representing the interests of diverse sectors and populations across the MSA. 16 individuals were invited to the Advisory Committee, and approximately 60 individuals were involved in meetings, surveys, and outreach throughout the development of this PCAP. Members were convened at an accelerated pace to facilitate the development of the PCAP and will continue to be engaged throughout the duration of the planning grant. Member organizations include local governments and governing agencies, utilities, business and industry consortia, higher education, and technical experts. The list of the member organizations of the Advisory Committee is provided below followed by a summary of meetings held to support the development of the PCAP in Table 1-2.

- City of Knoxville
- City of Alcoa
- City of Maryville
- City of Oak Ridge
- Knoxville-Knox County Planning
- Tennessee Valley Authority (TVA)

- Knoxville Utilities Board (KUB)
- Knoxville Chamber
- Tennessee Advanced Energy Business Council
- LawlerWood, LLC
- Maryville College
- Oak Ridge National Laboratory (ORNL)
- Southern Alliance for Clean Energy (SACE)
- Socially Equal Energy Efficient Development (SEEED)
- Sierra Club Harvey Broome Group

Table 1-2: PCAP Advisory Committee Meetings

Date of Meeting	Number of Attendees
November 30, 2023	27
December 18, 2023	20
January 29, 2024	23

Other Regional Stakeholders

In addition to the Advisory Committee, TPO made phone calls and emails to staff in 14 cities and counties throughout the MSA to identify relevant priorities, projects, and programs in the development of this PCAP.

Public and Stakeholder Engagement

In coordination with the City of Knoxville, TPO set up a public website (https://knoxbreathe.org) containing high-level information about CPRG and the local planning process, members of the Advisory Committee, meeting materials, and contact information.

LIDAC Engagement

Regional engagement with community groups and the general public is led by the TPO, in coordination with the City of Knoxville. TPO and the City of Knoxville incorporated known LIDAC priorities into the PCAP, including findings from the community engagement efforts and equity priorities of the City of Knoxville Mayor's Climate Council (detailed below). TPO and the City also undertook several key steps to set up further LIDAC engagement during the CCAP, including mapping regional stakeholders and releasing an RFP for engagement support for the remainder of the planning grant, as discussed in detail below.

City of Knoxville Mayor's Climate Council

From 2020-2021, the City of Knoxville (the largest community in the MSA) convened the Mayor's Climate Council to identify and evaluate strategies to achieve the City's goal of reducing emissions 80% across the community by 2050. Over 65 individuals participated in the Council and working groups. Participating organizations are summarized in Table 1-3.

Table 1-3: Participating Organizations in City of Knoxville Mayor's Climate Council

Mayor's Climate Council	
• Battlefield Farms / The Underground Collective • City of Knoxville* • Coldwell Banker Wallace & Wallace • Dewhirst Properties • Forest Heights Neighborhood Association • Knoxville Chamber* • Knoxville Utilities Board* • Socially Equal Energy Efficient Development* • Southern Alliance for Clean Energy* • Sunrise Movement Knoxville Hub • Tennessee Valley Authority* • Tennessee Advanced Energy Business Council* • University of Tennessee Knoxville	
Transportation Technical Working Group	**Energy/Buildings Technical Working Group**
• Bike Walk Knoxville • City of Knoxville* • East Tennessee Clean Fuels Coalition • Knoxville Area Transit • Knoxville Chamber* • Knoxville Regional TPO* • Knoxville Utilities Board* • Knoxville-Knox County CAC* • Oak Ridge National Laboratory* • Sierra Club Harvey Broome Group* • Southern Alliance for Clean Energy* • University of Tennessee Knoxville	• Ameresco • City of Knoxville* • Elizabeth Eason Architecture • Knoxville Chamber* • Knox County Schools • Knoxville Utilities Board* • Knoxville-Knox County CAC* • Oak Ridge National Laboratory* • Sanders Pace Architecture • Southern Alliance for Clean Energy* • Sunrise Movement Knoxville Hub • Tennessee Solar Energy Industries Association • University of Tennessee Knoxville
Waste Technical Working Group	**Equity Working Group**
• City of Knoxville* • Green Heron Compost Services • Keep Knoxville Beautiful • Knoxville Chamber* • Sunrise Movement Knoxville Hub • University of Tennessee Knoxville • Waste Connections, Inc. • Waste Management, Inc. • WestRock	• AFL-CIO • Battlefield Farms • Centro Hispano de East Tennessee • Community Voices • Great Schools Partnership • Knoxville Area Urban League • Knoxville-Knox County CAC* • NAACP Knoxville Chapter • Socially Equal Energy Efficient Development* • University of Tennessee Knoxville: Student Disabilities Services

*Organizations also involved in development of PCAP.

See https://www.knoxvilletn.gov/climatecouncil for list of individual participants.

The Council's Equity Working Group (EWG) was one of four working groups established to evaluate measures for topic-specific impacts and outcomes. The EWG was formed to ensure that strategies not only addressed climate change but were responsive to community needs – as determined through an equity lens and continuous evaluation. The Mayor intentionally appointed a diverse group to help bring voice to perspectives of those in the community who have been historically marginalized within decision-making, have unique needs, and/or are on the frontlines of climate change. EWG member organizations are listed above in Table 1-3.

The EWG had three primary objectives:

1. Gather and present insights about the needs and perspective of frontline and vulnerable communities to inform the Mayor's Climate Council as they evaluate opportunities to reduce carbon emissions;
2. Review and evaluate proposed carbon-reducing actions by applying an equity lens/tool to help assess potential benefits or burdens to frontline/vulnerable communities; and
3. Advise the Climate Council on equity principles for implementation.

An equity framework was developed during EWG discussions in 2020, and five umbrella criteria were identified to serve as key priority benefit categories (see Table 1-4). These 'screening criteria' for assessing climate strategies were revisited and refined during two workshops at the beginning of 2021.

Table 1-4: EWG Priority Benefit Categories

Category	Definition
Responsive to Cultural + Community Needs	Strategies likely to 1) benefit diverse groups, 2) facilitate social cohesion and civic engagement through improved neighborhood quality and connectivity, 3) advance racial equity outcomes in historically segregated neighborhoods, 4) advance community development efforts and existing assets, and 5) result in community being a desirable place to live.
Provides Economic Opportunity	Includes likelihood the strategy will 1) build wealth in low-wealth communities (e.g., property values increase/control gentrification), 2) provide employment opportunities that advance workers' rights and living wages, 3) provide new business contracts for small and minority-owned enterprises, 4) provide capacity-building opportunities and access to innovation, and 5) involve infrastructure investments in under-resourced communities.
Protects Communities from Environmental Harm	Emphasizes strategies that are likely to 1) improve air quality (near the ground and ambient, 2) improve water quality, 3) reduce exposure to multiple hazards that accumulate where people live, learn, work, play and worship, 4) reduce health disparities; especially for individuals of color and those who are socioeconomically vulnerable, and 5) improve health and safety.

Category	Definition
Facilitates Transformative Social Outcomes	Expands benefits beyond direct benefits likely to 1) improve educational outcomes and reduce educational disparities, 2) improve childhood/youth opportunities, 3) result in legal and human rights protections from harm, 4) result in just allocation or distribution of resources, and 5) reduce black and minority poverty rates.
Addresses Need for Basic Life Essentials	Focus on strategies that 1) improve access to and security of food, 2) improve energy security and access to green power, 3) reduce housing and energy cost burdens, 4) improve overall quality of life and well-being (e.g., reduced psychosocial stress, saved time), and 5) improve resilience to climate change impacts (e.g., flooding, extreme temperatures).

Two community surveys were developed and administered in frontline communities to help inform the EWG's determination of whether proposed climate strategies were responsive to community issues and needs. The "Findings from the Community Voices Coalition's Utility Costs Survey" revealed utility affordability and insecurity concerns for most households surveyed; nearly half of respondents reported at least one household member dependent on electricity to operate lifesaving medical equipment or lifesaving refrigerated medicine. The "Walkability and Bikeability Survey" provided important feedback on neighborhood quality, public transit, and material deprivation barriers for getting around Knoxville. The survey also captured walking proximity to basic essentials like grocery stores, pharmacies, schools, parks, and banks.

After the collection of survey data and upon achieving consensus for screening criteria for assessing climate strategies, two workshops were facilitated in January 2021. The objective of the workshops was to discuss 12 proposed high-impact practices (HIPs) for climate mitigation in Knoxville, refine and apply screening questions for assessing each HIP for equity, provide feedback on which HIPs should be prioritized, and to offer HIPs not proposed by the Council for consideration. Subject matter expertise, lived experiences, and survey results were all used to guide the EWG equity screening process. Findings from this process have been integrated into the LIDAC benefits sections for each PCAP measure in Section 3.

Stakeholder Mapping

To plan for engagement of LIDACs in the development of the CCAP, the City of Knoxville and TPO first undertook a stakeholder mapping exercise. This process involved identifying and characterizing relevant regional stakeholders, mapping them to each county in the MSA, and noting which stakeholders have already been engaged. Stakeholders include government entities, institutions and non-governmental organizations (NGOs), grassroots and community-based organizations (CBOs), community representatives, tribal governments and Native American organizations, and business entities. In addition to mapping stakeholders by county, organization type, and engagement level, each stakeholder was labeled according to its sector and the population(s) it serves if the organization has a targeted focus. In total, over 300 unique stakeholders were identified through this initial mapping process. A summary of the types of organizations identified and their geographic coverage is provided in Table 1-5.

Table 1-5. Overview of Stakeholder Mapping Results by Type and County

Stakeholder Type	Multiple / All	Anderson	Blount	Campbell	Grainger	Knox	Loudon	Morgan	Roane	Union	Total
CBOs and Community Representatives	10	4	0	4	2	39	1	0	2	5	**67**
Government Entities	29	15	18	15	9	25	8	6	13	9	**147**
Institutions and NGOs	39	8	6	8	2	15	2	2	5	1	**88**
Tribal Governments and Native American Organizations	4	0	0	0	0	0	0	0	0	0	**4**
Businesses and Contractors	3	0	0	0	0	2	0	0	0	0	**5**

Planned LIDAC Engagement

To build on the prior work completed by the Mayor's Climate Council and the initial CPRG stakeholder mapping effort, the City of Knoxville and TPO are in the process of hiring a consultant to lead stakeholder and community outreach and engagement to support the development of the CCAP. Planned engagement efforts include development of a comprehensive outreach plan, expansion of the stakeholder map to ensure broad representation across the MSA, development and distribution of surveys, development of communication tools and content, and facilitation of outreach events. TPO released a request for proposals on February 12, 2024, with the aim of selecting a consultant by April 1, 2024.

2 The Knoxville MSA's Climate Context

Prior to this effort, the Knoxville MSA did not have a GHG inventory representing all localities, nor had most localities ever inventoried their own emissions. The City of Knoxville is the exception, having inventoried emissions from both municipal operations and the community since 2005. For the PCAP, a simplified GHG inventory was completed covering key sources of emissions for the entire MSA. The simplified inventory covers all the priority GHG reduction measures. This section of the PCAP presents:

- The Knoxville MSA's GHG inventory and business-as-usual (BAU) projections.
- A summary of the climate risks to vulnerable communities and the Census Block identifications of LIDACs in the MSA, as recognized using EPA's EJScreen.
- A brief review of the MSA's existing climate goals, plans, policies, and programs.

2.1 GHG Inventory and BAU Projections

The Knoxville MSA GHG inventory assesses GHG emissions from the buildings, transportation, and waste sectors for a baseline year of 2019. The BAU scenario projects the 2019 emissions under BAU conditions through 2050.

Inventory and BAU Methodology

Buildings Sector

The City of Knoxville acquired state-level building energy and electricity use sector emissions data from EPA's State Inventory Tool (SIT) and then scaled the state-level data down to the nine counties of the MSA using the following equation:

$$County\ building\ data_{2019} = \frac{County\ population_{2019}}{Tennessee\ population_{2019}} \times Tennessee\ building\ data_{2019}$$

The BAU projections were compiled by growing the MSA-level building data by a rate of growth calculated from the U.S. Energy Information Administration's (EIA) Short-Term Energy Outlook. EIA's Short-Term Energy Outlook provides energy consumption by sector and source from 2019 to 2050. The City of Knoxville calculated an average yearly growth rate for each county (0.27%) and applied it to the 2019 inventory data to project energy sector emissions through 2050.

Transportation Sector

The City of Knoxville used EPA's emission modeling system, Motor Vehicle Emission Simulator (MOVES3), to calculate the emissions from the transportation sector. MOVES3 has on-road vehicle projection data for vehicle population, vehicle miles traveled (VMT), energy consumption, and tailpipe GHG emissions by vehicle type and fuel type for internal combustion engine vehicles. It accounts for projected fuel efficiency improvements for internal combustion engine vehicles as a result of existing policies. The City of Knoxville ran MOVES3 with default settings to create the 2019 inventory and BAU projections for population, VMT, energy consumption, and emissions from on-road vehicles.

Waste Sector

The City of Knoxville calculated waste emissions using waste combustion data and landfill data. Based on data from EPA Greenhouse Gas Reduction Program Facility-Level Information on Greenhouse gases Tool (FLIGHT), the City of Knoxville does not have any waste combustion facilities within its boundaries. Therefore, no waste combustion emissions were calculated. The City of Knoxville calculated landfill emissions for 2019 using data from EPA's Landfill Methane Outreach Program (LMOP). LMOP data presents annual and cumulative municipal solid waste (MSW) tonnage, the total capacity of the landfill, and whether the landfill has a gas capture system. The 2019 LMOP data did not include a value for annual tons of MSW generated, and therefore LMOP 2021 data were used as a proxy for 2019 data. The following equation was used to calculate the emissions from each landfill:

$$Emissions = MSW_{annual} \times (Methane_{EF} \times Methane_{GWP}) \times (1 - O_{rate}) \times (1 - G_{capture})$$

Variable	Value	Description
Emissions	Calculated	Annual emissions for the landfill in $MTCO_2e$.
MSW_{annual}	Retrieved from LMOP data	Annual tons of MSW buried.
$Methane_{EF}$	0.0648	Methane emission factor based on EPA Waste Reduction Model (WARM) assumptions.
$Methane_{GWP}$	28	The AR5 global warming potential of CH_4.
O_{rate}	0.1 for landfills without gas capture; 0.2 for landfills with gas capture	Oxidation rate based on EPA WARM assumptions.
$G_{capture}$	0 for landfills without gas capture systems; 0.6 for landfills with gas capture systems	Gas capture rate based on EPA WARM assumptions.

The sum of emissions from all landfills within the Knoxville MSA in 2019 was used to represent the total emissions from solid waste for 2019 for the MSA. The waste data were scaled down from the MSA level to the counties using the following formula:

$$County\ waste\ data_{2019} = \frac{County\ population_{2019}}{Knoxville\ MSA\ population_{2019}} \times Knoxville\ MSA\ waste\ data_{2019}$$

The BAU waste projections were calculated using an average annual population growth rate for each county using U.S. Census 2020 population data and 2050 population projection data from the University of Tennessee Boyd Center for Business and Economic Research. The county-level waste emissions data from 2019 were grown by the average annual population growth rate.

Inventory Results

The GHG emissions inventory for 2019 for the Knoxville MSA is presented in Table 2-1, along with emission projections for 2030, 2040, and 2050 under a BAU scenario.

Table 2-1. Knoxville MSA GHG Emissions Inventory and BAU Projections ($MTCO_2e$)

Emissions Source	2019 Inventory	2030 BAU	2040 BAU	2050 BAU
Total Buildings	**7,543,050**	**10,670,590**	**10,730,026**	**11,324,153**
Residential - Direct	572,114	461,454	448,512	470,552
Commercial - Direct	549,217	435,918	434,075	448,172
Industrial - Direct	2,029,730	6,362,292	6,532,174	6,927,253
Residential - Electricity	1,873,007	1,510,722	1,468,353	1,540,507
Commercial - Electricity	1,590,483	1,208,528	1,174,634	1,232,356
Industrial - Electricity	928,496	691,677	672,278	705,314
Total Transportation	**5,403,834**	**4,702,906**	**4,581,084**	**4,847,653**
HDV	1,673,957	1,547,604	1,565,567	1,716,990
LDV	3,612,999	3,031,845	2,884,100	2,985,809
MCY	25,629	27,409	28,927	30,846
Bus	91,249	96,047	102,490	114,008
Total Waste	**489,025**	**524,315**	**559,503**	**597,917**
Landfill Emissions	489,025	524,315	559,503	597,917
Waste Combustion	-	-	-	-
Total Emissions	**13,435,908**	**15,897,811**	**15,870,612**	**16,769,724**

Note: Totals may not sum due to rounding.

Figure 2-1. Knoxville MSA 2019 GHG Emissions Inventory

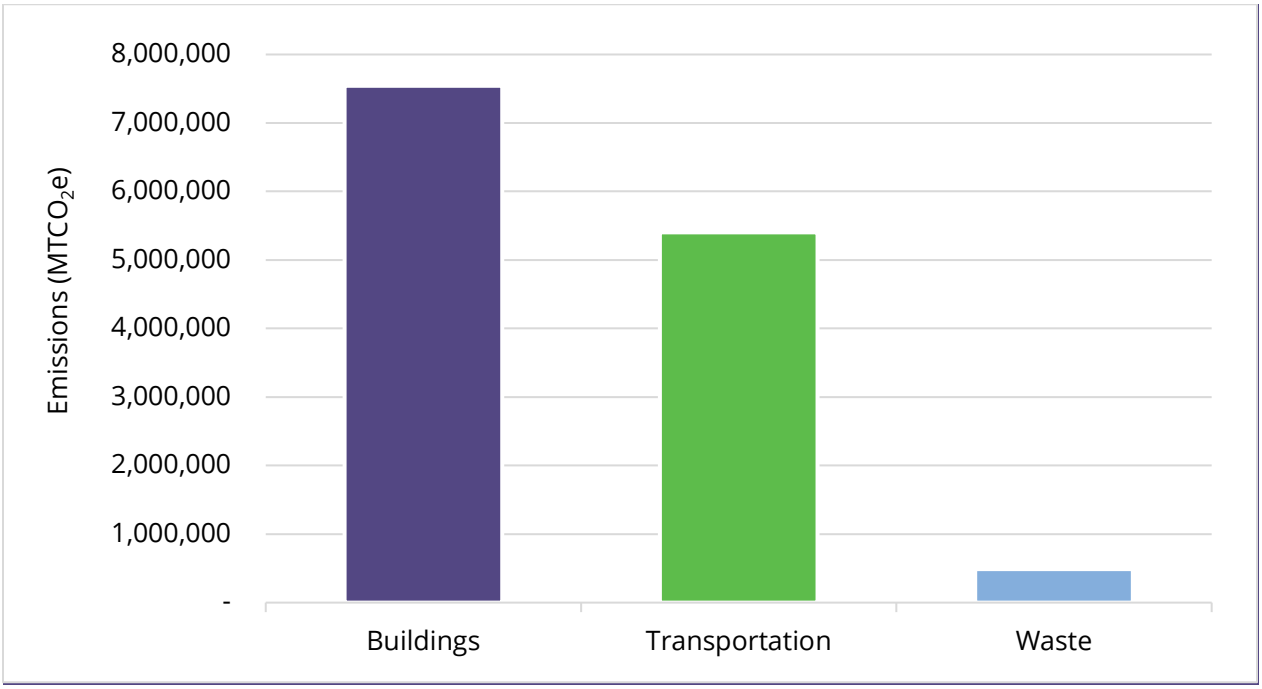


Figure 2-2. Knoxville MSA 2019 Emissions by County

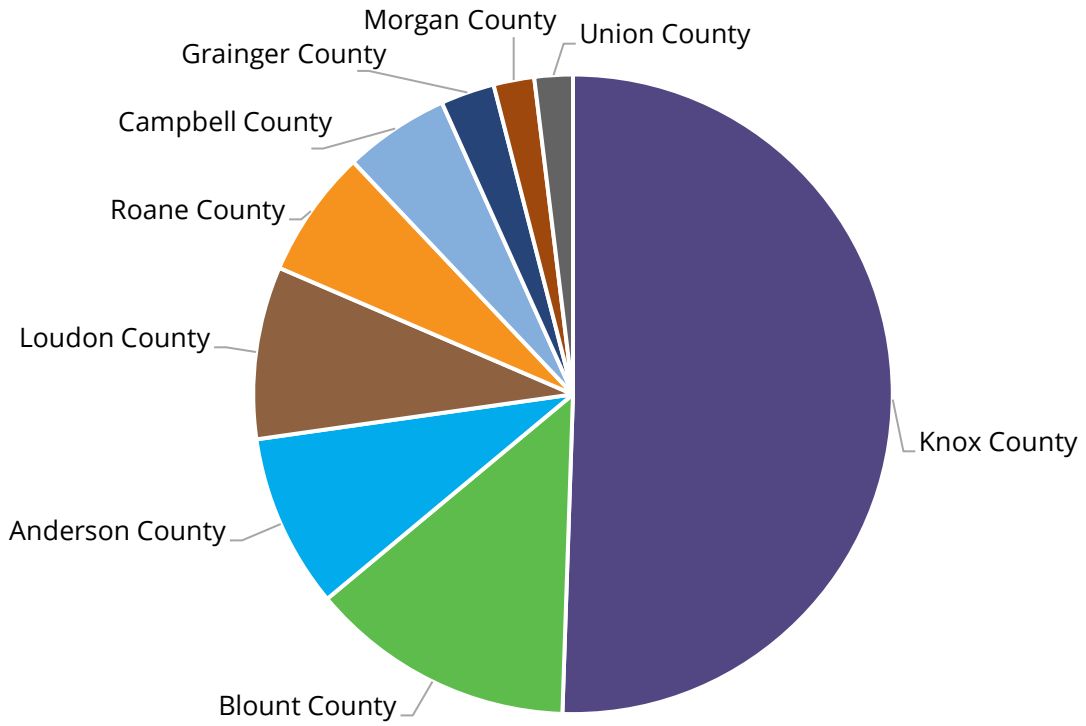
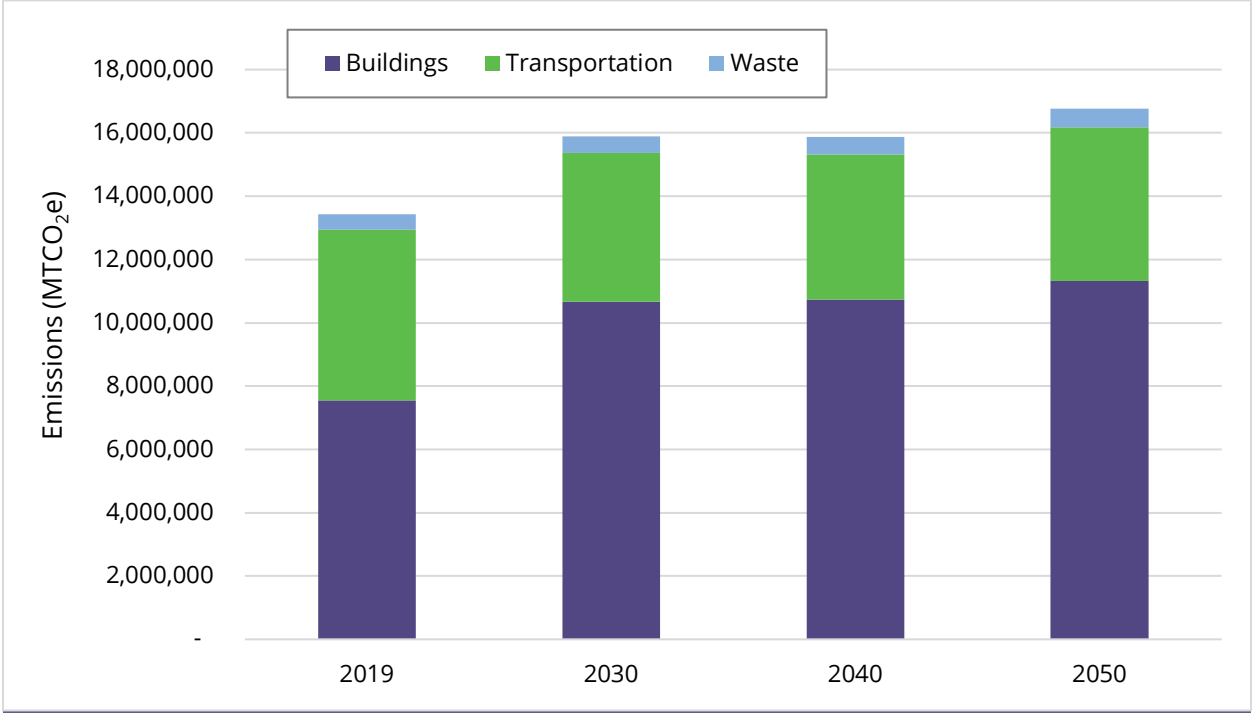


Figure 2-3. Knoxville MSA BAU Projections by Emissions Source ($MTCO_2e$)



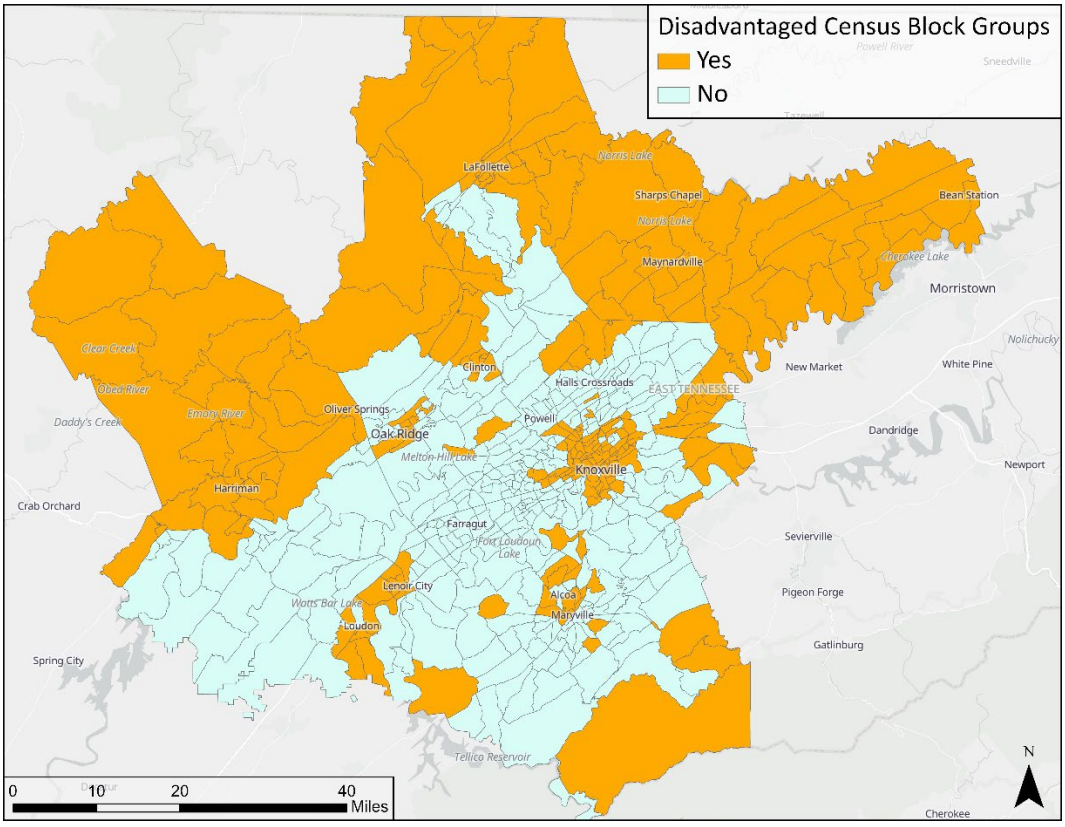
2.2 Low Income Disadvantaged Community (LIDACs)

Identification of LIDACs in the Knoxville MSA

A core component of the CPRG program is to provide benefits to LIDACs, as these communities are particularly vulnerable to risks and impacts from climate change. Per CPRG requirements, this section identifies LIDACs in the state by Census Block ID using EJScreen and discusses the climate risks for LIDACs within the Knoxville MSA. Refer to Section 1.4 for a discussion of how the City of Knoxville and TPO have started to engage with LIDACs in the development of this PCAP and how they will continue to engage these communities in the future.

The City of Knoxville utilized EJScreen (an EPA environmental justice screening tool) to visualize and identify census block groups that the EPA designates as disadvantaged in the state (see Figure 2-4). In the Knoxville MSA, 243 census block groups out of the total 591, or 41%, are identified as disadvantaged. The largest number of disadvantaged communities is in Knox County, accounting for 100 of the 243 disadvantaged census block groups. The next highest being Campbell County with 26 disadvantaged census block groups, followed by Anderson County, Blount County, and Grainger County with 21, 20, and 18 respectively. Morgan, Roane, and Union Counties all have the lowest amount of LIDACs with 14 disadvantaged census block groups in each county. A full listing of the Census Block IDs that are identified as LIDACs in the Knoxville MSA is included in Appendix B.

Figure 2-4. LIDACs in the Knoxville MSA



Climate Risks and LIDAC Impacts

The climate risks most prevalent in the United States include extreme weather events (hurricanes, extreme rainfall, etc.), extreme heat and urban heat island effects, flooding, sea level rise, drought, and wildfires. Social systems inequitably distribute negative impacts from these climate risks on BIPOC (Black, Indigenous, and People of Color) individuals and communities, low-income households, unhoused individuals, rural communities, and agricultural workers.[5] Not only do these communities feel the most severe impacts of climate change, but they are also the least able to prepare for and respond to said impacts due to a lack of resources and socio-political power. According to a 2021 EPA analysis, racial and ethnic minorities are particularly vulnerable to climate change impacts, especially Black and African American individuals.[6]

Minority and low-income communities are more likely to suffer the consequences of climate change due to heightened exposure to climate risks and inaccessibility to resources, such as adequate infrastructure and proper insurance. Many factors contribute to this inequality, including historical discriminatory practices in housing, education, and employment. Pre-existing health status and living conditions are two key components of climate vulnerability – components which, in the United States, are often determined by economic power, social policies, political influence, and structural racism.[7]

The most prevalent climate risks in the Knoxville MSA and their potential impacts include:

- **Extreme Heat.** Annual average heat as well as extreme heat events are projected to increase in the Knoxville MSA throughout the century. The Knoxville MSA currently sees up to 6 days per year with temperatures over 95°F. By 2050, this could skyrocket to almost 27 days per year under a high-emissions scenario.[8] Exposure to extreme heat can cause heat exhaustion and heat stroke, and can contribute to deaths from a range of cardiovascular diseases such as heart attacks and strokes. Older adults, young children, people of color, outdoor workers, those with poorer health, and low-income individuals are more at risk of heat-related death. Additionally, higher temperatures will lead to increased energy demand and higher energy costs. Individuals belonging to LIDACs will be less able to afford these increased costs, thus exacerbating heat-related health risks.[9]

[5] "Social Systems and Justice." 2023. https://nca2023.globalchange.gov/chapter/20/.
[6] US EPA, OAR. 2021. "Social Vulnerability Report." Announcements and Schedules. March 24, 2021. https://www.epa.gov/cira/social-vulnerability-report.
[7] "Racial Disparities and Climate Change." 2020. PSCI. August 15, 2020. https://psci.princeton.edu/tips/2020/8/15/racial-disparities-and-climate-change.
[8] Projections based on analysis of a 23-model ensemble of Localized Constructed Analogs Version 2 (LOCA2) downscaled Coupled Model Intercomparison Project Phase 6 (CMIP6) Global Climate Models (GCMs) from Pierce et al. (2024). Projections are based on a 30-year average centered on the decadal time horizon of 2050 (2035-2065). Baseline data are based on the 30-year historical baseline between 1985-2014 using an observational reanalysis dataset from Pierce et al. (2021) that also served as the training dataset for LOCA2.
[9] US EPA. 2014. "Climate Change and Heat Islands." Overviews and Factsheets. June 17, 2014. https://www.epa.gov/heatislands/climate-change-and-heat-islands.

- **Extreme Weather Events.** Extreme precipitation events are projected to increase in the Knoxville MSA. The baseline maximum consecutive five-day precipitation (the maximum amount of rainfall in a five-day consecutive period) is 157.5 mm (6.2 inches). By 2050, however, this could reach as high as 173 mm (6.81 inches) under a high-emissions scenario.[10] Data from ClimateCheck shows that by 2050, about 21.8 inches of rain are projected over roughly 14 storms each year, a large increase from the historical average of 18.7 inches over 11 storms per year. Furthermore, ClimateCheck projects that annual precipitation in the MSA will increase from about 48 inches to 50.8 inches.[11] Extreme rain events will likely cause more intense flooding, harming primarily households without homeowners or renters insurance or that cannot afford the necessary infrastructure repairs. In addition to flooding, heavy precipitation can cause landslides, which can further damage infrastructure. Flooding can also impact human health by increasing mold production and exposure to waterborne diseases, particularly affecting those in poor living conditions and lacking access to safe and reliable drinking water.[12] Furthermore, the increase in the severity of storms can cause power outages that can lead to exposure to extreme heat and cold temperatures and dangerous conditions for vulnerable populations.
- **Drought.** Higher temperatures are projected to increase the severity and frequency of drought. Drought can contribute to water scarcity, causing major food insecurity and threatening farming livelihoods. Food insecurity leads to hikes in food prices and potentially civil unrest and mass migration. All of these impacts will be felt most strongly by minority and low-income communities.[13]

Opportunity Zones

In the Tax Cuts and Jobs Act of 2017, a new community development tool was established named "Opportunity Zones." This tool is designed to provide low-income communities with more long-term capital. Tennessee identified 176 census tracts to qualify for opportunity zones; the Knoxville MSA has 18 designated zones, including two in Anderson County, four in Blount County, two in Loudon County, eight in Knox County, one in Roane County, and one in Union

[10] Projections based on analysis of a 23-model ensemble of Localized Constructed Analogs Version 2 (LOCA2) downscaled Coupled Model Intercomparison Project Phase 6 (CMIP6) Global Climate Models (GCMs) from Pierce et al. (2023). Projections are based on a 30-year average centered on the decadal time horizon of 2050 (2035-2065). Baseline data are based on the 30-year historical baseline between 1985-2014 using an observational reanalysis dataset from Pierce et al. (2021) that also served as the training dataset for LOCA2.

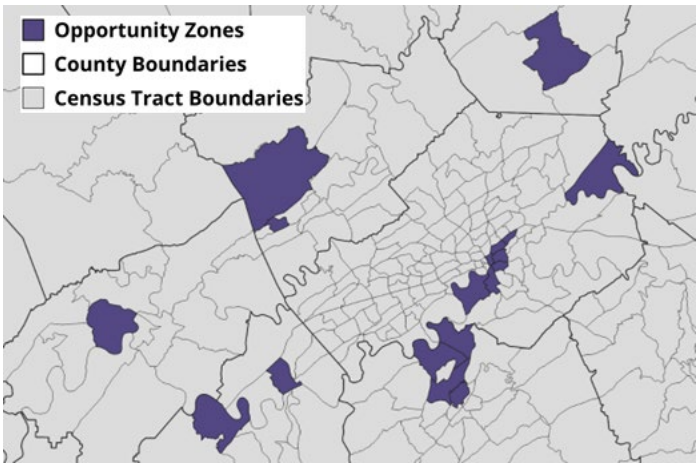
[11] "Knoxville, Tennessee Climate Change Risks and Hazards: Precipitation, Heat." n.d. Accessed February 19, 2024. https://climatecheck.com/tennessee/knoxville.

[12] US EPA, OAR. 2021. "Social Vulnerability Report." Announcements and Schedules. March 24, 2021. https://www.epa.gov/cira/social-vulnerability-report.

[13] Bolster, C.H., R. Mitchell, A. Kitts, A. Campbell, M. Cosh, T.L. Farrigan, A.J. Franzluebbers, D.L. Hoover, V.L. Jin, D.E. Peck, M.R. Schmer, and M.D. Smith, 2023: Ch. 11. Agriculture, food systems, and rural communities. In: 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.CH11.

County.[14] Final recommendations for opportunity zones were determined based on data-driven review of city and county Mayor feedback as well as the following:

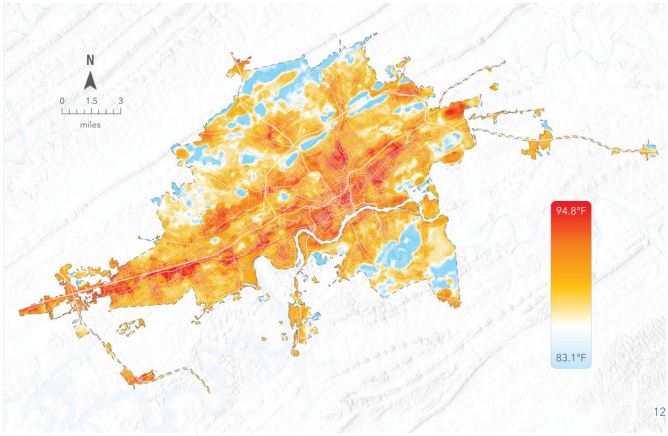
Figure 2-5. Knoxville MSA's Opportunity Zones



- Business development and brownfield redevelopment opportunities
- Retail, commercial and tourism development opportunities
- Community and rural development initiatives
- Low-income housing development opportunities
- Proximity to entrepreneur centers, technology transfer offices, and colleges and universities[15]

Roughly 12% of the Knoxville MSA's population (or approximately 113,700 people) reside in opportunity zones (see Figure 2-5). The median household income for these zones is between $15,000 to $64,000.[16] In addition to these communities, the region's Black communities are also more susceptible to climate change hazards. For example, while Black communities make up 17% of the City of Knoxville's population, 43% live at or below the poverty line. This is higher than the City's overall poverty rate and over three times the national average.[17]

Figure 2-6. City of Knoxville Afternoon Area-Wide Model from CAPA Heat Watch Report



Communities of color, communities residing in opportunity zones, and rural communities all lack adequate resources to cope with the impacts of extreme heat and flooding. As a result, they will face heightened health risks as well as more damage to infrastructure

[14] Tennessee's Opportunity Zones. Accessed February 26, 2024. https://oz.tnecd.com/wp-content/uploads/2021/04/Tennessee-Opportunity-Zones-8-7-2018.pdf.
[15] Department of Economic & Community Development. Opportunity Zones. Government of Tennessee. https://www.tn.gov/ecd/opportunity-zones.html.
[16] Opportunity Db. List of Tennessee Opportunity Zones & OZ Funds. The Opportunity Zones Database. https://opportunitydb.com/location/tennessee/.
[17] WBIR Staff. 2021. The Knoxville Divide: Poverty and Black Communities. 10News. https://www.wbir.com/article/news/community/the-knoxville-divide-poverty-and-black-communities/51-c8a22ba9-5d15-45c2-8d33-5edefe29decf.

and housing from climate crises. For example, as extreme heat events increase, the risk of heat-related illnesses will go up as well, especially in urban areas due to the urban heat island effect.[18] In 2022, the City of Knoxville participated in the 2022 Heat Mapping Campaign supported by the National Oceanic and Atmospheric Administration (NOAA) (see Figure 2-6). The study found that the hottest areas often had the highest populations of low-income families. Broadway and Western Heights, regions of the City where many are unsheltered or live in affordable housing complexes, had the highest risk for heat-related illnesses.[19]

2.3 Existing Climate Goals, Plans, Policies, and Programs

City of Knoxville

The City of Knoxville has calculated GHG emissions from both municipal operations and the community at-large, with baseline data beginning in 2005. Inventories are prepared and published by the Office of Sustainability. In 2008, the City of Knoxville set goals to reduce GHG emissions by 20% by 2020 relative to 2005 levels for both municipal operations and the broader community. The City met its municipal goal early, and adopted two new goals in 2019:

1. A 50% reduction in GHGs for municipal operations from 2005-2030
2. An 80% reduction in GHGs for the entire community from 2005-2050

The City of Knoxville has also participated in several voluntary energy and climate initiatives, including the Climate Mayors and Global Covenant of Mayors; Department of Energy Better Buildings Challenge, Better Climate Challenge, and Low-Carbon Pilot; Solar America Cities; Smart Communities Extreme Energy Makeover; and Smarter Cities Challenge. Despite participation in these initiatives, community emissions continue to increase, which mirrors national and international trends. In 2020, Mayor Indya Kincannon convened over 65 community leaders and technical experts to identify strategies to meet our community climate goal. The priorities of the Mayor's Climate Council formed the City of Knoxville 2021 Energy & Sustainability Work Plan. [20] These priorities are summarized below in Table 2-2.

Table 2-2: Mayor's Climate Council Priority Climate Strategies

Priority Climate Strategies
Transportation
• Expand and improve bicycle and pedestrian facilities, connectivity, convenience, and/or safety in a manner that significantly increases the number of trips taken by walking or biking. • Make public transit investments that significantly enhance coverage, service quality, frequency, and/or speed.

[18] The Urban Heat Island (UHI) effect is when urban temperatures have higher temperatures compared to rural areas due to lack of natural land cover and vegetation, as well as heat generation from human activities. Compact, dense development in urban areas also exacerbates this effect.

[19] Render, J. 2022. Researchers map heat inequities in Knoxville, finding higher temperatures in lower-income areas. 10News. https://www.wbir.com/article/tech/science/ut-researchers-looking-into-heat-inequities-in-knoxville-and-in-the-us/51-60a5bfa4-96cb-45c5-8551-782fab850cd4

[20] City of Knoxville Mayor's Climate Council. https://www.knoxvilletn.gov/climatecouncil.

• Significantly accelerate community adoption of electric vehicles. • Partner with major local commercial fleet operators to transition to electric vehicles.
Buildings and Energy
• Create voluntary, large, commercial, and multifamily energy upgrade program(s) (e.g., incentives, technical assistance) that achieve deep energy savings (~25%+) in ~20%+ of buildings. • Amplify and opportunistically expand voluntary home energy upgrade program(s) that will achieve deep energy savings (~25%+) in 20% of homes. • Develop or amplify opportunities to invest in renewables at scale, including community solar and in-valley investments. • Research and develop strategies to promote opportunistic electrification (e.g., replacement of fossil fuel-fired furnaces with electric heat pump technologies) in existing buildings over time.
Waste
• Implement food waste reduction and collection programs that capture ~80%+ of organic waste from all high-volume locations (e.g., restaurants). • Increase residential recycling through community engagement and education strategies. • Promote consumption-reduction approaches such as sharing and re-use through education campaigns. • Research pathways to offer organics (food/yard waste) collection for single-family and multifamily residential properties.

Other resources include:

- Knoxville Area Transit Decarbonization Plan
- City of Knoxville 2021 Energy & Sustainability Work Plan
- City of Knoxville Green Fleet Policy
- City of Knoxville Vision Zero Action Plan
- City of Knoxville Downtown Circulation & Mobility Study
- City of Knoxville Sidewalk Study
- City of Knoxville State of the Urban Forest Report
- City of Knoxville Urban Tree Canopy Report
- City of Knoxville Urban Forest Management Plan

Other Stakeholders

Pre-existing goals, plans, policies, and programs with climate impacts from the Knoxville MSA include but are not limited to the following.

- Spark Cleantech Accelerator
- University of Tennessee, Knoxville
    - Office of Sustainability
    - Institute for a Secure & Sustainable Environment
    - Center for Energy, Transportation, and Environmental Policy
    - Sustainability Master Plan
    - University Global Coalition
    - Heat Mapping Campaign

- Knoxville-Knox County Community Action Committee
    - Low-Income Home Energy Assistance Program (LIHEAP)
    - Low-Income Home Water Assistance Program (LIHWAP)
    - Owner-Occupied Home Repair Program
    - Water Savings Program
    - Weatherization & Energy Efficiency Program
    - Transit program
    - Knox County Air Pollution Control Board
- TVA Home Uplift, EnergyRight, and Green Flex programs
- KUB RoundItUp, Green Switch Match, and Community Solar programs
- Oak Ridge National Laboratory Climate Change Science Institute
- City of Maryville Tree Board
- City of Alcoa Tree Board
- City of Clinton Tree Advisory Board
- City of Knoxville Tree Board

3 PCAP Measures

This section summarizes the Knoxville MSA's seven priority GHG reduction measures that were developed through the process outlined in Section 1.2. The measures are listed in Table 3-1 and discussed in detail in the subsequent sections. The methodologies used to quantify GHG reductions for each measure are provided in Appendix A.

Table 3-1. Knoxville MSA's PCAP Measures

#	Measure Description
P1	Implement energy efficiency upgrades in residential, commercial, and public buildings.
P2	Electrify residential, commercial, and public buildings.
P3	Develop and invest in clean and renewable energy.
P4	Expand electric vehicle infrastructure.
P5	Transition to electric and alternative fuel vehicles in public fleets and provide access to charging or fueling infrastructure.
P6	Expand and improve public transit.
P7	Boost active transportation and the use of alternative transportation systems.

The implementation of actions and projects across all PCAP measures will begin in the near term (i.e., pre-2030), albeit subject to available staffing, funding, and other resources. Depending on the funding available, it may take more time to ramp up actions and secure additional funding and resources for implementation. Table 3-2 summarizes the general timeline for implementing the CPRG program and PCAP measures in the near-term.

Table 3-2. CPRG Implementation Milestone Summary

Milestone	Timeframe
Deliver PCAP to EPA, which includes stakeholder input on measures.	March 1, 2024
Submit CPRG Implementation Grant applications.	April 1, 2024
Begin CCAP development, which will include identifying additional measures, broad engagement activities, and quantifying emission, cost, benefit, workforce, and LIDAC impacts.	Mid–Late 2024
Coordinate resources across jurisdictions and take initial actions across the PCAP measures where feasible.	2025
Finalize CCAP development, which will include identifying additional measures, broad engagement activities, and quantifying emissions, cost, benefit, workforce, and LIDAC impacts, and deliver to EPA.	August 1, 2025
Continue implementing CPRG measure actions where feasible.	2026+
Secure local government approval and budget for ongoing GHG reductions, in addition to seeking additional outside funding opportunities.	2026+

Milestone	Timeframe
Track progress toward GHG reduction targets and other milestones, and collect data as needed to prepare the Status Report.	2026+
Deliver Status Report to EPA.	Mid-2027
Continue to implement measures and reduce GHGs at the county and municipal level. Track progress across the Knoxville MSA.	2027+
Complete initial stage of implementing PCAP actions; actual timing and specific projects implemented will depend on available staffing, funding, and other resources.	2030+

P1. Implement Energy Efficiency Upgrades in Residential, Commercial, and Public Buildings

This measure focuses on expanding and creating new opportunities for implementing building energy efficiency upgrades in existing commercial, residential, and public buildings. Energy efficiency upgrades may include, but are not limited to, thermal envelope insulation, envelope and duct air sealing, window replacement, heating and cooling equipment replacement, and appliance and lighting upgrades to decrease overall energy consumption. Actions to achieve this measure include the design and implementation of voluntary energy efficiency incentive and technical assistance programs.

Quantified GHG Reductions

This measure reduces GHG emissions from buildings. The GHG emissions reduction potential for this measure are:

PCAP Measure	GHG reductions ($MTCO_2e$), 2025-2030	GHG reductions ($MTCO_2e$), 2025-2050
Energy efficiency upgrades in residential, commercial, and public buildings	314,322	3,772,829

Key Implementing Agencies

- **Local Government Organizations.** Including all entities such as counties, cities, and other forms of local government as well as their respective public agencies. Local government entities can upgrade public buildings and help create and administer incentive and technical assistance programs.
- **State Government Agencies.** State agencies such as the Tennessee Department of Economic and Community Development offer programs that provide funding and technical assistance for energy efficiency projects.
- **Utilities.** Utilities can provide energy efficiency and weatherization programs to rate-payers.

- **Community-Based Organizations.** CBOs can help with program design, raise awareness, and promote community participation.
- **Trade Unions.** Building trade unions can provide apprenticeship readiness, pre-apprenticeship, apprenticeship and job placement programs with an emphasis on diversifying the clean energy workforce.
- **Contractors.** Partnership with insulation, window, and HVAC contractors will be needed to implement building energy efficiency upgrades.
- **Property Owners.** Homeowners and property owners have control over changes to and within buildings and can make decisions that affect building efficiency.

Implementation Activities and Milestones

Implementation activities to increase building energy efficiency could include:

- Conduct energy audits and other site assessments to identify opportunities for energy efficiency improvements.
- Expand or create new incentive programs for the purchase and installation of weatherization measures and energy efficient equipment and products, in single- and multifamily residential and commercial buildings.
- Expand or create new programs for upgrades to municipal and other government buildings.

Authority to Implement

Local governments within the Knoxville MSA have the authority to implement energy efficiency upgrades in government-owned buildings and support the implementation of programs within their jurisdictions. Private building owners have the authority to install improvements in their properties, and to participate under program rules and conditions.

Geographic Coverage

This measure will reduce GHG emissions across the entire MSA.

Relevant Funding Sources

Example potential funding sources include:

- U.S. Department of Energy (DOE) Energy Efficiency and Conservation Block Grants
- DOE HOMES Efficiency Rebates
- DOE State Energy Program
- DOE and State Weatherization Assistance Programs
- U.S. Department of Housing and Urban Development (HUD) Green and Resilient Retrofit Program
- TVA Energy Right

LIDAC Benefits

The City of Knoxville's Climate Council Equity Working Group determined that energy efficiency upgrades were '*Likely to advance equity outcomes*.' The EWG recommended that energy efficiency upgrades and other energy sector strategies include the need for intentional workforce development to build capacity and advance access to jobs or contracts for minority contractors and members of LIDAC and BIPOC populations. The EWG also recommended that climate action strategies include water conservation and other housing quality assessments and measures, bundling resources for comprehensive assessments of energy and health in housing and buildings. Additional LIDAC benefits and considerations are described in Table 3-3.

Table 3-3. LIDAC Benefits and Considerations for Energy Efficiency Upgrades

LIDAC Benefits	Description	Considerations
Neighborhood Enhancement + Resilience	Accrual of benefits associated with building upgrades for energy efficiency and resiliency add value to the building stock and surrounding area.	Protections against gentrification or other forms of displacement for residents living in LIDAC neighborhoods targeted for enhancement need to be explored and adopted.
Capacity-building + Economic Inclusion	Access to clean energy jobs. Pre-apprenticeship, apprenticeship, and job placement programs for building trades.	Partnerships with workforce development organizations and trade unions will be critical for co-designing training/apprenticeship programs and inclusion or procurement policies.
Access to Basic Essentials	Energy cost savings reduce energy burdens and increase energy security.	Energy affordability often leads to uninterrupted access to power (and water) and improved housing conditions.
Health + Well-being	Uninterrupted access to affordable energy provides healthy indoor environmental quality, reduced financial and psychosocial stress, and connectivity.	Focus on priority individuals and households with vulnerabilities to high energy burdens and energy insecurity including those medically dependent on electricity.
Social Equity	A focus on LIDAC areas in historically disinvested communities will likely benefit diverse groups and populations.	Identification of and intentional outreach to targeted groups and populations will lead to the co-design of participating in strategies likely to result in transformative social outcomes.

Metrics for Tracking Progress

- Participation in incentive and assistance programs
- Changes in building energy consumption

P2. Electrify Residential, Commercial, and Public Buildings

This measure focuses on developing and implementing strategies to promote electrification in residential, commercial, and public buildings. Activities include the replacement of fossil fuel-fired heating, hot water, and cooking equipment with electric heat pumps and induction technologies. Actions to achieve this measure include the design and implementation of voluntary commercial, residential (both single- and multifamily), and municipal electrification programs comprising incentives and technical assistance.

Quantified GHG Reductions

This measure reduces GHG emissions from buildings. The GHG emissions reduction potential for this measure are:

PCAP Measure	GHG reductions ($MTCO_2e$), 2025-2030	GHG reductions ($MTCO_2e$), 2025-2050
Electrify residential, commercial, and public buildings	25,166	441,152

Key Implementing Agencies

- **Local Government Organizations.** Including counties, cities, and other forms of local government as well as their respective public agencies. Local government entities can electrify public buildings and help create and administer incentive programs.
- **State Government Agencies.** State agencies such as the Tennessee Department of Economic and Community Development offer programs that provide funding and technical assistance for electrification projects.
- **Utilities.** Utilities can serve as providers of electrification programs to customers.
- **Community-Based Organizations.** CBOs can help with program design, raise awareness, and promote community participation.
- **Trade Unions.** Building trade unions provide apprenticeship readiness, pre-apprenticeship, apprenticeship and job placement programs with an emphasis on diversifying the clean energy workforce.
- **Equipment Providers.** Partnership with equipment retailers, suppliers and contractors will be needed to help educate consumers and install new equipment.
- **Property Owners.** Homeowners and property owners have control over changes to and within buildings and can make decisions that affect building electrification.

Implementation Activities and Milestones

Implementation activities to electrify buildings could include:

- Expand or create incentive programs for the purchase of electric heat pumps, induction, and other eligible technologies used for space heating, water heating, and cooking.

- Provide incentives to and educate homeowners and the builder community on completing electrification-ready upgrades when doing other work (e.g., panel upgrades to be prepared for a future heat pump or electric appliance).

Authority to Implement

Local governments within the MSA have the authority to implement equipment upgrades in government-owned buildings and support the implementation of programs within their jurisdictions. Private building owners have the authority to participate in programs under program rules and conditions.

Geographic Coverage

This measure will reduce GHG emissions across the entire MSA.

Relevant Funding Sources

Example potential funding sources include:

- DOE Energy Efficiency and Conservation Block Grants
- DOE HEEHRA Electrification Rebates
- DOE State Energy Program
- HUD Green and Resilient Retrofit Program
- TVA Energy Right

LIDAC Benefits

The City of Knoxville's Climate Council Equity Working Group determined that climate measures focused on programs that 'drive thermal decarbonization/electrification' (e.g., replacement of fossil fuel-fired furnaces, boilers, and domestic hot water systems with electric heat pump technologies or other renewable options) were '*Somewhat likely to advance equity outcomes*.' The EWG suggested that fuel switching opportunities should be accessible to low-income households and landlords and these households should be prioritized. Similar to other energy sector strategies, the EWG recommended that PCAP measures in this sector should include intentional workforce development to build capacity and advance access to jobs or contracts for minority contractors and members of LIDAC and BIPOC populations. Additional LIDAC benefits and considerations are described in Table 3-4.

Table 3-4. LIDAC Benefits and Considerations for Building Electrification

LIDAC Benefits	Description	Considerations
Neighborhood Enhancement + Resilience	Accrual of benefits associated with building electrification and resiliency add value to the building stock and area.	Community outreach efforts will help target implementation for historically disinvested communities. Assessments and work scopes should include resiliency measures.

LIDAC Benefits	Description	Considerations
Capacity-building + Economic Inclusion	Access to clean energy jobs. Pre-apprenticeship, apprenticeship, and job placement programs for building trades.	Partnerships with workforce development organizations and trade unions will be critical for co-designing training/apprenticeship programs and inclusion or procurement policies.
Access to Basic Essentials	Electrification upgrades should increase energy security.	Electrification should not increase energy costs for low-income households already cost-burdened (e.g., through increased fixed fees for natural gas). Building upgrades should also consider upgrades that improve water quality.
Health + Well-being	Uninterrupted access to affordable energy provides healthy indoor environmental quality, reduced psychosocial stress and connectivity. Improved indoor and outdoor air quality from reduction in natural gas byproducts.	Outreach and education on the benefits of electrification is needed for community and household acceptance and adoption of electrification strategies.
Social Equity	A focus on LIDAC areas in historically disinvested communities will likely benefit diverse groups and populations.	Identification of and intentional outreach to targeted groups and populations will lead to the co-design of participating in strategies likely to result in transformative social outcomes.

Metrics for Tracking Progress

- Number of installations by equipment type

P3. Develop and Invest in Clean and Renewable Energy

This measure focuses on developing new or amplifying existing opportunities to invest in clean and renewable energy, including rooftop solar installations on residential, commercial, and public buildings. Actions to achieve this measure include assessing opportunities for renewable energy development, creating technical assistance and incentive programs, and investments in community solar. This measure also includes actions to increase battery storage and microgrids.

Quantified GHG Reductions

This measure reduces GHG emissions from buildings. The GHG emissions reduction potential for this measure are:

PCAP Measure	GHG reductions ($MTCO_2e$), 2025-2030	GHG reductions ($MTCO_2e$), 2025-2050
Develop and invest in clean and renewable energy	362,903	2,967,605

Key Implementing Agencies

- **Local Government Organizations.** Including counties, cities, and other forms of local government as well as their respective public agencies. Local government entities can install and procure renewable energy on or for public facilities, create solar ordinances and updated zoning ordinances, and develop policies to support renewable energy.
- **Utilities.** Utilities can work with entities to negotiate for and procure renewable energy and support permitting and integration with the grid.
- **Community-Based Organizations.** CBOs can help ensure that on-site solar initiatives address the specific needs and concerns of local communities. They can also help raise awareness and promote community participation.
- **Trade Unions.** Building trade unions provide apprenticeship readiness, pre-apprenticeship, apprenticeship and job placement programs with an emphasis on diversifying the clean energy workforce.
- **Private Sector Partners.** Private sector partners include solar developers, financers, building owners, and technology providers.

Implementation Activities and Milestones

Implementation activities to invest in clean and renewable energy could include:

- Conduct clean energy feasibility studies.
- Expand or create new incentive programs to encourage installation of solar in the community and for battery storage.
- Invest in community solar for multifamily and other housing that cannot install solar on site.
- Install renewable energy systems on publicly owned buildings.
- Establish physical and virtual power purchase agreements (PPAs) to provide clean electricity to local government facilities.
- Update permitting to facilitate local government and utility clean energy approvals.

Authority to Implement

State and local governments have the authority to implement on-site renewable energy incentive programs. Utilities have the authority to interconnect clean energy generation with their systems, Property owners have the authority to install clean energy systems on their premises. The authority for off-site renewables may require changes in state or local laws or regulations governing utility systems.

Geographic Coverage

This measure will reduce GHG emissions across the entire MSA.

Relevant Funding Sources

Example potential funding sources include:

- DOE Energy Efficiency and Conservation Block Grant program
- State Energy Program
- HUD Green and Resilient Retrofit Program
- EPA Greenhouse Gas Reduction Fund Solar for All funding

LIDAC Benefits

The City of Knoxville's Climate Council Equity Working Group determined that climate measures focused on programs that work to 'establish a community-shared renewable energy programs' (e.g., community solar) were '*Likely to advance equity outcomes*.' The EWG suggested that this strategy has high potential to facilitate a just energy transition to community-owned power. The EWG recommended that renewable and clean energy technologies be implemented alongside weatherization/energy efficiency upgrades. Similar to other energy strategies, the EWG recommended that PCAP measures in this sector should include intentional capacity-building or skills development to integrate workforce development and advance access to jobs or contracts for minority contractors and members of LIDAC and BIPOC populations. Additional LIDAC benefits and considerations are described in Table 3-5.

Table 3-5. LIDAC Benefits and Considerations for Clean and Renewable Energy Investments

LIDAC Benefits	Description	Considerations
Neighborhood Enhancement + Resilience	Community-scale clean and renewable energy enhances neighborhood access to energy and resilience. Accrual of benefits through reduced cost for municipality and re-distribution of funding/resources for other programs.	Community outreach efforts will help target implementation of community-scale projects in historically disinvested communities. Assessments and work scopes should include resiliency measures.
Capacity-building + Economic Inclusion	Access to clean energy jobs and a just energy transition. Pre-apprenticeship + apprenticeship programs for building trades.	Partnerships with workforce development organizations and trade unions will be critical for co-designing training/apprenticeship programs and inclusion or procurement policies.

LIDAC Benefits	Description	Considerations
Access to Basic Essentials	Electrification upgrades should increase energy security.	Electrification should not increase energy costs for low-income households already cost-burdened. Building upgrades should also consider upgrades that improve water quality.
Health + Well-being	Sustainable access to affordable energy provides healthy indoor environmental quality, reduced psychosocial stress and connectivity. Improved outdoor air quality from reduction in air pollutants from combustion byproducts.	Outreach and education on the benefits of electrification is needed for community and household acceptance and adoption of electrification strategies.
Social Equity	A focus on LIDAC areas in historically disinvested communities will likely benefit diverse groups and populations.	Identification of and intentional outreach to targeted groups and populations will lead to the co-design of participating in strategies likely to result in transformative social outcomes.

Metrics for Tracking Progress

- Total solar generation/capacity installed
- Participants in community solar programs
- Number of installed projects completed

P4. Expand Electric Vehicle Infrastructure

This measure focuses on stimulating the widespread adoption of electric vehicles (EVs) by improving community access to EV charging infrastructure and making EV ownership more accessible and appealing to consumers. This measure includes deployment of new charging infrastructure for all-electric and plug-in hybrid vehicles (EVs and PHEVs, respectively). Actions to achieve this measure include policy development and incentive programs to promote installation of EV infrastructure at public and private sites and by residential customers.

Quantified GHG Reductions

This measure reduces GHG emissions from transportation. The GHG emissions reduction potential for this measure are:

PCAP Measure	GHG reductions ($MTCO_2e$), 2025-2030	GHG reductions ($MTCO_2e$), 2025-2050
Expand electric vehicle infrastructure	988,114	17,227,343

Key Implementing Agencies

- **Local Government Organizations.** Including counties, cities, and other forms of local government as well as their respective public agencies, including the Knoxville Regional TPO. Local government entities can install EV charging infrastructure in public spaces and play a significant role in zoning and permitting requirements.
- **State Government Agencies.** The Tennessee Departments of Transportation (TDOT) and Environment and Conservation (TDEC) are currently using federal funding to implement an EV Infrastructure Deployment Plan.
- **Utilities.** Local utilities will need to be involved to ensure the electricity grid can support electrification of transportation and can provide additional incentives through rebate and rate programs. In addition, they can also offer make-ready rebates/programs to help with pre-wiring, managed charging programs, and deployment pilots.
- **Community-Based Organizations.** CBOs can help raise awareness and promote community participation.
- **Trade Unions.** Trade unions provide apprenticeship readiness, pre-apprenticeship, apprenticeship and job placement programs with an emphasis on diversifying the clean energy workforce.
- **Private Sector Partners.** Private sector partners include businesses, fleets, residents, and owners of land who want to install EV charging infrastructure on their property.

Implementation Activities and Milestones

Implementation activities to expand EV infrastructure could include:

- Conduct an inventory of EV chargers and develop a plan for regional charging network, using the Alternative Fuels Data Center Station Locator as a starting point.
- Install EV infrastructure in public spaces, including parking lots at municipal buildings, libraries, schools, public parks, park-and-rides, outdoor recreational sites, tourist destinations, shopping plazas, rest stops, and more.
- Enact and expand EV charger rebate programs for community members who install chargers at their homes or businesses. A rebate program can be paired with a technical assistance component to guide property owners on best practices for EV charger installation and maintenance.
- Adopt specially designed charging rate plans or other financial incentives for charging installations in multifamily, public, commercial, and rental properties.
- Provide public educational opportunities, such as webinars, on how to operate and maintain EV chargers.
- Implement local legislation or incentives that facilitate the expansion of EV charging infrastructure to new and existing buildings, such as policies that allow curbside

charging, adopting building codes that encourage pre-wiring for EV chargers, or streamlining permitting processes for EV charging station installations.
- Create and implement clean vehicle procurement policies.
- Explore innovations in charging such as vehicle-to-grid and solar tie-in to EV infrastructure.

Authority to Implement

Local governments have the authority to install EV charging infrastructure in public, government-owned spaces, including at municipal buildings, park-and-rides, schools, public parks, and more. Private companies, non-government organizations, and building owners have the authority to install EV infrastructure on their own property, depending on land use and zoning codes enacted by the state or local government. Local zoning or code changes may need to be made for charging and fueling infrastructure.

Geographic Coverage

This measure will reduce GHG emissions across the entire MSA.

Relevant Funding Sources

- Federal Highway Administration (FHWA) National Electric Vehicle Infrastructure Formula Program (NEVI)
- FHWA Charging and Fueling Infrastructure Grants
- IRA Clean Vehicle Tax Credit
- IRA Previously Owned Vehicle Tax Credit
- IRA Clean Commercial Vehicle Tax Credit
- IRA Alternative Fuel Vehicle Refueling Property Tax Credit
- Additional incentives, laws, and regulations are summarized on the Alternative Fuels Data Center here: https://afdc.energy.gov/laws/state_summary?state=TN

LIDAC Benefits

LIDACs within the Knoxville MSA can financially benefit from reduced barriers to purchasing and operating EVs by realizing lower fuel costs and lower maintenance costs for EVs. The City of Knoxville's Climate Council Equity Working Group determined that climate measures focused on 'creating voluntary program(s) capable of significantly accelerating community adoption of EVs' and that 'significantly expand electric vehicle charging infrastructure in publicly accessible locations' were '*Somewhat likely to advance equity outcomes*.' The EWG suggested that this strategy would have great potential if and when EVs can be accessed by all groups. Similar to other strategies, the EWG recommended that PCAP measures in this sector should include intentional workforce development to build capacity and advance access to jobs or contracts for minority contractors and members of LIDAC and BIPOC populations. Additional LIDAC benefits and considerations are described in Table 3-6.

Table 3-6. LIDAC Benefits and Considerations for Expanding EV Infrastructure

LIDAC Benefits	Description	Considerations
Neighborhood Enhancement + Resilience	More charging facilities in LIDAC areas supplies infrastructure for community members and visitors.	Apply what others have learned from past community outreach efforts to better understand community interests and barriers to access and adoption of EV and installation of EV charging facilities. Leverage available data to inform placement of EV infrastructure in LIDAC communities.
Capacity-building + Economic Inclusion	Expansion of clean energy workforce and commitment to a just energy transition. Pre-apprenticeship + apprenticeship programs for building trades.	Partnerships with workforce development organizations and trade unions will be critical for co-designing training/apprenticeship programs and inclusion or procurement policies.
Access to Basic Essentials	Access to transportation infrastructure for community members; reduced range anxiety.	Cost burdens can be reduced by making free charging facilities available in LIDAC areas.
Health + Well-being	Improved outdoor air quality from reduced air pollutants from vehicle combustion byproducts. Reduced noise pollution.	Opportunities to create awareness of pollution exposures in real time through neighborhood level citizen science air quality monitoring.
Social Equity	A focus on LIDAC areas in historically disinvested communities will likely benefit diverse groups and populations.	Identification of and intentional outreach to targeted groups and populations will lead to the co-design of participating in strategies likely to result in transformative social outcomes.

Metrics for Tracking Progress

- Number of charging stations by type
- Uptime for charging stations
- Number of EVs and low-carbon fuel vehicles registered and/or purchased
- VMT by vehicle type and fuel

P5. Transition to Electric and Alternative Fuel Vehicles in Public Fleets and Provide Access to Charging or Fueling Infrastructure

This measure focuses on accelerating the deployment of zero-emission vehicles (ZEVs), alternative fueled vehicles (AFVs), and hybrid EVs (HEVs) across all on-road transportation

sectors, including light-, medium-, and heavy-duty vehicles from public fleets. It also includes actions to install infrastructure to support the fueling and charging of these vehicles. The conversion from internal combustion engine (ICE) vehicles to EVs presents an opportunity for significant emissions reductions in the Knoxville MSA. While EVs are the lowest-emission vehicles available, this measure also allows for flexibility in the use of green hydrogen, biodiesel, and other fuels (e.g., propane, natural gas, ethanol, renewable diesel) when electric options are not available or feasible. Support of electric charging and low-carbon fuel infrastructure will increase reliability of these vehicles. Utilizing existing stations that offer alternative fuels (e.g., E85, B5/B20) may be a short-term solution as fleets transition to EVs.

This measure aligns with the City of Knoxville's Green Fleet Policy, which aims to transition Knoxville's municipal fleet to lower-emission vehicles to support its goal of reducing GHGs from municipal operations by 50% from 2005-2030.[21] The measure also aligns with priorities of the local transit agency. In 2021, Knoxville Area Transit (KAT) introduced 12 all-electric buses into its transit fleet. In 2023, KAT partnered with the City of Knoxville to produce its first Decarbonization Plan, which includes a path to full electrification of transit vehicles and significant decarbonization of operations. KAT has received funding to support EVs and EV charging infrastructure through the Federal Transit Administration (FTA) Low or No Emissions Grant and the Congestion Mitigation and Air Quality Improvement (CMAQ) program.

Quantified GHG Reductions

This measure reduces GHG emissions from the transportation sector. The GHG emissions reduction potential for this measure are:

PCAP Measure	GHG reductions ($MTCO_2e$), 2025-2030	GHG reductions ($MTCO_2e$), 2025-2050
Transition to electric and alternative fuel vehicles in public fleets and provide access to charging or fueling infrastructure	78,873	526,285

Key Implementing Agencies

- **Local Government Organizations.** Including counties, cities, and other forms of local government as well as their respective public agencies. Local government entities can operationalize the transition to electric and alternative vehicles in public fleets and serve as an example for other fleets and the public. Successful adoption and operations of EVs can raise awareness and inspire confidence in new EV technologies across other fleets.
- **State Government Agencies.** TDOT is a key partner in transportation infrastructure planning, development, and operations for the municipalities within the MSA.

[21] More information on the Green Fleet Policy can be found here: "Green Fleet Policy." n.d. City of Knoxville. https://www.tncleanfuels.org/wp-content/uploads/2023/06/City-of-Knoxville_Green-Fleet-Policy_FINAL.pdf.

- **Utilities.** Local utilities will also need to be involved to ensure the electricity grid can support electrification of government operations.

Implementation Activities and Milestones

Implementation activities to transition public fleets could include:

- Assess the existing public fleet and infrastructure by inventorying existing fleets and plan for AFVs and infrastructure.
- Align fleet procurement procedures with Green Fleet goals. Update public vehicle procurement policies and procedures to promote the purchasing of ZEV or clean fuel vehicles.
- Ensure that EV and alternative fuel infrastructure deployment are available to support vehicle purchases and investigate opportunities to deploy EV charging infrastructure on public property.
- Accelerate the adoption of alternative fuels by modifying existing fuel tanks to accommodate biodiesel or ethanol.
- Explore opportunities to expand the Green Fleet Policy to jurisdictions outside of Knoxville and share lessons learned from its implementation to the broader region.

Authority to Implement

Local jurisdictions have the authority to purchase vehicles for their fleets, which allows for the transition of public fleets, school fleets, and public transportation buses to clean fuel and EVs. The State of Tennessee is also using funds to plan for and develop EV charging infrastructure and electrify public buses.

Geographic Coverage

This measure will reduce GHG emissions across the entire MSA.

Relevant Funding Sources

Example potential funding sources include:

- EPA Clean School Bus Program
- EPA Diesel Emissions Reduction Program
- EPA Clean Heavy-Duty Vehicle Program
- IRA Clean Vehicle Tax Credit
- IRA Previously Owned Vehicle Tax Credit
- IRA Clean Commercial Vehicle Tax Credit
- IRA Alternative Fuel Vehicle Refueling Property Tax Credit
- FHWA National Electric Vehicle Infrastructure Formula Program (NEVI)
- FHWA Charging and Fueling Infrastructure Grants (CFI)
- Additional incentives, laws, and regulations are summarized on the Alternative Fuels Data Center here: https://afdc.energy.gov/laws/state_summary?state=TN

LIDAC Benefits

The City of Knoxville's Climate Council Equity Working Group determined that climate measures focused on the 'transition to EVs' were '*Somewhat likely to advance equity outcomes*.' The EWG suggested that this strategy has greater potential with the adoption of electric buses and by thinking about which population(s) would be served by cleaner/quieter vehicles. Similar to other strategies, the EWG recommended that PCAP measures in this sector should include intentional workforce development to build capacity and advance access to jobs or contracts for minority contractors and members of LIDAC and BIPOC populations. Additional LIDAC benefits and considerations are described in Table 3-7.

Table 3-7. LIDAC Benefits and Considerations for Transition to Electric and Alternative Fuel Vehicles in the Public Fleet

LIDAC Benefits	Description	Considerations
Neighborhood Enhancement + Resilience	Quieter neighborhoods and cleaner air.	Introduction and operation of electric and alternative fuel vehicles should focus on LIDAC areas.
Capacity-building + Economic Inclusion	Workforce development opportunities.	Partnerships with workforce development organizations and trade unions will be critical for co-designing training/apprenticeship programs and inclusion or procurement policies.
Access to Basic Essentials	Electric and alternative fuel vehicles provide affordable and reliable public transportation benefits.	Improved public transit reduces time spent on travel for work and basic needs.
Health + Well-being	Improved outdoor air quality from reduced air pollutants from vehicle combustion byproducts. Reduced noise pollution.	Electric and alternative fuel vehicles should be operated in LIDAC areas to maximize improvements of outdoor air quality benefits.
Social Equity	A focus on LIDAC areas in historically disinvested communities will likely benefit diverse groups and populations.	Identification of and intentional outreach to targeted groups and populations will lead to the co-design of participating in strategies likely to result in transformative social outcomes.

Metrics for Tracking Progress

- Number of EV and AFVs in public fleets
- VMT by vehicle type and fuel
- Number of EV stations installed
- Number of fuel tanks converted
- Uptime for charging stations

P6. Expand and Improve Public Transit

This measure focuses on improving transit to reduce VMT in largely single-occupancy passenger vehicles. Improving access to and design of transit service can reduce VMT by increasing accessibility to local and regional destinations, such as housing, jobs, and goods/services. This measure aims to reduce VMT in the region by expanding and improving public transit systems throughout the MSA. This measure includes investments that enhance coverage, service quality, frequency, and/or speed of public transit.

In addition to the decarbonization goals described in P5, KAT, Knoxville Transportation Authority (KTA), and Knoxville Regional TPO have recently been evaluating how the local bus network is meeting the City of Knoxville's mobility needs and what targeted changes could increase ridership and access to destinations. The KAT Reimagined Study is a system-wide examination of KAT's fixed-route network, balancing the areas covered with services provided for a more effective city-wide system. The study concluded that KAT will focus 70% of its resources on ridership goals and 30% on coverage goals. This increased ridership model is aimed to reduce GHG emissions and traffic congestion. KAT also received a Bus Stop Improvement grant through the state's IMPROVE Transit Investment Grant Program to add stop shelters, benches, and real-time electronic signage showing arrival times.

Quantified GHG Reductions

This measure reduces GHG emissions from the transportation sector. The GHG emissions reduction potential for this measure are:

PCAP Measure	GHG reductions ($MTCO_2e$), 2025-2030	GHG reductions ($MTCO_2e$), 2025-2050
Expand and improve public transit	1,140	7,427

Key Implementing Agencies

- **Local Government Organizations.** Including counties, cities, and other forms of local government as well as their respective public agencies. Local governments are responsible for land use planning and comprehensive planning, transportation planning and transportation-related policies, and local policies that may incentivize or unintentionally disincentivize public transit use.
- **State Government Agencies.** State government organizations such as TDOT and TDEC will be key partners in transportation infrastructure planning, development, and operations.
- **Regional Planning Organizations and Commissions.** TPO, KAT, and KTA can help create a set plan with the design of the improved public transit system and can coordinate with the state and other partners.

- **Private Sector Partners.** Private sector partners include solar developers, financers, building owners, and technology providers. Landowners and developers may play a role in development decisions that shape the viability of transit options.

Implementation Activities and Milestones

Implementation activities to expand and improve public transit could include:

- Provide improvements and enhancements in public transit service (e.g., expansion of bus or rail service, transit priority treatments, bus rapid transit, operational and service enhancements, bus stop improvements such as benches and bus shelters, transit station improvements, mobility hubs that bring together transit, bike sharing, and other options; bus and rail maintenance and investments to improve reliability and quality of service).
- Implement incentives for increased use of transit, such as reduced fare or fare free transit or other transit ridership incentives.
- Reduce emissions from transit vehicles through adoption of zero-emission technology, such as electric or hydrogen fuel cell buses, and through the installation of clean supporting fueling infrastructure (e.g., solar panels at transit facilities for bus charging, use of hydrogen produced with renewable resources).
- Prioritize transit in street design (e.g., dedicated bus lanes, signal prioritization for public transit, etc.).

Authority to Implement

For public transportation systems, there may be a requirement of approvals from regional or state transportation agencies to be implemented with still higher levels of authorization needed depending on the scope and scale of changes to public infrastructure. Additional agencies will need to approve actions related to charges on travel (e.g., congestion pricing or parking pricing changes). Employers also play a key role in providing company polices to allow for teleworking or to provide incentives for transit ridership.

Geographic Coverage

Within the City of Knoxville, KAT covers 23 fixed routes servicing over 1,100 bus stops. The initiatives outlined in this measure target Knox County, which has existing public transportation systems.

Relevant Funding Sources

- FTA Urbanized Area Formula Grants
- FTA Bus and Bus Facility Grants
- FTA Capital Investment Grants
- FTA Low or No Emission Vehicle Program
- FHWA Carbon Reduction Program
- FHWA Congestion Mitigation and Air Quality Improvement (CMAQ) Program

- FHWA Highway Safety Improvement Program (HSIP)
- FHWA Surface Transportation Block Grant (STBG) Program
- TDOT IMPROVE Transit Investment Grant Program for bus stop improvements

LIDAC Benefits

The City of Knoxville's Climate Council Equity Working Group determined that climate measures focused on "making public transit investments that significantly enhance coverage, service quality, frequency, and/or speed" were '*Likely to advance equity outcomes*.' In a public survey, community members reported the following barriers to public transit: bus routes take too long, public transit is confusing, needs improved accessibility, and bus stops are too far away. Additional LIDAC benefits and considerations are described in Table 3-8.

Table 3-8. LIDAC Benefits and Considerations for Expanding and Improving Public Transit

LIDAC Benefits	Description	Considerations
Neighborhood Enhancement + Resilience	Expanded public transit includes better transportation hub and bus stop areas; and less wait times.	Public involvement in the expansion of bus stops and routes should consider commute times outside of LIDAC areas and the greening of bus stops.
Capacity-building + Economic Inclusion	Workforce development opportunities.	Partnerships with workforce development organizations and trade unions will be critical for co-designing training/apprenticeship programs and inclusion or procurement policies for contracts associated with expansions.
Access to Basic Essentials	Expansion and improvement of public transportation improves access and reduces time spent on travel for work and basic needs.	Updated fleets can also provide improved connectivity through free Wi-Fi. Public transit is often confusing for limited English-speaking residents; improved translation services are needed.
Health + Well-being	Increased access to health care, education, childcare, food sources, social and cultural activities, and work opportunities improves general health and well-being.	Expansions of public transit should benefit areas with affordable or public housing to meet the needs of low-income community members.
Social Equity	A focus on LIDAC areas in historically disinvested communities will likely benefit diverse groups and populations.	Identification of and intentional outreach to targeted groups and populations will lead to the co-design of participating in strategies likely to result in transformative social outcomes.

Metrics for Tracking Progress

- Reduction of VMT by single-occupancy vehicles (SOVs)
- Public transit ridership
- VMT and VMT per capita
- Work mode share (percent of workers commuting by single occupant vehicles, rideshare, transit, active transportation, telework, etc.)
- Miles of public transit routes available
- Number of transit stops
- Percent of the MSA within walking distance of a transit stop
- Zero-emission buses
- Emissions from public transit vehicles by fuel type

P7. Boost Active Transportation and the Use of Alternative Transportation Systems

This measure focuses on the implementation of projects that expand active transportation infrastructure (e.g., sidewalks and bike lanes) and micro-mobility options (e.g., bike sharing) to reduce single-occupancy passenger vehicle travel in the region. This measure includes programs and policies such as vanpooling promotion programs, hybrid work programs, and parking management policies that incentivize the use of alternative transportation systems and provide more flexibility.

Quantified GHG Reductions

This measure reduces GHG emissions from the transportation sector. The GHG emissions reduction potential for this measure are:

PCAP Measure	GHG reductions ($MTCO_2e$), 2025-2030	GHG reductions ($MTCO_2e$), 2025-2050
Boost active transportation and the use of alternative transportation systems	134,547	949,792

Key Implementing Agencies

- **Local Government Organizations.** Including counties, cities, and other forms of local government as well as their respective public agencies. Localities are responsible for land use planning and comprehensive planning; transportation planning, development, and operations; program development and administration (e.g., travel demand management programs), and local policies.
- **Regional Planning Organizations**. In collaboration with state and local governments, planning organizations such as Knoxville's TPO can provide support and best practices to support the expansion of active transportation options, as well as help bring nonprofit and private stakeholders into the process. Regional planning organizations

can plan for, evaluate, and in some cases fund transportation infrastructure investments and programs.
- **State Government Agencies.** TDOT will be a key partner in transportation infrastructure planning, development, and operations.
- **Private sector partners.** Private sector partners, such as land use owners, developers, and businesses play a key role in development decisions and design that affect the viability of using alternatives to driving. Business can also implement telecommuting policies, active transportation incentives, and other policies that help manage travel demand.

Implementation Activities and Milestones

Implementation activities to boost active transportation and the use of alternative transportation systems could include:

- Promote and expand car/ride sharing to reduce single occupant vehicle travel through reduced parking minimums, parking pricing, and congestion pricing.
- Implement policies to manage travel demand, such as those that promote or require employer-based trip reduction, ride matching, and vanpool formation.
- Increase mileage of sidewalks and bike lanes and prioritize their maintenance.
- Implement an electric bikeshare program.

Authority to Implement

Local jurisdictions within the MSA have the authority to implement active transportation improvement projects in their own operations within their respective jurisdictions.

Geographic Coverage

This measure is intended to reduce emissions across the entire MSA.

Relevant Funding Sources

- Safe Routes to School (SRTS) Programs
- FHWA Transportation Alternatives Funds
- FHWA Congestion Mitigation and Air Quality Improvement (CMAQ) Program
- FHWA Surface Transportation Block Grant (STBG) Program

LIDAC Benefits

The City of Knoxville's Climate Council Equity Working Group determined that climate measures focused on the 'expansion and improvement of bicycle and pedestrian facilities, connectivity, convenience, and/or safety in a manner that significantly increases the percentage of trips taken by walking or biking' were '*Likely to advance equity outcomes*.' The EWG suggested that these types of strategies should address issues identified by community members including safety concerns (e.g., lack of streetlamps, crime), safer and shorter routes to schools, improved

accessibility for persons with disabilities, and improved access to critical resources. Additional LIDAC benefits and considerations are described in Table 3-9.

Table 3-9. LIDAC Benefits and Considerations for Boosting Active Transportation and the Use of Alternative Transportation Systems

LIDAC Benefits	Description	Considerations
Neighborhood Enhancement + Resilience	Quieter neighborhoods and cleaner air. Green corridors for walking and biking.	Walkability, bikeability, and improved/greening of corridors and bus stops enhances neighborhood quality and social cohesion.
Capacity-building + Economic Inclusion	Workforce development opportunities for improved walkability and bikeability infrastructure planning and implementation.	Equitable inclusion of minority-owned, women-owned and small businesses should be intentionally prioritized in procurement policies.
Access to Basic Essentials	Better public transportation and walkability improves access to basic essentials (e.g., food, schools).	Greening of neighborhoods and green spaces leads to overall well-being/quality of life.
Health + Well-being	Improved outdoor air quality from reduced air pollutants from vehicle combustion byproducts. Reduced noise pollution. Walkability and bikeability encourages exercise and advances health outcomes.	Community outreach and co-mapping of suggested improvements for walkability and bikeability increases awareness and civic participation.
Social Equity	A focus on LIDAC areas in historically disinvested communities will likely benefit diverse groups and populations.	Identification of and intentional outreach to targeted groups and populations will lead to the co-design of participating in strategies likely to result in transformative social outcomes.

Metrics for Tracking Progress

- Completed project count and length of shared use paths, sidewalks, bike lanes, paved shoulder, paved unpaved road, and/or other bike/pedestrian facilities or features
- VMT per capita
- Additional miles of bicycle or pedestrian lanes added

4 Next Steps

4.1 CPRG Implementation Grants

The City of Knoxville, local governments, and other related entities across the MSA are eligible to participate in the general competition for CPRG implementation grants, competing against other similar entities for individual grants ranging from $2-500 million each. Implementation grant applications are due April 1, 2024, with awards anticipated by the end of 2024.

4.2 Other CPRG Planning Grant Deliverables

As the lead organization for the MSA's CPRG planning grant, the City of Knoxville is responsible for developing this PCAP, a CCAP by mid-2025, and a Status Report on CCAP progress by 2027. Throughout the CCAP process, the City of Knoxville in coordination with TPO will continue to meaningfully engage with stakeholders, including industry, community organizations, local governments, the public and more. Their input will be essential to providing clear paths to implement actions to reduce GHG emissions.

Per the CPRG guidance, the CCAP due to the EPA in 2025 will include the following:

- An updated GHG inventory for the MSA
- BAU GHG emissions projections and an economy-wide GHG emissions reduction scenario
- GHG reduction targets for the Knoxville MSA (short- and long-term)
- A comprehensive list of GHG reduction measures that address economy-wide emissions, including the following for each measure:
    - Quantified estimates of GHG reduction and costs
    - Key implementing agency or agencies
    - Implementation schedule and milestones
    - Expected geographic location, if applicable
    - Quantified estimates of co-pollutant reductions (e.g., $PM_{2.5}$, NO_x, SO_2, VOCs, air toxics)
    - A more robust or quantified analysis of benefits for LIDACs
    - A review of the statutory or regulatory authority to implement the measure (and a schedule and milestones for key entities to obtain it if not existing)
    - Identification of funding sources that have been secured for implementation
    - Metrics for tracking progress
    - A workforce planning analysis

In 2027, the City of Knoxville will develop and submit a CPRG Status Report that will include:

- The implementation status of the GHG reduction measures from the CCAP.
- Relevant updated analyses or projections supporting CCAP implementation.
- Next steps and future budget or staffing needs to continue CCAP implementation.

Appendix A. Measure Quantification Methodology

P1: Energy Efficiency Upgrades in Residential, Commercial, and Public Buildings

Approach and Assumptions

This measure models GHG emission reductions achieved through building energy efficiency upgrades. Building energy use and building emission projections are based on energy consumption from electricity, natural gas, fuel oil, and propane in existing residential (single-family, multifamily, and mobile homes) and commercial buildings (office, food service, school, hotel, healthcare, retail, and warehouse). The base year and projections for energy consumption in existing buildings are built from the 2022 Annual Energy Outlook (AEO), which represent projected energy use prior to the passage of the Inflation Reduction Act.[22] AEO census-level data were scaled to the Knoxville MSA counties with the ResStock[23] and ComStock[24] building models of North American building stock with county-level resolution.

ICF's CO_2Sight platform and Distributed Energy Resources Planner (DER Planner) model were used to quantify the change in energy consumption from existing buildings under the low scenario for Building Envelope measures. DER Planner is a bottom-up model that is built upon the best practice principles for potential modeling outlined by the National Action Plan for Energy Efficiency (NAPEE) in their Guide for Conducting Energy Efficiency Potential Studies.[25] DER Planner, informed by stock CO_2Sight measures data, has the capabilities to model various energy efficiency, electrification, and building envelope measures in selected building types. The model uses key inputs such as equipment stock, participation rate curves, and energy change per measure and estimates potential savings from applying efficient measures available for each building type and end-use. Given the efficient technologies available, this quantifies how much energy could be reduced. To compute total savings potential, the model runs all permutations combining savings per measure unit, expected measure penetration, and total number of measure units (or total eligible stock) by all adoption types (ROB and RET).[26]

Building characteristics and energy use data for modeling buildings under the selected scenario were derived from ResStock and ComStock datasets provided by the National Renewable Energy Laboratory (NREL). These datasets integrate large public and private data sources statistical sampling, detailed sub-hourly building simulations, and high-performance computing. By synthesizing multiple sources into a single resource, these data allow for a granular understanding of the housing and commercial stock and the impacts of building

[22] "Annual Energy Outlook 2023 - U.S. Energy Information Administration (EIA)." March 16, 2023. https://www.eia.gov/outlooks/aeo/index.php.
[23] "ResStock Analysis Tool." n.d. Accessed February 19, 2024. https://www.nrel.gov/buildings/resstock.html.
[24] "ComStock - NREL." n.d. Accessed February 19, 2024. https://comstock.nrel.gov/.https://comstock.nrel.gov/
[25] U.S EPA. "Guide for Conducting Energy Efficiency Potential Studies."2007. https://doi.org/10.2172/1219674.
[26] Measures' adoption type definitions: ROB or "replace on burnout" implies that the technology will be adopted when the previous technology needs to be replaced. RET or "retrofit" implies that the technology is adopted before the previous technology needs to be replaced.

technologies in different communities and businesses. The ResStock and ComStock energy use data are calibrated to match the EIA's AEO dataset.

As an input into DER Planner, each measure has participation (or technology adoption curves) connected to them. A range of factors can impact whether new efficiency technologies are adopted. This approach builds from NREL's Electrification Future Study,[27] from which many of the adoption curves are provided, and through the adoption curves accounts for changes in costs, supporting infrastructure, ownership and availability, health and sustainability (including policies) and other factors that could influence technology adoption. Adoption curves are also provided from the implementation energy efficiency programs and informed by expert judgment. For ease of use, users can select prepopulated groupings of participation curves to match the types of energy change they want to model.

Key assumptions include:

- Modeled low scenario for Building Envelope measures meaning moderate building envelope work and some deep energy retrofits
- Modeled a moderate implementation of core energy efficiency measures including:
    - Full lighting retrofits and lighting controls
    - Smart Thermostats and Building Automation Systems
    - New energy efficient appliances
    - New energy efficient HVAC equipment
- BAU emissions factors (2019 eGRID held flat)
- Measure emissions factors (2023 AEO Reference Case)

Key Data Sources

- ComStock and ResStock data sets
- EPA's ENERGYSTAR Equipment performance thresholds
- Various state's Technical Reference Manual
- NREL's Electrification Future Study[28]
- DOE's equipment purchasing profiles
- PNNL's Building Retuning materials
- EPA's GHG Emission Factors Hub
- Electric Grid Emission Factor Projections, AEO 2023
- EPA eGRID, 2019

[27] "Electrification Futures Study: A Technical Evaluation of the Impacts of an Electrified U.S. Energy System." n.d. Accessed February 19, 2024. https://www.nrel.gov/analysis/electrification-futures.html.
[28] Jadun, Paige, Colin McMillan, Daniel Steinberg, Matteo Muratori, Laura Vimmerstedt, and Trieu Mai. 2017. "Electrification Futures Study Technology Data." National Renewable Energy Laboratory - Data (NREL-DATA), Golden, CO (United States); National Renewable Energy Laboratory. https://doi.org/10.7799/1414279.

P2: Electrify Residential, Commercial, and Public Buildings

Approach and Assumptions

This measure models GHG emission reductions achieved through the replacement of fossil fuel-fired heating, hot water, and cooking equipment with heat pump and induction technologies. Building energy use and building emission projections are based on energy consumption from electricity, natural gas, fuel oil, and propane in existing residential (single-family, multifamily, and mobile homes) and commercial buildings (office, food service, school, hotel, healthcare, retail, and warehouse). The base year and projections for energy consumption in existing buildings are built from the 2022 AEO, which represent projected energy user prior to the passage of the Inflation Reduction Act.[29] AEO data were scaled to the Knoxville MSA counties by scaling AEO census-level data with the ResStock[30] and ComStock[31] building models of North American building stock with county-level resolution.

ICF's CO_2Sight platform and DER Planner model were used to quantify the change in energy consumption from existing buildings under the beneficial electrification scenarios for HVAC measures and Water Heating and Cooking measures. DER Planner is a bottom-up model that is built upon the best practice principles for potential modeling outlined by NAPEE in their Guide for Conducting Energy Efficiency Potential Studies.[32] DER Planner, informed by stock CO_2Sight measures data, has the capabilities to model various energy efficiency, electrification, and building envelope measures in selected building types. The model uses key inputs such as equipment stock, participation rate curves, and energy change per measure and estimates potential savings from applying efficient measures available for each building type and end-use. Given the efficient technologies available, this quantifies how much energy could be reduced. To compute total savings potential, the model runs all permutations combining savings per measure unit, expected measure penetration, and total number of measure units (or total eligible stock) by all adoption types (ROB and RET).[33]

Building characteristics and energy use data for modeling buildings under the selected scenario was derived from ResStock and ComStock datasets provided by NREL. These datasets integrate large public and private data sources statistical sampling, detailed sub-hourly building simulations, and high-performance computing. By synthesizing multiple sources into a single resource, these data allow for a granular understanding of the housing and commercial stock and the impacts of building technologies in different communities and businesses. The ResStock and ComStock energy use data are calibrated to match the EIA's AEO dataset.

---

[29] "Annual Energy Outlook 2023 - U.S. Energy Information Administration (EIA)." March 16, 2023. https://www.eia.gov/outlooks/aeo/index.php.
[30] "ResStock Analysis Tool." n.d. Accessed February 19, 2024. https://www.nrel.gov/buildings/resstock.html.
[31] "ComStock - NREL." n.d. Accessed February 19, 2024. https://comstock.nrel.gov/.https://comstock.nrel.gov/
[32] U.S EPA. "Guide for Conducting Energy Efficiency Potential Studies."2007. https://doi.org/10.2172/1219674.
[33] Measures' adoption type definitions: ROB or "replace on burnout" implies that the technology will be adopted when the previous technology needs to be replaced. RET or "retrofit" implies that the technology is adopted before the previous technology needs to be replaced.

As an input into DER Planner, each measure has participation (or technology adoption curves) connected to them. A range of factors can impact whether new electrification technologies are adopted. This approach builds from NREL's Electrification Future Study,[34] from which many of the adoption curves are provided, and through the adoption curves accounts for changes in costs, supporting infrastructure, ownership and availability, health and sustainability (including policies) and other factors that could influence technology adoption change. Adoption curves are also provided from the implementation energy efficiency programs and informed by expert judgment. For ease of use, users can select prepopulated groupings of participation curves to match the types of energy change they want to model.

Key assumptions include:

- Modeling assumed beneficial electrification scenarios for HVAC measures and Water Heating and Cooking measures meaning a small amount of electrification for those projects that are presently cost-effective
- BAU emissions factors (2019 eGRID held flat)
- Measure emissions factors (2023 AEO Reference Case)

Key Data Sources

- ComStock and ResStock data sets
- EPA's ENERGYSTAR Equipment performance thresholds
- Various state's Technical Reference Manual
- NREL's Electrification Future Study[35]
- DOE's equipment purchasing profiles
- PNNL's Building Retuning materials
- EPA's GHG Emission Factors Hub
- Electric Grid Emission Factor Projections, AEO 2023
- EPA eGRID, 2019

P3: Develop and Invest in Clean and Renewable Energy

Approach and Assumptions

This measure models the resulting GHG emissions reductions from achievement of increased distributed solar adoption, representing the general potential for distributed clean resource additions in the MSA. Total technical potential for rooftop solar in the Knoxville MSA was aggregated from Project Sunroof's estimates of the technical potential in each of the counties in

[34] "Electrification Futures Study: A Technical Evaluation of the Impacts of an Electrified U.S. Energy System." n.d. Accessed February 19, 2024. https://www.nrel.gov/analysis/electrification-futures.html.
[35] Jadun, Paige, Colin McMillan, Daniel Steinberg, Matteo Muratori, Laura Vimmerstedt, and Trieu Mai. 2017. "Electrification Futures Study Technology Data." National Renewable Energy Laboratory - Data (NREL-DATA), Golden, CO (United States); National Renewable Energy Laboratory. https://doi.org/10.7799/1414279.

the MSA.[36] To determine an adoption rate, the most aggressive 2050 adoption scenario from NREL's Storage Futures Study (20%) was applied to the MSA's technical potential.[37] Existing rooftop solar capacity assumptions were sourced from the City of Knoxville's Clean Energy website and then grown to meet the assumed 2050 level.[38] To calculate the kWh of solar output, the capacity factor for residential solar from NREL's annual technology baseline corresponding to the geography of Knoxville MSA was used. The incremental growth in solar output from current levels, multiplied by grid emissions factors, resulted in the potential avoided emissions from rooftop solar.

Key assumptions include:

- Constant technical potential per building over time
- No incremental rooftop PV installation beyond existing in BAU case
- Linear growth of PV installations between 2023 and 2050 in Policy Case
- BAU emissions factors (2019 eGRID held flat)
- Measure emissions factors (2023 AEO Reference Case)

Key Data Sources

- Storage Futures Study: Distributed Solar and Storage Outlook: Methodology and Scenarios (2021), NREL
- City of Knoxville Website, Clean Energy, Accessed Feb 02, 2024
- Project Sunroof data explorer, (June 2019), Google
- Annual Technology Baseline, Residential PV (2023), NREL
- Electric Grid Emission Factor Projections, AEO 2023
- EPA eGRID, 2019

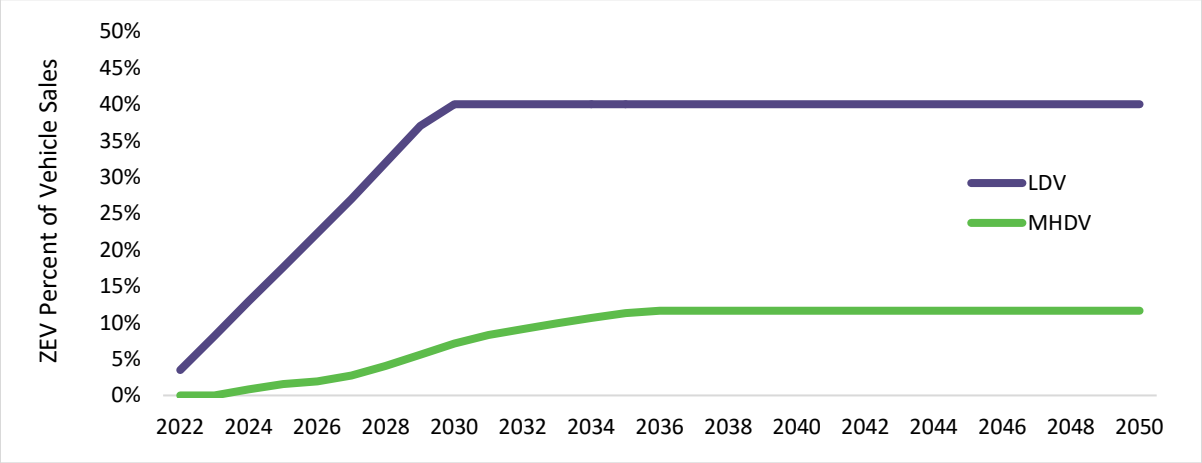
P4: Expand Electric Vehicle Infrastructure

Approach and Assumptions

This measure models the resulting GHG emissions reduced if the Knoxville MSA leverages the incentives in the Inflation Reduction Act to increase purchases of light-duty and medium- and heavy-duty ZEVs. Figure A-1 shows the sales targets assumed for LDVs and MHDVs, derived from the proposed EPA Multi-Pollutant Emissions Standards for Model Years 2027 and Later Light-Duty and Medium-Duty Vehicles, and the Greenhouse Gas Emissions Standards for Heavy-Duty Vehicles – Phase 3.

[36] "Project Sunroof." n.d. Accessed February 19, 2024. https://sunroof.withgoogle.com/.
[37] "Storage Futures." n.d. Accessed February 13, 2024. https://www.nrel.gov/analysis/storage-futures.html.
[38] City of Knoxville. "Clean Energy." Accessed Feb 13, 2024.
https://www.knoxvilletn.gov/government/city_departments_offices/sustainability/clean_energy

Figure A-1: ZEV Sales Targets



The model uses outputs from the EPA Motor Vehicle Emissions Simulator (MOVES3) to project baseline VMT, vehicle population, energy consumption, and direct (Scope 1) emissions for on-road transportation in the MSA by fuel type (gasoline, diesel, ethanol (E-85), compressed natural gas, and electricity), vehicle source type, and model year. Default input values were used. Scope 2 emissions from electricity consumption by EVs were calculated using the following equation:

$$Scope\ 2\ Emissions = Electricity\ Consumption\ \times\ Electricity\ Emission\ Factor \quad (1)$$

The electricity emissions factor was held at 2019 eGRID levels for the SRTV subregion, which includes the Knoxville MSA, through 2050 for the baseline.

To model GHG emissions reductions in the policy scenario, for each model year, a fraction of VMT was designated as fuel type "electricity" or "hydrogen" based on the ZEV sales curve. The resulting energy consumption was found using the following equation:

$$Energy\ Consumption = VMT\ \times Energy\ Efficiency, \quad (2)$$

where energy efficiency was in units of kJ/mi for battery EVs (BEVs) and fuel cell EVs (FCEVs). Implied BEV energy efficiencies from the MOVES4 baseline results were used. FCEV energy efficiencies were sourced from the California Advanced Clean Fleets (ACF) rule making. Scope 1 emissions were found by reducing baseline internal combustion engine vehicle (ICEV) emissions by the ZEV sales fraction. Scope 2 emissions were found using Equation (1). Electricity emissions factor projections were sourced from EIA's AEO for the SRCE region.

The following additional key assumptions were made as part of this analysis:

- ZEVs exist in the vehicle fleet for the same length of time as ICEVs.
- ZEV activity/use is identical to an ICEV.
- The annual ZEV sales fraction applies to every fuel type.
- Long-haul medium and heavy-duty vehicles (MHDVs) ZEVs are modeled as FCEV and all other MHDVs ZEVs are modeled as BEV.
- All LDVs ZEVs are modeled as BEVs.
- The hydrogen supply is assumed to be 50% green hydrogen and 50% blue hydrogen.

Key Data Sources

- EPA MOVES3
- EPA eGRID 2019
- EIA AEO 2023 Reference Case
- California ACF rulemaking
- Multi-Pollutant Emissions Standards for Model Years 2027 and Later Light-Duty and Medium-Duty Vehicles (EPA proposed rule)
- GHG Emissions Standards for Heavy-Duty Vehicles – Phase 3 (EPA proposed rule)

P5: Transition to Electric and Alternative Fuel Vehicles in Public Fleets and Provide Access to Charging or Fueling Infrastructure

Approach and Assumptions

The GHG emission reductions from transitioning to electric and alternative fuel vehicles in public fleets were estimated by assuming the achievement of goals within the City of Knoxville's Green Fleet Policy, which aims to lead by example to transition the municipal fleet to sustainable vehicles in support of a 50% GHG reduction by 2030 for municipal operations and an 80% GHG reduction by 2050 for the entire community. For this measure, the Green Fleet Policy goal of "an 80% reduction in GHG emissions by 2050 for the entire community" was applied to the municipal fleet. The GHG emissions from the City of Knoxville's municipal vehicle and transit fleet were scaled to the entire MSA using population data for the rest of the MSA.

For the BAU projection through 2050, emissions in the 2019 inventory were held constant. Emissions in 2030 and 2050 due to the implementation of this measure were estimated by reducing 2019 emissions by 30% and 50% respectively, and intermediate years were linearly interpolated. Cumulative GHG reductions between 2025-2030 and 2025-2050 were estimated by taking the difference between the BAU scenario and the scenario with the implemented measure and summing the resulting emissions reduced across the time series.

Key Data Sources

- City of Knoxville's Municipal GHG Inventory (Transit Fleet and Vehicle Fleet)
- Knoxville MSA population data by county from the U.S. Census Bureau
- City of Knoxville Green Fleet Policy

P6: Expand and Improve Public Transit

Approach and Assumptions

This measure models resulting VMT and GHG emissions reduced if the Knoxville MSA enhances its public transit system by increasing transit service frequency, extending transit network coverage or hours, implementing transit-supportive roadway treatments, and reducing transit fares throughout the MSA. The measure assumes these strategies only result in light-duty passenger vehicle VMT reduction. The potential VMT reduction due to

each of these actions was calculated based on the methodology outlined in the *Handbook for Analyzing Greenhouse Gas Emission Reductions, Assessing Climate Vulnerabilities, and Advancing Health and Equity,*[39] a document compiled for the California Air Pollution Control Officers Association to provide methods for estimating GHG reductions resulting from various measures.

The resulting passenger VMT reduction is shown in Table A-1. Larger reductions are possible when this measure is paired with other items such as improved transit-oriented development, congestion and/or VMT pricing, vanpooling, encouragement of teleworking, and other disincentives for driving, which are not quantified as part of this PCAP measure and will be further reviewed as part of the CCAP process.

Table A-1. VMT Reductions from Public Transit Strategies

Strategy Name	Potential VMT Reduction by 2030	Potential VMT Reduction by 2050
Increase Transit Service Frequency	-0.0033%	-0.0033%
Extend Transit Network Coverage or Hours	-0.0085%	-0.0085%
Implement Transit-Supportive Roadway Treatments	-0.00026%	-0.00053%
Reduce Transit Fares	-0.008%	-0.008%

Conservative estimates were made for calculation inputs for each transit strategy based on the maximum input value listed in the *Handbook.* The following additional key assumptions were made as part of this analysis:

- VMT reductions apply only to passenger vehicles.
- VMT reductions are taken from the baseline discussed in P4.
- Maximum VMT reductions are assumed to be achieved in 2030 and held constant at maximum levels through 2050, except for transit-supportive roadway treatments for which maximum VMT reductions are achieved by 2050 and half of the maximum reductions are achieved by 2030.

Key Data Sources

- EPA MOVES4
- EPA eGRID 2019
- EIA AEO 2023 Reference Case
- FWHA NHTS 2017 Statistics
- EPA Handbook for Analyzing Greenhouse Gas Emission Reductions, Assessing Climate Vulnerabilities, and Advancing Health and Equity

[39] "Handbook for Analyzing Greenhouse Gas Emission Reduction, Assessing Climate Vulnerabilities, and Advancing Health and Equity." 2021. U.S. EPA. https://www.airquality.org/ClimateChange/Documents/Handbook%20Public%20Draft_2021-Aug.pdf.

P7: Boost Active Transportation and the Use of Alternative Transportation Systems

Approach and Assumptions

This measure models resulting VMT and GHG emissions reduced if the Knoxville MSA enhances its active transportation infrastructure by improving pedestrian networks, expanding bike networks, and implementing an electric bikeshare program throughout the MSA. The measure assumes these strategies only result in light-duty passenger vehicle VMT reduction. The potential VMT reduction due to each of these actions was calculated based on the methodology outlined in the *Handbook for Analyzing Greenhouse Gas Emission Reductions, Assessing Climate Vulnerabilities, and Advancing Health and Equity,*[40] a document compiled for the California Air Pollution Control Officers Association to provide methods for estimating GHG reductions resulting from various measures.

The resulting passenger VMT reduction across the MSA is shown in Table A-2. Larger reductions are possible when this measure is paired with other items such as improved transit-oriented development, congestion and/or VMT pricing, vanpooling, encouragement of teleworking, and other disincentives for driving, which are not quantified as part of this PCAP measure and will be further reviewed as part of the CCAP process.

Table A-2. VMT Reductions from Active Transportation Strategies

Strategy Name	Potential VMT Reduction by 2030	Potential VMT Reduction by 2050
Provide Pedestrian Network Improvement	-0.25%	-0.50%
Expand Bikeway Network	-0.0028%	-0.0056%
Implement Electric Bikeshare Program	N/A	-0.0051%
Parking Pricing	-1.0%	-1.0%

Conservative estimates were made for calculation inputs for each transit strategy based on the maximum input value listed in the *Handbook.* The following additional key assumptions were made as part of this analysis:

- VMT reduction only applies to passenger vehicles.
- VMT reductions are taken from the baseline discussed in P4.
- Maximum VMT reductions are assumed to be achieved in 2050. Half of maximum reductions are achieved by 2030, except for electric bikeshare which is assumed to be implemented after 2030, and parking pricing which is assumed to be fully implemented by 2030.

[40] "Handbook for Analyzing Greenhouse Gas Emission Reduction, Assessing Climate Vulnerabilities, and Advancing Health and Equity." 2021. U.S. EPA. https://www.airquality.org/ClimateChange/Documents/Handbook%20Public%20Draft_2021-Aug.pdf.

Key Data Sources

- EPA MOVES4
- EPA eGRID 2019
- EIA AEO 2023 Reference Case
- FWHA NHTS 2017 Statistics
- EPA Handbook for Analyzing Greenhouse Gas Emission Reductions, Assessing Climate Vulnerabilities, and Advancing Health and Equity

Appendix B. LIDAC Census Tracts in Knoxville MSA

County	Census ID
Anderson County	470010201001
Anderson County	470010201002
Anderson County	470010202023
Anderson County	470010203001
Anderson County	470010204001
Anderson County	470010204002
Anderson County	470010204003
Anderson County	470010207001
Anderson County	470010207002
Anderson County	470010208001
Anderson County	470010208002
Anderson County	470010208003
Anderson County	470010212011
Anderson County	470010212012
Anderson County	470010212013
Anderson County	470010212014
Anderson County	470010212021
Anderson County	470010212022
Anderson County	470010212023
Anderson County	470010212024
Anderson County	470010213041
Blount County	470090101001
Blount County	470090101002
Blount County	470090102001
Blount County	470090102004
Blount County	470090103011
Blount County	470090103013
Blount County	470090103023
Blount County	470090105001
Blount County	470090105002
Blount County	470090108001
Blount County	470090108002
Blount County	470090109003
Blount County	470090110014
Blount County	470090111014
Blount County	470090112011
Blount County	470090114011
Blount County	470090114012
Blount County	470090116032
Blount County	470099801001
Blount County	470099802001
Campbell County	470139501001
Campbell County	470139501002
Campbell County	470139501003
Campbell County	470139502001
Campbell County	470139502002
Campbell County	470139503001
Campbell County	470139503002
Campbell County	470139504001
Campbell County	470139504002
Campbell County	470139504003
Campbell County	470139504004
Campbell County	470139506011
Campbell County	470139506012
Campbell County	470139506021
Campbell County	470139506022
Campbell County	470139506023
Campbell County	470139507011
Campbell County	470139507012
Campbell County	470139507021
Campbell County	470139507022
Campbell County	470139508001
Campbell County	470139508002
Campbell County	470139509001
Campbell County	470139509002
Campbell County	470139510001
Campbell County	470139510002
Grainger County	470575001001
Grainger County	470575001002
Grainger County	470575001003
Grainger County	470575002001
Grainger County	470575002002
Grainger County	470575002003
Grainger County	470575003011
Grainger County	470575003012
Grainger County	470575003013
Grainger County	470575003021
Grainger County	470575003022
Grainger County	470575003023
Grainger County	470575004011
Grainger County	470575004012
Grainger County	470575004021
Grainger County	470575004022
Grainger County	470575004023
Grainger County	470575004024
Knox County	470930001001

County	Census ID	County	Census ID
Knox County	470930001002	Knox County	470930038011
Knox County	470930008001	Knox County	470930038012
Knox County	470930008002	Knox County	470930038013
Knox County	470930008003	Knox County	470930038014
Knox County	470930009021	Knox County	470930039012
Knox County	470930014001	Knox County	470930039021
Knox County	470930014002	Knox County	470930039022
Knox County	470930014003	Knox County	470930040001
Knox County	470930015001	Knox County	470930040002
Knox County	470930015002	Knox County	470930040003
Knox County	470930015003	Knox County	470930040004
Knox County	470930016001	Knox County	470930043002
Knox County	470930017001	Knox County	470930045012
Knox County	470930017002	Knox County	470930046151
Knox County	470930019001	Knox County	470930046152
Knox County	470930020001	Knox County	470930048001
Knox County	470930020002	Knox County	470930049002
Knox County	470930020003	Knox County	470930050003
Knox County	470930021001	Knox County	470930053011
Knox County	470930021002	Knox County	470930053012
Knox County	470930023001	Knox County	470930053013
Knox County	470930023002	Knox County	470930053022
Knox County	470930024001	Knox County	470930054021
Knox County	470930024002	Knox County	470930054022
Knox County	470930024003	Knox County	470930054023
Knox County	470930026001	Knox County	470930055022
Knox County	470930026002	Knox County	470930059082
Knox County	470930027001	Knox County	470930062052
Knox County	470930027002	Knox County	470930062084
Knox County	470930028001	Knox County	470930063011
Knox County	470930028002	Knox County	470930063012
Knox County	470930028003	Knox County	470930063021
Knox County	470930028004	Knox County	470930063022
Knox County	470930029001	Knox County	470930065021
Knox County	470930029002	Knox County	470930065022
Knox County	470930030002	Knox County	470930065023
Knox County	470930030003	Knox County	470930066001
Knox County	470930031001	Knox County	470930066002
Knox County	470930031002	Knox County	470930066003
Knox County	470930032001	Knox County	470930067001
Knox County	470930032002	Knox County	470930067002
Knox County	470930035011	Knox County	470930067003
Knox County	470930035021	Knox County	470930068001
Knox County	470930035022	Knox County	470930068002
Knox County	470930037001	Knox County	470930068003

County	Census ID
Knox County	470930068004
Knox County	470930069011
Knox County	470930069012
Knox County	470930069021
Knox County	470930069022
Knox County	470930069031
Knox County	470930069032
Knox County	470930070001
Knox County	470930070002
Loudon County	471050602011
Loudon County	471050602012
Loudon County	471050602031
Loudon County	471050602032
Loudon County	471050602033
Loudon County	471050602041
Loudon County	471050602042
Loudon County	471050602043
Loudon County	471050602044
Loudon County	471050603011
Loudon County	471050604003
Loudon County	471050605021
Loudon County	471050605022
Loudon County	471050605031
Loudon County	471050606002
Loudon County	471050606003
Morgan County	471291101001
Morgan County	471291101002
Morgan County	471291102001
Morgan County	471291102002
Morgan County	471291103001
Morgan County	471291103002
Morgan County	471291103003
Morgan County	471291104001
Morgan County	471291104002
Morgan County	471291104003
Morgan County	471291105001
Morgan County	471291105002
Morgan County	471291105003
Morgan County	471291105004
Roane County	471450305001
Roane County	471450305002
Roane County	471450305003
Roane County	471450306001
Roane County	471450306002
Roane County	471450307001
Roane County	471450307002
Roane County	471450307003
Roane County	471450308011
Roane County	471450308012
Roane County	471450308021
Roane County	471450308022
Roane County	471450309001
Roane County	471450309002
Union County	471730401011
Union County	471730401012
Union County	471730401013
Union County	471730401021
Union County	471730401022
Union County	471730402011
Union County	471730402012
Union County	471730402013
Union County	471730402021
Union County	471730402022
Union County	471730402023
Union County	471730402024
Union County	471730403001
Union County	471730403002