



A Climate Action Plan for the Knoxville Region



Table of Contents

Acknowledgments.....	3
Acronyms and Abbreviations.....	4
Definitions.....	6
EXECUTIVE SUMMARY.....	7
Statement from the Mayors	11
CHAPTER 1. INTRODUCTION: CLIMATE IN THE REGION	12
The BREATHE Plan Development	13
Climate Perspectives in the Knoxville Region	14
How a Changing Climate Affects the Knoxville Region.....	16
The Knoxville Region's GHG Emissions	19
CHAPTER 2. REGIONAL GOALS	26
CHAPTER 3. BUILDING ON EXISTING CLIMATE ACTION	29
City of Knoxville.....	29
The BREATHE Working Group and Regional Partnerships	29
Foundations for Regional Climate Action	31
CHAPTER 4. ADVANCING CLIMATE ACTION	35
Emission Reduction Measures Overview.....	35
Buildings.....	40
Building Sector Measure Benefits	54
Energy	55
Energy Sector Measure Benefits.....	60
Transportation	62
Transportation Sector Measure Benefits.....	89
Waste	91
Waste Sector Measure Benefits	98
Natural & Working Lands.....	100
Natural & Working Lands Sector Measure Benefits	110
Agriculture	112
Agriculture Sector Measure Benefits.....	120
Outreach and Education	121



Example Actions	121
Outcomes for the Community	122
Developing Outcomes to Guide Plan Priorities.....	122
Community Outcomes.....	122
CHAPTER 5. THE REGION'S WORKFORCE.....	124
Workforce Analysis.....	124
Solutions to Meet Workforce Demand.....	127
CHAPTER 6. NEXT STEPS.....	134
Continue Engagement.....	134
Use the Community Outcomes Matrix	134
Evaluate and Study New Technologies.....	135
Advance the Local Workforce.....	135
Unlock Funding Sources.....	136
Establish Processes and Systems to Track Progress.....	136
Conclusion.....	136
Links to Appendices	137



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The BREATHE Team would like to thank the members of the Working Group, who played a central role in shaping the plan's goals, measures, and implementation strategies. A full list of Working Group participants is included in Appendix A. The team also appreciates the 1,330 individuals who shared their perspectives through the BREATHE survey in fall 2024. Their voices helped ensure that the BREATHE Plan reflects the priorities and values of the region.

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Acronyms and Abbreviations

AFV	Alternative Fuel Vehicle
ASE	Apprenticeship State Expansion
BAU	Business-as-Usual
BUILD	Better Utilizing Investments to Leverage Development
CAC	Community Action Committee
CBO	Community-Based Organization
CCAP	Comprehensive Climate Action Plan
CO	Carbon Monoxide
CPRG	Climate Pollution Reduction Grant
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
EPA	U.S. Environmental Protection Agency
EPSO	Early Post-Secondary Opportunities
ESCO	Energy Service Company
ESPC	Energy Savings Performance Contract
ETHRA	East Tennessee Human Resource Agency
EV	Electric Vehicle
FHWA	Federal Highway Administration
FTA	Federal Transit Administration
GHG	Greenhouse Gas
HUD	U.S. Department of Housing and Urban Development
HVAC	Heating, Ventilation, and Air Conditioning
KAT	Knoxville Area Transit
KUB	Knoxville Utilities Board
LED	Light- Emitting Diode
LEED	Leadership in Energy and Environmental Design
LMI	Low and Moderate Income
LPC	Local Power Company
LRTP	Long-Range Transportation Plan
MMTCO ₂ e	Million metric tons of carbon dioxide equivalent
MSA	Metropolitan Statistical Area
MTCO ₂ e	Metric tons of carbon dioxide equivalent
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
NWL	Natural & Working Lands
ORNL	Oak Ridge National Laboratory
PCAP	Priority Climate Action Plan
PM ₁₀	Particulate Matter 10 Micrometers or Smaller
PM _{2.5}	Particulate Matter 2.5 Micrometers or Smaller
PPA	Power Purchase Agreement



RAP	Registered Apprenticeship Program
REC	Renewable Energy Certificate
SACE	Southern Alliance for Clean Energy
SAEF	State Apprenticeship Expansion Formula
SEED	Socially Equal Energy Efficient Development
SMR	Small Modular Reactor
SO ₂	Sulfur Dioxide
STBG	Surface Transportation Block Grant
TDEC	Tennessee Department of Environment and Conservation
TDOT	Tennessee Department of Transportation
TPO	Transportation Planning Organization
TSU	Tennessee State University
TVA	Tennessee Valley Authority
USDA	United States Department of Agriculture
UT	University of Tennessee
UTK	University of Tennessee, Knoxville
VOCs	Volatile Organic Compounds
WAP	Weatherization Assistance Program



Definitions

Air Pollutants	Chemical and physical substances that can harm human health or the environment, such as nitrous oxides, sulfur dioxide, particulate matter, and carbon monoxide.
Business-as-Usual (BAU) Scenario	A projection of future emissions based on the assumption that no additional climate actions are taken beyond those already planned or underway.
Co-Benefits	The positive effects of climate action beyond GHG reductions (e.g., improved public health outcomes, economic benefits, increased climate resilience).
GHG Inventory	An accounting of past and current GHG emission sources and sinks for a specific geography or organization.
GHG Reduction Measure	Policies, programs, actions, or projects that reduce GHG emissions or remove carbon from the atmosphere (i.e., through the uptake of carbon and storage in soils, vegetation, and forests.)
GHG Reduction Target	A specific goal for reducing GHG emissions within a defined timeframe, relative to a baseline year.
Greenhouse Gas (GHG)	Air pollutants that trap heat in the atmosphere and contribute to climate change. The main types of GHGs include carbon dioxide, hydrofluorocarbons, methane, nitrous oxide, perfluorocarbons, and sulfur hexafluoride. Measurement of these various GHGs are standardized to carbon dioxide equivalents (CO ₂ e).



EXECUTIVE SUMMARY

BREATHE: A Climate Action Plan for the Knoxville Region charts a bold, community-driven path toward a more healthy, more resilient, and equitable future. Developed through the U.S. Environmental Protection Agency's Climate Pollution Reduction Grant program, and led by the City of Knoxville and the Transportation Planning Organization, this plan builds on the 2024 Priority Climate Action Plan and reflects two years of collaboration among regional stakeholders, local governments, and community members across the nine-county Knoxville Metropolitan Statistical Area.

Driving Climate Action

The Knoxville region is experiencing the accelerated effects of climate change, including extreme heat, flooding, severe storms, and poor air quality. In 2022 alone, Knox County endured 55 extreme heat days, and flooding continues to pose a significant threat across the region, with an estimated \$5 million in annual losses due to damage. These hazards threaten public health, infrastructure, and economic stability. Yet the region also has unique assets that are critical to unlocking action to address climate change—such as a legacy of innovation through the Tennessee Valley Authority, Oak Ridge National Laboratory, University of Tennessee, and a strong network of community organizations and research institutions.

Reflecting Community Voices

The BREATHE Plan is grounded in science and acknowledges and integrates local perspectives. BREATHE's 2024 region-wide survey revealed that 76% of respondents experienced climate effects firsthand and were most concerned about extreme heat



(50%), severe storms (49%), and poor air quality (45%).¹ The BREATHE Plan responds to these concerns with solutions that prioritize health, affordability, equity, and resilience.

Setting Ambitious, Yet Achievable, Goals

The plan presents regional greenhouse gas (GHG) reduction targets as follows:

- 40% by 2035, relative to 2022 emissions
- 75% by 2050, relative to 2022 emissions

These targets are based on achievable levels of GHG emissions reductions if the 19 mitigation measures presented in this plan are successfully implemented. The measures span six sectors: **Buildings, Energy, Transportation, Waste, Natural & Working Lands, and Agriculture.**

Identifying and Building on Key Strategies

In 2022, 15.8 million metric tons of carbon dioxide equivalent (MMTCO₂e) were emitted across the region. Including carbon sinks, the net emissions were 11.6 MMTCO₂e in 2022. On a per capita basis, the region emitted 12.4 metric tons of CO₂ equivalent (MTCO₂e) per person—lower than the U.S. average of 13.9 MTCO₂e per person.²

Without further action, in a business-as-usual scenario, net emissions will decline 27% by 2035 and 36% by 2050, relative to 2022 emissions, which is insufficient to meet climate goals. If all 19 GHG reduction measures presented in this plan were implemented, emissions could be further reduced, resulting in overall reductions of 34% by 2035 and 62% by 2050, relative to 2022 emissions.

With successful implementation of the BREATHE Plan, cumulative emission reductions would be 5.4 MMTCO₂e between 2022 and 2035 and 41.9 MMTCO₂e between 2022 and 2050 across the six key sectors:

- **Buildings:** Energy efficiency improvements, electrification, and upgrades could reduce emissions by 13.2 MMTCO₂e by 2050.
- **Transportation:** Electric vehicle (EV) adoption, green fleet transitions, and improved transit could cut 7.3 MMTCO₂e by 2050.
- **Energy:** Clean and distributed energy deployment (e.g., solar power and battery storage) could reduce emissions by 5.2 MMTCO₂e by 2050.

¹ The survey received responses from 1,300 people in the region.

² IEA, 2024. Available at: <https://www.iea.org/data-and-statistics/charts/co2-total-emissions-per-capita-by-region-2000-2023>.



- **Waste:** Diversion and composting measures could eliminate 7.9 MMTCO₂e by 2050.
- **Natural & Working Lands:** Tree canopy expansion, urban sprawl reduction, and green space conservation could sequester 7.0 MMTCO₂e by 2050.
- **Agriculture:** Climate-smart practices and small-scale farming could reduce emissions by 1.3 MMTCO₂e by 2050.

Understanding Workforce and Economic Opportunities

The adoption of new technologies and other changes presented in this plan creates significant potential for job creation and growth. The plan identifies 49 relevant occupations for the suite of GHG reduction measures, with targeted training needs in solar installation; EV infrastructure; heating, ventilation, and air conditioning; sustainable construction; and agriculture. Workforce development strategies analyzed by the BREATHE Team and supplemented by research at the state level from the Tennessee Department of Environment and Conservation and the University of Tennessee Baker School of Public Policy and Public Affairs will help promote equitable access to emerging opportunities.

Recognizing Co-Benefits Beyond GHG Emission Reductions

Climate action will deliver wide-ranging benefits beyond GHG reductions, across all members of the community. Many of these benefits were recognized by BREATHE's Working Group members and survey respondents alike and can be realized equitably with advanced planning and focus. The co-benefits assessed in this plan include the following:

- **Health:** Reduced heat-related illness, increased active transit options, and improved food accessibility
- **Affordability:** Lower utility bills, transportation costs, and healthcare expenses
- **Mobility:** Expanded safe and reliable transit and active transportation options
- **Resilience:** Infrastructure and energy systems that are better prepared for extreme weather
- **Economic Growth:** Tourism, local business development, and job creation
- **Air Quality:** Cleaner air and improved quality of life through reduced emissions from vehicles and energy generation

Roadmapping Implementation

While the plan's targets are non-binding, they are achievable with sustained commitment to implement the measures outlined within it. Implementation will need to be conducted over time through actions aligned with the following phases:



Explore, Build, and Scale. The implementation actions aligned to each GHG reduction measure within the plan provide concrete approaches for next steps but are designed to offer flexibility, recognizing that stakeholders, technologies, costs, funding, and resources will change over time. Funding to support plan implementation may include federal, state, utility, and local sources, as well as public-private partnerships.

Moving Forward Collectively

The BREATHE Plan is a roadmap for how to collectively act across the region to advance climate action in an equitable and sustained manner. Success depends on action from governments, businesses, nonprofits, and residents. Whether by weatherizing buildings, riding public transit, planting trees, or supporting local farms, every action counts. Together, we can build a Knoxville region that breathes easier, lives healthier, and thrives for generations to come.



Statement from the Mayors

Fellow East Tennesseans,

Climate change is one of the defining challenges of our time, and the Knoxville region is rising to meet it with determination, innovation, and heart. Extreme heat, flooding, and extreme weather events are becoming more frequent and intense. We have seen firsthand how these disruptions ripple across our communities. These events are not isolated but rather are part of a larger story unfolding across our region.

BREATHE: A Climate Action Plan for the Knoxville Region is our roadmap for a more sustainable future, shaped by the voices of our communities from across the nine counties that make up our shared region. This plan outlines actionable strategies to help reduce emissions across all sectors of our vibrant, growing economy. The plan reflects our continued commitment to climate action and our shared priorities for a better future in the region.

Climate action is not just about goals and policy. It's about people. It's about creating good-paying jobs, improving air quality, and ensuring that everyone benefits from a cleaner and more livable climate.

The actions we take today will shape the communities that future generations will live in, and we have a responsibility to protect their future. The BREATHE Plan gives us the insight and structure we need to build a more sustainable Knoxville region, and we look forward to working with all of you to see this plan succeed.

Sincerely,

Indya Kincannon

Mayor, City of Knoxville

Tanya Martin

Mayor, City of Alcoa

Andy White

Mayor, City of Maryville





INTRODUCTION: CLIMATE IN THE REGION

The Knoxville region sits at an intersection of rapid population and economic growth and a changing climate. If current growth trends continue, the nine-county region (Figure 1) will increase from approximately 932,000 to 1,000,000 residents by 2028.³ Amid this growth, the region feels the acute effects of a changing climate as weather events become more frequent and severe. In recent years, East Tennessee has experienced more extreme and frequent hazards, including storms, heat waves, and droughts. For example, Knox County experienced 55 extreme heat days in 2022—more than double the number of days in the 1970s; flooding continues to pose a threat across the region, with an estimated \$5 million in annual losses due to damage.⁴

However, the region's climate story is deeper than the recent trends. The region has a significant history of climate action and innovation, even long before these developments.

Since the Tennessee Valley Authority (TVA) was founded in 1933 and later headquartered in Knoxville, it has addressed flood risk to the watershed while leveraging renewable hydroelectric power. Each year, its system of dams prevents about \$309 million in flood damage in the region from the Ohio and Mississippi rivers, to date totaling more than \$9.7 billion in savings from prevented flood losses.⁵ Today, TVA's modeling and reservoir management tools help forecast and prepare for extreme rain events, such as during 2020, when a historic 70 total inches of rain fell and an estimated \$1 billion in flood damages were averted

Figure 1. The Knoxville Region (Metropolitan Statistical Area)



³ Knoxville-Knox County Planning, 2023. "What Metropolitan Area Changes Mean for Knoxville and Region." Available at: <http://knoxplanning.org/news/2023/0817/806/what-metropolitan-area-changes-mean-for-knoxville-and-region>.

⁴ Federal Emergency Management Agency, 2025. "National Risk Index for Natural Hazards." Available at: <https://www.fema.gov/national-risk-index>; Knoxville-Knox County Community Action Committee, 2023. "Community Needs Assessment." Available at: <https://www.knoxcac.org/wp-content/uploads/CAC-Needs-Assessment-2023-FINAL-web-compressed.pdf>.

⁵ TVA, 2025. "Flood Damage Reduction." Available at: <https://www.tva.com/environment/managing-the-river/flood-management>.



and electric power service continued uninterrupted.⁶ Additionally, the majority of TVA's current dams produce hydroelectric energy, generating about 10% of the region's energy and lowering the emissions impact of TVA customers.

The region has long been at the forefront of nuclear innovation and development—from the development of nuclear technologies by the U.S. Department of Energy's Oak Ridge National Laboratory (ORNL) in the 1940s to the Tennessee Valley Authority receiving the nation's first early site permit for small modular reactors at their Clinch River Site in Oak Ridge. In addition, the U.S. Department of Energy's (DOE) Oak Ridge Office of Environmental Management has led the nation in the remediation and reindustrialization of federal land where many of the region's advanced nuclear industries are locating. ORNL's technological innovation and local workforce impact positions the region to serve as a potential leader in clean energy solutions.

So while rapid population growth, expanding economic activity, and intensifying climate pressures present real challenges, they also create opportunities that this plan recognizes and attempts to harness. The region can build on its legacy—stormwater infrastructure, hydroelectric and nuclear energy, and community networks and institutions—to scale lasting solutions which benefit nine counties that are poised to innovate and address these challenges head on. The region will rely on its unique resources, including community members dedicated to uplifting the region, a rich network of local nonprofits, and national research leaders.

The BREATHE Plan Development

This BREATHE Plan is the second planning deliverable funded by the U.S. Environmental Protection Agency (EPA) two-stage Climate Pollution Reduction Grant (CPRG) Program. The City of Knoxville, representing the Knoxville Metropolitan Statistical Area (MSA), submitted the first deliverable, the [Priority Climate Action Plan \(PCAP\)](#), to the EPA in 2024. Led by the City of Knoxville's Office of Sustainability and the Knoxville Regional Transportation Planning Organization (TPO), public outreach and stakeholder engagement have shaped the BREATHE Plan through two years of listening and collaboration with local communities. The BREATHE Plan leverages data-driven science, reflects regional priorities, acknowledges local constraints, and charts a path toward a more proactive and resilient future.

⁶ Everett, J., 2022. "A Look Back: How the Tennessee Valley Authority Managed Historic Rainfall in 2020." Available at: <https://www.hydro.org/powerhouse/article/a-look-back-how-the-tennessee-valley-authority-managed-historic-rainfall-in-2020/>.



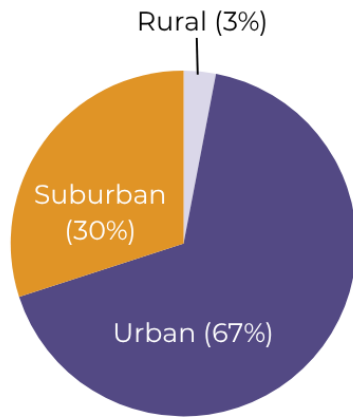
Climate Perspectives in the Knoxville Region

The BREATHE Team conducted a randomized, region-wide survey in fall 2024 to learn more about what community members were thinking and feeling about the effects of climate change and actions they could take to address it. Survey highlights are summarized in the BREATHE Plan; for the full results, see the BREATHE [website](#).

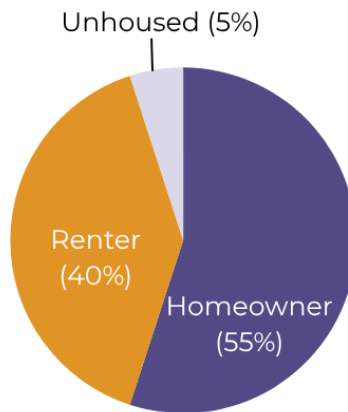
While the survey results demonstrated that many community members are committed to change in their own homes and neighborhoods, their ability to act is limited in certain situations. In response, creative solutions for making these options a reality for everyone are explored within this BREATHE Plan. While the BREATHE survey focused on individual actions, comprehensive climate solutions are only within reach when government, community groups, energy providers, and businesses work toward solutions together with the public.

What are Knoxville region residents saying about the area's changing climate?

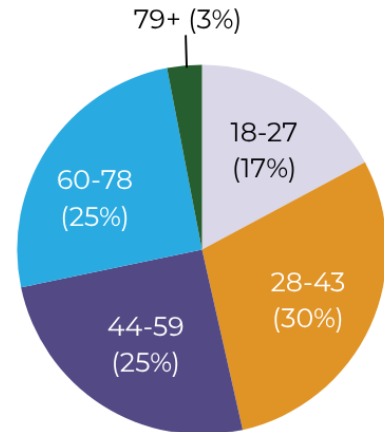
Of the **1,300 community members** who took the BREATHE Survey...



Community Type



Residence



Age

The Knoxville region supports climate action

77% of respondents care about **climate change issues**.

68% of respondents said **planting trees** is very beneficial for their community.

64% of respondents reported wanting to **take action**.

64% of respondents are already trying to **reduce energy consumption** at home.

Key barriers to taking climate action

54% of respondents said a lack of affordability is a key barrier in addressing climate change.

71% of respondents said addressing climate change is outside of their personal control.

79% of respondents agree that **government should do more to address climate change**.



How a Changing Climate Affects the Knoxville Region

Working Group members and survey respondents voiced concerns about issues directly tied to climate change: public health, job availability, access to food, weather extremes, and cost of living. Climate change exacerbates each of these issues, making climate action essential for improving the quality of life across the region. Identifying and prioritizing actions require an understanding of how climate change effects unfold in practice.

Climate change effects occur when climate hazards such as record-breaking heat, flooding, severe storms, or drought interact with the environment. The actions proposed in this plan respond to both the direct and indirect effects of climate change (see Table 1).

Direct climate change effects are the immediate, physical effects of changing temperature and precipitation patterns. Generally, indirect effects are the cascading effects that result from direct effects, and they can produce either net negative or positive effects on key social and economic systems. For example, while climate change may not directly cause high living costs, it can indirectly do so over time through rising energy bills and food prices. While direct effects are localized, indirect effects ripple across systems, affecting more than those directly in the line of a flood, storm, or heat wave.

Table 1. Direct versus Indirect Effects

Direct Effects	Indirect Effects
Direct effects are immediate and physical effects, such as the following:	Indirect effects are ripple effects that result from the direct effects, such as the following:
● Heat waves causing heatstroke or death ● Flood damaging homes and roads ● Droughts reducing crop yields ● Wildfires destroying forests ● Increased atmospheric CO₂ levels accelerating crop growth through CO₂ fertilization	● Worsening of chronic conditions such as heart disease and asthma due to prolonged extreme heat ● Economic losses from disrupted industries or supply chains ● Food insecurity due to decreased crop yields ● Respiratory and other health challenges from air pollution

Community members in Knoxville are already experiencing the direct and indirect effects of climate change: 76% of survey respondents stated that they have



personally witnessed climate change effects in the region, 63% of respondents witnessed extreme heat firsthand and 49% experienced flooding; 35% stated that a member of their household has been negatively affected by climate change. When asked about climate change impacts, **individuals said that they are most concerned about extreme heat (50%), more severe storms (49%), and poor air quality (45%).**



Climate science and local plans, such as the multi-jurisdictional [2025 Knox County Hazard Mitigation Plan](#), support the validity of the three key climate concerns below and outline reasons why actions should be taken to avoid the impacts. The BREATHE Plan focuses on stopping these effects from occurring at the source by reducing the emission of air pollutants and greenhouse gases (GHGs).

Flooding

Average annual precipitation by 2050:

50 inches*

from an average of 48 inches per year between 1961 and 1990

Increasing hazards: landslides, infrastructure damages, power outages, mold production, and exposure to waterborne diseases

Vulnerable populations: low-income populations, living in older homes and/or in floodplains, lack of access to safe drinking water, or people with respiratory illnesses

Extreme Heat

days per year of extreme heat by 2050:

25 days over 95°F*

Increasing hazards: heat exhaustion, heat stroke, trouble sleeping, mental health episodes, AC and power outages, and crop failures and other plant death

Vulnerable populations: low-income populations, older adults, young children, people living in urban heat islands, people with cardiovascular illnesses, outdoor workers, or people lacking access to AC

Air Quality

If the Knoxville region does not implement the measures in this plan, cars and trucks will contribute 25.2 MT of nitrous oxide (NO_x), 0.9 MT of particulate matter (PM_{2.5}), and 0.6 MT of sulfur dioxide (SO₂) by 2035.

Increasing hazards: respiratory illness, various cancers, decrease in days safe for outdoor activities and labor, mental health concerns

Vulnerable populations: living or working close to highways, low-income populations, older adults, young children, people with respiratory illnesses, outdoor workers, and career drivers

*Projections for temperature and precipitation are from the U.S. Climate Explorer, accessed Oct 2025.



The Knoxville Region's GHG Emissions

Understanding current sources and sinks of GHG emissions, as well as analyzing past and future trends, is imperative before planning effective action to slow climate change and reduce the worst of its effects. As a result, the BREATHE Team completed two key analyses at the start of this planning process: (1) a comprehensive GHG inventory identifying current emission sources and sinks, and (2) a business-as-usual (BAU) projection demonstrating how emissions might evolve if the Knoxville region continues with only current and already planned actions.

2022 GHG Inventory

The region's GHG inventory shows the sources and scale of emissions across different sectors (see Table 2), providing crucial data to help prioritize climate actions and allocate resources effectively. The inventory uses 2022 data as that is the most recent year available. Technical information about how the GHG inventory was developed is available in Appendix B.

Table 2. Emission Sources and Sinks by Sector

Sector	Emission Sources
Buildings	Use of electricity and natural gas in residential, commercial, and industrial buildings for heating, cooling, appliances, and lighting
Transportation	Use of fuel in on-road vehicles (e.g., gasoline and diesel-powered cars, trucks, and buses), off-road forms of transportation (e.g., trains and planes), and equipment (e.g., construction machinery and landscaping tools)
Energy*	Generation of electricity using fossil fuels
Solid Waste and Wastewater	Chemical breakdown of organic material, such as solid waste in landfills and wastewater processed in treatment plants
Industrial Processes and Products*	Use of energy** in industrial processes (e.g., cement manufacturing, iron and steel production) and the use of certain chemical products (e.g., refrigerants, semiconductors)
Land Use and Forestry	Soil disruption and tree removal
Agriculture	Livestock digestion and waste and soil management processes (e.g., fertilization and tilling)
Sector	Emission Sinks
Land Use and Forestry	Trees, plants, and soil absorb CO ₂
Agriculture	Regenerative techniques, such as agroforestry and cover cropping

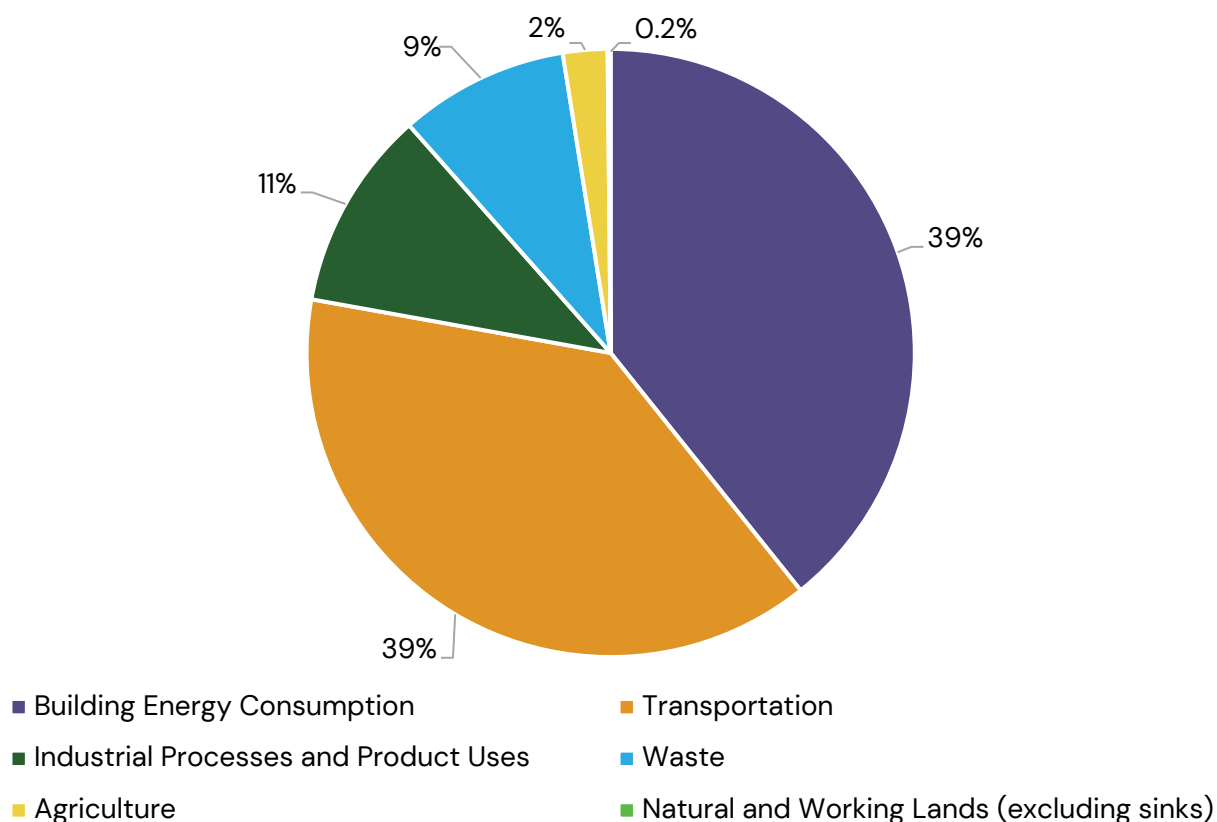
**Note: To avoid double counting emissions from building electricity consumption and emissions from electricity generation, emissions from electricity generation in the Energy sector are only provided for informational purposes and are not included in GHG inventory totals.*

***Note: Energy used by industry is captured in the Buildings sector.*



In 2022, the region's gross emissions, or the total emissions excluding sinks, were 15.8 million metric tons of carbon dioxide equivalent (MMTCO₂e). When accounting for emissions sequestered by carbon sinks in the region, net emissions were 11.6 MMTCO₂e in 2022, which is equivalent to the emissions produced from driving 2.7 million gasoline-powered passenger vehicles for year.⁷ On a per capita basis, the region emitted 12.4 metric tons of CO₂e per person—lower than the U.S. average of 13.9 metric tons of carbon dioxide equivalent (MTCO₂e) per person.

Figure 2. Knoxville MSA 2022 Gross GHG Emissions Inventory



The 2022 GHG inventory accounts for emissions across major sectors, identifying where targeted climate actions might yield the greatest benefits (Figure 2). Key trends include the following:

⁷ EPA, 2024. "Greenhouse Gas Equivalencies Calculator." Available at: <https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator#results>; EDGAR, 2023. "Emissions Database for Global Atmospheric Research." Available at: https://edgar.jrc.ec.europa.eu/report_2023.



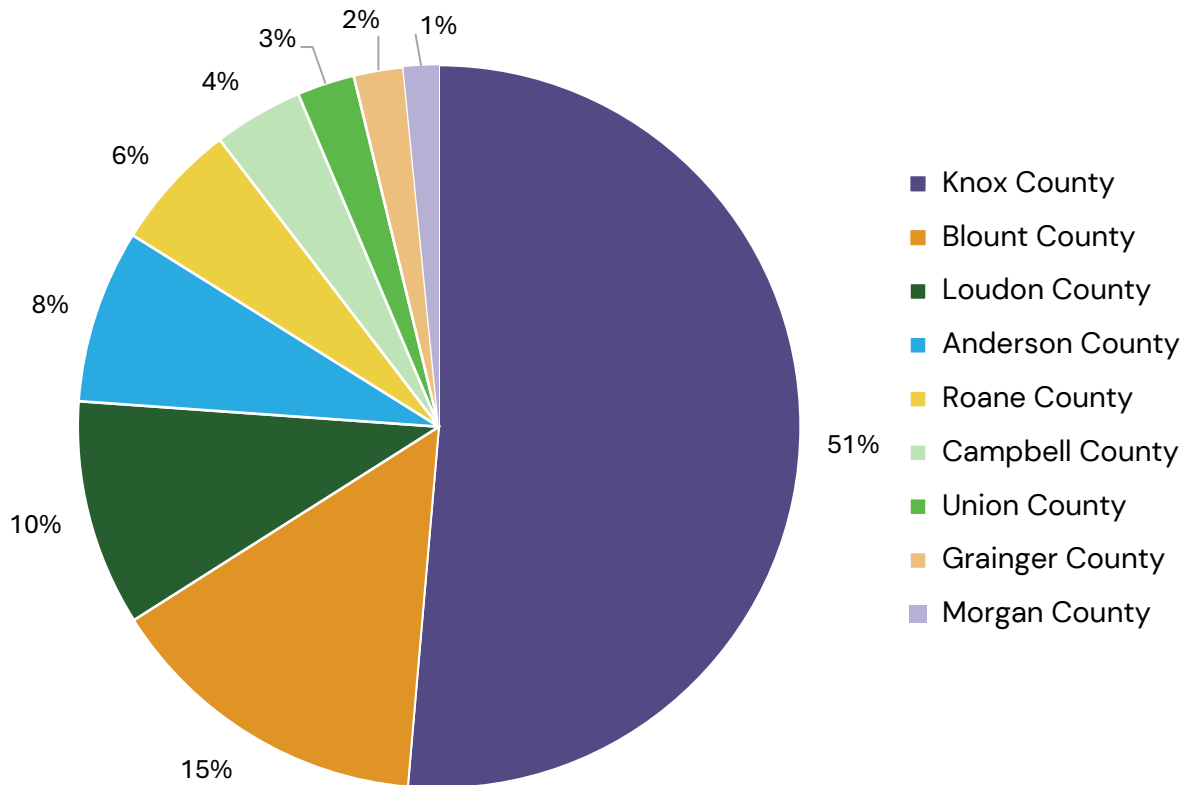
- The Buildings sector accounted for about 39% of emissions (6.2 MMTCO₂e) with about 64% of these emissions resulting from electricity consumption.⁸ Remaining emissions were a result of on-site combustion of fuels, such as natural gas, and the associated upstream fugitive methane emissions from fuel extraction and distribution. Emissions from residential buildings, commercial buildings, industrial buildings, and fugitive emissions made up 49%, 19%, 32%, and 0.1% of sector emissions, respectively.
- The Transportation sector also accounted for 39% of emissions (6.1 MMTCO₂e), with on-road vehicles accounting for 93% of emissions, and remaining emissions resulting from off-road activities, such as rail, aviation, and construction equipment.
- The Waste sector was 9% of GHG emissions (1.4 MMTCO₂e) in 2022, with 83% coming from solid waste and the remainder coming from wastewater treatment.
- Industrial processes and products resulted in 11% of regional GHG emissions (1.7 MMTCO₂e), mostly from refrigerant use, cement manufacturing, and iron and steel production.
- The Agriculture sector accounted for 2.4% of emissions (0.4 MMTCO₂e), with 88% resulting from livestock production and the remaining 12% from agricultural soil management, liming, urea, and field burning of agricultural residues.
- The Natural & Working Lands sector sequestered a net 4.1 MMTCO₂e of emissions through forests, urban trees, landfilled yard trimmings, and food scraps. Emissions from this sector included emissions from forest fires, N₂O from settlement soils, and agricultural soil carbon flux.

Figure 3 presents the GHG emissions inventory by geographic distribution across the nine-county region. Looking at the inventory in this way can indicate which counties may have increased opportunities for reductions. On a per capita basis, the counties with the highest emissions (excluding sinks) were Loudon, Union, Blount, and Knox, largely due to the presence of manufacturing facilities, airports, landfills, and wastewater treatment facilities.

⁸ Emissions from energy generation (i.e., the power sector) were estimated for informational purposes but are not included in inventory totals to avoid double counting. Emissions from the Power sector for electricity generation in the region were 5.2 MMTCO₂e in 2022.



Figure 3. Knoxville MSA 2022 Gross Emissions by County



2022 GHG Inventory County-Level Insights

- Knox County accounts for more than 50% of the region's emissions in the Transportation, Buildings, Industry, and Waste sectors.
- Morgan, Grainger, and Union Counties each emit less than 0.5 MMTCO₂e.
- Knox, Blount, Campbell, and Morgan Counties each sequester about 0.6 MMTCO₂e through natural and working lands.
- Loudon County has the highest per capita emissions in the region, despite only accounting for 10% of emissions overall. Knox County has the highest emissions for four out of six sectors but also sequesters more emissions than any other county in the region.
- Although accounting for only 2.5% of emissions, Union County generates 9% of agricultural emissions.
- Campbell and Morgan County both achieved net-zero emissions as their natural and working lands sequestered more carbon than the counties produced.



BAU Scenario (Future GHG Emissions Trends)

Business-as-usual projections help analyze future trends in GHG emissions without additional climate actions by considering factors such as population growth, market influences, and future energy needs. This scenario creates a benchmark for long-term planning and goal setting by identifying the largest potential sources of future emissions and sinks, helping guide decision makers toward the most impactful near- and long-term climate actions.

In the Knoxville region's BAU scenario (Figure 4, Table 3, and Table 4), gross and net emissions for the region are expected to decline by 27% and 36%, respectively, between 2022 and 2050, despite steady population growth and development. Emissions are projected to decline at a steady pace through 2035, followed by a slower rate of decline through 2050. This reflects the projected trend in the regional electric grid as utilities "clean the grid" with low- or no-emitting energy sources (e.g., nuclear, renewables) coming online. This decreasing trend in the emissions associated with each kilowatt-hour of electricity use will lower emissions associated with energy use in the Buildings and Transportation sectors, as long as energy use is also managed.



Figure 4. Knoxville MSA BAU Projections by Emissions Source (MMTCO₂e)

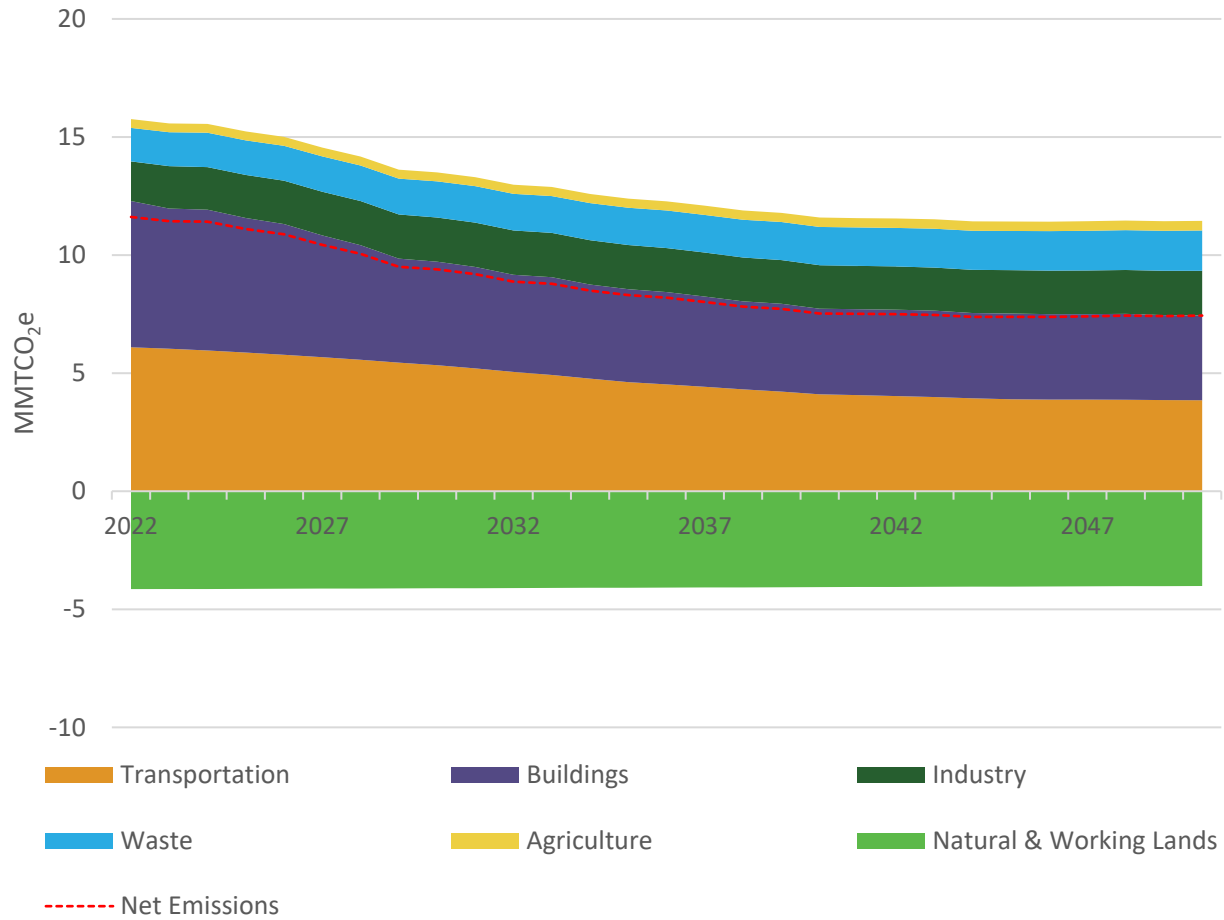


Table 3. Knoxville MSA Net GHG Emissions Inventory and BAU Projections (MTCO₂e)

Net Emissions by Sector	2022 Inventory	2035 BAU	2040 BAU	2050 BAU
Transportation	6,081,866	4,615,327	4,104,882	3,851,483
Buildings	6,190,196	3,933,839	3,625,122	3,588,247
Industry*	1,677,872	1,869,946	1,842,318	1,897,637
Waste	1,419,745	1,578,862	1,619,951	1,703,416
Agriculture	373,345	387,045	393,171	406,484
Natural & Working Lands	(4,144,875)	(4,085,963)	(4,061,814)	(4,013,517)
TOTAL	11,598,148	8,299,056	7,523,629	7,433,751

*Represents product use and processing emissions.

Note: Totals may not sum due to independent rounding.



Table 4. Knoxville Region Emissions Projection by County (MTCO₂e)

Net Emissions by County	2022 Inventory	2035 BAU	2040 BAU	2050 BAU
Knox County	7,405,490	5,582,736	5,171,770	5,144,487
Blount County	1,663,799	1,264,172	1,181,235	1,209,963
Loudon County	1,406,575	1,213,484	1,154,238	1,135,782
Anderson County	797,211	463,199	382,138	351,705
Roane County	492,027	288,592	239,518	231,698
Union County	165,618	133,673	123,357	124,822
Grainger County	87,528	10,084	(9,838)	(17,673)
Campbell County	(2,359)	(176,386)	(223,426)	(246,409)
Morgan County	(417,740)	(480,498)	(495,363)	(500,624)
TOTAL	11,598,148	8,299,056	7,523,629	7,433,751

Note: Totals may not sum due to independent rounding.

Key trends from the 2050 BAU scenario include the following:

- Building emissions are expected to fall 42% from 2022 to 2050 due to cleaner electricity supply and increased efficiency. Emissions from residential and commercial building fuel consumption are projected to decrease by 12% and 1%, respectively, and electricity emissions are projected to decrease by 65% across all building types.
- Transportation emissions are projected to fall 37% from 2022 to 2050 due to the large-scale adoption of electric vehicles (EVs).
- Agricultural emissions are projected to increase slightly (by 9% from 2022 to 2050) following growth in the livestock population.
- Industrial process emissions are projected to increase overall, reflecting growth in manufacturing. However, emissions from product use are projected to decline as refrigerants are phased out.
- Waste emissions are projected to increase 20% between 2022 and 2050, reflecting population growth.
- Sequestration (i.e., emissions sinks) from Natural & Working Lands is expected to decrease slightly over time with increased development.

These trends highlight an opportunity for focused climate action across all sectors, with an emphasis on Buildings and Transportation, which will continue to make up the greatest share of emissions through 2050. The baseline BAU scenario will not be enough to meet the region's climate goals. Rising emissions in the Industry, Waste, and Agriculture sectors underscore the need for deeper action to reach climate goals and achieve a more resilient and equitable future. Additionally, taking action across all sectors is critical to achieving additional co-benefits.



REGIONAL GOALS

While the BAU projections presented in Chapter 1 show a downward trend in future emissions, research has overwhelmingly shown that significantly more reductions are needed to slow the pace of climate change and provide beneficial outcomes for health, affordability, energy resilience, and sustainable growth.⁹ This BREATHE Plan presents GHG reduction targets of 40% by 2035 and 75% by 2050, relative to 2022 emissions. These non-binding targets are based on the emission reduction potentials from the 19 measures outlined in this plan and incorporate other existing GHG targets in the region.

The BREATHE Plan sets forth GHG reduction targets of

40% by 2035 and 75% by 2050

relative to 2022 emissions.

Existing GHG Targets in the Region

Although the BREATHE Plan's targets are the first to cover the entire Knoxville region, they were informed by existing targets set by key public and private leaders across the region. A few examples are described below.

City of Knoxville

The City of Knoxville set its first climate goals in 2008, aiming to reduce GHG emissions 20% by 2020 relative to 2005 levels for both municipal operations and the broader community. Having met its 2020 goals early, the City Council unanimously adopted two new goals in 2019 to align with U.S. Climate Mayors: a 50% reduction in municipal emissions by 2030 and an 80% reduction in community emissions by 2050, both relative to 2005 levels.

The city's Office of Sustainability calculates emission inventories regularly. In 2019, the city measured an 8% increase in community-wide emissions relative to 2005 estimates, largely due to a growing population, increasing vehicle traffic, and commercial/industrial activity. In 2024, the city calculated a 45% reduction from municipal operations relative to 2005 estimates, ahead of schedule for the 2030 goal. The city also helped Knoxville Area Transit (KAT), the primary operator of public transportation within Knoxville, publish a 2023 Decarbonization Plan that established a goal of 40% reduction by 2040 and net-zero by 2050 (both relative to 2015). KAT's Decarbonization Plan aims to replace all internal combustion transit buses and paratransit vehicles with EVs by 2050 and electrify all non-revenue vehicles by 2030.

⁹ United Nations, 2016. "Sustainable Development Goals." Available at: <https://www.un.org/sustainabledevelopment/climate-change/>.



These efforts can help the city achieve its 50% reduction in municipal emissions by 2030.

Tennessee Department of Transportation

The Tennessee Department of Transportation (TDOT) Carbon Reduction Strategy aligns with the U.S. National Blueprint for Transportation Decarbonization¹⁰— setting a goal to achieve net-zero emissions by 2050.¹¹ TDOT's Carbon Reduction Strategy prioritizes active transportation, alternative fuels, and green construction.¹²

Tennessee Valley Authority

In 2023, TVA partnered with the University of Tennessee Baker School of Public Policy and Public Affairs to co-lead development of the Valley Pathways Study, which charts strategies for wide-ranging economic sectors across the valley to reach net-zero by 2050. TVA achieved a 49% reduction in carbon emissions intensity from a 2005 level in calendar year 2024, making TVA's emissions intensity of electricity delivered 24% lower than the regional average.

University of Tennessee, Knoxville

The University of Tennessee, Knoxville (UTK) set a goal in 2011 to achieve carbon neutrality by 2061 (from 2007–2008 levels). To help achieve this, UTK has also set a goal to reduce campus energy consumption to ~1992–1993 levels by 2030, and another target of 50% waste diversion by 2030. These targets set an example for the region and influence other government agencies and the private sector. In addition, the UTK Baker School of Public Policy and Public Affairs co-led the Valley Pathways Study 2023–2025 to determine what actions are needed to reach net-zero emissions across the Tennessee Valley Region.

Private Sector

Several of the region's businesses and major employers have set climate or sustainability goals and are already demonstrating meaningful progress through action.

DENSO, a global automotive supplier with more than 4,000 employees in Maryville and more than 1,500 in Athens, has a target of carbon neutrality by 2035. DENSO is partnering with TVA, Silicon Ranch, and the City of Maryville to build three solar facilities in Blount County, with the group launching their first on DENSO's Maryville

¹⁰ DOE, DOT, HUD, and EPA, 2023. "The U.S. National Blueprint for Transportation Decarbonization." Available at: https://eelp.law.harvard.edu/wp-content/uploads/2025/01/the-us-national-blueprint-for-transportation-decarbonization-compressed_1.pdf.

¹¹ TDOT. "Carbon Reduction Program." Available at: <https://www.tn.gov/tdot/long-range-planning-home/air-quality-planning/carbon-reduction-program.html>.

¹² TDOT, 2023. "TDOT Carbon Reduction Strategy." Available at: https://www.tn.gov/content/dam/tn/tdot/long-range-planning/air-quality/carbon-reduction/TDOT%20Carbon%20Reduction%20Strategy%20Final_02.20.24.pdf.



campus in August 2025. DENSO will leverage a portion of the electricity generated at the on-site solar facility to help power their local operations, and the remainder will flow into the local grid. DENSO also pursues other sustainability initiatives across East Tennessee, ranging from supporting community green spaces, improving the sustainability of its operations, and offering EV charging for employees.¹³

As one of the leading builders of manufactured and modular homes in the country, Clayton Homes has focused on advancing sustainability while maintaining affordability. Clayton's headquarters in Maryville is certified Silver by the Leadership in Energy and Environmental Design (LEED) and 1.94 megawatts of solar power are installed across their facility portfolio. All 56 of their buildings and supply facilities have achieved International Organization for Standardization (ISO) 14001 certification for resource efficiency, diverting 123 million pounds of waste from landfills in 2024. Their partnership with the Arbor Day Foundation has supported the planting of more than 5 million native trees, contributing to both reforestation and carbon capture. For customers, Clayton Homes offers long-term energy savings through ENERGY STAR® certification (20% more energy efficient than traditional homes) and even solar-compatible Zero Energy Ready Home standards that can reduce energy use by 50% to 100%.¹⁴

¹³ DENSO, n.d. "DENSO's SDGs." Available at: <https://www.denso.com/global/en/about-us/sustainability/sdgs/>.

¹⁴ Clayton Homes, n.d. "Clayton Homes Sustainability." Available at: <https://www.claytonhomes.com/sustainability>.



BUILDING ON EXISTING CLIMATE ACTION

Local governments, companies, and community organizations in the Knoxville region have spent years developing policies and programs that lay the foundation for future climate action. The BREATHE Plan builds on these existing efforts.

City of Knoxville

The City of Knoxville has led and participated in several voluntary energy and climate initiatives over the past two decades. Examples include the Climate Mayors and Global Covenant of Mayors; DOE's Better Buildings Challenge, Better Climate Challenge, and Low-Carbon Pilot; DOE's Solar America Cities; TVA's Smart Communities Extreme Energy Makeover; and IBM's Smarter Cities Challenge. These city initiatives offer a model for the broader region.

In 2020, Knoxville Mayor Indya Kincannon convened more than 65 community leaders and experts to identify priority strategies to meet the city's community-wide emissions reduction goals. The priorities of the Mayor's Climate Council shaped the 2021 Energy & Sustainability Work Plan and laid the groundwork for the measures and actions in this BREATHE Plan. The City of Knoxville was the lead grant recipient for the CPRG planning grant that funded the development of the PCAP and the BREATHE Plan (the CCAP).

The BREATHE Working Group and Regional Partnerships

To develop the BREATHE Plan, the City of Knoxville and TPO collaborated with leaders across the region to build a roadmap that aims to provide equitable benefits across the community. The BREATHE Plan leveraged the recent development of the PCAP in 2024 as a starting point for creating the BREATHE Working Group.

Through the BREATHE Working Group, more than 100 individuals from 56 organizations participated in 6 rounds of sessions from 2024 to 2025 to shape the plan's goals, measures, and actions, emphasizing equitable outcomes and workforce and business development. BREATHE Working Group members represented a diverse set of communities, organizations, businesses, and government agencies from across the nine counties covered in this plan. They identified local challenges and developed achievable steps to address them. Many already lead climate actions and will likely serve as early adopters and promoters of the plan's vision.



BREATHE Working Group Organizations

- AIA East Tennessee
- Algaeo
- Alliance for Community Transformation
- Ameresco
- Appalachian Renewable Resources
- Appalachian Voices / Energy Democracy TN
- BarberMcMurry Architects
- Bike Walk Knoxville
- Bridge Refugee Services
- Centro Hispano de East Tennessee
- City of Alcoa
- City of Knoxville
- City of Maryville
- City of Oak Ridge
- Clayton Homes
- East Tennessee Clean Fuels Coalition / Drive Electric TN
- East Tennessee Development District
- East Tennessee REALTORS®
- Energy Home Basic
- Great Smoky Mountains Institute at Tremont
- Housing Systems Advisory Council
- Keep Knoxville Beautiful
- Knox Climate Watch
- Knox County Air Pollution Control Board
- Knox County Schools
- Knoxville Chamber of Commerce
- Knoxville Electric Vehicle Association (KEVA)
- Knoxville Utilities Board (KUB)
- Knoxville-Knox County Community Action Committee (CAC)
- Knoxville-Knox County Food Policy Council
- Labor at the Table
- Maryville College
- McCarty Holsaple McCarty Architects, Inc.
- Metropolitan Knoxville Airport Authority – Board of Commissioners
- Microbial Insights
- Museum of Infinite Outcomes
- Oak Ridge National Laboratory (ORNL) Rooted East
- Sanders Pace Architecture
- Sierra Club – Harvey Broome Group
- Socially Equal Energy Efficient Development (SEED)
- Solar Alliance
- SOULar Equity Project
- Southern Alliance for Clean Energy (SACE)
- Tennessee Advanced Energy Business Council
- Tennessee Composting Council
- Tennessee Interfaith Power and Light (TIPL)
- Tennessee Solar Energy Industries Association (TenneSEIA)
- The Bredesen Center
- Trees Knoxville
- Union of Concerned Scientists
- United Way of Anderson County
- United Way of Greater Knoxville
- University of Tennessee
- Women With Vision



Foundations for Regional Climate Action

The plans and programs below are examples of existing regional efforts to reduce GHG emissions in the Buildings, Energy, Transportation, Waste, Natural & Working Lands, and Agriculture sectors.

Buildings and Energy

- The [Valley Pathways Study](#), developed by the University of Tennessee Baker School of Public Policy and Public Affairs and TVA, outlines a plan to reduce emissions across the valley's economic sectors while fostering a sustainable economy. It sets bold, achievable emissions reduction targets (see Chapter 2) and highlights opportunities for the region to pursue decarbonization strategies benefiting both the climate and the economy.
- TVA's [EnergyRight](#) program provides incentives to business and industry entities and support for energy efficiency upgrades while its [Home Energy Workshop](#) teaches residents how to identify and reduce their home energy costs through "do it yourself" energy-saving techniques and home efficiency improvements.
- [TVA's Home Uplift](#), local power company programs (such as [Knoxville Utilities Board \[KUB\] Round It Up](#)), and other agencies (such as [Knox CAC's Housing & Energy Services program](#) and the [East Tennessee Human Resource Agency](#)) provide weatherization assistance.
- TVA's [Demand Response](#) program provides energy credits or payments to participants who voluntarily reduce loads during peak demand.
- TVA provides various renewable energy initiatives, including [Green Flex](#), [Green Switch](#), and [Green Invest](#). Green Flex allows businesses with high energy consumption to purchase renewable energy certificates (RECs), helping them meet sustainability goals at a lower cost. Green Swift allows both businesses and homeowners to switch to solar-powered energy usage. Green Invest supports renewable energy installations for businesses. TVA also hosts the [Dispersed Power Production Program](#) to allow companies or residents to sell all or excess generation of renewable energy back to TVA.
- The [Southern Alliance for Clean Energy \(SACE\)](#), headquartered in Knoxville, advocates for policies that promote clean energy to ensure clean, safe, and healthy communities throughout the Southeast. SACE develops public resources, such as reports that track utility performance and clean energy trends across the Southeast; hosts educational events, such as webinars on



incorporating clean energy into your home; and more to promote clean energy adoption.

- [KUB Community Solar](#), launched in partnership with TVA and the City of Knoxville, is a shared solar program that expands access to renewable energy. Customers can subscribe to a portion of a 1-megawatt solar array without installing panels at home and receive monthly bill credits based on the energy produced. This initiative helps reduce carbon footprints through locally generated solar energy.

Transportation

- Knoxville Regional TPO developed [Mobility Plan 2050](#), the region's long-range transportation plan (LRTP) that guides the selection and implementation of transportation projects, particularly those that support the regional goals of sustainability, resilience, and environmental and human health. The plan assessed transportation needs as the region grows, identifying opportunities to enhance efficiency, coordinate construction activities, and improve infrastructure (e.g., roadways, sidewalks, bicycle lanes). Developed with input from residents, local leaders, and other stakeholders, LRTP identifies short- and long-range actions for an integrated, intermodal, efficient, and resilient transportation system in the Knoxville region.
- Knoxville Regional TPO has allocated federal funding for transportation projects that improve air quality and lower emissions, such as helping to fund the purchase of electric buses and charging infrastructure, greenways, and Advanced Traffic Management Systems that monitor, control, and manage traffic flow in real-time to improve safety, efficiency, and reliability on roads. TPO's [Smart Trips](#) program encourages alternatives to driving alone (e.g., biking, walking, carpooling, public transit) by offering commuter incentives such as rewards.
- KAT introduced 12 all-electric buses in 2021 and added 8 more in 2025. They published a [decarbonization plan](#) in 2023, setting a goal of net-zero emissions by 2050.^{15,16}
- [East Tennessee Clean Fuels](#) and [Drive Electric Tennessee](#) administer the [Tennessee Green Fleets Certification Program](#) to recognize alternative fuel fleets. Their [Ride and Drive EV Events](#) promote EV adoption and provide opportunities to learn about the benefits of EVs.

¹⁵ KAT, n.d. "New All-Electric Bus." Available at: <https://katbus.com/schedules-maps/new-all-electric-bus/>.

¹⁶ TVA. 2022. "Washington County Schools: Tennessee's First Electric School Bus." Available at: https://tva-azr-eastus-cdn-ep-tvawcm-prd.azureedge.net/cdn-tvawcma/docs/default-source/energy/transmission/electrifying-school-transportation/electric-school-bus-case-study.pdf?sfvrsn=a3d48af6_1.



- The City of Knoxville, in partnership with TDOT, has installed free public EV charging stations across the city—at parks, garages, and municipal buildings. The city's website provides a map of the chargers.¹⁷ With technical support from [Drive Electric Tennessee](#), the City of Knoxville was Tennessee's first city to join the [Charging Smart](#) program.
- The City of Knoxville's [Vision Zero](#) program aims to eliminate all traffic deaths and serious injuries on city roads by prioritizing pedestrian and cyclists' safety.
- [Bike Walk Knoxville](#) aims to increase bike and pedestrian safety and accessibility. They provide the [Kids Love Bikes](#) and [Safe Routes to School](#) programs to teach children how to safely ride bikes, and the [Friendly Driver Training](#) to educate drivers on safely sharing the road. In addition, the group hosts [Tour de Lights](#)—a family-friendly bike ride and holiday market—and Open Streets, which temporarily closes urban roads to traffic to offer open space for recreational activities.
- [Two Bikes](#) and [Kickstand Bicycle Collective](#) are nonprofits in Knoxville that aim to expand access to bicycles. Two Bikes donates one bike for each one sold and provides three community programs: [The Bike School](#), Pedal It Forward, and Bicycle Outreach. Kickstand Bicycle Collective is an all-volunteer, community bike shop that offers bike giveaways and repairs, rider training, and community outreach.

Waste

- The [City of Knoxville's Compost Project](#) introduced their first food scraps drop-off program in 2022 and has since expanded to four sites. Food waste is transported to local nonprofit farms, where it is composted and used to grow food for the community. The program also offers backyard composting workshops and provides free composters to community gardens and households.
- [United Way of Greater Knoxville](#) reduces food waste by coordinating with businesses and organizations to recover surplus food and distribute it to community members in need.
- The University of Tennessee Knoxville (UTK) operates an industrial composting facility, diverting a significant amount of organic waste from its dining halls, landscaping maintenance, and other activities on campus. They also developed a composting location decision model for the city of Nashville.

¹⁷ City of Knoxville, n.d. "EV Charging." Available at: https://www.knoxvilletn.gov/government/city_departments_offices/sustainability/transportation/electric_vehicles/EV_charging.



- UT's [food4VOLS program](#) collects usable food from campus outlets, prepares ready-made meals, and distributes them to people with food insecurity through partnerships with food pantries such as FISH Hospitality Pantries and Second Harvest of East Tennessee.

Land and Agriculture

- The 2024 [Knoxville Urban Forest Master Plan](#) sets a goal of raising tree canopy cover from about 38% to 40% by 2040, reversing decades of tree loss. The plan emphasizes equitable distribution of trees by prioritizing underserved neighborhoods, schools, and historic sites while also ensuring species diversity and long-term tree health.
- Supported by \$4.3 million in United States Department of Agriculture (USDA) grants, [Trees Knoxville](#), the City of Knoxville, and UTK are planting and giving away thousands of trees annually. This program also incorporates green infrastructure for stormwater and heat mitigation and invests in public education and workforce training for successful natural resource management.
- The Great Smoky Mountains Institute at Tremont is pursuing a Living Building Challenge certification by integrating regenerative practices, including water reclamation infrastructure, water treatment, and agriculture into their facilities. The Living Building Challenge showcases the benefits of rainwater harvesting and greywater reuse.
- [UT's MANAGE Program](#), led by UT Extension, offers free, individualized farm and financial planning services to producers in all 95 Tennessee counties. The program helps farmers evaluate operations, improve profitability, and make informed decisions about land use, conservation, and business growth.
- The [Legacy Parks Foundation](#) has preserved more than 1,000 acres of forest and farmland, added 700+ acres of parkland, and invested \$21 million in public parks and green space in Knox County.



ADVANCING CLIMATE ACTION

Emission Reduction Measures Overview

The Knoxville region has opportunities to reduce emissions across the Buildings, Energy, Transportation, Waste, Natural & Working Land, and Agriculture sectors. The 19 measures to reduce GHG emissions in the BREATHE Plan (see Table 5) were developed with significant input from the Working Group. The measures incorporate policies, programs, and projects that address regional priorities and barriers. If fully implemented, these measures will help achieve the plan's emission reduction targets (see Chapter 2) and build on existing efforts (see Chapter 3). As part of measure development, the Working Group, along with the City of Knoxville and TPO, identified what would be necessary to implement each measure, thinking through cost considerations, potential implementing partners, and metrics for tracking success over time. As a result, the measures include actionable elements for today, alongside more ambitious actions needed to help the region meet long-term emission targets.

If all the measures are successfully implemented, **the Knoxville region can achieve 5.4 MMTCO₂e cumulative reductions by 2035 and 41.9 MMTCO₂e cumulative reductions by 2050**, compared with a 2022 baseline. These estimates are based on an analysis of existing technologies and actions and moderate assumptions about their growth in the future (see Figure 5). While these expected results are slightly short of the stated 2035 and 2050 GHG reduction targets, future innovations, policy changes, and advances in technology may narrow that gap over time. Beyond their GHG reduction potential, the BREATHE Plan measures can provide tangible benefits for communities across the region, including the following:

- More energy efficient buildings and homes with lower utility costs
- Resilient, diversified energy sources and energy security
- More affordable, accessible, and efficient transportation
- Improved air quality and health outcomes
- Safer streets and more mobility options
- Sustainable agricultural production
- More access to compost and recycling
- More green spaces and protected lands

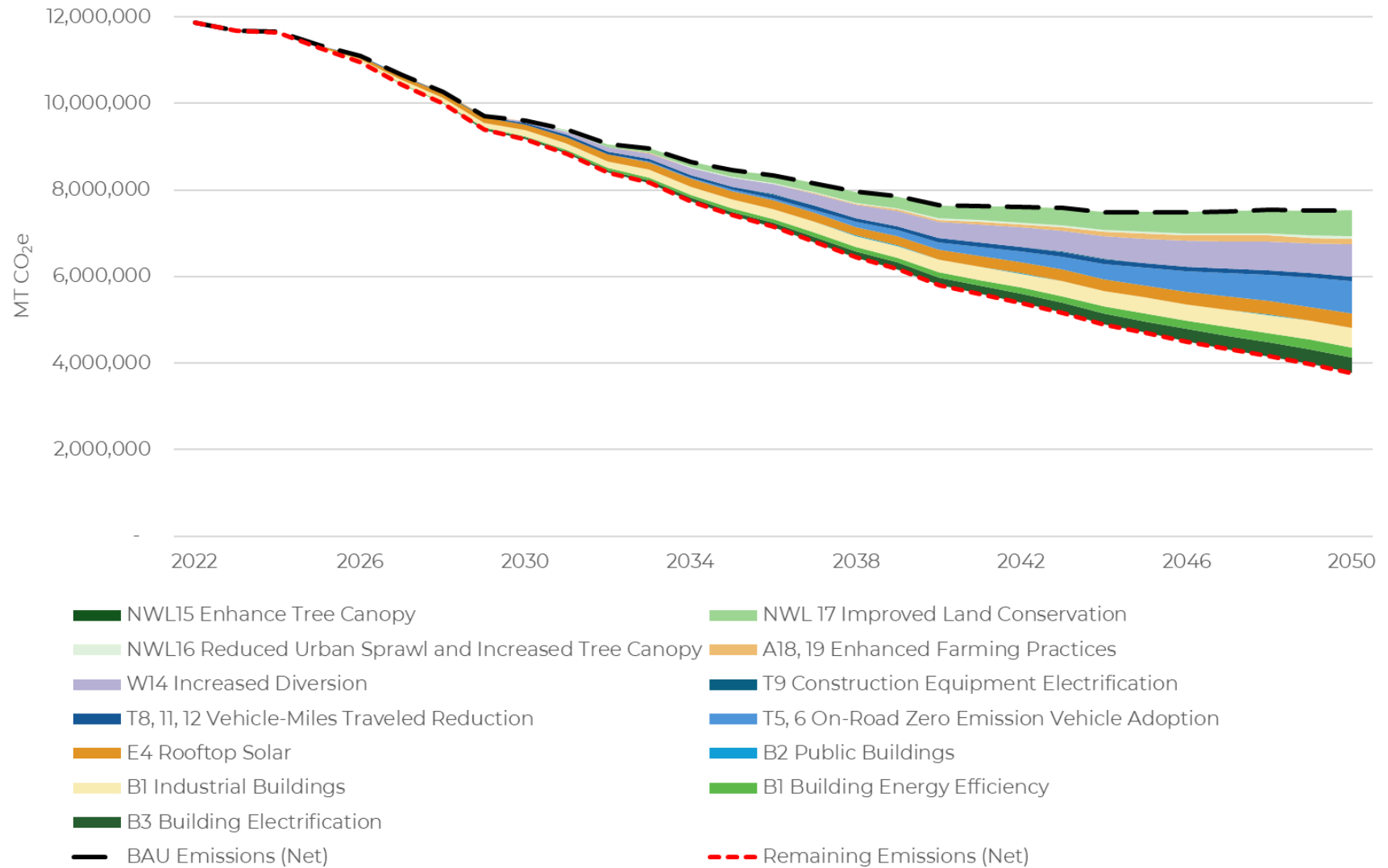


Table 5. BREATHE Plan Measures

Sector	Measure
Buildings	B1. Increase energy efficiency and the weatherization of buildings
	B2. Upgrade energy efficiency in and decarbonize public buildings
	B3. Electrify residential, commercial, and industrial buildings
Energy	E4. Accelerate the deployment of clean and distributed energy
Transportation	T5. Accelerate the adoption of electric vehicles across the region
	T6. Transition to electric and alternative fuel vehicles in public fleets
	T7. Expand publicly accessible and private electric vehicles and alternative fueling infrastructure
	T8. Optimize and improve the efficiency of freight routes
	T9. Improve transportation systems through sustainable construction practices
	T10. Improve transportation system efficiency to reduce traffic volume, congestion, and idling
	T11. Improve public transit infrastructure
	T12. Boost active transportation systems
Waste	W13. Reduce or divert waste going to landfills and improve wastewater treatment plant operations
	W14. Implement organic waste management programs
Natural & Working Lands	NWL 15. Enhance tree canopy, particularly in urban heat islands
	NWL 16. Evaluate policies and opportunities to reduce sprawl
	NWL 17. Conserve and expand natural lands and community green spaces
Agriculture	A18. Increase urban and micro farming
	A19. Improve agricultural practices



Figure 5. Emission Reductions from the BREATHE Plan's Measures





How to Read a Measure

Following a two-page summary for each sector, each measure includes a description and estimates potential emission reductions. The measures are not presented in a particular order and do not reflect prioritization. Each measure addresses the following questions:

How should this measure be implemented?

Measures include specific actions that are classified in two ways:

First, actions are categorized based on their importance to achieving successful measure implementation:¹⁸

Core Actions determine the success of measure implementation.

Supplementary Actions improve the outcomes of measure implementation but do not determine the overall success of reducing GHG emissions.

Bonus Actions contribute to measure implementation but should be considered a lower priority compared with core or supplementary actions.

Next, each action¹⁹ is further categorized by its current stage of development in the region:

Explore

Actions that are new to the region and may require upfront research and development.

Build

Actions that are ready for broader implementation but have not yet been “built” or piloted widely in the region.

Scale

Actions that are already partially implemented and are ready to scale further in the region.

What are the anticipated challenges for implementation?

Certain policies, structures, costs, and other barriers will need to be addressed before and during implementation. Additionally, implementation may have some adverse effects that can be mitigated if they are considered and addressed early on. Working Group members with prior experience in similar regional work identified many of these anticipated challenges.

Direct Benefits



GHG emissions reduced by implementing this measure

Co-Benefits

Discussed in detail in the sector-wide measure benefits section

A high-level overview of the types of benefits the measure can provide to communities, beyond reducing GHG emissions

¹⁸ Note that some measures do not have actions for all categories.

¹⁹ Note that some measures do not have actions that span all three phases.



How could we evaluate the success of this measure?

Each measure summarizes metrics to evaluate success. Working Group members and the BREATHE Team developed a feasible set of measurable indicators to track implementation.

What will this measure cost and how could it be funded?

Data were collected from Working Group members and climate action experts to estimate the approximate costs of and potential savings from implementation. Opportunities to pursue grant funding, donations, or public-private partnerships are also identified.

Who are the key partners and programs to help implement this measure?

Each county across the region has different advocates who may be essential to the implementation of these measures. These key partners are those who are already doing the work or those who are well positioned to do so in the future given their area of expertise, demonstrated interest, or responsibilities.²⁰ All partners have the authority to implement all measures.

²⁰ Note that named implementation partners have not committed to participating in these strategies.

Buildings Sector

The Knoxville region's Buildings sector includes residential, commercial, public, and industrial buildings. The measures in this section reduce emissions from the Buildings sector through electrification, and they enhance building energy performance through weatherization and the installation of more efficient appliances. Efficiency actions will reduce energy costs for households, businesses, and local government by lowering buildings' overall electricity usage. Energy efficiency is essential for grid reliability as demand and strain on the system continue to rise, helping to avoid the costs associated with building new power plants. In addition to lowering energy costs, weatherization makes residential buildings safer to live in, decreasing moisture and preventing mold growth. Improved indoor air quality lowers risks associated with respiratory illnesses.

Buildings Measures

- B1.** Increase energy efficiency and the weatherization of buildings
- B2.** Upgrade energy efficiency in and decarbonize public buildings
- B3.** Electrify residential, commercial, and industrial buildings



Sources of GHG emissions: Combustion of natural gas and use of electricity to power heating/cooling systems, cooking appliances, lighting, and more.

6.19 MMTCO₂e

emitted in 2022 from the Buildings sector, representing **39% of regional emissions.**



13.2 MMTCO₂e

reduced cumulatively from 2022 to 2050 if the Knoxville region successfully implements these measures.

1,771 LEED-certified buildings

in Tennessee as of October 2025.

What does the region's Buildings sector look like now?

3,000 homes

within the Knoxville Utilities Board service area have been weatherized as of 2025.

67.6% of energy

in Tennessee is used by the Buildings sector. Transportation is responsible for the other 32.4%.

How are community members taking action?

54% of respondents

have insulated or weatherized their homes to save energy.

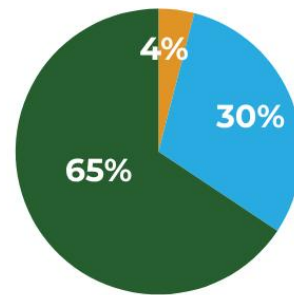
46% of respondents

would install rooftop solar panels on their home in the future.

Climate change is already making life harder for low-income families through higher utility costs and weather-related home damage... I'm inspired to see a climate plan that recognizes the connection between energy efficiency, affordability, and community resilience.

-Jeffery V. from CAC's Housing and Energy Services

How do Tennesseans heat their homes?



- Fuel oil, kerosene, or propane
- Natural gas
- Electricity

Solar panels on top of the **Knoxville Convention Center** generate power to reduce energy use, utility costs, and emissions.





Buildings Measure 1. Increase energy efficiency and the weatherization of buildings

This measure advances energy efficiency and weatherization strategies for residential, commercial, and industrial buildings through marketing, education, and outreach, leveraging new and existing funding opportunities and offering new or expanded incentives for owners, landlords, and renters.

How should this measure be implemented?

Improving building energy efficiency and weatherization includes efforts such as switching to light-emitting diode (LED) lights, using energy-saving appliances, adding insulation or sealing air leaks, and conducting an energy audit to see where other improvements can be made.

Expanding weatherization and energy efficiency programs and incentives likely requires collaboration among local power companies (e.g., KUB), TVA, ORNL, and community-based organizations (CBOs). For example, ORNL can model regional and building-specific energy savings, while local power companies and TVA can coordinate to streamline incentives and program delivery. Coordinated outreach should target renters, homeowners, and small businesses to communicate the benefits of upgrades, available financing and incentives, and guidance on navigating the process—from selecting contractors to securing funding.

Measure 1 Direct Benefits



GHGs reduced 2022–2035: **1,786,884 MTCO₂e**

GHGs reduced 2022–2050: **9,236,039 MTCO₂e**

Annual Criteria Air Pollutant or Hazardous Air Pollutant emissions reduced (MT) 2025 to 2050:

- NO_x: **11,404.27**
- SO₂: **848.88**
- PM: **1,426.43**
- CO: **6,819.65**
- Lead: **0.08**
- VOC: **889.65**

Measure 1 Co-Benefits

Discussed in detail in the sector-wide measure benefits section



Improved Air Quality and Healthy Communities



Cost Savings



Job Creation and Workforce Development



Improved Equity



Increased Resilience



Core Actions

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Explore opportunities to implement energy efficiency in multifamily rental residences while ensuring that rent and energy bills remain affordable.
- Explore pathways to provide financial incentives and zero- or low-interest loans for developers, building managers, and homeowners (including landlords) to install weatherization and energy efficiency upgrades.
 - Example: Explore Solar and Energy Loan Fund and Community Development Financial Institutions programs.

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Educate heating, ventilation, and air conditioning (HVAC) companies and general contractors about high-efficiency technologies, practices, and available incentives.
 - Example: Encourage installers to utilize existing HVAC rebates from TVA.
- Utilize and promote the American Council for an Energy Efficient Economy toolkit on responding to renter challenges with energy efficiency strategies.
- Promote comprehensive energy audits for both commercial and utilities by providing clear standards and accessible resources.

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Expand training and funding to grow the local weatherization workforce.
 - Example: Partner with local technical programs (such as the Tennessee College of Applied Technology) to create or expand HVAC and energy auditor certification programs across the region.
- Work with local utilities to promote available incentives and programs that reduce energy use, especially during peak demand hours.
 - Example: Encourage local power companies to adopt smart thermostat incentives and time-of-use rate structures.
- Expand existing regional weatherization and energy efficiency programming to incorporate the latest building technologies and building science.
 - Example: Integrate smart thermostats, advanced insulation materials, and high-performance windows into weatherization offerings.
- Conduct marketing, outreach, and education efforts targeted at renters, homeowners, and small businesses on the benefits of energy efficiency upgrades and how to access available incentives.



- Example: Promote TVA's EnergyRight building audits, rebate incentives, and the Preferred Partner Network/Quality Contractor Network.
- Expand financing programs for energy upgrades.
 - Example: Promote the Pathway Lending Energy Efficiency Loan Program to allow small entities to repay energy-saving upgrade investments over time.

Supplementary Actions

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Develop regional energy savings estimates for efficiency projects across building use categories (e.g., homes, community centers, schools, offices).
 - Example: Collaborate with ORNL to conduct energy modeling at the neighborhood or building stock level.

Bonus Actions

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Explore ways to strengthen building code enforcement for new construction and major renovations.
 - Example: Integrate post-occupancy energy audits into the permitting process.
 - Example: Explore virtual home assessments to determine the best energy upgrades without needing an in-person visit.
- Consider property tax incentives that reward buildings constructed with long-term resilience, sustainable materials, and energy efficiency.

What are the anticipated challenges for implementation?

Energy efficiency and weatherization upgrades often require significant upfront investment. Utility incentive programs are frequently underfunded, and many households and organizations may be discouraged from participating, especially if they are unaware of the long-term return on investment.

Building trust within communities is crucial for program success, yet can be complicated by language barriers, limited awareness of available incentives, and tight budgets. Many residents in the region are renters who have limited ability to make upgrades. It is important to identify solutions that ensure retrofits do not lead to higher costs for renters. Another challenge is that the most inefficient homes are often the oldest and most vulnerable to extreme weather events. These homes may require additional investment to achieve meaningful energy savings.

To address these issues, outreach should be localized and led by trusted community members who understand the specific concerns and barriers. A successful rollout



also depends on having a skilled workforce as the implementation requires a high-level of technical expertise (see Chapter 5).

Regulatory constraints add another layer of complexity. For example, Tennessee's Dillon Rule mandates that status codes to be regulated and adopted at the state level. As a result, city and county governments cannot adopt building codes that surpass the state's, making it difficult to require improvements in building stock. One way to boost energy efficiency is to promote voluntary stretch codes²¹ for communities.

How could we evaluate the success of this measure?

- Number of participants or households using available incentive programs
- Dollars of incentives used and/or available
- Marketing metrics from key resources (e.g., website views, meetings held)

What will this measure cost and how could it be funded?

To make this measure more affordable and accessible to all households, the availability of zero-interest loans for weatherization and efficiency upgrades will be important, along with increased funding for weatherization programs. These loans and existing incentives from TVA and the federal government can help reduce upfront costs. Exploring bulk purchasing and coordinated procurement programs could further lower equipment and installation costs, making upgrades more feasible.

	2035	2050	2025—2050
Initial Cost to Implement	\$55.37	\$65.61	\$1,357.78
Ongoing Cost to Implement	(\$62.93)	(\$230.23)	(\$2,501.10)

Note: Costs are in million USD (2025); parentheses indicate net savings.

Potential funding sources may include the following:

- DOE and State Weatherization Assistance Programs
- DOE HOMES Efficiency Rebates
- DOE State Energy Program
- Knoxville Smarter Cities Partnership
- TVA EnergyRight
- U.S. Department of Housing and Urban Development (HUD) Green and Resilient Retrofit Program

²¹ A stretch code is an adoptable and enforceable code that exceeds the requirements of the base code.



- U.S. DOE Energy Efficiency and Conservation Block Grants
- Utility Programs

Who are the key partners and programs to help implement this measure?

- **Appalachian Solar Finance Fund:** Expand access to solar financing for nonprofits and public institutions.
- **City and County Governments and Community Development Programs:** Oversee public housing projects and affordability programs, coordinate with stakeholders to support outreach and marketing, help upgrade public buildings through incentive and technical assistance programs, and explore voluntary stretch codes to improve building energy performance.
- **CBOs:** Help with program design, raise awareness, provide educational resources, and promote community participation.
- **Contractors:** Install high-efficiency HVAC, weatherization, and retrofit measures. Leverage existing incentives to save on costs. Educate customers on the cost benefits of various technologies.
- **EnergyRight:** Offer residents rebates and education on energy efficiency upgrades, including free services for low-income households through Home Uplift.
- **Knoxville-Knox County Community Action Committee (CAC), other CACs, East Tennessee Human Resource Agency (ETHRA), and the Weatherization Assistance Program (WAP):**²² Administer efficiency and weatherization programs to qualifying households.
- **Local Power Companies (LPCs):** Provide energy efficiency and weatherization programs to rate payers.
- **ORNL:** Provide technical modeling of energy savings potential.
- **Owner-Occupied Home Repair Program:** Assist low- and moderate income (LMI) households with the cost of home repairs.
- **Property Owners:** Support implementation in residential and commercial buildings.
- **State Government Agencies:** Offer programs that provide funding and technical assistance for energy efficiency projects.

²² TN Community Action, 2024. "Community Action Agency Contacts." Available at: https://www.tncommunityaction.org/images/pdf/TACA_Agencies_-_2024.pdf and https://dogvxws799i6n.cloudfront.net/wp-content/uploads/Weatherization-Service-Providers_Temporary-List-1.pdf



- **Trade Unions:** Provide apprenticeship programs with an emphasis on expanding the clean energy workforce.
- **TVA:** Provide strategic leadership for energy efficiency and weatherization efforts and assist LPCs in the administration of programs, including customer engagement and financial incentives.
- **Water Savings Program:** Help low-income residential customers manage their water and wastewater costs.

Buildings Measure 2. Upgrade energy efficiency in and decarbonize public buildings

This measure implements energy efficiency electrification upgrades, such as lighting, air conditioning, heating, appliances, and renewable energy, to decarbonize public buildings. It ensures that public buildings lead by example, save taxpayer funds, and introduce community members to improvements that could be implemented in their own homes and establishments.

How should this measure be implemented?

Energy efficiency upgrades require coordination within and across city and county governments and partner agencies to ensure a standardized and effective approach. Setting minimum design standards for new and retrofitted buildings will help maintain consistency and maximize the impact. The focus will be on practical, cost-effective solutions, such as switching to high-efficiency HVAC systems, lighting, and plumbing fixtures, as well as installing solar panels. To guide and prioritize upgrades, city and county governments can work with LPCs to identify buildings with the highest potential for energy savings and public-serving buildings, such as libraries and community centers.

Measure 2 Direct Benefits

GHGs reduced 2022–2035: **10,791 MTCO₂e**

GHGs reduced 2022–2050: **82,955 MTCO₂e**

Co-pollutant reductions modeled under B1.

Measure 2 Co-Benefits

Discussed in detail in the sector-wide measure benefits section



Cost Savings



Job Creation and Workforce Development



Improved Air Quality and Healthy Communities



Core Actions

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Establish minimum energy use intensity benchmarks for new public buildings and make these targets achievable.
 - Example: Use utility data platforms, such as DOE ENERGY STAR, to compare the energy use of existing buildings to others of the same size and use to determine benchmarks.
- Explore the potential of collecting LPC energy data across the region.

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Establish Working Group(s) with representatives from different public agencies and departments to help advance, track progress, and share information and lessons learned.
- Create standards and guidelines for determining which buildings are the least energy efficient and have the greatest potential for savings.
- Encourage, promote, and implement low-cost energy efficiency improvements in public buildings and assets.
 - Example: Use energy savings performance contracts (ESPCs) to target cost-effective upgrades across public building portfolios.
 - Example: Convert all public streetlights to LEDs.
 - Implement green, cool, and/or solar roofs on suitable public buildings.

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Coordinate local agencies that implement multifamily energy efficiency upgrades to weatherize more public housing units.

Supplementary Actions

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Study opportunities for alternative and innovative technologies to reduce energy use in or decarbonize public buildings (e.g., geothermal, district heating and cooling, wastewater heat capture).
 - Example: Utilize SHARC Energy, which captures thermal energy from wastewater to cool and heat buildings.



Bonus Actions

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Provide sustainable buildings training for public sector employees and promote green teams or energy committees.

What are the anticipated challenges for implementation?

The primary barrier to implementing this measure is funding. City and county governments can partner with TVA and LPCs to explore potential incentives, find ways to cut costs for the implementation of energy efficient systems, and ensure that any increase in electricity use from building decarbonization is matched by renewable energy sources.

How could we evaluate the success of this measure?

- Energy use intensity (post-occupancy)
- Megawatts of installed and/or generated behind-the-meter clean energy resources

What will this measure cost and how could it be funded?

To help make decarbonization upgrades in public buildings affordable and feasible, it is important to pursue federal and state level funding. Partnering with organizations such as TVA may also uncover potential incentives and cost-saving strategies for installing energy efficient systems. Another financing option is ESPCs, which allow building owners to make these upgrades without paying anything upfront—the improvements are paid for over time, using the energy savings they generate.

	2035	2050	2025—2050
Initial Cost to Implement	\$1.66	\$2.09	\$42.01
Ongoing Cost to Implement	(\$12.08)	(\$45.00)	(\$488.41)

Note: Costs are in million USD (2025); parentheses indicate net savings.

Potential funding sources may include the following:

- DOE and [State Weatherization Assistance Programs](#)
- DOE HOMES Efficiency Rebates
- DOE State Energy Program
- TN Department of Environment and Conservation Energy Efficiency and Renewable Energy Loan Program
- TVA EnergyRight



- U.S. DOE Energy Efficiency and Conservation Block Grants
- U.S. HUD Green and Resilient Retrofit Program
- Utility Programs

Who are the key partners and programs to help implement this measure?

- **City and County Governments:** Create building policies and plans to electrify the portfolio over time. Determine which government buildings to decarbonize and coordinate procurement and implementation.
- **Energy Service Companies (ESCOs) and ESPCs providers:** Provide formal agreements and contracts to install efficiency upgrades.
- **Organizations working to develop the workforce (Tennessee College of Applied Technology [TCAT], Electrical Training Alliance – Knoxville [ETAK], Resource Valley Construction Training Council, Associated Builders & Contractors of Greater Tennessee, Knox County START Center, SEED):** Support green jobs training and workforce development opportunities.
- **Tennessee State Government:** Provide high-level expertise and potentially financial support.
- **TVA and LPCs:** Provide utility data to city and county governments, assess potential energy savings and available incentives, and help coordinate the installation of projects.



Buildings Measure 3. Electrify residential, commercial, and industrial buildings

This measure explores, plans, and implements targeted electrification of residential, commercial, and industrial buildings. Electrification is the process of replacing technologies and systems that rely on fossil fuels (e.g., natural gas, propane) with those powered by electricity. This may include switching to electric heat pumps (e.g., air source, ground source, network geothermal), electric appliances (e.g., dryers and stoves), and other innovative, efficient technologies. The goal is to reduce dependence on and the preference for equipment that uses fossil fuels (e.g., gas stoves), while also improving indoor air quality and lowering long-term energy costs.

How should this measure be implemented?

Encouraging electrification upgrades requires incentives, education, and financing options, with clear outreach about the health benefits and cost savings. Heat pumps are efficient for East Tennessee's climate and are a smart choice for homes and businesses. Education should address cultural preferences, using hands-on demonstrations to build trust. Voluntary programs are important in Tennessee due to regulatory limits, and partnerships with utilities and nonprofits can support community adoption through incentives and outreach.

Measure 3 Direct Benefits



GHGs reduced 2022–2035: **415,415 MTCO₂e**

GHGs reduced 2022–2050: **3,868,420 MTCO₂e**

Co-pollutant reductions modeled under B1.

Measure 3 Co-Benefits

Discussed in detail in the sector-wide measure benefits section



Improved Air Quality and Healthy Communities



Cost Savings



Job Creation and Workforce Development



Improved Equity



Increased Resilience

Core Actions

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Promote and incentivize heat pumps and electric appliances as a first choice technology for new construction.



Phase 1: Explore	Phase 2: Build	Phase 3: Scale
● Expand educational initiatives and training to help individuals, contractors, and organizations navigate available building electrification funding options and incentives. ● Example: Engage American Institute of Architects East Tennessee and the East Tennessee Community Design Center to provide expertise on how to best decarbonize buildings.		

Bonus Actions		
Phase 1: Explore	Phase 2: Build	Phase 3: Scale
● Explore ways to incentivize electrification in energy building codes for new construction and major renovations. ● Example: Update codes to prioritize all-electric construction in the residential and commercial sectors.		

What are the anticipated challenges for implementation?

Upfront electrification costs can be prohibitive, especially for LMI households and renters who face financial and information barriers and have limited control over home systems. To improve access, incentives such as zero-interest loans, renter-friendly solutions, and multilingual resources should be explored. Targeting outreach and mapping electrification gaps can help distribute upgrades equitably and affordably. Education should emphasize health and cost benefits to encourage a shift from gas appliances. For commercial and industrial buildings, outreach should focus on long-term savings to motivate owners and landlords to invest in electrification. Additionally, increased capacity needs and higher peak electricity demand present further challenges, requiring careful planning and investment in grid infrastructure to ensure reliable service as electrification expands.

How could we evaluate the success of this measure?

- Reductions in buildings' energy consumption
- Participation rates in incentive programs

What will this measure cost and how could it be funded?

Electrification upgrades can be costly upfront, especially for older buildings with outdated infrastructure. To make this measure more affordable, incentive programs (e.g., rebates, low-interest loans) can be expanded. Federal programs (e.g., WAP, State and Community Energy Program) and local funding partnerships can also help offer affordable installations in underserved areas. Additional initiatives may include protections to prevent rising property values from displacing residents in gentrifying communities. Supporting programs that offer affordable installation of distributed



energy systems (e.g., solar panels paired with battery storage) can also help reduce long-term energy costs and improve energy resilience.

	2035	2050	2025—2050
Initial Cost to Implement	\$52.16	\$68.08	\$1,349.45
Ongoing Cost to Implement	(\$162.74)	(\$668.93)	(\$6,912.01)
Total Cost to Implement in Industrial Buildings	\$232.78	\$560.48	\$7,562.60

Note: Costs are in million USD (2025); parentheses indicate net savings; industrial building estimates are summarized separately because modeling did not disaggregate initial and ongoing costs.

Potential funding sources may include the following:

- DOE High-Efficiency Electric Home Rebate Act Electrification Rebates
- DOE State Energy Program
- TN Department of Environment and Conservation Energy Efficiency and Renewable Energy Loan Program
- TVA EnergyRight
- U.S. DOE Energy Efficiency and Conservation Block Grants
- U.S. HUD Green and Resilient Retrofit Program
- Utility Programs

Who are the key partners and programs to help implement this measure?

- **Developers:** Guide and execute installation plans for solar panels and heat pumps.
- **ESCOs:** Implement large-scale building energy efficiency retrofits and electrification projects.
- **LPCs (e.g., KUB and others):** Administer incentives to increase the affordability of electricity compared with natural gas, and support electrification infrastructure upgrades.
- **Organizations working to develop the workforce (Tennessee College of Applied Technology [TCAT], Electrical Training Alliance – Knoxville [ETAK], Resource Valley Construction Training Council, Associated Builders & Contractors of Greater Tennessee, Knox County START Center, SEED):** Support green jobs training and workforce development opportunities.
- **TVA:** Support LPCs in electrifying communities.
- **WAP and CAC:** Facilitate low-income electrification and weatherization upgrades.



Building Sector Measure Benefits

Cost Savings

Measures B1, B2, and B3 can all provide cost savings to consumers through lower energy bills. By expanding energy efficiency programs and incentives, these upgrades become more accessible for homeowners, renters, and local businesses, which is especially important for LMI households. Qualifying low-income households can receive free upgrades through the Home Uplift program.

Improved Air Quality and Healthier Communities

The energy efficiency and electrification upgrades mentioned in Measures B1, B2, and B3 make buildings safer and healthier for occupants. The energy efficiency improvements in Measures B1 and B2 help shield buildings from harsh wind and heavy rain, reducing indoor moisture levels and preventing mold growth, air pollution, and allergen exposure. Actions in Measure B3 reduce residents' risk of exposure to pollutants from gas appliances, such as carbon monoxide and particulate matter. Partnerships among LPCs, TVA, ORNL, and local nonprofits could promote low- and no-cost actions for underserved communities.

Job Creation and Workforce Development

The expansion of energy efficiency and electrification through Measures B1, B2, and B3 will drive demand for a larger green workforce in the region, creating local job opportunities in fields such as electrical work and HVAC.

Improved Equity

Measures B1 and B3 both target the needs of underserved communities. By expanding access to energy-saving technologies and electrification, these measures help reduce persistent disparities in energy costs, allowing families and individuals to allocate more of their income toward other essential needs. Measure B1 supports comprehensive weatherization efforts, which protect vulnerable households from the effects of extreme weather, lessening the risk of property damage. The focus on electrification in Measure B3 is especially beneficial in communities historically burdened by environmental hazards, contributing to healthier living environments. Collectively, these strategies reduce the financial and health burdens faced by marginalized residents, fostering greater equity throughout the region.

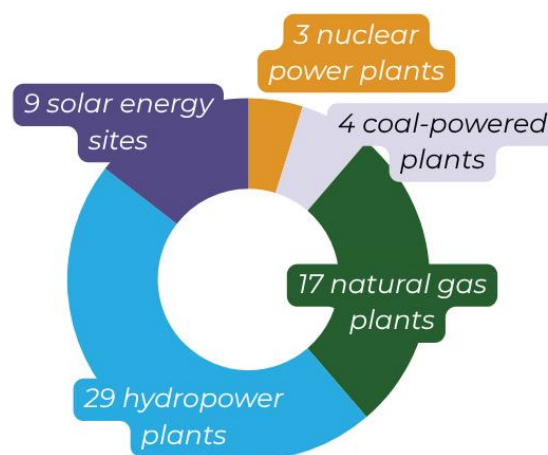
Increased Resilience

Measures B1 and B3 help make communities in the region more resilient. Measure B3 encourages the use of electric appliances, which lowers reliance on fossil fuels. Measure B1 focuses on weatherizing buildings, making them better able to handle severe weather and reducing the costs needed for repairs and maintenance.

Energy Sector

The Knoxville region's Energy sector includes all the ways electricity is generated, from traditional energy sources such as natural gas, to clean energy sources such as solar panels, nuclear power plants, and hydroelectric generation. The measure in this section aims to expand access to distributed clean energy, meaning non-grid energy sources, such as solar panels or batteries. This kind of electricity generation lowers energy costs for households and businesses. It also enhances the flexibility and resilience of the electricity grid, allowing homes and businesses to continue to access electricity even if the grid experiences disruptions.

TVA's asset portfolio:



Energy Measure

E4. Accelerate the deployment of clean and distributed energy

Sources of GHG emissions: Combustion of fossil fuels, such as natural gas and coal (20% of electricity generation in Tennessee), and biomass (1% of electricity generation in Tennessee).

5.23 MMTCO₂e

emitted in 2022 from the Energy sector.

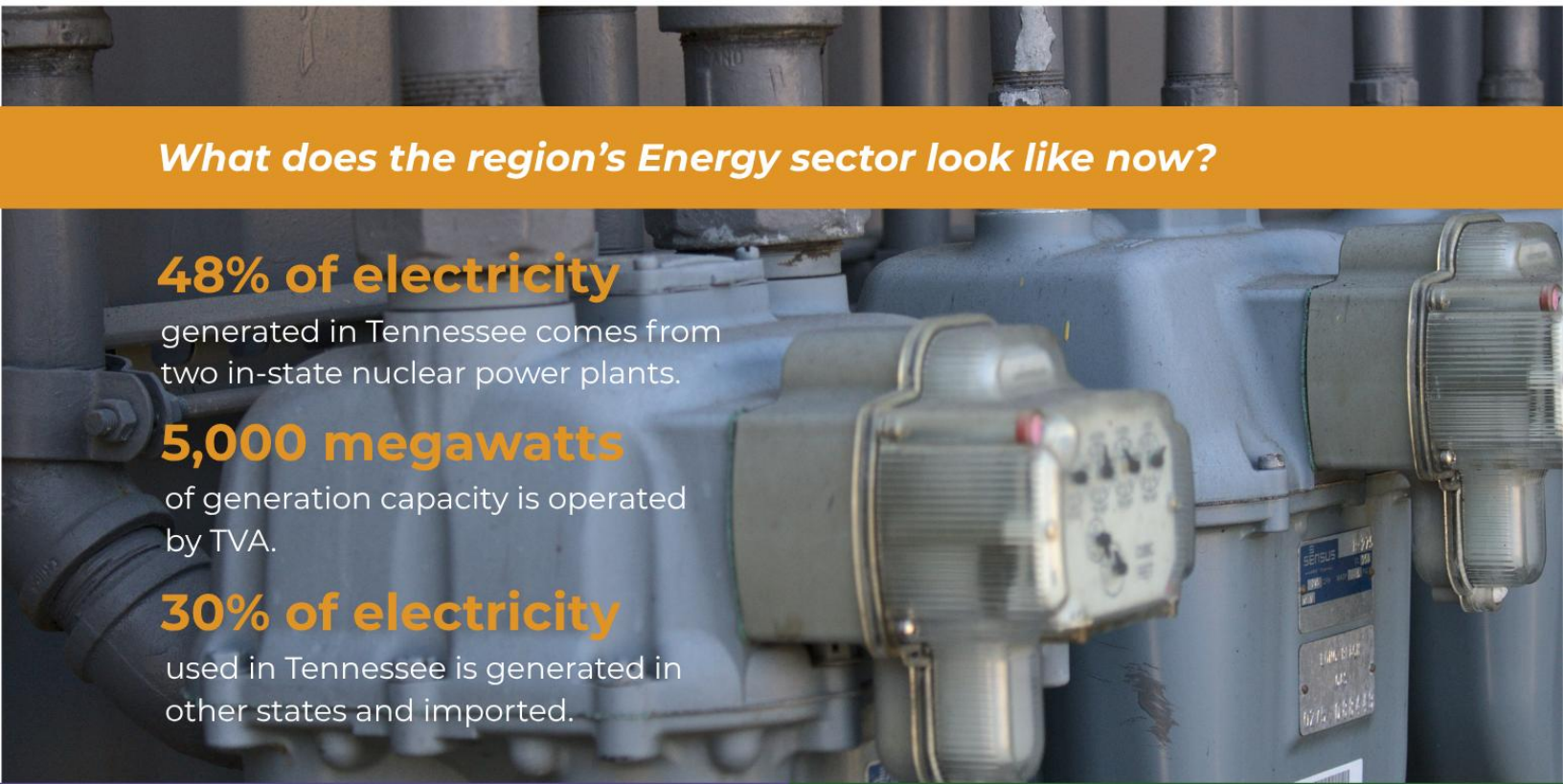
Note: These emissions are reported for informational purposes.

5.2 MMTCO₂e

reduced cumulatively from 2022 to 2050 if the Knoxville region successfully implements this measure.

11% of electricity

in Tennessee is generated at hydroelectric facilities, including the **Melton Hill Dam** in Loudon County.



What does the region's Energy sector look like now?

48% of electricity

generated in Tennessee comes from two in-state nuclear power plants.

5,000 megawatts

of generation capacity is operated by TVA.

30% of electricity

used in Tennessee is generated in other states and imported.

How are community members taking action?

62% of respondents

are currently trying to reduce energy usage at home.

53% of respondents

set indoor temperatures higher in the summer and lower in the winter to save energy.

What actions are community members interested in?

46% of respondents

would install rooftop solar panels on their home in the future.

33% of respondents

would subscribe to a green energy power grid in the future.

Spotlight on Nuclear Energy

Nuclear energy is growing in East Tennessee. TVA authorized an investment of **\$350 million** toward the New Nuclear Program in 2022 that will develop a range of nuclear technologies, including SMRs. In 2023, Kairos Power received permission from the U.S. Nuclear Regulatory Commission to build the Hermes demonstration reactor, with plans to invest **\$100 million** in reactor construction and operations.

“We are excited to see our region's commitment to clean, renewable energy sources. These investments will give us a competitive edge in long-term economic stability.” - Lauren L. from Knoxville Chamber of Commerce



Energy Measure 4. Accelerate the deployment of clean and distributed energy

This measure aims to expand renewable energy generation across the region—on-site solar, battery storage, and community choice solar, in particular. Community choice solar allows multiple residents to get electricity from a single solar installation, whereas utility-scale solar generates electricity for sale to the grid. This measure focuses on marketing and educational campaigns to make resources and information on solar more accessible.

How should this measure be implemented?

A key first step is strong coordination among TVA, LPCs, and city and county governments to ensure that incentives and community resources are thoughtfully planned and accessible. Outreach should prioritize LMI households and multifamily developments, with the goal of reducing energy burdens and expanding access to clean energy. It is important to explain the measurable benefits of solar energy, such as cost savings and cleaner air. Outreach can also include the introduction of additional technologies that build energy resilience (e.g., battery storage).

Measure 4 Direct Benefits

GHGs reduced 2022–2035: **1,371,823 MTCO₂e**

GHGs reduced 2022–2050: **5,244,902 MTCO₂e**

Annual Criteria Air Pollutant or Hazardous Air Pollutant emissions reduced (MT) 2025 to 2050:

- NO_x: **7,637.49**
- SO₂: **7,500.75**
- PM_{2.5}: **1,972.83**
- NH₃: **390.90**
- VOCs: **312.72**

Measure 4 Co-Benefits

Discussed in detail in the sector-wide measure benefits section



Cost Savings



Increased Resilience



Improved Air Quality and Healthy Communities



Job Creation and Workforce Development

Core Actions

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Explore opportunities for large-scale solar installations on vacant lots, brownfields, and other underutilized properties.
- Invest in battery storage, resilience hubs, and microgrids to reduce peak demand and ensure the continuity of power during extreme weather events.
- Explore alternative excess power purchase programs and dynamic pricing models to improve the return on distributed solar. Utility programs that offer



credit for excess electricity can offset costs, improving affordability and accessibility.

Phase 1: Explore	Phase 2: Build	Phase 3: Scale
- Promote the installation of residential solar panels, especially in low-income residential and multifamily developments. - Invest in battery storage solutions to make local solar more viable and improve power reliability. - Offer incentives for solar and battery storage installations through LPCs. - Support LPCs' efforts to take full advantage of TVA's 5% Flex Program for local renewable energy generation by exploring various end-use customer solar programs, including community solar projects. - Support programs for affordable installation of distributed generation (solar and storage) to reduce long-term energy costs.		

Phase 1: Explore	Phase 2: Build	Phase 3: Scale
Study opportunities for installing solar panels and/or using power purchase agreements (PPAs) at municipal and community buildings. PPAs are long-term contracts where buyers agree to purchase electricity at a set price to support clean energy project financing.		

Supplementary Actions

Phase 1: Explore	Phase 2: Build	Phase 3: Scale
Offer voluntary incentives or recognition programs (e.g., community awards) for homeowners and small businesses that install solar, especially in neighborhoods that face high energy costs due to inefficient housing stock.		

What are the anticipated challenges for implementation?

The return on investment for solar energy can take multiple years, which may make it harder for some residents to see the extensive long-term cost savings from subscribing to community choice solar. It can be intimidating to consider installing new energy sources or joining community energy initiatives, especially when there are upfront costs. To address this, outreach efforts can model the long-term financial savings that can come from these programs, such as a cost-benefit analysis to provide data on financial savings. Having trusted community members lead these outreach efforts can help build confidence and encourage participation.



How could we evaluate the success of this measure?

- Solar power generation over time
- Number of solar installations (megawatts installed)
- Number of residents with solar
- Emission intensity of electricity generated by LPCs
- Number of solar permits that are processed or interconnected

What will this measure cost and how could it be funded?

It is important to work with utilities and solar installation companies to create accessible pricing of clean and distributed energy for all East Tennesseans. While household rooftop solar is more widely known, community-scale initiatives such as community choice solar can be more cost-effective and feasible, especially for renters.

	2035	2050	2025—2050
Initial Cost to Implement	\$46.47	\$69.45	\$2,489.33
Ongoing Cost to Implement	\$12.60	\$22.71	\$365.75
Bill Savings	\$123.57	\$303.43	\$3,970.08

Note: Costs are in million USD (2025).

Potential funding sources may include the following:

- DOE and State Weatherization Assistance Programs
- DOE State Energy Program
- Internal Revenue Service (IRS) Residential Clean Energy Credit
- TN Solar Easement and Access Laws
- U.S. DOE Energy Efficiency and Conservation Block Grant Program
- U.S. EPA Greenhouse Gas Reduction Fund Solar for All Funding
- U.S. HUD Green and Resilient Retrofit Program
- Utility and Developer Investments

Who are the key partners and programs to help implement this measure?

- **City and County Governments:** Identify opportunities to deploy solar on public buildings (e.g., Knoxville’s Community Development Corporation, community centers).



- **LPCs:** Leverage flexibility and TVA programs to increase clean energy generation. Support community-based programs to improve the accessibility of renewable energy (e.g., Community Solar and Green Switch Match Program).
- **Tennessee Department of Environment and Conservation (TDEC):** Revisit opportunities previously funded by the canceled Solar for All program and pursue new funding avenues at the state level.
- **TVA:** The Green Flex program allows businesses with high energy consumption to purchase RECs to reduce their energy footprint. The Green Invest program supports renewable energy installations for businesses. TVA will also regulate local utility rates and implement excess purchase programs and increased flexible generation policies for LPCs.

Energy Sector Measure Benefits

Cost Savings

Both on-site and community solar lower energy costs in the long-term. Although there is an initial upfront cost to purchase and install on-site solar, individual solar systems typically pay for themselves in 13 years through energy savings and in 10 years when clean energy tax credits are used.²³ For renters, community choice solar offers a valuable alternative by allowing communities to generate, own, and purchase their own energy collectively. Renters can receive financial benefits through subscription credits on their utility bills.

Increased Resilience

By generating energy locally through on-site solar and community choice solar, communities have greater control over their energy supply. Those with solar panels on their roofs can maintain power during short utility grid outages. Community solar also diversifies energy sources, making all residents in the service area less likely to experience disruptions during grid stress and extreme weather events. Solar is a high-value option for households that are more vulnerable to blackouts and brownouts and for critical infrastructure such as hospitals, food banks, and traffic signals.

Improved Air Quality and Healthier Communities

Power generated using fossil fuels is a major source of GHG emissions, solid particulate matter, and chemical air pollutants. Reducing the use or idling of these

²³ Consumer Affairs, 2023. "What is solar panel ROI?" Available at: <https://www.consumeraffairs.com/solar-energy/what-is-solar-panel-roi.html>.



vehicles through Measure E4 can reduce local air pollution, which improves public health and mitigates urban heat island effects.²⁴

Job Creation and Workforce Development

Expanding clean energy systems will drive demand for a larger workforce in the region, creating local job opportunities in fields such as solar installation, maintenance, and manufacturing.

²⁴ Guo, et al, 2024. “Fifteen Pathways between Electric Vehicles and Public Health: A Transportation–Health Conceptual Framework.” Available at: <https://pmc.ncbi.nlm.nih.gov/articles/PMC11667283/#:~:text=The%20adoption%20of%20EVs%20diminishes,24%2C25>; U.S. EPA. “What Are Heat Islands?” Available at: <https://www.epa.gov/heatislands/what-are-heat-islands#causes>



Transportation Sector

The Knoxville region's Transportation sector includes every way people travel, from cars and trucks, to trains, planes, buses, and bikes. The measures in this section aim to make the region's transportation systems more efficient, safe, and accessible. Increased access to public transit and active transportation, such as biking and walking, will reduce traffic congestion, create more transportation choices for community members, and improve accessibility for people who do not own or drive a car. Incentivizing electric vehicle ownership and charging station infrastructure will further add to the Knoxville region's mix of transportation options while improving air quality.

Transportation Measures

- T5.** Accelerate the adoption of electric vehicles across the region
 - T6.** Transition to electric and alternative fuel vehicles in public fleets
 - T7.** Expand publicly accessible and private electric vehicles and alternative fueling infrastructure
 - T8.** Optimize and improve the efficiency of freight routes
 - T9.** Improve transportation systems through sustainable construction practices
 - T10.** Improve transportation system efficiency to reduce traffic volume, congestion, and idling
 - T11.** Improve public transit infrastructure
 - T12.** Boost active transportation systems
- 

Sources of GHG emissions: Gasoline- and diesel-powered cars, trucks, and buses; off-road vehicles such as construction equipment; rail; ferries; planes



6.08 MMTCO₂e

emitted in 2022 from the Transportation sector, representing **39% of regional emissions.**

7.3 MMTCO₂e

reduced cumulatively from 2022 to 2050 if the Knoxville region successfully implements these measures.

What does the region's Transportation sector look like now?

more than 11.5 billion VMT

(vehicle-miles traveled) in 2022.

~0.5% of commuters

use public transportation.

~138.9 million tons

of truck freight transported on I-40 and I-75 in Knoxville per year.

Some of the measures included in this sector overlap with the goals outlined in the **Knoxville Region's Mobility Plan 2050**.

How are community members taking action?

12% of respondents

drive a high-efficiency or alternative fuel vehicle.

16% of respondents

take public transportation.

What actions are community members interested in?

32% of respondents

would drive a high-efficiency or alternative fuel vehicle in the future.

30% of respondents

would take public transportation in the future.

By making Knoxville a place where everyone can comfortably and safely access active transportation, we're investing in a healthier, greener, more vibrant future.

- Zoe S. from Bike Walk Tennessee

Respondents from **urban and rural areas** were twice as likely to say they were interested in taking public transportation in the future (as compared to suburban respondents).





Transportation Measure 5. Accelerate the adoption of electric vehicles across the region

This measure aims to increase the adoption of electric vehicles (EVs) across the region through enhanced education, targeted incentives, and community partnerships. As EV ownership grows, new infrastructure and programs are needed to accommodate widespread use. Successful implementation will result in better air quality, reduced maintenance, and lower fuel costs for drivers.

How should this measure be implemented?

To expand the adoption of EVs, the Knoxville region should prioritize making EVs more accessible and affordable through infrastructure expansion and educational efforts. Expanding rebates and incentives for purchasing used EVs, deploying chargers in LMI communities, and creating EV carpool programs are priorities for implementation.

Education and outreach programs are also important for building public confidence in EVs. Community-led programs, such as ride-and-drive events and peer-to-peer workshops, provide an opportunity for residents to build trust around EVs. By combining these incentives, the region can support an inclusive and informed transition to clean mobility.

Measure 5 Direct Benefits



GHGs reduced 2022–2035: **66,967 MTCO₂e**

GHGs reduced 2022–2050: **5,149,946 MTCO₂e**

Annual Criteria Air Pollutant or Hazardous Air Pollutant emissions reduced (MT) 2025 to 2050:

- NO_x: **1,593.97**
- SO₂: **61.38**
- PM10: **55.38**
- PM2.5: **49.19**
- CO: **44,631.11**
- Lead: **0.00**

Measure 5 Co-Benefits

Discussed in detail in the sector-wide measure benefits section



Improved Air Quality and Healthy Communities



Noise Reduction



Cost Savings



Improved Equity

Core Actions

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Offer rebates and incentives for new and used EVs.



Phase 1: Explore	Phase 2: Build	Phase 3: Scale
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- Create or expand EV car share/carpool programs, especially in low-income housing and multifamily developments.
 - Example: EV car share program in Charlotte, NC,²⁵ or St. Paul, MN.²⁶

Supplementary Actions

Phase 1: Explore	Phase 2: Build	Phase 3: Scale
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- Identify and provide resources to make EV ownership, leasing, and rentals more affordable for LMI drivers.
 - Example: Explore programs such as CityCar that offer low-cost, short-duration EV rentals in urban areas.
- Launch incentive programs to encourage turnover of older, higher polluting vehicles.
 - Example: “Cash for Clunkers.”

Phase 1: Explore	Phase 2: Build	Phase 3: Scale
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- Provide EV education to reduce range anxiety and improve consumer understanding.
 - Example: Develop partnerships with dealerships and conduct ride-and-drive events to educate the public and boost EV market adoption (e.g., TDOT/Tennessee Electric Vehicle Infrastructure, Knoxville Electric Vehicle Association, Drive Electric TN’s Ride & Drive Events).

What are the anticipated challenges for implementation?

The availability of charging infrastructure and high upfront costs remain the greatest barriers to EV adoption. Since public transportation is limited and personal vehicles are often the most practical transportation option, EVs must be just as convenient and cost-effective as gas-powered cars.

As the region expands clean transportation options, it must also navigate competing priorities between electrifying personal vehicles and improving public and active transportation systems. Prioritizing EV investments could unintentionally create a further dependence on private vehicles and further mobility gaps.

Finally, EV use increases electricity demand, especially during the evening hours when people charge their vehicles, which can strain infrastructure. By investing in

²⁵ Carolina Carshare, n.d. “Carolina Carshare.” Available at: <https://www.charlottenc.gov/Streets-and-Neighborhoods/Parking-and-Streets/Carolina-Carshare>.

²⁶ Evie Carshare, n.d. “Evie Carshare.” Available at: <https://eviecarshare.com/>.



grid modernization technology and managing charging programs to shift demand, utility companies can integrate EVs as flexible grid-supporting assets.

How could we evaluate the success of this measure?

- Number of EV registrations
- Participation in EV rebate programs

What will this measure cost and how could it be funded?

While EVs offer long-term reduced costs on fuel and maintenance, high upfront costs—compared with gas-powered cars—can make them feel out of reach for many households. Subsidies and financing options highlighted below can bridge the gap, lowering costs for consumers. Incentive programs, such as vehicle repair assistance for low-income drivers or “Cash for Clunkers,”²⁷ can accelerate the turnover of high-emissions vehicles without a significant investment. Funding should also support equitable and affordable charging in multifamily housing, for renters, and expanded access to EV carpooling and smart trip programs.

	2035	2050	2025—2050
Initial Cost to Implement	\$1.66	\$ 697.23	\$5,769.74
Ongoing Cost to Implement	\$381.68	\$1,677.09	\$17,928.57

Note: Costs are in million USD (2025) and are bundled for Measures T4, T5, and T6.

Potential funding sources may include the following:

- Additional incentives, laws, and regulations are summarized at the Alternative Fuels Data Center at: https://afdc.energy.gov/laws/state_summary?state=TN
- Federal Highway Administration (FHWA) National Electric Vehicle Infrastructure Formula Program
- Federal Transit Administration (FTA) Low or No Emission Grant Program
- FHWA Charging and Fueling Infrastructure Grants
- U.S. EPA Diesel Emissions Reduction Program

Who are the key partners and programs to help implement this measure?

- **CBOs:** Lead outreach and education programs such as peer-led workshops or EV ride-and-drives to build trust and awareness.
- **City and County Governments:** Lead installation of EV chargers to support EV adoption.

²⁷ A program that offers residents cash or trades for older vehicles.



- **Drive Electric TN:** Promote EV adoption through education, outreach, and strategic planning by organizing community-based events.
- **Knoxville Electric Vehicle Association:** Organize monthly meetings to help educate EV adopters and host Ride-and-Drive events.
- **LPCs:** Develop and manage time-of-use charging and vehicle-to-grid (V2G) initiatives, including financial incentives such as charger rebates.
- **TVA:** Support EV adoption by partnering on the Fast Charge TN Network.
- **UTK Center for Transportation Research:** Provide technical assistance and expertise for outreach and deployment strategies to meet emission reduction goals.
- **Vehicle Manufacturers and Dealers:** Support bulk purchasing programs and help leverage subsidies to reduce costs.

Transportation Measure 6. Transition to electric and alternative fuel vehicles in public fleets

This measure aims to support the transition to EVs and alternative fuel vehicles (AFVs) in public fleets, including city and county governments, transit agencies, school districts, and waste haulers. Replacing high-emission vehicles with cleaner alternatives, especially in heavy-duty fleets, improves local air quality and can lower long-term operating costs. These upgrades also help normalize EV adoption in the region.

How should this measure be implemented?

The region's first priority is to identify vehicles that would provide the greatest benefits if electrified. Although they require high upfront costs, electrifying older school buses, garbage trucks, and other heavy-duty, short-run vehicles that are up for replacement first should be targeted for replacement. Charging infrastructure changes would also need to occur in parallel. Installing EV charging stations and alternative fuel infrastructure in municipal locations ensures that the new vehicles will run reliably. Effective coordination facilitated by regional planning agencies, state DOT, and technical experts such as

Measure 6 Direct Benefits



GHGs reduced 2022–2035: **655 MTCO₂e**

GHGs reduced 2022–2050: **50,363 MTCO₂e**

Co-pollutant reductions modeled under T5.

Measure 6 Co-Benefits

Discussed in detail in the sector-wide measure benefits section



Improved Air Quality and Healthy Communities



Noise Reduction



Job Creation and Workforce Development



Drive Electric Tennessee could help other parts of the Knoxville region electrify their fleet.²⁸

Core Actions		
Phase 1: Explore	Phase 2: Build	Phase 3: Scale
- Develop and adopt green fleet policies. - Examples: City of Knoxville Green Fleet policy, Tennessee Clean Fuels' Green Fleet certification program, KAT Decarbonization plan and electric buses. - Advocate for and participate in state and federal funding opportunities to support fleet transitions. - Electrify school bus fleets. - Example: Engage with local school leadership to promote the health benefits of electric buses (see electric bus adoption in Putnam County, TN, schools).		

Bonus Actions		
Phase 1: Explore	Phase 2: Build	Phase 3: Scale
Explore vehicle-to-grid (V2G) technologies and policies to enhance fleet resilience and reduce costs.		

What are the anticipated challenges for implementation?

EVs present new operational constraints for public fleets that need to be accounted for in planning efforts. For example, electric buses have a shorter range than diesel-powered vehicles, so routes may need to change or en route charging may need to be installed. Because many school buses in the Knoxville region are operated by private contractors, it is essential to engage these partners early in the process to ensure alignment.

While EVs and AFVs offer long-term savings through lower fuel and maintenance costs, their higher initial costs can pose financial barriers to public agencies. Additionally, limited market availability and higher prices for medium- and heavy-duty AFVs constrain procurement and fleet transition timelines.²⁹

²⁸ City of Knoxville, n.d. "Green Fleet Policy." Available at: https://www.tncleanfuels.org/wp-content/uploads/2023/06/City-of-Knoxville_Green-Fleet-Policy_FINAL.pdf.

²⁹ Axsen, J., & Pickrell-Barr, J, 2024. "What drives fleets? Organizations' perceived barriers and motivators for alternative-fuel vehicles." Available at: <https://www.sciencedirect.com/science/article/pii/S1361920924001779>.



Finally, utilities should ensure that the grid can support increased draws from city and county governments' EV fleets and general EV use. TVA and LPCs are already planning for this load growth across the region.

How could we evaluate the success of this measure?

- Number or percentage of fleet vehicles transitioned to EVs or AFVs
- Relative fleet operations and maintenance costs as fleets electrify over time

What will this measure cost and how could it be funded?³⁰

While long-term savings from reduced fuel and maintenance costs may offset some expenses, implementation requires a higher initial investment. Electric and alternate fuel buses and garbage trucks are initially more costly than their gas-powered vehicles today. To address this, the region can leverage existing federal and state grants/programs, such as EPA's Clean School Bus Program, to reduce upfront costs.³¹

Potential funding sources may include the following:³²

- EPA Clean Heavy-Duty Vehicle Program
- EPA Diesel Emissions Reduction Program
- FHWA Charging and Fueling Infrastructure Grants
- FHWA National Electric Vehicle Infrastructure Formula Program
- FTA Low or No Emission Grant Program
- IRA Alternative Fuel Vehicle Refueling Property Tax Credit
- IRA Clean Commercial Vehicle Tax Credit
- IRA Previously Owned Vehicle Tax Credit
- U.S. DOE Vehicle Technologies Office (VTO) Grants
- U.S. EPA Clean School Bus Program

Who are the key partners and programs to help implement this measure?

- **CAC/East Tennessee Human Resource Agency (ETHRA):** Support public EV access for low-income and vulnerable populations through mobility programs, community outreach, and human services.

³⁰ Costs are summarized in Measure T5.

³¹ EPA, 2025. "Clean Heavy-Duty Vehicles Grant Program." Available at: <https://www.epa.gov/clean-heavy-duty-vehicles-program/clean-heavy-duty-vehicles-grant-program>.

³² Alternative Fuels Data Center, 2024. "Tennessee incentives, laws, and regulations." Available at: https://afdc.energy.gov/laws/state_summary?state=TN.



- **City and County Governments:** Set green fleet policies, lead fleet transition planning, coordinate infrastructure upgrades, and facilitate interdepartmental collaboration.
- **Drive Electric TN:** Promote public EV adoption by providing technical support and assistance to public fleets.
- **KAT:** Demonstrate the viability of electric transit by sharing operational insights and help build public confidence in EV technology.
- **School Administrators and Private Bus Companies:** Oversee decisions related to transitioning school buses while collaborating with private bus operators.
- **TVA:** Support EV adoption by partnering on the Fast Charge TN Network.
- **UTK:** Continue to electrify the campus bus fleet, serving as a demonstration for public EV adoption, while contributing insight to help scale public EV adoption efforts.

Transportation Measure 7. Expand publicly accessible and private electric vehicle and alternative fueling infrastructure

This measure involves expanding EV and AFV infrastructure across the region, including installing fast chargers at key locations such as workplaces and multifamily housing units, as well as making alternative fueling options more accessible. Expanding EV and AFV infrastructure will make clean mobility more convenient and accessible across the region.

How should this measure be implemented?

Collaboration with LPCs and TVA can help identify charging solutions that reduce peak demand and ensure grid readiness. Chargers should be installed along key transit routes and corridors. Regional siting analyses and planning processes can help optimize the installation of chargers where people spend time, while ensuring coverage along motorways, such as at gas stations. Since 80% of charging occurs at home, ensuring access to public chargers in multi-unit across all income

Measure 7 Direct Benefits



GHG reductions modeled under T5.

Co-pollutant reductions modeled under T5.

Measure 7 Co-Benefits

Discussed in detail in the sector-wide measure benefits section



Expanded Tourism and Economic Development



Job Creation and Workforce Development



levels is essential for supporting a widespread transition.³³

Core Actions

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Research ways to leverage and apply current innovations in charging and grid resilience (such as bidirectional charging or vehicle-to-grid [V2G] technology).

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Conduct regional siting analyses to identify optimal locations for chargers at destinations where people stay for longer periods and in other high-priority areas.

Supplementary Actions

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Regularly inspect and maintain publicly accessible municipal chargers to ensure reliable service.
 - Example: Maintain charger status updates via PlugShare or similar platforms.
- Incentivize private businesses such as gas stations to install reduced-cost or free high-wattage chargers to expand the public charging network.

Bonus Actions

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Expand training and funding to grow the local EV infrastructure workforce.

What are the anticipated challenges for implementation?

High costs currently restrict EVs and infrastructure to wealthier households. To improve equity, data can be used to identify underserved areas and trusted community organizations could be engaged to help site and host chargers. Current EV battery warranties often discourage vehicle-to-home (V2H) and vehicle-to-grid (V2G) applications as these uses may fall outside the covered conditions and risk

³³ U.S. Department of Energy, n.d. "National EV Charging Network." Available at: <https://www.energy.gov/topics/national-ev-charging-network>.



voiding the warranty. Targeted rebates or incentives could help offset the financial barriers of these modifications and promote resilience solutions.

General reliability and trust in the network are essential for EV deployment. Chargers and infrastructure must be consistently operational and easy to locate as poor reliability and accessibility can undermine public confidence and stall progress. Government regulators and utilities should coordinate grid modernization and increase capacity to avoid any negative effects on power availability and consumer costs. Additionally, it is important that once infrastructure is installed, it remains operational, which requires dedicated upkeep.

How could we evaluate the success of this measure?

- Total number and geographic coverage of public and private charging stations

What will this measure cost and how could it be funded?³⁴

Cost-sharing models among city and county governments, public agencies, TDOT, and private businesses can help balance the cost burden of charger installation and maintenance. Long-term savings from reduced gasoline and diesel use can offset upfront costs.

Potential funding sources may include the following:

- EPA Clean Heavy-Duty Vehicle Program
- EPA Diesel Emissions Reduction Program
- FHWA Charging and Fueling Infrastructure Discretionary Grants
- FHWA National Electric Vehicle Infrastructure Formula Program
- FTA Low or No Emission Grant Program
- IRA Alternative Fuel Vehicle Refueling Property Tax Credit
- TVA and TDEC Fast Charge TN Network
- U.S. EPA Clean School Bus Program

Who are the key partners and programs to help implement this measure?

- **City and County Governments:** Lead regional planning efforts and coordinate public charger stations in the region.
- **LPCs:** Assist with charger siting, ensuring equity considerations and grid integration.

³⁴ Costs are summarized in Measure T5.



- **Public and Private Partners:** Install and maintain charging stations in optimal locations. Identify key entities to partner with through charging implementation studies.
- **TDOT:** Integrate EV infrastructure into transportation projects, ensuring strategic investment and deployment, and addressing gaps with grant offerings.
- **TVA:** Incentivize EV infrastructure development through community programs, education, and expansion.
- **UTK Center for Transportation Research:** Provide technical expertise through data-driven decision-making to guide the transition.

Transportation Measure 8. Optimize and improve the efficiency of freight routes

This measure serves to improve the efficiency of freight routes by using data to find the shortest path for delivery vehicles or trains, minimizing idling, saving travel time, and reducing unnecessary fuel consumption. Investments in route optimization technologies, such as smart planning platforms and real-time traffic management systems, can enhance efficiency.³⁵

How should this measure be implemented?

Implementing freight route optimization involves a coordinated effort across infrastructure, technology, and policy. Initial priorities could include developing hybrid freight/passenger rail lines to shift freight activity away from roads. Over time, the region can expand these efforts by deploying traffic management systems in congested areas and designating priority freight corridors.

To support businesses adopting these changes, the region could provide training and outreach on route optimization and idle reduction strategies. Other strategies involve creating peer-to-peer learning networks for freight companies and incentivizing zero-emission freight technology, such as all-electric delivery vehicles. Demonstrating earlier success through partnerships and pilot projects can build trust and further business participation.

Measure 8 Co-Benefits

Discussed in detail in the sector-wide measure benefits section



Cost Savings



Improved Air Quality and Healthier Communities



Traffic Improvement

³⁵ EPA, 2024. "Idle Reduction." Available at: <https://www.epa.gov/smartway/idle-reduction>.



Core Actions

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Support public-private partnerships to utilize rail lines for both freight and passenger transport.

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Promote the electrification of freight systems, including trucks and rail where feasible.
- Develop maps that identify areas with grid capacity constraints to help prioritize electric truck charger locations that will not require major grid upgrades.

Supplementary Actions

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Explore idle air solutions at truck stops.
 - Example: Electrified parking spaces provide a power connection so the driver can use electricity for heating and air conditioning without having to run the engine.

What are the anticipated challenges for implementation?

Companies may hesitate to adopt new freight efficiency and electrification technologies without clear financial benefits and technical support. High upfront costs for infrastructure upgrades may limit participation, especially for smaller freight operators. Like EV deployment, the electrification of freight systems could strain the grid if not accounted for in resilience planning.

Dedicated freight lanes could have negative effects on communities near roadways. Construction introduces environmental effects, including an increase in impervious surfaces that may worsen flood risks and urban heat island effects, as well as changes in traffic patterns that affect the surrounding neighborhoods. Community engagement throughout the planning and implementation process is crucial to ensure that disruptions are minimal and temporary.

How could we evaluate the success of this measure?

- Trends in total freight-miles traveled (validated through regional freight data)
- Number of electric freight vehicles adopted



What will this measure cost and how could it be funded?³⁶

Many freight optimization strategies are relatively low-cost (e.g., digital route planning, idle reduction training), which can deliver immediate benefits. However, infrastructure changes may require more substantial investment. These costs can be mitigated by promoting private investment. For small- and mid-sized freight operators, offering incentives for adopting truck electrification and idle reduction technologies can help reduce financial barriers. Additionally, grid upgrade costs can be mitigated through the strategic siting of truck chargers.

Potential funding sources may include the following:

- FHWA Surface Transportation Block Grant (STBG) Program
- FTA Capital Investment Grants
- FTA Grants – Urbanized Area Formula Program

Who are the key partners and programs to help implement this measure?

- **Private Sector:** Implement optimized routing, idle reduction, and fleet electrification measures.
- **TDOT:** Support corridor designations and freight company truck electrification efforts.
- **TVA and LPCs:** Plan and build out infrastructure to support freight electrification by strategically siting charging stations and making minimal grid upgrades.

Transportation Measure 9. Improve transportation systems through sustainable construction practices

Sustainable construction practices can improve transportation systems by extending the life of infrastructure while minimizing waste and reducing fuel. This measure focuses on using electric equipment, recycling waste, procuring low-carbon materials, prioritizing retrofit over replacement, and integrating green infrastructure where possible. These actions can save on costs and improve resilience.

³⁶ GHG emissions were not modeled for this measure and thus this measure was excluded from cost modeling.



How should this measure be implemented?

City and county governments and contractors should integrate low-carbon, reusable, and green infrastructure into project planning from the outset. Prioritizing reuse and retrofit over replacement, conducting lifecycle cost assessments, and requiring sustainability evaluations during project scoping can shift projects toward greener, more resilient infrastructure. Planners should also design detours that maintain safe, accessible routes for pedestrians and drivers during construction projects. Additionally, training programs for contractors and inspectors can build familiarity with climate-friendly techniques.

Measure 9 Direct Benefits

GHGs reduced 2022–2035: **4,380 MTCO₂e**

GHGs reduced 2022–2050: **41,418 MTCO₂e**

Annual Criteria Air Pollutant or Hazardous Air Pollutant emissions reduced (MT) 2025 to 2050:

- NO_x: **298.67**
- SO₂: **0.61**
- PM₁₀: **27.18**
- PM_{2.5}: **25.30**
- CO: **7,195.96**
- Lead: **0.00**

Measure 9 Co-Benefits

Discussed in detail in the sector-wide measure benefits section



Improved Air Quality and Healthier Communities



Noise Reduction



Job Creation and Workforce Development



Increased Resilience



Core Actions

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Review opportunities to create incentive programs (e.g., grants, subsidies, tax credits, contractual specifications) for contractors using electric equipment.
- Update city and county specifications for construction materials to achieve lower carbon objectives while maintaining performance and safety standards.
- Minimize idling time and optimize construction schedules and equipment usage to reduce emissions.

Secondary Actions

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Encourage the use of recycled materials (e.g., tires, glass sand) in asphalt and concrete for transportation projects.
- Require assessments of retrofit versus replacement options in infrastructure projects.

Bonus Actions

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Explore alternative materials for sidewalks that resist heat absorption and root disruption.
 - Example: Test light-colored asphalt or porous concrete alternatives for sidewalks.

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Close the construction material lifecycle by supporting the development of markets for reclaimed materials and upgrading collection and resale sites.

What are the anticipated challenges for implementation?

Many contractors and inspectors may be unfamiliar with climate-friendly techniques such as warm mix asphalt or permeable pavement. These new technologies may require specialized skills that require upfront investment in training and certifications.

How could we evaluate the success of this measure?

- Number of jobs created in advanced manufacturing and sustainable construction in the region



- Number of infrastructure projects that use low embodied carbon or recycled materials

What will this measure cost and how could it be funded?

While sustainable materials can reduce lifecycle costs, they often carry higher upfront costs. Securing consistent funding from federal and local programs is important. Promoting the use of recycled and reused materials, when available and cost-effective, can lower material procurement costs and emissions, while designing projects for durability and efficiency minimizes lifecycle expenses. City and county governments can further offset costs by developing property tax incentives to encourage the use of longer lasting, sustainable building materials.

	2035	2050	2025—2050
Initial Cost to Implement	\$2.21	\$12.16	\$136.32
Ongoing Cost to Implement	\$0.01	\$0.04	\$0.44

Note: Costs are in million USD (2025).

Potential funding sources may include the following:

- FHWA Highway Safety Improvement Program
- FHWA STBG Program
- FTA Capital Investment Grants

Who are the key partners and programs to help implement this measure?

- **City and County Governments:** Update design standards, especially in vulnerable and disadvantaged areas.
- **Construction Companies and Contractors:** Participate in low-waste materials procurement deals and workforce development efforts to train employees and contractors.
- **Low-Waste Construction Materials Providers:** Ensure that a supply of necessary low-carbon, recycled, or other low-waste materials are available for procurement.
- **Recycling Partners:** Ensure that there is recycling infrastructure in place for construction materials such as concrete, even if facilities are not immediately available within the region.
- **TDEC:** Develop and enforce policies that promote sustainable materials and recycling.
- **TDOT:** Lead implementation of sustainable practices during transportation construction.



- **UTK:** Research and pilot new and existing low-waste materials and construction technologies while developing performance data.

Transportation Measure 10. Improve transportation system efficiency to reduce traffic volume, congestion, and idling

This measure improves the region's transportation system through traffic management systems, which enhance operations and upgrade targeted infrastructure to reduce overall vehicle-miles traveled, congestion, and idling. Traffic management systems improve efficiency for existing road systems through tools such as intersection optimization, signal coordination, and real-time traffic monitoring. Broader infrastructure projects such as new road construction, transit system upgrades, integrating sidewalks and bike lanes, and smart mobility programs such as optimizing signal timing and optimizing route efficiency can further improve the transportation system.

Measure 10 Co-Benefits

Discussed in detail in the sector-wide measure benefits section



Improved Air Quality and Healthier Communities



Traffic Improvement



Increased Connectivity and Mobility

How should this measure be implemented?

This measure can be achieved through low-lift policy changes, technology installations, and/or infrastructure changes. Ideally, these improvements occur in parallel to maximize the efficiency and benefits for the community; however, any one of these actions, on its own, can serve to improve transportation outcomes in the region.

In addition, outreach programs, such as no idle zones, roundabouts, and park-and-ride facilities, could support widespread adoption of these solutions. Public engagement campaigns can also highlight the benefits of these programs. Any infrastructure or policy changes should be incorporated into driving education, as well as public safety campaigns. Businesses can also serve as important partners by better connecting their facilities to the broader transport network by adding bike racks, enhancing pedestrian access, or coordinating transit stops.



Core Actions

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Reduce school bus and all vehicle idling in school zones.
 - Example: Implement school-based campaigns encouraging drivers to wait inside cooled buildings rather than in idling vehicles and implement “no idling” policies at schools.
- Coordinate traffic signals that lead to reduced vehicle stops and optimized traffic flow.

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Promote the installation of roundabouts where appropriate to improve traffic flow, reduce congestion, and lower emissions.

What are the anticipated challenges for implementation?

Behavioral change and public perception present challenges for combating idling and operations. Any major infrastructure or transit system changes should actively engage the communities most affected by them to build public trust and prevent unintended effects.

How could we evaluate the success of this measure?

- Average commute times and other traffic congestion metrics

What will this measure cost and how could it be funded?³⁷

Implementing these low-cost solutions can produce high impact benefits more immediately than more expensive major infrastructure projects. Initiatives such as signal retiming and optimization can ease congestion and reduce emissions with minimal investment, while adaptive signal control systems could be installed later to provide long-term efficiency gain. Anti-idling campaigns in schools and community hubs can be implemented at minimal cost. Over the long-term, once funding is acquired, larger infrastructure projects and technologies could be implemented; however, low-cost initiatives should lead the way.

Potential funding sources may include the following:

- FHWA Carbon Reduction Program
- FHWA Congestion Mitigation and Air Quality Improvement Program

³⁷ GHG emissions were not modeled for this measure and thus this measure was excluded from cost modeling.



- FHWA Highway Safety Improvement Program
- FHWA STBG Program
- FTA Bus and Bus Facility Grants
- FTA Capital Investment Grants
- FTA Urbanized Area Formula Program

Who are the key partners and programs to help implement this measure?

- **City and County Governments:** Lead traffic optimization efforts and park-and-ride development programs.
- **ORNL:** Provide modeling and simulation support for immediate and long-term traffic flow improvements.
- **School Boards, Superintendents/Principals, Parent-Teacher Association/Parent-Teacher Organization Groups:** Implement anti-idling programs, coordinate information sharing to parents on the health benefits of low or no idle.
- **TDOT:** Support freight and interstate bus lane planning and traffic management.
- **TPO:** Coordinate planning and improvement efforts while leading studies on transportation system efficiency.

Transportation Measure 11. Improve public transit infrastructure

This measure expands and improves public transit infrastructure to create safe, reliable, and affordable options for the region. Key improvements include increasing transit service frequency, improving transit stop amenities, and making first-mile/last-mile connections more efficient so that transit is a viable alternative to single-occupancy vehicle travel. These changes would provide more mobility options for residents to access work and amenities.



How should this measure be implemented?

Expanding public transit begins with targeted investments that make transit safe, reliable, and convenient for communities in the region. The most significant barrier to public transit use is the first-mile/last-mile journeys that determine whether people can reach the transit stop itself. Infrastructure that supports access to transit stops, such as sidewalks, crosswalks, and park-and-ride facilities, can incentivize people to make the switch. The region could create partnerships to incentivize services such as e-bikes and scooters, making it easier for riders to connect to transit systems. As the public transit system expands route coverage and increases service frequency, strategically siting new stops in easily accessible locations ensures that the service benefits everyone.

Additionally, outreach campaigns could highlight the affordability, convenience, and environmental benefits of the updated system to encourage ridership. Other actions, such as a bus rapid transit system with dedicated bus lanes and improved onboard amenities, could further encourage ridership while decreasing current trip times.

Measure 11 Direct Benefits



GHGs reduced 2022–2035: **496,741 MTCO₂e**

GHGs reduced 2022–2050: **2,020,334 MTCO₂e**

Co-pollutant reductions modeled under T5

Measure 11 Co-Benefits

Discussed in detail in the sector-wide measure benefits section



Improved Air Quality and Healthier Communities



Traffic Improvement



Increased Connectivity and Mobility



Improved Equity



Expanded Tourism and Economic Development

Core Actions

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Explore first-mile/last-mile connections to connect to public transit.
 - Example: Improved sidewalks, bike storage, greenways, bike lanes, scooter and bike share programs, and active transportation infrastructure.
 - Example: katConnect is a pilot program for an on-demand transportation service connecting passengers to fixed-route services.
- Improve transit stop safety and comfort with design enhancements such as increasing lighting, adding shelters, and planting trees to add shading.
- Ensure that wait times are accurate and reliable.



- Increase bus service frequency and reduce wait times to make transit a viable option for more residents.
- Promote building density within 0.5 mile of bus stops to encourage transit-supportive development.

Supplementary Actions

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Launch regional commuter public transportation and consider design options to promote accessibility, such as park-and-ride networks and lots.

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Increase availability and access to public transit options and stops, particularly surrounding city and suburban centers.
 - Example: Improve sidewalks and pedestrian access around bus stops.

Bonus Actions

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Promote commuting by public transit by providing Wi-Fi and power outlets on buses.
- Provide backup transportation options for riders missing the last scheduled bus.
 - Example: Limited late-night service or rideshare subsidies.
- Add direct bus routes to major regional destinations.
 - Example: Add service routes connecting downtown Knoxville to Dollywood and the airport.

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Offer free or reduced-cost public transit options to lower barriers.
 - Example: The KAT bus provides low fares for the general public, free rides for youth, and discounts to disabled persons and the elderly.

What are the anticipated challenges for implementation?

Currently, the region does not have a fixed-route transit system with full geographic coverage. KAT buses primarily serve the core Knoxville area and do not connect major regional destinations, such as McGhee-Tyson Airport, UTK, and ORNL. Where public transit is available, the stigma against using it persists. Involving key stakeholders, such as bus riders, active transport users, and community groups, in planning and decision-making ensures that infrastructure investments reflect users' needs and capture potential new riders. Increasing ridership overall can help reduce



the stigma and boost support for public investment in improved transit systems. Further network expansion under KAT's transit plan provides a path that aligns with the region's broader climate and resilience goals.³⁸ Additionally, individual financial barriers exist that can be reduced through fare subsidies or zero-cost programs.

How could we evaluate the success of this measure?

- Trends in transit ridership and satisfaction over time
- Number of new bus routes and riders
- Frequency of service (headways and wait times)
- Number of bus stops with shelters, lighting, and shaded areas

What will this measure cost and how could it be funded?

New infrastructure and expanding fleets require high upfront costs. By prioritizing short-term solutions that are low-cost and have a high impact, such as bus stop infrastructure and park-and-ride zones, community members can feel the immediate effects of a better transit system. Pairing this with outreach initiatives could help reduce the public stigma and encourage use. State and federal transit funding sources should be leveraged for infrastructure upgrades.

	2035	2050	2025—2050
Initial Cost to Implement	\$1,604.80	\$6,313.91	\$66,625.62
Ongoing Cost to Implement	\$1,023.92	\$4,101.65	\$42,991.52

Note: Costs are in million USD (2025) and are bundled for Measures T10 and T11.

Potential funding sources may include the following:

- FHWA Carbon Reduction Program
- FHWA Congestion Mitigation and Air Quality Improvement Program
- FHWA Highway Safety Improvement Program
- FHWA STBG Program
- FTA Bus and Bus Facility Grants
- FTA Capital Investment Grants
- FTA Low or No Emission Vehicle Program
- FTA Urbanized Area Formula Grants
- TDOT IMPROVE Transit Investment Grant Program for bus stop improvements

³⁸ Knoxville Area Transit, 2023. "Knoxville Area Transit Decarbonization Plan." Available at: <https://katbus.com/wp-content/uploads/2023/07/KAT-Decarbonization-Plan-02-21-23-1.pdf>.



- U.S. DOT Better Utilizing Investments to Leverage Development (BUILD) Grant Program

Who are the key partners and programs to help implement this measure?

- **CAC/ETHRA:** Lead inclusive planning efforts and partner with local agencies to address transportation barriers through community-based solutions.
- **City and County Governments:** Lead regional transit planning and infrastructure improvements while considering key entities and prioritizing underserved communities. Fund the expansion of transit services throughout the region.
- **KAT:** Lead implementation of transit infrastructure improvements and conduct first-mile/last-mile studies to improve public accessibility.
- **TDOT:** Fund infrastructure projects, coordinate with housing partners, and expand rural access through inclusive planning and investment strategies.
- **TPO:** Coordinate transit expansion and prioritize project funding.



Transportation Measure 12. Boost active transportation systems

This measure aims to enhance active transportation systems in the region by expanding and marketing safe, reliable, and affordable options. Active transportation options involve non-vehicular “pedestrian” travel such as walking or running, along with biking, scootering, and even activities such as roller-skating.

How should this measure be implemented?

The first priority for implementing this measure is to make infrastructure changes and improvements. Residents need safe, comfortable, and accessible pathways to feel confident switching their car ride to a walk or bike ride. Investments in programs that reduce the cost of e-bikes and educate residents about bike safety can make these options easier to choose.

The region could also expand “Open Streets” events, where roads are closed to vehicles to encourage more pedestrian activity. Knoxville has hosted open streets events that bring people from surrounding areas to enjoy safe, comfortable, car-free movement and activities.

Measure 12 Direct Benefits



CHG reductions modeled under T11.

Co-pollutant reductions modeled under T5.

Measure 12 Co-Benefits

Discussed in detail in the sector-wide measure benefits section



Improved Air Quality and Healthier Communities



Noise Reduction



Cost Savings



Traffic Improvement



Expanded Tourism and Economic Development

Core Actions

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Provide parking options and safe storage for bikes.
- Implement protected bike infrastructure to prioritize safety.
 - Example: Bike lanes separated from traffic by fixed bollards, curbs, and/or on-street parking.
 - Develop and implement a comprehensive pedestrian and bicycle master plan to identify and prioritize infrastructure needs.

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Expand sidewalk, bike, and greenway connectivity to close gaps and link more neighborhoods to destinations. As a part of this, consider comfort



features such as shade, benches, lighting, and signs to make walking and biking more feasible for all ages, abilities, and seasons.

- Prioritize dedicated bike lanes and pedestrian spaces in downtown areas and transit corridors.
- Improve safe routes to schools by planning for connected sidewalks, crossings, and neighborhood engagement.

Supplementary Actions

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Work with the community to map and analyze traffic, transit use, and safety data, using tools such as heat maps to prioritize safe and accessible transportation investments.

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Allow scooters on greenways and downtown while ensuring safety for pedestrians.
- Expand existing active mobility options, such as e-bike incentives, rental programs, and partnerships with providers, to keep fleets efficient and available.

Bonus Actions

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Test temporary but regularly scheduled street closures on select days to allow for car-free events and encourage active transportation.

What are the anticipated challenges for implementation?

This measure requires significant infrastructure changes to make active transit options available, and these changes require an upfront investment. Efforts to improve accessibility and repair sidewalks often conflict in the region with car-oriented infrastructure. In areas with heavy traffic, ensuring safe pedestrian crossings and accessible routes is important for universal accessibility.

How could we evaluate the success of this measure?

- Miles of bike lanes and sidewalks
- Miles of greenway
- Pedestrian and bike crashes and fatalities



What will this measure cost and how could it be funded?³⁹

Implementing the strategy to enhance active transit options in the region requires significant upfront investment in infrastructure, planning, and coordination. Costs may include new bike lanes and sidewalk improvements. While initial expenses are high, long-term benefits include reduced emissions, improved mobility and health, and greater transportation equity.

Potential funding sources may include the following:

- FHWA Congestion Mitigation and Air Quality Improvement Program
- FHWA STBG Program
- FHWA Transportation Alternatives Funds
- FTA Bus and Bus Facility Grants
- FTA Capital Investment Grants
- FTA Urbanized Area Grants
- Grants from U.S. DOT, TDOT, and other nongovernmental organizations focused on transportation, smart cities, and public health (e.g., TDOT Transportation Alternatives Program)
- Local community resources
- Public-private partnerships
- Safe Routes to School Programs

Who are the key partners and programs to help implement this measure?

- **CBOs:** Engage with and educate communities to ensure that transit improvements reflect local needs and benefit all.
- **City and County Governments:** Oversee the budget amendments necessary to make infrastructure changes to support active transportation.
- **Construction Contractors:** Build infrastructure updates (e.g., widened sidewalks, expanded bike lanes).
- **Local Businesses:** Install infrastructure such as bike racks.
- **School Boards and District Officials:** Review and approve a curriculum for bike and pedestrian safety and review bike safety for school routes.

³⁹ Costs are summarized in Measure T10.



- **TPO:** Facilitate the development and operations of programs and policies that expand and manage alternative transportation systems.

Transportation Sector Measure Benefits

Improved Air Quality and Healthier Communities

Gasoline- and diesel-powered cars are a major source of GHG emissions, solid particulate matter, and chemical air pollutants. Reducing the use or idling of these vehicles through Measures T5, T6, T8, T9, T10, T11, and T12 can reduce local air pollution, which improves public health and mitigates urban heat island effects.⁴⁰ Measures T10 and T11 also support healthier communities by building physical activity into daily transportation.

Noise Reduction

Reducing the use of internal combustion engine vehicles through Measures T5, T6, and T12 can reduce noise pollution along transportation corridors and in areas where heavy vehicles, such as garbage trucks, operate. Measure T9 aims to reduce noise from construction projects by shifting to electric equipment. Lower noise levels can reduce stress from traffic noise, particularly in dense urban areas.⁴¹

Job Creation and Workforce Development

Measures T6, T7, and T9 can create new local jobs to support EV charging infrastructure development and maintenance, vehicle maintenance, grid energy management, and sustainable construction. These roles require specialized training and certifications, opening pathways to jobs in clean energy, manufacturing, materials testing, and infrastructure installation.

Cost Savings

Measure T5 lowers costs by promoting EVs, which offer a cheaper total cost of ownership compared with internal combustion vehicles due to lower long-term fuel and maintenance costs.⁴² Measure T8 reduces costs for businesses by optimizing

⁴⁰ Guo, et al, 2024. "Fifteen Pathways between Electric Vehicles and Public Health: A Transportation–Health Conceptual Framework." Available at: <https://pmc.ncbi.nlm.nih.gov/articles/PMC11667283/#:~:text=The%20adoption%20of%20EVs%20diminishes,24%2C25>; U.S. EPA. "What Are Heat Islands?" Available at: <https://www.epa.gov/heatislands/what-are-heat-islands#causes>

⁴¹ Mohamed, A-M. O., Paleologos, E. K., and Howari, F. M, 2021. "Chapter 19 - Noise pollution and its impact on human health and the environment." Available at: <https://www.sciencedirect.com/science/article/abs/pii/B9780128095829000190>.

⁴² Energy Innovation, 2022. "Most Electric Vehicles are Cheaper Off the Lot than Gas Cars." Available at: <https://energyinnovation.org/wp-content/uploads/2022/05/Most-Electric-Vehicles-Are-Cheaper-Off-The-Lot-Than-Gas-Cars.pdf>.



delivery routes, thus improving efficiency in goods transportation. Measure T12 offers more affordable transportation options, including rental and rebate options for bikes, e-bikes, and scooters.

Traffic Improvement

Measures T11 and T12 reduce the number of cars on the road, providing a long-term reduction for traffic congestion. Measures T10 and T8 improve traffic management, reducing stop-and-go traffic. Together, these measures reduce both travel times and fuel consumption.

Increased Connectivity and Mobility

Measure T11 strengthens public transit infrastructure, creating connections among urban, suburban, and rural areas, thus ensuring that all communities have access to mobility options. Measure T10 improves public transit (e.g., direct bus routes), further improving mobility options.

Improved Equity

Measures T5 and T11 improve transportation equity and access in underserved communities. Measure T5 focuses on expanding EV access through rebates, flexible leasing, and carpool programs to reduce the barriers faced by historically marginalized populations. Measure T11 complements these efforts by increasing transit routes and frequency in LMI neighborhoods, thus enhancing connectivity to jobs, schools, and essential services. Together, these measures promote inclusive mobility, reduce transportation-related economic disparities, and support community well-being.

Increased Resilience

Measure T9 encourages the use of low-carbon infrastructure practices such as permeable pavements and tree-lined corridors that help mitigate risks such as floods, heavy downpour, and extreme heat, thus enhancing resilience.

Expanded Tourism and Economic Development

Expanding multimodal transportation is a key strategy for supporting tourism and local businesses across East Tennessee. By making transit convenient for reaching the region's attractions, Measure T11 can broaden visitor access. Additionally, building out charging infrastructure for EVs along major routes and scenic locations through Measure T7 enhances East Tennessee's appeal to eco-conscious travelers, further supporting small business growth and regional economic development. Measure T12 focuses on active transportation, supporting the growth of bicycle and pedestrian infrastructure to connect communities, shopping districts, and outdoor recreation areas, which encourages foot traffic and spending at local businesses.



Waste Sector

The Knoxville region's Waste sector includes both wastewater and solid waste, encompassing everything from the water that goes down household drains, to food waste from restaurants, to the electronic waste of old computers. Limiting the amount of waste that goes to landfills through recycling and composting and other measures not only reduces emissions and improves air quality, it also has economic and public health co-benefits. Improving hazardous waste management programs can help keep hazardous materials from polluting soil and water. Limiting food waste through meal planning and food recovery programs will lower household and business costs and increase equitable access to food, especially for low-income communities.

Waste Measures

W13. Reduce or divert waste going to landfills and improve wastewater treatment plant operations

W14. Implement organic waste management programs



GHG emissions sources: Wastewater treatment plants; landfills.

Methane and other greenhouse gases are released as bacteria break down organic matter in landfills and in wastewater treatment plants. These gases are a natural byproduct of the decomposition process. Methane is an especially potent greenhouse gas, trapping more heat than carbon dioxide. Just a small amount can contribute to a more extreme warming effect, in comparison to other gases like carbon dioxide. Landfills can contribute to the contamination of water and soils with heavy metals such as arsenic, lead, and mercury.



1.42 MMTCO₂e

emitted in 2022 from the
Waste sector, representing **9%**
of regional emissions.

7.9 MMTCO₂e

**reduced cumulatively from 2022
to 2050** if the Knoxville region
successfully implements these
measures.



What does the region's Waste sector look like now?

8% of waste

in Knoxville is recycled.

79,894 tons of waste

generated in Knoxville in 2024.

17% of waste

placed in recycling bins in Knoxville is non-recyclable, in comparison to a 25% national average.

What are community members saying about waste reduction actions?

60% of respondents

reduce waste by recycling, reusing, or composting.

67% of respondents

said recycling and composting is very beneficial for communities.

How are community members taking action to reduce waste?

9.1 tons of food

were collected for compost in Knoxville in 2024.

~50% of households

are enrolled in Knoxville's free curbside recycling pickup program.



Knoxville Utilities Board operates **four wastewater treatment plants** in the region.

The Kuwahee Wastewater Treatment Plant is the largest and can process **44 million gallons of wastewater per day**.



Waste Measure 13. Reduce or divert waste going to landfills and improve wastewater treatment plant operations

This measure aims to reduce the amount of waste produced by the region and improve the operations of wastewater treatment plants. It diverts and minimizes waste streams to landfills through engagement, education, and expanding reuse, recycling, and safe disposal programs.

How should this measure be implemented?

Partnerships with businesses, organizations, and residents are crucial to support and expand waste diversion infrastructure and connect people with existing services. There should be information about waste reduction that is accessible to diverse audiences, including non-English speaking communities and those with limited access to technology.

Measure 13 Direct Benefits

GHGs reduced 2022–2035: **532,577 MTCO₂e**

GHGs reduced 2022–2050: **6,140,050 MTCO₂e**

Annual Criteria Air Pollutant or Hazardous Air Pollutant emissions reduced (MT) 2025 to 2050:

- NOx: **267.96**
- PM: **113.88**
- CO: **5,024.20**
- VOCs: **27.47**

Measure 13 Co-Benefits

Discussed in detail in the sector-wide measure benefits section



Cost Savings



Improved Air Quality and Healthier Communities

Core Actions

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Encourage waste reduction in businesses and at community events (e.g., restaurants, bars, coffee shops, neighborhood organizations, festivals) by focusing on reusable items, recycling, and minimizing single-use disposables.
- Encourage construction, demolition, and other commercial sectors to purchase recovered materials and adopt recycling and diversion practices.
- Install on-site renewable energy generation at wastewater treatment plants and landfills.

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Provide accessible recycling infrastructure, including curbside recycling pickup, drop-off locations, and bins for residential, commercial, and multifamily units.



- Promote awareness about how community members can dispose of household hazardous waste at the Knox County/City of Knoxville's Household Hazardous Waste Facility.
- Implement anaerobic digestion at wastewater treatment plants.
 - Example: The anaerobic digester in Sevier County accepts wastewater sludge.

Supplementary Actions

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Coordinate with local and regional community members, businesses, and organizations to anticipate new streams of recyclables (e.g., EV batteries) and how to manage them.
- Assess the feasibility of implementing and expanding hazardous waste pickup sites.

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Host sharing events and open donation centers to help residents mend, repurpose, or rehome items instead of discarding them.

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Designate pickup locations and schedules for bulky items (e.g., furniture, appliances, other large items) to prevent dumping.
 - Example: The City of Knoxville provides curbside bulky pickup for residents.

Bonus Actions

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Provide tours of the materials recovery facility and look for other opportunities to provide access to recycling and material processing facilities to build public confidence in the process.

What are the anticipated challenges for implementation?

Reducing landfill waste requires active engagement from residents, businesses, and the waste management sector. Implementation may require people to change their personal habits and commercial practices that are more convenient.



How could we evaluate the success of this measure?

- Number of households participating in both curbside and drop-off recycling programs
- Quantification of materials that are landfilled and recycled or otherwise diverted

What will this measure cost and how could it be funded?

This measure requires investment and buy-in across community members, including private developers, city and county governments, and businesses. Costs will include expanding infrastructure, covering labor expenses, and funding public communications.

	2035	2050	2025—2050
Cost of Recycling	\$13.78	\$52.14	\$551.80

Note: Costs are in million USD (2025).

Potential funding sources may include the following:

- EPA Consumer Recycling Education and Outreach Grant Program
- EPA Water Reuse Infrastructure Funding Programs
- TN Department of Environment and Conservation Waste Reduction Grants
- U.S. EPA Solid Waste Infrastructure Recycling Grant Program
- USDA Rural Energy for America Program Renewable Energy Systems & Energy Efficiency Improvement Guaranteed Loans and Grants
- USDA Solid Waste Management Grants

Who are the key partners and programs to help implement this measure?

- **City and County Governments:** Oversee and implement waste reduction and recycling systems.
- **Materials Recovery Facilities (such as Smurfit WestRock):** Work with recycling facilities to assess contamination rates and types, and provide information to the public about what is recyclable.
- **Nonprofits (e.g., Keep Knoxville Beautiful, Keep Blount Beautiful, Keep the Tennessee River Beautiful, Ijams Nature Center):** Provide community engagement campaigns and events regarding recycling and waste reduction initiatives.
- **Waste Haulers:** Implement transparent and efficient recycling and waste collection. Decarbonize the hauling fleet.



Waste Measure 14. Implement organic waste management programs

This measure aims to reduce the amount of organic matter sent to landfills by conducting community engagement and implementing education, food recovery, and expanding composting programs.

How should this measure be implemented?

Implementation should focus on a mix of education, infrastructure, and support. Workshops can help residents and businesses understand how composting works and why it matters, that public drop-off sites make composting more convenient, and offering tools and guidance to individuals and businesses can help ensure that everyone can participate.

Partnering with local organizations can help raise awareness about food recovery and organic waste diversion. Connecting food-related businesses and institutions with farms can create a circular organics economy—where food scraps become valuable compost instead of going to waste. Establishing industrial composting facilities in the region is a critical step toward scaling up this measure in the long-term.

Measure 14 Direct Benefits



GHGs reduced 2022–2035: **155,439 MTCO₂e**

GHGs reduced 2022–2050: **1,799,564 MTCO₂e**

Co-pollutant reductions modeled under W13.

Measure 14 Co-Benefits

Discussed in detail in the sector-wide measure benefits section



Cost Savings



Improved Air Quality and Healthier Communities

Core Actions

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Partner with universities or private partners to establish a regional commercial composting facility that is open to the public.

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Expand access to backyard and community composting programs through educational workshops.
- Collaborate with organizations to raise awareness about food insecurity, food recovery, and organic waste diversion.
 - Example: UTK's food4VOLS collection program or Second Harvest of East Tennessee's food collection/redistribution effort.



- Provide public compost drop-off sites, tools, and ongoing support to individuals and businesses who wish to compost.
 - Example: City of Knoxville's Compost Project, with Green Heron Compost Services, and community farms.
- Add leaf and brush pickup to collection programs to divert grass clippings, leaves, and other yard waste from landfills.

Supplementary Actions

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Connect restaurants, grocery stores, and institutions with unrecoverable food waste to farms and organics processing facilities to promote a circular organics economy.

Bonus Actions

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Integrate food waste pickup with government-operated brush and leaf pickup.

What are the anticipated challenges for implementation?

Reducing organic waste in landfills requires participation from residents, businesses, farmers, city and county governments, and Waste sector workers. Diverting or reducing organic waste requires more forethought than disposal, and the Knoxville region currently lacks large-scale composting infrastructure. Successful implementation requires building this infrastructure and changing practices.

How could we evaluate the success of this measure?

- Number of households participating in composting programs
- Pounds of food waste diverted from the landfill

What will this measure cost and how could it be funded?

Implementing this strategy will require investment and buy-in across community members, including private developers, city and county governments, and nonprofit organizations. City and county governments can serve as key sources of funding for the expansion of composting and food recovery programs.

	2035	2050	2025—2050
Cost of Organic Waste Diversion	\$9.16	\$34.64	\$368.22

Note: Costs are in million USD (2025).



Potential funding sources may include the following:

- TDEC Organic Management Grants
- USDA Composting and Food Waste Reduction Cooperative Agreements
- USDA Solid Waste Management Grants

Who are the key partners and programs to help implement this measure?

- **CBOs:** Help raise awareness, provide educational resources, and promote community participation in composting and food recovery.
- **City and County Government Solid Waste Staff:** Oversee and implement composting initiatives. Analyze waste streams.
- **Community Gardens/Farms:** Provide spaces for composting, manage compost bins, and utilize the finished compost.
- **Mulching Facilities:** Accept organic materials, chip, cure, and sell mulch.
- **Organics Processors:** Accept food waste, manage the compost process, cure, and sell the finished compost.
- **Private Haulers:** Implement efficient and thorough compost collection.
- **Food Recovery and Redistribution Programs:** Support food recovery and redistribution efforts, thus reducing food waste. Key partners include Second Harvest of East Tennessee, St. Andrews Society of Gleaners, and UT Food Growers.
- **TDEC:** Coordinate, fund, and promote composting efforts.
- **United Way of Greater Knoxville:** Provide key performance food indicator data in Knoxville to understand trends in food waste.

Waste Sector Measure Benefits

Cost Savings

Measure W13 reduces expenses over time through reuse and recycling. Households save by investing in reusable items and purchasing secondhand goods, while businesses save by procuring reusable materials. Measure W14 eliminates the need for households with backyard composting to purchase fertilizers, while organizations that divert organic waste to composting facilities or farms may reduce waste hauling and disposal fees. Leaf and brush pickup programs lower costs by diverting yard materials from landfills that have more expensive fees than mulch facilities.



Improved Air Quality and Healthier Communities

While grocery stores and restaurants throw out uneaten food every day, many people in the region experience insufficient and inconsistent access to nutritious food. Food recovery and distribution programs in Measure W14 donate uneaten food to community members, reducing the amount of organic waste going to landfills and supporting more equitable access to food. Expanding hazardous waste collection through Measure W13 prevents materials such as chemicals, batteries, refrigerants, and electronics from ending up in landfills, thus reducing the pollution risks for nearby communities.

Natural & Working Lands Sector

The Knoxville region's Natural & Working Lands sector encompasses East Tennessee's green spaces—forests, grasslands, urban parks, and street trees. From the Great Smoky Mountains to World's Fair Park, the Knoxville region is home to vast natural resources that are worth protecting, not only for their beauty, but also for the economic, public health, and pollution reduction benefits they provide. Planting more trees in Knoxville's urban neighborhoods will reduce communities' exposure to extreme heat, promote economic growth, and lower energy costs for homes and businesses. Conserving and expanding natural lands and reducing sprawl by evaluating land use policies will ensure East Tennessee's green spaces can continue improving air quality and serving as spaces for recreation for future generations.

Natural & Working Lands Measures

NWL15. Enhance tree canopy, especially in urban heat islands

NWL16. Evaluate policies and opportunities to reduce sprawl

NWL17. Conserve and expand natural lands and community green spaces



GHG emissions sources vs. sinks: Sources are processes and systems that release carbon dioxide and other greenhouse gases into the atmosphere. Sinks are processes and systems that sequester and store carbon dioxide. Trees and plants are the main greenhouse gas sinks in the Knoxville region's Natural & Working Lands sector, taking carbon dioxide out of the atmosphere through photosynthesis.

4.14 MMTCO₂e

sequestered in 2022 in the Natural & Working Lands sector in the Knoxville region. Emissions from this sector make up 0.2% of total emissions.

This is equivalent to the emissions generated by:

10.5 billion miles

driven in an average car.

862,758 homes

powered for one year.



What does the region's Natural & Working Lands sector look like?

24,000 acres

of tree cover in Knoxville as of 2018

75% of tree canopy

in Knoxville is on private land.

13.9 million acres

of forests in Tennessee as of 2017

Knoxville's Urban Forest Master Plan aims to **increase the city's tree canopy cover from 38% to 40% by 2040.**

What are East Tennesseans saying about **natural & working lands actions**?

How is **extreme heat** affecting Knoxville region communities?

76% of respondents

said planting more trees would be beneficial to their communities.

70% of respondents

said they have been affected by extreme heat.

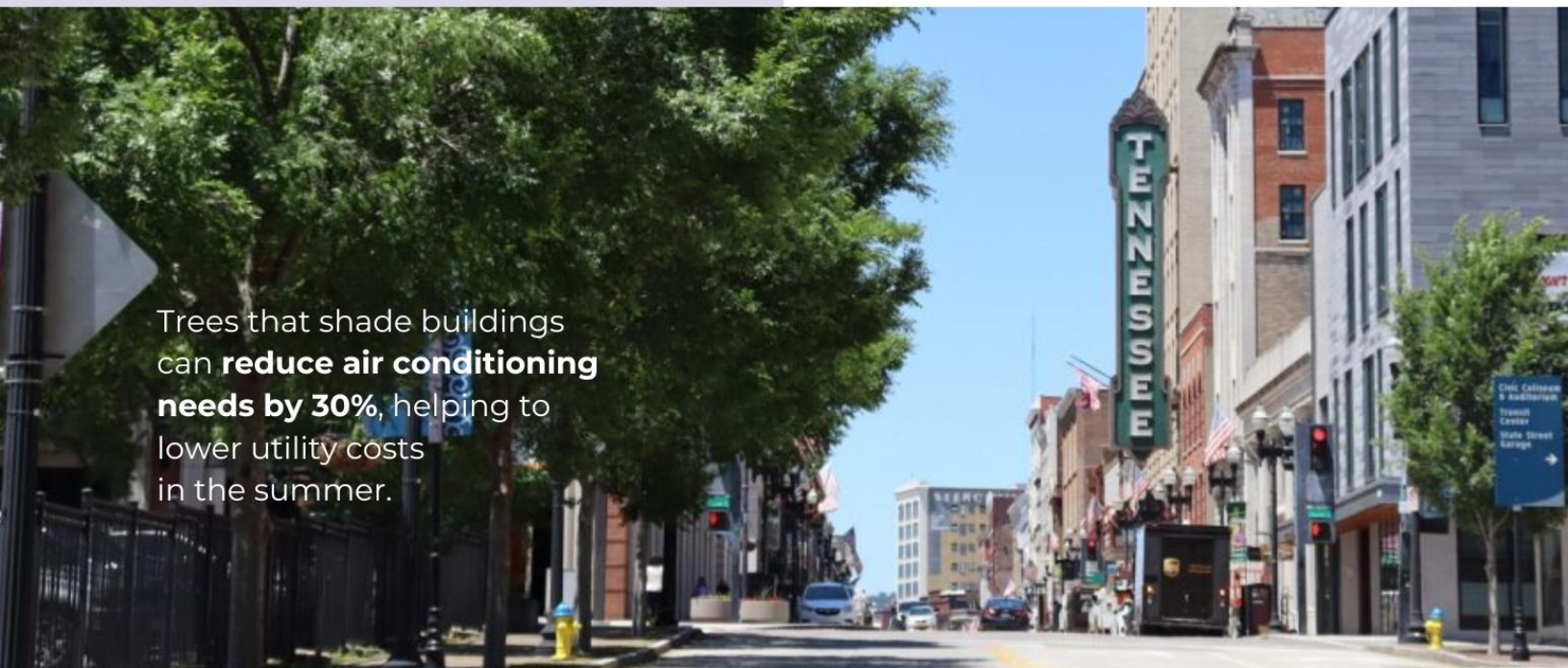
74% of respondents

said land conservation would be beneficial to their communities.

34% of respondents

said they have experienced poor health due to extreme heat.

Trees that shade buildings can **reduce air conditioning needs by 30%**, helping to lower utility costs in the summer.





Natural & Working Lands Measure 15. Enhance tree canopy especially in urban heat islands

This measure aims to plant more trees through strategic planning and community engagement, with a focus on areas most affected by urban heat island effects. Trees planted along streets; in yards; and near parking lots, bus stops, and playgrounds provide shade and cooling, sequester carbon, improve air quality, and enhance the overall livability of urban spaces.

How should this measure be implemented?

This measure will require the identification of areas for both successful and equitable tree planting. Priority locations with the greatest need may include neighborhoods with a high proportion of concrete and asphalt compared with green space. Partnerships and outreach can help communities and businesses actively participate in the planning process. Collaborating with landowners and homeowners can help preserve and increase tree canopy on residential properties and private lands, where most trees grow.

Measure 15 Direct Benefits

GHGs reduced 2022–2035: **1,489 MTCO₂e**

GHGs reduced 2022–2050: **12,835 MTCO₂e**

Measure 15 Co-Benefits

Discussed in detail in the sector-wide measure benefits section



Cost Savings



Improved Air Quality and Healthier Communities



Expanded Tourism and Economic Development



Increased Resilience

Core Actions

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Map high-heat areas, including bus stops, roads, schools, playgrounds, and public spaces, and plant trees strategically to maximize shade and minimize the urban heat island effect.
 - Example: Perform an Urban Heat Island analysis and collaborate with ORNL to prioritize decreasing urban heat island effects on the communities who are disproportionately affected by heat.
 - Example: UT/National Oceanic and Atmospheric Administration (NOAA) heat island study of Knoxville.
- Incentivize developers to plant trees properly and maintain them.
- Encourage homeowners, neighborhood organizations, schools, faith communities, and other groups to increase canopy cover, highlighting the benefits for climate resilience, public health, property value, and ecosystem services.



- Create and implement maintenance plans for trees and vegetation that include funding, watering, pruning, and other stewardship responsibilities to ensure long-term survival.

Phase 1: Explore	Phase 2: Build	Phase 3: Scale
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- Assess the tree canopy and create plans for expansion
 - The City of Knoxville's Urban Forest Master Plan).

Supplementary Actions

Phase 1: Explore	Phase 2: Build	Phase 3: Scale
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- Prioritize planting native and climate-resilient species, selected for biodiversity and resiliency to pests, disease, and extreme weather.
- Integrate tree planting into stormwater management and roadway flooding prevention, as well as other city planning initiatives.

What are the anticipated challenges for implementation?

Tree planting takes time and sustained funding, technical expertise, and labor, especially in the first few years. Urban and developed areas can be a challenging environment for trees, with pollution, pests, inconsistent watering, damage from human activity, and poor soil conditions. Successful tree plantings require plans to protect trees from these challenges and to overcome opposition from people who see street trees as an undue burden. Outreach can help residents understand the benefits and offer support for maintenance.

How could we evaluate the success of this measure?

- Change in tree canopy based on geographic areas
- Number of trees planted
- Mapping of heat island effects over time and evaluating the impact of planting efforts

What will this measure cost and how could it be funded?

Tree planting and purchasing will require a funding plan. While volunteers can help offset labor costs, purchasing trees can be a significant expense. Working with local tree nurseries can help secure trees for planting at competitive rates, and partnering with businesses can provide additional funding and help identify suitable planting sites within commercial districts. Grants can also help fund tree planting efforts and ensure long-term success. Meanwhile, community resources such as schools, libraries, and neighborhood groups can support education and outreach around urban forestry, ensuring that residents have the knowledge and resources needed to plant and maintain trees.



	2035	2050	2025—2050
Initial Cost to Implement	\$0.001	\$0.0004	\$0.01
Ongoing Cost to Implement	\$0.04	\$0.03	\$0.92

Note: Costs are in million USD (2025).

Potential funding sources may include the following:

- National Forest Foundation Grant Programs
- TN Department of Agriculture Community Tree Planting Program
- TN Department of Agriculture Urban and Community Forestry Grants
- U.S. Forest Service Urban and Community Forestry Grant
- USDA Natural Resources Conservation Service (NRCS) Healthy Forests Reserve Program

Who are the key partners and programs to help implement this measure?

- **City and County Governments:** Plant and maintain trees on public property.
- **Local Landscaping Companies:** Provide insight and expertise about tree planting and maintenance.
- **Local Tree Boards:** Coordinate planting efforts in public areas, collaborate to engage community members about tree planting, and coordinate evaluation studies regarding the need for tree canopy.
- **Neighborhood Associations and Homeowners Associations:** Provide funding and volunteers to implement and maintain their own green infrastructure on private and neighborhood rights-of-way.
- **Trees Knoxville:** Plant trees, educate the public on the benefits of trees, provide resources for tree care, and organize volunteer tree planting events.
- **UTK and NOAA:** Pursue research into local urban heat islands and their consequences.



Natural & Working Lands Measure 16. Evaluate policies and opportunities to reduce sprawl

This measure prioritizes ensuring that community members have easy access to everyday essentials, such as childcare, grocery stores, healthcare, and work opportunities, by clustering these resources near residential areas.

How should this measure be implemented?

Creating a more efficient land use pattern will require communities to identify areas that can support future growth and areas that should be conserved for other uses. Local governments can employ a variety of implementation strategies to create a more efficient land use pattern through incentives, development code updates, and educational resources for community members and developers.

Measure 16 Direct Benefits

GHGs reduced 2022–2035: **447,595 MTCO₂e**

GHGs reduced 2022–2050: **6,266,335 MTCO₂e**

Measure 16 Co-Benefits

Discussed in detail in the sector-wide measure benefits section



Cost Savings



Improved Air Quality and Healthier Communities



Increased Resilience

Core Actions

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Explore updates to zoning, building, and development regulations that guide growth in existing developed areas and encourage walkable, mixed-use corridors, centers, and neighborhoods.

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Promote multifamily and mixed-use developments in areas already served by adequate infrastructure and in close proximity to jobs, schools, and transit.
- Utilize incentives, such as tax abatements and public-private partnerships, to encourage development in walkable mixed-use centers, corridors, and neighborhood centers.
- Encourage development that conserves and connects natural features and habitats.



Supplementary Actions

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Explore tax incentives or other supportive measures that encourage housing in walkable, mixed-use areas.
- Identify and prioritize green spaces and natural areas with the goal of focusing growth in areas with existing infrastructure and incentivizing the conservation of farmlands, forests, and floodplains.

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Encourage a range of housing types in areas with existing infrastructure to meet the range of needs of current and future residents.
- Coordinate regionally to plan for growth, development, and conservation of critical natural areas and habitats.

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Expand outreach and education on a range of housing (e.g., duplexes, triplexes, townhouses) to increase public awareness.
 - Example: City of Knoxville Middle Housing Redevelopment Program provides short-term loans to renovate or reconstruct unoccupied residential structures and infill vacant lots with residential structures containing more than one unit.

Bonus Actions

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Celebrate best practices in redevelopment, infill, and conservation by partnering with community and professional organizations such as the Urban Land Institute, Legacy Parks, Keep Knoxville Beautiful, Keep Blount Beautiful, and the East Tennessee American Institute of Architects.

What are the anticipated challenges for implementation?

There are often negative perceptions about growth and development. It is key to incorporate diverse perspectives into planning for more efficient growth to ensure that plans for future growth and infrastructure investments reflect the goals and priorities of the community.

How could we evaluate the success of this measure?

- Number of new housing units per acre



- Miles of new sidewalk and bike lanes installed
- Number of new housing units within a mile radius of public transit
- Acres of farmland lost to new development

What will this measure cost and how could it be funded?

Incentives can help developers build high-quality housing more affordably, and cost-sharing agreements and development fees can help ensure that the financial burden does not fall on residents. Local government priorities and public-private partnerships can ensure the installation of sidewalks, bike lanes, and other infrastructure that promotes active transportation. Partnerships with businesses and nonprofits could also help fund and manage new open space and community amenities.

	2035	2050	2025—2050
Initial Cost to Implement	\$0.01	\$0.01	\$0.14
Ongoing Cost to Implement	\$0.80	\$0.55	\$14.17

Note: Costs are in million USD (2025).

Potential funding sources may include the following:

- HUD HOME Investment Partnership Program
- U.S. Department of the Treasury Community Development Financial Institutions Programs
- U.S. DOT Neighborhood Access and Equity Program
- U.S. EPA Smart Growth Program
- U.S. HUD Community Development Block Grant
- U.S. National Park Service Land and Water Conservation Fund

Who are the key partners and programs to help implement this measure?

- **City and County Governments:** Regulate and coordinate development and employ incentive programs and public-private partnerships.
- **Developers:** Build a wide range of housing in mixed-use areas served by existing infrastructure.



Natural & Working Lands Measure 17. Conserve and expand natural lands and community green spaces

This measure aims to enhance land conservation through education and the equitable expansion of shared green spaces, such as small urban parks and community gardens.

How should this measure be implemented?

The Knoxville region can conserve natural lands and expand community green spaces through policy changes, incentives programs, and by setting quantitative targets for land preservation. Community engagement will be key to building support and shaping priorities based on local needs, assets, and values.

Measure 17 Direct Benefits



GHGs reduced 2022–2035: **74,700 MTCO₂e**

GHGs reduced 2022–2050: **678,155 MTCO₂e**

Measure 17 Co-Benefits

Discussed in detail in the sector-wide measure benefits section



Cost Savings



Expanded Tourism and Economic Development



Increased Resilience



Improved Air Quality and Healthier Communities



Improved Equity

Core Actions

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Establish financial tools and incentives (e.g., tax breaks or conservation easements) to preserve forests and sensitive lands.
- Equitably establish new green spaces in areas currently lacking safe, walkable access to parks, trees, and community outdoor areas.

Supplementary Actions

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Collaborate with neighborhoods and community groups to set shared goals for the number of neighborhood parks or green spaces relative to population size.
- Educate households and businesses on sustainable landscaping practices (e.g., reducing turf lawns, planting native species and edible plants).



- Partner with local and national organizations (e.g., Trees Knoxville, The Nature Conservancy, Land Conservation Trust) to expand access to green spaces, provide education, and build local support for conservation.

Bonus Actions

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Pilot shared-use and dual-use models in green spaces.
 - Example: Dr. Walter Hardy Park Foodscapes Project, pollinator habitats on solar farms.

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Encourage creative green space development in unconventional areas (e.g., highway interchanges, utility corridors, or redevelopment sites).

What are the anticipated challenges for implementation?

The Knoxville region should prioritize communities that have historically had limited access to parks and nature. This means evaluating where green spaces throughout the region are located and their accessibility. Planners should also evaluate unintended consequences, including rising property values and rental costs that could lead to displacement in urban communities. Land conservation efforts will need to balance multiple uses, such as renewable energy generation and habitat protection, to ensure long-term sustainability.

How could we evaluate the success of this measure?

- Acres of green space protected
- Number of community green spaces

What will this measure cost and how could it be funded?

Federal and state funding opportunities allow for the purchase of land to conserve and protect for East Tennesseans, benefiting both today's communities and future generations. Working with neighborhood organizations, local organizations, and national environmental organizations to fundraise for increased green spaces will be crucial for successful implementation.

	2035	2050	2025—2050
Initial Cost to Implement	\$0.00	\$0.00	\$0.00
Ongoing Cost to Implement	\$0.04	\$0.03	\$0.66

Note: Costs are in million USD (2025); initial costs estimated to be near zero because they are modeled as a management change, rather than installing infrastructure.

Potential funding sources may include the following:



- National Forest Foundation Grant Programs
- U.S. Department of the Interior Land and Water Conservation Fund
- U.S. EPA Smart Growth and Open Space Conservation Program
- U.S. Forest Service Urban and Community Forestry Grant
- USDA Agricultural Conservation Easement Program
- USDA Conservation Reserve Program
- USDA Environmental Quality Incentives Program
- USDA NRCS Healthy Forests Reserve Program

Who are the key partners and programs to help implement this measure?

- **City and County Governments:** Assess development regulations and develop master plans to ensure that community green spaces are created and protected.
- **Local and National Land Trust Organizations and Nonprofits:** Conserve land and promote education about the benefits and importance of land conservation.

Natural & Working Lands Sector Measure Benefits

Improved Air Quality and Healthier Communities

Expanding tree canopy and green space through Measures NWL15 and NWL17 will cool ambient temperatures, reduce heat-related illnesses, filter harmful air pollutants, and foster social connection. Measure NWL16 limits sprawl and invests in active transport options, encouraging physical activity that supports cardiovascular health and mental well-being.

Expanded Tourism and Economic Development

Measure NWL15 helps promote tree canopy coverage that supports local economies as trees have been shown to raise commercial and residential property values by 7% and incentivize shoppers to browse for longer periods of time.⁴³ The Knoxville region is home to remarkable natural beauty that attracts visitors. Measure NWL17 protects these resources by supporting denser development patterns that preserve forests and support biodiversity.

⁴³ For more information, see [Knoxville's Urban Forestry Master Plan](#).



Increased Resilience

All three NWL measures strengthen the Knoxville region's resilience to climate effects by preserving and enhancing nature. By promoting tree canopies through Measure NWL15, communities can enhance environmental resilience by reducing urban heat, managing stormwater, and protecting against flooding. Measure NWL17 conserves forests and green spaces that buffer communities from extreme weather, while Measure NWL16 reduces the pressure on natural lands and enables infrastructure investments that better withstand climate stressors.

Cost Savings

Measure NWL16 promotes denser communities, leading to shorter distances between homes, jobs, and services, thereby lowering transportation costs for households. Planting trees through Measures NWL15 and NWL17 reduces the need for air conditioning in the summer and heating in the winter, lowering energy costs for homes and businesses.

Improved Equity

Measure NWL17 improves equity and access to green spaces in underserved communities through establishing new green spaces in areas that have historically lacked safe, walkable access to parks, trees, and community outdoor areas.



Agriculture Sector

The Knoxville region's Agriculture sector includes all forms of food production, from commercial-scale corn and soybean farms to backyard vegetable patches. The measures in this section aim to make the Knoxville region's agriculture and food systems more resilient and sustainable for the long term. By improving agricultural practices, the Knoxville region can increase crop output and safeguard jobs for workers in the farming industry. Expanded education about and resources for urban and micro farming can improve access to fruits and vegetables, ensuring community members have the food they need.

Agriculture Measures

A18. Increase urban and micro farming

A19. Improve agricultural practices



Sources of GHG emissions: Livestock management, soil management, fertilizer use, and manure.

Emissions from livestock mostly come from **enteric fermentation**, the process by which the digestive system breaks down food. The primary byproduct of this process is methane, a potent greenhouse gas. Preparing agricultural soils can also produce emissions as carbon dioxide stored in soils is released into the atmosphere during **plowing**.



0.37 MMTCO₂e

emitted in 2022 from the Agriculture sector, representing **2% of all regional emissions.**

1.3 MMTCO₂e

reduced cumulatively from 2022 to 2050 if the Knoxville region successfully implements these measures.



What does the region's Agriculture sector look like now?

10.7 million acres

of land are actively farmed in Tennessee.

more than \$446.4 million

in corn is grown in Tennessee each year.

17% of respondents

across the Knoxville region report not having reliable access to food.

Women and low-income households are more likely to report not having reliable access to food.

What are the **most important reasons** for creating a sustainable future, according to Knoxville region community members?

71% of respondents

said **reliable food production** was a very important reason to create a sustainable future.

60% of respondents

said **strengthening local economies** was a very important reason to create a sustainable future.



What actions are community members already taking?

Beardsley Community Farm, organized through the Knoxville-Knox County Community Action Committee, supports 17 community gardens and donates food with 10 community partners.



Agriculture Measure 18. Increase urban and micro farming

This measure aims to create opportunities for, reduce barriers to, and increase education about small-scale farming and its benefits. Small-scale farming, including rooftop herb gardens, community orchards, and home vegetable patches, can help build a more resilient and equitable food system across the Knoxville region.

How should this measure be implemented?

This measure requires collaboration with community partners, including schools, farms, developers, landowners, parks, community centers, and libraries, to identify spaces and resources for growing food. Updates to zoning policies can also allow for more urban and suburban farming opportunities, especially in areas where space is limited.

Measure 18 Direct Benefits



CHG reductions modeled under A19.

Measure 18 Co-Benefits

Discussed in detail in the sector-wide measure benefits section



Cost Savings



Improved Air Quality and Healthier Communities



Increased Resilience

Core Actions

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Establish zoning policies that enable and encourage urban and suburban agriculture, community gardens, and small-scale farms.
 - Example: City of Knoxville's Urban Agriculture zoning policies.
- Establish shared land and cooperative farming models where farmers can share plots, equipment, and resources to reduce barriers to entry and increase collaboration and profitability.
- Incentivize developers to set aside land in new developments for urban farms, gardens, or community agriculture, integrating access to food into neighborhood design.

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Expand education and workforce development in small-scale farming through partnerships with schools, universities, libraries, and community groups. Programs should include hands-on training (e.g., growing native plants and produce, reducing erosion through sustainable practices, small-scale composting).
 - Example: Locavore farms is working to increase community awareness of farm-to-table efforts.



- Example: UTK/University of Tennessee Institute of Agriculture educates students and community members on small farming techniques.
- Example: Rooted East's programs build community gardens, educate members on gardening and healthy living, and distribute fresh produce.

Supplementary Actions

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Provide shared community resources, such as tools, seeds, and equipment co-ops at libraries, community centers, public parks, and gardens.
 - Example: The Museum of Infinite Outcomes uses exhibits, programs, and workshops to change the way that people think about nature.

Bonus Actions

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Use innovative new technology, such as agrivoltaics and carbon capture, to use farmland more sustainably.
- Create local food purchasing programs that connect small farms with buyers and link them to food security initiatives through community-supported agriculture, farmers markets, and direct sales in underserved neighborhoods.

What are the anticipated challenges for implementation?

In highly developed areas, roofs and vacant lots tend to be the most logical places for farms. However, not all roofs have the capacity to hold the amount of soil and water needed to grow fruits and vegetables. Vacant lots pose unique challenges in terms of determining who owns the land and receiving permission from landowners to use the lots for farming.

How could we evaluate the success of this measure?

- Urban populations of pollinators, such as bees and butterflies
- Quantity, variety, and number of sources of local food available at farmers markets
- Participation in programming and educational opportunities on small farming

What will this measure cost and how could it be funded?

Federal, state, and private grants can fund small-scale farming education initiatives. UTK's Department of Agriculture and UT/Tennessee State University (TSU) Extension have existing outreach and funding avenues that the Knoxville region can leverage to expand urban and micro farming.



	2035	2050	2025—2050
Initial Cost to Implement	\$0.002	\$0.005	\$0.074
Ongoing Cost to Implement	\$0.252	\$0.805	\$10.890
Savings and Financial Benefits	\$0.128	\$0.793	\$9.125

Note: Costs are in million USD (2025) and are bundled for Measures A18 and A19.

Potential funding sources may include the following:

- TN Agricultural Enhancement Program
- TN AgTrack Cost Share Program
- TN Department of Agriculture Agricultural Enterprise Fund
- USDA Conservation Innovation Grants
- USDA Farm Ownership and Operating Loans
- USDA Farm Service Agency Climate-Smart Agriculture and Farm Loan Programs
- USDA Microloans and EZ Guarantee Loans
- USDA NRCS Agricultural Conservation Easement Program
- USDA NRCS Conservation Reserve Program
- USDA NRCS Conservation Stewardship Program
- USDA NRCS Environmental Quality Incentives Program
- USDA Regional Conservation Partnership Program

Who are the key partners and programs to help implement this measure?

- **City and County Governments:** Evaluate the feasibility of and plan for zoning codes that promote urban and micro agriculture.
- **Farmers:** Implement sustainable farming practices.
- **Knoxville Botanical Gardens and Arboretum:** Provide education through community garden programming.
- **Landowners:** Participate in small farming programs.
- **Local Nonprofit Farms (such as Battlefield Farms, Beardsley Farm, Knox County Community Garden and Growers Alliance, and Rooted East):** Support community gardens, organize food donation and distribution services, spread awareness about agricultural events and learning opportunities, and organize community members around sustainable food system issues.



- **ORNL:** Conduct research on agricultural practices and crops to enhance farming techniques.
- **Tennessee Department of Agriculture:** Promote agricultural practices across the state and provide resources and educational opportunities to farmers.
- **United Way of Greater Knoxville:** Collaborate with small farms to make food accessible to communities in need.
- **UTK:** Provide data on agricultural practices and farming in the region.
- **UT/TSU Extension:** Perform regional outreach to the agricultural community and provide educational and community development opportunities to them.

Agriculture Measure 19. Improve agricultural practices

This measure aims to increase output and safeguard jobs in the Agricultural sector by improving agricultural farming practices. Nutrient management, planting cover crops, and better livestock feed practices are feasible ways to reduce GHG emissions in the Agriculture sector.

How should this measure be implemented?

This measure requires collaboration with local partners, such as farmers, universities and schools, and grocery stores, to implement both technical improvements and educational programs. These partnerships can help share knowledge, build trust, and ensure accessibility of the practices to the farming community.

Measure 19 Direct Benefits

GHG emissions reduced 2022–2035: **18,399 MTCO₂e**

GHG emissions reduced 2022–2050:
1,269,455 MTCO₂e

Measure 19 Co-Benefits

Discussed in detail in the sector-wide measure benefits section



Cost Savings



Job Creation and Workforce Development



Improved Air Quality and Healthier Communities



Core Actions

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Adopt farmland-supportive land use policies and infrastructure that encourage sustainable practices, including agrivoltaics, agroforestry, and forest farming/foraging.

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Increase or encourage new adoption of climate-smart agriculture practices, including cover cropping, nitrification inhibitors, feed additives, no-till or reduced tillage practices, and manure management practices.
- Connect farmers to free and ongoing training, technical assistance, and demonstration projects on cost-effective agricultural best practices that maintain crop yields and reduce or even sequester emissions.
 - Example: UT Extension

Supplementary Actions

Phase 1: Explore

Phase 2: Build

Phase 3: Scale

- Strengthen local food systems by fostering partnerships between farms and institutions (e.g., farmers markets, mobile grocers, grocery stores, schools, universities, public agencies) to expand reliable and accessible markets for local produce.
- Integrate climate-controlled strategies into agricultural practices to extend growing seasons and improve food system resiliency.

What are the anticipated challenges for implementation?

Some farmers, especially those that are low-income, face financial and technical barriers to adopting new agricultural practices, and they may also be hesitant to change the methods that they have used for decades. To address these challenges, it is important to review options for targeted financial assistance and offer technical training and demonstrations to build confidence and skills in adopting climate-smart methods.

How could we evaluate the success of this measure?

- Total number of farms implementing one or more mitigation strategies (e.g., rate of synthetic nitrogen fertilizer applied, number of new anaerobic digestors per year)



- Total acres (cover crops and nitrification inhibitors) affected by new mitigation adoption, potentially using satellite imagery to compare yearly changes in land use
- Number of livestock using feed additives for emission reduction or whose manure is managed through new anaerobic digesters

What will this measure cost and how could it be funded?⁴⁴

Funding will be essential to support the transition to improved agricultural practices. Federal and state level funding, such as from NRCS, may open opportunities to support new farming techniques and educational programs.

Potential funding sources may include the following:

- TN Agricultural Enhancement Program
- TN Department of Agriculture Agricultural Enterprise Fund
- USDA Conservation Innovation Grants
- USDA Farm Service Agency Climate-Smart Agriculture and Farm Loan Programs
- USDA NRCS Agricultural Conservation Easement Program
- USDA NRCS Conservation Reserve Program
- USDA NRCS Conservation Stewardship Program
- USDA NRCS Environmental Quality Incentives Program
- USDA Regional Conservation Partnership Program

Who are the key partners and programs to help implement this measure?

- **City and County Governments:** Engage and educate farmers on sustainable land management practices.
- **Knoxville Botanical Gardens and Arboretum:** Provide education through the community garden program.
- **Local Farms (such as Battlefield Farms, Beardsley Farm, Knox County Community Garden and Growers Alliance, and Rooted East):** Support community gardens, organize food donation and distribution services, spread awareness about agricultural events and learning opportunities, and organize community members around sustainable food system issues.

⁴⁴ The costs are summarized in Measure A18.



- **NRCS:** Help landowners conserve their natural resources (i.e., soil and water).
- **ORNL:** Conduct research on agricultural practices and crops to enhance farming techniques.
- **TDEC:** Promote agricultural practices across the state and provide resources and educational opportunities to farmers.
- **TVA/LPCs:** Develop policies and programs in support of agrivoltaics; implement and coordinate utilities for agrivoltaic projects.
- **United Way of Greater Knoxville:** Collaborate with small farms to make food accessible to communities in need.
- **UT/TSU Extension:** Perform regional outreach to the agricultural community and provide educational and community development opportunities.
- **UTK:** Provide data on agricultural practices and farming in the region.

Agriculture Sector Measure Benefits

Improved Air Quality and Healthier Communities

Expanding urban and micro farming through Measure A18 increases access to fresh fruits and vegetables, especially for low-income and food-insecure communities. Ensuring that community members get the food and nutrients they need protects long-term public health outcomes. Measure A19 supports reduced land degradation and the potential buildup of topsoil and soil carbon promotes healthier crops, greater yields, greater carbon sequestration, and the potential to reduce fertilizer requirements.

Increased Resilience

Producing food at small scales through Measure A18 increases the resilience of the Knoxville region's food systems during times of disruption, including droughts, flooding, extreme heat, pest or disease outbreak, or supply chain failures. Local gardens and farms provide system redundancy, helping to fill in the gaps in the food supply as the system recovers and strengthening food security to ensure access to fresh, nutritious foods.

Job Creation and Workforce Development

Sustaining and increasing agricultural output protects jobs and livelihoods in the Knoxville region's farming communities. Lifelong farmers depend on reliable yields to support their families and contribute to the local economy. The uptake of improved agricultural practices can help farmers keep agricultural lands productive for generations to come and ensure job security. The climate-smart techniques in



Measure A19 help farmers adapt to changing environmental conditions while maintaining or increasing yields.

Cost Savings

The climate-smart agricultural processes in Measure A19 help farmers avoid unnecessary costs. Feed management practices can enhance feed efficiency, lower costs, and improve outcomes. Additionally, growing produce locally at home or in community gardens through Measure A18 can be more affordable than the grocery store, where transportation and storage costs increase prices.

Outreach and Education

Education and outreach are vital to successful climate plan implementation because they build public understanding, trust, and engagement. When communities are informed about climate risks and the benefits of climate actions, they are more likely to support policies, adopt sustainable behaviors, and hold leaders accountable. Outreach also ensures that diverse voices are included in planning, especially those most affected by climate change, leading to more equitable and effective solutions. In short, education empowers action—without it, even the best climate plans risk falling short.

Example Actions

- Use education and outreach to improve residents' perceptions of public transportation.
 - Examples: Use movies, music, and visual arts. Invite local schools and colleges to create programs, classes, and outreach for students of all ages to learn and get engaged in local activities.
- Promote active transportation with education and outreach.
 - Example: Integrate arts and engineering through placemaking and quick builds (i.e., managing and designing public spaces to reflect community needs).
- Provide education and outreach campaigns to demystify solar, address common concerns, and show pathways to adoption.
 - Examples: Highlight success stories of local solar projects, offer incentives or recognition programs (e.g., property tax adjustments or community awards) for homeowners who install solar, and quantify and publish cost-benefit analyses and case studies to highlight financially feasible solar photovoltaic applications.
- Implement broad education and engagement campaigns through local news outlets, social and artistic platforms, ambassador programs, and community organizations to build trust in waste reduction programs, increase participation, and reduce contamination.



- Provide education and outreach to residential and building property owners on the benefits of building energy efficiency, weatherization, and clean energy technologies, and provide education to lighting companies about lighting incentives and savings.
- Organize a regional energy fair to update and educate professionals on best practices for energy efficiency retrofits of existing buildings.

Outcomes for the Community

Developing Outcomes to Guide Plan Priorities

Over the course of the BREATHE planning process, a set of themes emerged through discussion and other participant-driven activities in the Equity Working Group. These themes reflected both high-level and specific expressions of values, needs, and expectations for what it means for a climate action plan—and planning process—to be centered in equity. For example, one common theme was securing both participation in the design of new programs or policies and access to the results of those climate action investments, such as community solar. Other equity considerations included both fair distribution of benefits and prevention of unintended adverse consequences from climate action measure implementation, such as high housing costs and gentrification.

The BREATHE Team rendered these themes into a set of outcomes that guide the evaluation and adoption of climate action measures as they are further defined and developed. The six outcomes below were presented to the Working Group during the last planning workshop and are the foundation for the Community Outcomes Matrix Toolkit in Appendix F.

Community Outcomes

While the measures in the BREATHE Plan primarily aim to reduce emissions and provide co-benefits, they can also support the following six broader community outcomes. Many of these outcomes are described in more detail as specific benefits at the end of each sector's measures in this chapter.



Environmental Resilience

Climate action can provide benefits at the individual, neighborhood, and community levels through intentional planning of green spaces, improved preparedness and response to climate hazards, and reduced exposure to increasingly frequent and severe weather events, such as poor air



quality, flooding, and heat waves. This outcome area extends across a range of issues and can be targeted as needed depending on the action being evaluated.



Access to Innovation

This outcome captures community and stakeholder commitment to ensuring equitable access to new or innovative technologies, opportunities, and partnerships likely to result from the proposed climate action. Access to emerging technologies and new partnerships allows for participation in the design of important programs and the use of technologies that aim to improve the quality of life, reduce the cost of living, and contribute to a clean environment.



Economic Opportunity

This outcome includes economic benefits that accrue directly from the climate action, such as contracting opportunities for small, minority, and women-owned businesses; access to quality jobs; workforce development and union work; and entrepreneurial opportunities.



Community and Capacity Building

Climate action planning and investment involves both sharing knowledge and creating capabilities at all levels of community and across sectors, such as housing and transportation. This outcome area helps determine how a climate action values, builds on, and advances local knowledge. The outcome also asks whether the proposed action is likely to create or lead to inclusive education, training, and capacity building opportunities for all.



Quality of Life

This outcome captures the extent to which a climate action improves access for all to basic life essentials, including affordable, adequate, and secure housing and utilities; nutritious food; safe and reliable transportation; clean air and water; good health and well-being; and other basic needs. Although it is unrealistic to expect that a single climate action will improve the quality of life across all basic needs categories, the proposed strategy should improve the quality of life in some way.



Future Generations

Climate action affects both current and future generations. When future generations are meaningfully considered in climate action planning, long-term benefits are likely to be achieved. This outcome area helps identify and measure benefits—and the possible unintended consequences—for generations not yet born who will inherit what we leave behind. This outcome area intends to ensure that the effects of climate action extend beyond immediate benefits and are not at the expense of future generations.



THE REGION'S WORKFORCE

BREATHE's workforce analysis focuses on how the implementation of the 19 climate measures identified in this plan may affect employment in the Knoxville region in the long-term. It is designed to prepare the region for a changing future and position the region to benefit from opportunities related to those shifts. Understanding how climate strategies affect jobs is essential for successful implementation and meaningful community engagement.

One key resource that guided the workforce development planning process is *Energy Transition and Workforce Planning in Tennessee*, which was developed by the Tennessee Department of Environment and Conservation as part of the state's CCAP development (see Appendix E). The BREATHE Team also convened a dedicated Workforce Development Working Group that met multiple times over 2024 and 2025 to discuss barriers, areas of opportunity, and existing programs. Together, these efforts laid the foundation for a comprehensive workforce analysis that addresses regional concerns and experiences.

The following analysis discusses potential implications of workforce shortages during measure implementation, which requires effective coordination and workforce development planning. Additional technical context on employment trends and affected job categories is available in Appendix E.

Workforce Analysis

The BREATHE Team assessed the region's current labor market to identify shortages and surpluses in occupations related to this plan's 19 GHG reduction measures. Each measure was mapped to corresponding occupations using the U.S. Bureau of Labor Statistics' Standard Occupational Classification system using 2025 data. A total of 49 occupations were mapped to the plan, ranging from farm workers and carpenters to electrical engineers and waste haulers. In total, these occupations employed 52,283 people in 2024.⁴⁵

Workforce gaps were calculated using the following formula:

$$\text{Workforce Gap} = \text{Supply (positions)} - \text{Demand (growth + separations)}$$

- **Supply** = Number of positions

⁴⁵ Labor market data was collected for each of those occupations in the region from Lightcast, a labor market analytics tool. Additional information on the results and methodology is available in Appendix E.



- **Demand** = Number of workers needed to fill new positions from projected growth and from separations
- **Separation** = Number of workers estimated to leave an occupation (e.g., retirement, leaving the occupation for another job)
- **A negative gap** indicates that demand is greater than supply, showing a **shortage** of workers
- **A positive gap** indicates that supply is greater than demand, showing a **surplus** of workers

Importantly, the workforce calculations are based on the existing conditions of the labor market and do not factor in the effects of implementing the measures. Rather, this analysis intends to serve as a starting point for planning by identifying employment sectors that may need to be bolstered or reduced.

Anticipated Workforce Shortages

Overall, the Knoxville region's workforce is well positioned to support the implementation of the BREATHE Plan (see Table 6). Of the 49 occupations evaluated, only 10 are experiencing workforce shortages in 2025, totaling 514 workers. Among these, only four are experiencing deficits in 2025. Three of these four high-deficit occupations are related to truck and tractor operations:

- Heavy and Tractor-Trailer Truck Drivers: Shortage of 233 workers
- Light Truck Drivers: Shortage of 73 workers
- Industrial Truck and Tractor Operators: Shortage of 23 workers

The second largest shortage in 2025 is a deficit of 138 workers—laborers in freight, stock, and material movers, who primarily support the solid waste and wastewater sectors.

Nine of the occupations currently experiencing shortages are projected to grow over the next 10 years in the Knoxville region. This could indicate that unless the labor force increases to meet the demand, there will likely continue to be shortages in these occupations over the next 10 years. The only exception is farm workers and laborers in the Agriculture sector, which is projected to decline by 0.4%.



Table 6. All Occupations with Projected Shortages in the Knoxville Region

Affected Occupations	Sector	Employment (2025)	Potential Workforce Shortage (2025)	% Shortage in Employment (2025)	Projected % Growth* (2025—2035)
Heavy and Tractor-Trailer Truck Drivers	Transportation, Solid Waste and Wastewater	8,026	-233	2.9%	9.6%
Laborers and Freight, Stock, and Material Movers	Solid Waste and Wastewater	9,927	-138	1.4%	11.2%
Light Truck Drivers	Transportation	3,762	-73	1.9%	15.5%
Industrial Truck and Tractor Operators	Solid Waste and Wastewater	1,519	-23	1.5%	12.6%
Paving, Surfacing, and Tamping Equipment Operators	Buildings, Transportation	298	-13	4.4%	8.3%
Electrical Power Line Installers and Repairers	Energy	366	-12	3.2%	8.4%
Civil Engineers	Transportation	1,048	-9	0.9%	11.1%
Farmworkers and Laborers, Crop, Nursery, and Greenhouse	Agriculture, Natural & Working Lands	756	-8	1.1%	-0.4%
Electrical Engineers	Energy	447	-5	1.0%	12.7%
Automotive Service Technicians and Mechanics	Transportation	2,740	-1	0.0%	6.5%

*The projected % growth column indicates the percent change in employment over the next 10 years.

Anticipated Workforce Surpluses

Of the 49 occupations evaluated, 33 are experiencing workforce surpluses in 2025, totaling 622 workers (see Table 7). In 2025, the Knoxville region's largest workforce surplus is in construction in the Transportation sector, with an excess of 73 workers in the on- and off-road Transportation sector (e.g., bulldozer and excavator operator). The next largest surpluses are concentrated in the Buildings sector, totaling 280 carpenters, electricians and electrical helpers, roofers, and HVAC installers.



Table 7. Top 10 Occupations with the Largest Projected Surpluses

Affected Occupations	Sector	Employment (2025)	Potential Workforce Surplus (2025)	% Surplus in Employment (2025)	Projected % Growth (2025–2035)
Construction Laborers	Transportation	5,363	73	1.4%	7.4%
Carpenters	Buildings, Transportation	2,908	69	2.4%	2.1%
Electricians	Buildings, Transportation	2,842	66	2.3%	9.5%
Roofers	Buildings	476	51	10.8%	3.8%
Helpers—Electricians	Buildings	272	48	17.6%	1.4%
Heating, Air Conditioning, and Refrigeration Mechanics and Installers	Buildings	1,510	46	3.1%	14.3%
Farmers, Ranchers, and Other Agricultural Managers	Agriculture, Forestry, and Other Land Use	869	45	5.2%	-27.3%
Plumbers, Pipefitters, and Steamfitters	Buildings	1,629	44	2.7%	11.2%
First-Line Supervisors of Construction Trades and Extraction Workers	Buildings	2,607	37	1.4%	6.4%
Helpers—Pipelayers, Plumbers, Pipefitters, and Steamfitters	Buildings	161	31	19.5%	12.3%

Solutions to Meet Workforce Demand

Identifying Skills

The implementation of the BREATHE Plan will shift demand for occupations and may require more specialized or technical expertise. Apprenticeship Readiness Programs already exist to train new workers (e.g., IBEW Local 760 and SMART Local 5). For example, new skills may be needed in solar installation, advanced electrical systems (including EV infrastructure), and high-efficiency HVAC system installation and maintenance.

Most of the identified occupations, aside from farmers, ranchers, and other agricultural managers, are projected to experience positive employment growth between 2025 and 2035. This presents an opportunity to align existing workforce capacity with emerging needs by focusing on targeted training and reskilling in the next 10 years. To fully leverage this surplus and support climate action goals, it will be



important to identify the specific skills and growth areas required for each occupation. Ensuring that workers have access to diverse and relevant training will help create clear and sustainable career pathways. Key example skill areas to prioritize based on measure needs and the occupation projections include the following:⁴⁶

Buildings and Energy

- Installation of building electrification systems
- Installation and maintenance of energy efficient appliances, such as heat pumps and heat pump water heaters
- Installation and maintenance of weatherization measures
- Sustainable building construction, energy auditing, and retrofit practices
- Installation of solar projects

Transportation

- Installation and maintenance of EV chargers
- Maintenance and repair of EVs and AFVs

Waste and Wastewater

- Operation and maintenance of composting facilities
- Materials recovery and recycling systems operation
- Wastewater treatment innovation

Natural & Working Lands

- Native species cultivation and invasive species removal
- Ecosystem restoration
- Advocacy, fundraising, and land trust work
- Land stewardship (e.g., tree planting, pruning, maintenance techniques)

Agriculture

- Soil testing and recordkeeping
- Cover crop selection and planting

⁴⁶ Skill areas were compiled by the BREATHE Team and the Working Group.



- Feed optimization and manure handling

By investing in these skills, the Knoxville region can better match its workforce to future demands, supporting both economic opportunity and decarbonization.

Skills Training and Professional Certification

One effective approach to addressing workforce imbalances is **reskilling**, which is providing workers in surplus occupations with skills training to transition into fields where there are labor shortages. Reskilling is most successful when occupations share transferable skills or belong to similar sectors.

For example, the Knoxville region has a surplus of construction laborers in the Transportation sector and a shortage of waste laborers and freight, stock, and material movers. Although these jobs fall under different sectors, they require comparable skills and work environments. As such, minimal training may be needed to transition workers among them to help meet regional labor demands.

It will be essential to prioritize reskilling efforts for workers in fossil fuel-related occupations (e.g., petroleum and natural gas technicians and pipeline maintenance workers). As the plan's measures are implemented, these industries may be affected. Early outreach, marketing of training programs, and the development of reskilling and apprenticeship opportunities will be critical to supporting affected workers.

Upskilling refers to enhancing the skills of current workers to increase their technical capabilities and readiness for more complex tasks.

Many of the occupations associated with the BREATHE measures may require additional technical training to meet future demand. For example, electricians and roofers may need to learn specialized skills in solar installation.

Upskilling programs can help workers expand their qualifications and contribute more directly to climate-focused projects. In the Knoxville region, opportunities already exist through such those shown in Table 8.

Table 8. Example Local Programs and Training Providers

Provider / Program	Focus / Trades	Measure(s)	Description and Highlights
TCAT Knoxville – HVAC/R Program	HVAC, refrigeration, electrical controls	B1, B2, B3	1,728-hour entry-level program covering residential and commercial HVAC/R, electricity, controls, ductwork, brazing, system installation, and repair. Students may receive four credentials. (TCAT Knoxville HVAC/R – Program)

BREATHE
A Climate Action Plan for the Knoxville Region
Chapter 5: The Region's Workforce



Provider / Program	Focus / Trades	Measure(s)	Description and Highlights
TCAT Knoxville – Online HVAC/R Certified Technician	HVAC, refrigeration	B2	330-hour hybrid/online course preparing students with 1–2 years of work experience for HVAC Excellence or North American Technician Excellence (NATE) certification. (TCAT Knoxville – Online Training)
TCAT Knoxville – Online Residential Electrician Course	Electrical/residential wiring	B3	125-hour entry-level online course covering circuits, wiring, code, and introduction to renewable/ electrical aspects. (TCAT Knoxville)
TCAT Harriman – Truck Driving	Truck driving and maintenance	T11, W13	222-hour full-time course on driving skills, trip planning, vehicle maintenance, and safety. (TCAT Harriman)
TCAT Jacksboro – Farming Operations Technology	Farming operations	A19	1,728-hour program on farming operations, understanding farm machinery/maintenance, and soil/hard/plan management. (TCAT Jacksboro)
TCAT Jacksboro – Electric Vehicle Production Technology	EV manufacturing	T5, T6	864-hour course on entry-level EV manufacturing. Prepares students to work in EV production facilities. (TCAT Jacksboro)
ETAK (Electrical Training Alliance – Knoxville) Apprenticeship and Construction Wireman Programs	Electrical apprenticeship, journeyman training, continuing education	B3	Apprenticeship and pre-apprenticeship programs to train electricians with on-the-job learning. Also offers journeyman upgrade classes (motor control, instrumentation). (ETAK)
Resource Valley Construction Training Council Carpentry and Electrical Apprenticeship Programs	Carpentry, electrical, construction trades	B3	4-year registered apprenticeship program in carpentry and electrical requiring 144 classroom hours and 2,000 on-the-job hours each year. (Go Build Tennessee)
Associated Builders and Contractors of Greater Tennessee – Construction Trades Academy	Electrical, HVAC, plumbing, carpentry, masonry	B1, B2, B3	Entry-level apprenticeships requiring approximately 180 hours of classroom instruction plus on-the-job training. (ABC TN)
Various unions	Electrical, HVAC, plumbing, carpentry, masonry, other trades	B1, B2, B3	Cooperative Agreement of Labor & Management promotes labor-management initiatives.



Early Post-Secondary Opportunities (EPSOs)

Introducing high school students to “green collar” career pathways will help address future workforce shortages while providing students with structured, goal-oriented employment options. School counselors and career advisers should play a key role in mapping out these pathways and clearly communicating the necessary credentials, timelines, and application processes.

EPSOs allow students to earn college credit while still in high school, helping them advance toward technical degrees in high-demand fields such as clean energy and sustainable construction.

Local Example: The Associated Builders and Contractors’ Greater Tennessee Regional Dual Enrollment Training Program, offered through the Knox County START Center, works with students to earn college credit, gain hands-on construction experience, and receive the National Center for Construction Education and Research Core Certification.

EPSOs provide early exposure to in-demand careers and equip students with relevant, job-ready skills.

Community-Based Organizations

CBOs serve as trusted sources of information and will be a critical partner in expanding green workforce opportunities and ensuring accessibility to underserved populations. For example:

- SEEED is a Knoxville-based nonprofit that offers green job training and career readiness programs for low-income and at-risk youth. Their focus is on preparing young adults for environmentally focused employment opportunities.
- The Knoxville Area Urban League runs the RISE Re-Entry Program, which supports formerly incarcerated individuals through resume building, interview preparation, and job placement assistance.
- The East Tennessee Apprenticeship Readiness Program provides training for the clean energy workforce.
- The Knoxville Building and Construction Trades Council partners with Jobs for the Future to build capacity for clean energy jobs.
- Two Bikes has a high school apprenticeship program that trains bicycle mechanics.

By collaborating with these and similar organizations, the region can make workforce development more inclusive and equitable.



Additional Workforce Training Resources in the Region

Several state and federal apprenticeship grants are currently available to support and expand workforce development efforts in the Knoxville region. These funding sources play a critical role in scaling apprenticeship programs, building training capacity, and aligning the regional workforce with BREATHE Plan goals. Some local examples include the following:

- ORNL provides internship opportunities in decarbonization and clean energy that are targeted toward underrepresented communities.
- Cooperative Agreement of Labor and Management promotes apprenticeships, training opportunities, and resources for skilled craft workers.

Apprenticeship State Expansion (ASE) Grant

The U.S. Department of Labor ASE Grant provides states with funding to strengthen and expand local Registered Apprenticeship Programs (RAPs). It supports workforce intermediaries, employer engagement, and outreach to underrepresented populations. Funding from ASE can be used to accomplish the following:

- Develop new apprenticeship pathways.
- Offset training-related costs for employers.
- Provide supportive services to apprentices.

This grant enhances the region's ability to scale high-quality training in key industries such as HVAC, electrical, energy efficiency, and construction.

Innovation Grant

The U.S. Department of Labor Innovation Grant is designed to build state level infrastructure and innovation around apprenticeship models. It encourages collaboration among workforce boards, educational institutions, and employers to accomplish the following:

- Create flexible and industry-driven apprenticeship models.
- Incorporate emerging technologies and sustainability-focused skills.
- Support equity-focused outreach and program design.

This grant provides a pathway to innovate within traditional trades and prepares workers for clean energy jobs.

State Apprenticeship Expansion Formula (SAEF) Grant

The U.S. Department of Labor SAEF Grant offers formula-based funding to expand the reach and impact of RAPs. It supports strategies that:



- Improve the quality and accessibility of apprenticeship programs.
- Strengthen partnerships with employers and training providers.
- Provide wraparound services such as mentoring, job placement, and retention.



NEXT STEPS

To implement the BREATHE Plan, the City of Knoxville and TPO, alongside implementing partners and other stakeholders, can focus on the following key steps.

Continue Engagement

Voices across the nine counties that make up the region shaped the measures and actions laid out in the BREATHE Plan. The plan outlines multiple engagement strategies, including outreach and education; assurance of equitable access and representation; workforce development and training; and partnerships with local organizations, utilities, and government agencies. CBOs are emphasized as critical partners. Ongoing and effective engagement is essential to ensure inclusive, informed, and coordinated implementation of the BREATHE GHG reduction measures. Beyond the example actions outlined at the end of Chapter 4, continued engagement may include the following:

- Expanding stakeholder networks.
- Applying lessons learned.
- Addressing outreach limitations.

Use the Community Outcomes Matrix

What is the Community Outcomes Matrix?

An outcomes matrix is a tool developed to assess potential actions by first defining what matters and then scoring outcomes. It can help identify the strengths and weaknesses of actions while also pinpointing potential risks or consequences, short- and long-term benefits, and positive and negative effects on different groups or populations.

The BREATHE Team adapted a matrix originally created by community members and nonprofit Three³ for local food system projects. The BREATHE Community Outcomes Matrix is tailored to evaluate the plan's actions and identify their potential community outcomes, as listed at the end of Chapter 4.



How to Use the Community Outcomes Matrix

Individuals or groups might use the matrix to determine whether a potential climate action is worth further consideration and investment, and how to move forward with planning and implementation. For example, when actions are screened for potential community outcomes, the evaluation matrix might reveal that some options are not likely to meet any of the desired community outcomes and therefore should not be considered. Sometimes, actions are screened together and although one proposed strategy may meet only some of the preferred community outcomes, as a collective strategy, the actions provide major benefits across all community outcomes.

Anyone considering the implementation of a proposed climate action can use the Community Outcomes Matrix in Appendix F.

Evaluate and Study New Technologies

As technology advances and evolves, new opportunities will become available to advance climate action. Keeping abreast of and supporting these technologies offers an opportunity for future reductions, beyond the modeled reductions in this plan, to achieve BREATHE GHG reduction goals. For example, looking ahead, small modular reactors (SMRs) and microreactors are poised to play a pivotal role in decarbonizing the region's energy mix as part of a broader climate strategy. With projected commercialization of the technologies in the early 2030s, continued investment in SMRs and regional coordination could position the region as a deployment hub and innovation cluster for advanced nuclear energy. Combined with the BREATHE measures, SMRs can help achieve long-term GHG reduction goals by replacing fossil fuel generation and enabling a resilient, low-carbon grid. Strategic alignment of workforce development, local permitting, and clean energy policy will be critical to realize this opportunity.

Advance the Local Workforce

As the Knoxville region begins implementing the BREATHE Plan, continued investment in workforce development will be essential. This includes the following:

- Strengthening partnerships with CBOs.
- Expanding mentorship and training programs.
- Regularly re-aligning workforce data and initiatives.

One of the overarching goals of the BREATHE Plan is to provide the region with long-term, stable, and meaningful employment opportunities that support implementation of the GHG reduction measures. Ensuring that job opportunities are accessible, inclusive, and responsive to evolving workforce needs will be key to the plan's success.



Unlock Funding Sources

Securing funding is essential to shift from planning to the implementation of measures. For each BREATHE measure, it will be important to assess funding needs and availability. Especially as the landscape for climate action funding is shifting, more innovative ideas (e.g., new or evolved financing options) will be essential to advance BREATHE implementation. By identifying potential funding sources, public-private partnerships, and innovative financing options, the region can increase the chances of closing financial gaps for the implementation of BREATHE measures.

Establish Processes and Systems to Track Progress

Establishing robust metric tracking processes and systems is essential for evaluating progress and ensuring accountability in climate action planning. Using the metrics defined for the 19 GHG reduction measures, the city and stakeholders can implement regular tracking and reporting processes with clear responsibilities and timeframes. Progress reporting may be done through dashboards or public reports that allow for transparency and the ability to measure progress and then make adjustments throughout plan implementation. The tracking system should integrate both quantitative and qualitative data, support periodic reporting, and be flexible enough to incorporate evolving conditions.

Conclusion

The BREATHE Plan for the Knoxville region stands as a comprehensive, community-driven roadmap for a healthier, more resilient, and equitable future. By setting ambitious yet achievable GHG reduction targets and outlining actionable strategies across the Buildings, Energy, Transportation, Waste, Natural & Working Lands, and Agriculture sectors, the plan empowers local governments, organizations, and residents to work together toward meaningful climate solutions. Through ongoing engagement, targeted investments, and workforce development, Knoxville and its surrounding counties are positioned to lead by example, demonstrating that climate action can deliver wide-ranging benefits for public health, affordability, mobility, resilience, and economic growth. Success will depend on collective commitment and sustained collaboration, ensuring that every step taken today helps build a region where all can thrive for generations to come.



Links to Appendices

Appendix A: BREATHE Engagement

Appendix B: GHG Inventory Technical Report

Appendix C: GHG Emissions Projections Technical Report

Appendix D: Air Quality Methodology

Appendix E: Workforce Planning Analysis Technical Report

Appendix F: BREATHE Community Outcomes Matrix Toolkit

Appendix G: Works Cited in Sector Overviews