

SOUTHEAST MICHIGAN
Healthy Climate Plan



JANUARY 2026

SEMCOG

SOUTHEAST MICHIGAN COUNCIL OF GOVERNMENTS

MISSION

SEMCOG, the Southeast Michigan Council of Governments, is the only organization in Southeast Michigan that brings together all governments to develop regional solutions for both now and in the future. SEMCOG:

- Promotes informed decision making to improve Southeast Michigan and its local governments by providing insightful data analysis and direct assistance to member governments
- Promotes the efficient use of tax dollars for infrastructure investment and governmental effectiveness
- Develops regional solutions that go beyond the boundaries of individual local governments; and
- Advocates on behalf of Southeast Michigan in Lansing and Washington

Southeast Michigan Healthy Climate Plan

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ABSTRACT

The Southeast Michigan Healthy Climate Plan, serving as the region’s Comprehensive Climate Action Plan (CCAP), outlines data-driven pathways to reduce greenhouse gas emissions, enhance natural systems, improve air quality, and build more resilient communities. Developed through broad stakeholder engagement and cross-sector collaboration, the Plan aligns with the MI Healthy Climate Plan and supports national climate and resilience goals. It includes a regional emissions inventory, along with potential emissions scenarios through 2050. The Plan empowers local governments and partners to pursue the actions that best fit their community’s needs and priorities—advancing a shared vision for a cleaner, healthier, and more sustainable future.

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GLOSSARY

ATI	Authority to Implement
BAP	Business as Planned Scenario
BAU	Business as Usual Scenario
CAP	Criteria Air Pollutant
Carbon Sequestration	Biological processes that store atmospheric carbon in plants and soils.
CCAP	Comprehensive Climate Action Plan: A narrative report that provides an overview of the region’s significant greenhouse gas (GHG) sources/sinks and sectors, establishes near- and long-term GHG emission reduction goals, and identifies strategies to help the region meet those goals
CEDS	Comprehensive Economic Development Strategy
CEJST	Climate and Economic Justice Screening Tool
CH4	Methane - a greenhouse gas that is 28 times as potent as carbon dioxide over a period of 100 years
Clean electricity	Electricity or steam generated without emitting GHGs, including renewables and nuclear, and natural gas with at least 90%-effective carbon capture ¹
N2O	Nitrous oxide - a greenhouse gas that is 273 times as potent as carbon dioxide over a period of 100 years
CO	Carbon monoxide - a criteria air pollutant commonly produced as a result of combustion. CO can be found both indoors and outdoors but is more harmful at high concentrations indoors
CO2	Carbon dioxide - the most common greenhouse gas
CO2e	Carbon dioxide equivalent - used to compare different greenhouse gases based on the severity of their effects (Example: one Mton of methane has a CO2e of 28 Mtons, because - as a greenhouse gas - it is 28 times as potent as CO2)
CPRG	Climate Pollution Reduction Grant
DDOT	Detroit Department of Transportation
EGLE	Michigan Department of Environment, Great Lakes, and Energy

¹ State of Michigan. “Clean Energy & Jobs Act.” <https://www.legislature.mi.gov/documents/2023-2024/billintroduced/House/pdf/2023-HIB-5120.pdf>. This definition is used for the purposes of this document only.

GLOSSARY

EJScreen	Environmental Justice Screening and Mapping Tool
EPA	Environmental Protection Agency
EV	Electric Vehicle
GHG	Greenhouse Gas
GHG Inventory	<p>A calculation of total emissions during one calendar year from a specific region, which can be grouped by source and sorted based on attributes such as:</p> <ul style="list-style-type: none">• type of greenhouse gas produced• whether emissions are generated by energy use <p>Calculations use standardized methods so that inventories can be compared across regions. SEMCOG'S CCAP includes a GHG inventory for the project area for 2019.</p>
GJ	Gigajoule, a unit of energy (equal to one billion joules)
GPC	Global Protocol for Community-Scale Greenhouse Gas Emissions Inventories - an industry-standard methodology for calculating greenhouse gas emissions for a geographical area
GREEN	Growing our Resilience, Equity, and Economy with Nature
GSI	Green Stormwater Infrastructure
GWP	Global Warming Potential
HAP	Hazardous Air Pollutant
HFC	Hydrofluorocarbons, synthetic organic compounds with GHG effects, including insulating foams, refrigerants, fire protection substances, and aerosol propellants
HSOW	High Strength Organic Waste, includes fats, oils, and greases
IAP2	International Association for Public Participation, an international organization advancing public participation and community engagement through initiatives that are guided by culturally adaptive standards of practice and core values
ICE	Internal Combustion Engine
IPCC	Intergovernmental Panel on Climate Change
IRA	Inflation Reduction Act
LIDAC	Low-Income and Disadvantaged Community
MDOT	Michigan Department of Transportation

GLOSSARY

MMBtu	Metric Million British Thermal Unit
MMt CO₂e	Million Metric Tons of Carbon Dioxide Equivalent
MPO	Metropolitan Planning Organization
MSA	Metropolitan Statistical Area
MT	Metric Ton (or Tonne) – equals 1,000 kg or 2,205 pounds
MW	Megawatt – a measure of electricity-generating capacity
MWh	Megawatt hour – a measure of power produced
NAAQS	National Ambient Air Quality Standards: the Clean Air Act requires EPA to set NAAQS for six commonly found air pollutants, known as criteria air pollutants
NDC	Nationally Determined Contribution
NF₃	Nitrogen trifluoride – a potent greenhouse gas used in high-tech industries, with a 100-year warming potential 17,200 times greater than carbon dioxide
N₂O	Nitrous oxide – a greenhouse gas produced by agricultural fertilizers, fossil fuel combustion, and industrial processes
NO₂	Nitrogen dioxide – a criteria air pollutant commonly produced as a result of combustion and found in the exhaust of cars, trucks, buses, offroad equipment, and from power plants
NO_x	Nitrogen oxides
O₃	Ozone – a criteria air pollutant often found at ground level
PACE	Property-Assessed Clean Energy
PFC	Perfluorocarbon
PM_{2.5}	Particulate Matter Smaller Than 2.5 Micrometers
Renewable Electricity	Electricity or steam generated by energy from solar, hydro, wind, biomass, geothermal, landfill gas, wastewater or manure-based RNG. ²
RNG	Renewable Natural Gas, also known as biomethane, is a gas made from the decomposition of organic waste that can replace natural gas for heating or other purposes.

² State of Michigan. “Clean Energy & Jobs Act.”

GLOSSARY

RLF	Revolving Loan Fund
RTA	Regional Transit Authority
RTP	Regional Transportation Plan
SBT	Science-Based Target
RNG	Renewable Natural Gas, also known as biomethane, is a gas made from the decomposition of organic waste that can replace natural gas for heating or other purposes.
RLF	Revolving Loan Fund
RTA	Regional Transit Authority
RTP	Regional Transportation Plan
SBT	Science-Based Target
Southeast Michigan	For the purposes of this document, this shall refer to the geographic area encompassed by the counties of Wayne, Monroe, Macomb, St. Clair, Livingston, Lapeer, Oakland, and Washtenaw.
SEMAQS	Southeast Michigan Air Quality Study
SF6	Sulfur hexafluoride - a greenhouse gas with a global warming potential of 23,900, meaning it traps 23,900 times more heat in the atmosphere over a 100-year period. It is currently known as the most potent greenhouse gas currently known.
SMART	Suburban Mobility Authority for Regional Transportation
SO2	Sulfur dioxide - an air criteria pollutant
SSG	Sustainability Solutions Group, the consulting firm supporting the development of SEMCOG's Climate Action Plans
Stationary Energy	Refers to energy that is consumed for purposes other than transportation
UNFCCC	United Nations Framework Convention on Climate Change
USDA	U.S. Department of Agriculture
VMT	Vehicle Miles Traveled
VOC	Volatile Organic Compounds - a wide range of harmful, carbon-based air pollutants occurring in both indoor and outdoor air.

EXECUTIVE SUMMARY

DEVELOPING REGIONAL SOLUTIONS

The Southeast Michigan Healthy Climate Plan identifies the region’s major sources of greenhouse gas emissions and tracks how energy is used across sectors. Based on this analysis, the Plan outlines pathways to reduce emissions, improve energy efficiency, and support economic development across Southeast Michigan. It focuses on five regional opportunities:

- Modernize Mobility Systems
- Promote Efficient, Affordable Homes and Buildings
- Expand Local Renewable Energy Options
- Advance Clean Innovation in Industry
- Manage Waste and Natural Resources Sustainably

A coordinated approach in these areas will not only support a thriving and connected region but position Southeast Michigan as a climate leader—developing a healthier, more sustainable, and more livable region for all.

UNDERSTANDING CURRENT EMISSIONS

Southeast Michigan’s economy and daily activities rely on fossil fuels that lead to significant greenhouse gas (GHG) emissions. In 2019, Southeast Michigan’s greenhouse gas (GHG) emissions totaled 74.1 million metric tons of CO₂ equivalent (MT CO₂e). At 15.4 MT CO₂e per capita annually, the region is slightly higher than the U.S. average of 14.3 MT CO₂e per capita.

As shown in Figure 2 (page 10), approximately 63% of the region’s GHG emissions come from the energy used in buildings, representing residential, commercial, and industrial uses combined. Transportation accounts for 33% of the region’s GHG emissions, and remaining emissions come from waste, industrial processes, and agricultural sectors.

MODELING FUTURE EMISSION SCENARIOS

This Plan analyzes three emissions scenarios based on the five regional opportunities described above to understand future trends:

- **Business as Usual (BAU):** Results in only a **2% reduction** in emissions from 2019 levels by 2050, primarily driven by reduced heating needs due to warming climate trends. This scenario answers the question, “What would happen if no actions are taken?”
- **Business as Planned (BAP):** Anticipates a **48% reduction** by 2050, with significant progress from cleaner energy sources and the adoption of electric vehicles. This scenario answers the question, “What would happen if only current actions, plans and policies are implemented?” The 48% emissions reduction is primarily due to Michigan’s Public Act 235, which establishes the requirement for all grid electricity to be generated by clean energy by 2040.
- **Reduced Emissions (RE):** Aims for a **52% reduction** by 2030 and **net-zero** emissions by 2050, relying on improved energy efficiency, a decarbonized electricity grid, and increased renewable energy generation. This scenario answers the question, “What would happen if all the twenty (20) actions, policies, and programs in this Plan are successfully implemented?”

These scenarios build on a range of emission-reduction measures already prioritized and underway across the region. Efforts such as expanding transit and non-motorized travel, developing infrastructure for zero-emissions vehicles, and promoting building efficiency are aligned with community and climate goals.

Together, these actions not only reduce greenhouse gas emissions but also deliver significant co-benefits for public health and environmental quality. These benefits include improved local air quality from the reduction of other air pollutants such as volatile organic compounds (VOCs), fine particulate matter (PM_{2.5}), nitrogen oxides (NO_x), carbon monoxide and methane. Greater collaboration, awareness, data-driven analysis, and coordinated investment can amplify these impacts.

Working towards an aspirational goal of net-zero emissions requires significant investment of approximately \$83 billion through 2050 across the twenty (20) actions within the five regional opportunities. Over that same time, a region-wide savings of nearly \$350 billion may be realized. The most cost-effective emissions reduction action centers around increasing transit and train ridership while the costliest action is represented by the combined alternatives for retrofitting existing residential buildings.

ESTABLISHING REGIONAL PRIORITIES

Through this process, three broad priorities have been identified as regional policies to advance this plan in Southeast Michigan:

- **Reduce greenhouse gas emissions** across sectors to achieve a cleaner environment, stronger economy, and more resilient communities for all residents.
- **Apply regional data analysis** to support local planning and policy development to increase funding opportunities, and to coordinate partnerships across sectors.
- **Increase awareness** on climate action issues by engaging local governments and the public to promote context-sensitive, community-driven solutions.

These policies create a framework for regional coordination and implementation strategies. Throughout the plan, these overarching policies are highlighted to show how they support specific measures. These connections help to highlight regional challenges, opportunities, and case studies for implementation. This plan is designed as a practical resource for local governments, agencies, and stakeholders to draw from – offering a range of strategies that can be tailored to different scales, capacities, and priorities. Stakeholders and partners are encouraged to explore and analyze the actions that best fit their needs, while still contributing to shared regional goals. By doing so, this plan aims to foster collaboration, spark innovation, and create a common language around climate action that can be adapted and implemented across the region over time.

INTRODUCTION

Funded through the U.S. Environmental Protection Agency’s Climate Pollution Reduction Grant program (CPRG), this plan guides investments in a cleaner, more resilient, and equitable economy that supports innovation and local economic growth. The CPRG program advances three broad objectives:

- Reduce harmful climate pollution while creating good jobs and lowering household energy costs.
- Reduce environmental injustice and support community-driven solutions in overburdened neighborhoods.
- Improve air quality where people live, work, learn, and play.

Through the development of the Southeast Michigan Healthy Climate Plan (Plan), SEMCOG aims to identify integrated, comprehensive measures that reduce greenhouse gas (GHG) emissions and strengthen regional resilience.

PURPOSE AND SCOPE

The Southeast Michigan Healthy Climate Plan identifies comprehensive strategies to reduce regional greenhouse gas (GHG) emissions and assess their long-term, interconnected impacts. The plan was developed through extensive stakeholder outreach, community engagement, and cross-sector coordination to ensure equitable and community-centered benefits for environmental justice.

In alignment with EPA’s CPRG requirements, the Plan addresses electricity generation, industry, transportation, buildings, natural working lands, and waste management. Each measure is designed to:

- Create good jobs and strengthen the regional economy
- Reduce local and regional air and water pollution
- Lower long-term energy costs for household and businesses
- Improve the health, comfort and resilience of homes and other buildings
- Expand access to and quality of healthy, safe, affordable, and sustainable transportation for all ages
- Enhance urban vegetation to capture emissions, manage stormwater, moderate heat, and support local biodiversity

The measures described in this Plan will directly reduce climate pollution and accelerate Southeast Michigan’s transition to a lower emissions future. They are designed to create good jobs, lower household energy costs, and prioritize implementation in overburdened communities. This will advance environmental justice in the region with cleaner air and water; healthier homes and workplaces; and safer, greener outdoor spaces.

Contents of the Plan

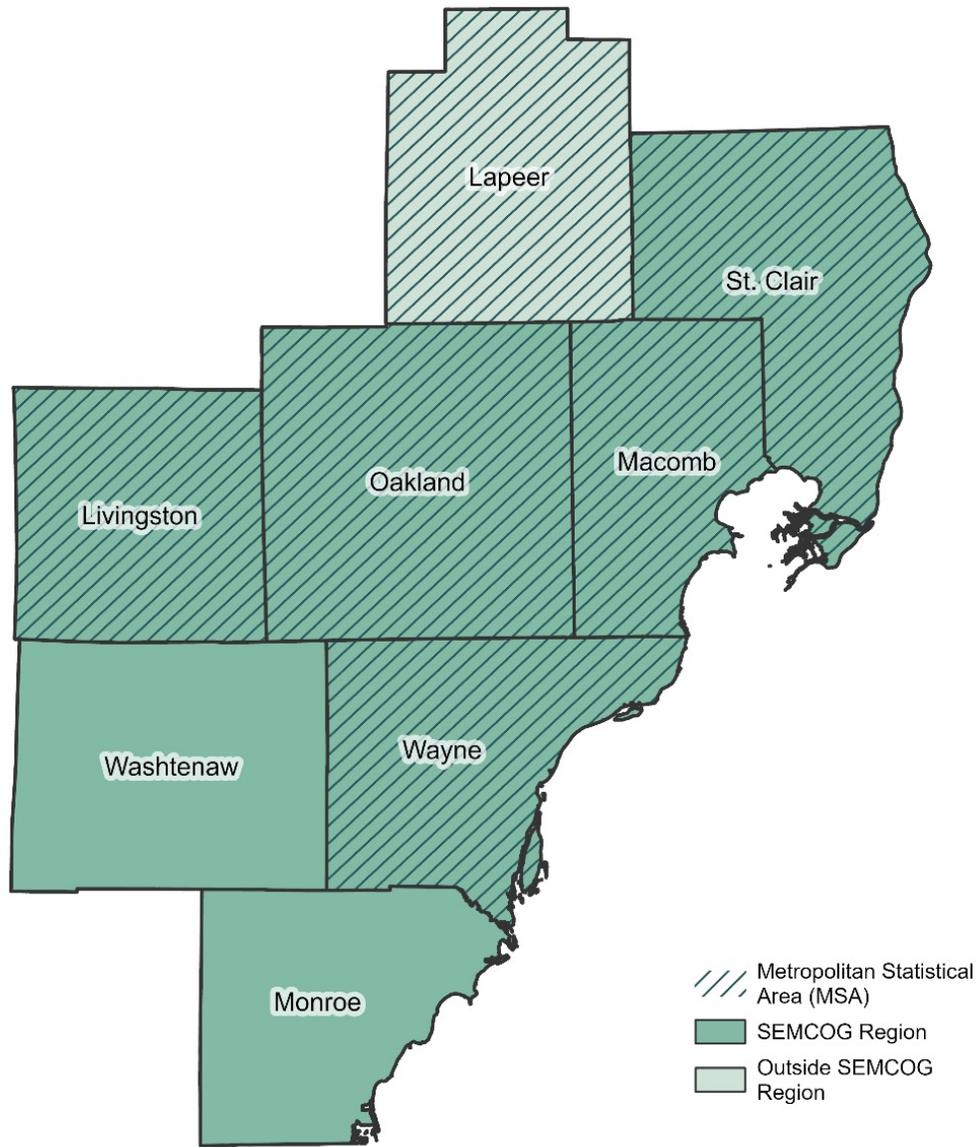
This Plan represents a comprehensive overview of measures that can reduce GHG emissions in the region, with a focus on the high-level opportunities, challenges, and implementation strategies. It is supported by technical appendices that provide detailed data and analysis. Based on the EPA’s CPRG requirements and SEMCOG’s intention to develop a regional plan that meets the specific needs of Southeast Michigan, this Plan is comprised of:

- **Southeast Michigan Healthy Climate Plan** – Features a summary of the region’s opportunities and challenges for reducing GHG emissions; also includes an analysis of measures to achieve them with quantified benefits and implementation strategies.
- **Appendix A: Engagement Analysis** – Highlights insights from conversations with residents, organizations and partners involved in shaping the priorities and solutions in the plan.
- **Appendix B: GHG Inventory and Reduction Targets** – Presents a complete overview of the sources of greenhouse gas emissions in Southeast Michigan, what gases they are, and how much was emitted from these sources in the year 2019.
- **Appendix C: Scenario Analysis** – Provides what Southeast Michigan’s annual energy use and emissions can be expected to be between 2025 and 2050 in a Business as Usual (BAU) scenario, a Business as Planned (BAP) scenario, and in a Reduced Emissions (RE) Scenario.
- **Appendix D: Benefits Analysis** – Breaks out the quantified reductions of GHGs, air quality improvements, and other co-benefits related to public health, environmental resilience, and the region’s economy.
- **Appendix E: Financial Analysis** – Accounts for the costs and savings associated with the measures identified to reduce emissions.
- **Appendix F: Implementation Analysis** – Illustrates how the reduction measures identified in this Plan can move from vision to reality with potential, funding sources, and timelines defined.
- **Appendix G: Workforce Analysis** – Reviews impacts to jobs in the region and opportunities for education and readiness programs to prepare the future workforce.
- **Appendix H: Data, Methods, and Assumptions** – Offers technical details that have guided the Plan’s analyses.

Geographic Scope

This Plan covers eight counties in Southeast Michigan: Lapeer, Livingston, Macomb, Monroe, Oakland, St. Clair, Washtenaw, and Wayne, as shown in Figure 1. The CPRG planning grant was awarded to the Detroit-Warren-Dearborn Metropolitan Statistical Area (MSA), which includes Lapeer, Livingston, Macomb, Oakland, and Wayne Counties. SEMCOG, as a regional council of local governments, includes Livingston, Macomb, Monroe, Oakland, St. Clair, Washtenaw, and Wayne Counties. EPA has encouraged inclusive regional planning beyond the CPRG’s focus on the MSA, and SEMCOG has well-established collaborative relationships with all the counties and communities engaged in the planning process.

Figure 1: Geographic Scope



THE OPPORTUNITY

Southeast Michigan’s future will stand on its legacy of innovation, manufacturing, and resilience. The region is now positioned to lead the transition toward a clean, low-carbon economy that fosters economic growth, environmental sustainability, and improved public health. By leveraging the region’s skilled workforce and industrial expertise, Southeast Michigan can meet the evolving demands of a clean-energy future.

This Plan outlines pathways to reduce GHG emissions, create skilled jobs, and enhance the quality of life – positioning the area as a leader in clean energy and sustainable development. With strategic policies and investments, Southeast Michigan can reduce emissions and create economic opportunities by shifting toward energy-efficient solutions, clean energy technologies, and sustainable development practices.

ENGAGING OUR COMMUNITIES

Between October 2023 and June 2025, SEMCOG conducted an extensive outreach effort to gather input and build consensus on regional priorities, challenges, and opportunities. SEMCOG’s Healthy Climate Task Force, co-chaired by local elected leaders, guided this process with input from partners across government, transportation, utilities, business, health, development, workforce, and environmental sectors.

SEMCOG maintained open communication with interested agencies and individuals to understand priorities and the existing climate planning initiatives throughout Southeast Michigan. SEMCOG engaged hundreds of residents, local leaders, experts, and stakeholders, including those from underserved communities. Participants emphasized actions that improve quality of life, create jobs, reduce disparities, and expand access to housing and mobility options.

Additional ongoing coordination with regional partners – including local environmental and community-based organizations; utility providers; port authorities; academic institutions; industry representatives; State and Federal agencies, including the Michigan Department of Environment, Great Lakes, and Energy (EGLE), and Michigan Department of Transportation (MDOT) – has strengthened alignment with existing initiatives.

Key themes emerged during this engagement process, including the need to lower energy burdens, improve housing quality, expand clean and affordable transportation options, and invest in community-owned energy solutions. Partners also highlighted several implementation challenges such as high upfront costs, limited access for renters, and limited contractor capacity. The plan reflects these concerns and emphasizes practical near-term solutions that deliver benefits to all.

FOCUSING ON NEEDS

While the benefits of a low-emissions future are significant for the whole region, they are most impactful for communities facing higher environmental and economic challenges. These areas often have higher energy costs, poorer air quality, and more vulnerable infrastructure. Targeting clean energy and efficiency investments works towards improving living conditions, reducing energy burdens, and expanding economic opportunities.

For example, investments in affordable, energy-efficient housing can reduce utility bills for low-income families while also improving indoor air quality and comfort. Expanding clean

transportation options, such as public transit and electric vehicle infrastructure, can reduce transportation costs and air pollution, improving health outcomes in these communities. Community-driven renewable energy solutions further empower residents and businesses to take control of their energy future, while also creating local jobs and economic activity.

A detailed summary of these impacts in our region's communities is included in Appendix D, Benefits Analysis.

BUILDING ON MOMENTUM

SEMCOG's coordinated approach builds on existing local, regional, and State efforts to reduce emissions, enhance natural areas, and strengthen community resilience. Representatives from all levels of government contributed to this Plan, ensuring priorities align with their experience and ongoing work. Working together with local governments and regional partners to reduce GHG emissions and enhance natural areas, Southeast Michigan can mitigate future impacts of climate change and ensure the region is a more resilient, equitable, thriving home for future generations.

This Plan expands on SEMCOG's Priority Climate Action Plan (PCAP), developed as an early deliverable for CPRG. The PCAP identified high-impact, near-term strategies and demonstrated the region's capacity for a coordinated approach. The PCAP process involved engagement with key stakeholders, analysis of emissions data, targeting of priority sectors, and creation a strong foundation for deeper long-term planning. This early momentum fostered cross-sector collaboration and built the institutional knowledge necessary to develop this robust, long-term Plan.

SEMCOG's broader work covers a range of topics that work together to support a healthy climate, including the region's environment and infrastructure, transportation and mobility networks, and economic and community vitality. As the designated local air-quality planning agency under the federal Clean Air Act, SEMCOG leads a variety of efforts to help attain and maintain national air quality standards in the region. As the region's Metropolitan Planning Organization (MPO), SEMCOG is responsible for developing the Regional Transportation Plan (RTP), which serves as a policy document to guide long-term transportation investment. As the region's federally designated Economic Development District, SEMCOG is also responsible for developing, updating, and implementing the Comprehensive Economic Development Strategy (CEDS), addressing the region's priorities for workforce and education, quality of place, and the business climate. Climate action is embedded in other aspects of SEMCOG's work, including:

- **The Southeast Michigan Community EV Toolkit** sets the stage for emerging technology in the world of sustainability. It gives local communities and stakeholders quick access to key data and background information regarding electric vehicles and helps guide communities towards the implementation of EV policies and projects.
- **SEMCOG's Water Infrastructure Planning Guide** examines how future rainfall projections and storm intensity are projected to exceed existing stormwater infrastructure capacities and convenes regional partners and experts to strengthen system resilience and protect public health, property, and infrastructure.
- **SEMCOG's GREEN Initiative** aims to expand the quality, quantity, and connectivity of the green infrastructure network and ensure that public benefits of green infrastructure are resilient, equitable, and improve the quality of life in Southeast Michigan communities.

Many private sector partners, including our region’s largest industries and utilities, are advancing sustainability commitments that align with regional climate goals. Many are adopting clean technologies, improving energy efficiency, and reducing supply chain emissions, presenting a compelling case for partnerships that can accelerate the future deployment of emerging technologies.

At the State level, the MI Healthy Climate Plan lays out a pathway to reach carbon neutrality by 2050, advancing goals for job creation, public health, equity, and environmental sustainability. Published in 2022 by the Michigan Department of Environment, Great Lakes, and Energy (EGLE), its objectives have informed the regional planning process to develop strategies that align with the State, while meeting the specific needs and goals of Southeast Michigan communities. Throughout the planning process, SEMCOG has coordinated with EGLE to share data, collect feedback from the public, and build upon the existing work laid out in the MI Healthy Climate Plan.

EMPOWERING LOCAL GOVERNMENTS

Across Southeast Michigan, local governments are laying the groundwork for a low-carbon, resilient future. Many communities have adopted or are developing climate and sustainability plans, including Oakland, Washtenaw, and Wayne Counties, the cities of Ann Arbor, Birmingham, Detroit, Ferndale, Southfield, Sterling Heights, Royal Oak, and Scio Township. Many other communities are taking steps to adopt energy-efficient building codes, retrofit public infrastructure, and integrate renewable energy into their power grids. These actions reduce emissions while creating jobs and lowering costs. In many examples throughout the region, communities have converted these savings into revenue to implement their plans and expand their programs. Engaging these local leaders and aligning with their initiatives has been central to the development of this Plan.

Land use planning decisions made today shape long-term impacts on emissions, resilience, and community well-being. The location and design of housing, employment centers, and public spaces influence how people travel, how energy is used, and how effectively natural systems can buffer environmental stress. Historically, industrial development near residential areas has exposed communities to higher levels of pollution. However, new approaches to clean and efficient industry can create shared benefits – such as providing renewable energy or distributing excess heat to nearby facilities without compromising air or water quality. Similarly, adding parks, trees, and green or open spaces – especially in underserved areas – can improve air quality, reduce flooding, and lessen the urban heat island effect. Through comprehensive planning and land use decisions, local governments have a powerful opportunity to guide growth patterns that lower emissions, strengthen resilience, and improve public health across Southeast Michigan.

In addition to land use planning policies, local governments play multiple roles in advancing and enabling emissions reduction efforts, including as:

- **Mobilizers:** Local governments can unite residents, municipalities, and other organizations around shared goals (Example: leading community engagement or coordinating bulk renewable energy purchases).
- **Innovators:** Local governments can directly or indirectly spur innovation through targeted investments, partnerships, and/or policies that advance clean energy and low-carbon solutions, reducing risk for investors and community members – for example, by expanding

ZEV charging and fueling infrastructure to accelerate adoption.

- **Collaborators:** Local governments can strengthen the clean energy and resilience transition through partnerships with federal, state, and regional agencies, transit authorities, utilities, businesses, and community organizations, working towards shared goals, coordinated policies, and joint investments.
- **Investors:** Local governments can leverage low-interest financing and public-private partnerships to fund energy efficiency like building retrofits and renewable energy technologies. Separately or in addition, local governments can also enable third-party investment through local financing tools such as improvement districts or retrofit programs.
- **Implementers:** Local governments can advance the renewable energy transition through policies, codes, and incentives that support businesses and households. For example, local governments can update building standards to encourage high-efficiency or Passive House construction.
- **Incubators:** Local governments can cultivate clean technology innovation by attracting and supporting businesses that advance the low-carbon economy, creating hubs or ecosystems that encourage collaboration and market growth – for example, through green business parks or performance-based building incentives.

THE CHALLENGE

Everyday activities in Southeast Michigan – commuting, powering homes and businesses, manufacturing goods, and moving freight – depend largely on fossil fuels such as gasoline, diesel, natural gas, and coal. These energy uses, along with emissions from industrial processes and waste decomposition, release GHGs into the atmosphere.

Globally, natural systems such as forests, oceans, soils, and wetlands absorb less than half of the GHG emissions that these activities generate each year. Natural systems in Southeast Michigan absorb approximately 3% of the region’s annual emissions. The remaining emissions accumulate in the atmosphere where their chemical properties trap heat, leading to associated climatic changes.

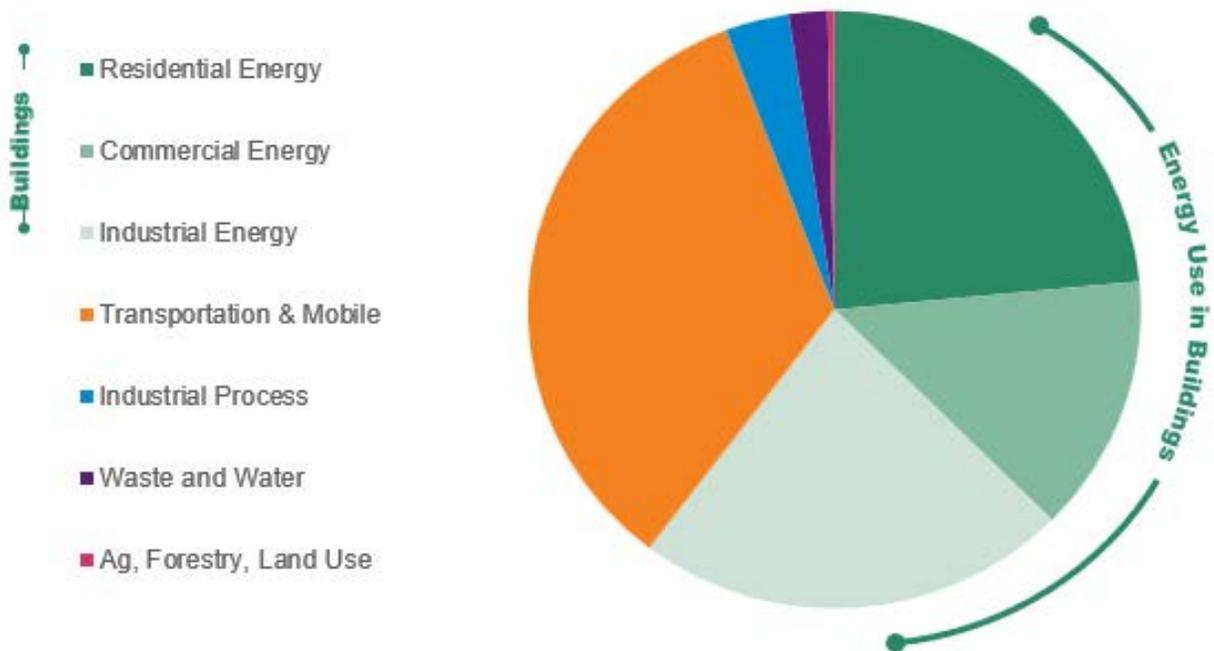
Maintaining a GHG inventory and emission reduction targets provides a data-driven foundation to identify major sources, set measurable goals, prioritize investments, and track progress toward effective regional strategies.

A detailed overview of the region’s 2019 GHG Inventory is included in Appendix B.

OUR STARTING POINT

In 2019, GHG emissions in Southeast Michigan totaled 74.1 million metric tons of carbon dioxide (CO₂) equivalent (MTCO₂e) (Figure 2). This is about 15 MTCO₂e per person, slightly above the U.S. average of 14.3 MTCO₂e. Emissions were distributed across multiple sectors and fuel types. (Figures 2 and 3), as shown in Figure E.3. Understanding these emissions is key to identifying targeted actions for reduction.

Figure 2: GHG Emissions Inventory



Approximately 60% of greenhouse gas (GHG) emissions in the region come from the energy used in buildings, including industrial, residential, and commercial. Residential emissions (23% of the total) stemmed mainly from natural gas for heating and cooking, and electricity for appliances and lighting. Industrial emissions (23% of the total) reflect the energy-intensive manufacturing powered by natural gas, electricity, and other fuels. Emissions from commercial buildings (14% of the total) result from heating, cooling, lighting, and using other technology or office equipment.

Transportation is the region's single largest sector, accounting for 34% of emissions. These are driven primarily by gasoline and diesel use, accounting for nearly one-third of total emissions. Industrial processes produce approximately 3.5% of the region's emissions related to physical and chemical transformations of raw materials and fugitive emissions that occur through natural gas leakage and oil production wells. At 2%, waste management and water treatment processes represent emissions from composting or landfills and other processes. Agriculture, forestry, and land use involve emissions as well as carbon sequestration from forests, crops, and other vegetation as well as livestock and manure management – representing a net 0.5% of the region's emissions.

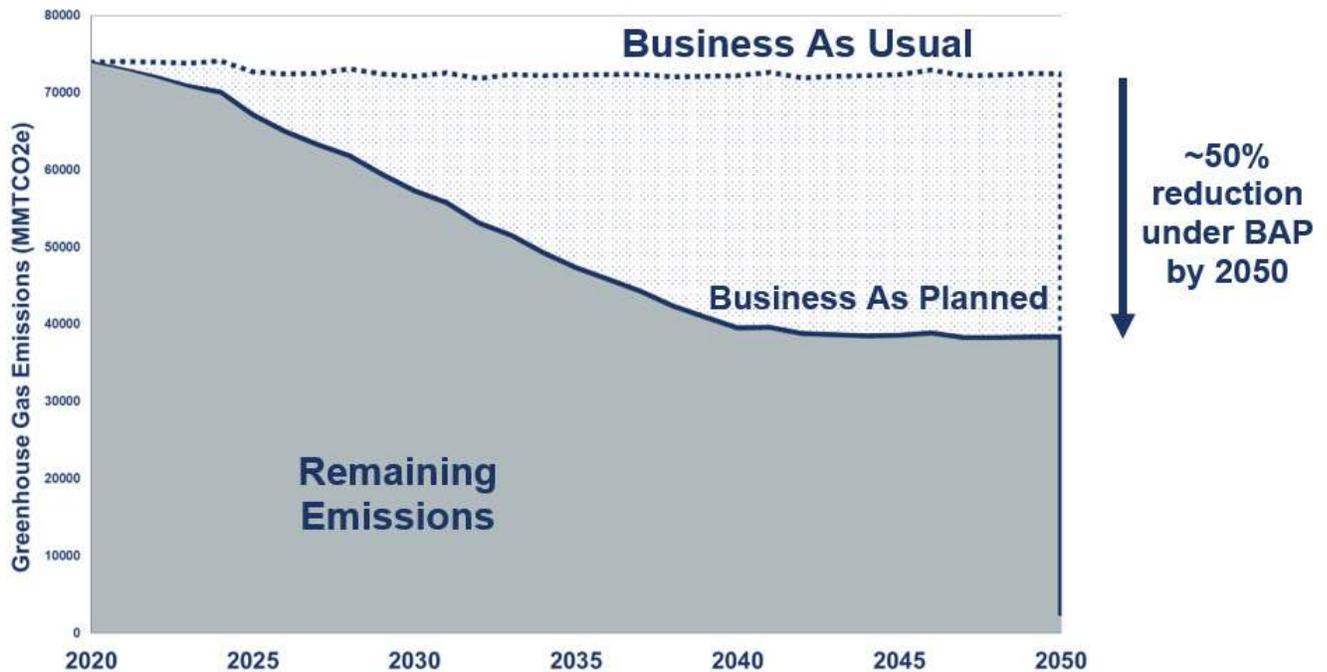
OUR CURRENT TRAJECTORY

If current trends continue, GHG emissions in Southeast Michigan are projected to remain near today's levels through 2050 (Figure 3). In a Business as Usual Scenario, which assumes no new policies or programs, emissions are projected to decline by 2%, largely due to reduced heating needs from a warming climate.

In contrast, under the Business as Planned Scenario, which incorporates existing and approved plans, legislation, and targets, emissions are projected to decrease by approximately 48%, reaching 38.4 million MT CO₂e) by 2050. Most reductions stem from a cleaner electricity grid, electric vehicle adoption, and improved vehicle fuel efficiency. This represents substantial reductions across Michigan and the Southeast Michigan region, exceeding reductions planned in many areas across the country.

These projections provide a flexible pathway toward alignment with the State of Michigan's MI Healthy Climate Plan and its 2050 carbon-neutral goal, recognizing that continued innovation, investment, and collaboration will be needed to sustain and accelerate progress. While the Business as Planned Scenario represents meaningful progress and provides a strong foundation for future partnerships, additional investments and policy actions will work towards deeper, long-term reductions that maximize regional benefits.

Figure 3: GHG Scenario Modeling



GHG Reduction Targets

Establishing data-driven GHG emission reduction targets offers Southeast Michigan communities a powerful opportunity to shape their own clean energy future – guiding investments, supporting innovation, and improving quality of life across the region. These goals create a framework that any community or county can build upon, helping align local priorities with state objectives while tracking measurable progress over time.

This Plan outlines a pathway toward deep regional reductions, including:

- **A 52% reduction GHG emissions by 2030**, compared to 2019 levels
- **Net-zero emissions by 2050** for the region

Pursuing these targets can open doors to new funding, cleaner technologies, local jobs, and sustainable communities while advancing the MI Healthy Climate Plan. Each community can align with strategies and partnerships that best fit its needs and context, and continue through this Plan to explore the actions, tools and collaborations that make these opportunities real. Reaching these targets will require coordinated action across energy, transportation, industry, and residential sectors, as well as continued investments in clean technologies, sustainable infrastructure, and energy efficiency.

THE PATHWAY This Plan identifies a pathway for reducing emissions in Southeast Michigan based on both technical analysis and community engagement. This **Reduced Emissions Scenario** (Appendix C) outlines a set of locally adaptable measures to help the region advance emission-reduction targets, reduce dependence on fossil fuels, improve energy efficiency, and expand renewable energy generation.

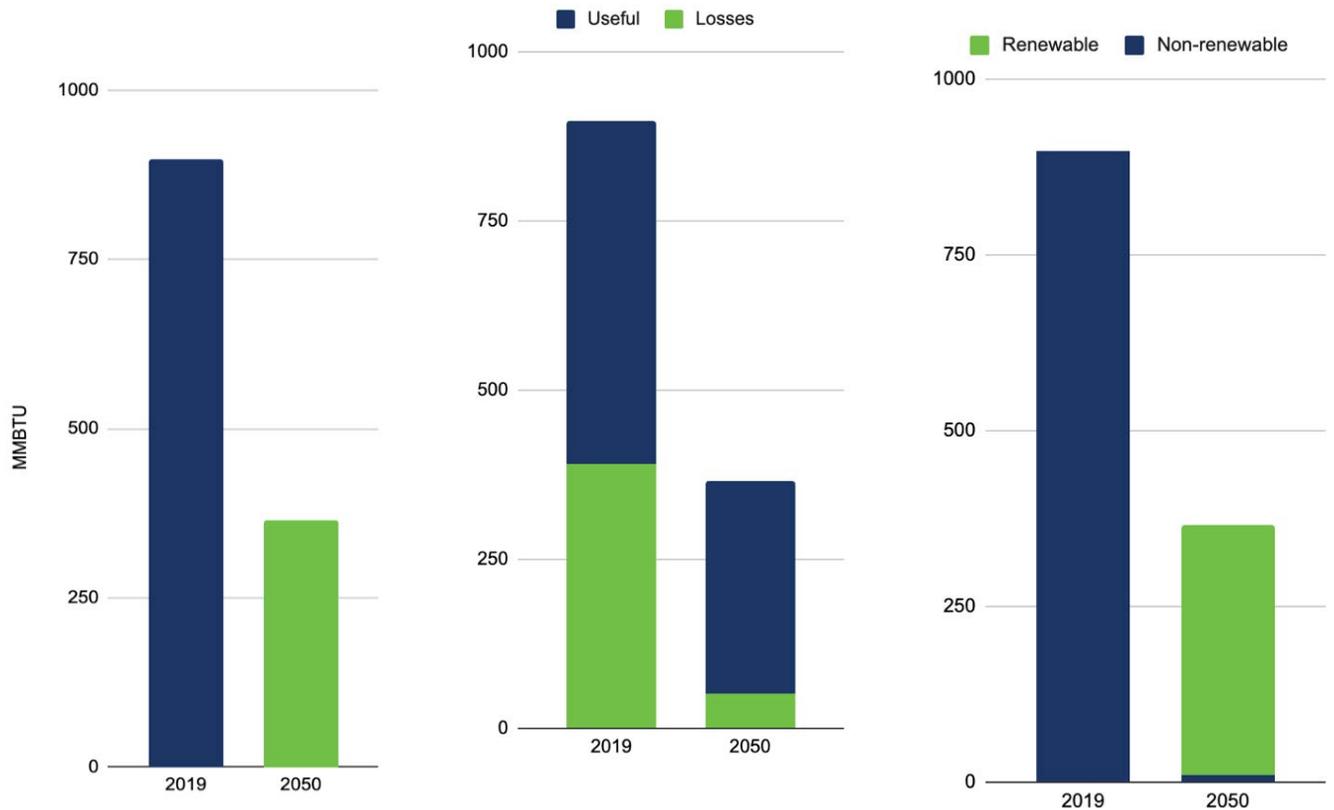
If implemented, these measures could reduce Southeast Michigan’s total energy use by 59%, while transitioning the region toward a renewable power supply (Figure 4).

Figure 4: Approaches to Reducing Energy Use

Starting with measures that **reduce or avoid energy use**

Then **improving efficiency** in the system to reduce losses

Finally, **switching fuels** to renewable resources



Building on the region’s energy strengths and legacy of innovation, this approach applies proven technologies and practical strategies to transform the energy system and built environment over the next 25 years. Achieving these reductions will require coordinated actions across five key focus areas, covering buildings, transportation, energy, waste, industry, and natural lands. A summary of these actions can be found in Table 1.

Table 1: Emissions Reduction Measures

Key Focus Areas to Reduce Emissions	Reduction Measures
Promote Efficient, Affordable Homes and Buildings	<ul style="list-style-type: none"> Retrofit and Weatherize Homes Retrofit and Weatherize Non-Residential Buildings Use Electric Heat Exchange Systems in Existing Buildings Increase Housing Options with Infill and Adaptive Reuse Establish Net-Zero Emission Standards for New Buildings
Modernize Mobility Systems	<ul style="list-style-type: none"> Increase Active Transportation Use Increase Transit Ridership Replace Personal Vehicles with ZEVs Replace Buses and Fleets with ZEVs Replace Outdoor Lighting with LEDs
Grow Local Renewable Energy Options	<ul style="list-style-type: none"> Develop Rooftop and Ground Mount Solar Power Systems Develop Local Energy Storage and Distributions Systems Develop Renewable Natural Gas Systems
Advance Clean Innovation in Industry	<ul style="list-style-type: none"> Improve Industrial Energy Efficiency Promote Clean Manufacturing Processes
Manage Waste and Natural Resources Sustainably	<ul style="list-style-type: none"> Restore and Enhance Green Spaces Divert Organic Waste from Landfills Increase Capacity for Anaerobic Digestion Systems Improve Waste and Water Treatment Operations

Figure 6 highlights the potential impact of each low-carbon measure on regional GHG emissions. While some individual measures—such as building retrofits and electric vehicle adoption—offer larger benefits, interdependent implementation is needed to achieve the projected emissions reductions. For instance, reductions from building retrofits and ZEV adoption are closely tied to expanding renewable energy sources both at the utility level and locally. Altogether, these measures could reduce emissions from 74.1 million metric tons (MMT) CO₂e in 2021 to just 2.0 MMT CO₂e, a 97% potential reduction.

Achieving these objectives will depend on collaboration among communities, local governments, businesses, and regional partners. The strategies outlined in this Plan are intended as tools and opportunities that municipalities can adapt to their own priorities and capacities. More details on how these strategies can be implemented are provided in Appendix F: Implementation Analysis.

Figure 5: Reduced Emissions Scenario – by Focus Areas

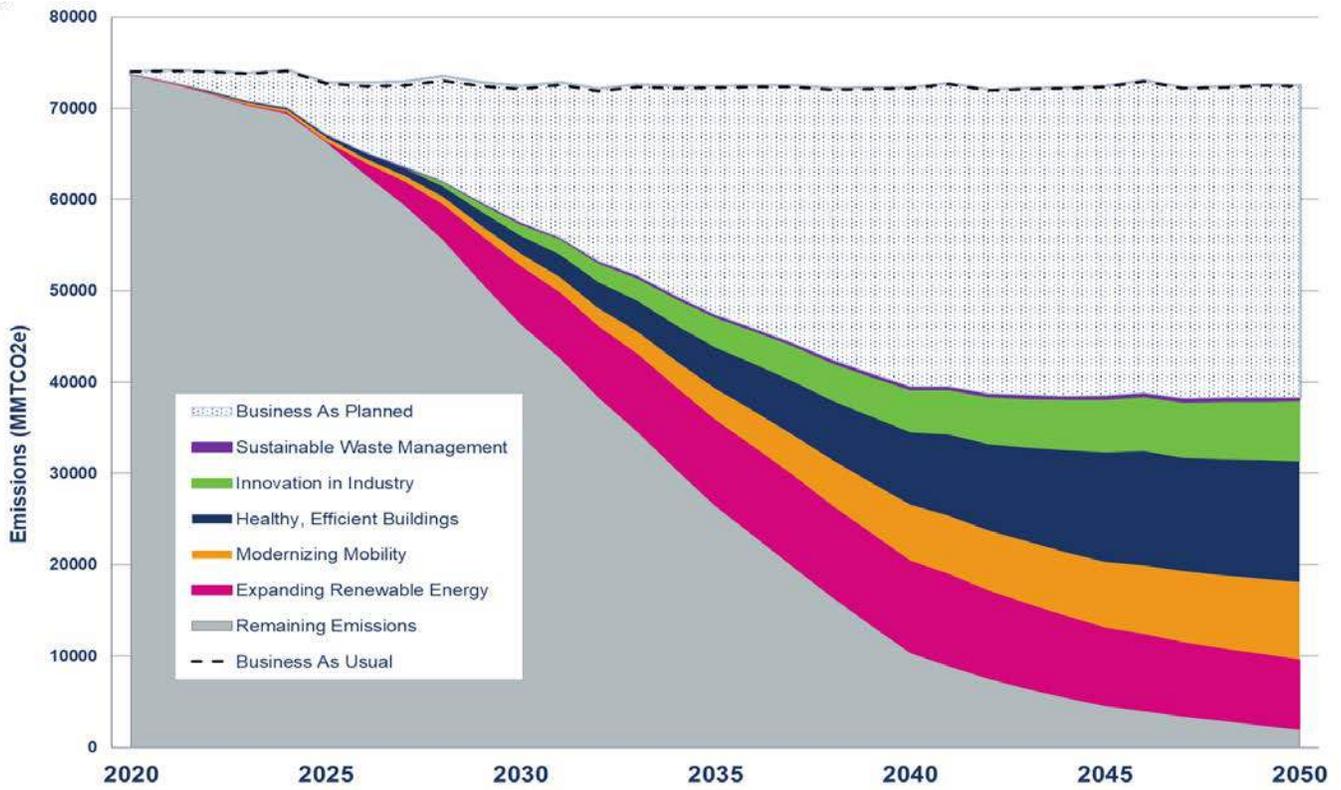
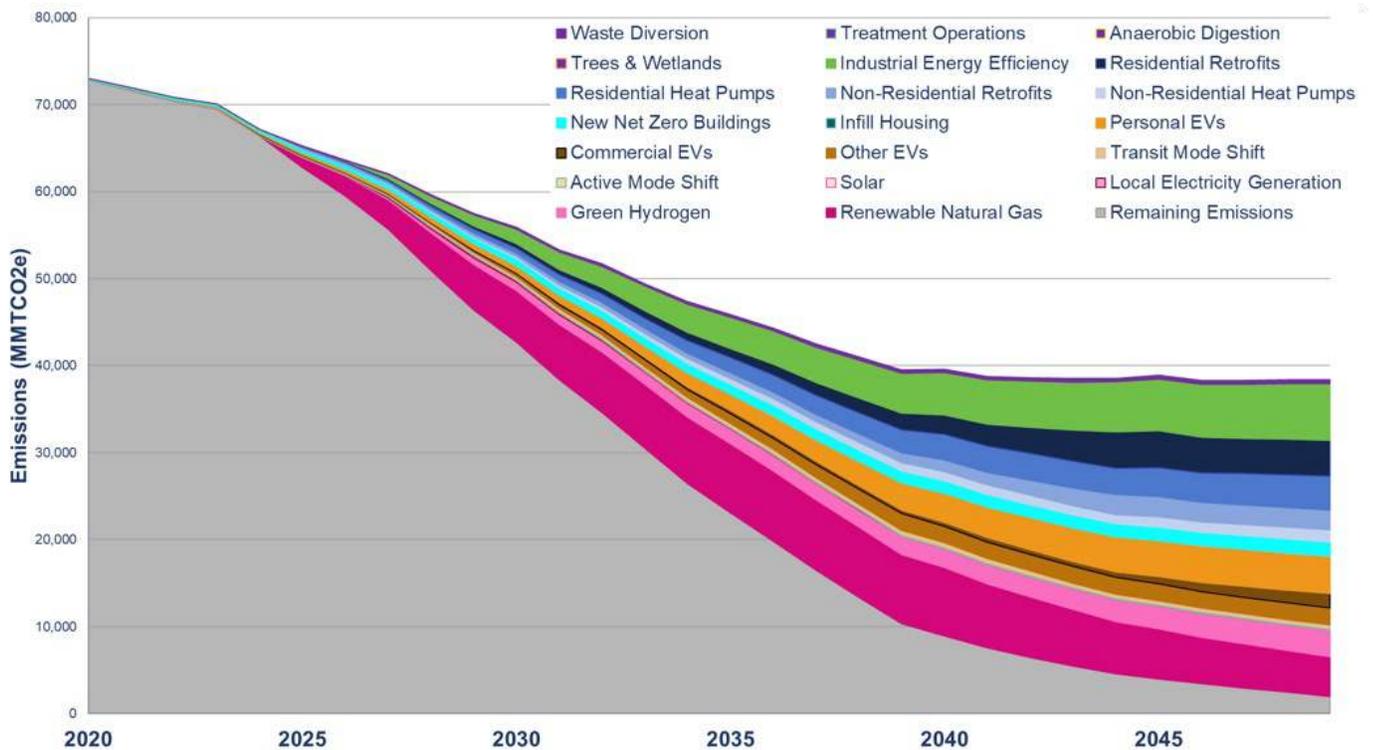


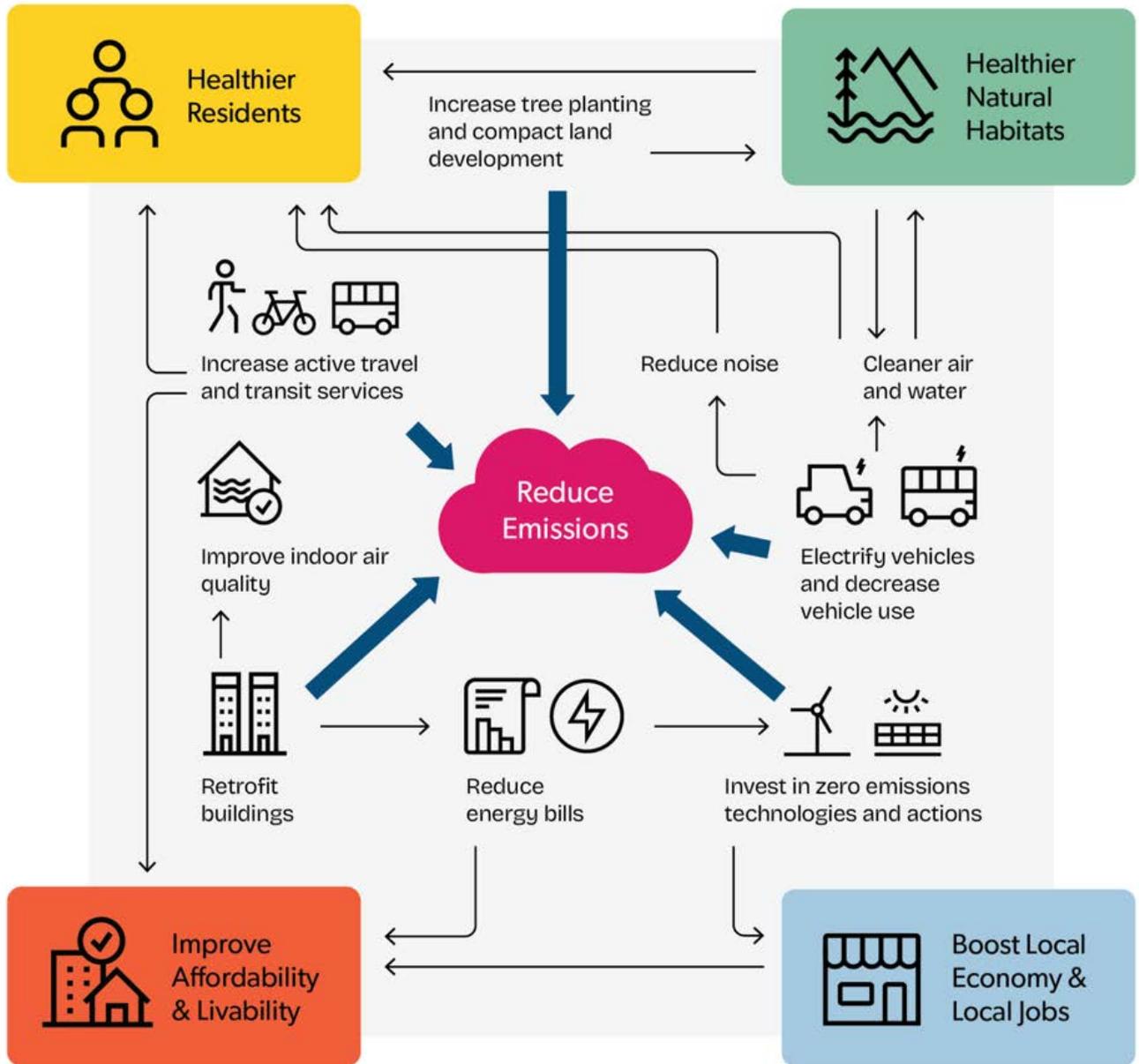
Figure 6: Reduced Emissions Scenario – by Reduction Measures



THE BENEFITS

The actions outlined in this Plan offer multiple benefits for Southeast Michigan’s communities in addition to reducing GHG emissions. Improved public health, lower household energy costs, and a more resilient economy (Figure 7) are among these. A full summary of this benefits analysis is detailed in Appendix D.

Figure 7: Co-Benefits of Reduced Emissions



CO-BENEFITS OF REDUCING EMISSIONS

Healthier Residents

One of the most immediate benefits of reducing GHG emissions is improved air quality. Lowering fossil fuel use reduces pollutants such as those regulated under the Clean Air Act: sulfur dioxide (SO₂), nitrogen oxides (NO_x), fine particulate matter (PM_{2.5}), carbon monoxide (CO), and volatile organic compounds (VOCs), all of which contribute to a range of health issues, including asthma, heart disease, and other health concerns. Communities that choose to pursue these actions can expect healthier air, improving public health and quality of life.

Table 2: Impacts to Criteria Air Pollutants from the RE Scenario

Criteria Pollutant	Percent Change to 2030	Percent Change to 2050
CO	-27%	-99%
HC	-29%	-99%
NO _x	-27%	-97%
PM ₁₀	-45%	-97%
PM _{2.5}	-22%	-84%
SO ₂	-41%	-98%
VOCs	-26%	-98%

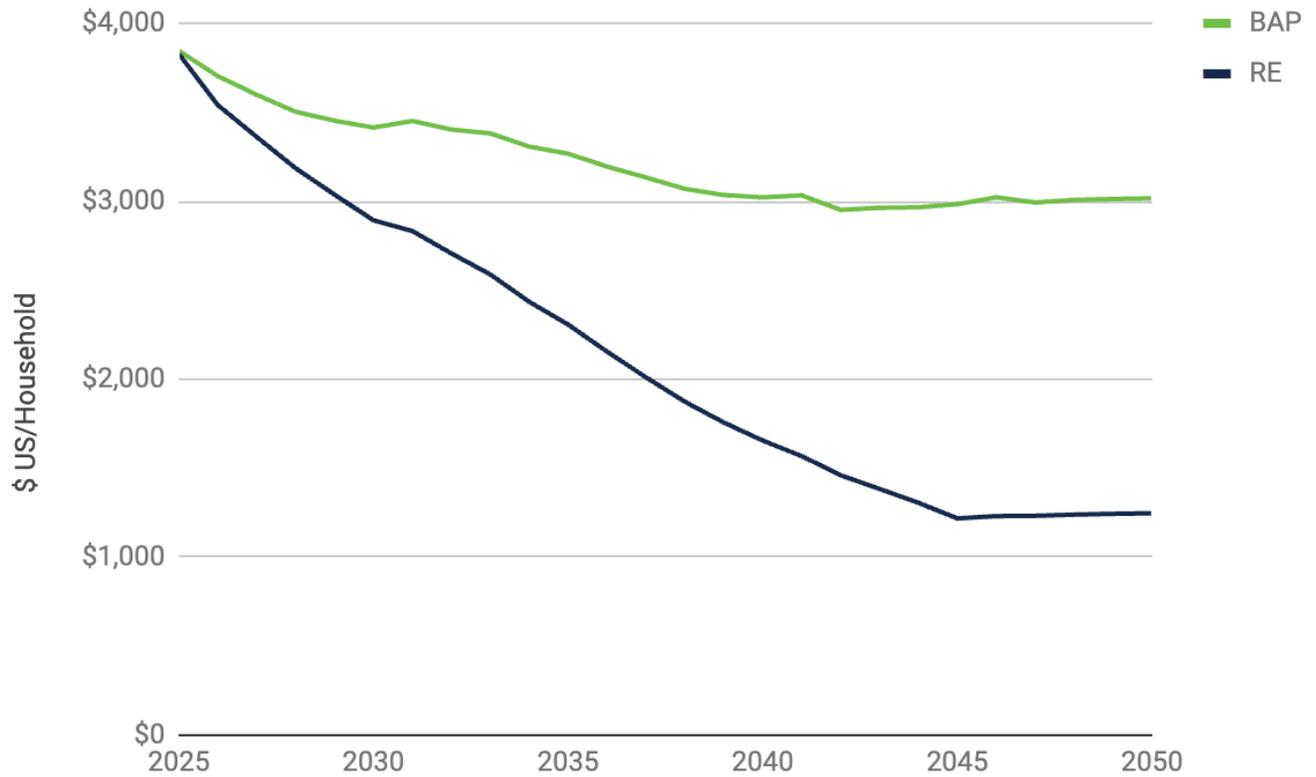
Improving energy efficiency in homes through building retrofits not only lowers emissions but also enhances physical and mental well-being. Better insulation and ventilation can reduce mold and indoor air pollutants, lowering risks of respiratory illness and stress. Energy-efficient buildings, with features like operable windows and daylight controls, give residents greater comfort and control over their environment, supporting overall healthier, more resilient communities.

Improved Affordability and Livability

A key opportunity within this Plan is the potential to reduce household energy costs. In 2021, the average household in Southeast Michigan spent nearly \$3,800 annually on home energy and vehicle fuel (Figure 8). Through building retrofits, improved insulation and air sealing, and high efficiency heating and cooling systems, households can significantly reduce their energy expenses over time, after initial investments in these improvements. Transitioning to electric appliances such as heat pumps and induction stoves, adding solar panels, and adopting electric vehicles can further reduce long-term energy costs.

By 2050, these improvements could lower average household energy expenses to approximately \$1,250 per year – roughly one-third of current energy costs. Beyond savings, these upgrades enhance comfort and energy security, helping families better withstand extreme weather events or power outages.

Figure 8: Annual Household Energy Cost Savings with the Reduced Emissions Scenario

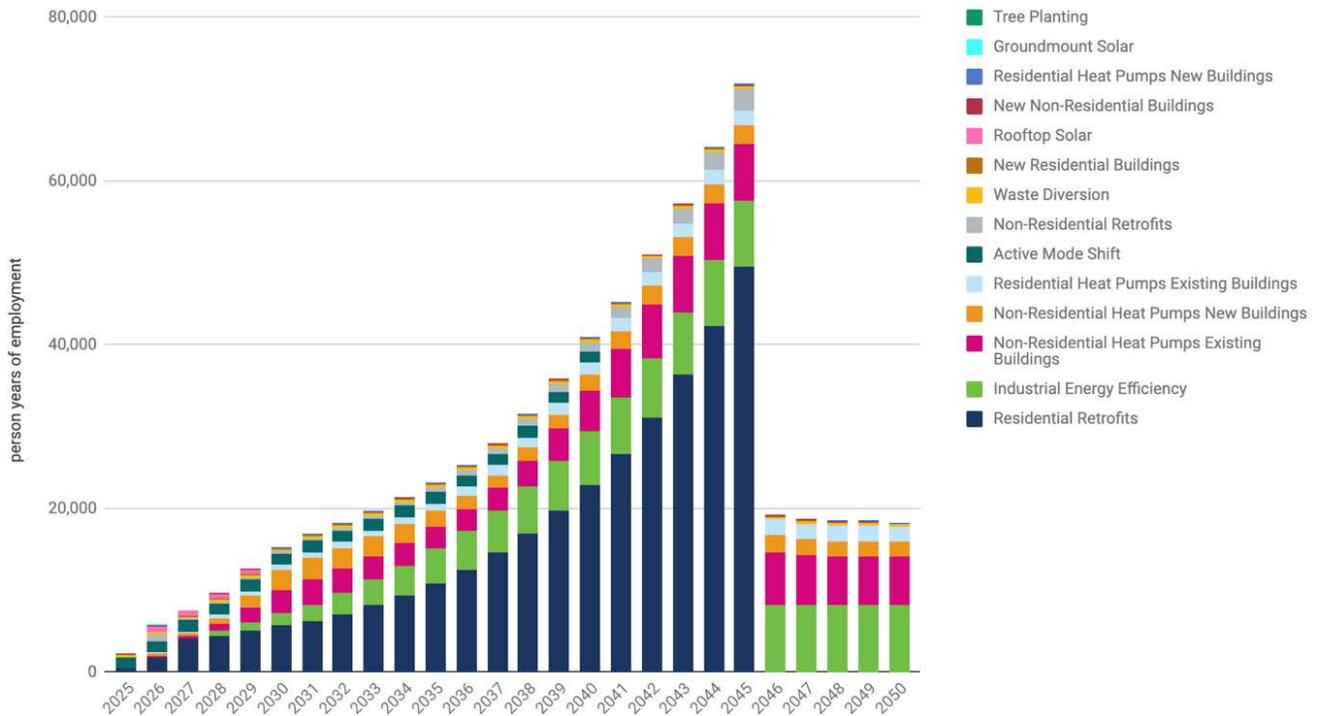


Expanded Job Opportunities

The transition to an environmentally sustainable economy will require significant investments in infrastructure across multiple sectors, including transportation, energy efficiency in buildings, renewable energy, and waste management. These investments will generate new job opportunities in areas such as building retrofits, heat pump installation, renewable energy generation, active transportation infrastructure, and industrial efficiency.

If fully implemented between 2025 and 2050, the strategies identified in this Plan are expected to create approximately **8,000 full-time jobs** in Southeast Michigan sustained for the entire 25-year period, or a larger number of jobs for shorter periods of time. Additional employment and economic benefits are likely to result from utility-scale renewable energy projects and increased local investment activity.

Figure 9: Job Opportunities from the RE Scenario



Healthier Natural Environments

Reducing emissions also delivers significant benefits for environmental health and resilience. Cleaner air and reduced pollutant levels improve soil and water quality, which supports plant and animal life across both urban and rural areas. Actions such as restoring wetlands, planting trees, and expanding green infrastructure enhance biodiversity by providing habitat and migration corridors for wildlife. Wetlands and forested areas also act as natural filters, capturing pollutants, storing carbon, and reducing nutrient runoff into waterways, which helps prevent algal blooms and maintain healthier aquatic ecosystems. By cutting emissions from vehicles and industries, these measures also reduce ground-level pollutants like ozone, which can damage vegetation and weaken ecosystems.

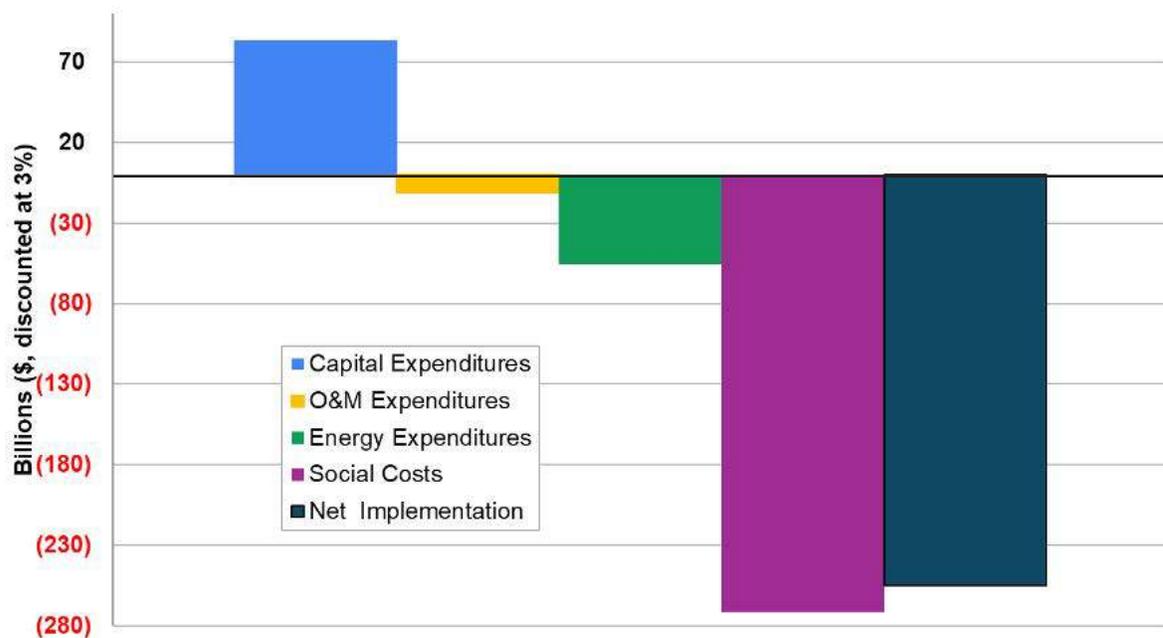
A stronger, more connected network of natural systems increases the region’s ability to withstand and recover from climate-related stressors. Expanding tree canopy and restoring native vegetation help regulate local temperatures, reduce erosion, and stabilize watersheds, protecting communities from flooding and drought. Healthy ecosystems absorb and store more carbon, making them a key component of long-term climate resilience. These improvements also support pollinators and other key species that sustain agriculture and food systems. In Southeast Michigan, where urban areas and natural landscapes are intertwined, actions that reduce emissions and restore ecosystems can help make natural systems cleaner, more diverse, and better equipped to adapt to changing conditions.

COSTS, SAVINGS, AND RETURNS ON INVESTMENT

Implementing the actions in the Reduced Emissions Scenario (RE) represents a strategic investment in Southeast Michigan’s economic efficiency, public health, and climate resilience. Between 2025 and 2050, an estimated \$83.4 billion in capital investments—averaging less than 1% of region’s GDP annually—would modernize infrastructure, transportation, and energy systems. These investments will create jobs and enhance regional competitiveness while driving substantial operational savings and risk reductions.

In return, this investment would yield nearly \$350 billion in savings and avoided costs over the same 25-year period. Homeowners, businesses, and local governments are projected to save \$67 billion through lower energy use, reduced maintenance, and more efficient operations. Additional incidental savings of social costs—including \$280 billion in avoided health and infrastructure costs from potential climate-related disruptions—reflect the broader economic benefits of cleaner air, more reliable energy systems, and reduced damage to public assets.

Figure 10: Costs and Savings from the Reduced Emissions Scenario



Several specific measures stand out for their cost effectiveness. Expanding transit and train ridership saves commuters \$8 billion, while replacing internal combustion vehicles with electric vehicles yields \$24 billion in fuel savings for drivers. Retrofitting older homes, though the most capital-intensive measure, significantly cuts household energy costs and lowers the number of residents facing high energy burdens.

In total, the RE Scenario delivers net implementation savings of \$254 billion. In addition to direct financial returns, these investments provide long-term cost avoidance and fiscal risk management, helping the entire region avoid escalating expenses from fuel, infrastructure wear, and health-related impacts. By investing strategically in efficiency and modernization, Southeast Michigan positions itself for a stronger, more prosperous, and more resilient future.

MAKING IT HAPPEN

Implementing the measures identified in this Plan will require significant collaboration across all sectors and levels of government. The Reduced Emissions Scenario represents a simultaneous and transformative shift across planning, development, technology, and daily behavior. Significant benefits, including lower energy costs, healthier communities, a more reliable energy grid, and a stronger regional economy.

The Key Focus Areas tell us why reducing emissions can support long-term sustainability for the region's environment, economy, and communities. Alternative scenarios answer the question, What changes can be made to reduce emissions?

Implementation planning focuses on:

- How will those reductions be achieved?
- Who has a role in the process?

The Implementation Opportunities on the following pages describe these key reduction components and identify roles for partners in each action. These are not exhaustive or prescriptive lists; they provide examples to highlight where local governments may have influence or authority to effect these changes. For more information on implementation, see Appendix D.

It is important to recognize that strategies may take different forms depending on local priorities and resources. For example, one community may be more focused on accelerating building electrification through local ordinances and incentives while another may be better positioned to prioritize transit-oriented development. The opportunities described in this section are based on various implementation mechanisms that can be adapted and applied in different ways, ensuring flexible approaches to advancing progress and maximizing impacts.

Table 3: Implementation Mechanisms – A flexible framework for comprehensive strategies

Regulatory and Policy	<ul style="list-style-type: none"> • Codes and Standards: Update building codes, appliance standards, and fuel standards to align with climate goals. • Permitting Reform: Streamline and reduce permitting processes for clean energy and ZEV infrastructure installations. • Mandates and Requirements: Adopt enforceable policies or regulations that set targets and timelines for climate actions.
Planning and Governance	<ul style="list-style-type: none"> • Integrated Planning Requirements: Require climate action integration into land-use, transportation, energy, and adaptation planning. • Cross-Sector Coordination: Establish task forces or working groups to align state, local, Tribal, and private-sector efforts. • Public Engagement: Co-develop programs and implementation approaches that address their priorities in alignment with climate actions.
Technical Assistance and Capacity Building	<ul style="list-style-type: none"> • Guidance and Toolkits: Provide resources for local governments and other stakeholders to develop and implement climate action projects. • Community-Based Support: Offer direct planning support to community organizations in LIDACs and Tribes. • Workforce Development: Expand training, apprenticeships and job placement programs aligned with the Plan’s measures.
Private Sector, Partnerships, and Collaboration	<ul style="list-style-type: none"> • Private Sector Investment: Southeast Michigan benefits from the presence of private corporations and a spirit of renewal that has been growing in recent years. The potential to leverage the investment power of these corporations can be a significant contributor to the transformation of the region. • Public-Private Partnerships: Collaboration between government and the private sector to deliver public services, infrastructure, or innovation. • Demonstration Projects: Develop pilot projects with government, industry, and educational institutions. • Innovation Accelerators: Support early-stage technologies and startups through incubators and testbeds. • Utility and/or Developer Collaboration: Coordinate large-scale deployment with key actors.
Market Development and Procurement	<ul style="list-style-type: none"> • Public Procurement Standards: Use aggregated purchasing power to catalyze demand for low emissions products and services. • Green Purchasing Requirements: Require low emissions materials in public construction and operations. • Bulk Purchasing: Pool purchasing power to reduce costs and expand access.
Monitoring, Evaluation, and Transparency	<ul style="list-style-type: none"> • Public Reporting: Track and publish implementation, emissions and community outcomes and progress toward goals. • Evaluation Frameworks: Build in opportunities for reviewing actions and processes to improve or correct the plan’s course.

Implementation Opportunities

WHY <i>Key Focus Areas</i>	WHAT <i>RE Scenario Measures</i>	HOW <i>Steps Toward Reducing Emissions</i>	WHO <i>Roles for Everyone</i>
Promote Healthy and Efficient Buildings	Retrofit homes	Create an energy advisor service designed to support retrofits of homes and replace fossil fuel systems with zero-emissions alternatives, prioritizing low-income homes.	Coordinated approach with Counties
		Expand existing weatherization programs to include additional energy efficiency improvements designed to optimize reducing energy costs for homeowners and reducing energy consumption and emissions.	Counties and County Level Community Action Agencies
		Develop a program to install simple, effective repairs (Example: City of Detroit’s plan to replace broken or missing doors and windows on the estimated 20% of occupied homes in need of these repairs).	Municipalities
	Retrofit non-residential buildings	Introduce municipal ordinance and administrative support to make use of the Commercial Property-Assessed Clean Energy (PACE) legislation. Consider cooperative efforts across communities	Municipalities
		Develop ‘corporate climate leadership programs’ to educate corporations on reducing energy use and emissions, with a requirement to track energy use and emissions. Celebrate and provide public marketing materials for corporate participants.	Public-Private Partnerships

Implementation Opportunities

WHY <i>Key Focus Areas</i>	WHAT <i>RE Scenario Measures</i>	HOW <i>Steps Toward Reducing Emissions</i>	WHO <i>Roles for Everyone</i>
Promote Healthy and Efficient Buildings	Use electric heat exchange systems in existing buildings	Create, continue, and expand incentive programs for the installation of electric equipment, devices, and appliances, which will decrease energy consumption (Examples: heat pumps to replace space heating/ cooling, water heating, and clothes dryers, to tap aerators and light bulbs). These programs and process would be integrated and coordinated through the Energy Advisor service described previously.	Municipalities, Counties
	Increase housing options with infill development and adaptive reuse	<p>Combine brownfield redevelopment grants with corporate property tax reductions to encourage private companies and investors to transform existing vacant properties into rejuvenated, net-zero, affordable housing, prioritizing lower income neighborhoods, mixed-use developments, and other walkable, bikeable, and transit-oriented areas.</p> <p>Update zoning to allow smaller average sizes for both lots and structures.</p> <p>Decrease maximum lot sizes in both greenfield and infill areas to encourage smaller residential buildings.</p> <p>Change ordinances to allow accessory dwelling units to be added to existing residences, either in out-buildings or within the principal dwelling.</p>	<p>Public-Private Partnerships</p> <p>Municipalities</p> <p>Municipalities</p> <p>Municipalities</p>

Implementation Opportunities

WHY <i>Key Focus Areas</i>	WHAT <i>RE Scenario Measures</i>	HOW <i>Steps Toward Reducing Emissions</i>	WHO <i>Roles for Everyone</i>
<p style="text-align: center;">Promote Healthy and Efficient Buildings</p>	<p style="text-align: center;">Establish net-zero emission building standards</p>	<p>Convene a regional working group initiative with builders and land developers to determine how to accelerate building to a net-zero standard. Identify sustainability champions in the builder and developer communities as well as builders who disagree with the approach. Meet regularly for at least a year to identify challenges, increase awareness.</p> <p>Integrate passive house-building standards into construction and energy audit training at technical institutes.</p> <p>Create a local commercial PACE program to help support energy efficiency upgrades, renewable energy installations, and water efficiency projects for commercial buildings. Program details should include ordinances and financial backing, establishing program administration and rollout timeline.</p>	<p>State and Regional Cooperative Effort of Municipalities, Builders, Developers, Technical Schools</p> <p>Builders, Developers, Technical Schools</p> <p>Municipalities</p>

Implementation Opportunities

WHY <i>Key Focus Areas</i>	WHAT <i>RE Scenario Measures</i>	HOW <i>Steps Toward Reducing Emissions</i>	WHO <i>Roles for Everyone</i>
Modernize Mobility Systems	Increase active transportation	Reduce and eventually eliminate vehicle parking minimums in development standards or the zoning ordinance.	Municipalities
		Create zero-emissions, last-mile delivery zones within urban areas, and support the creation of last-mile delivery services with delivery hubs, cargo bikes, and electric delivery vans.	Municipalities
		Develop a fully connected system of high-quality, active transportation networks that connect residences with both recreational, work and school destinations, with a priority on communities that currently have inadequate access to transportation.	Coordinated approach with municipalities, transit agencies
	Increase transit and train ridership	Optimize and expand existing transit service, with a focus on making transit a more appealing alternative than a trip in a personal vehicle.	Coordinated approach with municipalities, transit agencies
		Evaluate key transit routes to determine system operations, costs, and convenience for riders, and other systemic factors to help increase transit ridership.	Transit agencies
		Re-initiate an evaluation of regional passenger rail opportunities, such as an electric commuter train service from Ann Arbor to downtown Detroit.	Coordinated with municipalities and transit agencies

Implementation Opportunities

WHY <i>Key Focus Areas</i>	WHAT <i>RE Scenario Measures</i>	HOW <i>Steps Toward Reducing Emissions</i>	WHO <i>Roles for Everyone</i>
Modernize Mobility Systems	Replace buses with ZEVs	<p>Develop a zero-emissions bus procurement strategy that will gradually replace current fleet vehicles with ZEVs and acquire the necessary charging/ fueling infrastructure. Direct the operational savings realized from the avoided fuel and maintenance costs of ZEVs into a revolving fund that will then be used to fund the next round of new ZEV buses.</p> <p>Begin a program to regularly refurbish existing buses to extend the use of the vehicle body and refresh the comfort and appearance of the vehicles. Incorporate the replacement of their ICE motors with ZEV alternatives into the refurbishment process.</p>	<p>Coordinated approach with municipalities, school districts, transit agencies</p> <p>Coordinated approach with municipalities, school districts, transit agencies, workforce training</p>
	Replace light and medium-duty vehicles with ZEVs	<p>Hold free ZEV Expos to provide the public and fleet owners with opportunities to drive an ZEV, dispel misperceptions, and learn more about available models, charging, and financial incentives.</p> <p>Develop and carry out a ZEV procurement strategy that will replace all current fleet vehicles with ZEV's and acquire the necessary charging/ fueling infrastructure. Direct the operational savings realized from the avoided fuel and maintenance costs of ZEVs into a revolving fund that will then be used to fund the next round of new ZEV fleet vehicles.</p>	<p>Coordinated approach with municipalities, transit agencies</p> <p>Coordinated approach, Municipalities</p>

Implementation Opportunities

WHY <i>Key Focus Areas</i>	WHAT <i>RE Scenario Measures</i>	HOW <i>Steps Toward Reducing Emissions</i>	WHO <i>Roles for Everyone</i>
Modernize Mobility Systems	Replace heavy-duty vehicles with ZEVs	Initiate a study to replace high-emissions truck transportation along standard corridors among manufacturing and assembly plants with hydrogen trucks, electric trucks, and freight rail	SEMCOG, Utilities, Auto Manufacturers, Hydrogen Hub, Municipalities along transportation corridors
	Replace offroad vehicles with ZEVs	Create an ordinance requiring that by a certain year, municipal construction vehicles must generate zero emissions. Gradually increase the zero-emissions proportion of offroad vehicles over time.	State and Regional Cooperative Effort, Municipalities, Construction companies
	Replace port equipment and vehicles with ZEVs and use only electricity for docked ships	Coordinate an educational session for all ports in the SEMCOG region to familiarize them with the status of climate action in maritime shipping (e.g., U.S. Action Plan for Maritime Energy and Emissions Innovation, International Maritime Organization), with a case study overview from a U.S. port authority that is partway through a project to eliminate emissions from port operations (such as the Long Beach Port).	Port authorities at the commercial ports in Harbor Beach, Port Huron, Marysville, St. Clair, Marine City, Detroit, and Monroe.
	Replace street, traffic, park, stadium and sportsfield lighting with LEDs	Collaborate to develop a goal to fully replace region-wide street, traffic, parking, recreation, sports field, and stadium lighting, and create a grant program and / or revolving fund to reduce the up-front cost for participating municipalities and other entities. Consider partnership with a large sports facility with LED lighting, such as Ford Field would provide a local corporate champion for the initiative.	Municipalities and other entities with outdoor lighting requiring replacement, across the region, and corporate partners

Implementation Opportunities

WHY <i>Key Focus Areas</i>	WHAT <i>RE Scenario Measures</i>	HOW <i>Steps Toward Reducing Emissions</i>	WHO <i>Roles for Everyone</i>
Modernize Mobility Systems	Replace buses with ZEVs	<p>Develop a zero-emissions bus procurement strategy that will gradually replace current fleet vehicles with ZEVs and acquire the necessary charging/ fueling infrastructure. Direct the operational savings realized from the avoided fuel and maintenance costs of ZEVs into a revolving fund that will then be used to fund the next round of new ZEV buses.</p> <p>Begin a program to regularly refurbish existing buses to extend the use of the vehicle body and refresh the comfort and appearance of the vehicles. Incorporate the replacement of their ICE motors with ZEV alternatives into the refurbishment process.</p>	<p>Coordinated approach with municipalities, school districts, transit agencies</p> <p>Coordinated approach with municipalities, school districts, transit agencies, workforce training</p>
	Replace light and medium-duty vehicles with ZEVs	<p>Hold free ZEV Expos to provide the public and fleet owners with opportunities to drive an ZEV, dispel misperceptions, and learn more about available models, charging, and financial incentives.</p> <p>Develop and carry out a ZEV procurement strategy that will replace all current fleet vehicles with ZEV's and acquire the necessary charging/ fueling infrastructure. Direct the operational savings realized from the avoided fuel and maintenance costs of ZEVs into a revolving fund that will then be used to fund the next round of new ZEV fleet vehicles.</p>	<p>Coordinated approach with municipalities, transit agencies</p> <p>Coordinated approach, Municipalities</p>

Implementation Opportunities

WHY <i>Key Focus Areas</i>	WHAT <i>RE Scenario Measures</i>	HOW <i>Steps Toward Reducing Emissions</i>	WHO <i>Roles for Everyone</i>
Modernize Mobility Systems	Replace heavy-duty vehicles with ZEVs	Initiate a study to replace high-emissions truck transportation along standard corridors among manufacturing and assembly plants with hydrogen trucks, electric trucks, and freight rail	SEMCOG, Utilities, Auto Manufacturers, Hydrogen Hub, Municipalities along transportation corridors
	Replace offroad vehicles with ZEVs	Create an ordinance requiring that by a certain year, municipal construction vehicles must generate zero emissions. Gradually increase the zero-emissions proportion of offroad vehicles over time.	State and Regional Cooperative Effort, Municipalities, Construction companies
	Replace port equipment and vehicles with ZEVs and use only electricity for docked ships	Coordinate an educational session for all ports in the SEMCOG region to familiarize them with the status of climate action in maritime shipping (e.g., U.S. Action Plan for Maritime Energy and Emissions Innovation, International Maritime Organization), with a case study overview from a U.S. port authority that is partway through a project to eliminate emissions from port operations (such as the Long Beach Port).	Port authorities at the commercial ports in Harbor Beach, Port Huron, Marysville, St. Clair, Marine City, Detroit, and Monroe.
	Replace street, traffic, park, stadium and sportsfield lighting with LEDs	<p>Collaborate to develop a goal to fully replace region-wide street, traffic, parking, recreation, sports field, and stadium lighting, and create a grant program and / or revolving fund to reduce the up-front cost for participating municipalities and other entities. Consider partnership with a large sports facility with LED lighting, such as Ford Field would provide a local corporate champion for the initiative.</p> <p>Consider partnership with a large sports facility with LED lighting, such as Ford Field would provide a local corporate champion for the initiative.</p>	Municipalities and other entities with outdoor lighting requiring replacement, across the region, and corporate partners

Implementation Opportunities

WHY <i>Key Focus Areas</i>	WHAT <i>RE Scenario Measures</i>	HOW <i>Steps Toward Reducing Emissions</i>	WHO <i>Roles for Everyone</i>
Expand Local Renewable Energy Generation	Install rooftop solar PV systems	Generate renewable power for municipal operations. Formally evaluate the business cases for installing solar within the community, procuring net-new, emissions-free power from outside the community, creating a sustainable energy utility (as in Ann Arbor), and others. Learn from expertise of others in the region already pursuing this measure.	A cooperative approach between municipalities and counties would be beneficial but is not necessary.
	Install ground mount solar PV systems	Continue and expand community solar programs (Example: building on the success of Detroit’s existing Solar Neighborhoods program by adding another 2 MW to the current 31 MW program).	Municipalities
	Develop energy storage	Develop an educational “solar and energy storage tour” of homes and other buildings to introduce people to how the systems work, what they look like, and how energy storage can enhance resilience. Create a pilot program in which building owners are provided with energy storage for free if they agree to allow the utility to draw from their storage in the event of a grid outage.	Municipalities, Counties, Private Corporations Utilities
	Reduce and replace natural gas use with renewable natural gas	Complete a region-wide feasibility study/ business case to determine how much RNG could be produced if all sources were optimized (from small agricultural ADs to adding FOGs and high-energy waste to wastewater treatment), and the potential revenue opportunity.	Cooperative regional effort with industry, treatment facilities, agricultural businesses and farms, municipalities
	Develop green hydrogen systems	Develop a pilot project to produce green electricity on-site and convert excess into green hydrogen stored as backup energy drawn upon during a power outage and replacing generator backup.	Educational institution, private company

Implementation Opportunities

WHY <i>Key Focus Areas</i>	WHAT <i>RE Scenario Measures</i>	HOW <i>Steps Toward Reducing Emissions</i>	WHO <i>Roles for Everyone</i>
Advance Clean Innovation in Industry	Improve industrial efficiency	Design a program offering assistance to manufacturing and industrial companies to reduce their total energy consumption and emissions– e.g. consulting services to perform deep energy audits, identify potential sources of reusable waste heat and energy, continuous improvement coaching, as well as grants for automated lighting, upgraded equipment, etc.	Cooperative regional effort with industrial and manufacturing facilities, technical training centers and colleges, universities
	Reduce cement- and lime manufacturing emissions	Create a working group to develop a strategy for reducing emissions associated with cement.	Collaborative effort with EGLE and industrial partners
Sustainably Manage Waste and Natural Resources	Reduce waste	Collaborate with communities across the region to participate in the Make Food Not Waste initiative to eliminate food waste.	Make Food Not Waste and cooperating cities
		Increase local community opportunities to support and benefit from a more circular economy, such as hosting Neighborhood Swap Days, creating a Tool Library, or hosting Repair Cafes with tools and experts available to help residents repair household items.	Municipalities
	Enhance tree canopy and wetland coverage	Update Materials Management Plans per the State requirement with goals of 45% waste diversion and increased recycling and composting programs.	County Materials Management Planning Committees
		Identify and promote locations for enhancement, provide tree planting and wetland enhancement guidance based on best practices for resilience and long-term maintenance, connect opportunities with funding and stewardship support.	SEMCOG, DNR, Municipalities, Counties, Workforce Groups, Watershed Councils, and other environmental services

APPENDIX A: ENGAGEMENT ANALYSIS

CONTENTS

- A.1 – Engagement Strategy
- A.2 – Engagement Activities
- A.3 – Engagement Findings

This appendix outlines how interested and affected parties were consulted between October 2023 and June 2025, along with key themes that emerged during the process. This input was distilled into recommendations that informed the technical process and the measures in the Plan. This section organizes input by key themes and identifies key takeaways for climate action planning.

A.1 ENGAGEMENT STRATEGY

Sustainability Solutions Group (SSG), Civix, Rhie Planning, and EcoWorks developed an engagement strategy for the Plan using the International Association of Public Participation (IAP2) methodology. The approach was grounded in the regional context of climate action planning in Southeast Michigan, with an emphasis on the meaningful engagement of low-income and disadvantaged communities (LIDACs).

Pre-engagement and design principles

In late 2023, the team conducted 11 pre-engagement interviews with individuals from local and State of Michigan government, nonprofits, the private sector, academia, and transit agencies. Interviewees expressed cautious optimism about the Southeast Michigan Healthy Climate Plan, envisioning it as a chance to “avert the worst impacts of the climate crisis, create good-paying jobs, and build a healthier, more prosperous, equitable, and sustainable Michigan.” Their insights point to the importance of:

Building and maintaining trust (“move at the speed of trust”)

- Connecting climate action to everyday lived experiences
- Elevating community-identified priorities with near-term, tangible benefits
- Tailoring engagement and messaging to varied populations
- Managing power dynamics among industry, energy companies, and community voices

Guided by these findings, the team developed an engagement plan that outlines objectives, techniques, and decision-making statements for each phase of the Climate Pollution Reduction Grant (CPRG) process. Key recommendations included clarifying decision scopes and ensuring



continuous feedback loops through “what we heard/what we changed” reporting. The strategy combines the inform, consult, involve, and collaborate levels of the IAP2 spectrum.

Pre-engagement participants identified SEMCOG’s unique value as a regional convener and coalition-builder — able to connect municipalities, scale successful pilots, align with State policy, and help local governments and partners access federal funding. The engagement plan positions SEMCOG to “matchmake” collaborations, surface community-driven priorities, and ensure that promising projects are implementation-ready.

Guidance and expert input

SEMCOG established a Southeast Michigan Healthy Climate Task Force with people representing various sectors, including government, transportation, energy, business, health, development, workforce, and the environment. This Task Force provided leadership, built consensus, and helped guide decision-making for the Plan.

To support the Task Force, SEMCOG convened Healthy Climate Focus Groups to bring subject matter expertise on specific topics, including electric vehicles, public transit, energy efficiency, materials management, industrial uses, and nature-based solutions. These groups were open to SEMCOG members and regional partners and provided targeted recommendations.

Finally, EcoWorks contracted eight Healthy Climate Ambassadors to lead outreach within Low Income/Disadvantaged Communities (LIDACs) on behalf of SEMCOG. They co-planned events with local partners, tested plain-language materials, and ensured authentic two-way communication between the project team and residents.

A.1.1 INVOLVED PARTIES

For the purposes of this process, “the community” refers to any individual, group, or organization in Southeast Michigan. “Interested or affected parties” include those directly impacted by or invested in the Plan. Engagement prioritizes representation across geography, race/ethnicity, income, age, language, and sector.

Perspectives were sought from the following groups, using a range of communication and engagement techniques:

Black, Indigenous, and People of Color (BIPOC) communities

- Low-income communities
- Youth and students
- Seniors
- Civic and neighborhood associations
- Business and trade associations
- Faith-based organizations and cultural/ethnic associations
- Educational institutions
- Environmental and community development organizations
- Public sector agencies (local governments, transit providers) and regulated utilities
- Regional policy and advocacy organizations

A.2 ENGAGEMENT ACTIVITIES

Engagement activities were conducted between October 2023 and June 2025, with outreach to various audiences. SEMCOG’s engagement partners facilitated activities through a mix of broad public communication, technical working sessions, and targeted LIDAC engagement.

Table A.1: Summary of engagement activities

Activity	When	Where
Southeast Michigan Healthy Climate Task Force meetings	Oct 2023 - Oct 2025	SEMCOG office + Online
Healthy Climate Focus Groups	Oct 2023 - Feb 2025	Online
At-Large Community Engagement and Public Education	Oct 2023 - Dec 2024	SEMCOG office, Oakland County + Online
LIDAC Community Meetings with Climate Ambassadors	Nov 2024 - Dec 2024	Lapeer, Howell, Sterling Heights/Warren, Oak Park, Port Huron, Ypsilanti Township, Detroit, River Rouge, Westland
LIDAC Focus Groups	May 2025 - Jun 2025	Detroit 48213, Hamtramck, Highland Park, Detroit 48217, Pontiac, Southfield + Online

A.2.1 Summary of Activities

Engagement activities were conducted between October 2023 and June 2025, with outreach to various audiences. SEMCOG’s engagement partners facilitated activities through a mix of broad public communication, technical working sessions, and targeted LIDAC engagement.

Southeast Michigan Healthy Climate Task Force Meetings

SEMCOG convened a Healthy Climate Task Force to lead this initiative and engage regional partners in consensus-building and decision-making. The task force included representatives from government, transportation, energy, business, health, development, workforce, and environmental sectors.

Healthy Climate Focus Groups

Focus Groups engaged subject matter experts to examine specific topics and provide recommendations to the Task Force. Focus groups were open to all SEMCOG members and regional partners, covering topics such as electric vehicles, public transit, energy efficiency, materials management, industrial uses, and nature-based solutions.

At-Large Community Engagement and Public Education

SEMCOG emphasized broad public education through meetings, webinars, newsletters, social media, and its website. These channels were used to raise public awareness, invite participation in events, and collect community input about priorities for future implementation.

LIDAC Community Meetings with Healthy Climate Ambassadors

Coordinated public outreach was co-led by climate ambassadors, who identified existing community meetings and events at which they could inform their audiences about the climate planning process and involve them in focused discussions to gather specific input. This strategy ensured engagement activities were rooted in trusted relationships and reached historically underrepresented voices. Eight in-person community meetings were attended across the region in Lapeer, Livingston, Macomb, Oakland, St. Clair, Washtenaw, and Wayne counties.

LIDAC Focus Groups

Following the initial round of community meetings in November and December 2024, the project team conducted a second phase of engagement through a series of in-depth focus group discussions across additional locations in May and June 2025. These sessions were designed to offer a more intimate format for participants to share insights and expand on the themes identified during earlier meetings.

A.2.2 LIDAC Priorities

Low-income and disadvantaged communities (LIDACs) are a core priority for the Southeast Michigan Healthy Climate Plan. Many residents across Southeast Michigan are already experiencing the compounding impacts of climate change and systemic disinvestment. High energy bills, uncomfortable or unhealthy homes, poor air quality, and unreliable transportation systems were raised in nearly every community conversation. These burdens are particularly acute for low-income households and communities of color. For more information on LIDACs and how they were identified, refer to D.2 (Identifying Low-Income and Disadvantaged Communities).

The project team began engagement by meeting with community-based organizations, faith leaders, and neighborhood advocates to design culturally relevant outreach. SEMCOG leveraged existing relationships through its member governments and nonprofit partners. These insights shaped engagement by:

- Locating sessions in accessible, trusted community venues
- Hosting virtual sessions to accommodate travel limitations
- Offering stipends or incentives for participation
- Providing food and beverages
- Ensuring materials were clear, jargon-free, and translated where needed.
- Providing interpretation services where needed
- Building ongoing communication channels through CBOs and SEMCOG's networks

Acknowledging a history of harmful interactions between LIDACs and government institutions, the team emphasized transparency and accountability in the process. Skepticism or misalignment about how input influences decision-making was an important factor to be addressed during LIDAC engagement. Working with trusted Healthy Climate Ambassadors and EcoWorks helped create safe spaces where residents could voice this skepticism openly, which in turn allowed the team to address concerns directly and demonstrate how community perspectives would shape the plan. Despite skepticism, participants engaged when they saw connections between climate measures and tangible improvements in housing, jobs, and health.

Based on the pre-engagement insights, the team undertook the activities detailed in Table A.1.

A.3 ENGAGEMENT FINDINGS

The section summarizes the insights gathered during the engagement process. It categorizes the main topics or issues raised and highlights key points and priorities for detailed action planning. It also identifies areas of consensus and disagreement.

A.3.1 Overall Themes

Overall themes that emerged through engagement with community members are listed in Table A.2. The takeaways are important insights that influence aspects of the Plan, identify specific actions for SEMCOG and local governments, or represent concerns and opportunities that may require additional conversation with interested and affected parties.

Table A.2: Summary of key themes and findings from the engagement process

Theme	Takeaways for Action Planning
Affordability and Energy Burden	<ul style="list-style-type: none"> Reducing utility costs was a top priority, especially for low-income, senior, and renter households. Action planning should prioritize weatherization, no-cost energy audits, expanded rebates/grants, and equitable energy pricing.
Housing Quality and Comfort	<ul style="list-style-type: none"> Older housing stock leaves residents vulnerable to drafts, unsafe temperatures, and high bills. Investments in retrofits, electrification, and indoor air quality improvements can deliver health and comfort benefits that are important to residents.
Access for Renters and Frontline Residents	<ul style="list-style-type: none"> Renters lack the authority to make improvements to their homes, and often miss out on retrofit programs. Programs must be redesigned to serve renters, low-income households, and communities of color equitably.
Community-Scale Solutions	<ul style="list-style-type: none"> Community solar, shared energy, and local resilience hubs were identified as good ways to extend benefits to those without direct control over buildings. Policies should enable cooperative and neighborhood-based approaches. Participants saw valuable opportunities in the job creation that will come from climate action.
Workforce Development and Local Jobs	<ul style="list-style-type: none"> Residents of disadvantaged communities should be prioritized to receive training for contractors, HVAC installers, and weatherization workers. Many residents voiced skepticism due to past experiences with government programs.

Theme	Takeaways for Action Planning
Trust and Ongoing Engagement	<ul style="list-style-type: none"> Engagement must continue as climate actions are taken in Southeast Michigan, and this engagement must be transparent, sustained, and delivered through trusted local partners such as faith-based organizations and community groups.
Program Access and Simplicity	<ul style="list-style-type: none"> Residents described confusion about eligibility, overlapping programs, and lack of coordination. Climate action programs need to be well-publicized, streamlined, and with clear entry points.
Resilience and Reliability	<ul style="list-style-type: none"> Daily realities such as frequent power outages and extreme heat underscore the need for more reliable infrastructure. Distributed energy, microgrids, and building standards can help households withstand climate impacts.

A.3.2 Healthy and Efficient Buildings

Aspirations

Participants envisioned healthier, more comfortable homes—especially for older adults, renters, and low-income residents. Key goals included lower utility bills, improved indoor air quality, more efficient homes and businesses, and the electrification of buildings. Participants also noted that energy upgrades could also create local jobs.

Challenges

Frequently named obstacles included the high cost of building upgrades, difficulty accessing incentives, and lack of authority or agency for renters. Participants pointed out that existing retrofit programs are often not designed with renters or frontline residents in mind. They also voiced concern about a lack of coordination among weatherization programs and confusion over eligibility. Many residents noted the need for increased knowledge among local contractors and landlords. Participants also named the potential loss of federal tax credits as a barrier.

Solutions

Proposals included education campaigns and public demonstrations of clean energy technologies, expanded rebate and grant programs, free energy audits, and contractor training (e.g., HVAC installer training on heat pumps). Several recommended partnering with faith-based institutions and community organizations to scale adoption and noted the need for new funding streams for weatherization.

A.3.3 Modernizing Mobility

Aspirations

A strong desire emerged for safer streets, clean and frequent public transit, and mobility options beyond personal vehicles. Participants emphasized the importance of walkability, biking as a lifestyle, and accessible public transit that serves all age groups. Almost every community meeting stressed the importance of protected bike lanes, improved sidewalks, and walkable neighborhoods. Specific concerns about sidewalks included gaps in coverage, poor lighting, uneven pavement, and lack of winter maintenance—all of which disproportionately affect low-income neighborhoods and residents with mobility challenges. Participants called for a more equitable and comprehensive approach to pedestrian infrastructure that prioritizes safety, accessibility, and connections to transit. Reducing traffic fatalities and pollution was a recurring goal.

Challenges

Participants highlighted a lack of reliable public transit—most often citing long wait times, buses that arrive late or not at all, and limited service during evenings and weekends—as well as unsafe road conditions and poor coordination between systems like SMART, DDOT, and RTA. Regarding vehicle electrification, participants noted cost barriers, a lack of ZEV charging options for renters, concerns about grid capacity, and cultural resistance to giving up gasoline-powered vehicles. Some expressed concerns about battery disposal.

Solutions

Suggested actions included unifying regional transit agencies, subsidizing electric vehicles (EVs) and charging infrastructure, launching community-based transit education programs, and enhancing bike and pedestrian infrastructure with traffic calming and safety features. Additional solutions presented include real-time bus tracking apps, neighborhood mobility programs—such as community shuttles, on-demand services, or local bike-share options to bridge transit gaps—and regional planning that centers areas historically underserved by public transit.

A.3.4 Expanding Renewable Energy

Aspirations

Residents across Southeast Michigan expressed a strong desire for cleaner, more locally controlled energy. There was broad interest in community-owned solar projects, solar installations on schools and public facilities, and utilizing underused or unconventional spaces—such as brownfields, rooftops, and parking lots—for solar arrays. Affordability and resilience were recurring themes, as participants emphasized the need for energy systems that can withstand and recover quickly from outages.

Many participants articulated a desire for greater autonomy over their energy sources, with energy justice emerging as a key priority. Energy justice refers to the fair distribution of both the benefits and burdens of energy systems, ensuring that all communities—particularly those historically marginalized—have access to affordable, reliable, and clean energy. Residents also described renewable energy as a pathway to improve public health by reducing air pollution, particularly in communities near industrial facilities. Youth education and clean energy job

training also emerged as aspirations tied to this transition.

Challenges

The cited barriers include the cost of installation, limited financial incentives, maintenance barriers, and concerns about the economic feasibility of implementing large solar arrays in the current policy environment. State-level policies, such as net metering restrictions, were identified as significant obstacles. Frustration with utilities and perceived inaction or obstruction were also recurring concerns. Several residents noted that past utility actions and opaque regulatory processes had undermined trust, and voiced concern that clean energy incentives may not reach the communities that need them most.

Solutions

Recommendations included expanding financial incentives and grants, increasing public education about solar benefits, easing regulatory barriers, integrating solar into zoning policies, and using vacant or underutilized land for solar deployment. Community solar programs, municipal utilities, solar cooperatives, and accessible financing options, such as rebates or on-bill financing, were among the most widely supported solutions. Participants also recommended linking solar development with economic opportunities, such as prioritizing installations on schools, offering youth apprenticeships, or reinvesting cost savings into community services.

A.3.5 Optimizing Natural and Working Lands

Aspirations

Participants voiced excitement for tree planting, urban mini-forests, native vegetation, and pollinator gardens. Many spoke about the measures' co-benefits, including flood prevention, heat relief, improved air quality, biodiversity, and beautification. Some participants envisioned green spaces as places of intergenerational learning and connection—particularly for young people and elders. Several emphasized the importance of ensuring that greenery reaches historically disinvested neighborhoods.

Challenges

Participants named barriers, including property owners' resistance to trees, maintenance burdens, a lack of community understanding, and limited public resources for green infrastructure, especially pertaining to tree care and green stormwater infrastructure.

Solutions

Ideas included creating native plant education centers, increasing funding for local tree nurseries, launching public education initiatives, integrating tree planting into neighborhood improvement plans, and expanding ordinances to protect wetlands and native ecosystems.

A.3.6 Sustainable Waste Management, and Innovation in Industry

Aspirations

There was enthusiastic support for achieving zero waste, particularly through food composting, community gardens, and better recycling programs. Residents also connected food recovery to hunger relief and community health, and wanted to see locally generated compost available for local agriculture and gardens.

Challenges

Participants identified high garbage fees, low participation in recycling and composting programs, pest issues (e.g., rodents), and a lack of education and infrastructure as major barriers. Low participation was often linked to limited access—such as the absence of curbside pickup, long distances to drop-off sites, or unclear instructions. While pay-as-you-throw systems could theoretically promote waste reduction, participants noted that in the absence of free or accessible alternatives, high garbage fees simply shift the burden onto low-income households. This creates a system where the most impacted communities bear disproportionate costs without access to meaningful solutions.

A key concern raised in several meetings was the high cost of garbage collection services. While charging higher fees for waste disposal can, in theory, be a tool to incentivize waste reduction and move toward a zero-waste future, participants shared that for low-income households, these fees act as a financial burden rather than a behavioral nudge—especially in the absence of free or accessible composting and recycling alternatives. This creates a system where the most impacted communities bear disproportionate costs without access to meaningful solutions.

Solutions

Community members proposed incentive programs—such as paying people to recycle or providing free compost—to encourage greater participation in waste diversion efforts. Additional solutions included curbside compost collection, pay-as-you-throw systems, and regional coordination—which could include shared composting or recycling facilities between neighboring municipalities, common public education materials, or aligned policies to improve efficiency and reduce costs. There was also support for municipal composting hubs, local soil production, improved packaging standards—such as requiring recyclable or compostable materials—and “leave the leaves” campaigns.

A.3.7 Cross-Cutting Themes

Communication and Trust

Throughout all sessions, trust and communication surfaced as foundational issues. Participants sought clear and transparent explanations of costs, benefits, and how their input would be utilized. They also want transparency about timelines, funding, and accountability. While participants expressed skepticism about past institutional effectiveness, they also provided valuable local knowledge and demonstrated readiness to act. Howell participants demonstrated a nuanced understanding of political division and emphasized the importance of building trust through shared values and transparency.

Centering Vulnerable Population Groups

Many participants emphasized the importance of youth engagement, localized job creation, and collaboration with community organizations and trusted messengers. The regional survey echoed these values and highlighted a shared concern about climate-related infrastructure damage, health impacts, and imbalances in who bears the burden of change. A common theme was the need to include renters, low-income residents, youth, and non-English-speaking communities in design and implementation. Some worried that climate action might inadvertently fuel displacement or economic burdens.

Climate Education

Finally, there was a strong call for accessible, culturally competent climate education in schools, community centers, and online. Suggestions ranged from hands-on field trips and school partnerships to neighborhood storytelling and accessible data.

A.3.8 LIDAC Engagement Findings

Engagement with LIDAC communities helped to situate the Plan's reduction measures within the context of real-life experiences and priorities. This section describes the key themes that emerged. Considerations for minimizing risks and harms, prioritizing, and designing measures to benefit LIDACs, and incorporating community-driven priorities have been incorporated into the GHG reduction measures described in Appendix C, Future Emissions Scenarios.

A.3.9 LIDAC Community Priorities

LIDAC residents were generally supportive of most GHG reduction measures, but their interest and support were linked to, and contingent upon, the measures' direct impact on well-being. Through the focus groups and community meetings, LIDAC residents shared lived experiences that illustrate how current conditions—industrial pollution, drafty homes, high heating costs, poor air quality, and car dependency—not only undermine daily life but also point to urgent opportunities for climate action.

These hardships are not separate from the climate crisis—they are the local symptoms of a global problem rooted in dependence on fossil fuels and inefficient infrastructure. Addressing these issues through climate action planning is not just a matter of environmental stewardship, it's a matter of social, health, and economic justice. The very same solutions that reduce emissions—weatherizing homes, electrifying transit, investing in solar, expanding tree canopy—can lower costs, improve public health, and enhance quality of life. Conversely, inaction will only deepen hardship for the most burdened communities.

The key priorities in Southeast Michigan that relate to emissions reductions include:

- Improved air quality
- Improved public health
- Improved access to green jobs
- Improved public transportation
- Decreased cost of living
- Improved home heating and cooling
- Improved outreach and education

Participants specifically called for lower energy costs, better access to weatherization programs, investment in public transit, and air quality improvements—not just for climate mitigation, but because they improve health and reduce costs. By centering these intersecting priorities, the region has a unique opportunity for a “win-win”—advancing climate goals while simultaneously improving residents’ quality of life. Failure to act risks deepening existing disparities and leaving frontline communities even more vulnerable to rising costs, climate disruptions, and disinvestment.

A.3.10 Benefits to LIDACs

LIDAC residents identified numerous ways emission reduction measures could benefit the community and help achieve progress toward their priorities. The full extent of potential benefits is detailed in Section 8: Benefits Analysis. The following summaries reflect what participants raised throughout the engagement with LIDACs.

Lower utility bills and reduced energy burden

Many households, particularly low-income and senior residents, struggle with high energy bills due to inefficient homes, old appliances, and reliance on costly fuels. Emission reduction measures such as weatherization, heat pumps, solar power, and efficiency retrofits can lower monthly utility costs, improving affordability and financial stability. Residents in Detroit (48217) highlighted the need for weatherization funding to reduce energy costs in older housing stock, while participants in Port Huron emphasized stronger local incentives to make upgrades affordable for seniors.

Improved health and indoor comfort

Residents noted that older housing stock contributes to poor indoor air quality, draftiness, and unsafe temperatures during extreme weather. Energy efficiency and electrification upgrades can provide healthier, more comfortable living environments, reduce respiratory illnesses, and enhance resilience to heat waves and cold snaps. In Sterling Heights, participants noted that rebates covering wiring upgrades would allow more households to pursue electrification, directly improving comfort and safety indoors.

Clean air and public health gains

Transportation emissions and inefficient combustion in buildings contribute to the development of asthma, cardiovascular disease, and other health issues. Shifting electric vehicles, active transportation, and electrified buildings can significantly improve local air quality and reduce pollution-related health disparities. Residents in Oak Park and Ypsilanti Township linked air quality improvements to renters’ wellbeing, noting that community-scale clean energy could reduce exposure for households that lack direct control over upgrades.

Job creation and workforce development

Participants highlighted that clean energy investments could support training and employment opportunities for local workers. Programs for weatherization, solar, and electrification can create good-paying jobs, particularly if paired with contractor training and workforce pipelines that prioritize residents of LIDACs. Some participants recommended HVAC installer training on heat pumps as a direct way to expand local workforce capacity while meeting community needs.

Community resilience and reliability

Frequent power outages and climate-related disruptions were noted as daily realities for some households. Distributed energy solutions—such as solar with storage, microgrids, and efficiency improvements—can provide more reliable service, keep critical facilities running, and help communities better withstand climate impacts. In Westland, participants even suggested a regulatory approach, similar to a building performance standard, to ensure consistent oversight and accountability for decarbonization across the private sector.

Resident empowerment

Renters and frontline residents often lack control over housing improvements and face disproportionate energy burdens. Well-designed climate action measures can expand access to incentives, address pricing disparities, and empower residents with affordable, clean, and safe energy choices. Howell and Oak Park participants recognized the potential of community energy projects, such as community solar, to provide renters with more equitable access to the benefits of clean energy.

A.3.11 Barriers and Concerns for LIDACs

Participants identified a few key concerns about emission reduction measures. Some of these concerns are deeply rooted in a history of lost confidence in government systems to effect meaningful, positive change in LIDACs. In contrast, others are more technical or logistical in nature. Strategies for overcoming these barriers have been integrated into the GHG reduction measures described in Appendix D, Benefits Analysis. The following points reflect what LIDAC participants raised throughout the engagement.

Risk of exacerbating disparities

Programs could be implemented in ways that favor higher-income households or homeowners, leaving renters, seniors, and low-income residents behind. For example, Howell, Oak Park, and Ypsilanti Township participants emphasized that renters have little authority to make improvements, and retrofit programs rarely serve their needs.

High upfront costs

Energy retrofits, heat pumps, wiring upgrades, and solar installations remain unaffordable for most households without significant subsidies. In Port Huron, older residents noted that existing incentives are insufficient to overcome steep upfront costs, particularly for fixed-income households.

Program complexity and confusion

Residents cited challenges navigating eligibility, understanding incentives, and coordinating overlapping weatherization programs. Detroit residents described difficulties accessing support from multiple, fragmented programs, with unclear rules and limited coordination.

Renters' lack of control

Renters have little authority to make improvements and may not benefit directly from landlord-driven retrofits. This was a recurring concern in Oak Park and Ypsilanti Township, where renters

feared being left out of decarbonization programs or facing pass-through costs without receiving benefits.

Energy cost burdens

Concerns that electricity is currently more expensive than gas, making electrification less accessible. Residents across sessions raised this point, noting that higher electricity prices, especially without subsidies, could worsen energy burdens in LIDACs.

Limited local contractor capacity

Lack of trained contractors and HVAC installers create bottlenecks for implementing efficiency and electrification. Sterling Heights highlighted that without rebates to cover wiring and more skilled contractors, most households cannot pursue electrification.

Trust and accountability

A history of limited government responsiveness has created skepticism about whether new programs will deliver meaningful change in LIDACs. Some Detroit residents explicitly linked their hesitation to past experiences where promised assistance did not materialize or was poorly managed.

Sustainability of incentives

Concerns about the potential expiration of federal tax credits or other funding streams, which could undermine long-term progress. Participants in multiple communities worried that if tax credits expire, households who wait to upgrade—often those with fewer resources—will be left out entirely.

APPENDIX B: GREENHOUSE GAS INVENTORY AND REDUCTION TARGETS

CONTENTS

- B.1 – Methodology
- B.2 – Results
- B.3 – Trends and Analysis
- B.4 – Reduction Targets

B.1 METHODOLOGY

SEMCOG's GHG inventory follows the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC) Basic framework. The complete inventory of GHG emissions in Southeast Michigan in 2019 is available on [SEMCOG's website](#).

This framework calculates GHG emissions³ from the following sources across the project area over the course of a single calendar year:

- **Buildings** – Commercial, residential, industrial/manufacturing, and institutional emissions from building systems are often put in a category called Stationary Energy Use, which includes:
 - Use of electricity inside buildings
 - Use of fuel in residential, commercial, or industrial furnaces, generators, or other stationary combustion equipment
- **Transportation** – This category includes emissions from fuel and energy sources used to move people, freight, and equipment within the community. Sources include:
 - On-road passenger travel (including public transportation), freight motor vehicle travel and energy used to move waste
 - Freight and passenger rail
 - Off-road vehicles and equipment
 - Waterborne shipping in and out of ports in the community
- **Waste and Materials Management** – This category includes emissions from energy used to treat waste and wastewater and emissions produced during the decomposition of waste. Examples include:
 - Use of energy in potable water treatment and distribution (through pumping)
 - Solid waste deposited in landfills or composted
 - Energy used in wastewater pumping and treatment processes, including filtering and aeration and chemical, UV and other treatments
- **Industrial Emissions** – These are emissions produced through industrial processes. They include:
 - Fugitive emissions, which are gases (most commonly natural gas) that leak out of wells and distribution pipes, directly into the atmosphere
 - Emissions of a number of greenhouse gases that are produced during chemical reactions and processes from industrial facilities (includes emissions of hydrofluorocarbons (HFCs),

3 Some of these sources are optional according to the GPC framework.

perfluorocarbons (PFCs), sulfur hexafluoride (SF6) and nitrogen trifluoride (NF3) from industrial processes and products)

- **Agriculture, Natural and Working Lands** – This category is comprised of energy-based and non-energy-based emissions resulting from agricultural practices, along with the emissions and sequestration from natural systems. This includes:
 - Energy used to run agricultural equipment, machinery and transportation
 - Emissions from livestock, manure, crops, and soil
 - Carbon sequestration in forests and other plants and in wetlands

This inventory quantifies the community-wide GHG emissions produced by the project area for the calendar year 2019, which is also referred to as the “base year”. 2019 was selected because it was the most recent year for which all the required data was available, excluding pandemic years. This inventory is the “baseline inventory,” which is now a reference point to which future emissions for the area can be compared.

The GPC GHG inventory is a production-based protocol that is used to report primarily on:

- Emissions released (or ‘produced’) directly from sources within the project area. Examples include emissions from natural gas furnaces or from gas cars driving in the area.
- Emissions that are a result of the activities occurring within the project area but that may be produced outside the area. For example, electricity may be generated by a facility outside the community, but the emissions released to produce the amount of electricity that community uses are reported on the community’s GPC inventory.
- The most common GHGs, specifically carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O).⁴ Within the Industrial Emissions section of the inventory, the protocol also accommodates but does not require the reporting of hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF6), nitrogen trifluoride (NF3).

The GPC protocol **does not** comprehensively include “consumption-based emissions.” These emissions are produced as a result of purchases made inside the area, including emissions from the transportation required to ship goods to the purchaser, as well as emissions from the production of the goods in their place of origin. Consumption-based emissions are not included in this plan.

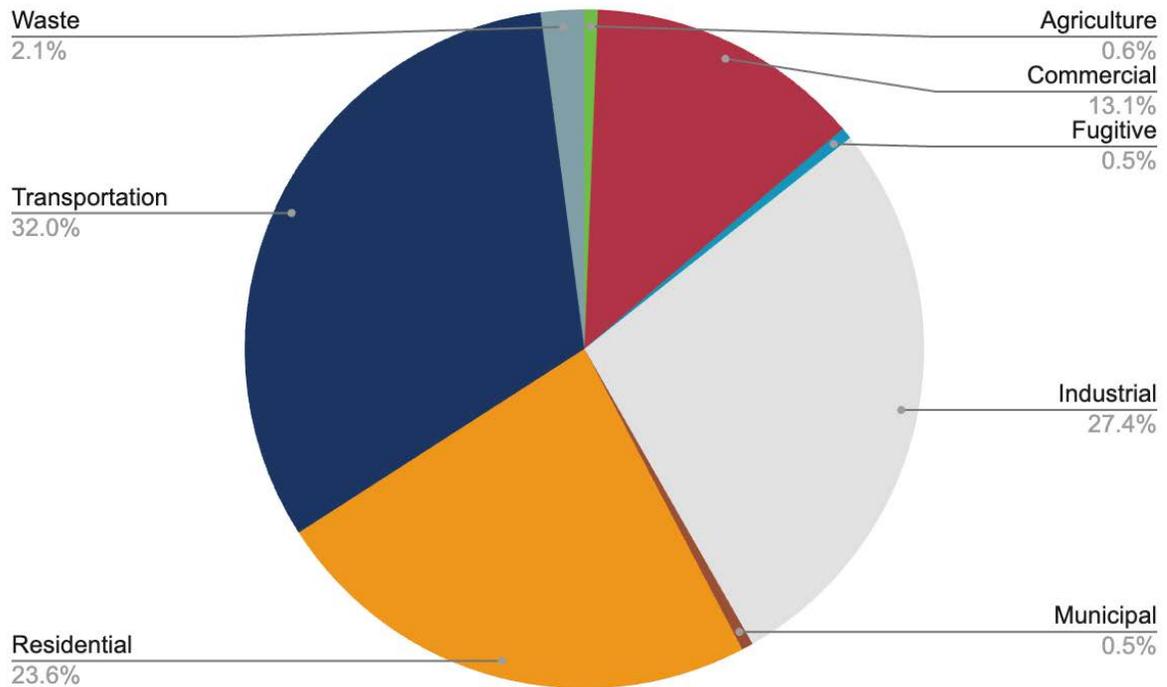
All communities that produce a GPC Basic GHG Inventory are expected to report on the same key categories and sources of emissions. As a result, it is reasonable to compare them to each other and to aggregate them into a single regional inventory. Those producing a GPC Basic+ GHG Inventory are reporting on more sources of emissions than they would in a GPC Basic, so they can be compared to each other but should not be considered comparable to (or aggregated with) communities with GPC Basic inventories.

4 In accordance with the requirements of the Climate Pollution Reduction Grants, this CCAP also identifies industrial GHGs, such as hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF6), and nitrogen trifluoride (NF3), if they are released in the project area.

B.2 RESULTS

The GHG inventory completed for Southeast Michigan indicates that in 2019, the region emitted a total of 74,096,000 MTCO₂e. Figure B.1 shows the proportion of these emissions that were produced by each sector.

Figure B.1: GHG Emissions by Sector



As shown in Figure B.1, the transportation sector released the most GHG emissions in Southeast Michigan in 2019.

Emissions from the transportation sector are primarily generated from the combustion of gasoline and diesel. They account for 32% of the total GHG emissions from the region in 2019; this is 3% higher than transportation's portion of all emissions statewide.⁵

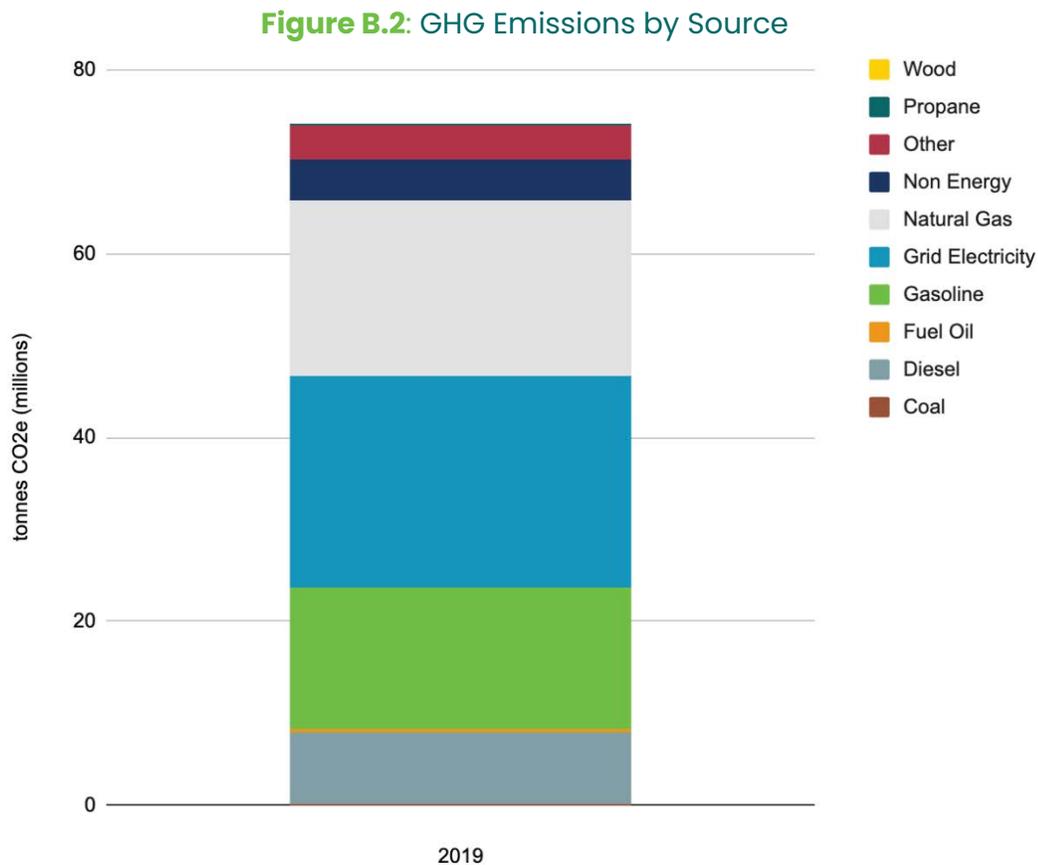
Energy vs. Non-Energy Emissions

Over 97% of Southeast Michigan's 2019 emissions were produced from the combustion of fossil fuels to produce energy. The largest amounts of these emissions came from natural gas, gasoline, grid electricity, and diesel fuel.

The remaining 2% of emissions were emitted from waste decomposing into methane, and being released from landfills and wastewater in the region.

⁵ State of Michigan Department of Environment, Great Lakes, and Energy. "Stakeholder Engagement Session: Clean the Electric Grid." 2025. <https://www.youtube.com/watch?v=FWy-H4TPWIA>

Both the energy and non-energy sources of emissions in Southeast Michigan are shown in Figure B.2 below.



With a population of 4.8 million people, this means that per capita emissions in 2019 were 15.3 MT CO₂e. For comparison, the national per capita emissions in 2019⁶ were slightly higher, at 15.6 MT CO₂e.

B.3 TRENDS AND ANALYSIS

Between 2005 and 2021, the State of Michigan’s greenhouse gas emissions decreased by 23%. Despite this however, in 2025, Michigan is the 10th-highest emitting state in the U.S.⁷ The most significant reasons for these high emissions are:

- Over half of all electricity consumed in the state is generated by natural gas power plants.
- In 2021, over 50% of the state’s total emissions came from the 200+ large facilities including power plants, petroleum and natural gas systems, a refinery, chemical plants, mineral processing facilities, waste facilities, metal refineries, glass manufacturers, and pulp and paper facilities.⁸ (Southeast Michigan currently has 18 of these facilities.)

6 “Data Page: Per capita CO₂ emissions,” part of the following publication: Hannah Ritchie, Pablo Rosado, and Max Roser (2023) – “CO₂ and Greenhouse Gas Emissions”. Data adapted from Global Carbon Project, Various sources. Retrieved from <https://ourworldindata.org/grapher/co-emissions-per-capita> [online resource]

7 “Climate Policy Dashboard: Michigan.” <https://www.climatepolicydashboard.org/states/michigan>

8 EPA. FLIGHT. <https://ghgdata.epa.gov/ghgp/main.do>

- There is a large volume of heavy-duty vehicle traffic traveling within the state as well to and from Canada and neighboring states. This traffic supports (in particular) the auto manufacturing industry, transporting materials, parts, components, and vehicles frequently from one facility to another.

B.4 REDUCTION TARGETS

This plan lays out a pathway for Southeast Michigan to reduce all GHG emissions in the region by 52% by 2030 (relative to 2019⁹) and to achieve economy-wide net-zero emissions by 2050. These targets are supported by more specific actions that can reduce emissions in the energy, buildings, transportation, industrial, waste, and municipal sectors, as well as through sequestration.

For the purposes of this Plan, the GHG reduction targets and the years associated with them¹⁰ were selected to align with those of the State of Michigan.¹¹ The baseline year for this Plan will be 2019 rather than 2005, which is the State’s baseline year. 2019 was selected for SEMCOG because neither a GHG inventory nor the data required to complete one for the year 2005 is available for Southeast Michigan. However, because Michigan’s total emissions decreased by over 20% between 2005 and 2019, using a baseline year of 2019 rather than 2005 makes these targets slightly more ambitious than the State’s.

This Plan also adopts and supports the achievement of State goals related to:

- Retire coal-fired power and decarbonize the electricity grid;
- Increase infrastructure for electric vehicles, and access to clean transportation;
- Reduce emissions from home heating;
- Triple the recycling rate and cut food waste in half; and,
- Protect Michigan’s land and water.

9 The State of Michigan’s goals are to reduce emissions by 28% by 2025 and by 52% by 2030, relative to 2005. Because an inventory of Southeast Michigan’s emissions in 2005 is not available, this CCAP used the baseline year of 2019. Source: State of Michigan. “MI Healthy Climate Plan.” <https://www.michigan.gov/egle/-/media/Project/Websites/egle/Documents/Offices/OCE/MI-Healthy-Climate-Plan.pdf?rev=d13f4adc2b1d45909bd708cafccbffa>.)

10 The targets and dates are described in section 4.3 of this document.

11 State of Michigan. “MI Healthy Climate Plan.” <https://www.michigan.gov/egle/-/media/Project/Websites/egle/Documents/Offices/OCE/MI-Healthy-Climate-Plan.pdf?rev=d13f4adc2b1d45909bd708cafccbffa>

APPENDIX C: FUTURE EMISSIONS SCENARIOS

CONTENTS

- C.1 – Overview of Scenarios
- C.2 – Business as Usual Scenario
- C.3 – Business as Planned Scenario
- C.4 – Reduced Emissions Scenario
- C.5 – The Big Moves
- C.6 – Reduced Emissions Projections
- C.7 – Emissions Outlook by Sector

C.1 OVERVIEW OF SCENARIOS

This Plan includes modeling near-term (2030) and long-term (2050) projections of GHG emissions in three scenarios, as described in Table C.1.

Table C.1: Description of Projected Scenarios

Label	Title	Description
BAU	Business-as-Usual	<p>A reference scenario that extrapolates energy use and GHG emissions out to 2050 based on forecast population and economic growth, as well as the impacts of a warming climate. All other policies (e.g., new editions of the building and energy code) and trends (e.g., ZEV uptake) do not change; they remain fixed at their baseline year level.</p> <p>This scenario answers the question, <i>“What would happen if no actions were taken?”</i></p>
BAP	Business-as-Planned	<p>A reference scenario that builds on the BAU, by adding the impact of all existing, approved, and funded policies, programs and legislation on energy use and emissions. However, no additional climate actions are taken.</p> <p>This scenario answers the question, <i>“What would happen if only current actions, plans and policies are implemented?”</i></p>
RE	Reduced Emissions	<p>A scenario that selects and models actions that will dramatically decrease energy consumption and GHG emissions across all sectors, aiming to achieve net-zero emissions by no later than 2050.</p> <p>This scenario answers the question, <i>“What would happen if all the actions, policies, and programs in this Plan are successfully implemented?”</i></p>

The modeled results for each of these scenarios are not predictions. Rather, they are plausible, evidence-based forecasts on how the future may evolve based on data and assumptions about the key drivers for emissions and critical trends in Southeast Michigan.

The region’s projected emissions for 2019, 2030 (the near-term) and 2050 (the long-term), in each of the three scenarios are shown in Table C.2 below.

Table C.2: Total GHG emissions by scenario and sector.

Sector	2019	2030	2050	2030	2050	2030	2050
Agriculture	463,000	464,000	463,000	393,000	321,000	375,000	287,000
Commercial	9,738,000	11,159,000	11,518,000	8,060,000	4,815,000	5,877,000	108,000
Energy Production	4,000	0	0	0	0	0	0
Fugitive	398,000	414,000	411,000	412,000	405,000	369,000	95,000
Industrial ¹²	20,363,000	21,350,000	21,405,000	16,039,000	10,744,000	13,188,000	110,000
Municipal	403,000	397,000	382,000	272,000	135,000	204,000	3,000
Residential	17,490,062	18,236,827	18,495,783	14,126,183	9,988,045	10,187,000	10,000
Transportation	23,733,541	18,535,912	18,046,709	16,784,977	10,708,956	14,962,872	527,941
Waste	1,531,662	1,608,212	1,745,531	1,445,525	1,290,131	1,267,510	287,293
TOTAL	74,095,639	72,136,437	72,436,552	57,503,769	38,407,078	46,401,305	1,986,037
% CHANGE	-3%	-2%	-22%	-48%	-37%	-97%	

The methodology used to develop these scenarios and model the projections for each of them are fully explained in Appendix H: Data, Methods, and Assumptions.

12 Industrial emissions include 28,584 MTCO₂e from SF₆ (released from electricity transmission and distribution equipment) for all years and scenarios except the Low Carbon Scenario in 2050. Based on legislation and technologies in development, it is assumed this gas will no longer be in use in 2050. Source: EPA. “Moving Toward SF₆-Free High Voltage Circuit Breakers.” 2020. https://www.epa.gov/sites/default/files/2020-09/documents/sf6_partnership_moving_toward_sf6-free_high_voltage_circuit_breakers.pdf.

C.2 BUSINESS AS USUAL

What would Southeast Michigan's emissions be in 2030 and 2050 if we don't change anything about the way we live? The BAU Scenario modeled a projection of this in which the population and employment continue to grow and the climate warms, but the use of land, sources of energy, and modes of transportation remain as they were in the baseline year of 2019.¹³

The specific demographic and climatic changes incorporated in the BAU Scenario (as well as the BAP and RE Scenarios) are described below. Other assumptions, such as the types of fuels being used, average energy consumption by household, and the amount of waste being added to landfills, were based on the baseline year data, and scaled up relative to the population growth.¹⁴

Demographic Forecast

Between 2019 and 2050, Southeast Michigan's population is expected to increase by approximately 6.4% (approximately 308,000 people) along with an additional 265,000 jobs.¹⁵

Climatic Forecast

In the past 30 years, Southeast Michigan's average daily temperature has increased by 2.5 degrees F compared to the period between 1950 and 2000. This warming trend is expected to continue with increasing speed. For example, during the 2010s the region experienced one day/ year (on average) when the maximum temperature exceeded 95 degrees F. By 2030, this is expected to increase to 10 days; by 2040 it will be 14 days; and by 2050, Southeastern Michiganders can expect 20 days each year with temperatures exceeding 95 degrees F.¹⁶

This translates into an increased demand for air conditioning on hot days. According to NOAA's Climate Explorer, the number of Cooling Degree Days in Wayne County is expected to increase from 1,000 annually in 2010–2019 to 1,500 by 2050.

C.2.1 Projected Business as Usual Scenario Emissions

Under these conditions, the modeling shows that emissions in Southeast Michigan will likely decrease by 3% by 2030 and then rise slightly such that by 2050 they are 2% lower than they were in 2019. The annual emissions for each sector in the BAU Scenario are shown in Figure C.1.

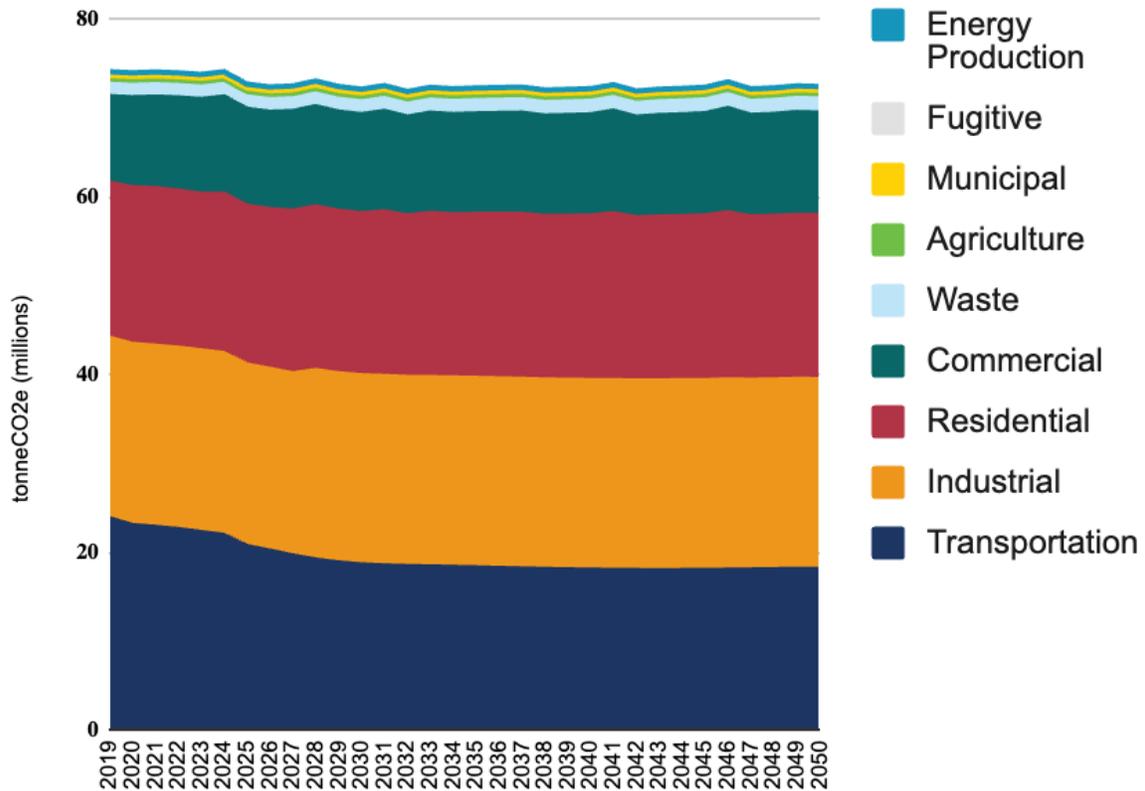
13 In the BAU scenario, vehicle fuel efficiency is assumed to continue improving as required by the current CAFE standards.

14 The assumptions for all scenarios can be found in Appendix A: Data, Methods, and Assumptions.

15 SEMCOG. "SEMCOG 2050 Forecast". https://crt-climate-explorer.nemac.org/climate_graphs/?city=Wayne%2BCounty%2C+MI&county=Wayne%2BCounty&area-id=26163&fips=26163&zoom=7&lat=42.2790746&lon=-83.33618799999999&id=days_tmax_gt_95f

16 The Climate Explorer. https://crt-climate-explorer.nemac.org/climate_graphs/?city=Wayne%2BCounty%2C+MI&county=Wayne%2BCounty&area-id=26163&fips=26163&zoom=7&lat=42.2790746&lon=-83.33618799999999

Figure C.1: GHG Emissions by Sector – BAU Scenario 2019 – 2050



Overall Trend

In this scenario, although the population and economic activity are increasing, total emissions hover around the same level as they are in 2019. This is because the increased energy demand and emissions from community growth are basically offset by improvements in new vehicle fuel efficiency. The existing Corporate Average Fuel Economy (CAFE) standards¹⁷ require vehicle manufacturers to continue improving fuel efficiency and reducing emissions in new vehicles each year until the 2030s. Because transportation constituted 32% of all emissions in Southeast Michigan in 2019, these standards are sufficient to offset the impacts of the area’s population and economic growth in the BAU scenario.

Per Capita Emissions

In 2019, Southeast Michigan’s per capita emissions were 15.3 MT CO₂e. This was:

- Slightly lower than the statewide per capita emissions, which were 15.9 MT CO₂e.¹⁸
- Slightly lower than those of neighboring states Wisconsin and Ohio, which were 16.2 and 16.8 MT CO₂e, respectively.

17 National Highway Traffic Safety Administration. “Corporate Average Fuel Economy (CAFE website).” <https://www.nhtsa.gov/laws-regulations/corporate-average-fuel-economy>.

18 U.S. Energy Information Administration. “Table CO2.7. Total CO₂ emissions estimates from energy consumption, per capita CO₂ emissions, and carbon intensities, ranked by state.” https://www.eia.gov/state/seds/data.php?incfile=/state/seds/sep_sum/html/rank_co2_capita.html&sid=US.

- 24% lower than the national average of state-based, per capita emissions, which was 20.1 MT CO₂e.

According to the EIA, between 2019 and 2023, actual per capita emissions:¹⁹

- Decreased across all states by an average of 24% with only 4 states reporting an increase
- Decreased by 12% in the State of Michigan
- Decreased by 5.8% in Southeast Michigan

In the BAU Scenario, Southeast Michigan’s per capita emissions are projected to decrease by only 5% by 2030 and by 9% by 2050.

C.2.2 Sector-specific BAU Trends

Commercial Properties

The most significant of these is commercial buildings which in 2019 produced 9.7 million MT CO₂e, or 13% of the region’s total emissions. In the BAU scenario, by 2030 – in the very short term – emissions from commercial properties are projected to rise to 11.2 million MT CO₂e. They will continue to rise at a slower pace after 2030, ultimately reaching 11.5 million MT CO₂e, which will be an 18% increase relative to 2019.

Increase of 1.8 million MT CO₂e annually.

Industries

Industrial facilities in Southeast Michigan generated 27% of the region’s emissions in 2019, making them the second-largest source of emissions at that time. In the BAU Scenario, these facilities will produce more than a million more Metric tons of emissions each year by 2050.

Increase of 1.0 million MT CO₂e.

Residential Buildings

Emissions from homes constituted 24% of the region’s total emissions in 2019. Like industry, without intervention, this source of emissions is expected to release an additional million Metric tons of emissions annually in Southeast Michigan.

Increase of 1.0 million MT CO₂e annually.

Waste

Emissions from waste are also projected to increase. While these will continue to constitute only 2% of the region’s total emissions throughout the period, they will rise steadily by approximately 3% every five years, and in 2050 will produce 1.7 million MT CO₂e emissions.

Increase of 214,000 MT CO₂e annually.

¹⁹ Ibid.

C.3 BUSINESS AS PLANNED (BAP) SCENARIO

The BAP Scenario describes Southeast Michigan’s energy use and emissions trajectory if existing legislation and programs²⁰ achieve the level of change they expect, but no additional actions on climate change occur. This scenario builds on the BAU Scenario, by adding the impact of these plans, policies, legislation and regulations at the municipal, State and federal levels²¹. It does not include the impact of pledges, promises or ideas that are not yet endorsed, passed through legislation or funded.

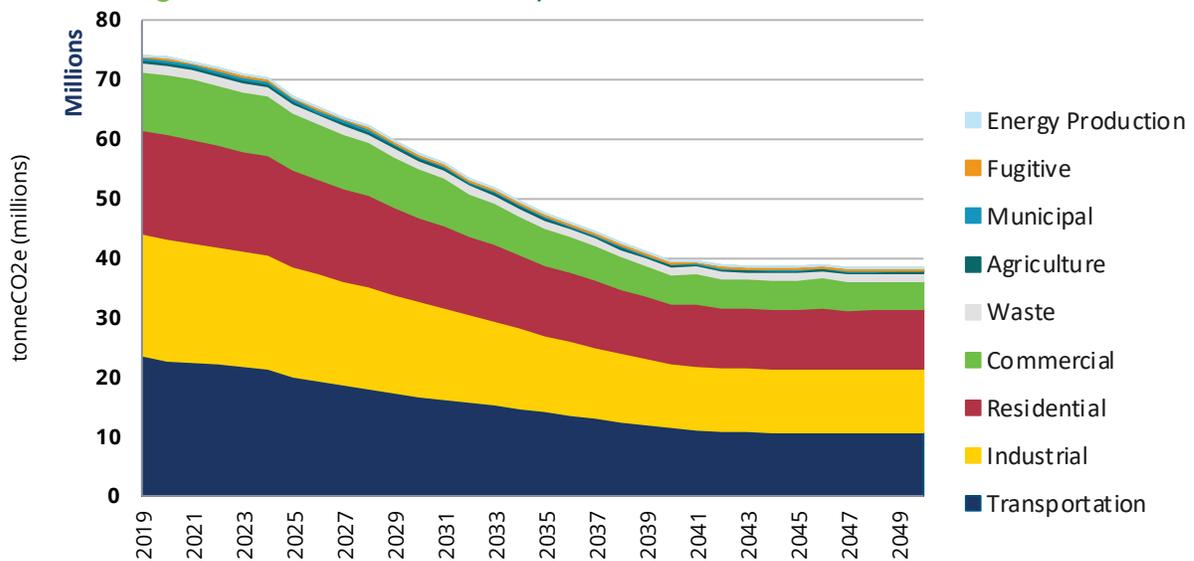
The projections from this scenario answer the question, “Is what we’re already doing enough to meet our climate goals?”

The modeling for this Plan was completed before the change in federal government in January 2025. As such, it reflects programs and policies in place at the end of 2024. The new administration has committed to ‘clean air, land, and water for every American,’²² and is introducing significant changes to legislation, environmental monitoring, market development, and industrial policy as part of this commitment. It will be important for regional partners to support the monitoring of these changes, and for SEMCOG to keep members and stakeholders advised of new legislation, changes to incentives, and updates to industrial policy that may impact the region’s efforts to implement this plan.

C.3.1 Projected BAP Emissions

Southeast Michigan’s total emissions in the BAP Scenario are projected to decrease by 22.4% to 57.5 million MT CO₂e by 2030 and by 48% to 38.4 million MT CO₂e by 2050.

Figure C.2: GHG Emissions by Sector – BAU Scenario 2019 – 2025



20 The programs that are included in the BAP scenario are only those that have been formally approved and have funding allocated to them.

21 The assumptions made for the BAP scenario focused primarily on initiatives at the State level or lower.

22 EPA. “EPA Administrator Lee Zeldin announces EPA’s ‘Powering the Great American Comeback.’ February 2025. <https://www.epa.gov/newsreleases/epa-administrator-lee-zeldin-announces-epas-powering-great-american-comeback>

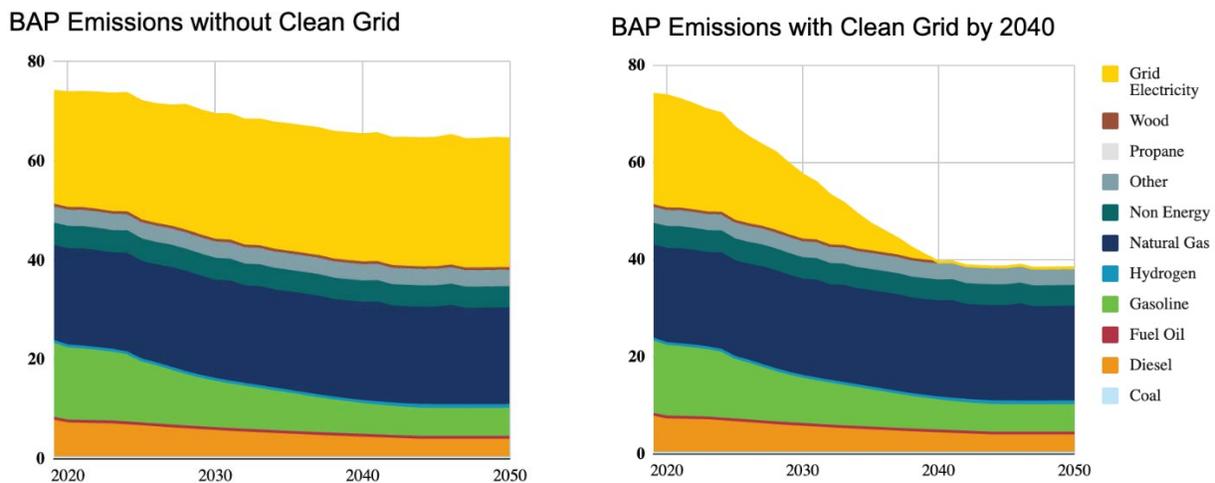
C.3.2 Overall Trend

The forecasts from the BAP Scenario clearly show the benefits of the federal and State legislation and the broad range of incentive and tax credit programs that were in place in 2024.

The single most impactful factor in the BAP Scenario is the State requirement for all grid electricity to be generated by clean energy by 2040. In 2019, electricity produced 50% of Southeast Michigan’s total emissions, so converting the grid to clean energy sources will reduce emissions across all sectors - from street lighting to home appliances to cooling the air in office towers. The resulting drop in the region’s emissions from electricity generation between 2019 and 2040 is 22.9 million MT CO₂e each year.

The two graphs shown in Figure C.3 show the difference in outcomes under the BAP Scenario with and without transitioning Michigan’s grid to 100% clean energy by 2040.

Figure C.3: Projected total community GHG emissions by fuel type in the BAP Scenario, without a clean energy grid (left), and with a clean energy grid (right).



C.3.4 Per Capita Emissions

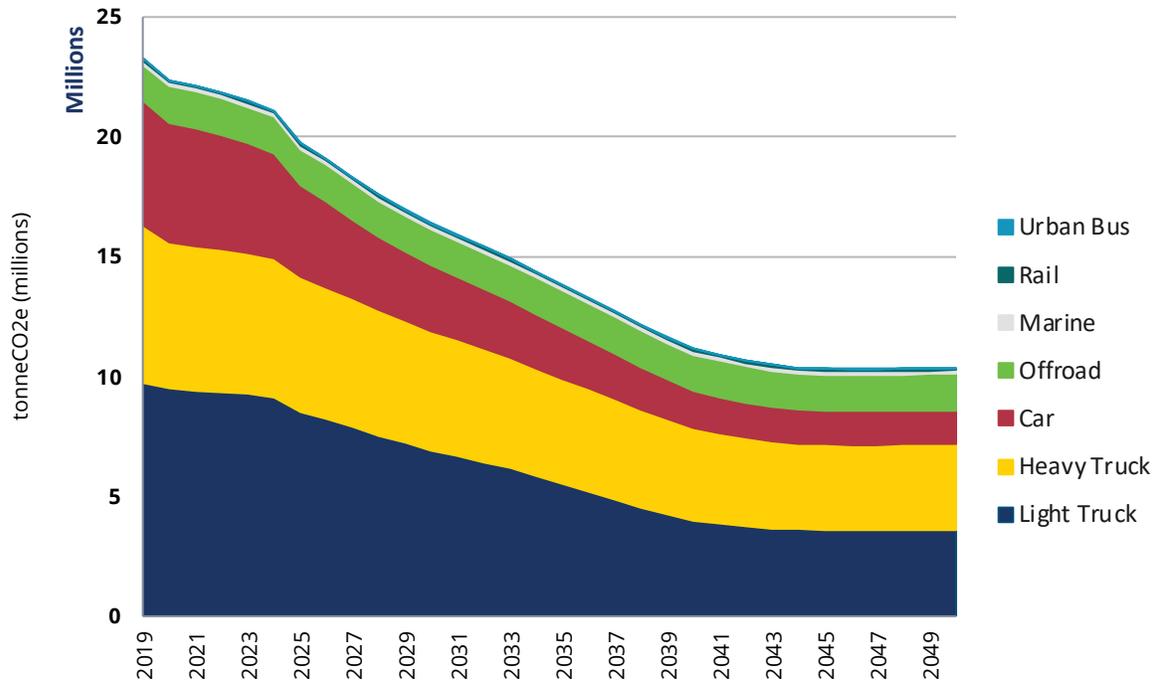
Per capita emissions in the BAP Scenario are projected to decline from 15.3 to 11.5 MT CO₂e between 2019 and 2030 (a reduction of 25%), and to 7.3 MT CO₂e per person by 2050 in the BAP Scenario (a reduction of 52%).

C.4.5 Sector-specific BAP Trends

Transportation

Transportation emissions decrease more than any other sector in the BAP Scenario, falling by 56% from 23.3 million to 10.4 million MT CO₂e annually between 2019 and 2050. This reflects the impact of ZEVs increasing from just over 10% of all vehicle sales in 2025, to 51% by 2030.²³ Figure C.5 illustrates how transportation emissions are projected to decrease for each vehicle type in the BAP Scenario.

Figure C.5: Projected BAP Emissions from Transportation, 2019–2050



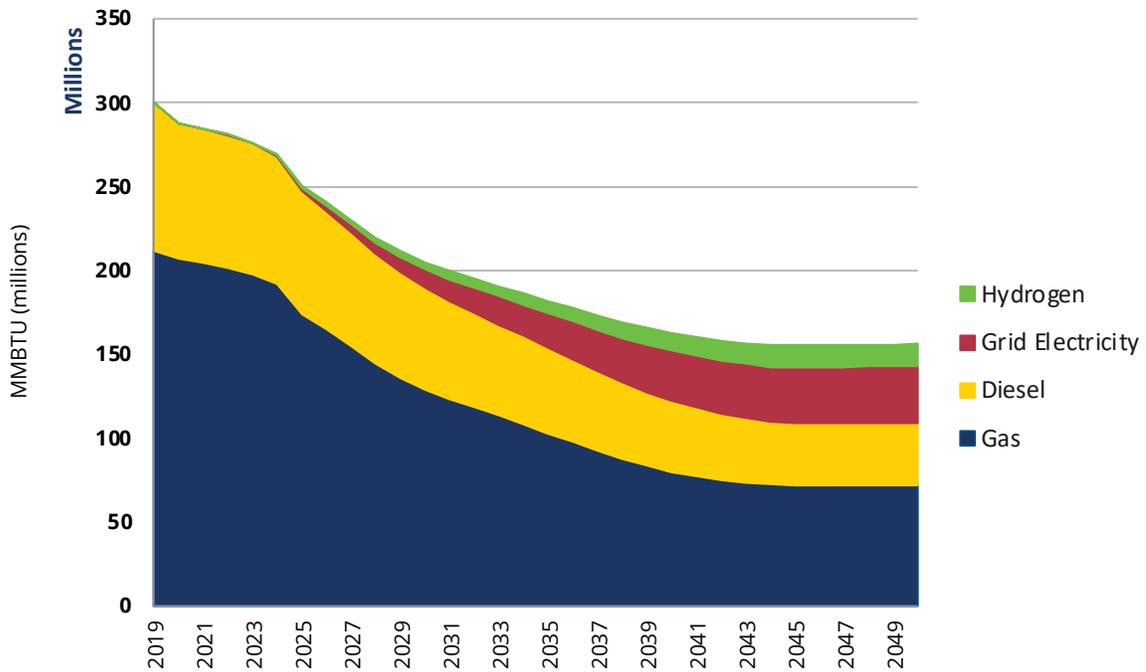
The impact of switching from gas and diesel ICE vehicles to electric and hydrogen-powered vehicles reduces emissions in two ways.

Firstly, gas and diesel vehicle engines are approximately 25% efficient, meaning that 75% of the fuel purchased to run an ICE vehicle is lost in the combustion process and heat, and is not used to actually move the vehicle.²⁴ In contrast, electric and hydrogen-fueled vehicles are approximately 87% efficient. In other words, much less energy is required to operate the same number of vehicles if they are electric or hydrogen-powered rather than gas or diesel-powered. As a result, as Southeast Michigan retires ICE vehicles and replaces them with zero-emission vehicles, the total energy required to transport goods and people will fall, even as the population increases. Figure C.6 illustrates the reduction in total energy required for transportation in the BAP Scenario.

²³ This assumption was aligned with the IEA's 2024 forecast of EV vehicles sales. After January 2025, the IEA updated this forecast to reach only 20% of all vehicles sold by 2030 in the U.S. Source: <https://www.iea.org/reports/global-ev-outlook-2025/executive-summary>

²⁴ U.S. Environmental Protection Agency. "Electric Vehicle Myths" webpage.

Figure C.6: BAP Scenario Transportation Energy by Fuel Type



A further reduction in emissions is achieved as more vehicles rely on an increasingly 'clean' electricity grid for power.

The combined impact does not achieve the reduction in transportation emissions that is required by 2030 until 2050. This means that a faster transition is required, particularly in the early years of this Plan horizon, to achieve the targets.

Building Sector

Emissions from commercial and residential buildings fall by 51% and 43% respectively between 2019 and 2050. Switching the electricity grid to clean energy reduces emissions by 54% and 56% respectively in commercial and residential buildings. However, the overall increase in commercial activity and population over the period causes a net increase in the use of wood, propane, fuel oil, and natural gas which will offset the reduction in electricity emissions by 3%.

Figure C.7 shows the trajectory of emissions for the Building Sector (only) in the BAP Scenario. It shows that in this scenario, buildings will still be emitting over 23.4 million MT CO₂e annually in 2050, 19.1 million of which will be from natural gas.

Figure C.7: BAP Building Sector GHG Emissions, by Fuel Source

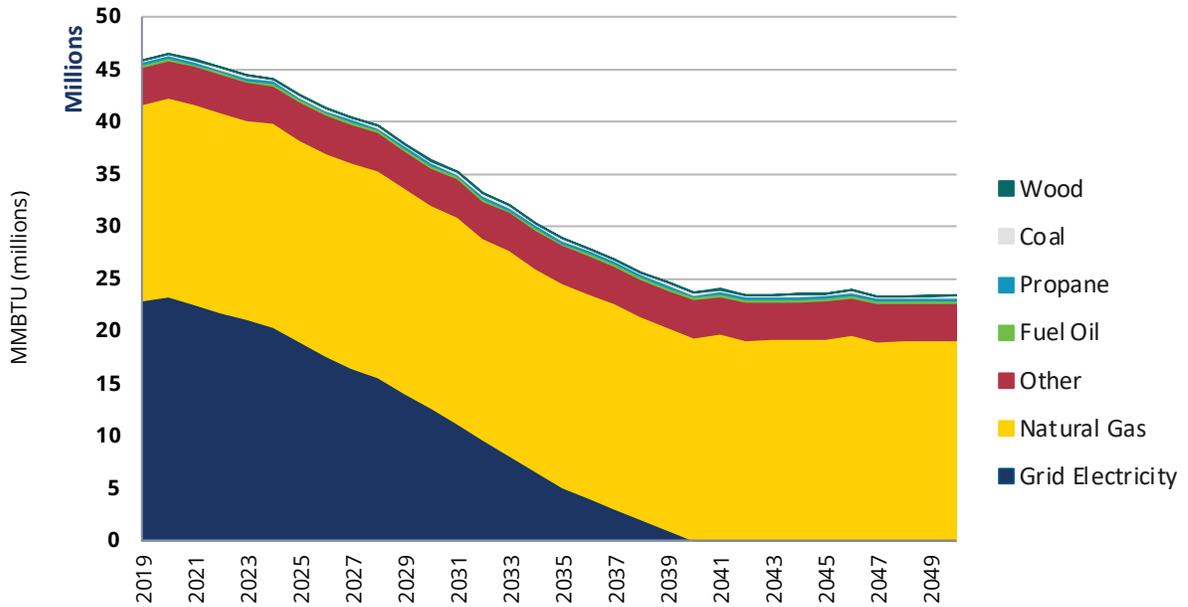
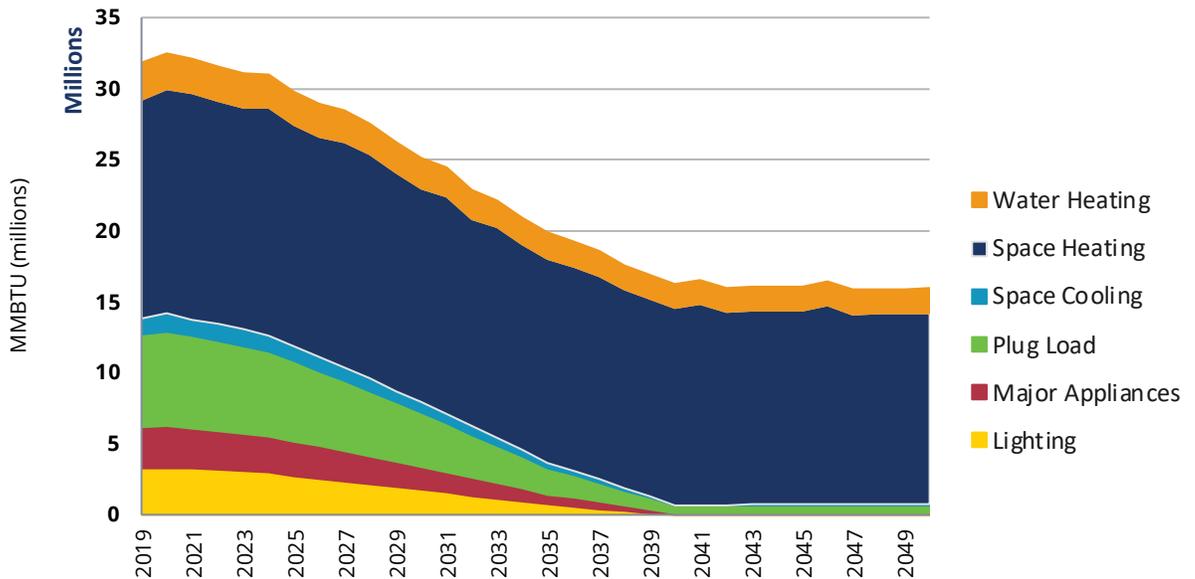


Figure C.8 further illustrates that while building emissions from electrically powered appliances and lighting, as well as overall plug load will steadily fall in the BAP Scenario, the remaining emissions in 2050 will come almost entirely from the use of fossil fuels for space heating and water heating.

Figure C.8: BAP Building Sector GHG Emissions, by End Use



Michigan’s access to inexpensive natural gas has resulted in this being the primary heating source in almost 80% of Michigan homes, significantly higher than the national average of 50% of homes relying on natural gas.²⁵

The BAP Scenario includes emissions reductions expected from a number of existing initiatives: the legislation requiring natural gas providers to reduce wasted energy by 0.875% annually,²⁶ State, county, and city-based retrofit and electrification programs, and Detroit’s Energy and Water Benchmarking Ordinance.²⁷ Despite the impacts of these initiatives, total natural gas use is projected to remain high. In particular, residential use of natural gas will be greater than the total natural gas used by the commercial, industrial, agricultural, and municipal sectors combined every year from 2019 – 2050. Clearly, additional action will be required in the Reduced Emissions Scenario to address this.

Waste Sector

In the BAU Scenario, the production of waste was expected to increase in proportion to the increase in population and economic activity. This increase will be counteracted somewhat in the BAP Scenario, primarily by State initiatives to reduce food waste by 50% by 2030,²⁸ as well as legislation requiring a reduction in total waste going to landfills.²⁹ In addition, the BAP Scenario assumes that Detroit will reach its goal of reducing its solid waste by 30% by 2030. The processes used to treat wastewater across the region were assumed to remain as they are until 2050.

As a result, between 2019 and 2030, the volume of waste sent to landfills will decrease by 13% (approximately 608,000 MT) annually. By 2050, population and economic growth will partly offset these initial gains, and the total volume will be only 9% lower than 2019.

Industrial Sector

In the BAP Scenario, emissions from industrial facilities are projected to decrease by 47% from 20.3 million to 10.7 million MT CO₂e annually between 2019 and 2050. This reduction is entirely due to switching the electricity grid away from fossil fuels to 100% clean energy sources. The remaining emissions in this sector are from two types of sources:

1. Continued use of natural gas, fuel oil, propane, and coal to generate energy
2. Emissions occurring from industrial processes (e.g., chemical reactions that produce and release CO₂) and product use; in Southeast Michigan this includes continued emissions of a very potent greenhouse gas – SF₆ – from electricity transmission and distribution equipment

Figure C.10 illustrates the reduction in total industrial emissions in the context of all sectors projected for the BAP Scenario.

25 EIA. “Household Energy Use in Michigan.” https://www.eia.gov/consumption/residential/reports/2009/state_briefs/pdf/MI.pdf

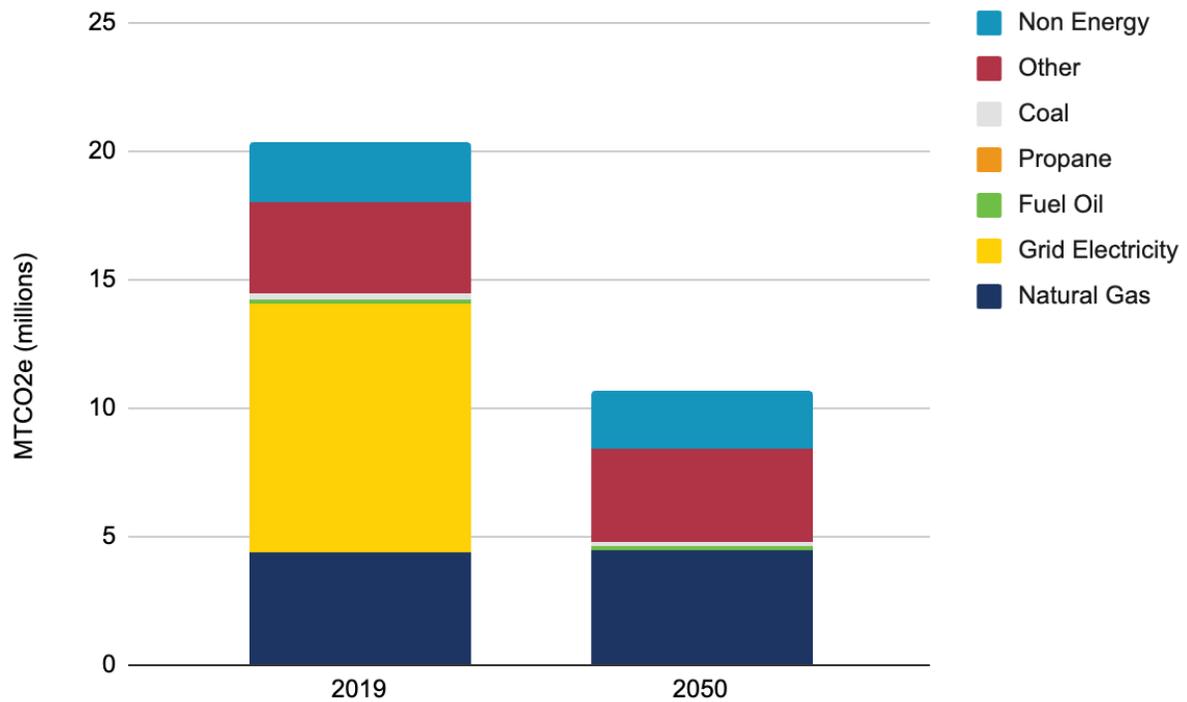
26 State of Michigan. “Public Act 342: The Clean and Renewable Energy Waste Reduction Act and Public Act 341.” <https://www.michigan.gov/mpsc/regulatory/ewr#:~:text=For%20electric%20and%20gas%20providers,per%20year%20for%20gas%20providers.>

27 City of Detroit. Energy and Water Benchmarking Ordinance. <https://detroitmi.gov/government/mayors-office/office-sustainability/energy/energy-and-water-benchmarking-ordinance>

28 Michigan Department of Environment, Great Lakes, and Energy. ‘Food Waste Reduction’ Web page. <https://www.michigan.gov/egle/about/organization/materials-management/pollution-prevention/food-waste-reduction>

29 State of Michigan. Part 115, ‘House Bill 4455’. 2022. <https://airtable.com/app50r3hfwk6m03A7/tblIGduZBE6v7kcaX/viwiXeZTINwbAHuEz/rec1UGyr35yaEAC7T/fldsK8uN8YQ2K8YYv?copyLinkToCellOrRecordOrigin=gridView>

Figure C.10: Projected industrial sector GHG emissions by source in the BAP Scenario



Agricultural Sector

As in the Industry Sector, the decrease in agricultural emissions in the BAP Scenario is entirely due to the electricity grid becoming emissions-free by 2040. This eliminates 142,000 MT CO₂e from the region’s annual emissions, which is a 31% reduction in total agricultural emissions. Actions in the Reduced Emissions Scenario will need to address the remaining use of natural gas and propane in this sector, as well as address emissions from livestock manure and other agricultural waste.

Local Renewable Electricity Generation

Generating electricity close to where it is used has several benefits:

- Less electricity is lost during a short journey than a long one. In 2019, 4.56% of the electricity that was generated in or transferred into Michigan was lost during transmission and distribution. These losses occur when electricity travels over power lines, generating heat that is released into the air around the line. Lost electricity is a cost that is passed on to rate payers, and although different factors affect how much is lost, the most direct way to avoid loss (and the cost of it) is to locate electricity at the same location where it will be consumed.

30 Emissions from agricultural vehicles are included in the Transportation Sector and not included in the Agriculture Sector.

31 For the purposes of this document, ‘local electricity’ is defined as electricity generated at the building or inside the community within which it is consumed.

32 U.S. Energy Information Agency (EIA). “Michigan Electricity Profiles: Table 10”. 2023. <https://www.eia.gov/electricity/state/michigan/>

- Generating and storing electricity at a building or within a community provides those residents with power even when the grid goes down. This is especially important at priority locations like hospitals where power must always be available.
- Relying on local power generation eliminates the volatility of prices for power that you import. Many American power plants experienced spikes in the cost of natural gas after Russia invaded Ukraine in 2022. This sudden price increase was passed on to consumers, and created financial hardship for many, particularly low-income residents.
- While generating renewable power on-site may require an initial investment to purchase solar PV or CHP (Combined Heat and Power) equipment, this investment is paid back quickly, and the systems then provide years of free electricity to the owner.

Local highlight: In the BAP Scenario, there is an increase by 2050 of 81,000 MMBTU in locally produced electricity by 2050. This reflects the conversion of the Detroit Thermal district energy system from using natural gas and incinerated waste to renewable electricity purchased from DTE, by 2030. The BAP Scenario does not project an increase in small-scale solar PV installations. As a result, the total amount of local, renewable electricity produced in 2050 in the BAP Scenario is projected to be only 125,000 MMBTU. This represents only 0.6% of the total electricity required by the region in the same year.³³

C.4 REDUCED EMISSIONS (RE) SCENARIO

The BAP Scenario results demonstrate that existing policies, regulations, market trends, and efficiency improvements in Southeast Michigan will lower emissions by 22% by 2030 and by 48% by 2050. While this represents significant progress, it falls short of the region’s targets. More ambitious efforts will be required in both the near- and long term.

In the RE Scenario, additional actions were developed specifically to bridge the gap between the BAP Scenario and the targets. The RE Scenario actions are grouped into five “Big Moves,” each of which focuses on a key of greenhouse gas emissions in Southeast Michigan:

1. Promote Healthy, Efficient Buildings
2. Modernize Mobility Systems
3. Expand Local Renewable Energy Generation
4. Grow Clean Innovation in Industry
5. Manage Waste and Natural Resources Sustainably

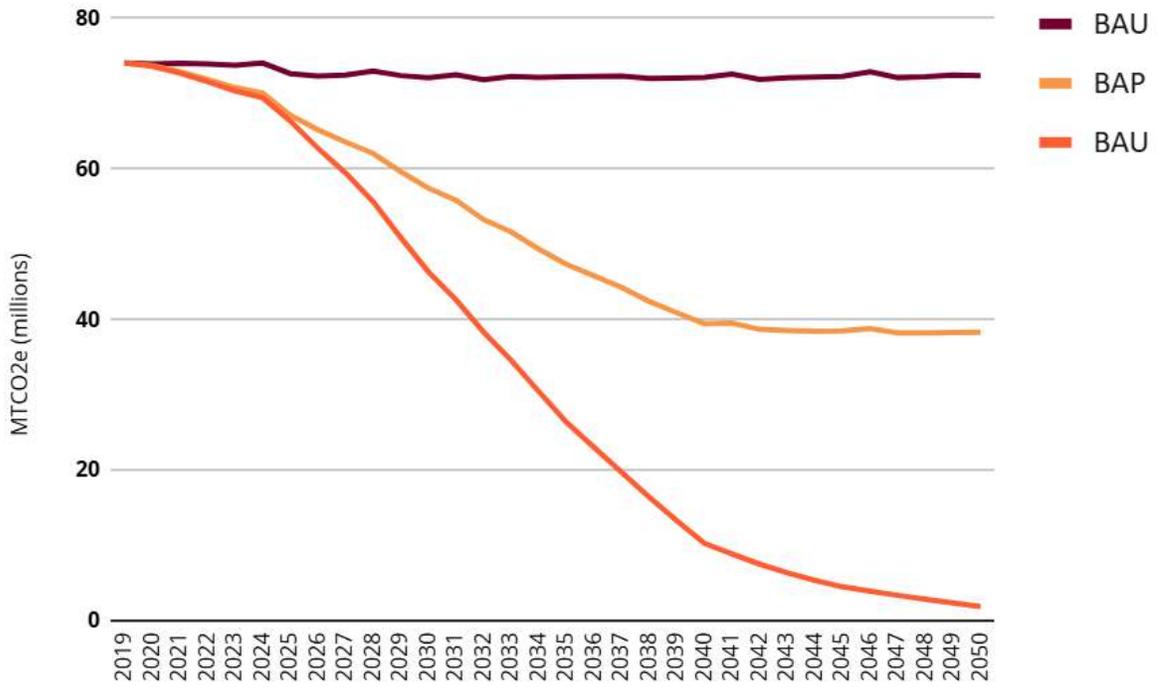
All of the actions are scheduled on a timeline designed to maximize the depth and speed of change, optimize energy use, and minimize investment and maintenance costs.

When implemented as laid out in this Plan, these actions will reduce Southeast Michigan’s total annual GHG emissions from Southeast Michigan by 37% by 2030 and by 97.3% by 2050.

Figure C.13 illustrates the overall trajectory of emissions reductions in the Reduced Emissions Scenario alongside those of the BAU and BAP Scenarios.

³³ Based on the modeling done for this project in ScenaCommunity.

Figure C.13 BAU, BAP and RE Scenario GHG Emission Projections



C.4.1 Actions Modeled in RE Scenario

The five Big Moves include 20 emissions reduction actions which are described in Table C.3.

Table C.3: The Big Moves and Actions in the Reduced Emissions Scenario

BIG MOVE	ACTIONS	DESCRIPTION
<p>Promote Efficient, Affordable Homes and Buildings</p>	<p>Retrofit Homes</p>	<ul style="list-style-type: none"> All homes³⁴ will be retrofitted to reduce their average energy consumption by 50%. All retrofits will be complete by 2045.
	<p>Retrofit Non-Residential Buildings</p>	<ul style="list-style-type: none"> All non-residential buildings⁵¹ will be retrofitted to reduce their total average energy consumption by 50%. All retrofits will be completed by 2045.
	<p>Use electric heat exchange systems in new and existing buildings</p>	<ul style="list-style-type: none"> Immediately after retrofitting buildings, all fossil-fueled space heating/ cooling, and water heating systems will be removed and replaced with either ground or air source heat exchange³⁵ systems. All fossil fuel appliances will be replaced with electric appliances at the same time. This will be complete by 2045. <ul style="list-style-type: none"> In Washtenaw County outside Ann Arbor, these changes will be completed between 2025 and 2035. In Ann Arbor, 80% of buildings will be switched to ground source heat exchange (some on a district energy system), and 20% to air source heat exchange. These changes will be completed between 2025 and 2030. From 2030 on, all new buildings in the region will be required to be heated and cooled and have hot water heaters that use heat exchange systems, as well as only electric appliances.

34 This project did not include a detailed analysis of how much of the housing stock should be demolished rather than retrofitted. However in general, as much as possible buildings and building materials should be re-used to preserve embodied carbon and avoid harvesting additional raw materials.

35 For the purposes of this document, all references to heat exchange systems or heat pumps refers to cold climate heat exchange systems with backup zero-emissions heating.

BIG MOVE**ACTIONS****DESCRIPTION****Increase housing options with infill development and adaptive reuse****Establish net-zero emission building standards**

- In Detroit, between 2025 and 2045, 30% of new city residents will be housed in new infill homes, or in renovated buildings that are currently vacant.³⁶
- A requirement to build new non-residential buildings to a net-zero standard will be introduced as follows:
 - Region-wide, all new county and local government buildings that become operational in 2030 or later will be required to meet a net-zero standard;
 - Region-wide except for Ann Arbor, all new industrial, commercial, and institutional buildings that become inhabited or operational in 2035 or later must meet a net-zero standard;
 - In Ann Arbor, all new industrial, commercial, and institutional buildings that become inhabited in 2030 or later must be built to a net-zero standard.
- A requirement to build all new residential buildings to a net-zero standard by 2030 in Ann Arbor, and by 2035 across the rest of the region.
- Across the region, the average size of new single-family homes will be reduced from 1,800 to 1,600 square feet by 2028.

36 This action will primarily reduce embodied carbon (or consumption-based emissions) which are not within the scope of the GHG inventory included in this project. It was not modeled as part of this project but is a recommendation of the Plan.

Table C.3: The Big Moves and Actions in the Reduced Emissions Scenario

BIG MOVE	ACTIONS	DESCRIPTION
<p>Modernize Mobility Systems</p>	<p>Increase active transportation</p>	<ul style="list-style-type: none"> The portion of all trips, region-wide that are taken using active modes of transportation will increase to the following: <ul style="list-style-type: none"> 1.5% by 2030 2% by 2032 3% by 2034 4% by 2036 5% by 2040³⁷
	<p>Increase transit and train ridership</p>	<ul style="list-style-type: none"> Transit and train service will be improved such that the portion of all trips, region-wide that are taken on transit or (passenger) trains increase to: <ul style="list-style-type: none"> 2% by 2028 4% by 2030 6% by 2033 8% by 2036 10% by 2040³⁸
	<p>Replace buses with ZEVs</p>	<ul style="list-style-type: none"> All buses will be replaced with electric models, and existing ICE buses will be retired by 2040. By 2030, 50% of all new, personal, and commercial light and medium-duty vehicles registered in Southeast Michigan will be battery electric vehicles (BEVs). By 2035, this will increase to 100% of new vehicles. By 2050, all ICE light- and medium-duty vehicles will be retired or converted to EV.

37 The trips that are shifted to active modes will be 0-5 miles in distance, and concentrated in LIDAC communities and denser areas, along routes that will support both commuting and recreation.

38 These trips will average 1-15 miles in distance, and be concentrated in LIDAC communities that lack access to affordable transportation, transit-oriented developments, and denser areas. In these areas, ridership may reach 15% of all trips.

BIG MOVE	ACTIONS	DESCRIPTION
Modernize Mobility Systems	Replace heavy-duty vehicles with ZEVs	<ul style="list-style-type: none"> By 2040, new heavy-duty vehicle sales will be 100% ZEVs, half of which will be electric and half of which will be hydrogen-powered. By 2050, all ICE heavy duty vehicles will be retired or converted to an EV.
	Replace offroad vehicles with ZEVs	<ul style="list-style-type: none"> Rail service in the region will switch from using diesel (including fossil-fuel diesel, biodiesel, and renewable diesel) to using a) 100% green hydrogen for freight rail transportation, and b) 100% electric engines for passenger transportation, by 2050.
	Replace port equipment and vehicles with ZEVs and use only electricity for docked ships	<ul style="list-style-type: none"> All offroad vehicles will be replaced by electric models by 2050.
	Replace freight ships with zero-emissions ships.	<ul style="list-style-type: none"> At all ports in Southeast Michigan, by 2028, 40% of cargo-handling equipment will be electric, and by 2034 this will rise to 80%. All ships docked at these ports will be required to only use electricity while docked.
	Replace street, traffic, park, stadium and sportsfield lighting with LEDs³⁹	<ul style="list-style-type: none"> All water-borne freight ships using port facilities in Southeast Michigan will be converted to operate on hydrogen and will use 100% green hydrogen by 2050. By 2030, all street, traffic, park, stadium, and sports field lighting will be converted to LEDs.

39 The data required to model this was not available so this action was not modeled, but it is included as a recommended action in this Plan.

Table C.3: The Big Moves and Actions in the Reduced Emissions Scenario

BIG MOVE	ACTIONS	DESCRIPTION
<p>Expand Local Renewable Energy Generation</p>	<p>Install rooftop solar PV systems</p>	<ul style="list-style-type: none"> • By 2029, 205 MW of rooftop solar PV systems will be installed. • 50 MW will be installed in Ann Arbor • 155 MW will be installed in LIDAC communities across the region and outside Ann Arbor • Beginning in 2027, Ann Arbor’s Sustainable Energy Utility’s electricity emissions will decrease faster than the rest of the regions until 75% of their total energy use is made up of zero-emissions electricity in 2030.
	<p>Install ground mount solar PV systems</p>	<ul style="list-style-type: none"> • By 2027, 33 MW of ground mount solar PV systems will be installed in Detroit.
	<p>Develop energy storage</p>	<ul style="list-style-type: none"> • By 2029, 9.1 MW of distributed energy storage will be installed across the region.⁴⁰ • 2.1 MW will be installed in Ann Arbor • 7 MW will be installed in LIDAC communities across the region⁴¹
	<p>Reduce and replace natural gas use with renewable natural gas</p>	<ul style="list-style-type: none"> • By 2030, the use of natural gas has been reduced by at least 30% region-wide through the retrofit and industrial actions and the gradual cleaning of the grid. By 2045, all residual uses of natural gas will be replaced with renewable natural gas produced from anaerobic digesters and agricultural locations.
	<p>Develop green hydrogen systems⁴²</p>	<ul style="list-style-type: none"> • By 2030, all blue hydrogen currently used for petroleum refining, semiconductor manufacturing, and glass manufacturing is replaced by green hydrogen. From 2031 on, green hydrogen is also used in steel manufacturing and cement and lime production, and as fuel for heavy duty vehicles.

40 This energy storage will be in addition to the 2,500 MW of energy storage required by Michigan’s Clean Energy Act.

41 This 7 MW of energy storage will be supported by the Michigan Solar for All program.

42 See XXX for a recommended adjustment to this action.

BIG MOVE	ACTIONS	DESCRIPTION
Advance Clean Innovation in Industry	Improve industrial efficiency	<ul style="list-style-type: none"> Beginning in 2025, the efficiency of processes, motive equipment, lighting, space, and equipment cooling, and plug load will be improved until by 2045 total energy demand across all industrial facilities is reduced by 50%.
	Reduce cement and lime manufacturing emissions	<ul style="list-style-type: none"> Emissions from cement and lime manufacturing will be reduced by 50% by 2035, and by 65% by 2045. This will be done by a) switching energy sources from heavy fuel, oil and natural gas to electricity, hydrogen and waste heat for energy, and b) sequestering CO2 in cement.
	Reduce steel manufacturing emissions	<ul style="list-style-type: none"> Emissions from steel manufacturing will be reduced by 50% by 2035 and to zero emissions by 2050 by switching from coal and natural gas as energy sources, to electricity and green hydrogen.
Sustainably Manage Waste and Natural Resources	Reduce Waste	<ul style="list-style-type: none"> Region-wide, the total amount of solid waste sent to landfills (excluding industrial waste) will be reduced by 30% by 2029, and by 45% by 2035, through: <ul style="list-style-type: none"> Elimination of food waste in 15 cities; Increased circular economy initiatives; Redeveloped waste management plans with landfills as a last resort.
	Anaerobic digesters for wastewater treatment	<ul style="list-style-type: none"> Anaerobic digesters will be constructed at wastewater treatment facilities including the Ann Arbor Water Recapture Facility and the GLWA Biosolids and renewable Energy project by 2030. At the GLWA, the design will ensure that incineration is reduced by 50% by 2030, and fully decommissioned by 2032. The biogas that is produced will replace natural gas currently being used in the industrial sector.
	Zero-emissions fuels for water and wastewater facilities	<ul style="list-style-type: none"> All natural gas, fuel oil, propane, or other fossil fuels used in water treatment and wastewater treatment facilities will be retired and replaced with zero-emission alternatives by 2030. By 2045 there will be no fossil-fuel natural gas in use in the region.
	Enhance tree canopy and wetland coverage	<ul style="list-style-type: none"> By 2050, 20,000 trees will be planted across the region, 500,000 acres of wetlands will be protected (10% of which will be restored), and the tree canopy in urban census tracts will reach 40%, with priority given to those below 20% in 2022.⁴³

43 Work to achieve this will be coordinated with work to achieve SEMCOG’s Green Initiative. Source: <https://www.semco.org/green>.

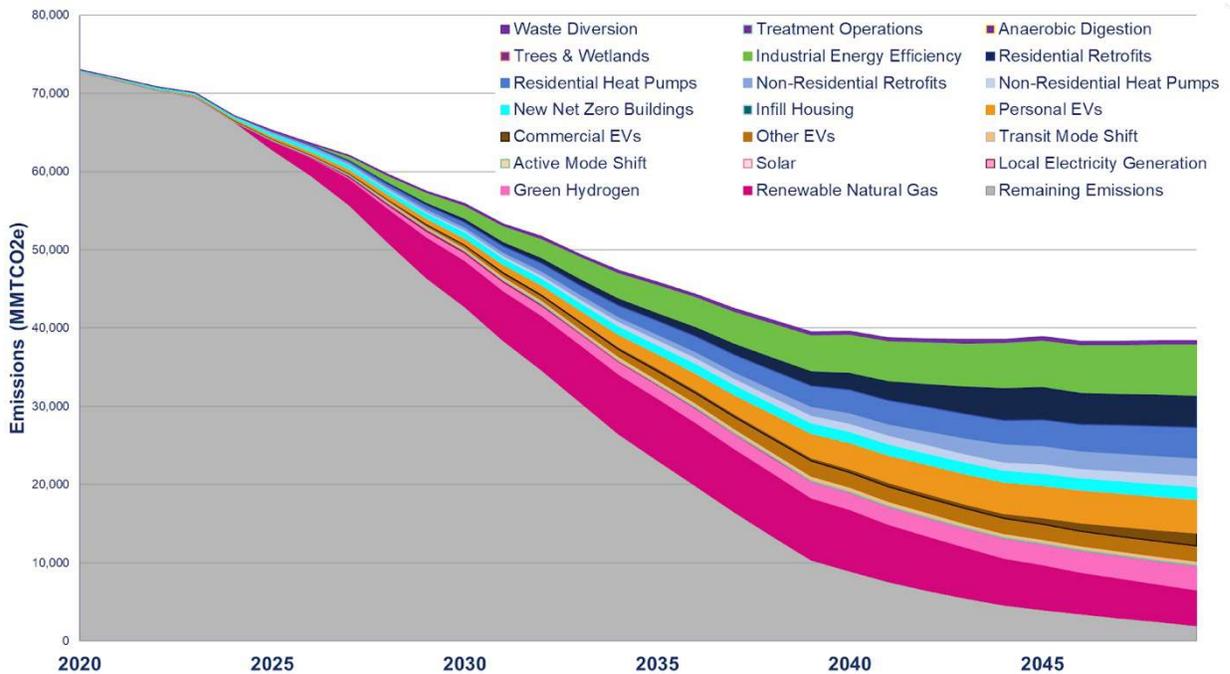
C.4.2 RE Scenario Projections

The five Big Moves include 20 emissions reduction actions which are described in Table C.3.

In the Reduced Emissions Scenario, SEMCOG’s total annual GHG emissions are projected to decrease by 37% by 2030 and by 97% by 2050 relative to the 2019 baseline. This decrease is a result of the combined impact of the RE actions all working together and proceeding in a specific order, in addition to the conditions already in place in the BAP Scenario.

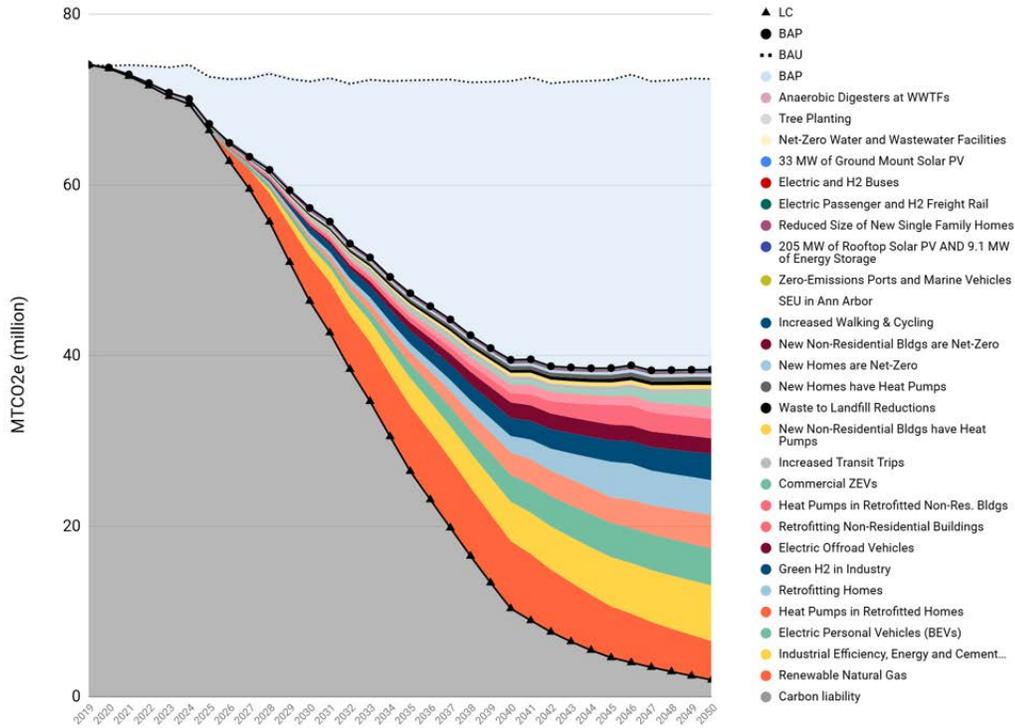
Figure C.14 illustrates the total impact over time of each of the actions in the RE Scenario, in the context of both the BAU and BAP emissions trajectories.

Figure C.14 Reduced Emissions Scenario: Emissions Reductions by Action



About Figure C.14 - the Wedge Diagram: The two important features on Figure C.14 illustrate the contrast between Southeast Michigan’s future emissions if no action is taken, and what they are projected to be if this Plan is fully implemented:

- The finely dotted, horizontal line at the top of the image represents future emissions in the BAU Scenario - if the region takes no action.
- The black line that is marked with triangles, falling from the upper left to the lower right corner of the graph represents projected reduction in regional emission if all the actions in the RE Scenario are implemented on schedule.
- The pale blue wedge between the BAU line and the black dotted line halfway down the right side of the graph represents the cumulative reductions in emissions projected to occur because of the changes in the BAP Scenario.
- Each colored wedge represents the impact of one action from the RE Scenario.



It's important to notice in this Figure C.14 that the identified pathway to zero-emissions includes many actions. No one or two actions will reduce the majority of the region's emissions. Instead, a broad range of actions will need to be prioritized and coordinated throughout the Plan's implementation.

As time progresses, the impact of many actions grows significantly. This emphasizes that the sooner this work begins, the sooner beneficial impacts will be realized. It is also true that the sooner the work begins, the less counties and municipalities will need to spend to address the damage of worsening climate change. This is discussed more in Appendices D and E of this document.

Figure C.15 illustrates the impacts of the RE Scenario actions grouped into the six Big Moves.

Figure C.15 RE Scenario GHG Emissions Impact of the Big Moves

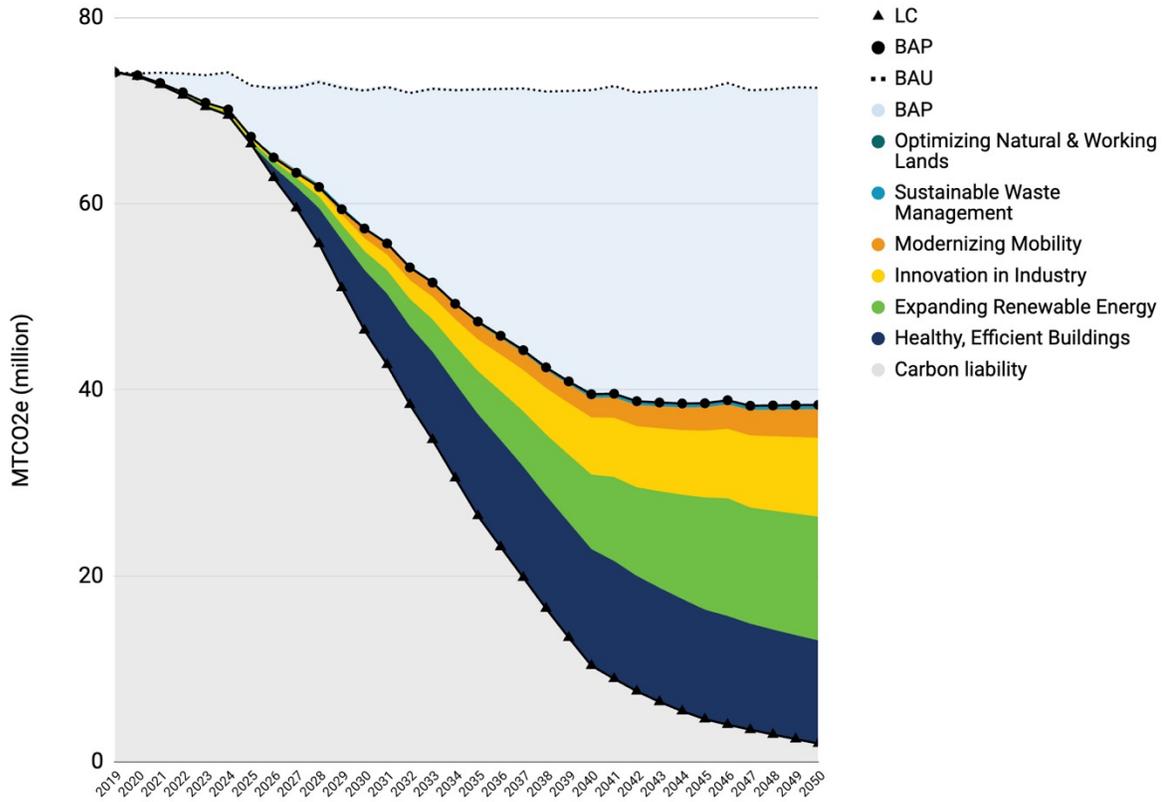
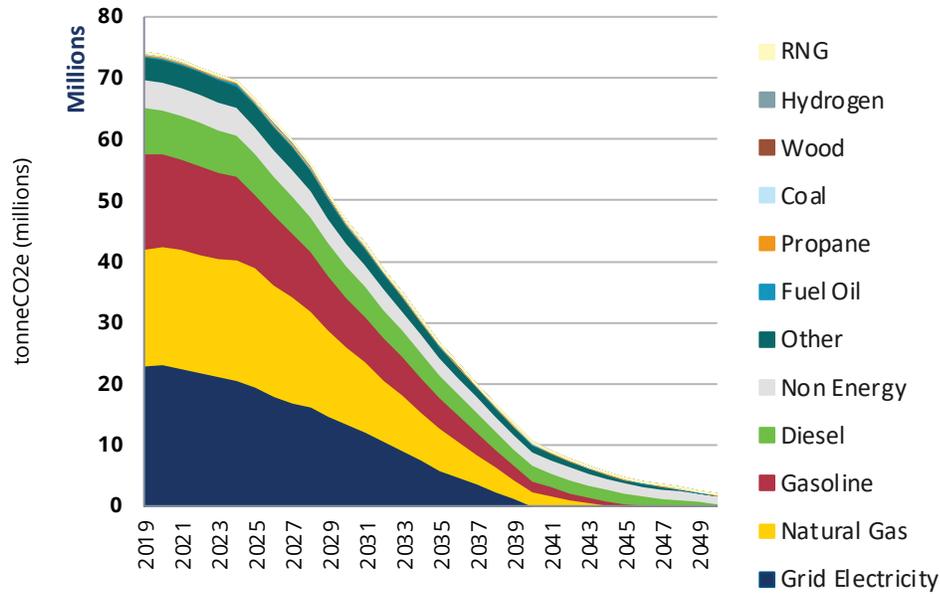


Figure C.15 illustrates that the Big Move with the greatest impact overall is ‘Healthy, Efficient Buildings.’ Initially, the actions within ‘Modernizing Mobility’ have a larger impact, but as soon grid electricity becomes emissions-free in 2040, the energy savings from ongoing building retrofits becomes a more powerful element of the Plan.

The ‘Innovation in Industry’ actions continue to grow after 2040. This reflects the gradual implementation of multiple, complex actions to fully eliminate emissions both from industrial energy use, and from greenhouse gases that are produced as a result of several industrial processes in the region.

Figure C.16 provides a third representation of the RE Scenario emissions reductions by fuel/energy source.

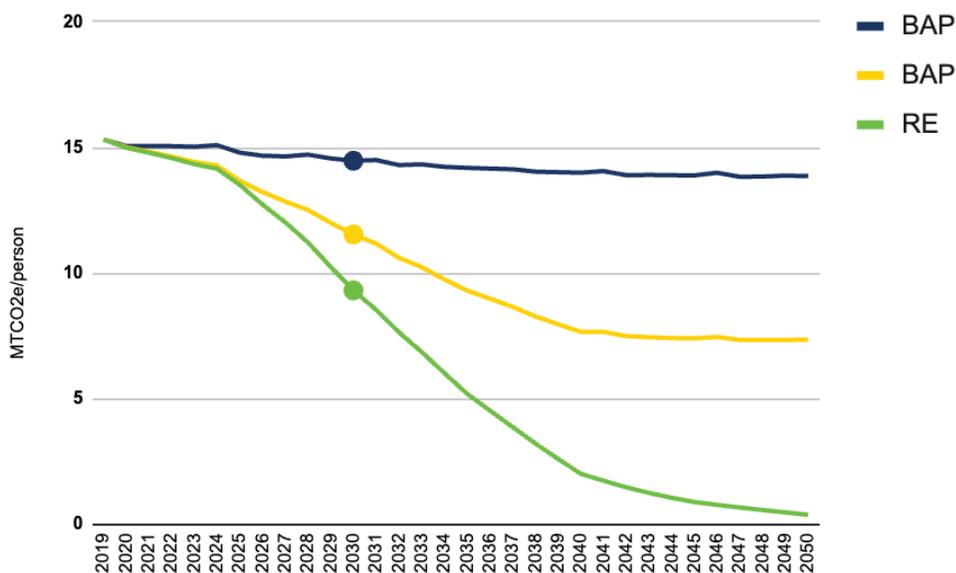
Figure C.16 RE Scenario GHG Emissions by Fuel / Energy Source



As shown in Figure C.16, a significant portion of the emissions remaining in 2050 will come from the use of diesel and gasoline. This may be surprising because most vehicles will have transitioned to zero-emissions models early in the period; however, these later emissions are due to the later transition of boats, port equipment, and vehicles, and both passenger and freight rail.

Figure C.17 displays the projected per capita greenhouse gas emissions in the region in all three modeled scenarios. In the RE Scenario, per capita emissions are anticipated to decline from 15.3 metric tons in 2019 to 9.3 MT CO₂e in 2030 (a reduction of 39%), and finally to 0.4 MT CO₂e in the RE Scenario.

Figure C.17 RE Scenario Per Capita Emissions



C.4.3 RE Scenario Outlook by Sector

Promote Healthy and Efficient Buildings

The eight modelled actions that constitute the Healthy and Efficient Buildings Big Move⁴⁴ begin by eliminating 675,000 MT CO₂e of emissions across the region in the year 2026. This rapidly increases to eliminate 2 million MT CO₂e in 2030, and between 2045 and 2050, over 12 million MT CO₂e emissions are eliminated annually by these actions. Over the period of 2025 to 2050, a total of 175 million MT CO₂e emissions that would have been produced by building systems, are eliminated in Southeast Michigan. This constitutes 30% of the total emissions eliminated in the RE Scenario.

In Southeast Michigan, as in most North American communities, reducing emissions in the building sector requires three major shifts:

1. Major energy efficiency improvements in all buildings, achieved by retrofitting existing buildings and significantly improving energy efficiency standards for new buildings.
2. Removal of all fossil fuel systems used for space and water heating and for appliances. These systems must then be replaced with heat exchange systems powered with electricity.
3. Finally, the electricity used in these buildings must generate zero emissions, whether it's zero-emissions grid electricity, renewable electricity produced on-site, or community renewable electricity generation.

There are also unique qualities about Southeast Michigan that are taken into consideration for these actions. For example:

- Residential energy use in Michigan is approximately 38% higher than the U.S. average. This is due in part to the fact that Michigan's residential building stock is older than the national average. There are also many energy-inefficient homes in Detroit.⁴⁵ A 2022 study⁴⁶ found that 19–26% of occupied homes in Detroit could be deemed 'inadequate' housing due to broken heating systems, broken window(s), broken exterior door(s), or insufficient insulation. All of these problems also significantly reduce the energy efficiency of the home, increasing the amount of energy required to keep the home at a healthy temperature. As a result of circumstances like this, Michigan householders spend 6% more for energy than the national average.⁴⁷ **Actions as simple as replacing broken windows and doors when made to thousands of homes can dramatically reduce overall energy consumption and home heating costs for Michiganders, bringing them more in line with the rest of the country.**⁴⁸

44 See Table 6.1 for the individual action details.

45 University of Michigan, Poverty Solutions. "Nearly 38,000 Households in Detroit estimated to be living in Inadequate Housing." 2021. <https://poverty.umich.edu/2021/10/21/nearly-38000-households-in-detroit-estimated-to-be-living-in-inadequate-housing/>

46 Ibid.

47 EIA. "Household Energy Use in Michigan." https://www.eia.gov/consumption/residential/reports/2009/state_briefs/pdf/Mi.pdf

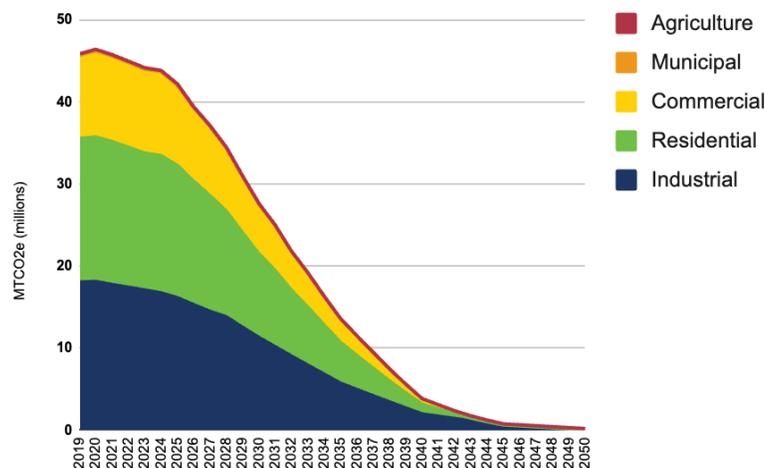
48 The City of Detroit's 'Renew Detroit Home Repair Program' is an excellent example of a program that aimed to make repairs like these to 2000 homes between 2021 and 2026.

- Since 2014, the City of Detroit has been working to deal with over 45,000 vacant homes within the city boundary, either through demolition or by renovating and selling them when possible.⁴⁹ The original construction of these buildings required energy and consumed materials, generating emissions that we can now consider to be ‘embodied’ in the remaining structures. (This is also referred to as ‘embodied carbon.’) Whenever these buildings or portions of them can be renovated, or their materials re-used, it avoids the need to use more energy and raw materials, and produce more emissions to build new homes. Actions in the Reduced Emissions Scenario include renovating vacant buildings where it is possible to house 30% of the city’s population growth before 2050.
- Southeast Michigan has many large, energy-intensive industrial and manufacturing facilities located close to institutional facilities like hospitals and campuses. This creates opportunities to channel excess heat and power from industry into the institutions through a district energy system. These are highly efficient systems that can provide space and water heating, cooling, and power with a single system, avoiding wasted energy and reducing total energy consumption and costs in the area. Actions to make both industrial and institutional buildings more energy-efficient can include renewable energy district energy systems.
- Of the 1,472 census tracts within the Plan’s project area, 498 (38%) meet or exceed both the qualifications for one or more of the CEJST burden thresholds and meet the associated socioeconomic thresholds. This represents approximately 1.4 million residents living in communities that are disproportionately vulnerable to the high costs of energy, housing insecurity, and pollution, all of which are likely to be exacerbated by climate change. The actions required to lower emissions from buildings can also significantly improve quality of life, affordability, and housing resilience for these residents.

The six actions in the Healthy and Efficient Buildings Big Move were developed based on both the shared and unique qualities of Southeast Michigan’s building stock. As a result, if these eight actions are implemented, building emissions in the RE Scenario are projected to fall 40% by 2030 and by 99.5% by 2050. In 2050, only 211,000 MT CO₂e are still being produced from buildings: approximately half of these emissions come from commercial properties still using fuel oil and propane, and the other half is from coal, propane, fuel oil, and renewable natural gas being used in industrial facilities.

Figure C.18 illustrates the RE Scenario’s reduction in building emissions by building type.

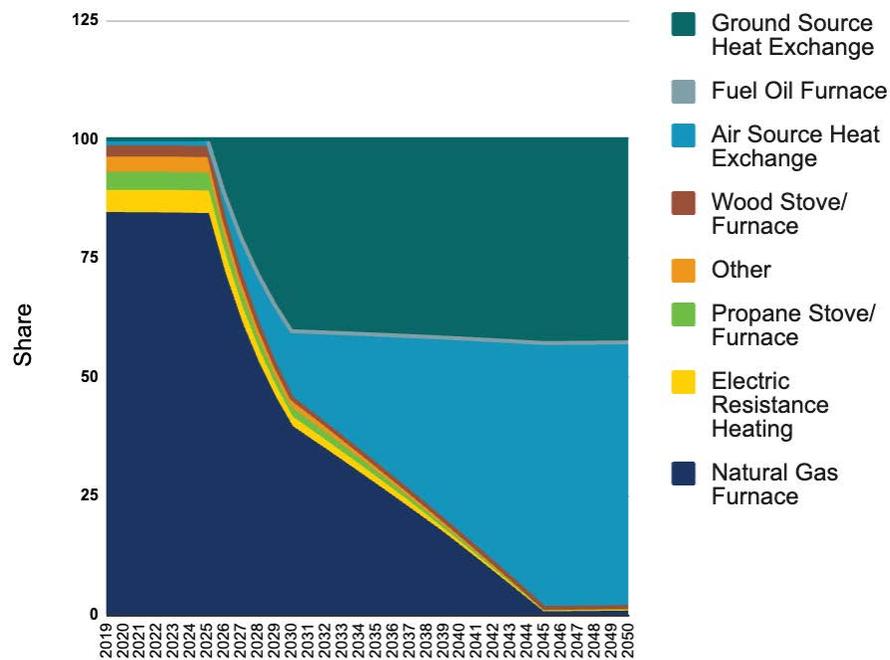
Figure C.18 RE Scenario GHG Emissions from Buildings



49 City of Detroit. “Demolition Data” website. <https://detroitmi.gov/departments/construction-and-demolition-department/demolition-data>

The transition from fossil-fuel systems to electric-powered heat exchange systems (or heat pumps) is shown in Figure C.19.

Figure C.19 RE Scenario Building Heating System Shares



Modernize Mobility Systems

Actions to reduce transportation emissions rely on two approaches. The first is to reduce the amount of travel taken in vehicles, and the second is to switch vehicles to zero-emissions fuels. The following actions were modeled for this plan to reduce the amount of travel taken in vehicles:

- **Increase active transportation**, such that by 2040, 5% of all trips – primarily those 1-4 miles in distance are taken using active modes of transportation.
- **Increase transit and train ridership** from the current 1% of all trips to 10% of all trips – primarily those 1-15 miles in distance – are taken by transit or train by 2040. These trips will replace vehicle trips that currently occur in more densely populated areas, in transit-oriented developments, along commuting routes, and in census tracts that lack access to affordable transportation.

The project also modeled actions to switch vehicles to zero-emissions energy sources – both hydrogen and electricity. Michigan has significant efforts underway to produce green hydrogen and provide hydrogen fueling stations, as well as to develop transportation corridors and ‘H2Hubs’ particularly for hydrogen-powered heavy-duty vehicles, such as long-haul trucks.⁵⁰ California has also invested in hydrogen fuel for transportation, but most other regions of the U.S. are planning to transition heavy-duty vehicles to electric models.

⁵⁰ University of Michigan. “Hydrogen Roadmap for the State of Michigan: Workshop Report.” 2022. https://deepblue.lib.umich.edu/bitstream/handle/2027.42/191567/CSS22-17_MI%20Hydrogen%20Roadmap%20Workshop%20Report.pdf?sequence=1&isAllowed=y

To reflect Michigan’s commitment to using hydrogen for heavy-duty transportation, the RE Scenario included the following transitions:

- Replace all buses with electric buses
- Replace all heavy-duty vehicles with zero-emissions models
- Zero-emissions shipping
- Zero-emissions rail

The RE Scenario also includes shifting the following:

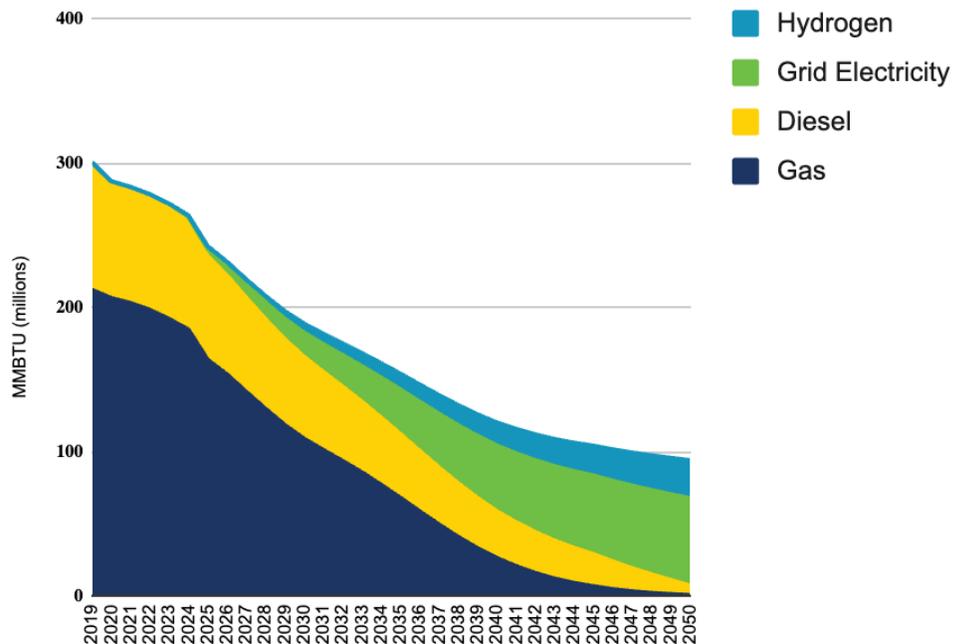
- Replace all personal and commercial light- and medium-duty ICE Vehicles with ZEVs
- Replace all offroad vehicles with electric models
- Replace port vehicles and equipment with electric models, and require docked ships to use only electricity.

Local highlight: Southeast Michigan has a large workforce familiar with vehicle manufacturing. This presents a unique opportunity for the region to transform a portion of the vehicle manufacturing industry into a circular economy focused on refurbishing vehicle bodies and replacing their ICE engines with EV drivetrains.

As a result of these actions both energy consumption and emissions are dramatically reduced in the transportation sector in the RE Scenario. By 2050, total transportation-related energy consumption falls by 69%, and emissions fall by 98%.

Figure C.20 illustrates how these actions result in diesel and gas use dropping off dramatically while grid electricity and hydrogen increase.

Figure C.20 RE Scenario Transportation Energy, by Fuel Type

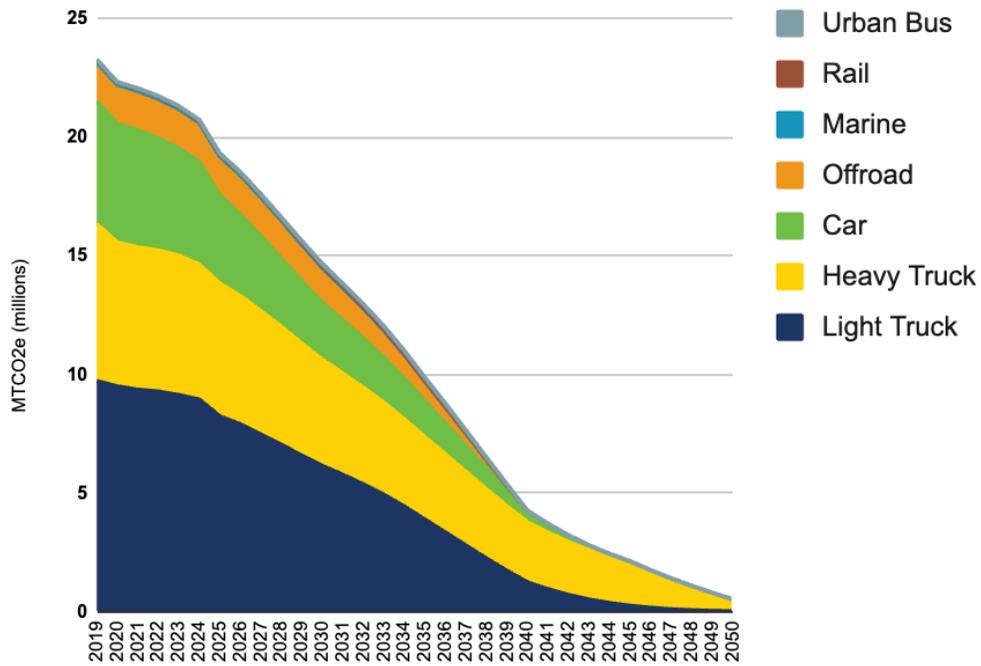


51 Plans for this have been completed for the Port of Detroit. <https://portdetroit.com/decarbonization-project-1>

52 The project to create this Plan was unable to acquire data on airplane fuel use and emissions in Southeast Michigan. As a result, a reduction in the use of jet fuel at the region’s airports is recommended but is not included in the modeled actions.

Correspondingly, transportation emissions in the RE Scenario fall by 98% by 2050. Figure C.21 illustrates transportation emissions over time by vehicle type, in the RE Scenario.

Figure C.21 RE Scenario Transportation Emissions, by Vehicle Type

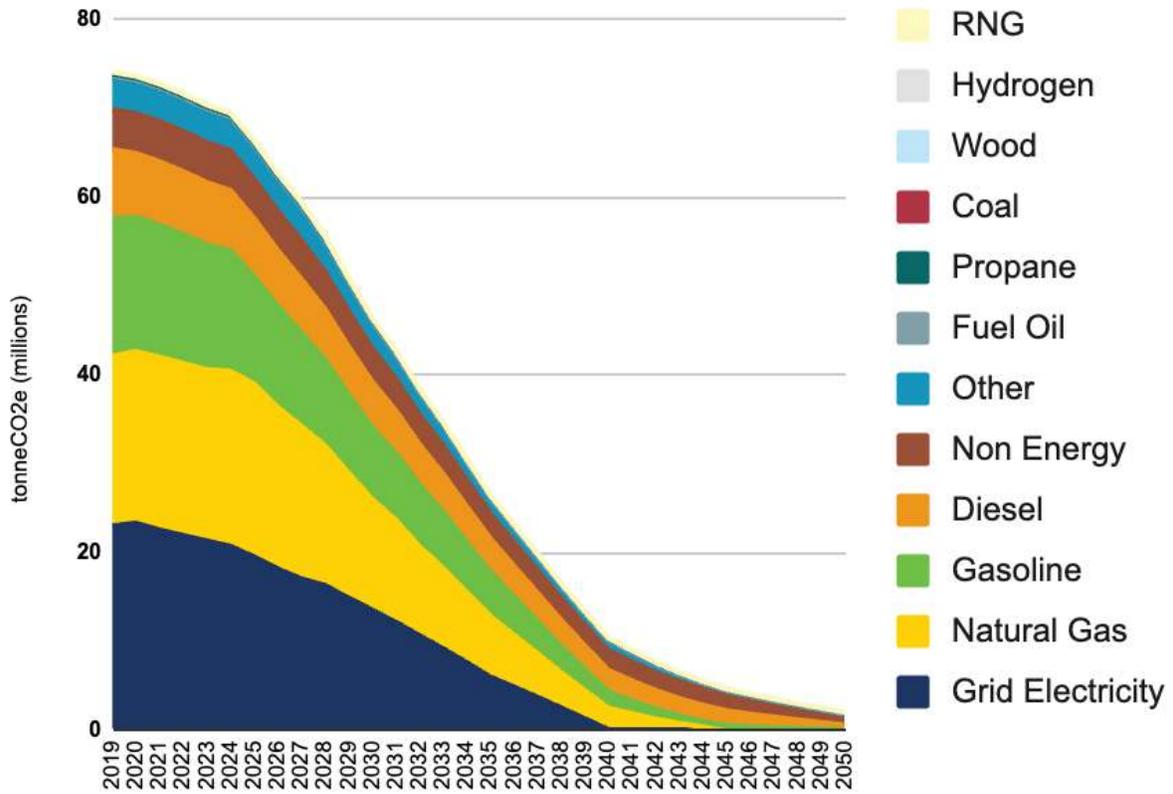


In the RE Scenario, Southeast Michigan shifts from getting 83% of its energy from fossil fuels in 2019 to only 3% in 2050. This translates into a reduction of 39% by 2030 and 99% by 2050 in emissions from energy sources.⁵³

This change to renewable, zero-emissions energy sources is responsible roughly a third of the total emissions reductions achieved in the RE Scenario. Figure C.22 illustrates this reduction over time.

⁵³ This calculation does not include emissions from non-energy sources, including waste and industrial processes and products.

Figure C.22 RE Scenario Emissions from Energy Sources, by Fuel Type



This Big Move includes four actions that focus on switching to and producing zero-emissions energy locally. It is supported by the State’s legislated requirement for a clean electricity grid by 2040,⁵⁴ and all actions that improve energy efficiency and increase the use of technologies using electricity.

Figure C.23 illustrates the energy sources that are used in 2019 vs 2050 in the RE Scenario.

54 State of Michigan. “Clean Energy and Jobs Act.”

Figure C.23 RE Scenario Energy Types and Consumption

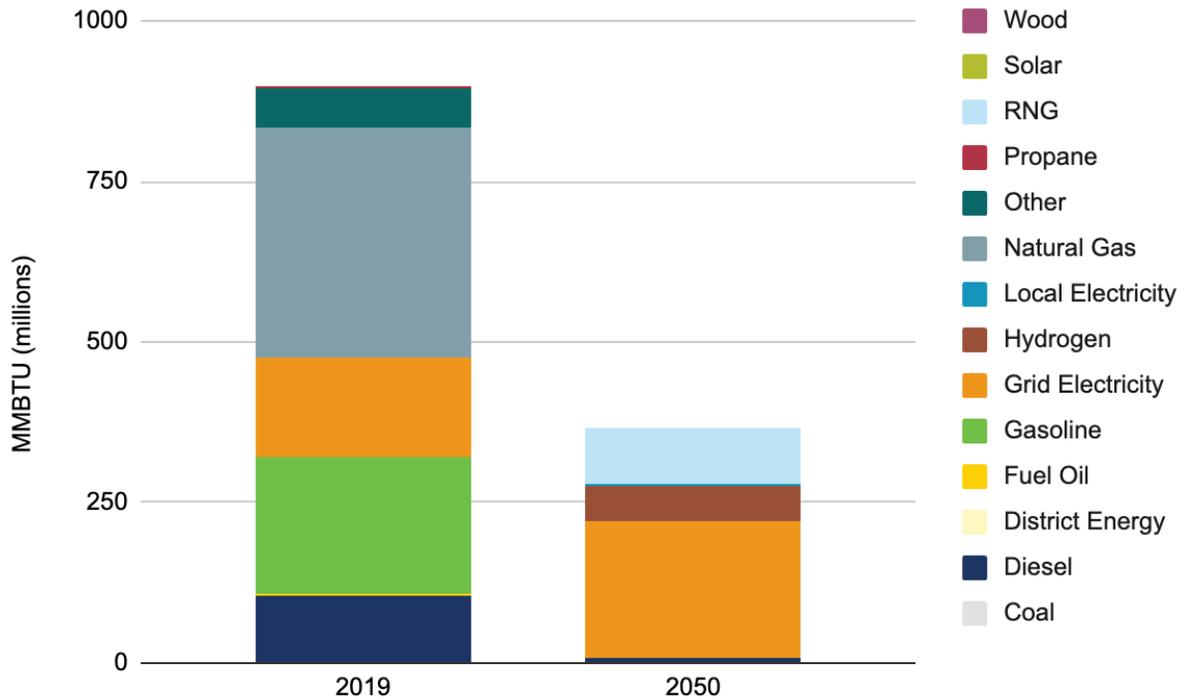


Figure C.23 also demonstrates that overall, the RE Scenario will reduce the total amount of energy consumed in the region by 59% between 2019 and 2050. This is a result of improving the energy efficiency of buildings and then switching to more energy-efficient technologies such as heat pumps. It also reflects the energy efficiency improvements of ZEVs relative to ICE vehicles, and reduced electricity losses wherever electricity is produced locally. All these changes translate into less energy consumption and lower energy bills for residents, business owners, and municipalities. The RE Scenario improves the region’s resilience overall because more energy will continue to be available during heat waves (for example) than it would be in the BAU and BAP Scenarios.

Two other points about the RE Scenario’s energy sources are important to note here:

1. One of the actions involves installing 9.1 MW of distributed energy storage in Ann Arbor and in LIDAC/ EJ census tracts across the region.⁵⁵ Energy storage allows excess renewable energy to be stored and used at another time. Distributing energy storage among LIDAC/ EJ households provides this additional energy to these homes, reducing their need to pay for power drawn from the grid at night (for example). Installing energy storage at institutions such as hospitals and educational campuses acts as a backup energy source that can replace diesel generators to ensure that power is never lost in high-priority facilities. All energy storage can, technically, be interconnected with the grid, increasing regional resilience when power shortages occur.

⁵⁵ This 9.1 MW of energy storage is in addition to the 2,500 MW of energy storage that utilities are required to install.

2. A number of data centers are expected to be built in Southeast Michigan in coming years. This Plan did not include any addition of data centers to the region, as detailed projections were not available. However, as SEMCOG and its member organizations implement this Plan, it will be important to monitor the demand placed on energy infrastructure from new data centers. These facilities consume significantly more energy than traditional business operations⁵⁶ – so much so that their lease contracts are generally priced based on forecast electricity consumption rather than on square footage. Media reports from August 2025 indicate that the data centers currently negotiating to set up in Michigan would require DTE and Consumers Energy to increase their electricity generation capacity from 18.6 GW to over 35 GW.⁵⁷ This poses significant risks to electricity reliability and affordability, and to the State’s legislated requirement for 100% renewable electricity by 2040. As part of this Plan, it is recommended that SEMCOG advocate that the State introduce legislation to require data centers to a) produce all of that power required for each data center from zero-emissions sources, and b) to install or have sole access to sufficient zero-emissions energy storage to meet their own operational needs without ever drawing from the grid. This would offer significant protection to the grid’s future reliability while also aligning with the State’s climate goals.

Manage Waste and Natural Resources Sustainably

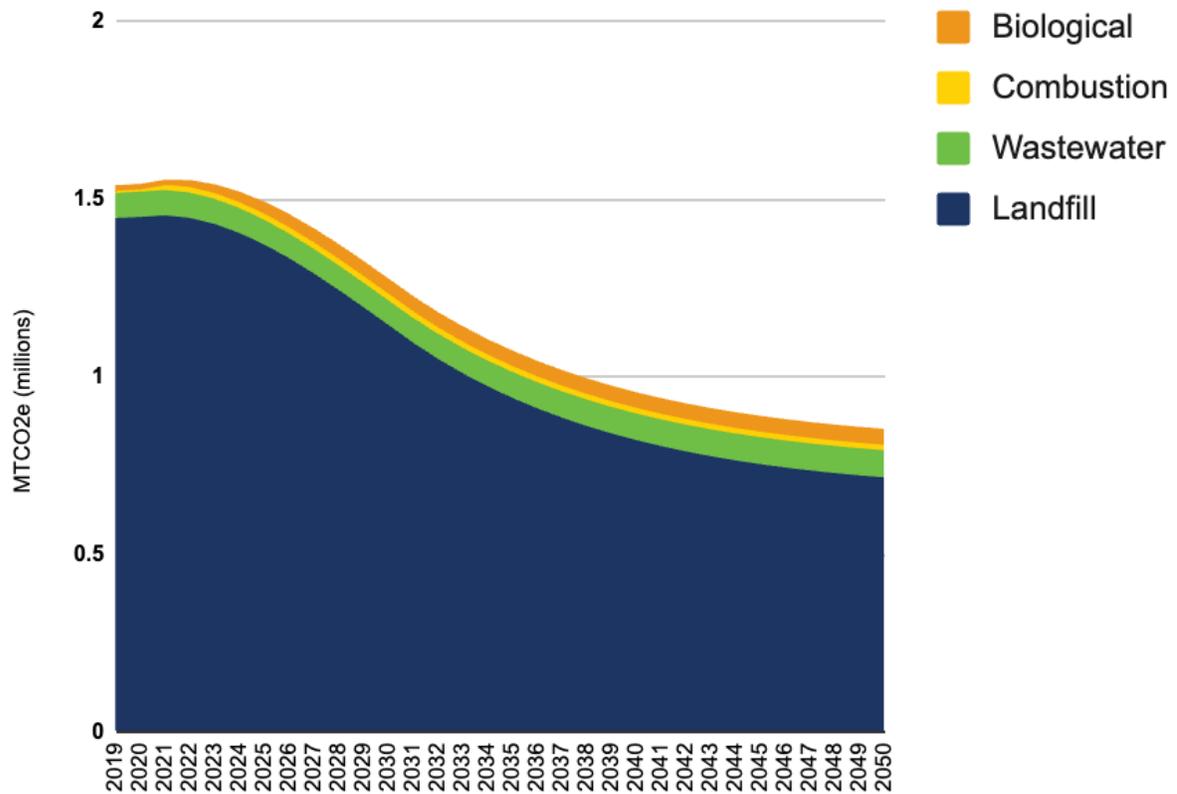
In 2019, waste in landfills, wastewater sludge, and organic compost in Southeast Michigan produced 1,532,000 MT CO₂e, which was 2% of the region’s total emissions. The RE Scenario’s three Sustainable Waste Management actions decrease total waste emissions by 17% by 2030 and by 42% by 2050. This means that in 2050 in the RE Scenario, Southeast Michigan is projected to produce 845,000 MT CO₂e from waste; this will constitute 43% of the region’s total emissions.

The actions include diverting organic waste from landfills to composting. Compost systems use aerobic chemical reactions to decompose organic matter into soil-enriching compost. However, in many composting facilities, a portion of the waste is not exposed to air, so it decomposes anaerobically rather than aerobically. Anaerobic decomposition produces methane, a potent greenhouse gas. For this reason, although Southeast Michigan’s landfill emissions fall from 1,440,000 to 709,000 MT CO₂e from 2019 to 2050 in the RE Scenario, this is offset somewhat by composting emissions increasing from 6,300 MT CO₂e to 44,700 MT CO₂e in the same period.

56 The following article suggests data centers use up to 50 times as much energy as a typical office building: Inside Climate News. ‘New Data Center Proposals Would ‘Kill’ Michigan’s Strong New Climate Laws.’ August 2025. <https://insideclimatenews.org/news/04082025/michigan-data-centers-would-kill-climate-laws/>

57 Ibid.

Figure C.24 Projected waste sector GHG emissions in the RE Scenario, 2019–2050



Several measures that will influence waste production in the region were not incorporated into the modeling for this Plan. These include:

- Extended Producer Responsibility legislation was introduced by the State in 2024. House Bill 5902⁵⁸ would require producers to manage their products throughout their lifecycles, including paying for processes like recycling to keep the products from entering landfills. This bill has not yet passed, but if it does it would be expected to reduce emissions from solid waste.
- State legislation introduced in 2022 requires counties’ Materials Management Plans to be updated to increase recycling, composting and other practices that will divert solid waste from landfills. Although the legislation does not include targets with dates to reduce waste, it would be expected to reduce emissions from solid waste in the region.

58 State of Michigan. ‘House Bill No. 5902. Packaging Reduction and Recycling Program.’ 2023. <https://legiscan.com/Mi/text/HB5902/id/3015625/Michigan-2023-HB5902-Introduced.html>

59 State of Michigan, Department of Environment, Great Lakes, and Energy. Materials Management Planning website. <https://www.michigan.gov/egle/about/organization/materials-management/solid-waste/planning>. Accessed September 2, 2025.

It is recommended that SEMCOG and its members support the passage and implementation of these and similar legislative initiatives. In addition, additional measures should be implemented to ensure residual waste emissions are reduced sufficiently. These measures may include:

- Replacing a portion of planned composting with anaerobic digesters, in which methane emissions are captured and converted to renewable natural gas for use in industrial processes.
- Implementing anaerobic digestion at additional wastewater facilities, supplementing wastewater sludge with fats, oils, and greases, as well as other 'high value' organic waste streams to increase production of renewable natural gas
- Expanding programs designed to reduce commercial waste
- Supporting regulations to reduce single-use plastics
- Eliminating the use of incineration, which produces harmful air pollutants (Appropriate replacement technologies depend on where the incineration is occurring, but could include technologies such as harnessing waste heat, and installing combined heat and power (CHP) technologies in conjunction with anaerobic digestion at wastewater facilities)

Innovation in Industry

Eliminating industrial emissions requires that two types of emissions are addressed.

1. The first type is emissions released from energy generated to power the industrial activity.
2. The second type of industrial emissions are released from chemical or thermal reactions that occur as part of the industrial activity or from waste products.

Local Highlight: *The Carmeuse Lime manufacturing facility in River Rouge generates power by burning coal, fossil fuel natural gas, solid byproducts and used oil , all of which produce greenhouse gas emissions. This is the first type of emissions described above. This facility's energy generation in the RE Scenario will need to be made as efficient as possible and then converted to zero-emissions energy sources.*

At the Carmeuse Lime manufacturing facility, CO₂ is also released as a result of chemical reactions occurring during the manufacturing process. This is the second type of emissions described above. If possible, these emissions will need to be eliminated by changing the manufacturing process to avoid the production of CO₂. If this isn't possible, the CO₂ will need to be captured and used or sequestered rather than released into the atmosphere

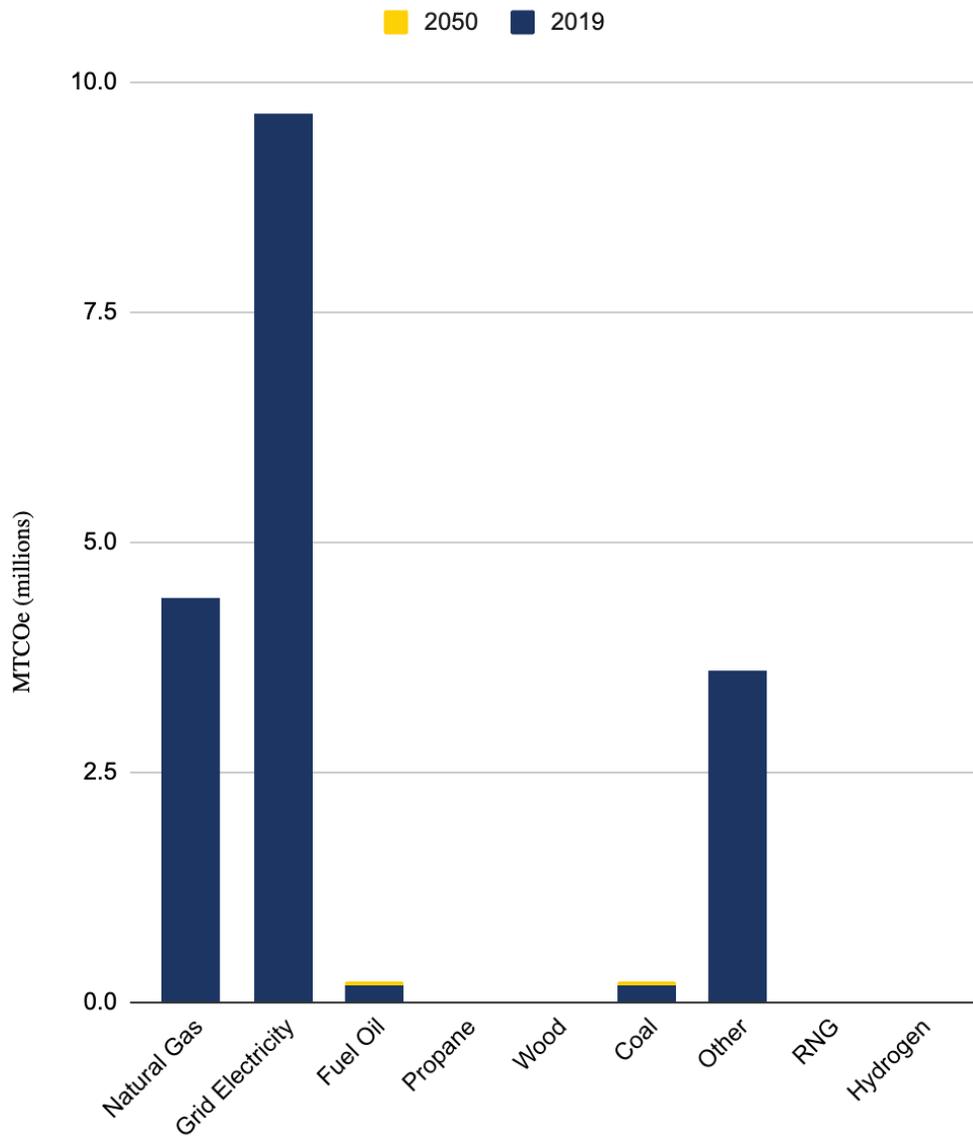
In 2019, industrial activity from 18 large industrial facilities and numerous smaller ones in Southeast Michigan produced 20,334,000 MT of greenhouse gas emissions. In the RE Scenario, the Innovation in Industry actions work together with related Expanding Renewable Energy actions to reduce total industrial emissions in the region by 99%, or a cumulative total of 92.8 million MT CO₂e between 2019 and 2050. In 2050, the industrial sector is projected to emit only 110,000 MT CO₂e annually.

60 Ann Arbor's A2Zero Plan, the Royal Oak Sustainability and Climate Action Plan, and Detroit's Sustainability Action Agenda all include initiatives that would support this.

61 An example of this is the City of Detroit's support for State Bill No. 228.

62 Based on 2019 data provided by the facility to the EPA, and reported publicly on the FLIGHT tool at: <https://ghgdata.epa.gov/ghgp/main.do>

Figure C.25 Projected industrial emissions in the RE Scenario, 2019-2050



Between 2019 and 2030, industrial energy sources that will generate emissions will include fossil fuel natural gas, grid electricity, fuel oil, propane, coal, specialized industrial fuels, and blue hydrogen. During the same period, non-energy-related industrial emissions will include CO₂ (as in the Carmeuse Lime example), SF₆ (sulfur hexafluoride) used as an insulator in electricity transmission and distribution equipment, and methane.

By 2050, in the RE Scenario, industrial emissions from fossil fuel natural gas, grid electricity, and specialized industrial fuels will have been eliminated. Emissions from blue hydrogen will have also been eliminated by switching to green hydrogen. Remaining industrial emissions will come from (reduced) use of coal, fuel oil, waste, renewable natural gas, and propane for energy generation, and from the ongoing use of SF₆.

Many of the goals of SEMCOG's GREEN Initiative are effective climate change mitigation and adaptation actions that are already broadly supported and being implemented in the region.

Vegetation and wetlands offer Southeast Michigan many valuable 'nature-based services. These include removing pollutants from water and the air, creating cooling shade in urban environments, and diverting precipitation from stormwater infrastructure during storm events. Plants also absorb carbon dioxide and transform carbon into their own vegetative growth. This means they contribute – albeit in a small way – to reducing the CO₂ levels in the atmosphere that are exacerbating climate change.

If we consider only the emissions sequestration benefits of the nature-based services, approximately 10,000 MT of CO₂e will be removed from the atmosphere and absorbed into living plants between 2019 and 2050. This is approximately 0.002% of the total emissions eliminated in the RE Scenario, and roughly equivalent to eliminating emissions from 2,333 gas-powered passenger vehicles driven for one year.

-
- 63 Blue hydrogen is produced from natural gas. A byproduct of this process is CO₂, which unless captured at the source, must be included as greenhouse gas emissions.
 - 64 Although renewable natural gas is considered 'renewable' because its sources can be replenished within a lifetime, it still produces greenhouse gas emissions.
 - 65 Although alternatives to SF₆ gas-insulated equipment are available, they are not yet being widely adopted. The California Air Resources Board has developed a phase-out schedule for SF₆ gas-insulated equipment, which is helping to ensure the market for these products increases, and prices decrease. Source: <https://ww2.arb.ca.gov/our-work/programs/elec-tandd/about>

APPENDIX D: BENEFITS ANALYSIS

CONTENTS:

- D.1 – GHG and Pollution Reduction Benefits
- D.2 – CO-Benefits and Co-Harms
 - Health
 - Economic Prosperity
 - Climate Adaptation and Resilience

D.1 GHG AND POLLUTION REDUCTION IMPACTS

GHG emissions, including carbon dioxide, hydrofluorocarbons, methane, nitrous oxide, perfluorocarbons and sulfur hexafluoride, are converted into CO2 equivalents based on their relative global warming potential. The cumulative CO2e reductions from each of the modeled actions are shown in Table D.1.

Table D.1 HG and pollution reduction impacts relative to the BAP Scenario.

MODELED ACTIONS	Total GHG Emissions Reductions (MTCO2e)		Cumulative Emissions (MTCO2e)
	2019-2030	2030-2050	2019-2050
Retrofit all homes	1,016,000	47,276,000	48,293,000
Retrofit all non-residential buildings	1,530,000	26,998,000	28,528,000
Use electric heat exchange systems for space and water heating in existing buildings	1,410,000	66,740,000	68,150,000
New homes are smaller	37,000	376,000	413,000
New non-residential buildings are net-zero emissions	1,914,000	4,130,000	6,043,000
New homes are net-zero emissions	1,323,000	6,273,000	7,596,000
Use electric heat exchange systems for space and water heating in new buildings	509,000	15,284,000	15,793,000
Increase active transportation	727,000	2,707,000	3,434,000
Increase transit and Train ridership	991,000	8,888,000	9,878,000
Replace all buses with electric buses	17,000	195,000	212,000
Replace all personal and commercial light and medium-duty vehicles with EVs	2,858,000	57,922,000	60,780,000
Replace all heavy-duty vehicles with zero-emissions models	585,000	12,025,000	12,610,000
Replace all offroad vehicles with electric models	393,000	28,518,000	28,911,000
Replace freight ships with zero-emissions ships	17,000	598,000	614,000
Zero-Emissions Rail	9,000	354,000	363,000

MODELED ACTIONS	Total GHG Emissions Reductions (MTCO2e)		Cumulative Emissions (MTCO2e)
	2019-2030	2030-2050	2019-2050
Rooftop solar PV systems and energy storage ⁶⁶	235,000	231,000 ⁶⁷	466,000
Ground mount Solar PV systems	57,000	37,000 ⁹⁹	94,000
Ann Arbor’s Sustainable Energy Utility	434,000	748,000	1,182,000
Reduce and replace natural gas with RNG	6,000	45,000	51,000
Green Hydrogen	1,659,000	41,978,000	43,638,000
Industrial efficiency improvements, and reduce emissions from cement, lime, and steel manufacturing	2,507,000	90,326,000	92,833,000
Reduce waste	657,000	7,092,000	7,749,000
Zero-emissions fuels for water and wastewater facilities	16,418,000	134,428,000	150,845,000
Tree planting and wetland protection	570	10,000	10,570

66 Although these are two separate actions in this Plan, their impact was modeled as a single action.

67 The 2030 to 2050 period is lower because this calculation is relative to the BAP scenario, and in the BAP scenario the grid will generate zero emissions by 2040.

D.1.1 Hazardous Air Pollutant and Criteria Air Pollutants

Hazardous air pollutants (HAPs) are toxic air pollutants that are known to or suspected to cause serious health effects, including cancer, reproductive effects or birth defects, or adverse environmental impacts. Examples of HAPs are benzene, perchloroethylene and methylene chloride.

Criteria air pollutants (CAPs) are commonly found air pollutants regulated by the EPA and reported as part of air-quality standards. These pollutants are ozone, particulate matter, carbon monoxide, lead, sulfur dioxide, and nitrogen dioxide.

Reducing HAPs and CAPs is critical to improving air quality, as well as protecting the health of people and the environment.

In this analysis, four specific CAPs have been tracked over time. These are volatile organic compounds (VOCs), fine particulate matter smaller than 2.5 micrometers (PM_{2.5}), nitrogen oxides (NO_x) and carbon monoxide (CO). The cumulative reduction of these pollutants is shown for each of the actions in the RE Scenario in Table D.2 next.

Table D.2 Hazardous Air Pollutant Reductions in the RE Scenario

Modeled Actions	Total VOC Emissions Reductions (MTons)		Total PM2.5 Emissions Reductions (MTons)		Total Nox Emissions Reductions (MTons)		Total CO Emissions Reductions (MTons)	
	2019-2030	2031-2050	2019 - 2030	2031 - 2050	2019 - 2030	2031 - 2050	2019 - 2030	2031 - 2050
Retrofit all homes	78	4,877	61	3,428	624	31,607	568	34,155
Retrofit all non-residential buildings	37	847	20	112	834	15,690	539	12,787
Use electric heat exchange systems for space and water heating in existing buildings	109	5,240	61	3,106	933	43,604	856	41,550
New homes are smaller	13	191	12	188	26	266	89	1,308
New non-residential buildings are net-zero emissions	44	124	28	24	1,032	2,369	638	1,865
New homes are net-zero emissions	90	777	71	610	805	4,174	661	5,431
Use electric heat exchange systems for space and water heating in new buildings	41	1,270	27	811	324	9,737	352	10,932
Increase active transportation	743	3,398	26	153	790	3,601	11,933	54,737
Increase transit and train ridership	865	11,715	-54 ⁶⁸	-338	-1,136 ⁶⁹	6,908	12,755	185,166
Replace all buses with electric buses	36	337	8	80	285	2,675	504	4,706
Replace all personal and commercial light and medium-duty vehicles with EVs	7,782	81,451	79	1,621	6,848	84,785	125,485	1,312,259

68 In the context of vehicle transportation, PM2.5 is produced primarily from tire wear. As a result, increased use of transit results in an increase in PM2.5. This is offset somewhat by increased active transportation trips.

69 Transit and train ridership increases before all of the buses and train engines are converted off of diesel. This causes a temporary increase in NOx emissions until they are converted to either electric or hydrogen fuel cell models operating with green hydrogen.

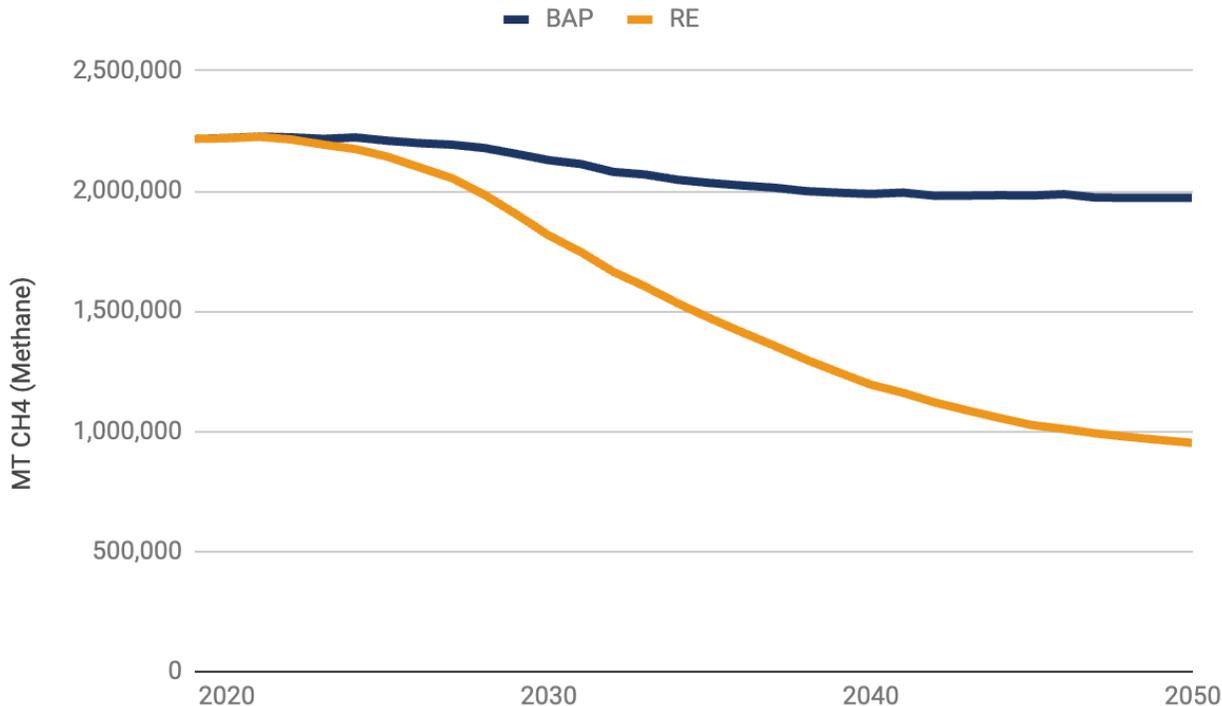
Modeled Actions	Total VOC Emissions Reductions (MTons)		Total PM2.5 Emissions Reductions (MTons)		Total Nox Emissions Reductions (MTons)		Total CO Emissions Reductions (MTons)	
	2019-2030	2031-2050	2019 - 2030	2031 - 2050	2019 - 2030	2031 - 2050	2019 - 2030	2031 - 2050
Replace all heavy-duty vehicles with zero-emissions models	254	4,569	78	1,383	3,387	57,274	1,843	34,785
Replace all offroad vehicles with electric models	5,789	207,463	307	11,402	2,726	104,557	47,346	1,697,406
Replace freight ships with zero-emissions ships.	11	406	5	191	306	10,941	35	1,257
Zero-emissions rail	6	214	4	131	136	4,877	25	890
Rooftop solar PV systems and energy storage ⁷⁰	3	3	7	7	113	111	34	34
Ground mount solar PV	1	0	2	1	28	18	8	5
Ann Arbor's Sustainable Energy Utility	5	9	12	22	209	360	5	109
Reduce and replace natural gas use with RNG	0	3	0	0	7	54	6	46
Green Hydrogen	47	1,919	23	964	1,204	49,680	260	6,545
Industrial efficiency improvements, and reduce cement, lime, and steel manufacturing emissions	4	134	2	93	37	1,946	17	809
Reduce waste	1,184	3,534	324	967	1,213	3,620	3,812	11,378
Anaerobic digesters for wastewater treatment	12	10	0	0	62	49	0	0
Zero-emissions fuels for water and wastewater facilities	483	3,405	38	266	8,407	59,289	4,657	32,847
Tree planting and wetland protection	Not calculated	Not calculated	2	7	4	15	0	2

70 Although these are two separate actions they were modeled together as a single action.

71 The amounts of pollutants absorbed by trees were calculated using the online MyTree tool. <https://mytree.itreetools.org/#/>

The Reduced Emissions Scenario also reduces methane (a powerful greenhouse gas) emissions in Southeast Michigan. In the RE Scenario, by 2035, methane emissions are projected to fall 34% relative to 2019 levels. And by 2050, they will be 57% lower than they were in 2019. Figure D.1 shows these reductions in methane emissions relative to the BAP Scenario.

Figure D.1 Projected methane (CH₄) emissions in the RE and BAP Scenarios, 2019–2050.

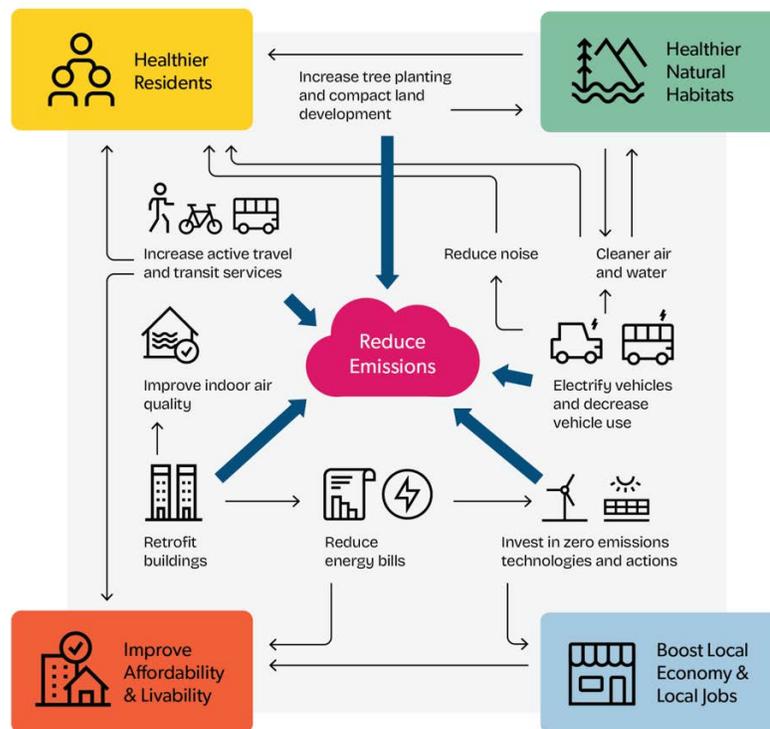


D.2 CO-BENEFITS AND CO-HARMS

Actions that reduce GHG emissions can also improve public health, create jobs, reduce energy costs, improve resilience to extreme weather, and improve affordability for all members of the community. This section describes the broad societal impacts of these measures for all people of Southeast Michigan, as well as low-income and disadvantaged communities in particular.

A co-benefit is a positive impact of a GHG reduction measure in addition to its impact on reducing GHG emissions.⁷² In many cases, actions that create vibrant cities and towns, improve public health outcomes, reduce municipal and state operating and capital costs, and support innovation are the same as or similar to the actions that reduce GHG emissions in SEMCOG – these are no-regrets policies.⁷³ For example, one review of more than a dozen studies on GHG mitigation policies found that the co-benefits of reduced air pollution – a single co-benefit – often equaled or exceeded the benefit of the GHG reduction itself.⁷⁴

Figure D.2 The Co-Benefits of Reducing Emissions



72 The IPCC defines co-benefits as “the positive effects that a policy or measure aimed at one objective might have on other objectives, irrespective of the net effect on overall social welfare” in its Fifth Assessment Report (2014). The term co-benefits and its corollary, co-harms, have a variety of synonyms, including “ancillary effects” and “ancillary benefits and costs.”

73 Lamia Kamal-Chaoui and Alexis Robert, “Competitive Cities and Climate Change,” 2009, http://www.oecd-ilibrary.org/governance/competitive-cities-and-climate-change_218830433146.

74 OECD, *Ancillary Benefits and Costs of Greenhouse Gas Mitigation* (OECD Publishing, 2000).

While many GHG reduction measures have positive effects, they can also have co-harms – unintended negative impacts – and create negative feedback cycles. For example:

- Compact urban development reduces emissions, but without careful design, people, including children and the elderly, may be exposed to elevated levels of air pollutants and traffic safety concerns as they walk or cycle near traffic
- Energy-efficiency retrofits in low-income neighborhoods can lead to rising rents and property values, causing gentrification
- Increased costs in urban centers may result in increased lower-cost housing at the edge of cities or outside of their boundaries, leading to an increase in transportation emissions and congestion

The positive – or negative – effects may be unintentional and have specific/local contexts, but governments can intentionally implement GHG reduction actions in ways that increase positive co-benefits and mitigate or avoid negative ones. Careful policy design that considers and prioritizes GHG emissions alongside health and equity impacts can be transformational.

D.2.1 Co-Benefits

Actions in this Plan have a wide variety of co-benefits and co-harms, as summarized in Table D.3 below. In it, ✓ denotes direct benefits; Ω denotes indirect benefits; X denotes co-harms.

Table D.3 Overview of GHG reduction measures in the RE Scenario and their associated co-benefits and co-harms.

Actions	Healthy Residents	Economic Prosperity	Environmental Resilience
Create high-performance building standards for new buildings	✓	✓	Ω
Retrofit existing buildings	✓	✓	✓
Expand transit and active infrastructure	✓	✓	✓
Industrial sector processes improvements	✓		
Agricultural sector improvements			
Waste management improvements			

Actions	Healthy Residents	Economic Prosperity	Environmental Resilience
Switch new and existing buildings to heat pumps, heat pump water heaters and electrified equipment and appliances	✓		
Electrify personal-use vehicles	✓		
Switch commercial vehicles to low-emissions fuel	✓	✓	✓
Switch mid-to-heavy-duty vehicles to zero-emissions fuel	✓		
Zero-emissions marine, air, and rail transportation	✓		
Grid updates	✓		✓
Rooftop solar	✓	✓	✓
Renewable energy installations	✓	✓	✓

D.2.2. Evaluating Co-Benefits and Co-Harms

Not all co-benefits or co-harms are equal. It is helpful to identify and prioritize criteria for evaluating co-benefits. These criteria include:⁷⁵

- **Synergies:** Many emissions-reduction actions have multiple socio-economic benefits, including improving transit, energy efficiency, and compact urban design.
- **Urgency:** Some emissions-reduction actions – such as conserving wetlands to sequester emissions and promoting compact communities that require less car use – require time to realize their effects. The longer process means these actions must be implemented with more urgency to sustain inertia and benefits from actions already taken⁷⁶ and avoid irreversible outcomes or deferred costs that increase as a result of deferment.
- **Costs:** Earlier action is generally cheaper than later, as delayed action involves ongoing investments in infrastructure, activities, and utilities that are higher emitting than low-

⁷⁵ Adapted from (Fay et al., 2015).

⁷⁶ Lock-in effects describe situations in which implementation of a strategy or action improves performance of an object or activity in the short term but is prohibitive to future emissions reductions. Lock-in effects may refer to building upgrades or land-use decisions that “lock in” a set level of emissions in the long term. For example, building retrofits that provide limited energy efficiency improvements can create a situation in which no additional improvements in the equipment installed can be expected over the course of its lifetime without considerable additional expense. In this way, lower levels of energy reductions can be locked in for a long period.

emissions solutions. Examples include investments in renewable energy infrastructure, transit, and energy efficiency.

- Longevity: Related to urgency, the long-term investment decisions predetermine the effects on future generations for decades, if not centuries.
- Distribution effects: Actions designed to reduce emissions have different impacts on different subsets of the population, including different income groups, generations (including future generations), regions or neighborhoods, and marginalized populations.

Based on these considerations, decision-makers should prioritize actions that have multiple co-benefits – such as synergies with other priorities, the ability to propel forward momentum, avoiding or reducing future costs, and positive impacts on low-income and disadvantaged communities.

D.2.3. Analytical Methods

Co-benefits and co-harms were quantified or assessed qualitatively for the region as a whole for the RE Scenario. Co-benefits and co-harms affecting low-income and disadvantaged communities are shown when available throughout the assessment.

Table D.4 Overview of co-benefits and co-harms categories, specific impacts and indicators and the analytical method used.

Category	Impact Overview	Indicators	Analytical Method
Health			
Outdoor air quality	Improvement in outdoor air quality	<ul style="list-style-type: none"> • Avoided mortality and incidence of disease. • Dollar value of total health benefits 	<ul style="list-style-type: none"> • Calculated using air pollutants from modeling input to EPA’s Co-Benefits Risk Assessment (COBRA) tool
Physical and emotional well-being	Increased physical activity, increased mental well-being	<ul style="list-style-type: none"> • Walking miles traveled; cycling miles traveled • Number of vehicles per household 	<ul style="list-style-type: none"> • Relationship between vehicle miles traveled and indicators of physical and mental health
Economic Prosperity			
Employment	New employment opportunities are created. Existing employment opportunities are lost.	<ul style="list-style-type: none"> • Jobs created/lost by sector 	<ul style="list-style-type: none"> • Employment multipliers for every dollar spent on decarbonization

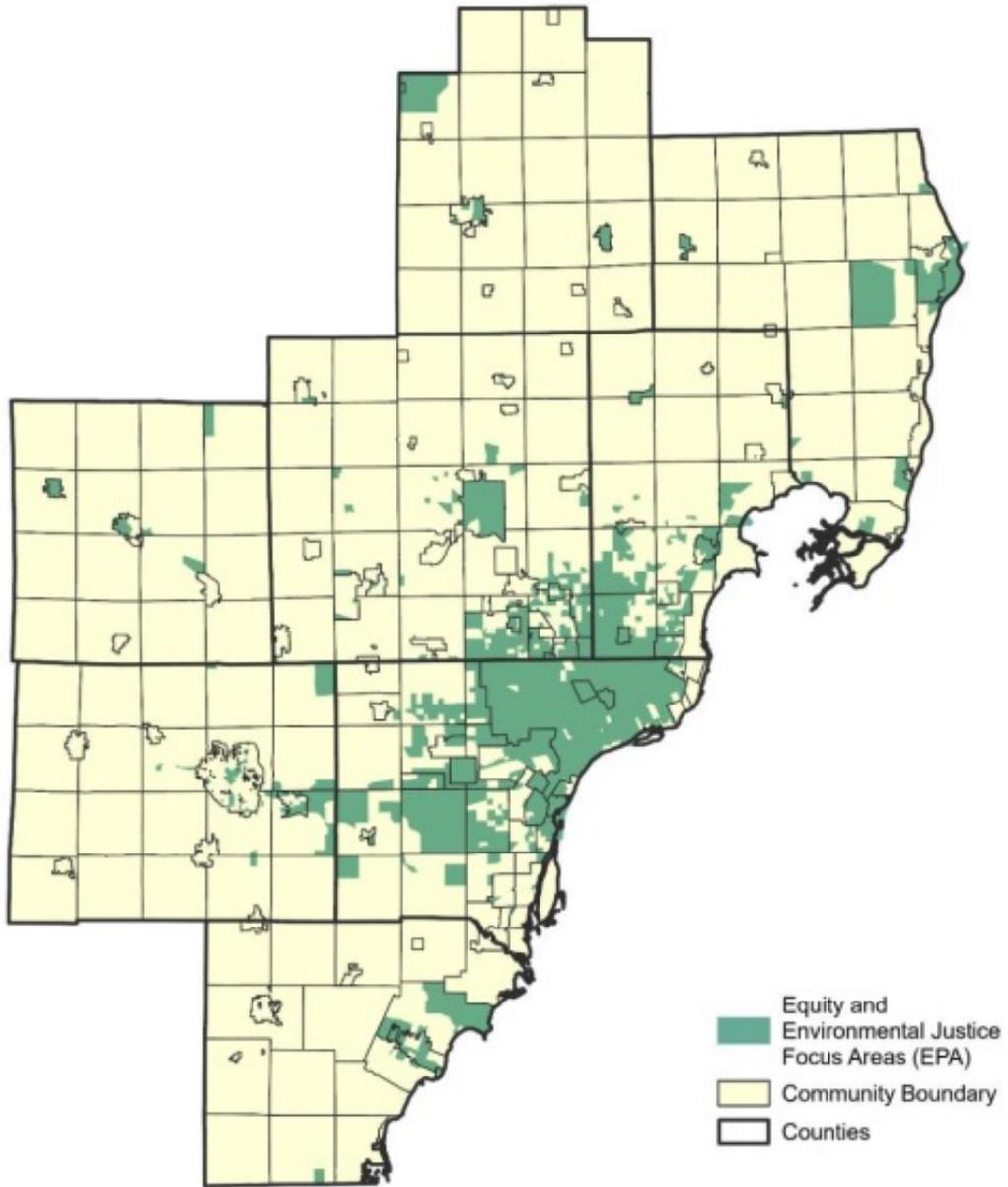
Category	Impact Overview	Indicators	Analytical Method
Health			
Poverty	Energy efficiency will reduce household building and transportation costs	<ul style="list-style-type: none"> Household energy and travel expenditures 	<ul style="list-style-type: none"> Calculated in the ScenaCommunity model (change in expenditures on transportation and housing)⁷⁷
Climate Adaptation and Resilience			
Passive survivability	Populations are able to withstand extreme weather events and power outages	<ul style="list-style-type: none"> Number of buildings with deep retrofits Number of batteries installed alongside renewable energy systems. Electricity provided within micro-grids or district energy systems 	<ul style="list-style-type: none"> Calculated in the ScenaCommunity model
Reduction of urban heat island effect	Planting trees for shade and expanding green infrastructure reduces local temperatures	<ul style="list-style-type: none"> Number of trees planted, or acres of landscape restored 	<ul style="list-style-type: none"> Calculated in the ScenaCommunity model and correlated with reductions in local temperature

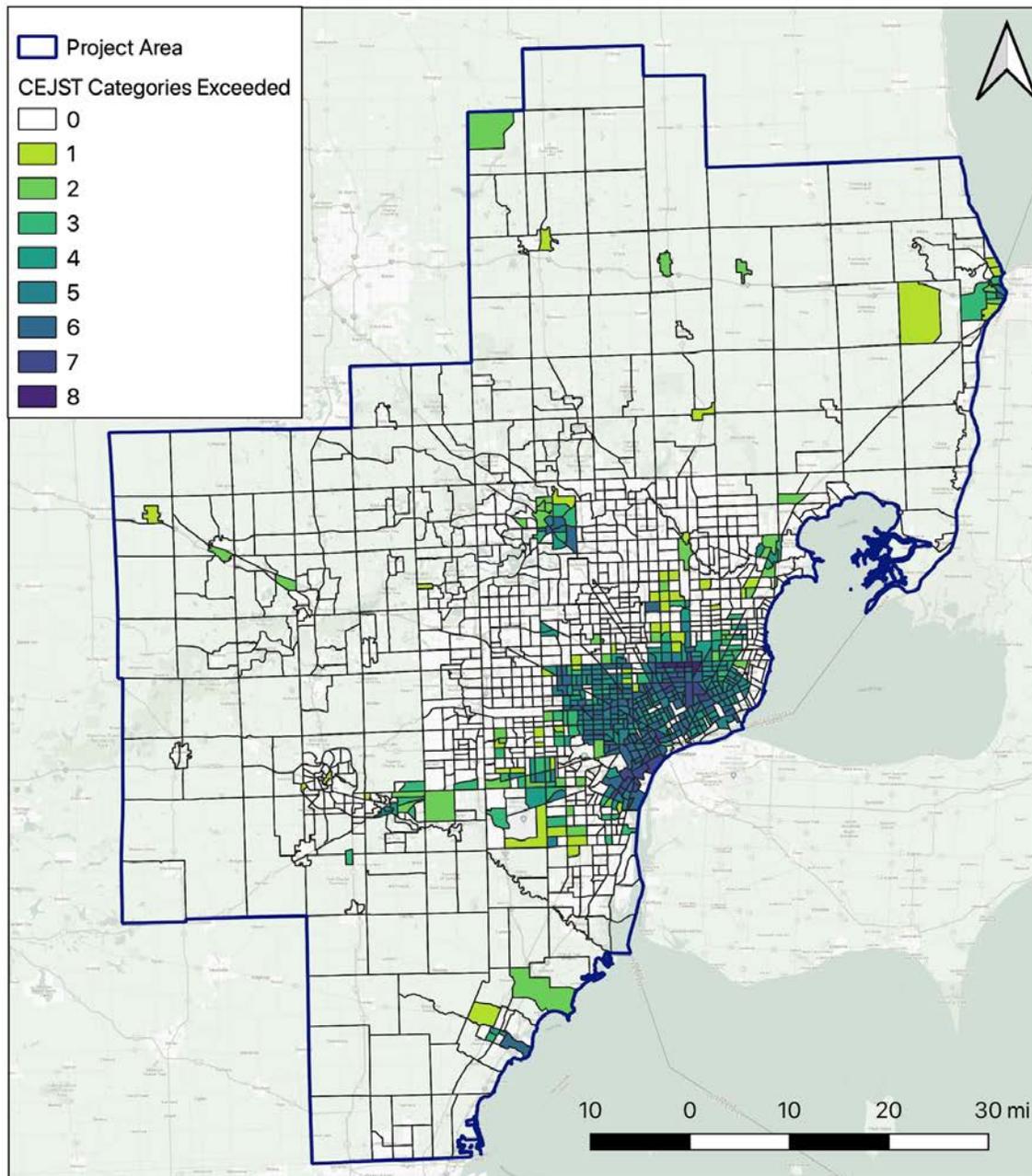
D.2.4 Identifying Low-Income and Disadvantaged Communities

Low-income and disadvantaged communities (LIDACs) were identified for this analysis by reviewing information about census tracts within SEMCOG using the EPA’s Environmental Justice Screening and Mapping Tool (EJScreen) and the Climate and Economic Justice Screening Tool (CEJST).

⁷⁷ See Appendix A: Data, Methods, and Assumptions (DMA) for the detailed assumptions made, and more information about SSG’s ScenaCommunity model.

Figure D.3 CEJST Census Tracts in Southeast Michigan





D.3 CO-BENEFITS AND CO-HARMS: HEALTH

D.3.1 Outdoor Air Quality

One of the most beneficial and immediate health co-benefits of reducing GHG emissions is improved air quality. Cleaner air reduces the risk of adverse health effects, such as aggravated asthma, decreased lung function, heart attacks, an increase in neurological disorders and premature death.^{78 79}

78 Buonocore, J. J., Reka, S., Y., D., Chang, C., Roy, A., Thompson, T., ... & Arunachalam, S. (2023). Air pollution and health impacts of oil & gas production in the United States. *Environmental Research: Health*, 1(2), 021006.

79 National Institute of Environmental Health Sciences, Air Pollution and Your Health, accessed June 20, 2025, <https://www.niehs.nih.gov/health/topics/agents/air-pollution>

Climate change trends increase the likelihood of conditions that exacerbate poor air quality.⁸⁰ Burning fossil fuels such as gasoline, diesel and natural gas releases air pollutants and greenhouse gases. These pollutants, including particulate matter (PM_{2.5}), carbon monoxide (CO), hydrocarbons (HC), sulfur dioxide (SO₂), nitrogen oxides (NO_x), mercury (Hg), and volatile organic compounds (VOCs), have adverse impacts on human health.

One of the key indicators of air pollution is the level of PM_{2.5}, which is fine particulate matter of 2.5 micrometers or less. Fine particulate matter can enter the blood system by penetrating the lung barrier and causes many health issues people from prenatal development all the way through to old age.⁸¹ Air pollution damages the lungs, heart, brain, skin and other organs, contributing to disease, disability, and death. Air pollution from fossil fuels has been linked to the development of neurological disorders including Parkinson's disease, Alzheimer's disease and other dementias, acute bronchitis in children, asthma and other respiratory illnesses, heart disease, stroke, and cancer.

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D.3.1.1 Outdoor Air Quality in Southeast Michigan

According to World Health Organization, annual average concentrations of PM 2.5 should not exceed 5 micrograms per cubic meter to avoid negative health outcomes.⁸² In 2020, Southeast Michigan exceeded this target, with an overall average of 8.1 micrograms per cubic meter of PM_{2.5}.

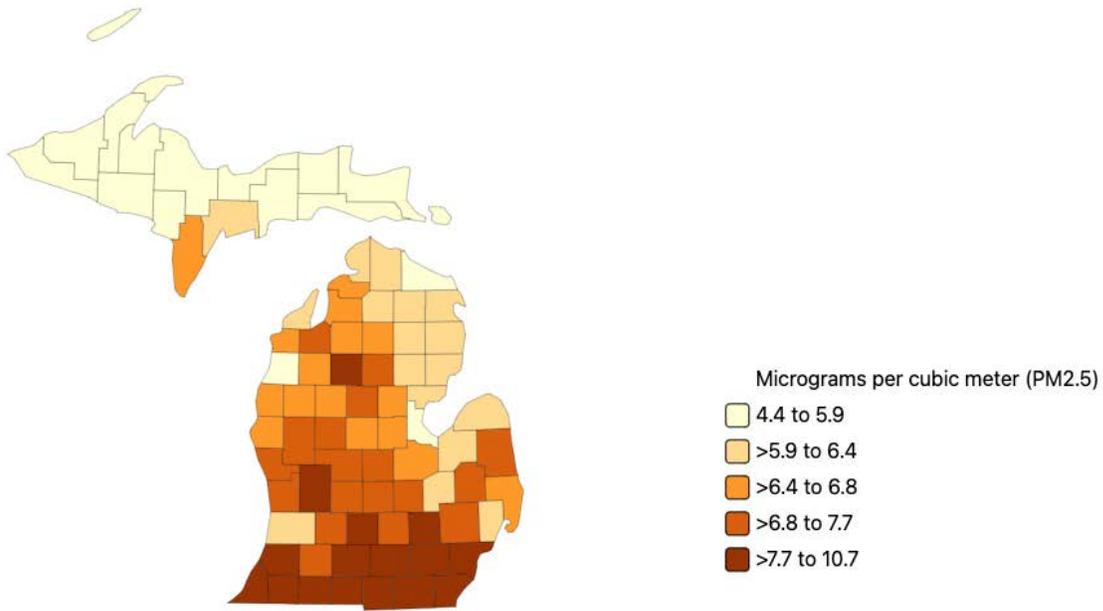
All of the State's individual counties also exceeded this limit, as shown in Figure D.5. Wayne County had the highest concentration, with 10.7 micrograms per cubic meter of PM_{2.5} - more than double the recommended maximum for avoiding negative health outcomes.

80 U.S. Environmental Protection Agency. Climate Change Impacts on Air Quality. Last modified June 6, 2023. <https://www.epa.gov/climateimpacts/climate-change-impacts-air-quality>

81 Shilpa S. Shetty, Deepthi D, Harshitha S, Shipra Sonkusare, Prashanth B. Naik, Suchetha Kumari N, and Harishkumar Madhyastha, "Environmental Pollutants and Their Effects on Human Health," Heliyon 9, no. 9 (August 25, 2023): e19496, <https://doi.org/10.1016/j.heliyon.2023.e19496>

82 World Health Organization, "WHO air quality guidelines," C40 Knowledge Hub, Sept. 2021, https://www.c40knowledgehub.org/s/article/WHO-Air-Quality-Guidelines?language=en_US.

Figure D.5 Average Annual Concentrations of PM2.5 in Michigan Counties, 2025



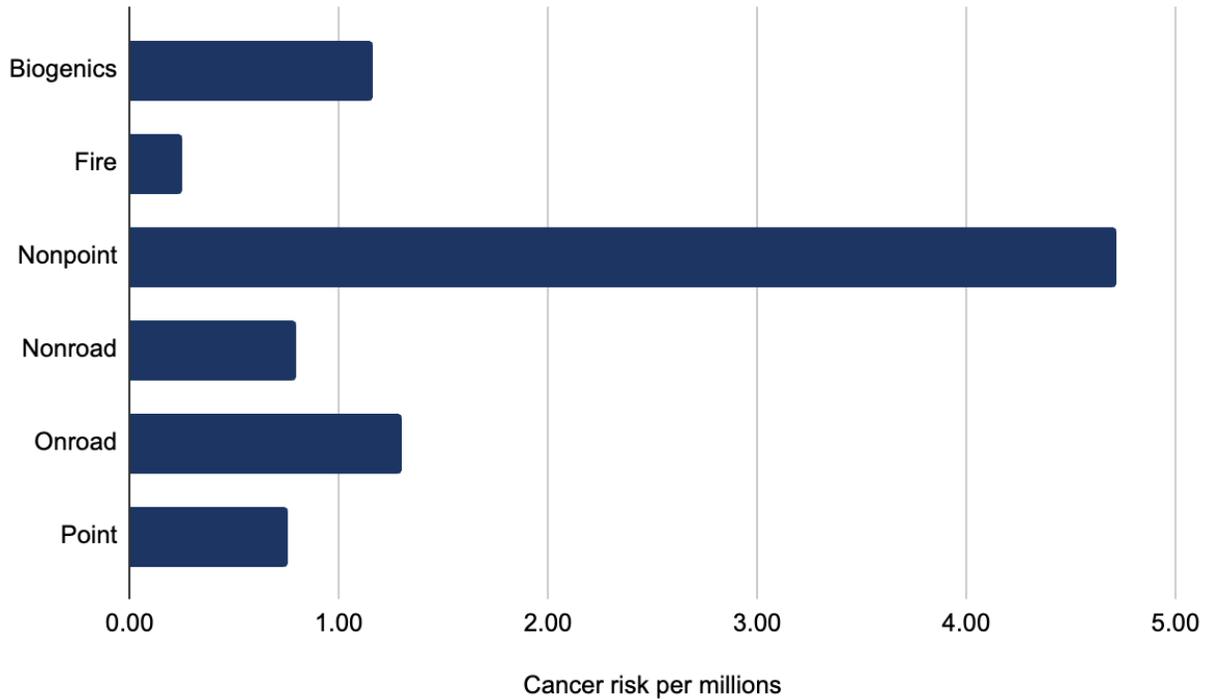
Air pollution does not impact everyone equally. As of 2024, an average of 11.3% of the adult population of Southeast Michigan (ranging from 10.3% in Oakland to 12.5% in Wayne County) reported having asthma, making them more sensitive to poor air quality. Outdoor workers and farmworker communities are particularly at risk of exposure to air pollutants from transportation and industrial activities, in addition to wildfire smoke and ozone. Air pollution also increases cancer risk.

Air pollution also increases the risk for certain cancers. The EPA's 2020 Air Toxics Screening Assessment assessed which air toxics may pose health risks across the country. Figure D.6 highlights the projected cancer risk per million by air pollution source for Michigan. The top sources of air pollution that may cause cancer risk in the region are nonpoint sources, biogenic sources, and on-road sources.

83 PLACES Local Data for Better Health, County Data 2024 release. https://data.cdc.gov/500-Cities-Places/PLACES-Local-Data-for-Better-Health-County-Data-20/swc5-untb/about_data

84 Cancer sources that were not emissions groups, including background and secondary sources, are not included in this figure. Source: <https://www.epa.gov/AirToxScreen/2020-airtoxscreen-assessment-results>

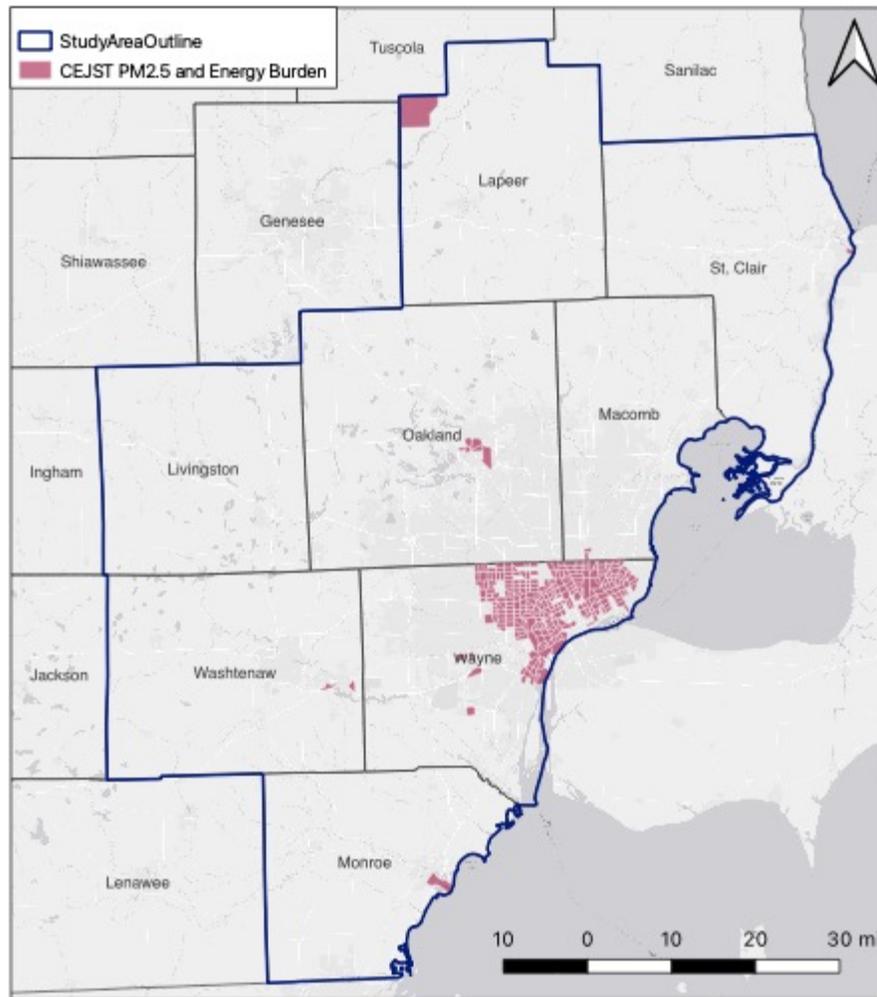
Figure D.6 Cancer risk (per million) in Southeast Michigan by air pollution source group



Vulnerable people in Southeast Michigan simultaneously experience high rates of energy poverty and exposure to particulate matter pollution (PM2.5) from traffic and industry, as well as other sources, as shown in Figure D.7.⁸⁵

⁸⁵ Climate and Economic Justice Screening Tool. <https://screeningtool.geoplatform.gov/en/#7.91/42.353/-83.616>. Accessed January 9, 2024.

Figure D.7 Energy Burden and PM2.5 Emissions



D.3.2 Physical and Emotional Well-Being

Regular physical activity improves overall health and fitness, reduces the risk of premature mortality and many chronic diseases, and contributes to happiness and reduced anxiety.

People living in cities and neighborhoods with more compact urban forms and robust public transportation are less likely to experience hypertension.⁸⁶ When people switch from driving to using public transit, their physical activity is likely to increase by eight to 33 minutes per day.⁸⁷ Studies have shown that children who walk or bike to school are more fit than those who travel by car or bus.⁸⁸

86 Ewing, R., L. Frank, and R. Freutzer. (2006). Understanding the Relationship Between Public Health and the Built Environment. A Report Prepared for the LEED-ND Core Committee.

87 Rissel, C., Curac, N., Greenaway, M., & Bauman, A. (2012). Physical Activity Associated with Public Transport Use—A Review and Modelling of Potential Benefits. *International Journal of Environmental Research and Public Health*, 9(7), 2454–2478.

88 Voss C, Sandercock G. (2010). Aerobic fitness and mode of travel to school in English schoolchildren. *Med Sci Sports Exerc.* 2010 Feb;42(2):281-7.

89 Andersen LB, Schnohr P, Schroll M, Hein HO. All-cause mortality associated with physical activity during leisure time, work, sports, and cycling to work. *Arch Intern Med* 2000;160:1621-8.

Getting around on foot or by bike can also reduce the risk of premature death. Studies have shown that the relative risk of premature mortality was 30–40% less among those who used active transportation compared to those who did not or did not get similar amounts of leisure time exercise.^{89,90} Similarly, studies have found that cycling to work would also reduce all-cause mortality rates by 40%.⁹¹

Increasing access to green spaces and parks also increases community levels of physical activity. Residents in neighborhoods with ample green space are three times more likely to be physically active and 40% less likely to be overweight than those in neighborhoods with limited green space.⁹² Seniors living in neighborhoods with walkable green spaces nearby may live longer on average.⁹³

The COVID-19 pandemic temporarily shifted transportation mode patterns. Many people no longer had to commute long distances by car and could spend more time walking or biking closer to home. These shifts, even if temporary, revealed that latent demand for active transportation modes may be higher than previously assumed.

If such latent demand is met, residents may experience relief or even joy. People who walk and bike to work are happier with their commutes; those who travel by car or transit in heavily congested areas are less happy with their commutes.⁹⁴ When done intentionally and for reasons unrelated to affordability, giving up a car has a positive effect on feelings of life satisfaction and joy, two positive indicators of subjective well-being, for up to three years after the event.⁹⁵

D.3.2.1 Potential Co-Harms

Active travel, through cycling and walking, is beneficial for health due to increased physical activity but may also expose people to higher levels of air pollution. However, a recent study has shown that the benefits of physical activity far outweigh risks from air pollution, even under the most extreme levels of active travel.⁹⁶ Additionally, planting a tall vegetation barrier along busy roads can significantly mitigate increased exposure to air pollution, as plants can capture air pollution particulates on their leaves.^{97,98}

90 Matthews CE, Jurj AL, Shu XO, Li HL, Yang G, Li Q, et al. Influence of exercise, walking, cycling, and overall nonexercise physical activity on mortality in Chinese women. *Am J Epidemiol* 2007;165:1343–50.

91 Andersen LB, Schnohr P, Schroll M, Hein HO. All-Cause Mortality Associated With Physical Activity During Leisure Time, Work, Sports, and Cycling to Work. *Arch Intern Med*. 2000;160(11):1621–1628.

92 [CABE] Commission for Architecture and the Built Environment (n.d.). *Future Health: Sustainable places for health and well-being*. London, U.K.: CABE

93 Bray, R., C. Vakil, and D. Elliot. (2005). *Report on Public Health and Urban Sprawl in Ontario: A review of the pertinent literature*. Ontario College of Family Physicians

94 Oliver Smith, “Commute Well-Being Differences by Mode: Evidence from Portland, Oregon, USA,” *Journal of Transport & Health* 4 (March 1, 2017): 246–54, <https://doi.org/10.1016/j.jth.2016.08.005>.

95 Ann-Kathrin Hess, “The Relationship between Car Shedding and Subjective Well-Being,” *Transportation Research Interdisciplinary Perspectives* 15 (September 1, 2022): 100663, <https://doi.org/10.1016/j.trip.2022.100663>.

96 Tainio, Marko, Audrey J. de Nazelle, Thomas Götschi, Sonja Kahlmeier, David Rojas-Rueda, Mark J. Nieuwenhuijsen, Thiago Hérick de Sá, Paul Kelly, and James Woodcock. “Can Air Pollution Negate the Health Benefits of Cycling and Walking?” *Preventive Medicine* 87 (June 2016): 233–36. doi:10.1016/j.ypmed.2016.02.002.

97 “Plants By School Playgrounds Protect Kids From Road Pollution, Study Finds,” accessed October 3, 2022, <https://nextcity.org/urbanist-news/plants-by-school-playgrounds-protect-kids-from-road-pollution-study-finds>.

98 ORD US EPA, “Living Close to Roadways: Health Concerns and Mitigation Strategies,” *Overviews and Factsheets*, January 10, 2017, <https://www.epa.gov/sciencematters/living-close-roadways-health-concerns-and-mitigation-strategies>.

Furthermore, the more people who walk and cycle, the more drivers become accustomed to looking out for them. Researchers have found that doubling the number of people who walk in a given area would reduce the risk of injury to each individual walker by approximately one-third.

D.3.2.2 RE Scenario Actions That Increase Physical and Emotional Well-Being

Table D.5 Overview of GHG reduction measures in the RE Scenario that will increase physical and emotional well-being in addition to reducing GHG emissions

Sectors	Actions
Modernizing Mobility	<ul style="list-style-type: none"> • The portion of all trips, region-wide that are taken using active modes of transportation will increase to the following: <ul style="list-style-type: none"> • 1.5% by 2030; • 2% by 2032; • 3% by 2034; • 4% by 2036; and, • 5% by 2040.¹⁰⁰ • Transit and train service will be improved such that the portion of all trips, region-wide that are taken on transit or (passenger) trains increase to: <ul style="list-style-type: none"> • 2% by 2028; • 4% by 2030; • 6% by 2033; • 8% by 2036; and, • 10% by 2040.¹⁰¹

99 Jacobsen, P. L. (2003). Safety in numbers: more walkers and bicyclists, safer walking, and bicycling. *Injury Prevention*, 9(3), 205–209.

100 The trips that are shifted to active modes will be 0–5 miles in distance, and concentrated in LIDAC communities and denser areas, along routes that will support both commuting and recreation.

101 These trips will average 1–15 miles in distance, and be concentrated in LIDAC communities that lack access to affordable transportation, transit-oriented developments, and denser areas. In these areas, ridership may reach 15% of all trips.

D.3.3 RE Building Occupant Comfort

Collectively, the conditions we experience inside buildings are known as “occupant comfort.” As we typically spend 90% of our time indoors,¹⁰² indoor health conditions are an important consideration.

The phenomenon of “sick building syndrome,” prevalent in the 1980s and 1990s and continuing today, as well as the COVID-19 pandemic, helped to identify indoor air quality as a major health-influencing factor. Improvements in ventilation systems and less toxic building materials (e.g., insulation, wall paneling) improve indoor air quality, often while reducing energy use. Improving energy efficiency can also affect health directly by influencing indoor temperatures, energy use and cost (with indirect effects on financial choices for low-income families) and the emission of toxic pollutants to the local environment.¹⁰³ Buildings with more stable and comfortable indoor environments have been found to reduce the risk of deaths from cold and hot spells and indirectly reduce absenteeism from school in children.¹⁰⁴

Benefits of improved energy efficiency and tighter building envelopes include reduced mold, which has been found to directly reduce depression, arthritis and rheumatism, injuries and death, as well as reduced allergies and symptoms of respiratory disease.¹⁰⁵ Energy-efficient buildings with opportunities for occupant control, such as windows that open and adjustable blinds, provide an increased sense of control, which reduces stress and depression.¹⁰⁶ Improving occupant comfort and energy efficiency also reduce the likelihood of residents turning to more dangerous sources of heat, such as gas ovens and stoves.

D.3.3.1 Potential Co-Harms

Meeting global greenhouse gas mitigation goals by 2030 could result in the health benefits described above if mechanical ventilation heat recovery systems with particle filtering are installed in retrofitted and new buildings. If such systems are not installed, operated, and maintained correctly, buildings could wind up with poor indoor air quality.¹⁰⁷ There may also be tradeoffs between preserving historic and heritage buildings and increasing occupant comfort. Reducing the severity of these tradeoffs means documenting current and historic energy use and creating detailed energy models for such buildings.¹⁰⁸

102 U.S. Environmental Protection Agency (EPA). 1989. Report to Congress on Indoor Air Quality – Vol. II: Assessment and Control of Indoor Air Pollution. EPA/400/1-89/001C. Washington, D.C.: US EPA. Available at tinyurl.com/CCN-2013-R017E

103 Milner, J., Davies, M., & Wilkinson, P. (2012). Urban energy, carbon management (low carbon cities), and co-benefits for human health. *Current Opinion in Environmental Sustainability*, 4(4), 398–404.

104 International Energy Agency, “Capturing the Multiple Benefits of Energy Efficiency” (Paris, France, 2014), http://www.iea.org/publications/freepublications/publication/Captur_the_MultiplBenef_ofEnergyEfficiency.pdf.

105 International Energy Agency.

106 Uteuova, “It’s a Sanctuary.”

107 Wilkinson P, Smith KR, Davies M, Adair H, Armstrong B, Barrett M, Bruce N, Haines A, Hamilton I, Oreszczyn T et al.: Public health benefits of strategies to reduce greenhouse-gas emissions: household energy. *Lancet* 2009, 374:1917-1929.

108 Larissa Ide et al., “Balancing Trade-Offs between Deep Energy Retrofits and Heritage Conservation: A Methodology and Case Study,” *International Journal of Architectural Heritage* 16, no. 1 (January 2, 2022): 97–116, <https://doi.org/10.1080/15583058.2020.1753261>.

D.3.3.2 RE Scenario Actions That Increase Occupant Comfort

Table D.6 Overview of GHG reduction measures in the RE Scenario that will increase occupant comfort in addition to reducing GHG emissions.

Sectors	Actions
Healthy, Efficient Buildings	<ul style="list-style-type: none"> • All homes¹⁰⁹ will be retrofitted to reduce their average energy consumption by 50%. All retrofits will be complete by 2045. • Immediately after retrofitting buildings, all fossil-fueled space heating/cooling, and water heating systems will be removed and replaced with either ground or air source heat exchange¹¹⁰ systems. All fossil fuel appliances will be replaced with electric appliances at the same time. • Across the region, the average size of new single-family homes will be reduced from 1,800 to 1,600 square feet by 2028. • A requirement to build all new residential buildings to a net-zero standard by 2030 in Ann Arbor, and by 2035 across the rest of the region. • From 2030 on, all new buildings in the region will be required to be heated and cooled and have hot water heaters that use heat exchange systems, as well as only electric appliances.

109 This project did not include a detailed analysis of how much of the housing stock should be demolished rather than retrofitted. However in general, as much as possible buildings and building materials should be re-used to preserve embodied carbon and avoid harvesting additional raw materials.

110 For the purposes of this document, all references to heat exchange systems or heat pumps refers to cold climate heat exchange systems with backup zero-emissions heating.

D.4 CO-BENEFITS AND CO-HARMS: ECONOMIC PROSPERITY

Actions that reduce emissions can play a major role in revitalizing local economies across Southeast Michigan. GHG reduction actions, such as those that promote energy efficiency and renewable energy, create jobs and often lower energy costs. Additionally, in the long run, having a low-emission, low-cost energy supply and supportive policies for reducing GHG emissions can position Southeast Michigan to attract new businesses, especially those in emerging green sectors.

D.4.1 Employment

In general, the transition to a low-emissions economy is expected to have four categories of impacts on labor markets:

- Additional jobs will be created in emerging sectors, such as electric vehicles and energy efficiency controls
- Some employment will be shifted, for example, from fossil fuel production and distribution to renewables
- Certain jobs will no longer be relevant or necessary, such as vehicle mechanics who specialize in gasoline motors
- Many existing jobs will be transformed and redefined, with some employment opportunities emerging that are not yet possible to anticipate¹¹¹

The transition from a fossil-fuel-based energy system to a system based on renewable energy will require massive investments in infrastructure — from vehicles to district energy, from manufacturing to energy efficiency. This mobilization of public and private finances of up to \$3.2 billion per city in one estimate¹¹² — will create many new jobs. For example, the IEA estimates that 8 to 27 jobs are created for each 1 million euros invested in energy efficiency.¹¹³ Reducing GHG emissions from the electricity grid through regulation can also result in job creation. In the U.S., the Natural Resources Defense Council projected that stricter emissions standards for electricity generation could net 210,000 national jobs over a seven-year time period.¹¹⁴

Analyses of recently passed state and federal legislation demonstrate the economic opportunities enabled by decarbonization. Climate and energy investments integrated into the recently passed Inflation Reduction Act could create more than 9 million person-years of employment across the U.S. over the next decade, with more than half of those jobs being created in the electricity, transportation and building sectors.¹¹⁵

111 Martinez-Fernandez, C., Hinojosa, C., & Miranda, G. (2010). Green jobs and skills: the local labor market implications of addressing climate change. Working Document, OECD. Retrieved from <http://www.oecd.org/regional/leed/44683169.pdf>

112 Gouldson, A., Colenbrander, S., McAnulla, F., Sudmant, A., Kerr, N., Sakai, P., ... Kuylenstierna, J. (2014). The economic case for low carbon cities. A New Climate Economy. Retrieved from <http://eprints.whiterose.ac.uk/82868/>

113 International Energy Agency. (2014). Capturing the multiple benefits of energy efficiency. Paris, France. Retrieved from http://www.iea.org/publications/freepublications/publication/Captur_the_MultiplBenef_ofEnergyEfficiency.pdf

114 Stanton, E., Comings, T., Takahashi, K., Knight, P., Vitolo, T., & Hausman, E. (2013). Economic impacts of the NRDC carbon standard. Retrieved from https://www.nrdc.org/sites/default/files/ene_13070101a.pdf

115 Robert Pollin, Chirag Lala, and Shouvik Chakraborty, "Job Creation Estimates through Proposed Inflation Reduction Act" (University of Massachusetts Amherst: Political Economy Research Institute (PERI), August 2022).

Investments in active travel and public transit create ample employment opportunities. Implementing policies to increase walking, biking and public transit has been found to increase GDP, total employment and employment in the transportation sector.¹¹⁶ One assessment estimated that \$1 billion dollars of spending on public transportation generated over 36,000 jobs, \$3.6 billion dollars of output, and \$1.8 billion dollars of GDP annually.¹¹⁷ Additionally, spending on transit generates 70% more job hours than spending the same amount on highway projects.¹¹⁸

D.4.2 Potential Co-Harms

Policy and implementation design are key to realizing the benefits of the new jobs created during the low-emissions transition, as well as mitigating the negative impacts of job losses. Workers in industries that will be phased out — automotive vehicle maintenance and repair, fossil fuel extraction and refinement, gasoline stations — need to be provided with the tools and resources necessary to transition into quality new jobs. These could include transition assistance (financial or otherwise), investment in workforce training and economic development assistance. For more details, see the workforce analysis section of this report.

Low-income and disadvantaged communities have long been on the front lines of jobs that expose them to toxic pollution and hazardous conditions. Special attention must be given to these workers and communities most likely to be impacted by job losses in the fossil fuel industry and related sectors. Creating well-paying, high-quality jobs should also be a focus to avoid potential economic harms. Currently, one in five utility industry workers are unionized, compared to one in 10 of all American workers.¹¹⁹ Ensuring an economically just transition includes investing in jobs that support unions and worker organizing, comply with or exceed mandatory labor standards, and maximize training and apprenticeship programs.¹²⁰ Advancing employment and training opportunities specifically for those from low-income households and historically marginalized groups, particularly in areas already experiencing job loss, is also key.

116 Doll, C.,Hartwig, J. (2012). Clean, safe, and healthy mobility through non-technical measures – Linking individual and public decision levels. Transportation Demand Management – mobil.TUM2012 International Scientific Conference on Mobility and Transport, Munich, Institute of Transportation, Technische Universitaet Muenchen

117 Reno, A.,Weisbrod, G. (2009). Economic Impact of Public Transportation Investment. Transit Cooperative Research Program. Rérat, P. (2012). “The new demographic growth of cities: The case of reurbanisation in Switzerland.” *Urban Studies* 49(5): 1107– 1125.

118 SGA (2011). Recent lessons from the stimulus: Transportation Funding and Job Creation, Smart Growth America.

119 “BlueGreen Alliance | Climate Change & the Clean Economy,” accessed October 5, 2022, <https://www.bluegreenalliance.org/work-issue/climate-change/>.

120 “Solidarity for Climate Action” (San Francisco, CA, US: BlueGreen Alliance), accessed October 5, 2022, <http://www.bluegreenalliance.org/wp-content/uploads/2019/07/Solidarity-for-Climate-Action-vFINAL.pdf>.

D.4.3 RE Scenario Actions That Increase Employment

Table D.7 Overview of GHG reduction measures in the RE Scenario that will increase employment in addition to reducing GHG emissions

Sectors	Actions
Healthy, Efficient Buildings	<ul style="list-style-type: none"> All homes¹²¹ will be retrofitted to reduce their average energy consumption by 50%. All retrofits will be complete by 2045. All non-residential buildings⁵¹ will be retrofitted to reduce their total average energy consumption by 50%. All retrofits will be completed by 2045. Immediately after retrofitting buildings, all fossil-fueled space heating/ cooling, and water heating systems will be removed and replaced with either ground or air source heat exchange¹²² systems. All fossil fuel appliances will be replaced with electric appliances at the same time. By 2050, 20,000 trees will be planted across the region, 500,000 acres of wetlands will be protected (10% of which will be restored), and the tree canopy in urban census tracts will reach 40%, with priority given to those below 20% in 2022.¹²³
Modernizing Mobility	<ul style="list-style-type: none"> The portion of all trips, region-wide that are taken using active modes of transportation will increase Transit and train service will be improved such that the portion of all trips, region-wide that are taken on transit or (passenger) trains increase By 2030, 50% of all new light and medium duty vehicles registered in Southeast Michigan will be battery electric vehicles. By 2035, this will increase to 100% of new vehicles. By 2050, all ICE light and medium duty vehicles will be retired or converted to an EV. By 2040, new heavy duty vehicle sales will be 100% ZEVs, half of which will be electric and half of which will be hydrogen-powered. By 2050, all ICE heavy duty vehicles will be retired or converted to an EV.
Sustainable Waste Management	<ul style="list-style-type: none"> Region-wide, the total amount of solid waste sent to landfills (excluding industrial waste) will be reduced by 30% by 2029, and by 45% by 2035, through a combination of waste diversion, organic redirection, recycling/ re-use, and redeveloped waste management plans. Anaerobic digesters will be constructed at wastewater treatment facilities including the Ann Arbor Water Recapture Facility and the GLWA Biosolids and renewable Energy project by 2030. At the GLWA, the design will ensure that incineration is reduced by 50% by 2030, and fully decommissioned by 2032. The biogas that is produced will replace natural gas currently being used in the industrial sector.

121 This project did not include a detailed analysis of how much of the housing stock should be demolished rather than retrofitted. However in general, as much as possible buildings and building materials should be re-used to preserve embodied carbon and avoid harvesting additional raw materials.

122 For the purposes of this document, all references to heat exchange systems or heat pumps refers to cold climate heat exchange systems with backup zero-emissions heating.

123 Work to achieve this will be coordinated with work to achieve SEMCOG’s Green Initiative. Source: <https://www.semco.org/green>.

Sectors	Actions
Expanding Renewable Energy	<ul style="list-style-type: none"> • By 2029, 205 MW of rooftop solar PV systems will be installed. <ul style="list-style-type: none"> • 50 MW will be installed in Ann Arbor; • 155 MW will be installed in LIDAC communities across the region and outside Ann Arbor. • By 2027, 33 MW of ground mount solar PV systems will be installed in Detroit. <ul style="list-style-type: none"> • By 2029, 9.1 MW of distributed energy storage will be installed across the region.¹²⁴ <ul style="list-style-type: none"> • 2.1 MW will be installed in Ann Arbor; • 7 MW will be installed in LIDAC communities across the region.¹²⁵

D.4.4 Impacts

Investments in the RE Scenario represent opportunities for existing and new businesses in Southeast Michigan. These include businesses directly implementing elements of climate action, such as contractors, HVAC suppliers, construction companies, appliance manufacturers, renewable energy developers, car dealerships¹²⁶ and bike shops, as well as businesses supporting them, such as banks and credit unions, engineering firms, architects and designers, and insurance companies.

Figure D.8 illustrates the number of person-years of employment during the implementation of the Reduced Emissions Scenario across Southeast Michigan.

The RE Scenario adds 126,500 person-years¹²⁷ of local and regional employment, relative to BAP. These new jobs are primarily in new construction and building retrofits. Most of the new employment opportunities will be created in the next decade. Building retrofits present the largest opportunity for new employment and create opportunities to partner with local education centers to provide job training. This could include expanding programs to teach the skills required to complete deep energy retrofits and install high-efficiency equipment. The transportation maintenance sector shows losses in total person-years of employment, since ZEVs require less maintenance than gas- and diesel-powered engines, and the actions modeled will reduce car ownership per household over time.

The creation of new industries and jobs provides opportunities to address inequities related to housing, income, and rural-urban disparities without the pressure of excessive growth. For example, jobs created by climate change mitigation strategies could help reduce unemployment for marginalized groups and low-income and disadvantaged communities.

¹²⁴ This energy storage will be in addition to the 2,500 MW of energy storage required by Michigan’s Clean Energy Act.

¹²⁵ This 7 MW of energy storage will be supported by the Michigan Solar for All program.

¹²⁶ Car dealerships may benefit from increased EV sales, but may lose revenue due to decreased maintenance needs of EVs.

¹²⁷ Person-years is a unit of measurement for the amount of work done by an individual throughout the entire year, expressed in the number of hours. The person-year takes the number of hours worked by an individual during the week and multiplies it by 52. Source: <https://www.investopedia.com/terms/m/manyyear.asp>

Figure D.8 Person-years of employment from the implementation of the RE Scenario.

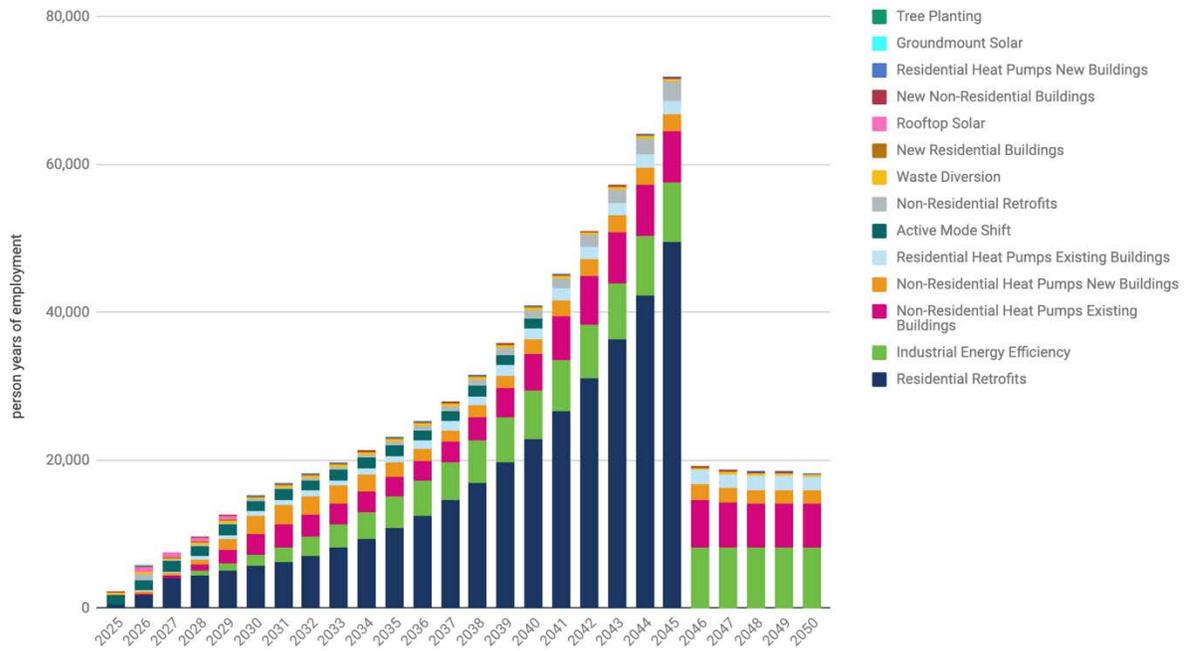


Table D.8 Average Annual Person Years of Employment in Reduced Emissions Scenario from 2026–2050, relative to the BAP Scenario, by Big Move.

Big Move	Reduced Emissions Scenario
Innovation in Industry	126,500
Healthy, Efficient Buildings	533,800
Modernizing Mobility	22,000
Sustainable Waste Management	8,047
Expanding Renewable Energy	2,400
TOTAL	126,500

Energy Poverty

Building out a clean energy system with distributed generation, renewables, microgrids, and storage will increase the resilience of Southeast Michigan communities by allowing them to increase their available spending for other needs and to withstand electricity disruptions.

A household faces a high energy burden when it spends more than 6% of its income on energy and a severe energy burden when it spends more than 10% of its income on energy. In Detroit, nearly a third of households are living with a high energy burden, and a quarter of low-income households spend more than 19% of their total income on energy.¹²⁸ Energy costs are particularly burdensome for low-income households; Black, Hispanic, and Native American households; elderly households; and renters.¹²⁹

Low-income households tend to have high energy cost burdens, in part because their homes tend to be draftier, older, and have poorer insulation than those of wealthier households, making them energy inefficient. According to the U.S. Department of Energy, cost-effective energy efficiency measures, such as improving insulation and installing more efficient appliances, have the potential to reduce energy use by 13–31%.

Additionally, combining energy retrofits with renewable generation, either through rooftop solar, community solar gardens, or the development of microgrids, can help reduce household energy costs even further. While the Low-Income Home Energy Assistance Program (LIHEAP) and the U.S. Department of Energy Weatherization Assistance Program (DOE-WAP) aids tens of thousands of households, the need is greater than available funding.

D.4.6 POTENTIAL CO-HARMS

The rebound effect – when households use the financial savings resulting from energy efficiency gains to access services that use more energy – is an important negative feedback cycle that can reduce the GHG emissions reductions resulting from a project but may also generate additional well-being co-benefits, particularly for low-income households. For example, a lower-income household could choose to spend savings generated from a home retrofit or reduced electricity bill on an electric vehicle, which could potentially increase emissions (if the electricity source is not clean) but could also improve access to jobs and economic mobility.

Increased density can also result in co-harms. For example, if increased density drives up housing prices, lower-cost development may occur on the outskirts of the city or in neighboring municipalities, which can have the effect of increasing emissions from transportation, as well as congestion, vehicle use and other impacts associated with greenfield development.¹³⁰

128 American Council for an Energy-Efficient Economy. Energy Burden in Detroit: A Closer Look at the Impact of Energy Costs on Low-Income Households. ACEEE, 2001. https://www.aceee.org/sites/default/files/pdfs/aceee-01_energy_burden_-_detroit.pdf.

129 Drehobl, A. and Ross, L., “Lifting the High Energy Burden in America’s Largest Cities: How Energy Efficiency Can Improve Low Income and Underserved Communities” (American Council for an Energy-Efficient Economy, April 2016), <http://aceee.org/sites/default/files/publications/researchreports/ui1602.pdf>.

130 Gagné, C., Riou, S., & Thisse, J.-F. (2012). Are compact cities environmentally friendly? *Journal of Urban Economics*, 72(2), 123–136.

D.4.7 RE Scenario Actions That Reduce Energy Poverty

Table D.9 Overview of GHG reduction measures that will reduce energy poverty in addition to reducing GHG emissions.

Sectors	Actions
Healthy, Efficient Buildings	<ul style="list-style-type: none"> All homes¹³¹ will be retrofitted to reduce their average energy consumption by 50%. All retrofits will be complete by 2045. Immediately after retrofitting buildings, all fossil-fueled space heating/cooling, and water heating systems will be removed and replaced with either ground or air source heat exchange¹³² systems. All fossil fuel appliances will be replaced with electric appliances at the same time. Across the region, the average size of new single-family homes will be reduced from 1,800 to 1,600 square feet by 2028. A requirement to build all new residential buildings to a net-zero standard by 2030 in Ann Arbor, and by 2035 across the rest of the region. From 2030 on, all new buildings in the region will be required to be heated and cooled and have hot water heaters that use heat exchange systems, as well as only electric appliances.
Expanding Renewable Energy	<ul style="list-style-type: none"> By 2029, 205 MW of rooftop solar PV systems will be installed. <ul style="list-style-type: none"> 50 MW will be installed in Ann Arbor. 155 MW will be installed in LIDAC communities across the region and outside Ann Arbor. By 2027, 33 MW of ground mount solar PV systems will be installed in Detroit. By 2029, 9.1 MW of distributed energy storage will be installed across the region.¹³³ <ul style="list-style-type: none"> 2.1 MW will be installed in Ann Arbor. 7 MW will be installed in LIDAC communities across the region.¹³⁴

D.4.8 Impacts

Measures to reduce greenhouse gas emissions can reduce household energy costs, as they reduce the costs of fuel for transportation, electricity and heating and cooling buildings. For example, transit-oriented urban development can reduce per capita use of automobiles by 50%, reducing household transport expenditures by 20%.¹³⁵ The impact of actions to reduce household energy costs in Southeast Michigan are shown in Figures D.10 and D.11, below.

¹³¹ This project did not include a detailed analysis of how much of the housing stock should be demolished rather than retrofitted. However in general, as much as possible buildings and building materials should be re-used to preserve embodied carbon and avoid harvesting additional raw materials.

¹³² For the purposes of this document, all references to heat exchange systems or heat pumps refers to cold climate heat exchange systems with backup zero-emissions heating.

¹³³ This energy storage will be in addition to the 2,500 MW of energy storage required by Michigan’s Clean Energy Act.

¹³⁴ This 7 MW of energy storage will be supported by the Michigan Solar for All program

¹³⁵ Arrington, G.,Cervero, R. (2008). TCRP Report 128: Effects of TOD on Housing, Parking, and Travel. Transportation Research Board of the National Academies. Washington, DC. 3.

Figure D.10 Percent of the population in SEMCOG experiencing an energy burden greater than 6% over time.

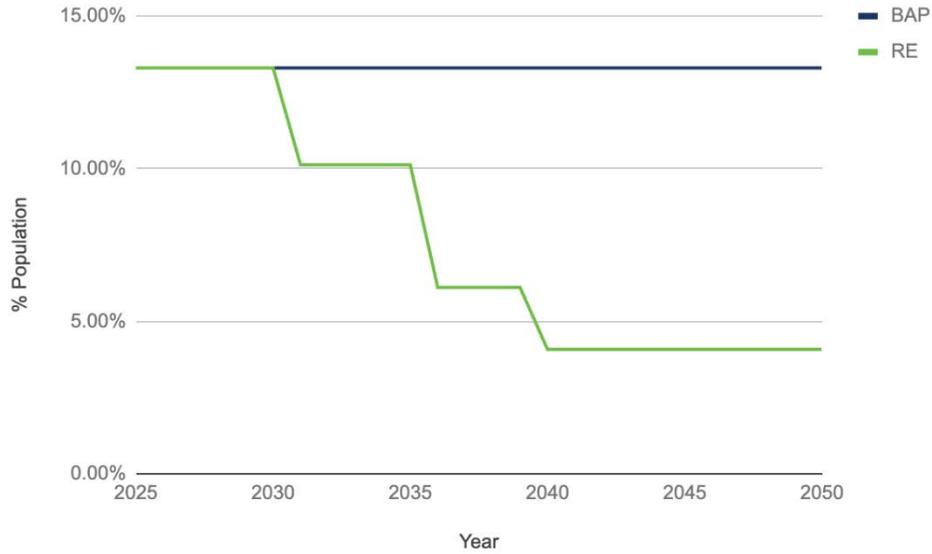
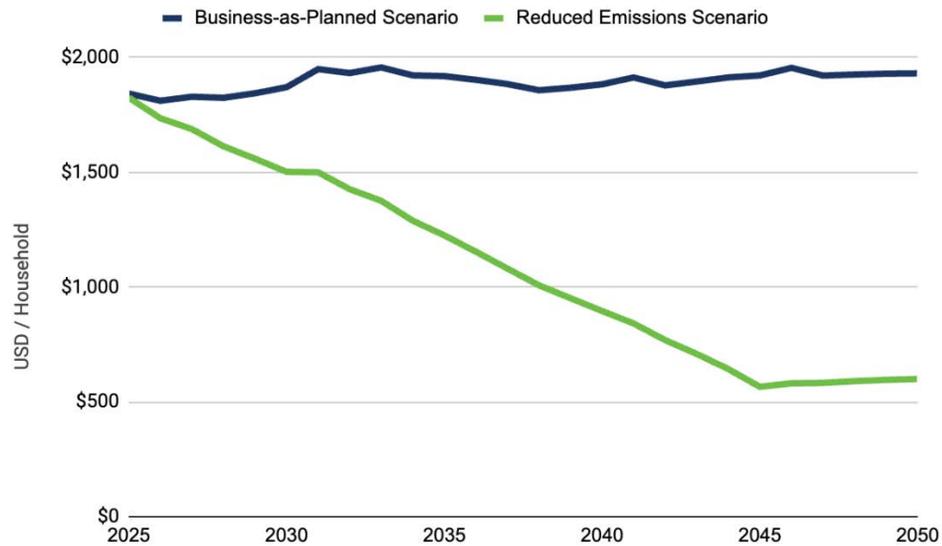


Figure D.11 Average annual household spending on transportation in the Reduced Emissions Scenario, compared with the BAP Scenario, 2025-2050.



D.5 CO-BENEFITS AND CO-HARMS: CLIMATE ADAPTATION AND RESILIENCE

D.5.1 Passive Survivability

Passive survivability is “the ability to maintain safe indoor conditions in the event of extended energy outage or loss of energy supply. In practice, passive survivability enables safe indoor thermal conditions, relying on building design measures that require no energy. As a measure of a building’s thermal performance, passive survivability offers an integrated assessment of both energy efficiency and resilience.”¹³⁶

Increasing the passive survivability of homes, community buildings, and essential infrastructure allows communities to withstand major events like power outages, heatwaves, and cold snaps. Well-insulated buildings that are designed to maximize solar heating during the winter and reduce heat gain during summer reduce overall energy demand, but also maintain livable temperatures for longer without additional energy input.

D.5.1.1 RE Scenario Actions That Increase Passive Survivability

Table D.10 Overview of GHG reduction measures that increase passive survivability in addition to reducing GHG emissions.

Sectors	Actions
Healthy, Efficient Buildings	<ul style="list-style-type: none"> All homes¹³⁷ will be retrofitted to reduce their average energy consumption by 50%. All retrofits will be complete by 2045. Immediately after retrofitting buildings, all fossil-fueled space heating/cooling, and water heating systems will be removed and replaced with either ground or air source heat exchange systems. All fossil fuel appliances will be replaced with electric appliances at the same time. Across the region, the average size of new single-family homes will be reduced from 1,800 to 1,600 square feet by 2028. A requirement to build all new residential buildings to a net-zero standard by 2030 in Ann Arbor, and by 2035 across the rest of the region. From 2030 on, all new buildings in the region will be required to be heated and cooled and have hot water heaters that use heat exchange systems, as well as only electric appliances.
Expanding Renewable Energy	<ul style="list-style-type: none"> By 2029, 9.1 MW of distributed energy storage will be installed across the region.¹³⁹ 2.1 MW will be installed in Ann Arbor. 7 MW will be installed in LIDAC communities across the region.¹⁴⁰

¹³⁶ <https://www.energycodes.gov/energy-resilience>

¹³⁷ This project did not include a detailed analysis of how much of the housing stock should be demolished rather than retrofitted. However in general, as much as possible buildings and building materials should be re-used to preserve embodied carbon and avoid harvesting additional raw materials.

¹³⁸ For the purposes of this document, all references to heat exchange systems or heat pumps refers to cold climate heat exchange systems with backup zero-emissions heating.

¹³⁹ This energy storage will be in addition to the 2,500 MW of energy storage required by Michigan’s Clean Energy Act.

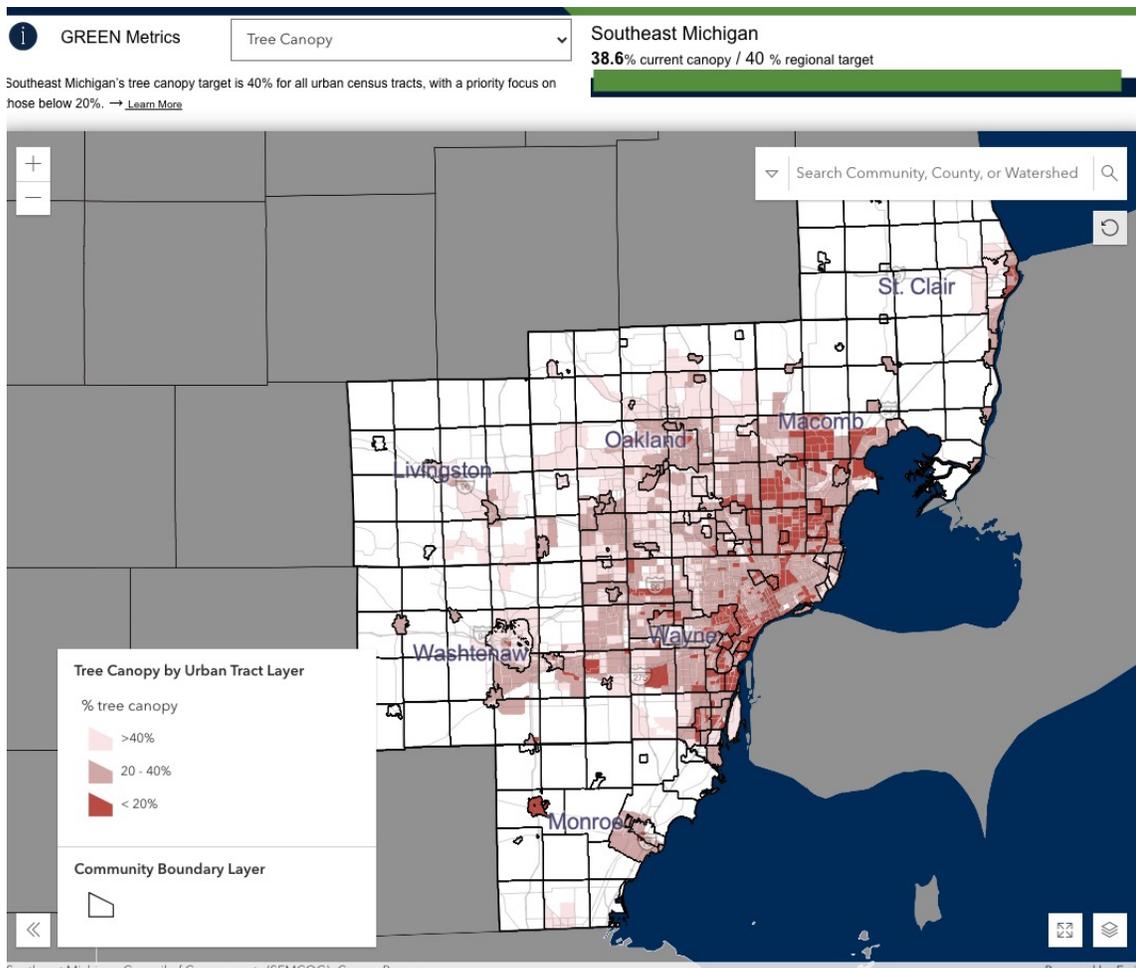
¹⁴⁰ This 7 MW of energy storage will be supported by the Michigan Solar for All program.

D.5.2 Reduction of Urban Heat Island Effect

The built environment greatly impacts the average temperature fluctuations of an area. Spaces that are heavily vegetated or treed or are near water bodies are typically cooler than those with hard, dry surfaces. Buildings, roads, sidewalks, and parking lots absorb heat from the sun and reflect it back, concentrating heat in densely developed areas. These areas, known as urban heat islands (UHIs), are pockets of the landscape with elevated temperatures that are worsened by human activities, such as driving or air conditioning, which release more heat into the environment. UHIs show elevated average temperatures, an issue of particular concern during heat events. While areas with lots of vegetation and natural cooling may be within a safe temperature range for humans during a heat wave, UHIs are pushed into an unsafe range, increasing the risk of serious health impacts on people within those locations. Therefore, areas with high population densities are more likely to be impacted by the urban heat island effect.

Figure D.12 below shows the variability of tree canopy cover across the SEMCOG region. Locations with less tree cover experience a greater urban heat island effect, which could be mitigated by increasing tree cover in these areas, as well as working to increase overall vegetation in denser neighborhoods across the region.

Figure D.12 Tree Canopy



D.5.2.1 RE Scenario Actions That Reduce the Urban Heat Island Effect

Table D.11 Overview of GHG reduction measures in the RE Scenario that will reduce the urban heat island effect in addition to reducing GHG emissions.

Sectors	Actions
Healthy, Efficient Buildings	<ul style="list-style-type: none">By 2050, 20,000 trees will be planted across the region, 500,000 acres of wetlands will be protected (10% of which will be restored), and the tree canopy in urban census tracts will reach 40%, with priority given to those below 20% in 2022.¹⁴¹

141 Work to achieve this will be coordinated with work to achieve SEMCOG’s Green Initiative. Source: <https://www.semco.org/green>.

APPENDIX E: FINANCIAL ANALYSIS

CONTENTS

- E.1 – Costs and Savings of the RE Scenario
- E.2 – Costs and Savings by Big Move
- E.3 – Post-Modeling Recommendations

E.1 COSTS AND SAVINGS OF THE REDUCED EMISSIONS SCENARIO

The following is a summary of the costs and returns from 2025 to 2050 of the actions in the Reduced Emissions Scenario.

Overall, \$83.4 billion in investments are required to complete the actions outlined in the Reduced Emissions Scenario. Over 25 years, this works out to an average of \$3.3 billion each year, or 0.99% of the region’s annual GDP.

In return, homeowners, businesses, institutions, and local levels of government will save a total of \$67 billion over this same period, or an average of \$2.7 billion annually. These savings will continue after 2050.

Table E.1 Costs and Savings with the Reduced Emissions Scenario (billions USD).¹⁴²

REQUIRED INVESTMENT 2025-2050			TOTAL SAVINGS 2025-2050		NET COST	
Total	Annual Average	Annual Average as Portion of GDP ¹⁴³	Total	Annual Average	Total	Annual Average
\$83.4	\$3.3	0.99%	\$67.0	\$2.7	\$16.4	\$0.66

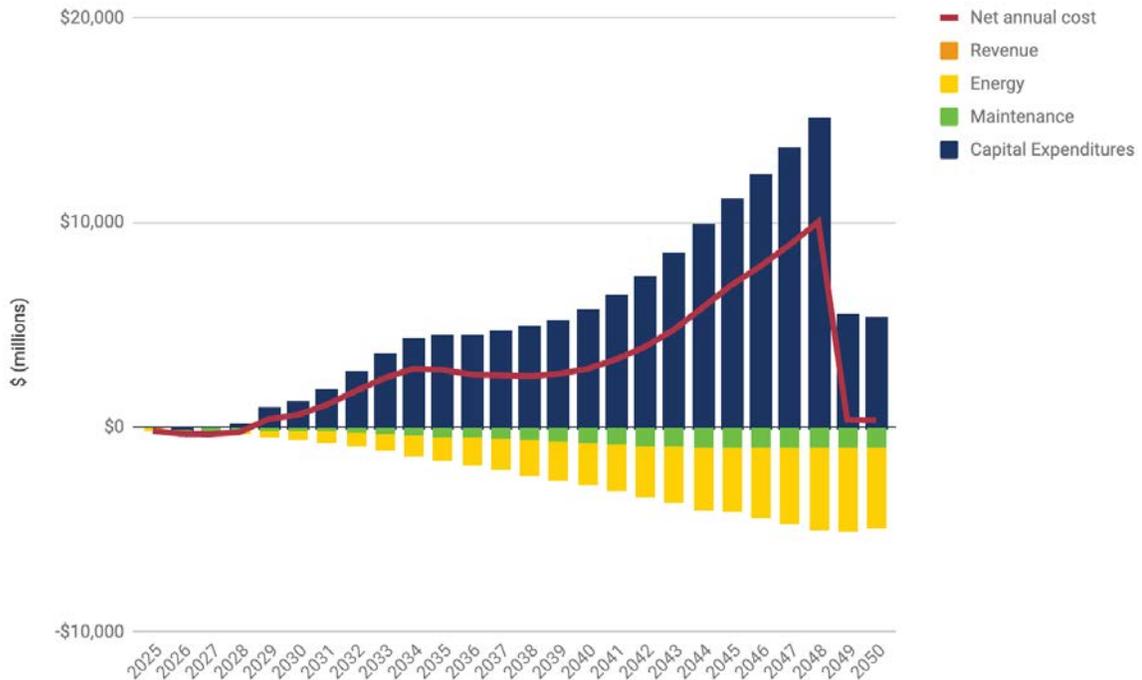
As shown in Figure E.1, annual required investment for the RE Scenario rises to approximately \$5 billion in 2035, and continues to increase to approximately \$15 billion in 2048, after which it drops back down to \$5 billion until 2050.

¹⁴² All values are incremental relative to the BAP scenario. A discount rate of 3% has been applied to future years.

¹⁴³ 2023 GDP for Detroit-Warren-Dearborn, Michigan, according to the Federal Reserve Bank of St. Louis. <https://fred.stlouisfed.org/series/NGMP19820>

Thirteen of the actions provide net savings over the 25 years. And recommendations are provided in the “[Recommended Changes to Actions After Financial Analysis](#)” section below to reduce costs for a further five of the actions.

Figure E.1 RE Scenario Year-Over-Year Investment and Returns



E.2 FINANCIAL ANALYSIS HIGHLIGHTS

The Most Effective Emissions Reduction Action per Dollar of Investment

The action that eliminates the most emissions per dollar of investment is Increase Transit and Train Ridership, which:

- Saves \$687 for every MT of emissions eliminated.
- Eliminates 9,878,000 MT CO₂e of emissions (1.7% of all emissions eliminated in the RE Scenario) between 2025 and 2050.
- Saves over \$8 billion, all of which goes to commuters as avoided fuel and maintenance costs between 2025 and 2050.

The Action with the Greatest Financial Savings

The action with the greatest financial returns is Replace All Light- and Medium-Duty ICE Vehicles with EVs, which:

- Saves personal vehicle owners \$24 billion dollars primarily in fuel and maintenance costs between 2025 and 2050.
- Saves \$395 for every MT CO₂e eliminated.
- Eliminates a total of 60,780,000 MT CO₂e (10% of all emissions eliminated in the RE Scenario) between 2025 and 2050.

The Most Expensive Action

The most expensive action in the scenario is Retrofitting Existing Residential Buildings, which requires a total investment of \$38.6 billion, or \$1.9 billion annually (average) between 2025 and 2045.¹⁴⁴ This works out to an average investment of \$18,000 per dwelling unit, which is relatively high, reflecting the age and condition of residential buildings in the region.

However, in return for this investment:

- Household energy costs will fall on average by 18% by 2030, by 51% by 2040, and by 69% to \$565 by 2045.¹⁴⁵
- The portion of the population experiencing energy burden¹⁴⁶ will fall from 13.3% to just over 4% by 2040 and remain at 4% thereafter.

The Least Expensive Action

The least expensive action in the RE Scenario is Reducing Single-Family Home Size, which:

- Has no capital or equipment costs associated with it, but provides over \$83 million in savings to homeowners in avoided energy costs
- Saves \$202 for every MT CO₂e eliminated
- Eliminates a total of 413,000 MT CO₂e (0.07% of total emissions eliminated in the RE Scenario) between 2025 and 2050

Capital Costs over Time by Action

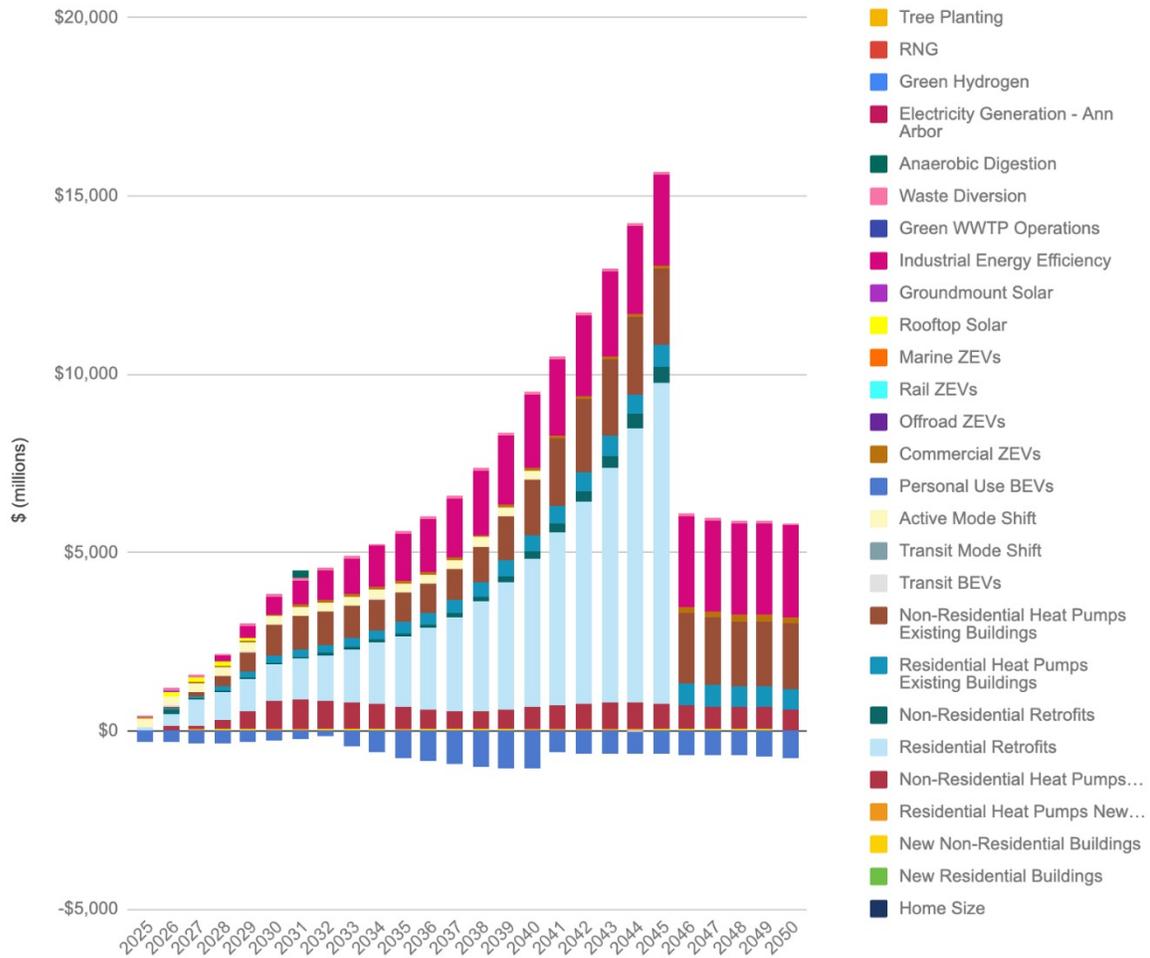
Figure E.2 shows the incremental capital investment required over time for each action.

144 The action completes all retrofits by 2045.

145 This reduction in household energy costs is shown in Figure 8.11 and discussed in more detail in section 8.

146 For the purposes of this Plan, a household is considered to be experiencing energy burden if home energy bills exceed 6%.

Figure E.2 RE Scenario Incremental Capital Investment by Action



E.3 COSTS AND SAVINGS BY BIG MOVE

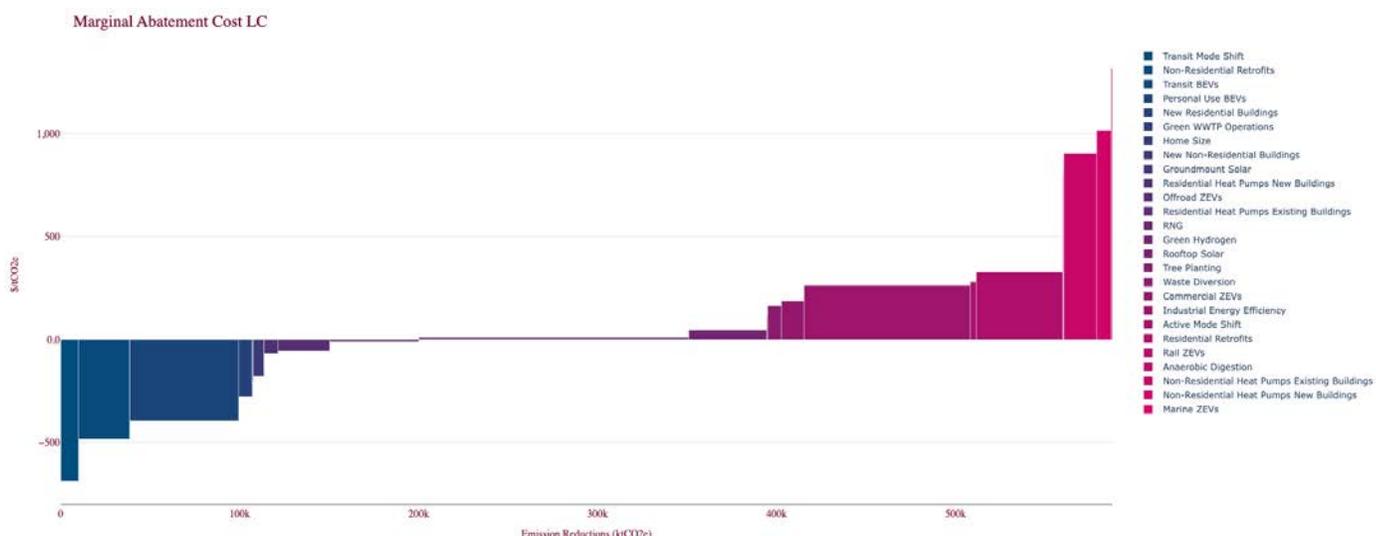
This section provides the costs and savings, as well as the marginal abatement cost and total emissions reduction by Big Move.

Table E.2 Costs and Savings, Total Emissions Eliminated and the Marginal Abatement Cost/ Savings by Big Move in the RE Scenario.

Total Investment Required (2025-2050)	Total Savings	Net Investment/ Savings	Total Emissions Eliminated	Marginal Abatement Cost/ Savings (\$ / MT CO ₂ e eliminated)
HEALTHY AND EFFICIENT BUILDINGS				
\$76.7 billion	\$54.4 billion	\$22.4 billion investment	174,816,000	Costs \$128.04 / MT
RESIDENTIAL BUILDINGS				
\$45.2 billion	\$32.7 billion	\$12.5 billion investment	113,833,000	Costs \$109 / MT
NONRESIDENTIAL BUILDINGS				
\$31.5 billion	\$21.6 billion	\$9.8 billion investment	60,983,000	Costs \$161 / MT
MODERNIZING MOBILITY SYSTEMS				
\$8 billion	\$36.1 billion	\$28.1 billion savings	116,802,000	Saves \$240.27 / MT
EXPANDING RENEWABLE ENERGY				
\$2.6 billion	\$464 million	\$2.1 billion investment	45,380,000	Costs \$46.21 / MT
INNOVATING IN INDUSTRY				
\$34.6 billion	\$8.9 billion	\$25.7 billion investment	243,678,000	Costs \$105.64 / MT
SUSTAINABLE WASTE MANAGEMENT				
\$1.5 billion	\$11.2 million	\$1.4 billion investment	8,017,000	Costs \$180.48 / MT
OPTIMIZING NATURAL AND WORKING LANDS				
\$1.2 million	\$1.3 million	\$21,000 savings	10,000	Saves \$2 / MT

Regarding cost-effectiveness, the marginal abatement cost curve (MACC) provides a snapshot of the relative costs and potential emissions reductions of all measures considered in the Plan. (Figure E.3) Each measure is represented as a colored bar, with the width indicating the volume of emissions reduced (in KT CO₂e) and the height representing the marginal cost (in \$/MT CO₂e). The MACC highlights the range of low-cost and cost-saving opportunities – such as active transportation, electrification of transit and personal vehicles, and solar generation – that deliver emissions reductions at negative or near-zero costs due to savings in energy or operating expenses. Higher-cost measures – such as residential retrofits, procuring green hydrogen and RNG – appear on the right side of the curve.

Figure E.3 Marginal Abatement Cost in the Reduced Emissions Scenario, 2022–2050



Overall, the MACC illustrates that 13 of the actions (as they were modeled) can be achieved with net benefits. Recommendations made in the [in the following section](#) would reduce the costs associated with five additional actions.

E.4 POST-MODELING RECOMMENDATIONS

Based on the financial analysis, this section recommends several changes be made when pursuing these measures, relative to what was modeled in the RE Scenario.

1. In general, heavy-duty hydrogen fuel cell vehicles have in some cases been shown to be able to travel farther with heavy loads than electric heavy vehicles. As a result, there is interest both in the long-haul trucking industry and for freight trains (and some passenger trains traveling to rural areas) in using hydrogen-powered vehicles. However, heavy-duty hydrogen fuel cell vehicles have only seen significant American adoption in California thus far.

The financial analysis completed for this Plan indicated that between 2025 and 2050, hydrogen fuel, hydrogen fueling infrastructure, and purchase costs for commercial hydrogen fuel cell vehicles (<4.5 MT) are all expected to be significantly higher than the equivalent costs for electric vehicles. Specifically:

- A. Hydrogen transportation fuel is expected to remain almost double the cost of charging electric vehicles (between \$60 and \$63 / MMBTU of H₂ compared to \$31 and \$36 / MMBTU of electricity)¹⁴⁷
- B. Hydrogen fueling stations are 22 to 45 times more expensive than charging infrastructure for electric heavy-duty vehicles¹⁴⁸
- C. The purchase price of a commercial hydrogen fuel cell vehicle (< 4.5 MT) is projected to remain approximately 30% higher than that of an equivalent electric vehicle until 2050

As a result, the total investment required by this Plan could be reduced significantly by shifting a larger proportion of all transportation to electric models and a smaller proportion to hydrogen vehicles in the future. Specifically, it is recommended that:

- The action **Replace All Heavy-Duty Vehicles with Zero-Emissions Models** be adjusted to replace more than 50% of HDVs in Southeast Michigan with electric models rather than hydrogen models
 - Freight and passenger rail in Southeast Michigan be studied in greater detail to determine where electric engines will be sufficient to replace diesel engines, and where hydrogen engines may be required (Depending on the results of this study, the **Zero Emissions Rail** action may require modification to increase the use of electric engines rather than hydrogen engines)
2. Renewable Natural Gas for industrial use currently costs approximately 12% more than electricity. By 2045, it is expected to cost 35% more than electricity. Furthermore, hydrogen currently costs twice as much as renewable natural gas, and is projected to continue rising in cost. As a result, the total investment required by this Plan could be reduced by increasing local production of RNG with the intention specifically of selling it to local industry, potentially at a lower cost than is currently forecast. The cost can be further reduced by choosing to electrify appliances and equipment wherever possible, rather than using RNG, and by limiting the use of RNG to uses that do not currently have any alternative fuel that meets their needs.

As a result, it is recommended that the following two actions be adjusted:

- The action **Reduce and replace natural gas with RNG** prioritize switching to electrification wherever possible, and limiting the use of limited and expensive RNG to industrial uses

147 Electricity cost: EIA. "Annual Energy Outlook 2025. Table 3 – Energy Prices by Sector and Source, East North Central Region." 2025. Hydrogen cost: Hydrogen Council. "Path to Hydrogen Competitiveness." 2020.

148 C40 Knowledge Hub. "Driving Towards Cleaner Air and Lower CO₂." and Hydrogen Fuel Cell Partnership. "Costs and Financing."

there is no other zero-emissions alternative; and

- The action **Anaerobic digesters for wastewater treatment** be expanded to include the installation of anaerobic digesters wherever possible - from installing small-scale digesters on farms to manage manure and produce RNG, to replacing the composting systems currently planned for organic waste with anaerobic digesters, and again producing RNG.

Both of these specific approaches would also result in greater reductions to emissions from the industrial, agricultural, and solid waste sectors.

3. The shipping industry has recently become more involved in determining the best way for ships to switch to renewable energy sources. Ongoing initiatives suggest that biofuels and wind power (i.e., sails) may be both more affordable and efficient zero-emissions energy sources for the shipping industry than hydrogen. As a result, it is recommended that the **Zero-Emissions Shipping** action be revisited and updated to reflect the most recent guidance of organizations like the International Maritime Organization and in cooperation with the ports and marine shipping sector.

APPENDIX F: IMPLEMENTATION ANALYSIS

CONTENTS:

- F.1 – Key Elements of Implementation Planning
- F.2 – Implementing Entities
- F.3 – Implementation Mechanisms
- F.4 – Implementation Strategy
- F.5 – Implementation Funding
- F.6 – Implementation Timeline

This section outlines how SEMCOG and its member communities and organizations can move from vision to action. Much of this work will require cooperation across multiple entities, so SEMCOG's existing role as a central point of coordination and support will be key to the region's success.

The speed and scale of the change described in the RE Scenario is transformative. The actions require significant changes in urban planning, infrastructure technologies, and personal behaviors. The faster these changes can be made, the sooner all residents of Southeast Michigan can experience reduced energy costs, healthier buildings, more accessible and less costly transportation, greener outdoor areas, increased resilience to extreme weather, and the economic benefits of the industries of the future.

F.1 KEY ELEMENTS OF IMPLEMENTATION PLANNING

Implementation planning refers to the process of designing programs, education, collaboration, and investments to achieve these changes as efficiently as possible. Where the RE Scenario actions describe what needs to change, implementation planning describes how the region will make the change happen. Key elements of implementation planning include:

F.1.1 Types of Implementation Measures

There are many ways to catalyze these actions in the region. Implementation measures can include:

- Creating **financial incentives** to reduce the cost of investing in a new technology like solar panels
- Providing **advisors** to help local businesses make their commercial properties more energy efficient
- Offering **education** to teach local residents how technologies like heat pumps and solar systems work, what the benefits are, and how much they cost
- Offering **tours** of local homes or facilities using energy-saving or zero-emissions technologies and energy sources, 'normalizing' these approaches by increasing the number of people who understand them to be proven and reliable
- Providing **online dashboards** to help the community monitor its collective progress – for example, how many ZEVs were registered in each city in the region each year, how many new homes were built region-wide in the past year that use heat pumps, etc.
- Providing **development incentives** to land developers and builders to meet higher energy efficiency standards

- Partnering with local universities and other educational institutions to ensure workers are taught the skills and standards they will need to complete the work described in this Plan
- Engaging regularly and meaningfully with low-income and disadvantaged communities throughout the implementation of this Plan, with the leadership of trusted partners, to design implementation measures that will ensure the well-being of these communities in terms of their quality of life, jobs, financial well-being, access to transportation, and health), and to change implementation approaches that do not do so.

F.1.2 Level of Authority

The type of implementation measures each organization uses is constrained by what they have the legal authority to do. For example, a municipality can (with the approval of its City Council) change the HVAC and energy systems in its own facilities because it has direct control (or authority) over the operations of these buildings. However, cities often cannot require new buildings to meet a higher building energy efficiency standard than what the State requires.

Local highlight: *Ann Arbor has shown creativity and determination in finding ways to achieve their own community climate goals. In 2024, the City leveraged community support to create a municipal Sustainable Energy Utility; this entity provides the City with the authority and means to provide the community with affordable, zero-emissions electricity by 2030 – ten years ahead of the legislated requirement for a state-wide, zero-emissions grid.*

F.1.3 Access to Funding

As described in Section 6.6 “Financial Costs and Savings of the RE Scenario,” the implementation of many of the actions in this Plan will require capital investment on the part of residents, businesses, cities, counties, utilities, and others in Southeast Michigan. Organizations like public utilities, with access to capital investment and a responsibility to maintain infrastructure and comply with regulations, have the ability (although it may still be challenging) to invest in their own infrastructure by incorporating it into regular Infrastructure Maintenance Plans, and demonstrating that the investment has a reasonable return on investment period. However, when it comes to helping residents and small businesses afford these investments, municipalities may have limited budgets for creating incentives; in such cases, they can provide financial support by creating a local ordinance to provide PACE funding to local businesses.

F.1.4 Human Resources

Developing programs, providing educational outreach and advisor services, and monitoring a community’s progress all require staff, or human resources. Private companies can invest in hiring staff to ensure they comply with State legislation, and cover these investments by increasing costs to their customers. Cities often have a more limited ability to hire staff to support programs because they have to rely primarily on property taxes, state revenue sharing from sales taxes, and charges for services and fees. Increasing those taxes and fees is often unpopular, and requires that City administration convince their City Council of the value and importance of the work. Entities like schools or non-profit organizations generally have even fewer human resources available to them, meaning they need to rely on simpler implementation measures that require less administrative overhead.

This section identifies the key organizations that will implement the Plan, and what it will mean to them. It lays out for each type of organization the key RE Scenario actions they can support,

and for each action, implementation measures appropriate to their authority, potential sources of funding, metrics to monitor, and potential for partnerships and coordination. Together, this framework provides the foundation for coordinated, well-resourced and accountable climate action across Southeast Michigan.

F.2 IMPLEMENTING ENTITIES

F.2.1 SEMCOG

SEMCOG, the Southeast Michigan Council of Governments is the federally designated planning agency for air and water quality, economic development, and transportation in the Metro Detroit region. SEMCOG works to coordinate planning among 180+ units of local government across seven counties. These counties serve over 4.8 million residents, which is approximately half the population of the State of Michigan. Approximately 28% of the region's census tracts are identified as low-income and disadvantaged communities (LIDAC), comprising more than 1.3 million people.

Proposed Focus: The Healthy Climate Task Force recommended that SEMCOG leverage its position as a central leader and strategic, regional planner by providing:

Strategic Leadership

- Updating SEMCOG's regional strategies, plans and programs to ensure they reflect the philosophy, principles, goals, and actions of this Plan. This will include adding new content as well as re-examining, updating and if necessary, removing existing approaches, principles, and initiatives that would otherwise act as barriers to reaching climate goals.
- Supporting counties and municipalities to review and update their own Master Plans, strategies, and policies to align with the Plan and regional climate goals.
- Developing a strategic plan to reduce emissions produced as a result of the organization's operations.

Convening and Facilitation

- Continuing the organization's role of coordinating local initiatives to ensure the results are consistent, integrated, and aligned with the region's climate goals.
- Facilitating regular meetings of region-wide or smaller working groups or project teams to share expertise, and coordinate activities on shared implementation initiatives.
- Acting as a conduit between SEMCOG members and State departments and agencies to facilitate information and data sharing, and alignment of related initiatives.

Monitoring and Reporting

- Dedicating resources to gather data annually and produce annual county-specific and region-wide GHG inventories;
- Creating and maintaining a dashboard of key performance indicators (as provided in Table 7.1) drawn from the Plan to track regional and county progress on climate actions and overall climate goals.
- Creating an annual Healthy Climate Plan Progress Report to celebrate success and progress, and share information about ongoing and completed projects, upcoming programs or funding, and opportunities for members to learn and cooperate in advancing climate work.

Funding and Grant Application Support

- Offering and awarding grants to member organizations to support the implementation of climate actions.
- Providing support to members to complete grant applications for funds that will support climate action work.

F.2.2 County Governments

The area included in the scope of this Plan includes the following eight counties: Livingston, Macomb, Monroe, Wayne, Washtenaw, Oakland, Saint Clair, and Lapeer.¹⁴⁹

Counties fill a variety of roles across Southeast Michigan. Many small communities rely on their county administrations for support and services. In Monroe, Macomb, and Oakland counties for example, towns and villages rely on county programs to get help to weatherize their homes. Some counties also provide temporary assistance with energy bills and rent during an emergency, or even food. Other counties such as Wayne, serve both rural communities and larger cities like Detroit. In these cases, they often coordinate services across these diverse communities.

As a result of these differences, there will be variation in how the eight counties included in this Plan's project area can best implement actions; however, there are some ways in which all counties can support this work.

Corporate-level Leadership

Counties, like all levels of government, have a social role in demonstrating leadership in times of change. As publicly funded entities, they also have a responsibility to use those public funds wisely, and to take advantage of opportunities to reduce operational costs and redirect funds to purposes that more directly serve their residents. Finally, they also have direct operational control over a number of public buildings and also operate fleets of vehicles and equipment. All of these factors suggest that some of the best ways for county governments to implement this plan is to make the necessary changes within their own organizations. This means:

- Systematically retrofitting their corporate buildings and facilities and replacing fossil fuel infrastructure in those buildings with zero-emissions alternatives
- Require that new county buildings are built to net-zero standards as soon as possible
- Switching to zero-emissions vehicles and equipment
- Supporting staff to use transit or active transportation to commute to work, or to work from home when appropriate

All of these initiatives will require initial investments but rapidly return that investment and then provide ongoing savings to the county government and to its staff.

Community Programs to Improve Home Energy-Efficiency

Another key way in which counties can support this work is to expand existing weatherization programs to offer more energy efficiency upgrades and to help residents switch to zero-emissions technologies in their homes. Across the region, many counties already provide programs that

¹⁴⁹ Lapeer County is not a member of SEMCOG but was included in the project to develop this Plan.

help residents improve the energy efficiency of their homes. County weatherization staff are well-positioned to do even more within these programs by increasing their understanding of 'deep energy audits,' 'passive house,' and 'net-zero' building standards, and other ways in which energy efficiency and renewable energy can bring even more value to their local communities.

F.2.3 Municipal Governments

There is significant variety in the sizes and capacities of the 169 municipal governments represented by SEMCOG members. Some are villages or chartered townships while others are large county or city administrations. Correspondingly, there are differences between the climate actions a city like Detroit has the authority and resources to take on and what smaller communities can do. Some good examples of municipal implementation measures include the following.

The Use of Zoning and Municipal Ordinances

Municipalities regularly update zoning ordinances to reflect the needs of growing communities and desired changes in urban form. This can include but is not limited to changes such as:

- Establishing car-free zones in the community
- Requiring developers to provide more bike parking and less vehicle parking at new residential developments
- Offering incentives for developers to re-use vacant buildings, or to build a new development to a net-zero standard
- Establishing emissions-free zones in congested business areas, within which goods must be delivered using zero-emissions vehicles

Incentives

Municipalities may be able to offer small additional incentives that can be added to utility, state, or federal grants or refunds to make energy efficiency retrofits, install rooftop solar PV systems, replace natural gas furnaces with heat pumps, etc.

Corporate-Level Leadership

Like county governments, municipal governments should prioritize:

- Reaching net-zero within their own buildings and facilities
- Requiring that new city buildings are built to net-zero standards beginning as soon as possible
- Transitioning their fleets and equipment to zero-emissions models
- Installing energy generation systems like solar PV systems on as many corporate rooftops as are suitable for it
- Installing ground mount solar PV systems on city-owned public parking lots
- Supporting staff to use transit and active transportation for commuting, support work from home where appropriate, and discouraging commuting in personal vehicles

All of these initiatives will require initial investments but rapidly return that investment, and then provide ongoing savings to the city government and to its staff.

Many of these implementation measures can also be used to educate residents. For example, new city vehicles can be branded to show that they are electric, and educational information

can be added to renewable energy systems on public buildings.

Leverage Direct Control over Utilities

Municipalities that own water treatment, wastewater treatment, power, or natural gas utilities may have the ability to prioritize improvements that will significantly reduce or eliminate emissions from these facilities.

- Communities that own a power generation facility can direct the facility to plan for and carry out a transition to renewable energy sources.
- Where wastewater facilities are municipally owned, if stormwater and wastewater travel through the same pipe network to a wastewater treatment facility, projects can be undertaken in cooperation with other 'City Works' departments to separate them. This will allow stormwater to be treated less than wastewater, reducing the energy required, the costs for energy, and deferring requirements for additional facilities to be built as the population increases.
- Wastewater treatment facilities can be made more efficient by using the heat of the wastewater to warm the treatment facility, and by upgrading aerators and fans. They can also be transitioned to anaerobic digesters where wastewater in combination with fats, oils and greases, and other high-energy waste gathered from restaurants, breweries, etc. is processed to produce valuable renewable natural gas which can then be sold for use in industrial processes. Solid residuals can be transformed into compost which can also be sold. There are often also opportunities to create renewable energy or offset credits which can be used either to reduce the community's greenhouse gas inventory or sold.
- Water treatment facilities can be upgraded to use more efficient equipment, pumping stations can be switched from diesel generators to renewable energy and battery storage systems, and in some cases, energy can be generated within water distribution networks, particularly if they flow downhill.

Public Education

Cities, towns, and villages have many contexts in which they interact with their residents. Public library programming, summer festivals, and farmers' markets are all useful spaces in which to offer education about the value of biking and walking rather than driving, solar PV technologies, electric vehicles, and many of the other changes underway to address climate change.

F.2.4 Implementation Partners

In addition to SEMCOG's member local governments, a wide range of community organizations, utilities, State and federal agencies, academic institutions, and nonprofit service providers across Southeast Michigan are actively advancing work that aligns with the Healthy Climate Plan. These entities are not SEMCOG members, but they represent critical implementation partners whose expertise, programs, and community relationships will help translate the plan's strategies into measurable action.

Table F.1 Implementation Partners

Entity	Roles	Authority	Function	building	energy	mobility	industry	waste
Commuter Connect	Sustainable Transportation Resource Support	SEMCOG Partnership	Coordination of sustainable transportation options			X		
Community Action Agencies (Wayne Metro, Washtenaw, Monroe, Oakland, Lapeer)	Weatherization, bill assistance, LIHEAP delivery	Nonprofits under federal/state designation	Direct services for low-income residents	X				
Consumers Energy	Utility programs, clean energy procurement	Investor-owned utility	Renewable energy, demand management		X			
Detroit & Washtenaw 2030 Districts	Building owner networks	Voluntary	Benchmarking, retrofit commitments	X				
Detroit Greenways Coalition	Advocacy for bike/trail networks	Nonprofit	Policy input, project advocacy				X	
Detroit Riverfront Conservancy	Parks and riverfront	Nonprofit	Infrastructure and placemaking				X	
Detroit Smart Parking Lab	Innovation Lab for transportation services and technologies	Private-Public Partnership	Testing of mobility, logistics and EV charging technologies				X	
Detroiters Working for EJ (DWEJ)	Community organizing, policy	Nonprofit	Convening, advocacy	X				
DTE Energy	Utility programs, grid investments	Investor-owned utility	Efficiency programs, renewables, EV charging		X			
Eastside Community Network (ECN)	Resident-led air quality and mobility	Nonprofit	Organizing, safe spaces				X	

Entity	Roles	Authority	Function	building	energy	mobility	industry	waste
EcoWorks	Community retrofits, climate education	Nonprofit	Retrofit delivery, trusted messenger	X				
EGLE (MI Dept. of Environment, Great Lakes and Energy)	Policy, grants, regulatory	State agency	Climate plan implementation, IRA/IIJA funding (e.g. – Solar for All)	X	X	X	X	X
Elevate	Multifamily retrofits, contractor accelerator	Nonprofit	Technical assistance	X				
Focus: HOPE	Technical training	Nonprofit	Workforce development	X				
Forgotten Harvest	Food rescue & redistribution	Nonprofit	Emergency logistics					X
Friends of the Rouge	River stewardship, GSI training	Nonprofit	Education, urban forest management workforce development					X
Gleaners Community Food Bank	Food rescue/distribution	Nonprofit	Logistics, access					X
Great Lakes Water Authority (GLWA)	Regional water/wastewater	Regional authority	Water and Wastewater Treatment and Infrastructure Management					X
Green Door Initiative	Workforce development	Nonprofit	Training pipelines	X				
Greening of Detroit	Urban forestry, workforce	Nonprofit	Tree planting, urban forest management workforce development					X
Huron River Watershed Council (HRWC)	River and wetland restoration	Nonprofit	Technical assistance					X
Huron-Clinton Metroparks	Parks	Regional authority	Park and trail management			X		

Entity	Roles	Authority	Function	building	energy	mobility	industry	waste
Keep Growing Detroit	Urban farming, resilience	Nonprofit	Food sovereignty, education					X
Lean & Green Michigan	Consulting to commercial, industrial, multifamily residential, nonprofit, and agricultural property owners	State Commercial PACE Administrator	Supports administration of commercial PACE program				X	X
LIHEAP	Utility bill assistance	Federal HHS via state agencies/ CAAs	Direct assistance		X			
Make Food Not Waste	Food rescue, redistribution, and composting	Nonprofit	Reduction of food waste and providing dignified meals to low-income residents					X
Michigan Central Innovation District	Regional mobility innovation center	Private initiative led by Ford Motor Company	Support for entrepreneurs to scale up their mobility solutions			X		X
Michigan Climate Investment Hub	IRA/Justice40 funding navigator	Philanthropy-nonprofit coalition	Capacity building, grant support		X			
Michigan Green Communities	Community-level strategic support for sustainability initiatives	State-County-Municipality-Township Collaboration	Sustainability benchmarking	X	X	X	X	X
Michigan Saves	Finance & incentive management	State-designated green bank	Provides affordable financing	X				
MoGo Detroit	Bike share & adaptive cycles	Nonprofit	Service provider			X		

Entity	Roles	Authority	Function	building	energy	mobility	industry	waste
MSHDA (MI-HOPE)	Housing retrofit and repair funding	State agency	Administers MI-HOPE grants	X				
Passive House Institute of the U.S. (PHIUS)	Workforce Training for passive house construction and verification	Private professional building standards organization	Net-zero construction, verification, and energy auditing workforce development	X				X
ReLeaf Michigan	Tree planting support	Nonprofit	Technical support					X
SE Michigan Land Conservancy	Land protection	Nonprofit	Conservation easements					X
Southwest Detroit Environmental Vision (SDEV)	Diesel reduction, air quality	Nonprofit	Project implementer			X		X
Strategic Outreach and Attraction Reserve Fund (SOAR)	Incentive program to keep large manufacturers within the region.	State program	Funding and guidance				X	
Transportation Riders United (TRU)	Transit rider advocacy	Nonprofit	Policy advocacy			X		X
University of Michigan SEAS	Research, technical assistance	University	Applied research, training	X				
Walker-Miller Energy Services	Efficiency program implementer	Private contractor (utility programs)	Retrofits, workforce development	X				
Watershed Councils and Conservation Districts	Watershed planning	Nonprofit	Technical support					X
Weatherization Assistance Program (DOE WAP)	Weatherization retrofits	Federal DOE via local CAA delivery	Efficiency upgrades for low-income households	X				

F.3 IMPLEMENTATION MECHANISMS

It is important to recognize that specific implementation strategies may take different forms depending on local priorities and resources. For example, one community may be more focused on accelerating building electrification through local ordinances and incentives, while another may be better positioned to prioritize transit-oriented development. The opportunities described in this section are based on various implementation mechanisms that can be adapted and applied in different ways, ensuring flexible approaches to advancing progress and maximizing impacts.

Implementation Mechanisms – A flexible framework for comprehensive strategies

- | | |
|---|--|
| Regulatory and Policy | <ul style="list-style-type: none"> • Codes and Standards: Update building codes, appliance standards, and fuel standards to align with climate goals. • Permitting Reform: Streamline and reduce permitting processes for clean energy and ZEV infrastructure installations. • Mandates and Requirements: Adopt enforceable policies or regulations that set targets and timelines for climate actions. |
| Planning and Governance | <ul style="list-style-type: none"> • Integrated Planning Requirements: Require climate action integration into land-use, transportation, energy, and adaptation planning. • Cross-Sector Coordination: Establish task forces or working groups to align state, local, Tribal, and private-sector efforts. • Public Engagement: Co-develop programs and implementation approaches that address their priorities in alignment with climate actions. |
| Technical Assistance and Capacity Building | <ul style="list-style-type: none"> • Guidance and Toolkits: Provide resources for local governments and other stakeholders to develop and implement climate action projects. • Community-Based Support: Offer direct planning support to community organizations in LIDACs and Tribes. • Workforce Development: Expand training, apprenticeships and job placement programs aligned with the Plan’s measures. |
| Private Sector, Partnerships, and Collaboration | <ul style="list-style-type: none"> • Private Sector Investment: Southeast Michigan benefits from the presence of private corporations and a spirit of renewal that has been growing in recent years. The potential to leverage the investment power of these corporations can be a significant contributor to the transformation of the region. • Public-Private Partnerships: Collaboration between government and the private sector to deliver public services, infrastructure, or innovation. • Demonstration Projects: Develop pilot projects with government, industry, and educational institutions. • Innovation Accelerators: Support early-stage technologies and startups through incubators and testbeds. • Utility and/or Developer Collaboration: Coordinate large-scale deployment with key actors. |

Market Development and Procurement	<ul style="list-style-type: none"> • Public Procurement Standards: Use aggregated purchasing power to catalyze demand for low emissions products and services. • Green Purchasing Requirements: Require low emissions materials in public construction and operations. • Bulk Purchasing: Pool purchasing power to reduce costs and expand access.
Monitoring, Evaluation, and Transparency	<ul style="list-style-type: none"> • Public Reporting: Track and publish implementation, emissions and community outcomes and progress toward goals. • Evaluation Frameworks: Build in opportunities for reviewing actions and processes to improve or correct the plan’s course.

F.4 IMPLEMENTATION STRATEGY

Implementing the measures identified in this Plan will require significant collaboration across all sectors and levels of government. The Reduced Emissions Scenario represents a transformative shift that would require significant changes in planning, development, technology, and daily behavior. These changes would also lead to significant benefits, including lower energy costs, healthier communities, and a stronger regional economy.

While the scenarios define *what* changes can be made to reduce emissions, implementation planning focuses on *how* to achieve those reductions and who has a role in the process. The Implementation Opportunities on the following pages describe these key components of implementation, and identifies roles for partners in each action. These are not exhaustive or a prescriptive list; rather they are examples to highlight opportunities where local governments may have influence or authority to impact these changes. For more information on implementation, see Appendix D

Table F.1 Implementation Opportunities

WHY <i>Key Focus Areas</i>	WHAT <i>RE Scenario Measures</i>	HOW <i>Steps Toward Reducing Emissions</i>	WHO <i>Roles for Everyone</i>
<p>Promote Healthy and Efficient Buildings</p>	<p>Retrofit homes</p>	<p>Create an energy advisor service designed to support retrofits of homes and replace fossil fuel systems with zero-emissions alternatives, prioritizing low-income homes.</p>	<p>Coordinated approach with Counties</p>
		<p>Expand existing weatherization programs to include additional energy efficiency improvements designed to optimize reducing energy costs for homeowners and reducing energy consumption and emissions.</p>	<p>Counties and County Level Community Action Agencies</p>
		<p>Develop a program to install simple, effective repairs (Example: City of Detroit’s plan to replace broken or missing doors and windows on the estimated 20% of occupied homes in need of these repairs).</p>	<p>Municipalities</p>
	<p>Retrofit non-residential buildings</p>	<p>Introduce municipal ordinance and administrative support to make use of the Commercial Property-Assessed Clean Energy (PACE) legislation. Consider cooperative efforts across communities</p>	<p>Municipalities</p>
		<p>Develop ‘corporate climate leadership programs’ to educate corporations on reducing energy use and emissions, with a requirement to track energy use and emissions. Celebrate and provide public marketing materials for corporate participants.</p>	<p>Public-Private Partnerships</p>

WHY <i>Key Focus Areas</i>	WHAT <i>RE Scenario Measures</i>	HOW <i>Steps Toward Reducing Emissions</i>	WHO <i>Roles for Everyone</i>
Promote Healthy and Efficient Buildings	Use electric heat exchange systems in existing buildings	Create, continue, and expand incentive programs for the installation of electric equipment, devices, and appliances, which will decrease energy consumption (Examples: heat pumps to replace space heating/cooling, water heating, and clothes dryers, to tap aerators and light bulbs). These programs and process would be integrated and coordinated through the Energy Advisor service described previously.	Municipalities, Counties
	Increase housing options with infill development and adaptive reuse	Combine brownfield redevelopment grants with corporate property tax reductions to encourage private companies and investors to transform existing vacant properties into rejuvenated, net-zero, affordable housing, prioritizing lower income neighborhoods, mixed-use developments, and other walkable, bikeable, and transit-oriented areas.	Public-Private Partnerships
		Update zoning to allow smaller average sizes for both lots and structures.	Municipalities
		Decrease maximum lot sizes in both greenfield and infill areas to encourage smaller residential buildings.	Municipalities
	Change ordinances to allow accessory dwelling units to be added to existing residences, either in out-buildings or within the principal dwelling.	Municipalities	

WHY <i>Key Focus Areas</i>	WHAT <i>RE Scenario Measures</i>	HOW <i>Steps Toward Reducing Emissions</i>	WHO <i>Roles for Everyone</i>
<p>Promote Healthy and Efficient Buildings</p>	<p>Establish net-zero emission building standards</p>	<p>Convene a regional working group initiative with builders and land developers to determine how to accelerate building to a net-zero standard. Identify sustainability champions in the builder and developer communities as well as builders who disagree with the approach. Meet regularly for at least a year to identify challenges, increase awareness.</p>	<p>State and Regional Cooperative Effort of Municipalities, Builders, Developers, Technical Schools</p>
		<p>Integrate passive house-building standards into construction and energy audit training at technical institutes.</p>	<p>Builders, Developers, Technical Schools</p>
		<p>Create a local commercial PACE program to help support energy efficiency upgrades, renewable energy installations, and water efficiency projects for commercial buildings. Program details should include ordinances and financial backing, establishing program administration and rollout timeline.</p>	<p>Municipalities</p>

WHY <i>Key Focus Areas</i>	WHAT <i>RE Scenario Measures</i>	HOW <i>Steps Toward Reducing Emissions</i>	WHO <i>Roles for Everyone</i>
Modernize Mobility Systems	Increase active transportation	Reduce and eventually eliminate vehicle parking minimums in development standards or the zoning ordinance.	Municipalities
		Create zero-emissions, last-mile delivery zones within urban areas, and support the creation of last-mile delivery services with delivery hubs, cargo bikes, and electric delivery vans.	Municipalities
		Develop a fully connected system of high-quality, active transportation networks that connect residences with both recreational, work and school destinations, with a priority on communities that currently have inadequate access to transportation.	Coordinated approach with municipalities, transit agencies
	Increase transit and train ridership	Optimize and expand existing transit service, with a focus on making transit a more appealing alternative than a trip in a personal vehicle.	Coordinated approach with municipalities, transit agencies
		Evaluate key transit routes to determine system operations, costs, and convenience for riders, and other systemic factors to help increase transit ridership.	Transit agencies
		Re-initiate an evaluation of regional passenger rail opportunities, such as an electric commuter train service from Ann Arbor to downtown Detroit.	Coordinated with municipalities and transit agencies

WHY Key Focus Areas	WHAT RE Scenario Measures	HOW Steps Toward Reducing Emissions	WHO Roles for Everyone
Modernize Mobility Systems	Replace buses with ZEVs	<p>Develop a zero-emissions bus procurement strategy that will gradually replace current fleet vehicles with ZEVs and acquire the necessary charging/ fueling infrastructure. Direct the operational savings realized from the avoided fuel and maintenance costs of ZEVs into a revolving fund that will then be used to fund the next round of new ZEV buses.</p> <p>Begin a program to regularly refurbish existing buses to extend the use of the vehicle body and refresh the comfort and appearance of the vehicles. Incorporate the replacement of their ICE motors with ZEV alternatives into the refurbishment process.</p>	<p>Coordinated approach with municipalities, school districts, transit agencies</p> <p>Coordinated approach with municipalities, school districts, transit agencies, workforce training</p>
	Replace light and medium-duty vehicles with ZEVs	<p>Hold free ZEV Expos to provide the public and fleet owners with opportunities to drive an ZEV, dispel misperceptions, and learn more about available models, charging, and financial incentives.</p> <p>Develop and carry out a ZEV procurement strategy that will replace all current fleet vehicles with ZEV's and acquire the necessary charging/ fueling infrastructure. Direct the operational savings realized from the avoided fuel and maintenance costs of ZEVs into a revolving fund that will then be used to fund the next round of new ZEV fleet vehicles.</p>	<p>SEMCOG, Utilities, Auto Manufacturers</p> <p>Coordinated approach, Municipalities</p>

WHY Key Focus Areas	WHAT RE Scenario Measures	HOW Steps Toward Reducing Emissions	WHO Roles for Everyone
Modernize Mobility Systems	Replace heavy-duty vehicles with ZEVs	Initiate a study to replace high-emissions truck transportation along standard corridors among manufacturing and assembly plants with hydrogen trucks, electric trucks, and freight rail	SEMCOG, Utilities, Auto Manufacturers, Hydrogen Hub, Municipalities along transportation corridors
	Replace offroad vehicles with ZEVs	Create an ordinance requiring that by a certain year, municipal construction vehicles must generate zero emissions. Gradually increase the zero-emissions proportion of offroad vehicles over time.	State and Regional Cooperative Effort, Municipalities, Construction companies
	Replace port equipment and vehicles with ZEVs and use only electricity for docked ships	Coordinate an educational session for all ports in the SEMCOG region to familiarize them with the status of climate action in maritime shipping (e.g., U.S. Action Plan for Maritime Energy and Emissions Innovation, International Maritime Organization), with a case study overview from a U.S. port authority that is partway through a project to eliminate emissions from port operations (such as the Long Beach Port).	Port authorities at the commercial ports in Harbor Beach, Port Huron, Marysville, St. Clair, Marine City, Detroit, and Monroe.
	Replace street, traffic, park, stadium and sportsfield lighting with LEDs	Collaborate to develop a goal to fully replace region-wide street, traffic, parking, recreation, sports field, and stadium lighting, and create a grant program and / or revolving fund to reduce the up-front cost for participating municipalities and other entities. Consider partnership with a large sports facility with LED lighting, such as Ford Field would provide a local corporate champion for the initiative.	Municipalities and other entities with outdoor lighting requiring replacement, across the region, and corporate partners

WHY <i>Key Focus Areas</i>	WHAT <i>RE Scenario Measures</i>	HOW <i>Steps Toward Reducing Emissions</i>	WHO <i>Roles for Everyone</i>
Expand Local Renewable Energy Generation	Install rooftop solar PV systems	Generate renewable power for municipal operations. Formally evaluate the business cases for installing solar within the community, procuring net-new, emissions-free power from outside the community, creating a sustainable energy utility (as in Ann Arbor), and others. Learn from expertise of others in the region already pursuing this measure.	A cooperative approach between municipalities and counties would be beneficial but is not necessary.
	Install ground mount solar PV systems	Continue and expand community solar programs (Example: building on the success of Detroit’s existing Solar Neighborhoods program by adding another 2 MW to the current 31 MW program).	Municipalities
	Develop energy storage	<p>Develop an educational “solar and energy storage tour” of homes and other buildings to introduce people to how the systems work, what they look like, and how energy storage can enhance resilience.</p> <p>Create a pilot program in which building owners are provided with energy storage for free if they agree to allow the utility to draw from their storage in the event of a grid outage.</p>	<p>Municipalities, Counties, Private Corporations</p> <p>Utilities</p>

WHY <i>Key Focus Areas</i>	WHAT <i>RE Scenario Measures</i>	HOW <i>Steps Toward Reducing Emissions</i>	WHO <i>Roles for Everyone</i>
<p>Advance Clean Innovation in Industry</p>	<p>Improve industrial efficiency</p>	<p>Design a program offering assistance to manufacturing and industrial companies to reduce their total energy consumption and emissions- e.g. consulting services to perform deep energy audits, identify potential sources of reusable waste heat and energy, continuous improvement coaching, as well as grants for automated lighting, upgraded equipment, etc.</p>	<p>Cooperative regional effort with industrial and manufacturing facilities, technical training centers and colleges, universities</p>
	<p>Reduce cement- and lime manufacturing emissions</p>	<p>Create a working group to develop a strategy for reducing emissions associated with cement.</p>	<p>Collaborative effort with EGLE and industrial partners</p>

WHY <i>Key Focus Areas</i>	WHAT <i>RE Scenario Measures</i>	HOW <i>Steps Toward Reducing Emissions</i>	WHO <i>Roles for Everyone</i>
<p>Sustainably Manage Waste and Natural Resources</p>	<p>Reduce waste</p>	<p>Collaborate with communities across the region to participate in the Make Food Not Waste initiative to eliminate food waste.</p> <p>Increase local community opportunities to support and benefit from a more circular economy, such as hosting Neighborhood Swap Days, creating a Tool Library, or hosting Repair Cafes with tools and experts available to help residents repair household items.</p> <p>Update Materials Management Plans per the State requirement with goals of 45% waste diversion and increased recycling and composting programs.</p>	<p>Make Food Not Waste and cooperating cities</p> <p>Municipalities</p> <p>County Materials Management Planning Committees</p>
	<p>Enhance tree canopy and wetland coverage</p>	<p>Identify and promote locations for enhancement, provide tree planting and wetland enhancement guidance based on best practices for resilience and long-term maintenance, connect opportunities with funding and stewardship support.</p>	<p>SEMCOG, DNR, Municipalities, Counties, Workforce Groups, Watershed Councils, and other environmental services</p>

F.5 IMPLEMENTATION FUNDING

Achieving significant emissions reductions will require sustained and strategic investment across public, private, and philanthropic sectors. Implementation will hinge on the ability to mobilize and manage funding effectively. Actions will rely on funding sources and financing mechanisms.

Funding sources include financial resources such as federal grants, State general funds, taxes, or private investment. Financing mechanisms are tools to attract and distribute those resources, including revolving loan funds, public-private partnerships, and on-bill financing.

Understanding and aligning sources and mechanisms will enable Southeast Michigan to identify viable financing pathways for each climate action, tailoring implementation strategies to available resources and administrative capacity.

At the federal level, the Infrastructure Investment and Jobs Act (IIJA) and Inflation Reduction Act (IRA) created significant new funding opportunities. However, since the change in administration these funds will not be available as long as originally planned. This makes it critical to vary funding and financing, combining federal opportunities with flexible State and local resources and leveraging private investment where possible.

F.5.1 Funding and Financing Mechanisms

Financial Incentives and Funding Tools

Grants and Rebates: Provide direct financial support to households, businesses, local governments, and nonprofits for climate actions.

Tax Incentives: Offer tax credits, deductions, or exemptions to reduce upfront costs of eligible technologies and actions.

Low-Interest Loans and PACE Programs: Establish municipal bylaws to support a local PACE funding program for the state-level Commercial PACE opportunity.

Revolving Funds: Establish a financial reserve fund into which savings (i.e., avoided energy or fuel costs) that have been realized due to initial climate work are directed. This fund is then drawn from to cover the capital costs of the next project.

Performance-Based Incentives: Link funding to measurable outcomes like GHG reductions or energy savings.

Taxes

Taxes can generate revenue directly from residents through property taxes, sales taxes, utility charges, vehicle registration fees, fuel taxes, etc. Governments can design or modify these tax structures to target specific sectors or behaviors, incentivize climate-positive actions, or generate dedicated revenue streams for climate programs. For example, a local sales tax may be levied to fund public transit expansion projects.

Both state and local governments have the authority to impose taxes, though the scope and flexibility depend on state law. Local governments often require voter approval to institute new taxes or increase existing rates. Some jurisdictions use special assessment districts or tax

increment financing (TIF) to capture future increases in property values to fund infrastructure projects today.

Taxes can fund a wide array of climate-action measures, including public transit expansion, energy efficiency upgrades in public buildings, ZEV infrastructure, water conservation projects, and renewable energy programs. Dedicated taxes can create stable, predictable revenue streams for long-term planning and program delivery.

Fees

Fees are specific charges on activities, services or resources that require regulatory oversight, create environmental impacts, or rely on public infrastructure. Fees are collected directly from the users, or the individuals, businesses or developers who use these resources. Fees can be structured to recover costs (i.e., paying for permitting and inspection) or incentivize or discourage certain behaviors (i.e., plastic bag fees encourage bringing a reusable bag). While taxes are general revenue-raising tools, fees are usually charged in exchange for a specific service or regulatory function and must comply with state and local legal constraints, especially in terms of their proportionality and use.

Fees can be levied and used by a wide range of actors, from state agencies and local governments to regional authorities and special districts. For example, utility fees can fund renewable energy infrastructure, while vehicle registration fees can support clean vehicle incentives.

The types of climate-action measures supported by fees are typically infrastructure- or compliance-oriented. These can include clean transportation infrastructure, building electrification compliance programs, etc. Importantly, fees can serve as a stable, locally controlled revenue stream to fund ongoing climate action, especially where external funding may be limited. However, implementing authorities should be aware that poorly designed fees can disproportionately impact low-income residents.

Budget Allocations

Budget allocations are one of the most direct and flexible funding sources and mechanisms available to governments. Budget allocations appropriate general fund revenue through a government's budgeting process, directing funds to specific programs, departments, or projects.

Flexible and discretionary, budget allocations can support a wide range of climate action measures, including energy efficiency retrofits for public buildings, tree planting programs, community solar installations, electrification of municipal fleets, climate planning studies, and public engagement.

Loans

Loans provide upfront capital that is repaid over time, often at low or subsidized interest rates. Loans may come from state revolving loan funds, federal loan programs, green banks, or private lenders. Borrowers, including governments, businesses or even households, can use loans as a financing mechanism to implement climate action projects without the need for immediate capital. Loans can be structured with flexible repayment terms, tied to project performance (e.g., energy savings), or even bundled with technical assistance.

Federally funded loan programs available to states include the following:

- The Loan Programs Office is a federal financing program that supports large-scale energy and infrastructure projects. The program is managed and administered by the Department of Energy.¹⁵⁰
- State Energy Program Funding provides grants to states to assist in designing, developing, and implementing renewable energy and energy efficiency programs. The funds are administered through the state’s energy office. Funding is authorized through 2026.¹⁵¹
- EPA’s Clean Water State Revolving Funds provide funding and guidance to states to provide low-cost financing for water quality infrastructure projects. States administer the program, making lending decisions and setting priorities.¹⁵²

State and local governments, utilities, nonprofits and, in some cases, private property owners are eligible to access and administer loan-based programs. For example, a revolving loan fund (RLF) is a capital source that provides loans to eligible projects with the repayments and interest replenishing and growing the fund over time. State and local governments can establish RLFs with seed funding from grants, federal funding, utility surcharges, bonds, or budget line items and administer the funds based on eligible uses (e.g., building retrofits, renewable energy installations, clean transportation, etc.). This is just one example of how loans work. Criteria and eligibility vary. A city might use a state-supported revolving loan fund to upgrade municipal buildings with energy efficiency retrofits, while a rural cooperative might use U.S. Department of Agriculture (USDA) loan support to finance distributed solar. States can also create their own green banks to administer low-interest loans and loan guarantees for clean energy projects. Property assessed clean energy (PACE) financing is another example that allows property owners to finance energy efficiency or renewable energy upgrades and repay the loan via a special assessment on their property tax bill.

Loans can fund a wide range of climate action measures, including energy efficiency upgrades, renewable energy installations for homes and businesses, electric vehicle infrastructure, water conservation retrofits, and climate-resilient infrastructure. While loans must be repaid, they can unlock upfront capital and deliver long-term savings for borrowers at every level.

Bonds

State and local governments can use bonds to raise capital for large-scale infrastructure investments. As a funding source, bonds are essentially loans issued by a public entity (like a city, county, or state government) to investors, who are repaid with interest over time. As a financing mechanism, bonds allow governments to spread the costs of major projects over many years, making them more affordable and accessible upfront. There are multiple types of bonds:

- General obligation bonds are backed by the full faith and credit of the issuing government.
- Revenue bonds are repaid through the income generated by the funded project (e.g., toll

150 Department of Energy, Loan Programs Office, accessed May 2025, <https://www.energy.gov/lpo/loan-programs-office>

151 Department of Energy, State Energy Program (SEP) Funding, accessed May 2025, <https://afdc.energy.gov/laws/317>

152 Environmental Protection Agency, Clean Water State Revolving Fund (CWSRF), accessed May 2025, <https://www.epa.gov/cwsrf>

roads or water utilities).

- Green bonds are specifically earmarked for environmentally beneficial projects.

Both state and local governments can issue bonds, although the process typically requires voter approval or legislative authorization. Entities such as municipalities, counties, transit authorities, school districts, and special districts (e.g., water, flood control, or energy districts) frequently use bonds to fund projects with long lifespans and public benefit. For example, a local government might issue general obligation bonds to upgrade public school HVAC systems for energy efficiency or construct solar-covered parking facilities at civic centers, while a state agency could use revenue bonds to fund new electric vehicle charging networks along highways, with repayment linked to fees or utility revenues.

Bonds are well suited to fund measures that involve capital-intensive infrastructure, such as renewable energy installations (e.g., solar fields, geothermal plants), public transit modernization, large-scale building retrofits, and water efficiency projects. Green bonds are particularly aligned with the Plan's implementation measures, as their proceeds are restricted to projects with defined environmental outcomes, and their transparency can build public trust in climate spending. Due to their scale and long-term structure, bonds can play a foundational role in implementing state and local climate plans.

Grants

Grants are a critical tool for implementing small-scale local projects and large-scale regional initiatives and are especially valuable since they do not typically require repayment. Grants are provided by federal, state, local or philanthropic entities and allocate funding for specific policy objectives or agendas. Grants are typically distributed as competitive awards or formula-based allocations, meaning recipients must either apply through a proposal process or qualify based on predetermined criteria.

At the state level, agencies may create their own grant programs funded by legislative appropriations or revenue. These funds can be used by a wide range of entities, including state and local governments, Tribes, regional agencies, nonprofits, utilities, universities, and community organizations, depending on the specific eligibility criteria.

Grants can fund a broad range of climate actions, including renewable energy installation, energy efficiency retrofits, building electrification, ZEV infrastructure, green jobs training, nature-based solutions, and more.

F.5 IMPLEMENTATION FUNDING

IMPLEMENTATION TIMELINE

#	Action #	Lead Dept.	Supporting Dept.	2020	2021	2022	2023	2024	2025	2030	2040	2050
TRANSPORTATION + LAND USE												
1	TLU-1	Align All Planning Policies & Regulations with ECAP Goals & Priorities	PBD	PW-SUS, DOT								
2	TLU-2	Align Permit and Project Approvals with ECAP Priorities	PBD	PW-SUS								
3	TLU-3	Take Action to Reduce & Prevent Displacement of Residents & Businesses	EWDD, HCD									
4	TLU-4	Abundant, Affordable, and Accessible Public Transit	DOT	PW			✓					✓
5	TLU-5	Create a Zero Emission Vehicle (ZEV) Action Plan	DOT	PW-SUS	✓							
6	TLU-6	Establish Temporary and Permanent Car-Free Areas	PBD	DOT, EWDD								
7	TLU-7	Rethink Curb Space	DOT	PBD								
8	TLU-8	Expand and Strengthen Transportation Demand Management Requirements	PBD	DOT								
9	TLU-9	Ensure Equitable and Clean New Mobility	DOT									
10	TLU-10	Expand Neighborhood Car Sharing	DOT							✓		
BUILDINGS												
11	B-1	Eliminate Natural Gas in New Buildings	PBD	PW-SUS			✓					
12	B-2	Plan for All Existing Buildings to be Efficient & All-Electric by 2040	PW-SUS	PBD		✓					✓	
13	B-3	Prevent Refrigerant Pollution	PW-SUS	PW-FAC			✓					
14	B-4	Reduce Lifecycle Emissions from Building Materials	PBD	PW-SUS			✓					
15	B-5	Require All Major Retrofits of City Facilities to be All-Electric	PW	PW-SUS	✓							
MATERIAL CONSUMPTION + WASTE												
16	MCW-1	Eliminate Disposal of Compostable Organic Materials to Landfills	PW-ZWP								✓	
17	MCW-2	Strengthen Infrastructure for Edible Food Recovery	PW-ZWP	HSD, OPRYD								
18	MCW-3	Eliminate Single-Use Plastics and Prioritize Reuse in Food Preparation, Distribution, and Sale	PW-ZWP				✓		✓			
19	MCW-4	Support the Reuse, Repair, Recovery, and Refurbishment Economy	PW-SUS	EWDD					✓			
20	MCW-5	Expand Community Repair Resources	OPL	EWDD						✓		
21	MCW-6	Establish a Deconstruction Requirement	PBD	PW-ZWP								
ADAPTATION												
22	A-1	Fund Creation and Operation of Resilience Hubs	CRO	PW-SUS		✓			✓			
23	A-2	Enhance Community Energy Resilience	PW-SUS	CRO								
24	A-3	Fund and Implement Citywide Vulnerability Assessment and Comprehensive Adaptation Plan	PBD, CRO	PW-SUS					✓			
25	A-4	Wildfire Risk Reduction	OFD, FIN	CRO								
26	A-5	Identify and Reduce Financial Risks from Climate Change	PW	CRO				✓				
27	A-6	Expand and Protect Green Infrastructure & Biodiversity	PW-WSM	OES, CRO			✓					
CARBON REMOVAL												
28	CR-1	Develop Local Carbon Investment Program	PW-SUS	EWDD, PBD			✓					
29	CR-2	Expand and Protect Tree Canopy Coverage	PW-PTS			✓						
30	CR-3	Rehabilitate Riparian Areas and Open Space	PW-WSM	CRO								
31	CR-4	Explore Carbon Farming	PW-SUS	PBD					✓			
32	CR-5	Assess Feasibility for Sequestration Incubator	EWDD	PW-SUS					✓			
33	CR-6	Explore Regional Aquatic Sequestration Opportunities	PW-SUS	EWDD, PW-WSM						✓		
CITY LEADERSHIP												
34	CL-1	Evaluate and Reduce Climate Impacts of City Expenditures and Operations	CAO	FIN, PW-SUS		✓	✓	✓	✓			
35	CL-2	Phase Out Fossil Fuel Dependency in City Agreements / Contracts	CAO	PW-SUS								
36	CL-3	Accelerate City Fleet Vehicle Replacement	PW-FL						✓	✓		
37	CL-4	Explore Creation of Public or Green Bank	FIN	PW-SUS								
38	CL-5	Establish the Oakland Climate Action Network to Support Inclusive Community Engagement on ECAP Implementation	PW-SUS	DRE	✓							
PORT OF OAKLAND												
39	P-1	Reduce Emissions from Port Vehicles and Equipment	Port			✓		✓				
40	P-2	Reduce Emissions from Electricity	Port				✓					
Total # of Actions Needed to Be Completed By Target Year:				2	1	5	9	3	8	5	1	1
Abbr. Department												
CAO	City Administrator's Office			OES	Office of Emergency Services			PW-FAC	PW - Facilities			
CRO	Office of Resilience			OFD	Oakland Fire Department			PW-FL	PW - Fleet			
DOT	Oakland Department of Transportation			OPL	Oakland Public Library			PW-PTS	PW - Parks and Tree Services Division			
EWDD	Economic and Workforce Development Department			OPRYD	Oakland Parks, Recreation, & Youth Develop			PW-SUS	PW - Sustainability Program			

APPENDIX G: WORKFORCE ANALYSIS

CONTENTS

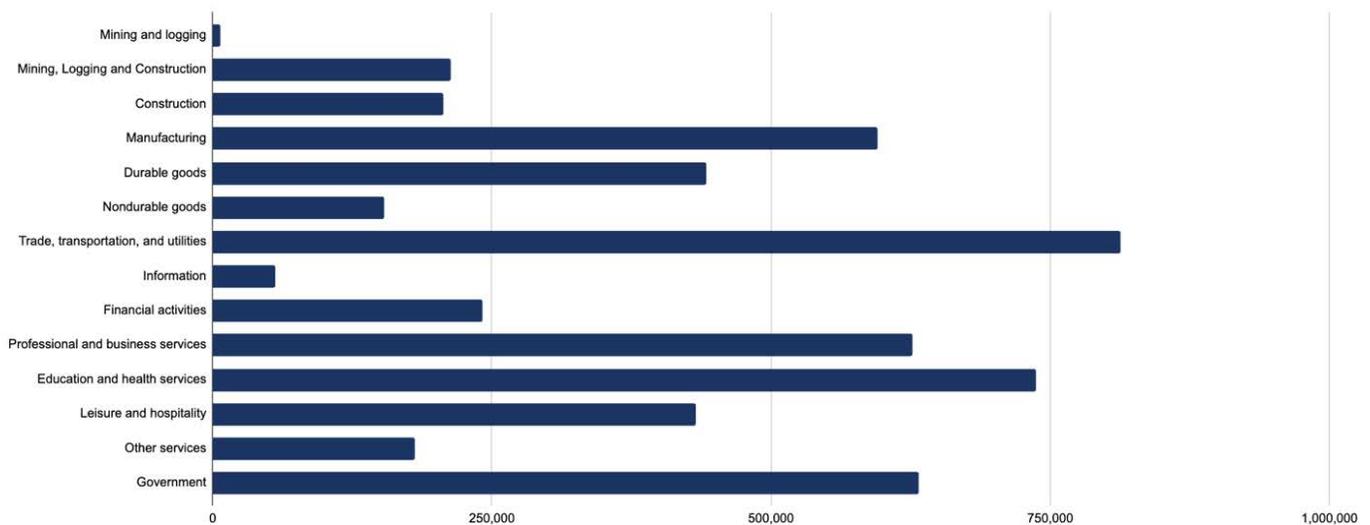
- G.1 – Current Labor Market Area Characteristics
- G.2 – Workforce Projections and Future Needs
- G.3 – Solutions and Partnerships
- G.4 – Training and Reskilling Programs
- G.5 – Tracking and Measuring Workforce Progress

G.1 CURRENT LABOR MARKET AREA CHARACTERISTICS

G.1.1 Labour Market

The labor market in Michigan is dominated by jobs in manufacturing; trade, transportation, and utilities; education and health services; professional and business services; and government.

Figure G.1 Employment by Sector in Southeast Michigan



The 2023 Michigan industry workforce analysis reports identify key sectors for development and growth. Four sectors directly relevant to the implementation of the Plan are the construction, manufacturing, energy, and mobility sectors.

Construction Workforce

Employment in the construction industry is growing rapidly, outpacing most other sectors. Construction jobs tend to offer salaries above the state average. Many of these positions do not require post-secondary education and instead emphasize on-the-job training or apprenticeships. The industry employs a higher percentage of individuals without a high school diploma compared to the state average. It remains a male-dominated field.

Manufacturing Workforce

Employment in manufacturing has increased at a faster rate than overall employment, although

it remains below pre-COVID-19 levels. Salaries in this sector are generally higher than the state average. The automotive subsector is the largest within manufacturing and offers wages above the state average. The sector hosts a significant number of registered apprenticeships, although its workforce is less diverse than that of other industries. The Detroit metro area leads the State of Michigan in the number of apprenticeships. Manufacturing tends to employ an older working-age population and offers many jobs that require only a high school diploma or less, along with on-the-job training.

Energy Workforce

The energy sector is experiencing strong growth and offers salaries that are substantially higher than the state average. Many key occupations in this sector require only a high school diploma or less, paired with on-the-job training. It is a male-dominated field, and across all roles, men earn more than women. Women in this sector often need higher levels of education to earn comparable wages.

Mobility Industry

The mobility sector is experiencing slower growth than other key industries. However, salaries remain above the state average. It is also a male-dominated field, with most employment opportunities concentrated in the Metro Detroit area and limited availability in northern rural regions. The workforce in this sector tends to be older.NA

F.1.2 Michigan Workforce Development Plan¹⁵³

The 2025 state-wide workforce development plan identifies three pillars to guide workforce development across Michigan:

1. Help more Michiganders earn a skills certificate or a degree
2. Increase access to opportunities that grow the middle class
3. Support business and entrepreneurial growth through talent solutions

Overall, Michigan is seeing growth in the job market, particularly in healthcare, hospitality and tourism, construction, manufacturing, mobility, and IT. Employees with educational or skills certifications, or degrees tend to have higher wages. Individuals without a high school diploma have the lowest rates of participation in the labor force when compared with those with a diploma, or higher levels of education.

G.2 WORKFORCE PROJECTIONS AND FUTURE NEEDS

G.2.1 Key Industries and Priority Occupations by Sector

This section identifies key occupations in each sector: energy, buildings, transportation, industry, waste, and working and natural lands. The occupations shown in the table below are the priority occupations required to implement the identified climate measures. However, this is not an exhaustive list and there are likely other occupations not shown that are required for the implementation of climate measures.

¹⁵³ Michigan Department of Labor and Economic Opportunity, Michigan Statewide Workforce Plan, (Lansing: Michigan Workforce Development Board, 2024). <https://www.michigan.gov/leo/-/media/Project/Websites/leo/Documents/MWDB/MI-State-Workforce-Plan.pdf?rev=c625cfcf3a314189be93694c987cf65e>.

Table G.1 Priority occupations by sector. ¹⁵⁴

Sectors	Description	Priority Occupations
Energy	Occupations related to renewable energy generation and power systems	<ul style="list-style-type: none"> • Construction laborers • Geothermal technicians • Solar photovoltaic installers • Wind turbine service technicians
Buildings	Occupations involved in energy-efficient building design, construction, retrofitting, HVAC, and weatherization	<ul style="list-style-type: none"> • Civil engineers • Construction and building inspectors • Electricians • Heating and air-conditioning mechanics and installers • Weatherization installers and technicians
Transportation	Occupations related to vehicles, public transit, logistics and infrastructure	<ul style="list-style-type: none"> • Automotive engineering technicians • Bus and truck mechanics and diesel engine specialists • Logistics analysts • Transportation engineers • Transportation planners
Industry	Occupations in manufacturing, engineering, production, and related operations	<ul style="list-style-type: none"> • Chemical engineers • Commercial and industrial designers • Electrical engineers • Industrial engineers • Machinists • Manufacturing production technicians
Waste	Occupations focused on recycling, waste removal, landfill gas, and wastewater	<ul style="list-style-type: none"> • Environmental engineers • Methane/landfill gas generation system technicians • Recycling coordinators • Water/wastewater engineers
Working and natural lands	Occupations related to land conservation, forestry, and wetland protection	<ul style="list-style-type: none"> • Environmental restoration planners • Forest and conservation technicians • Hydrologists • Soil and water conservationists

Southeast Michigan has a current labor pool of residents employed in the above occupations. The next table provides an overview of the current and projected employment trends for those occupations.

154 O*NET (2024).

Table G.2 Employment trends in priority energy occupations for Michigan. Source: O*NET (2024).¹⁵⁵

Sectors	Occupation	Total Employment (2022)	Median Wage (2024)	Projected Employment (2032)
Energy	Construction laborers	39,040	\$48,670	39,750
Energy	Geothermal technicians	5,540	\$46,030	5,460
Energy	Solar photovoltaic installers	200	\$54,860	250
Energy	Wind turbine service technicians	ND	\$60,920	ND, growing
Buildings	Civil engineers	7,540	\$85,550	7,790
Buildings	Construction and building inspectors	3,920	\$69,890	3,710
Buildings	Electricians	27,560	\$62,350	28,900
Buildings	Heating and air-conditioning mechanics and installers	10,260	\$60,090	10,730
Buildings	Weatherization, installers, and technicians	770	\$50,170	780
Transportation	Automotive engineering technicians	8,090	\$63,130	8,170
Transportation	Bus and truck mechanics and diesel engine specialists	8,530	\$59,270	8,380

155 "O*NET OnLine," 2025., <https://www.onetonline.org/>.

Sectors	Occupation	Total Employment (2022)	Median Wage (2024)	Projected Employment (2032)
Transportation	Logistics analysts	7,850	\$80,000	9,160
Transportation	Transportation engineers	7,540	\$85,550	7,790
Transportation	Transportation planners	540	\$78,960	550
Industry	Chemical engineers	830	\$106,690	900
Industry	Commercial and industrial designers	3,200	\$85,460	3,300
Industry	Electrical engineers	9,900	\$102,990	10,180
Industry	Industrial engineers	26,410	\$99,680	29,100
Industry	Machinists	23,940	\$49,930	23,830
Waste	Environmental engineers	2,580	\$100,090	2,790
Waste	Recycling coordinators	15,250	\$59,170	15,490
Waste	Water/wastewater engineers	7,540	\$85,550	7,790
Agriculture and Natural Lands	Environmental restoration planners	2,640	\$76,670	2,750
Agriculture and Natural Lands	Forest and conservation technicians	510	\$53,730	520

G.2.2 Review of Climate Measures and Workforce Implications

The implementation of the Plan will result in large direct and indirect impacts on employment opportunities in Southeast Michigan. The plan offers 698,000 direct person-years of employment through building retrofits, new construction of homes and non-residential buildings, conversions to electrical space heating and cooling with heat pumps, expansion of trail networks, industrial efficiency improvements, and renewable energy installations. The person-years of employment projected by 2050 for the implementation of each of the actions in the Plan are shown annually in Figure G.2, and cumulatively for the entire period in Table G.3, and in Figure G.2.

Figure G.2 Person-years of employment resulting from the implementation of the Plan.

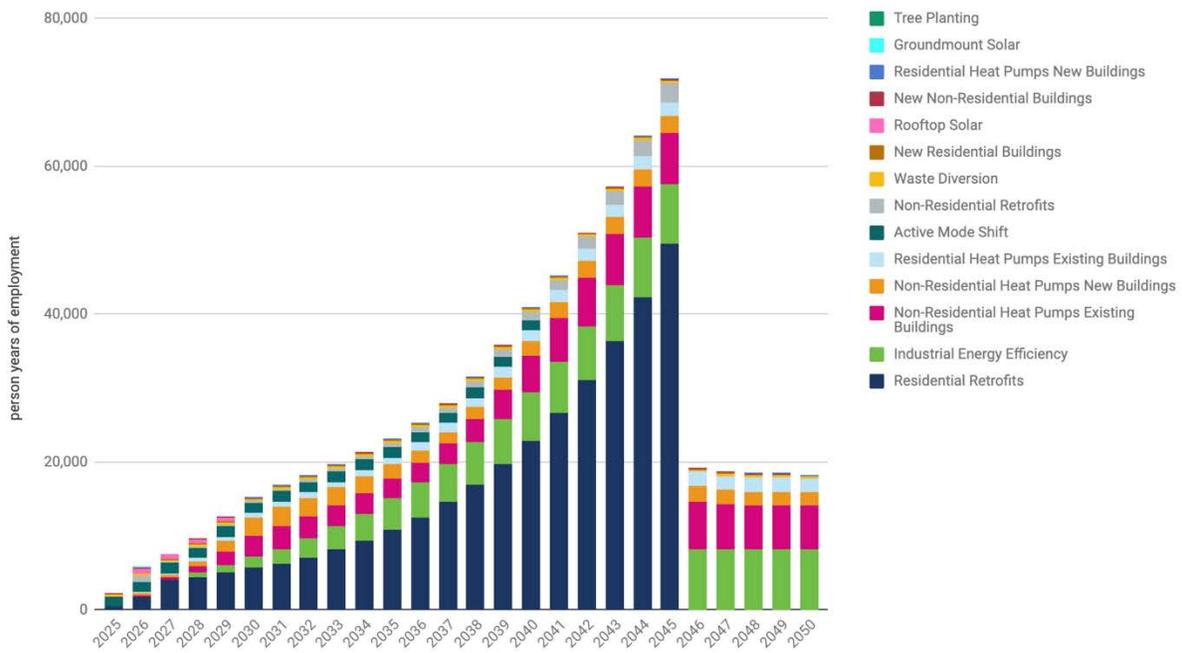


Table G.3 Employment by action from 2025–2050

Big Move	Actions	Workforce Demand (person-years of employment)
Healthy, Efficient Buildings	Retrofit all homes	335,421
	Retrofit all non-residential buildings	17,257
	Use electric heat exchange systems for space and water heating in existing buildings	131,315
	Infill development in Detroit	NA

Big Move	Actions	Workforce Demand (person-years of employment)
Healthy, Efficient Buildings	New homes are smaller	NA
	New non-residential buildings are net-zero emissions	3,435
	New homes are net-zero emissions	2,070
	Use electric heat exchange systems for space water heating in new buildings	48,435
Modernizing Mobility	Increase active transportation	22,000
	Increase transit and train ridership	NA
	Replace all buses with electric buses	NA
	Replace all personal light and medium-duty ICE vehicles with EVs	NA
	Replace all heavy-duty vehicles with zero emissions models	NA
	Replace all offroad vehicles with electric models	NA
	Replace port equipment and vehicles with electric models. Require docked ships to use only electricity	NA
	Replace freight ships with zero-emissions ships.	NA
	Zero-emissions rail	NA
LED street, traffic, park, stadium, and sports field lighting	NA	

Big Move	Actions	Workforce Demand (person-years of employment)
Expanding Renewable Energy	Rooftop solar PV systems	2,397
	Ground mount solar PV systems	238
	Energy storage	NA
	Ann Arbor's electricity grid emissions reduced	NA
	Reduce and replace natural gas with RNG	NA
Innovation in Industry	Green hydrogen	NA
	Industrial efficiency improvements	126,503
	Reduce cement and lime manufacturing emissions Reduce steel manufacturing emissions	
Sustainable Waste Management	Reduce waste	8,047
	Anaerobic digesters for wastewater treatment	NA
	Zero-emissions fuels for water and wastewater facilities	NA
Optimizing Natural and Working Lands	Tree Planting and wetland protection	19

G.3 SOLUTIONS AND PARTNERSHIPS

G.3.1 Workforce Development Solutions

The Michigan Workforce Development Plan aligns well with the employment needs that result from the implementation of the Plan. Many of the employment opportunities are in high-paying sectors, including construction, manufacturing, and energy resources.

Currently, these sectors are male dominated, with very few women employed. By focusing on increasing the diversity of the workforce in these sectors, the region will be able to maximize local employment opportunities, while ensuring that all residents can benefit from the green economy.

Increasing access to opportunity, as well as ensuring that new jobs are good quality are stated

goals of the Workforce Development Plan, and these goals should be centered in workforce development planning and resource development in the near future, as implementation of the Plan is initiated.

G.3.2 Good Jobs Principles

During the planning and implementation of climate actions, build quality jobs into the project planning process. High-quality jobs are those that provide stable pay, job security, safe working conditions, and secure benefits to support workers and their families.

Support employers in reducing barriers to accessing high-quality jobs by removing unnecessary hiring requirements, providing reasonable accommodations to individuals with disabilities during the hiring process, recruiting from communities underrepresented in the workforce, and providing transparent pay schedules with equal wages and career ladders.

In 2022, the U.S. Department of Commerce and Department of Labor partnered to define what makes a good job. The “Good Jobs Principles” provide a framework for employers, workers, and governments for creating stable, secure jobs with livable wages and safe working conditions. The eight principles are outlined below and can be a guide for developing future workforce development programs, training, job support, and recruitment initiatives.

Recruitment and hiring: Qualified applicants are actively recruited. Applicants are free from discrimination, including unequal treatment or application of selection criteria that are unrelated to job performance. Applicants are evaluated with relevant skills-based requirements. Unnecessary credentials and educational and experience requirements are minimized.

Benefits: Full-time and part-time workers are provided benefits that promote economic security and mobility. These include health insurance; a retirement plan; workers’ compensation benefits; work-family benefits, such as paid leave and caregiving support; and others that may arise from engagement with workers. Workers are empowered and encouraged to use these benefits.

Equal opportunity: All workers have equal opportunity. Workers are respected, empowered, and treated fairly. Individuals from underserved communities do not face systemic barriers in the workplace. Underserved communities are persons adversely affected by persistent poverty, discrimination or inequality, including Black, Indigenous, people of color; LGBTQ+ individuals; women; immigrants; veterans; military spouses; individuals with disabilities; individuals in rural communities; individuals without a college degree; individuals with or recovering from substance use disorder; and justice-involved individuals.

Empowerment and representation: Workers can form and join unions. Workers can engage in protected, concerted activity without fear of retaliation. Workers contribute to decisions about their work, how it is performed and organizational direction.

Job Security and working conditions: Workers have a safe, healthy, and accessible workplace, built on input from workers and their representatives. Workers have job security without arbitrary or discriminatory discipline or dismissal. They have adequate hours and predictable schedules. The use of electronic monitoring, data and algorithms is transparent, equitable and carefully deployed with input from workers. Workers are free from harassment, discrimination, and retaliation at work. Workers are properly classified under applicable laws. Temporary or contractor labor solutions are minimized.

Organizational culture: All workers belong, are valued, contribute meaningfully to the organization and are engaged and respected, especially by leadership.

Pay: All workers are paid a stable and predictable living wage before overtime, tips, and commissions. Workers’ pay is fair, transparent, and equitable. Workers’ wages increase with increased skills and experience.

Skills and career advancement: Workers have equitable opportunities and tools to progress to future good jobs within their organizations or outside them. Workers have transparent promotion or advancement opportunities. Workers have access to quality employer- or labor-management-provided training and education.

G.4 TRAINING AND RESKILLING PROGRAMS

G.4.1 Existing Resources

The list below includes current programs, policies, initiatives, and resources that can be leveraged and grown to meet future workforce needs. Other partners are also described in the Implementation section of this report.

Name	Coordinating Agency	Resource Type	Description
NATIONAL RESOURCES			
Reentry Employment Opportunities	U.S. Department of Labor	Funding	The Reentry Employment Opportunities (REO) program provides funding for youth and young adults and adults who were formerly incarcerated. ¹⁵⁶
Workforce Pathways for Youth	U.S. Department of Labor	Job Training, Workforce Development	The Workforce Pathways for Youth (WPY) program expands job training and workforce activities for youth, including soft-skill development, career exploration, job readiness and certification, summer jobs, year-round job opportunities, and apprenticeships in out-of-school time organizations nationwide. ¹⁵⁷
Youth Connections	U.S. Department of Labor	Online Learning Tool	The Youth Connections Community is an online learning destination for public workforce system staff and partners who serve youth in the Workforce Innovation and Opportunity Act (WIOA) Youth Program. ¹⁵⁸

¹⁵⁶ U.S. Department of Labor. Reentry Employment Opportunities. Available at: <https://www.dol.gov/agencies/eta/reentry>.

¹⁵⁷ U.S. Department of Labor. Workforce Pathways for Youth. Available at: <https://www.dol.gov/agencies/eta/youth/workforce-pathways-for-youth>.

¹⁵⁸ U.S. Department of Labor, Employment and Training Administration. Workforce GPS Youth Connections. Available at: <https://youth.workforcegps.org/>.

Name	Coordinating Agency	Resource Type	Description
NATIONAL RESOURCES			
YouthBuild	U.S. Department of Labor	Online Learning Tool, Resources	The YouthBuild Community is a shared electronic space where grantees can support each other in implementing successful programs, sharing tools, and fostering partnerships. ¹⁵⁹
Career Pathways	U.S. Department of Labor	Online Learning Tool, Resources	The Career Pathways Community helps workforce development leaders, practitioners, and policymakers expand state and local career pathways efforts currently underway or being planned. ¹⁶⁰
Building Pathways to Infrastructure Jobs	U.S. Department of Labor	Funding	Administered by the Department of Labor’s Employment and Training Administration, the grants enable public-private partnerships to develop, implement, and scale worker-centered programs that train people for in-demand jobs in advanced manufacturing, information technology, and professional, scientific and technical service occupations. ¹⁶¹
Map a Career in Clean Energy	U.S. Department of Energy	Interactive Career Mapping Tools	This interactive mapping tool showcases careers in clean energy based on your education and experience. The user can explore opportunities in advanced manufacturing, bioenergy, green buildings, hydrogen and fuel cells, hydropower, marine energy, solar, and wind. ¹⁶²

159 U.S. Department of Labor, Employment and Training Administration. Workforce GPS YouthBuild. Available at: <https://youthbuild.workforcegps.org/>.

160 U.S. Department of Labor, Employment and Training Administration. Workforce GPS Career Pathways. Available at: <https://careerpathways.workforcegps.org/>.

161 U.S. Department of Labor. (2024). Department of Labor announces approximately \$35M in additional funding available for 2nd round of Building Pathways to Infrastructure Jobs grants. Available at: <https://www.dol.gov/newsroom/releases/eta/eta20240515>.

162 U.S. Department of Energy. Map a Career in Clean Energy. Available at: <https://www.energy.gov/eere/jobs/map-career-clean-energy>.

Name	Coordinating Agency	Resource Type	Description
NATIONAL RESOURCES			
Better Buildings Accelerator	U.S. Department of Energy	Partner Networks	Better Buildings Accelerators are collaborative peer-to-peer networks designed to facilitate learning and leadership opportunities that result in new strategies and practices in clean energy deployment. Accelerators focus on partner-identified areas that aim to overcome persistent barriers to clean energy options. ¹⁶³
STATE AND LOCAL RESOURCES			
Going PRO Talent Fund	Michigan Department of Labor and Economic Opportunity	Funding	Provides grants to employers to train current employees, new hires, or apprentices. ¹⁶⁴
Michigan Works!	MichiganWorks! Association	Training, Resources	Provides jobseekers with training, support and services, helps them to find new employment, and obtain credentials
Michigan Workforce Development Institute (MWDI)	Michigan Workforce Development Institute	Training, Networks, Resources	Provides services to jobseekers and employers to help with training, placement assistance, and employee retention. ¹⁶⁵
Consultation Education and Training (CET) Grant Program	MIOSHA	Funding	Supports health and safety training for small- and medium-sized companies to reduce cost barriers

163 U.S. Department of Energy. Better Buildings Accelerators. Available at: <https://betterbuildingsolutioncenter.energy.gov/accelerators>.

164 "Going PRO Talent Fund," n.d., <https://www.michigan.gov/leo/bureaus-agencies/wd/programs-services/going-pro-talent-fund>.

165 "Michigan Workforce Development Institute | Premier Workforce Development in Southeast and Southwest Michigan.," n.d., https://miwdi.org/?utm_source=chatgpt.com.

Name	Coordinating Agency	Resource Type	Description
STATE AND LOCAL RESOURCES			
SEMCA Michigan Works!	SEMCA Michigan Works!	Resources	Provides access to career resources, job postings, retraining resources, HR agencies, and financial aid. ¹⁶⁶
Detroit Training Center	Detroit Training Center	Education	Education in construction, manufacturing, and transportation.
Going PRO Talent Fund	Detroit At Work	Funding	Grants for training, and employee development that leads to a credential
Detroit At Work	Detroit At Work	Education	Free job training in construction, skilled trades, IT, and pre-apprenticeship readiness. ¹⁶⁷
LIFT	Department of Defense	Education	Free training for low-to-moderate income Wayne County residents in robotics, welding, and CNC. ¹⁶⁸
Michigan Reconnect	Macomb Community College	Education, Funding	Scholarship program for adults to attend community college to obtain a degree or certificate. ¹⁶⁹

G.5 TRACKING AND MEASURING WORKFORCE PROGRESS

To ensure that workforce initiatives are meeting their intended audience, providing successful career and training outcomes and meeting the Good Jobs Principles, program progress will need to be measured and tracked consistently over time. The types of metrics tracked will depend upon the types of workforce initiatives, the availability of data and the frequency with which data can be tracked and updated. These metrics can also be supported through the collection of qualitative data from regular meetings with industry leaders, community organizations, policy makers, and workers in green industries. This can provide additional insight into workforce initiatives and ensure alignment with workforce goals and needs.

Key performance metrics will need to be refined during the program design and planning process. Metrics will be developed in partnership with workforce development partners to determine what can feasibly be tracked and who will be responsible for tracking, maintaining, and sharing the metrics, as needed. Potential key performance metrics are included in Table G.5.

166 SEMCA Michigan Works!, "Employment Services - SEMCA Michigan Works!," January 30, 2020, https://www.semcamworks.org/program/employment-services/?utm_source=chatgpt.com.

167 Goran, "Training," Detroit at Work, September 12, 2025, <https://detroitatwork.com/training>.

168 Joe Steele, "LIFT Launches No-Cost Skilled Trades Training Program for Low-Income Wayne County Residents - LIFT," LIFT, February 13, 2023, https://lift.technology/lift-launches-no-cost-skilled-trades-training-program-for-low-income-wayne-county-residents/?utm_source=chatgpt.com.

169 "Michigan Reconnect - Macomb Community College," n.d., https://www.macomb.edu/admissions-aid/paying-for-college/michigan-reconnect.html?utm_source=chatgpt.com.

Table G.5 Potential key performance metrics for workforce initiative evaluation.

Metric Type	Example Key Performance Metrics
Workforce Initiatives	<ul style="list-style-type: none"> • Number of new workforce initiatives • Number of expanded workforce initiatives • Total number of workforce initiatives
Job Creation	<ul style="list-style-type: none"> • Number of jobs created annually, by sector
Transitional Workforce	<ul style="list-style-type: none"> • Number of participants with full-time employment completing green job training programs • Number of workers transitioning to clean energy industries • Demographic breakdown of displaced and retrained workers
Job Quality	<ul style="list-style-type: none"> • Proportion of full-time versus part-time or contract positions • Retention rates within green industries • Availability of career advancement pathways and wage growth potential • Access to professional development and training • Availability of benefits such as healthcare, retirement plans and paid leave. • Median annual wages in green sectors compared to the overall median wage

APPENDIX H: DATA, METHODS, AND ASSUMPTIONS

CONTENTS

- H.1 – Modeling Tool
- H.2 – Modeling the Scenarios
- H.3 – Common to All Scenarios
- H.4 – 2019 GHG Inventory

H.1 MODELING TOOL

The scenarios were modeled using the consulting team’s ScenaCommunity model. ScenaCommunity is an integrated, multi-fuel, multi-sector, partially disaggregated energy systems, emissions, and finance model for cities.

H2 MODELING THE SCENARIOS

The ScenaCommunity spatial energy and emissions modeling tool was used to develop the BAU, BAP and RE Scenario using the assumptions and actions described in Table H.1.

Table H.1 Modeling assumptions and actions for BAU, BAP and RE Scenarios.

SOURCE AND CAUSE OF EMISSION	BAU SCENARIO ASSUMPTION	BAP SCENARIO ASSUMPTION	RE SCENARIO ASSUMPTION
New Home Construction	82,080 new housing units will be built across all regions by 2050. The types of residences (i.e., single-family, apartments or condos) will be the same as they were for each county in 2023, as provided in SEMCOG’s 2050 Regional Development Forecast, and in the US Census for Lapeer County.		30% of new city residents in Detroit will be housed in infill or redevelopment, currently vacant buildings between 2025 and 2045. ¹⁷⁰
Number of Non-Residential Buildings Constructed	Non-residential buildings will continue to grow at the rate of growth experienced in 2023, adjusted for forecast economic growth.	In addition to the BAU assumption, the Nel Hydrogen industrial facility will be added.	All new residential, commercial, municipal, and industrial buildings are net-zero ready by 2035; by 2030 for county and local government buildings, and new buildings in Ann Arbor.
Energy Efficiency of Buildings Constructed in the Future.	New buildings are constructed to 2015 building and energy code until 2050.	Beginning in 2026, new buildings are built to the 2021 building and energy code. This continues until 2050.	All new residential, commercial, municipal, and industrial buildings are net-zero ready by 2035; by 2030 for county and local government buildings, and new buildings in Ann Arbor.
Energy Efficiency of Existing Buildings	Buildings will continue to use the same amount of energy as currently, adjusted only for changes in heating and cooling days as a result of climate change.	In Detroit, buildings over 25,000 sq ft will reduce energy consumption by 7% by 2027. By 2030, 8 large industrial buildings will use 25% less energy and 9731 single-family homes will use 15% less energy. All other buildings in the region will not have energy improvements.	All existing residential, commercial, municipal, and industrial buildings are retrofitted to improve energy savings of 50% by 2045.
Space and Water Heating and Cooling Systems in Buildings	Systems will be kept the same as they are currently until 2050, replaced with equivalent systems at the end of life.	In Ann Arbor, heat pump adoption will continue to increase at the rate experienced in 2023. Elsewhere, heat pumps will continue to increase at 11% annually (as indicated by the IEA).	In Ann Arbor, all buildings use heat pumps only for space and water heating and cooling by 2030. Elsewhere in Washtenaw County this is achieved by 2035. Elsewhere in the region, beginning in 2030 all new buildings will use heat pumps only for space and water heating and cooling, and by 2045 all existing buildings will have been converted to heat pumps only for space and water heating and cooling.

170 This action is recommended but was not modeled for this Plan.

SOURCE AND CAUSE OF EMISSION | **BAU SCENARIO ASSUMPTION**

BAP SCENARIO ASSUMPTION

RE SCENARIO ASSUMPTION

Transit Fleet Vehicles	The transit fleet will use the fuel types as they do currently until 2050. Vehicles will be replaced with equivalents every 15 years. The total fleet will grow only in proportion to the population.		Buses will gradually transition to electric models by 2040; all buses will be electric.
Number of Trips Taken by Transit	The share of trips taken by transit will remain as it was in 2019 until 2050, as indicated by U.S. Federal Highway Administration data.	A small increase in transit ridership (as shown in the 2023 RTA Regional Transit Master Plan Update and SEMCOG’s transportation modeling) will occur between 2025 and 2050.	
Active transportation trips taken	The share of trips taken using active modes of transportation will remain as it was in 2019 until 2050.	A small increase in active transportation trips (as shown in the 2023 RTA Regional Transit Master Plan Update and SEMCOG’s transportation modeling) will occur between 2025 and 2050.	By 2050, 10% of trips 1–15 miles long are completed by transit. 5% of trips less than 5 miles are completed by walking and biking.
Number of Personal and Commercial Vehicles Owned	The number of vehicles owned per person or per commercial operation will remain as it was in 2019 until 2050. The total number of vehicles registered will increase with population and economic growth.		
Personal and Commercial Light and Medium-Duty Vehicles	LDV and MDV vehicle types and fuel shares will remain the same as they were in 2019 until 2050. Vehicles will be replaced with equivalent models every 15 years.	Share of H2 vehicles will remain the same as 2019 until 2050. In Ann Arbor EV uptake of LDVs and MDVs will increase 28% annually. Elsewhere, hybrids, PHEVs and BEVs will constitute 51% of new vehicles by 2030 and continue rising at the same rate.	Share of H2 vehicles will remain the same as 2019 until 2050. 50% of all new LDVs and MDVs will be BEVs by 2030; this will increase to 100% by 2035. All ICE vehicles will be retired or converted to ZEVs after 15 years or by 2050 at the latest.
Heavy-Duty Vehicles	HDV vehicle types and fuel shares will remain as they were in 2021 until 2050. Vehicles will be replaced with equivalent models every 15 years.	Share of H2 vehicles will remain the same as 2019 until 2050. Share of H2 vehicles will remain the same as 2019 until 2050. In Ann Arbor EV uptake of HDVs will increase 28% annually. Elsewhere, hybrids, PHEVs and BEVs will constitute 51% of new vehicles by 2030 and continue rising at the same rate.	By 2040, 100% of new HDVs will be ZEVs. 50% of them will be H2 fuel cell vehicles and 50% will be electric.
Offroad Vehicles	Offroad vehicles will continue to use the same fuels as they did in 2019 until 2050.	Offroad vehicles will continue to use the same fuels as they did in 2019 until 2050.	The share of offroad vehicles that are electric will gradually increase until it reaches 100% in 2040.
Freight and passenger Trains	Trains will continue to use the same fuels as they did in 2019 until 2050.	Trains will continue to use the same fuels as they did in 2019 until 2050.	By 2040, all passenger rail engines will be electric, and all freight rail engines will use green hydrogen.

SOURCE AND CAUSE OF EMISSION

BAU SCENARIO ASSUMPTION

BAP SCENARIO ASSUMPTION

RE SCENARIO ASSUMPTION

Port Vehicles and Equipment and Freight Ships

All port vehicles and equipment and all ships will use the same fuels as they do currently until 2050.

All port vehicles and equipment and all ships will use the same fuels as they do currently until 2050.

40% of cargo-handling equipment will be converted to electric models by 2028; this will rise to 80% by 2034. By 2038 100% of vehicles and equipment will be zero-emissions models. By 2040, all freight ships will be powered by H2 when not docked, and will use only zero-emissions electricity while docked in ports in Southeast Michigan.

Industrial sector processes improvements

Current efficiency held constant from base year.

Industrial processes are 50% more efficient by 2045, with a target of 50% emissions reductions by 2035 and zero emissions by 2050 for the steel industry, and a 50% emissions reduction from cement and lime manufacturing by 2035.

Waste management improvements

Food waste is reduced by 50% by 2030, and recycling is increased from 15% to 45% by 2030.

100% of organics will be diverted from landfills by 2030 in 15 select cities. Region-wide waste will be reduced by 45% by 2035.

Switch new and existing buildings to heat pumps, heat pump water heaters and electrified equipment and appliances

Current equipment fuel shares and efficiency held constant from base year.

Replace space heating, space cooling, and water heating systems with heat pumps. Electrify appliances and auxiliary equipment.

Electrify personal-use vehicles

The light-duty electric vehicle stock is held proportional to population growth.

By 2030, 50% of all new personal light and medium-duty vehicles will be electric, by 2035 100% of new personal vehicles will be electric. All fossil fuel-powered vehicles will be retired by 2050.

Switch commercial vehicles to low-emissions fuel

5% of light-duty vehicle stock is electric by 2050.

By 2035, all new commercial, light-duty vehicles sold are electric. By 2040, all new mid-to-heavy-duty vehicles, 50% will be electric, 50% will be hydrogen.

Switch mid-to-heavy-duty vehicles to zero-emissions fuel

No change.

Shift to hydrogen- powered vehicles.

Grid updates

By 2050, Southeast Michigan will achieve net-zero grid emissions

75% of Ann Arbor's electricity emissions will decarbonize by 2030.

Rooftop solar

No additional renewables added.

Increase solar rooftop PV installations to 155MW on residential and commercial buildings, with 9.1 MW of battery storage across the region.

Convert blue hydrogen to green hydrogen

No change.

Blue hydrogen is replaced with hydrogen generation from renewable energy sources by 2030.

H.3 COMMON SCENARIOS

The ScenaCommunity spatial energy and emissions modeling tool was used to develop the BAU, BAP and RE Scenario using the assumptions and actions described in Table H.1.

Demographics	Between 2020 and 2050, assume there will be a 6.4% increase in population. County-specific projections from SEMCOG's 2050 Forecast Total Population Households and Employment were also incorporated.
Vehicle Lifespan	All vehicles will be assumed to have a lifespan of 15 years.
Projected Employment Distribution	Employment distribution was modeled to reflect the county-specific and industry-specific projections provided in SEMCOG's 2050 Regional Forecast.
Land Use Base Layer	Land use was based on SEMCOG's 2019 Land Use spatial layer, and assumed to remain unchanged except for 33,182 vacant acres expected to be developed by 2045, rising to 41,280 acres by 2050.
Climate Projections	The forecast increase in cooling degree days (CDDs) and decrease in heating degree days (HDDs) that are provided by the Climate Explorer for Wayne County and GLISA were used to determine increased building cooling requirements and decreased building heating requirements for all counties in the BAU, BAP and RE Scenarios.

Limitations

The methodology and results presented here do not and cannot fully account for all the factors that could shape the future of energy use and GHG emissions in Southeast Michigan. The resulting projections do not predict the future, but help us understand how different choices and changes could affect the path forward.

H.4 2019 GHG Inventory

GPC ref No.	Scope	GHG Emissions Source	Incl?	Reason for exclusion (if applicable)	CO ₂	CH ₄	N ₂ O	Total CO _{2e}
I		STATIONARY ENERGY SOURCES						
I.1		Residential buildings						
I.1.1	1	Emissions from fuel combustion within the city boundary	Yes		9,849,950	19,718	6,346	9,876,015
I.1.2	2	Emissions from grid-supplied energy consumed within the city boundary	Yes		7,562,856	21,986	29,205	7,614,047
I.1.3	3	Emissions from transmission and distribution losses from grid-supplied energy consumption	Yes		0	0	0	0
I.2		Commercial and institutional buildings/facilities						
I.2.1	1	Emissions from fuel combustion within the city boundary	Yes		4,629,718	2,594	2,694	4,635,006
I.2.2	2	Emissions from grid-supplied energy consumed within the city boundary	Yes		5,468,610	15,898	21,118	5,505,626
I.2.3	3	Emissions from transmission and distribution losses from grid-supplied energy consumption	Yes		0	0	0	0
I.3		Manufacturing industry and construction						
I.3.1	1	Emissions from fuel combustion within the city boundary	Yes		8,376,886	2,322	2,200	8,381,408
I.3.2	2	Emissions from grid-supplied energy consumed within the city boundary	Yes		9,601,826	27,914	37,078	9,666,818
I.3.3	3	Emissions from transmission and distribution losses from grid-supplied energy consumption	Yes		0	0	0	0

H.4 2019 GHG Inventory

GPC ref No.	Scope	GHG Emissions Source	Incl?	Reason for exclusion (if applicable)	CO ₂	CH ₄	N ₂ O	Total CO ₂ e
I.4		Energy industries						
I.4.1	1	Emissions from energy used in power plant auxiliary operations within the city boundary	No	NR	4,276	2	2	4,280
I.4.2	2	Emissions from grid-supplied energy consumed in power plant auxiliary operations within the city boundary	No	NR	0	0	0	0
I.4.3	3	Emissions from transmission and distribution losses from grid-supplied energy consumption in power plant auxiliary operations	No	NR	0	0	0	0
I.4.4	1	Emissions from energy generation supplied to the grid	No	NR	0	0	0	0
I.5		Agriculture, forestry, and fishing activities						
I.5.1	1	Emissions from fuel combustion within the city boundary	Yes		33,180	18	17	33,214
I.5.2	2	Emissions from grid-supplied energy consumed within the city boundary	No	NR	141,191	410	545	142,147
I.5.3	3	Emissions from transmission and distribution losses from grid-supplied energy consumption	No	NR	0	0	0	0
I.6		Non-specified sources						
I.6.1	1	Emissions from fuel combustion within the city boundary	No	NR	0	0	0	0
I.6.2	2	Emissions from grid-supplied energy consumed within the city boundary	No	NR	0	0	0	0
I.6.3	3	Emissions from transmission and distribution losses from grid-supplied energy consumption	No	NR	0	0	0	0

H.4 2019 GHG Inventory

GPC ref No.	Scope	GHG Emissions Source	Incl?	Reason for exclusion (if applicable)	CO ₂	CH ₄	N ₂ O	Total CO ₂ e
I.7		Fugitive emissions from mining, processing, storage, and transportation of coal						
I.7.1	1	Emissions from fugitive emissions within the city boundary	No	NR	0	0	0	0
I.8		Fugitive emissions from oil and natural gas systems						
I.8.1	1	Emissions from fugitive emissions within the city boundary	Yes		153	397,949	0	398,102
II		TRANSPORTATION						
II.1		On-road transportation						
II.1.1	1	Emissions from fuel combustion for on-road transportation occurring within the city boundary	Yes		21,469,679	47,013	143,895	21,660,588
II.1.2	2	Emissions from grid-supplied energy consumed within the city boundary for on-road transportation	Yes		7,782	23	30	7,835
II.1.3	3	Emissions from portion of transboundary journeys occurring outside the city boundary, and transmission and distribution losses from grid-supplied energy consumption	Yes		0	0	0	0
II.2		Railways						71,961
II.2.1	1	Emissions from fuel combustion for railway transportation occurring within the city boundary	Yes		62,121	97	6,320	68,537
II.2.2	2	Emissions from grid-supplied energy consumed within the city boundary for railways	Yes		3,401	10	13	3,424
II.2.3	3	Emissions from portion of transboundary journeys occurring outside the city boundary, and transmission	Yes		0	0	0	0

H.4 2019 GHG Inventory

GPC ref No.	Scope	GHG Emissions Source	Incl?	Reason for exclusion (if applicable)	CO ₂	CH ₄	N ₂ O	Total CO ₂ e
		and distribution losses from grid-supplied energy consumption						
II.3		Water-borne navigation						
II.3.1	1	Emissions from fuel combustion for waterborne navigation occurring within the city boundary	No	N/A	0	0	0	0
II.3.2	2	Emissions from grid-supplied energy consumed within the city boundary for waterborne navigation	No	N/A	0	0	0	0
II.3.3	3	Emissions from portion of transboundary journeys occurring outside the city boundary, and transmission and distribution losses from grid-supplied energy consumption	Yes		162,943	429	1,160	164,531
II.4		Aviation						
II.4.1	1	Emissions from fuel combustion for aviation occurring within the city boundary	No	N/A	0	0	0	0
II.4.2	2	Emissions from grid-supplied energy consumed within the city boundary for aviation	No	N/A	0	0	0	0
II.4.3	3	Emissions from portion of transboundary journeys occurring outside the city boundary, and transmission and distribution losses from grid-supplied energy consumption	No	N/A	0	0	0	0
II.5		Off-road						
II.5.1	1	Emissions from fuel combustion for off-road transportation occurring within the city boundary	Yes		1,700,510	104,948	23,167	1,828,625
II.5.2	2	Emissions from grid-supplied energy consumed within the city boundary for off-road transportation	No	NR	0	0	0	0

H.4 2019 GHG Inventory

GPC ref No.	Scope	GHG Emissions Source	Incl?	Reason for exclusion (if applicable)	CO ₂	CH ₄	N ₂ O	Total CO ₂ e
III		WASTE						
III.1		Solid waste disposal						
III.1.1	1	Emissions from solid waste generated within the city boundary and disposed of in landfills or open dumps within the city boundary	Yes		0	1,420,948	0	1,420,948
III.1.2	3	Emissions from solid waste generated within the city boundary but disposed of in landfills or open dumps outside the city boundary	Yes		0	27,856	0	27,856
III.1.3	1	Emissions from waste generated outside the city boundary and disposed of in landfills or open dumps within the city boundary	No	N/A	0	0	0	0
III.2		Biological treatment of waste						
III.2.1	1	Emissions from solid waste generated within the city boundary that is treated biologically within the city boundary	Yes		0	934	5,364	6,298
III.2.2	3	Emissions from solid waste generated within the city boundary but treated biologically outside of the city boundary	No	N/A	0	0	0	0
III.2.3	1	Emissions from waste generated outside the city boundary but treated biologically within the city boundary	No	N/A	0	0	0	0
III.3		Incineration and open burning						
III.3.1	1	Emissions from solid waste generated and treated within the city boundary	Yes		0	9	8,171	8,180

H.4 2019 GHG Inventory

GPC ref No.	Scope	GHG Emissions Source	Incl?	Reason for exclusion (if applicable)	CO ₂	CH ₄	N ₂ O	Total CO _{2e}
III.3.2	3	Emissions from solid waste generated within the city boundary but treated outside of the city boundary	No	N/A	0	0	0	0
III.3.3	1	Emissions from waste generated outside the city boundary but treated within the city boundary	No	N/A	0	0	0	0
III.4		Wastewater treatment and discharge						
III.4.1	1	Emissions from wastewater generated and treated within the city boundary	No	N/A	0	0	77,640	77,640
III.4.2	3	Emissions from wastewater generated within the city boundary but treated outside of the city boundary	Yes		0	0	0	0
III.4.3	1	Emissions from wastewater generated outside the city boundary	No	N/A	0	0	0	0
IV		INDUSTRIAL PROCESSES AND PRODUCT USE (IPPU)						
IV.1	1	Emissions from industrial processes occurring within the city boundary	Yes		2,285,956	0	0	2,285,956
IV.2	1	Emissions from product use occurring within the city boundary	No	NR	0	0	0	0
V		AGRICULTURE, FORESTRY AND LAND USE (AFOLU)						
V.1	1	Emissions from livestock within the city boundary	Yes		0	135,341	4,526	139,867
V.2	1	Emissions from land within the city boundary	No	NR	0	0	0	0
V.3	1	Emissions from aggregate sources and non-CO ₂ emission sources on land within the city boundary	Yes		0	0	147,950	147,950
VI		OTHER SCOPE 3						

H.4 2019 GHG Inventory

GPC ref No.	Scope	GHG Emissions Source	Incl?	Reason for exclusion (if applicable)	CO ₂	CH ₄	N ₂ O	Total CO ₂ e
VI.1	3	Other Scope 3	No	N/A	0	0	0	0
							TOTAL	74,095,639

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