COMPREHENSIVE CLIMATE ACTION PLAN

December 2025

ThriveTogether

A Sustainability Playbook for Greater Cincinnati



GREATER CINCINNATI

COMPREHENSIVE CLIMATE ACTION PLAN

December 2025

TABLE OF CONTENTS

List of Figures and Tables 3

Acknowledgements 5

Executive Summary 9

1. Introduction 12

1.1 CPRG Overview 12
1.2 CCAP Purpose and Scope 13
1.3 Approach to Developing the CCAP / Community Engagement 20

2. Regional GHG Inventory 25

2.1 Inventory Methodology 25
2.2 Inventory Results 28
2.3 Inventory Trends and Analysis 32

3. Reduction Targets 34

4. Business-as-Usual Projections 35

4.1 BAU Projection Methodology 36
4.2 BAU Projection Results 38

5. GHG Emission Reduction Measures & Implementation Scenario Projections 40

5.1 GHG Emission Reduction Measures Summary 41
5.2 Implementation Scenario Projections 42
5.3 Emission Reduction Measures 43

6. Benefits Analysis 54

6.1 Transportation Sector Co-Benefits 55
6.2 Electric Power Sector Co-Benefits 61
6.3 Buildings Sector Co-Benefits 64
6.4 Industrial Sector Co-Benefits 69

6.5 Waste, Water, and Sustainable Materials Management Sector Co-Benefits 72
6.6. Agricultural Sector Co-Benefits 75
6.7 Carbon Removal Sector Co-Benefits 78

7. LIDAC Benefits Analysis 83
7.1 Defining LIDAC Communities and Study Area 83
7.2 LIDAC Engagement 84
7.3 Vulnerability Index Framework 85
7.4 Climate Drivers and Health Impacts 85
7.5 Conclusion 90

8. Workforce Planning Analysis 92
8.1 Methodology 94
8.2 Current Workforce Landscape 95
8.3 Investment Into Green Workforce 97
8.4 Overall Findings 105
8.5 Job Growth Challenge 106
8.6 Pathways to Green Jobs 107
8.7 Recommendations 108

9.0 Appendixes 110

Appendix A: Youth Engagement Report 111

Appendix B: Senior Engagement Report 161

Appendix C: Climate Safe Neighborhoods Engagement Report 189

Appendix D: GHG Inventory Methodology 233

Appendix E: Implementation Scenario Projections Notes 237

Appendix F: LIDAC Analysis Report 249

Appendix G: Workforce Analysis Addendum 278

LIST OF FIGURES & TABLES

Figure 1 Map of Cincinnati Metropolitan Statistical Area 12

Figure 2 Spectrum of Community Engagement to Ownership 21

Figure 3 Plan Steering Committee Meeting Feb 7, 2024 22

Figure 4 GHG Inventory Methodology for Each Sector 26

Figure 5 2022 Emissions by Sector 28

Figure 6 2022 Emissions by Sector (Including External Impacts) 29

Figure 7 2022 Regional Energy Burden Dashboard 31

Figure 8 Emissions by County and Sector in 2022 31

Figure 9 Emissions by Sub-category in 2022 32

Figure 10 Emissions by Source and Fuel in 2022 33

Figure 11 BAU Scenario Projection by Sector 2022-2050 39

Figure 12 Projected GHG Emissions Reductions BAU vs Implementation 40

Figure 13 Implementation Scenario Projection by Sector 2022-2050 43

Figure 14 Map of LIDAC Census Tracts in Cincinnati MSA 83

Figure 15 Workforce Breakdown in Cincinnati MSA 96

Figure 16 Number of Projected Green Jobs 2020-2050 97

Figure 17 Transportation Sector Jobs Projected 2020-2050 99

Figure 18 Electric Power Sector Jobs Projected 2020-2050 100

Figure 19 Buildings Sector Jobs Projected 2020-2050 101

Figure 20 Industrial Sector Jobs Projected 2020-2050 102

Figure 21 Waste Sector Jobs Projected 2020-2050 103

Figure 22 Agricultural Sector Jobs Projected 2020-2050 104

Figure 23 Carbon Removal Sector Jobs Projected 2020-2050 105

Figure 24 Projected Job Increases by Sector 2020, 2030, and 2050 106

Table 1 Primary Data Sources and Methods for Each Sector 27

Table 2 Complete GHG Inventory and Projections by Sector 36

Table 3 BAU Scenario Projections by Sector for 2030 and 2050 39

Table 4 GHG Reduction Measures Summary by Sector 41

Table 5 Greenhouse Gas Reduction Measures 44-49

Table 6 Implementation Scenario Projections by Sector 2030 and 2050 51

Table 7 Climate Drivers and Associated Health Impacts 52

ACKNOWLEDGEMENTS

PLAN WORKING GROUP

OKI Regional Council of Governments – *Primary Lead for CCAP Development*
Andy Meyer, Senior Planner and Primary Lead
Travis Miller, Regional Planning Manager
Ava Kalina, Land Use Intern
Jacob Sheridan, Land Use Intern
Jacob Matson, Land Use Intern

City of Cincinnati Office of Environment & Sustainability
Howard Miller, Environmental Manager
Lauren Clark, Climate Resilience Technician

Green Umbrella
Van Sullivan, Senior Director of Programs and Climate Strategy
Bamidele Osamika, Regional Climate Collaborative Manager
Nobi Kennedy, Regional Climate Collaborative Coordinator

Indiana University Environmental Resilience Institute
William Brown, Asst. Director for Strategy & Engagement
Francisco Martinez Marquez, McKinney Climate Fellow
Gie Wilson, McKinney Climate Fellow
Noel Baker, McKinney Climate Fellow

Northern Kentucky ADD District
Jeff Thelen, Transportation Planner

Southwest Ohio Air Quality Agency
Brad Johnson, Director
Julie Donna, Sustainability Manager
Jack Mangan, Community Coordinator – Hamilton County ReSource

PLAN STEERING COMMITTEE

Boone County, KY

Bracken County, KY

Brown County, OH

Butler County, OH

Campbell County, KY

Center for Local Government

Cincinnati Children's Hospital

City of Aurora, IN

City of Batesville, IN

City of Blue Ash, OH

City of Cincinnati, OH

City of Covington, KY

City of Fairfield, OH

City of Hamilton, OH

City of Lebanon, OH

City of Middletown, OH

City of Newport, KY

City of Oxford, OH

City of Williamstown, KY

Clermont County, OH

Colerain Township

Dearborn County, IN

Dearborn County Chamber

Delhi Township

Duke Energy

Gallatin County, KY

Grant County, KY

Great Parks of Hamilton County

Greater Cincinnati Homeless Coalition

Greater Cincinnati Regional Food Policy Council

Groundwork Ohio River Valley

Hamilton County, OH

Hispanic Chamber of Cincinnati

Interact for Health

Kenton County, KY

Kentucky Transportation Cabinet

Northern Kentucky Workforce Investment Board

Ohio Department of Transportation

Ohio County, IN

OKI Land Use Commission

Pendleton County, KY

Purdue University Extension

Refugee Connect

Rumpke

Southwest Ohio Regional Transit Authority

Union County, IN

University of Cincinnati

Urban Native Collective

Village of Golf Manor

Warren County

Special thanks are due to the following members of the ThriveTogether Steering Committee who gave generously of their time and talents beyond the expectations of serving on the committee.

Reena Murphy, Sustainability Coordinator, City of Oxford

Maeve Mason, Director of Utility Strategy, Duke Energy

Gillian Hart, Sustainability Manager, City of Fairfield, OH

Ardythe Morrow, Professor of Environmental & Public Health Sciences, University of Cincinnati

STEERING COMMITTEE STATEMENT

A Letter to the Region

2.2 million People call our region their home. 2.2 million People who share the same water, same air, and the same goals for a healthy, thriving, and resilient region. As a collaboration of governments, non-profits, schools, businesses, and residents, we are proud to work towards a more sustainable future for Greater Cincinnati.

We envision a future where people, industry, and the environment thrive. We are committed to reducing greenhouse gas emissions while growing good jobs by focusing on sustainable development and infrastructure.

While our region is diverse, climate change will impact every single community and industry. Therefore, *everyone* has the opportunity to be a part of the solution. We acknowledge that climate change will affect every community differently and that some communities face greater risks. The ThriveTogether Playbook empowers the region with the knowledge and resources to implement community level solutions to national challenges.

We are thankful to the US Environmental Protec on Agency (EPA) for the Climate Pollution Reduction Grant program (CPRG), which provided Greater Cincinnati with the grant to develop ThriveTogether and strengthen collaboration within the region.

We are grateful to OKI Regional Council of Governments for serving as the Primary Lead and to the City of Cincinnati Office of Environment & Sustainability, Green Umbrella, Indiana University Environmental Resilience Institute, Northern Kentucky ADD District, and Southwest Ohio Air Quality Agency, for leading the engagement process.

We look forward to continuing partnerships with federal and state agencies, as their support is integral to the successful implementation of this plan. Together, we are committed to a healthier, cleaner, greener, more resilient and thriving region.

Thrive Together Steering Committee Members

EXECUTIVE SUMMARY

The ThriveTogether Sustainability Playbook for the Greater Cincinnati Region provides a unified, data-driven strategy for reducing greenhouse gas (GHG) emissions across Ohio, Kentucky, and Indiana's 16-county Cincinnati Metropolitan Statistical Area (MSA). Developed under the EPA's Climate Pollution Reduction Grant (CPRG) program, the playbook builds on the collaborative ThriveTogether framework led by the OKI Regional Council of Governments, with key partners including the City of Cincinnati, Green Umbrella, Indiana University's Environmental Resilience Institute, the Northern Kentucky ADD District, and the Southwest Ohio Air Quality Agency. The plan serves 2.2 million residents and is designed for policymakers, local governments, community organizations, businesses, and the public.

Purpose and Scope

The ThriveTogether Playbook outlines a coordinated regional approach to reducing emissions, improving air quality, and increasing community resilience. It addresses the region's diverse social, economic, and environmental conditions—from dense urban neighborhoods with heat island challenges to rural communities experiencing agricultural and infrastructure stresses. The plan integrates insights from the Priority Climate Action Plan (PCAP), local climate plans (e.g., the Green Cincinnati Plan, Fairfield Sustains, and Oxford's CAP), and regional policy efforts such as OKI's Strategic Regional Policy Plan and 2050 Metropolitan Transportation Plan.

Collaborative Development and Engagement

The Playbook was shaped through an extensive, equity-centered engagement process. The ThriveTogether Planning Team convened a Steering Committee representing 3 states, 16 counties, 21 municipalities, utilities, nonprofits, chambers of commerce, educational institutions, and businesses. Engagement included over **45 public and stakeholder meetings**, **370+ in-person participants**, and more than **500 online contributors** through the ThriveTogether GoVocal platform. Specialized outreach connected with youth, seniors, unhoused residents, Indigenous and refugee communities, and frontline neighborhoods through partnership with the Climate Safe Neighborhoods initiative.

GHG Inventory and Business-as-Usual Projection

The 2022 regional GHG inventory establishes a baseline of **45.1 million metric tons CO_2e**, with emissions concentrated in the Buildings, Industrial, and Transportation sectors. Without action, Business-as-Usual (BAU) projections show only modest reductions—**8.6% by 2030** and **9.9% by 2050**—driven mainly by fuel efficiency trends and modest grid changes. These projections underscore the need for accelerated, coordinated emission reduction.

GHG Reduction Targets

Based on inventory findings and regional priorities, the Steering Committee adopted non-binding targets to guide the CCAP:

- **15% reduction by 2030**
- **50% reduction by 2050**, relative to 2022 levels

These targets reflect the region's commitment to transformative, achievable emission reduction over the next quarter century. Achieving these targets is vital to improving the health and economic future of the region, while bolstering resilience to increasingly volitile climate conditions and reducing disparite impacts felt by the region's most vulnerable communities and residents.

Implementation Scenario and Expected Impacts

The ThriveTogether Playbook identifies **28 implementation measures across seven sectors**: Transportation, Electric Power, Buildings, Industrial, Waste, Agriculture, and Carbon Removal. When implemented, these measures dramatically expand beyond BAU reductions:

- **15% total reduction by 2030**
- **47% total reduction by 2050**
- Emissions fall from **45.1 million MT CO_2e in 2022 to 24.0 million MT CO_2e in 2050**

Major reductions come from large-scale EV adoption, building efficiency retrofits, renewable energy expansion, industrial decarbonization, methane capture, and increased tree canopy.

Benefits and Equity Impacts

The Playbook emphasizes co-benefits that strengthen health, equity, and economic resilience:

- **Cleaner air and public health improvements** from reduced combustion emissions
- **Lower household energy burdens**, especially in LIDAC communities
- **Job growth**, with an estimated **6,977 new green jobs by 2030**
- **More resilient infrastructure** and reduced climate-related damages
- **Expanded green space and carbon sequestration** through forests, wetlands, and urban tree canopy investments

Equity is central to ThriveTogether's design. LIDAC-focused analysis, targeted engagement, and distributional equity principles ensure that benefits—including reduced pollution exposure, energy savings, and green job pathways—reach frontline communities disproportionately affected by emissions and climate risk.

Implementation and Accountability

The Playbook includes clear milestones, sector-specific metrics, and governance structures built through the ThriveTogether collaborative model. Continuous public reporting, data dashboards, and interagency coordination will support transparency, adaptive management, and sustained progress toward regional emission reduction goals.

1. INTRODUCTION

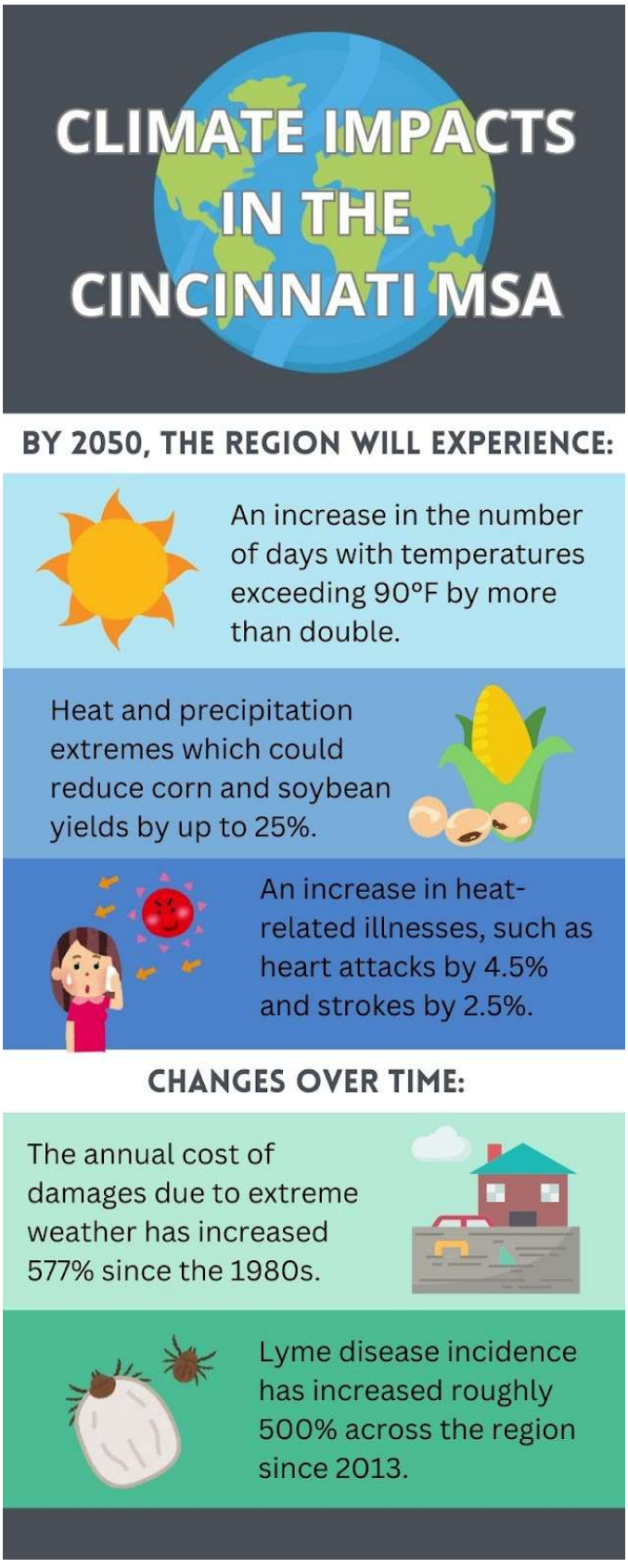
1.1 CPRG Overview

In 2023, a climate pollution reduction grant (CPRG) was awarded to Ohio-Kentucky-Indiana Regional Council of Governments (OKI) to shape the Comprehensive Climate Action Plan (CCAP) for Cincinnati's Metropolitan Statistical Area (MSA). OKI, as the lead developer, partnered with the City of Cincinnati, Green Umbrella, Indiana University Environmental Resilience Institute, Northern Kentucky ADD District, Southwest Ohio Air Quality Agency, and other regional collaborators under the ThriveTogether banner to shape the CCAP as a collaborative effort.

The Cincinnati MSA spans 16 counties across Ohio, Kentucky, and Indiana and is home to over 2.2 million residents across rural, suburban, and urban landscapes. As climate change and its impacts accelerate, national migration patterns reshape, anticipating growing population demands within the Cincinnati MSA. While this influx of population could allow for economic and cultural enrichment, it also puts added pressure on housing, infrastructure, healthcare systems, and natural resources. ThriveTogether recognizes these concerns and is seeking to address them by strengthening local systems to reduce greenhouse gas emissions and their associated impacts within the region.



Figure 1: Map of Cincinnati Metropolitan Statistical Area



1.2 CCAP Purpose and Scope

Climate change affects all communities differently. Vulnerable populations, such as older adults, children, individuals with preexisting health conditions, and those with limited economic resources, face greater risks from extreme heat, poor air quality, and severe weather. Rural communities may struggle with infrastructural gaps, while urban communities with low tree canopy and high impervious surfaces may experience intensified heat island effects. These discrepancies underscore the need for targeted strategies in addressing climate impacts.

Rising temperatures in the region are one of the most visible signs of change. The number of days with temperatures above 90°F is expected to more than double by 2050–from around 30 days historically to over 79 annually.[1] These hotter conditions increase the risks of heat-related illness, like asthma and heat stroke, especially for older adults, children, and individuals with preexisting health conditions.

Air quality, particularly from fine particulate matter (PM 2.5), remains a public health challenge across the MSA.

[1] **NOAA.** Climate Explorer.

The region's natural topography causes particulate matter to accumulate in valleys causing poor air quality. PM2.5 concentrations are further exacerbated by forest fire events to the northwest, which are expected to become more frequent. Particulate matter can travel long distances, reduce visibility, and contribute to dust and pollution that worsen respiratory conditions and chronic health outcomes.[2]

Extreme weather events, like heavy rainfall and flooding, are expanding in frequency and severity in the MSA. Annual precipitation in the Midwest has increased 5 to 10 percent in the last fifty years.[3] Between 1980 and 1989, Ohio experienced eight "billion-dollar disasters" (events with losses exceeding $1B each). In this period, the cost of each event ranged from $2B to $5B. This number had more than doubled to 19 events in the 2000s and 26 events in the 2010s. In just the first half of the 2020s, 36 such disasters have already occurred, with average costs now ranging from $5 to $10B per event.[4] This represents a 577 percent increase in the cost of annual damage due to extreme weather. Flooding, sewage overflows, and deteriorating water quality are among the associated risks of extreme weather, alongside physical and mental health consequences tied to property loss or displacement.

Urban areas in the MSA are especially susceptible to the heat island effect, a phenomenon in which paved surfaces and low tree canopy coverage lead to hotter local temperatures. Heat islands may also be more common in low-income communities, with limited green space and limited access to resources such as air conditioning. A 2023 study by the City of Cincinnati demonstrated a nearly 18°F temperature difference between shaded and unshaded areas of a city park, underscoring the value of urban green spaces in mitigating heat impacts, including heat-related health risks.[5]

The region's infrastructure can also be put under climate-induced stress. This includes increased power outages in the region, due to the frequency of severe thunderstorms. Severe storms in June 2025 caused widespread power outages, affecting thousands across Hamilton, Butler, and Campbell counties.[6] Additional outages occurred only a few

[2] Outdoor Air Quality: Implications of Climate Change: ERIT: Environmental Resilience Institute: Indiana University
[3] https://19january2017snapshot.epa.gov/sites/production/files/2016-09/documents/climate-change-oh.pdf
[4] Billion-Dollar Weather and Climate Disasters | Ohio Summary | National Centers for Environmental Information (NCEI)
[5] Urban Heat - Environment & Sustainability
[6] https://www.wlwt.com/article/power-outages-cincinnati-ohio-severe-weather-storms/65105270

weeks later, especially within Hamilton County, highlighting the costly impacts of severe weather on energy grids.[7]

Transportation infrastructure is also facing stress. For example, in 2019, intense periods of rainfall triggered hillside instability along Cincinnati's Columbia Parkway, necessitating a $17.6 million stabilization project. In June 2025, extreme heat caused a section of US Route 52 outside of New Richmond, Ohio to buckle. Earlier the same year pavement slipped two inches on a segment of I-275 between US 52/Kellogg Avenue and Five Mile Road.[8] These examples highlight the growing threat climate change is having on regional transportation networks and public safety. Without proactive investment and adaptation, these incidents can increase in frequency and cost, which jeopardizes the region's economic vitality and standard of living.

Agricultural operations are shifting due to climate impacts, as well. Climate projections suggest that summer heat and precipitation extremes could reduce corn and soybean yields 5-25% by 2050. Southern Indiana's growing season is projected to expand thirty days by 2050, allowing allergy-causing plants like ragweed to produce pollen for longer periods, extending allergy seasons.[9] Lengthened, warmer growing seasons can also allow for the proliferation of pests and weeds, straining farmers and traditional land management practices.

CLIMATE-IMPACTED TRANSPORTATION INFRASTRUCTURE EVENTS

March 2025



A two-inch pavement slip on a segment on I-275 between US 52/Kellogg Avenue and Five Mile Road, necessitated an emergency repair

June 2025



Extreme heat caused a section of US 52 outside of New Richmond, OH to buckle, calling for an emergency repair.

[7] **https://www.wlwt.com/article/thousands-without-power-storms-cross-greater-cincinnati/65388284**
[8] **Emergency Repair Project on I-275 | Ohio Department of Transportation**
[9] **Hoosiers' Health in a Changing Climate: A Report from the Indiana Climate Change Impacts Assessment – Indiana Climate Change Impacts Assessment**

Changes in climate expand the range and seasonality of disease-carrying vectors such as ticks and mosquitoes, raising concerns about public exposure to illnesses such as Lyme disease and West Nile virus. Data from the CDC suggests that there were 103 confirmed cases of Lyme disease in Kentucky in 2023 compared to 16 cases only a decade earlier in 2013–a 544% incidence increase.[10]

While the focus of the ThriveTogether Playbook is to reduce greenhouse gas emissions, primarily carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). As can be seen in the region's greenhouse gas inventory in Chapter 2, nearly all these emissions are the result of combustion. When the product of combustion, greenhouse gasses are often emitted alongside other harmful pollutants. These include nitrous oxides (NO_x), sulfur dioxide (SO_2), and fine particulate matter (PM2.5). These co-pollutants have more immediate and localized health impacts, especially in communities near combustion sources. By working to reduce greenhouse gas emissions, especially those resulting from combustion, we are also removing these co-pollutant emissions from our air, resulting in cleaner, healthier air locally.

ThriveTogether has identified seven sectors that will work to reduce greenhouse gas emissions in the region, improving air quality, public health, and enhancing resilience. The sectors are 1) transportation, 2) electric power, 3) industrial, 4) buildings, 5) waste, water, and sustainable materials management, 6) agricultural, and 7) carbon removal. These sectors will work independently and cohesively to implement targeted strategies which address the multifaceted challenges posed by climate change.

These strategic investments are not only to reduce risk, but to present economic opportunities. With an emphasis on green infrastructure, sustainable development, and workforce expansion, the Cincinnati region could benefit from an estimated 6,977 new jobs by 2030. These efforts support a more diversified and resilient economy while strengthening community cohesion.

[10] Lyme Disease Case Maps | Lyme Disease | CDC

ENERGY LANDSCAPE

OHIO --- In 2022, according to the US Energy Information Administration, 37% of electricity used by Ohioans was coal-fired and 51% from natural gas. Ohio also has 2 nuclear energy plants which provide 12% of the state's electricity generation. The residential sector uses almost 36% of the state's total electricity, followed by the industrial sector at 34% and the commercial sector making up 31% of Ohio's electricity consumption. Therefore it takes a combination of households, businesses and industry in targeting renewable electricity consumption.

The City of Cincinnati has made an ambitious goal to power their facilities using 100% renewable energy by 2035. Currently, more than 80% of City residents are powering their homes with 100% renewable energy.

KENTUCKY --- A majority of Kentucky's energy usage is in the industrial sector, accounting for 36% of total end-use energy consumption. This sector mainly consists of food, beverage and tobacco products, along with coal mining and petroleum refining. The transportation sector then makes up about 30% of energy consumption, followed by the residential sector at 20% and commercial at 14% of the state's energy use. Kentucky is the fifth largest coal producer among states and powers 68% of its electricity from coal. Natural gas powers 25% of Kentucky's electricity, followed by small scale hydroelectric, biomass, and solar energy productions.

The state of Kentucky does not have a renewable energy standard to require a specific amount of renewable electricity.

INDIANA --- In 2022, Indiana was the nation's third largest coal consumer, mostly used for electric power generation and industry. Coal powered electricity has declined in recent years, and made up 52% of Indiana's power generation in 2022. 33% is from natural gas sources and renewables, primarily wind, supply 12% of electricity. Industry consumes 43% of Indiana's electricity consumption, followed by residential (34%) and commercial (23%).

PREVIOUS CLIMATE PLANNING EFFORTS

City of Cincinnati, OH

The City of Cincinnati adopted its climate action plan, the Green Cincinnati Plan in 2008. It has since updated this plan twice – most recently in 2023. In the 2023 update, Cincinnati set the ambitious goal to reach carbon neutrality by 2050 and the plan establishes a roadmap of 30 goals, 40 strategies and 130 actions to reach this goal. One of the city's priorities with the plan is to inspire similar efforts from other local governments in the region. The city is a member of the Plan Working Group and will be involved in the formulation of this regional Climate Pollution Reduction Plan. Their experience in producing, implementing, and updating a climate action plan will be valuable to our effort.

City of Oxford, OH

In September 2023, the City of Oxford adopted a Climate Action Plan titled, *Towards a Sustainable, Resilient Future*. This plan acts as a road map for the city to achieve carbon neutrality and to ensure Oxford remains a thriving place despite the changing climate. The plan adopts the goals of reducing emissions 50% by 2030 and achieving net zero emissions by 2045.

City of Fairfield, OH

In 2024, City Council adopted *Fairfield Sustains*, the city's first comprehensive sustainability plan. This plan sets ambitious goals centered around improving the quality of life, conserving resources, and promoting economic vitality. With 10 goals, 30 strategies, and over 100 action steps, *Fairfield Sustains* provides a clear roadmap for the city's sustainability efforts, designed to create a shared vision for a more sustainable future.

OKI Regional Council of Governments

In 2023, OKI Regional Council of Governments created the *How Do We Grow From Here? – Strategic Regional Policy Plan*, a vision for regional vitality sustainability and competitiveness across the 8-county OKI region. The plan encompasses transportation, public facilities, natural systems, housing, economic development and land use, with an overarching focus on sustainable, clean solutions. Additionally, in 2020 the OKI 2050 Metropolitan Transportation Plan was approved: a collection of innovative transportation solutions that support the goals and economy of the Greater Cincinnati area.

From 2017 through 2020, OKI Regional Council of Governments leveraged a grant to produce local Energy Efficiency Plans for eight local governments in southwest Ohio. The eight

communities have all prepared energy plans in partnership with OKI. Although generally based on content from the US Department of Energy's guide on producing a local energy plan, OKI worked with each local government to tailor each plan to their situation. Each plan addressed a range of energy-related topics, including multiple avenues of public input, and included an energy audit of local government facilities. The project also dedicated over $130,000 toward sub-grants to the participating local governments to begin the implementation of their plans.

Green Umbrella

As Greater Cincinnati's Regional Climate Collaborative, Green Umbrella leads a network committed to taking decisive action in the face of climate change and help regional communities become more climate resilient and equitable while working collectively to decrease our region's emissions. Green Umbrella serves a 10-county region in Greater Cincinnati, consisting of dozens of urban and rural communities spanning Southwest Ohio, Northern Kentucky, and Southeast Indiana.

Green Umbrella hosts five staffed programs including the Cincinnati 2030 District, which works to draw down commercial building emissions, the Greater Cincinnati Food Policy Council and which centers climate action in food systems, and several greenspace initiatives that prioritize carbon sequestration strategies. Green Umbrella also hosts three cohort programs: a Climate Action Fellowship for local governments, a Climate Research Incubator for researchers, and annual training and forums for local climate candidates.

Green Umbrella has also established the **Climate Safe Neighborhoods** (CSN) partnership with Groundwork Ohio River Valley, which explores the relationship between disadvantaged urban neighborhoods and the current and predicted impacts of climate change. CSN developed neighborhood Climate Advisory Groups to identify solutions to address extreme heat and flooding. Details of the Climate Safe Neighborhoods program can be found in Appendix C of this document.

Green Umbrella is also a lead partner every five years in the development and finalization of the City of Cincinnati's Green Cincinnati Plan, including leading Climate Safe Neighborhoods engagement and a Climate Equity Benchmarking Analysis Report.

1.3 Approach to Developing the CCAP / Community Engagement

Community feedback helps us better understand the values, hopes, concerns, and perspectives of Greater Cincinnati's communities. Currently, the Greater Cincinnati region is facing multiple challenges – repairing a legacy and ongoing reality of injustice, mitigating and adapting to increasingly volitile climate conditions, tackling housing affordability and homelessness, and more. For all these reasons, the engagement process is crucial to the successful completion of the ThriveTogether Sustainability Playbook.

The ThriveTogether team uses a collaborative governance model to guide the development of its Playbook and the sourcing of implementation ideas. Collaborative governance, as defined by the University Network for Collaborative Governance, is a community-centered approach to public policy and decision-making that brings together participants from public, private, and civic sectors. Its purpose is to enable people to work collectively across boundaries, leverage diverse strengths, and co-create sustainable solutions that benefit the broader community.

ThriveTogether's engagement approach is grounded in principles of equity and justice identified in Green Umbrella's 2022 Climate Equity Benchmarking Analysis. These principles include:

- **Recognition** of historic and ongoing injustices
- **Procedural equity**, which focuses on shifting power, ensuring inclusive participation, and building trust and accountability
- **Distributional equity**, which addresses how burdens and benefits are shared across populations
- **Restorative equity**, which seeks to repair past harms
- **Transformative equity**, which works to change the structural conditions that create inequities and prevent future harm.

The initiative also emphasizes several forms of accountability drawn from the Institute for Sustainable Communities' Urban Equity Climate Compact.

- **Individual accountability** involves personal responsibility for actions and their consequences.

- **Mutual accountability** centers on shared commitment within a group, aligning collective duties and actions toward common objectives.
- **Community accountability** focuses on creating safe, supportive environments where communities can examine harmful systems and leadership structures, and develop strategies to eliminate oppressive practices.

Additionally, ThriveTogether draws on the "Spectrum of Community Engagement to Ownership" from Facilitating Power, which emphasizes deepening community involvement and leadership in decision-making processes.

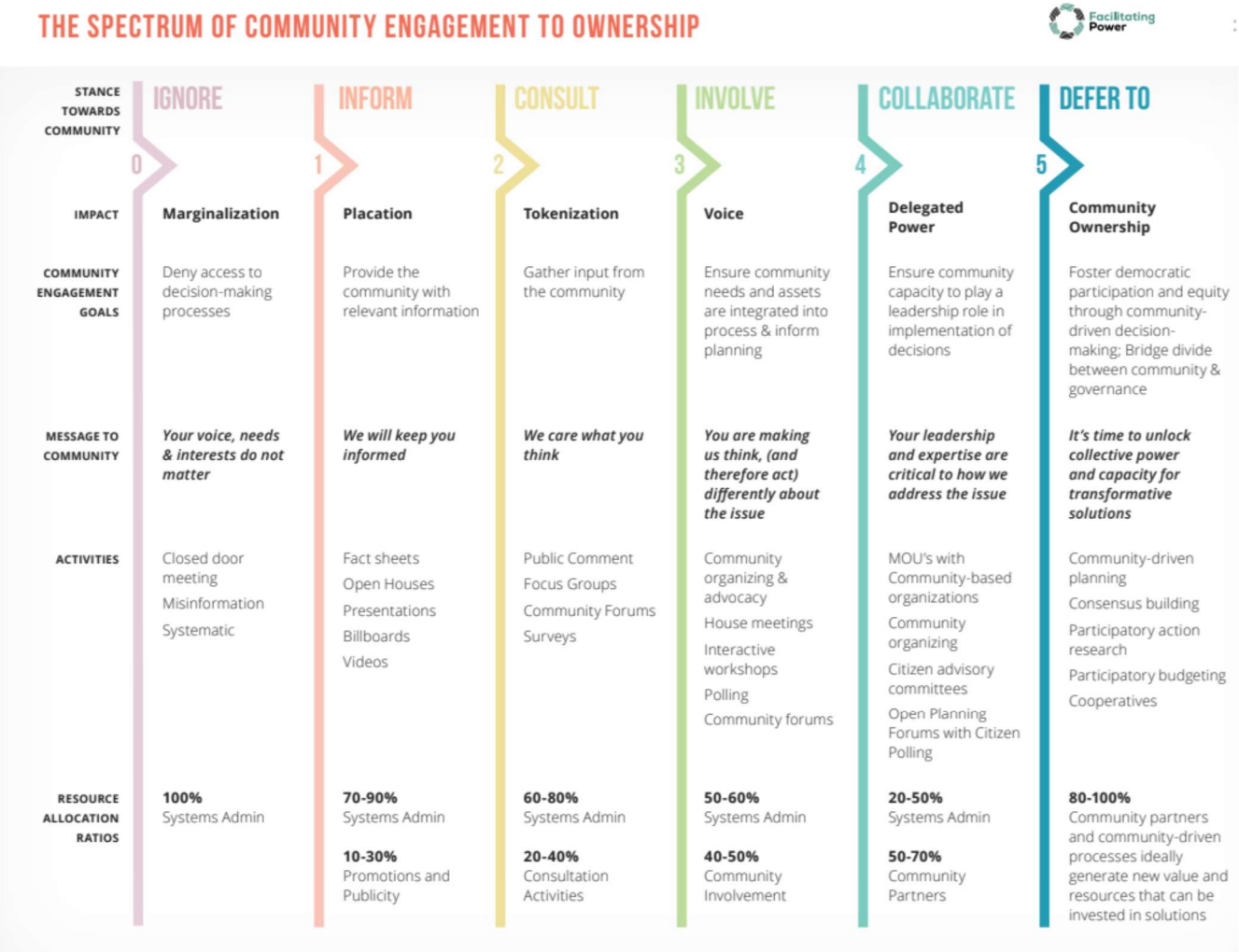


Figure 2: Spectrum of Community Engagement to Ownership (Source: Facilitating Power)

1.3.1 Steering Committee

To ensure a regional and diverse perspective throughout the planning process, ThriveTogether is convening a Steering Committee to provide guidance and input at key moments in the plan development process, as well as a regional submission for

implementation funds. The first Steering Committee meeting was held in December 2023 and met four additional times during the process of developing this playbook.

The ThriveTogether Planning Team actively recruited a diverse set of regional stakeholders to participate in the Steering Committee. The Steering Committee is composed of members representing the following:

- 3 states
- 16 counties
- 21 cities/towns/townships (11 of which contain LIDAC census tracts identified in the CJEST tool)
- 15 nonprofit organizations
- 4 chambers of commerce
- 4 educational institutions
- 4 utilities

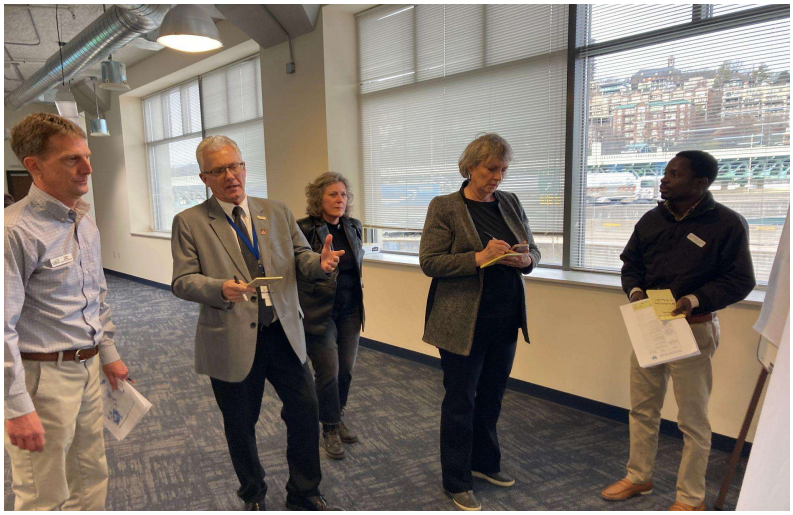


Figure 3: Plan Steering Committee Meeting Feb 7. 2024

1.3.2 Community-Based Engagement

There was a focus on engaging with several key demographic groups through the process. The targeted groups are those who are often overlooked, or face barriers in engaging via typical methods. Groups that we found success engaging with are youth, seniors, the unhoused, rural communities, the indigenous community, and the refugee community. Of these groups, we found the most widespread success in engaging with the youth and senior communities. The process and outcomes of engaging with youth and seniors are detailed in Appendix A and Appendix B respectively.

ThriveTogether partnered with the Climate Safe Neighborhoods Partnership led by Green Umbrella and Groundwork Ohio River Valley, which is dedicated to exploring the relationship between historically disadvantaged communities and the current and predicted impacts of climate change. The Partnership works directly with frontline community members to identify solutions to address climate impacts and pollution. Through intentional engagement with residents in priority communities, the effort honors community members as subject matter experts in identifying local issues and co-creating community-based solutions. Since the Fall of 2023, Climate Safe Neighborhoods hosted Climate Advisory Groups in the Avondale and Winton Hills neighborhoods of

Cincinnati, Norwood, OH, Covington, KY, and Newport KY. These groups were introduced to the ThriveTogether process and were activated to participate in the hub. This activity included 12 events with over 70 unique participants from frontline neighborhoods. Details of this engagement are found in Appendix C.

In all, the ThriveTogether planning process held over 45 public and stakeholder meetings and workshops and engaged with over 370 in-person attendees. These meetings featured participation from many key stakeholders, organizations, and companies from across the region

1.3.3 Topic-Area Engagement

From December 2023 through February 2024, an engagement effort took place to gather emission-reduction ideas. This effort, which utilized the ThriveTogether online engagement platform, generated 116 actions and project ideas. This list became the basis for our first draft list of Implementation Measures. The ThriveTogether Steering Committee met in February 2024 to refine this draft list, which was included in the PCAP document submitted in March 2024. This list of Measures still required further refinement.

From July through September 2025, a series of six Topic Roundtable Meetings were held focused on bringing together topic experts and key stakeholders to have in-depth discussion centered around key measures in the Playbook. Over 149 stakeholders, representing over 100 organizations took part in these roundtable discussions. Through these discussions, draft Measures that were vague in scope or outcome were crafted into well-defined and actionable elements.

1.3.4 Web-Based Engagement

The ThriveTogether team is using GoVocal to host a virtual hub for public engagement for the Regional Sustainability Playbook for Greater Cincinnati. The ThriveTogether team uses the site to share information about Playbook, as well as collecting, organizing, and analyzing public feedback about the issues and areas of policy that the Playbook addresses. Over the course of our engagement process, the platform will offer a variety of information and virtual engagement activities that will allow members of the public to learn about and contribute their ideas to shape the Playbook. The pandemic has demonstrated that virtual alternatives to in-person communication can present both

challenges and opportunities. The site can't replicate or replace in-person engagement—nor should it. However, it can offer a lower barrier to entry for some communities to participate in the engagement process. Accessing the information and contributing feedback on this Hub is free.

Most importantly, the site was designed to make the engagement process as transparent as possible. For example, the ThriveTogether team reports out results of surveys taken, offers recordings of steering committee meetings, and publishes engagement updates contributing to the plan. Over 500 individual users used the site to engage in the planning process. The site is used to explain how public feedback has been analyzed and incorporated into the Playbook and ultimately carries into the implementation phase.

1.3.5 Engagement's Impact on the Playbook

Public and stakeholder engagement has been foundational to developing the ThriveTogether Playbook. A multi-faceted engagement process from December 2023 through January 2024 led to the gathering of 116 unique project and implementation ideas, which became the 28 measures and 108 associated actions that form the core of the Playbook. These ideas were organized and vetted through an interactive "big tent" workshop during the PCAP phase. Later, a series of topic roundtable meetings with experts and stakeholders refined these measures and actions into the list found in this document.

Engagement with frontline communities throughout this process ensured that the ThriveTogether Playbook addresses key inequities and hardships felt by these communities. Frontline communities shaped the content of this Playbook at every phase through active participation on the steering committee, in workshops, through the online hub, and through targeted engagement.

2. REGIONAL GHG INVENTORY

The Greenhouse Gas (GHG) Inventory for the Cincinnati Metropolitan Statistical Area (MSA) provides a comprehensive accounting of greenhouse gas emissions across the 16-county region spanning Ohio, Kentucky, and Indiana. Conducted under the U.S. Environmental Protection Agency's Climate Pollution Reduction Grant (CPRG) program, this inventory establishes a regional baseline to guide coordinated climate action and inform emissions reduction strategies across jurisdictions.

To complete the GHG Inventory for the Cincinnati Priority Climate Action Plan (PCAP), the Working Group hired UNPREDICTABLE City, an Ohio-based consulting firm. The GHG Inventory adhered to a Quality Assurance Project Plan (QAPP) filed with and approved by the US EPA.

Developing a robust greenhouse gas inventory is a foundational step toward regional climate mitigation and resilience. It enables local governments, utilities, and community stakeholders to:

- Understand the distribution of emissions by sector.
- Identify major sources and reduction opportunities across the region.
- Establish a baseline year (2022) for tracking future progress.
- Meet CPRG reporting requirements and align with state and federal decarbonization initiatives.

This inventory lays the groundwork for a data-driven, equitable approach to reducing emissions, improving air quality, and advancing sustainability throughout the Cincinnati MSA.

2.1 Inventory Methodology

The inventory follows the U.S. EPA's Local Greenhouse Gas Inventory Tool (LGGIT) and is consistent with the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC) and ICLEI guidelines. These frameworks ensure methodological rigor, transparency, and comparability with national and global datasets. The full methodology is attached as an Appendix at the end of this document.

Different approaches are taken in the methodology of each sector. For buildings, industrial, and transportation state level data is downscaled to the county and census tract levels based on additional data to produce energy consumption data. Energy data is multiplied by standard emission rates to produce the inventory. Waste sector emissions are directly taken from US EPA Greenhouse Gas Reporting Program (US EPA GHGRP). Sources of local data is coupled with the US EPA's Local Greenhouse Gas Inventory Tool to estimate emissions for Agriculture and Tree Canopy.

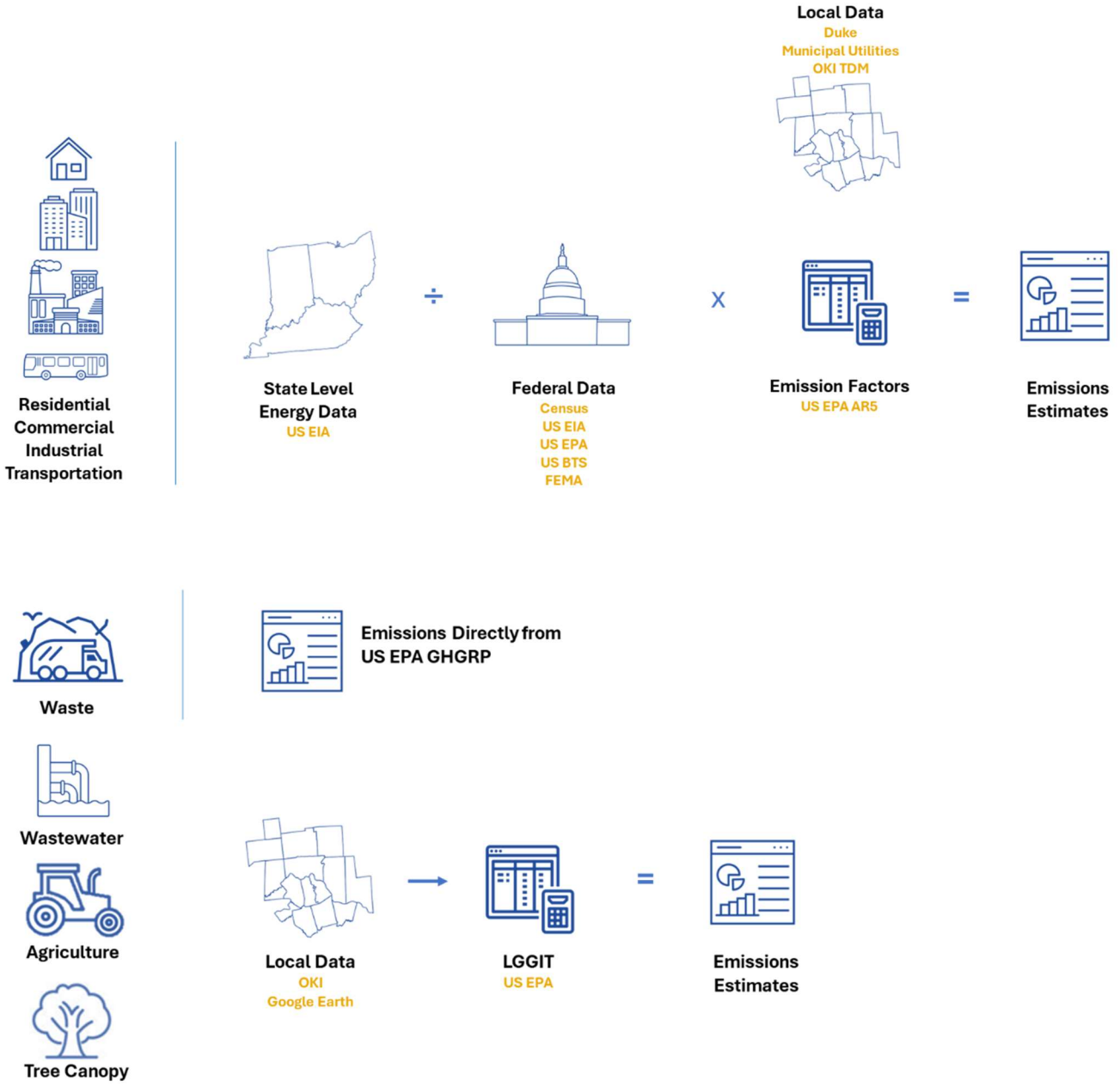


Figure 4. GHG Inventory methodology for each sector. Residential and Commercial combine to make up the buildings sector.

2.1.1 Data Sources and Estimation Methods

The inventory integrates multiple data streams across sectors. Data was compiled by OKI in collaboration with local utilities, agencies, and federal datasets (Table X).

Sector	Primary Data Sources and Methods
Energy (Residential, Commercial, Industrial)	**Utility-provided natural gas and electricity data, aggregated by county and estimated by sector using Census tract consumption values.**
Transportation (On-road, Non-road, Rail, Aviation)	**On-road data estimated using the EPA MOVES 4 model; other modes analyzed by consultants using regional datasets.**
Waste and Wastewater	**Landfill operator data, regional solid waste management reports, and wastewater facility emissions estimated using population-based factors.**
Industrial Processes and Product Use (IPPU)	**EPA's Greenhouse Gas Reporting Program (GHGRP) data and relevant industry reports.**
Agriculture, Forestry, and Other Land Use (AFOLU)	**USDA data, regional land cover assessments, and agricultural census data.**
Fugitive Emissions and Line Loss	**Estimated as a percentage of fuel or electricity consumption.**

Table 1. Primary Data Sources and Methods for each Sector.

Data from this inventory is presented in the OKI Regional Emissions Dashboard, an interactive, web-based tool that allows users to visualize emissions data across geography, sector, and source type. The dashboard also houses supplemental resources, including the Energy Burden Dashboard, Tree Canopy Tool, Solar Potential Map, and the Utility Aggregation Survey for Ohio counties (Ohio is the only state in the region that allows utility aggregation).

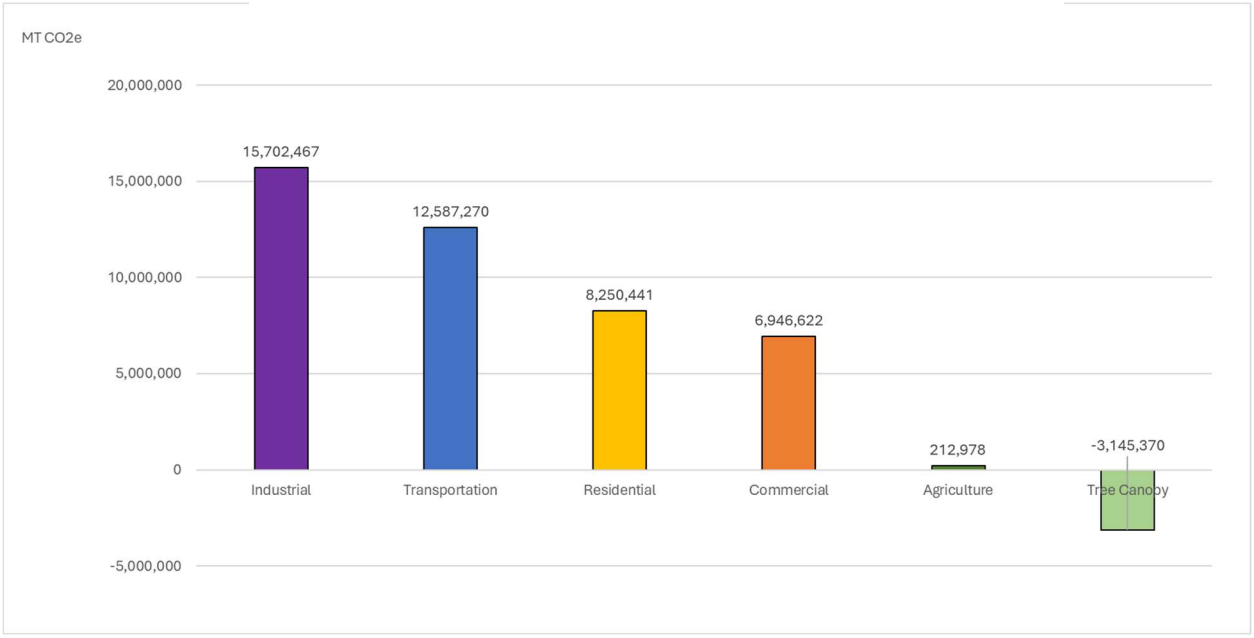


Figure 5. 2022 Emissions by Sector. 2022 emissions in the region total 40.5 million metric tons of carbon dioxide equivalents (MT CO2e).

2.2 Inventory Results

The base year for this inventory is 2022, chosen as the most recent year with comprehensive data available. The inventory encompasses the entire Cincinnati MSA, consisting of 16 counties in southwest Ohio, northern Kentucky and southeast Indiana: Union County, Franklin County, Butler County, Warren County, Franklin County, Dearborn County, Hamilton County, Boone County, Ohio County, Kenton County, Campbell County, Clermont County, Brown County, Gallatin County, Grant County, Pendleton County and Bracken County.

The inventory quantifies emissions generated from Industrial, Transportation, Residential, Commercial, and Agricultural Sectors, as well as accounts for the Tree Canopy sink (Figure 4). Results are expressed in metric tons of carbon dioxide equivalent (CO_2e)—a standard unit that allows comparison of gases with different global warming potentials (GWPs).

2022 GHG Emissions by Sector (Including External Impacts) **– Cincinnati MSA**

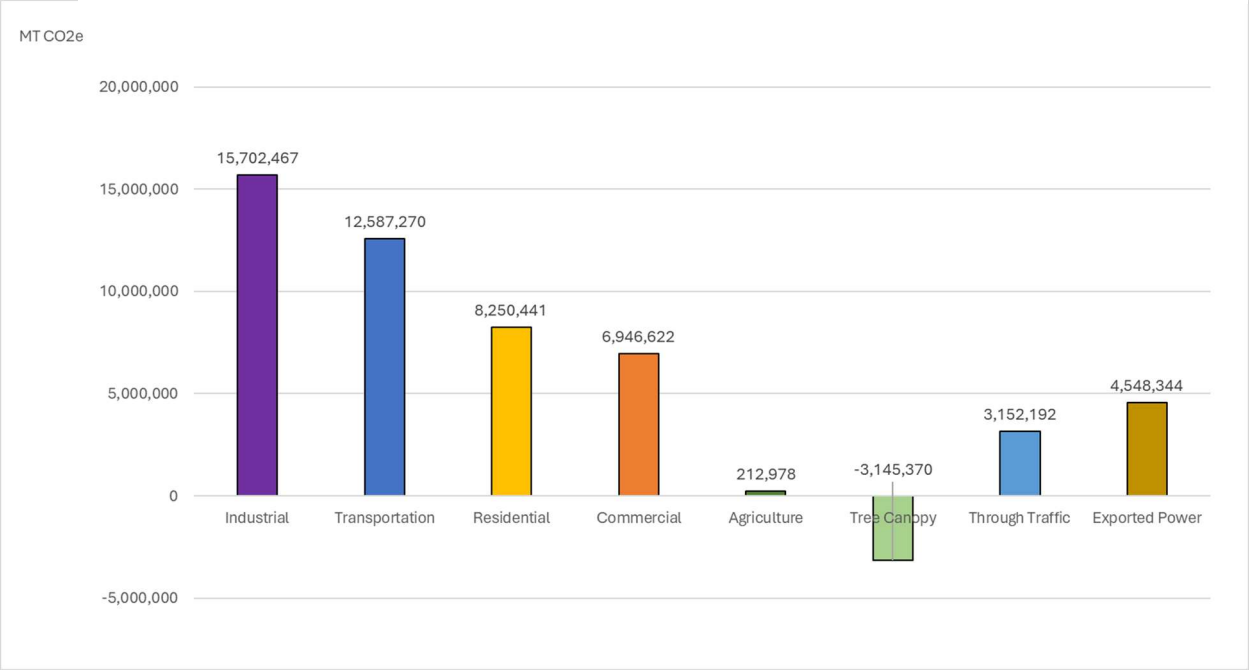


Figure 6. 2022 Emissions by Sector (including external impacts). Total net GHG emissions within the region are 48.2 million tons of CO2e. Through Traffic and Exported Power are considered external impacts that don't contribute directly to the Cincinnati MSA's emissions inventory. These external impacts emissions are attributed to other regions where the through traffic and exported power is going.

Emissions are organized into three "scopes," reflecting where and how they occur:

Scope 1 – Direct Emissions: Emissions from sources located within the MSA boundary and directly controlled by local entities (e.g., on-road vehicles, stationary fuel combustion).

Scope 2 – Indirect Energy Emissions: Emissions occurring outside the MSA boundary but associated with the consumption of purchased electricity within the region.

Scope 3 – Other Indirect Emissions: Emissions resulting from activities within the MSA that occur beyond its direct operational control. Scope 3 emissions were included where possible, though not all sources are captured due to data limitations.

2.2.1 The OKI Regional Emissions Dashboard

The OKI Regional Emissions Dashboard provides public access to the full greenhouse gas inventory data and allows users to interactively explore emission patterns. Users can filter by sector, analysis source, category, and emission source to view emissions totals, trends, and spatial variations across counties.

The dashboard includes:

- Interactive maps and charts for emissions by sector and source.
- Tabular data available for download.
- Filters and search tools to refine analysis.
- Detailed explanations of technical terms (e.g., fugitive emissions, enteric fermentation, line loss).

The dashboard is designed to enhance transparency, education, and collaboration among local jurisdictions, helping decision-makers and the public alike understand the region's carbon footprint.

Explore the Dashboard:
https://www.oki.org/data-maps/view-data-maps/regional-emissions-dashboard/

2.2.2 Data Tools

The OKI dashboard hosts several complementary datasets that provide broader insight into the region's environmental and energy landscape:

- **Energy Burden Dashboard:** Identifies areas where energy costs represent a disproportionate share of household income, supporting equity-focused strategies (Figure x).
- **Tree Canopy Tool:** Maps existing tree canopy and opportunities for reforestation and urban greening.
- **Solar Potential Map:** Highlights rooftop and land-based solar generation potential across the MSA.
- **Utility Aggregation Survey (Ohio Counties):** Tracks local energy aggregation agreements and renewable energy procurement trends.

These tools extend the impact of the inventory by connecting emissions data with energy equity, renewable energy potential, and natural systems resilience.

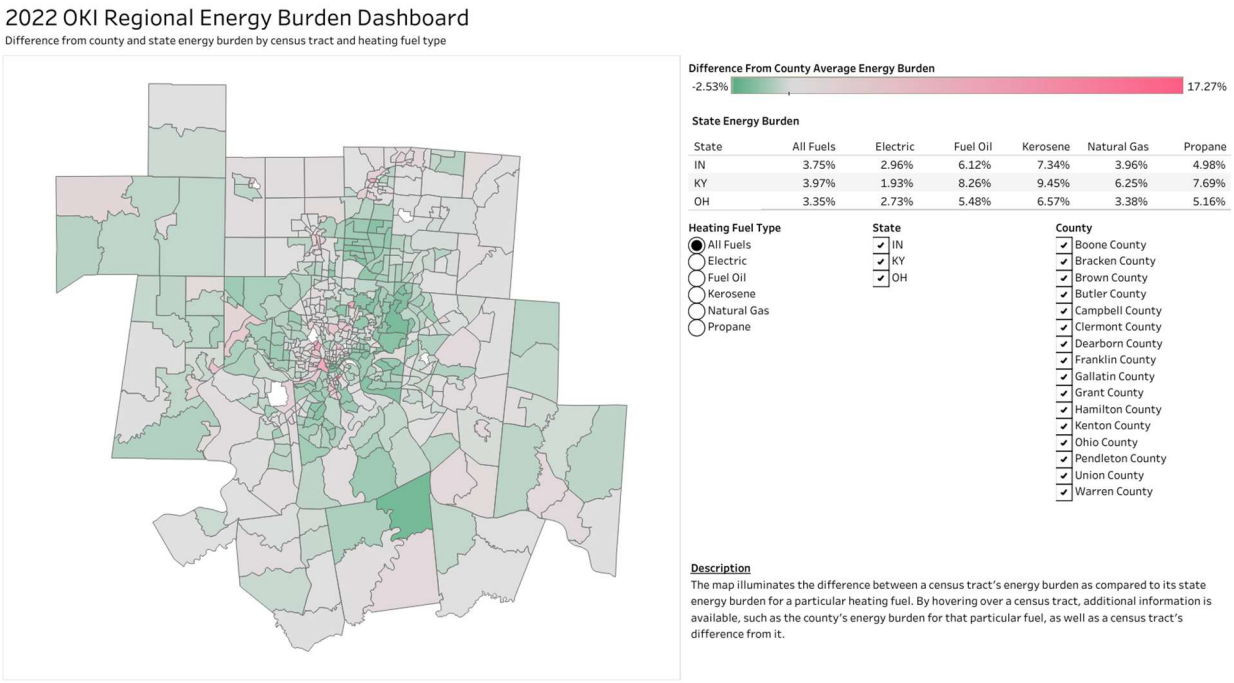


Figure 7. 2022 Regional Energy Burden Dashboard.

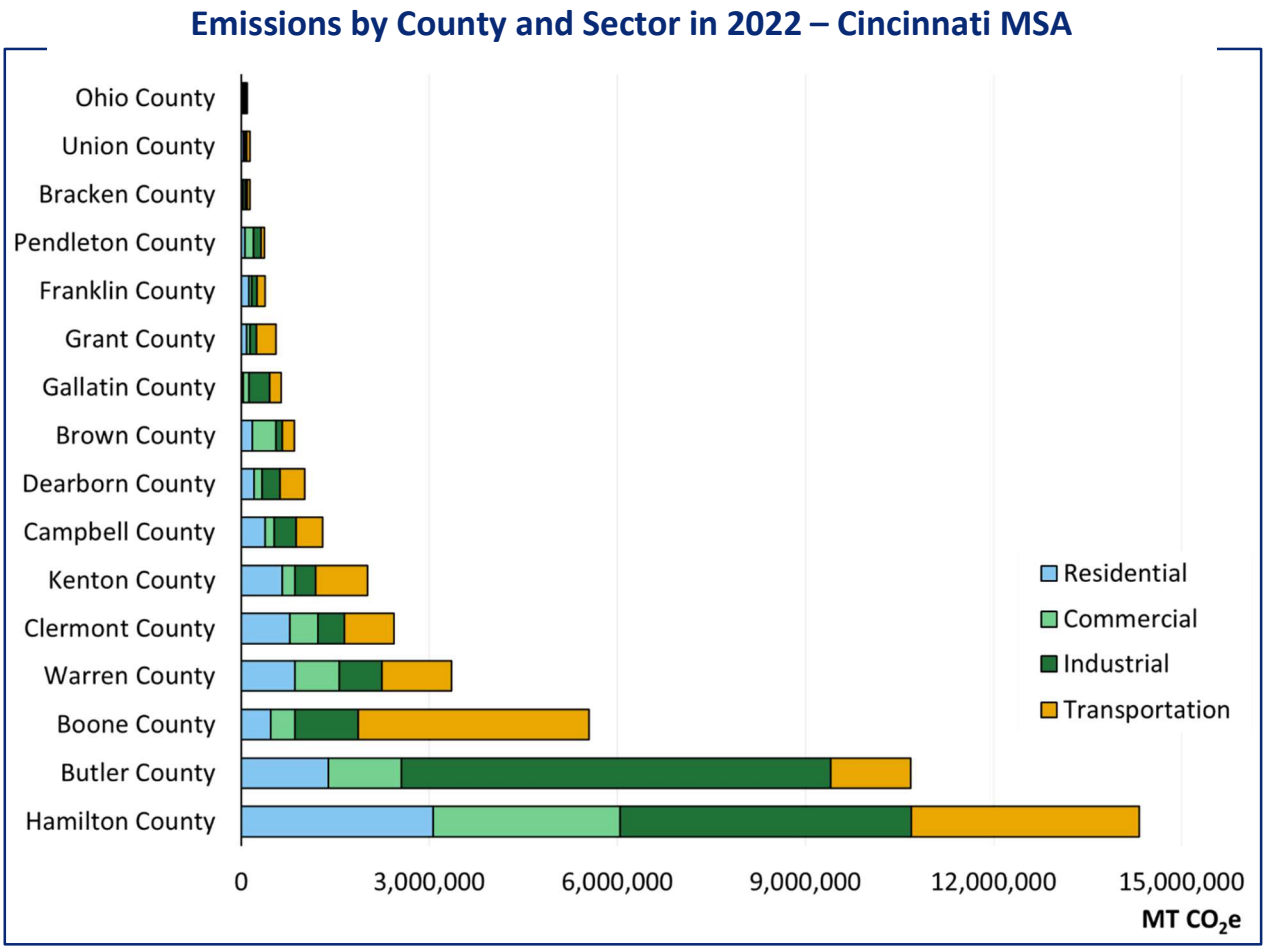


Figure 6. Emissions by County and Sector in 2022.

2.3 Inventory Trends and Analysis

70% of the region's emissions are produced in 3 counties: Hamilton, Butler and Boone County. The graph presents the amount of emissions per county with indicators of emissions sector. As expected, the majority of emissions are attributed to the most populous counties in the region. Also, specific economic activity in counties influence the relative weight some emissions sectors have locally.

2.3.1 Emissions by Sub-Category

Buildings and equipment are by far the largest source of emissions based on their subcategory, making up 68% of total emissions, primarily driven by electricity and natural gas consumption. Air represents in-boundary emissions (scope 1), as well as out-of-boundary (scope 3) emissions that occur from flights originating from or arriving at airports in the region.

2022 Emissions by Sub-Category – Cincinnati MSA

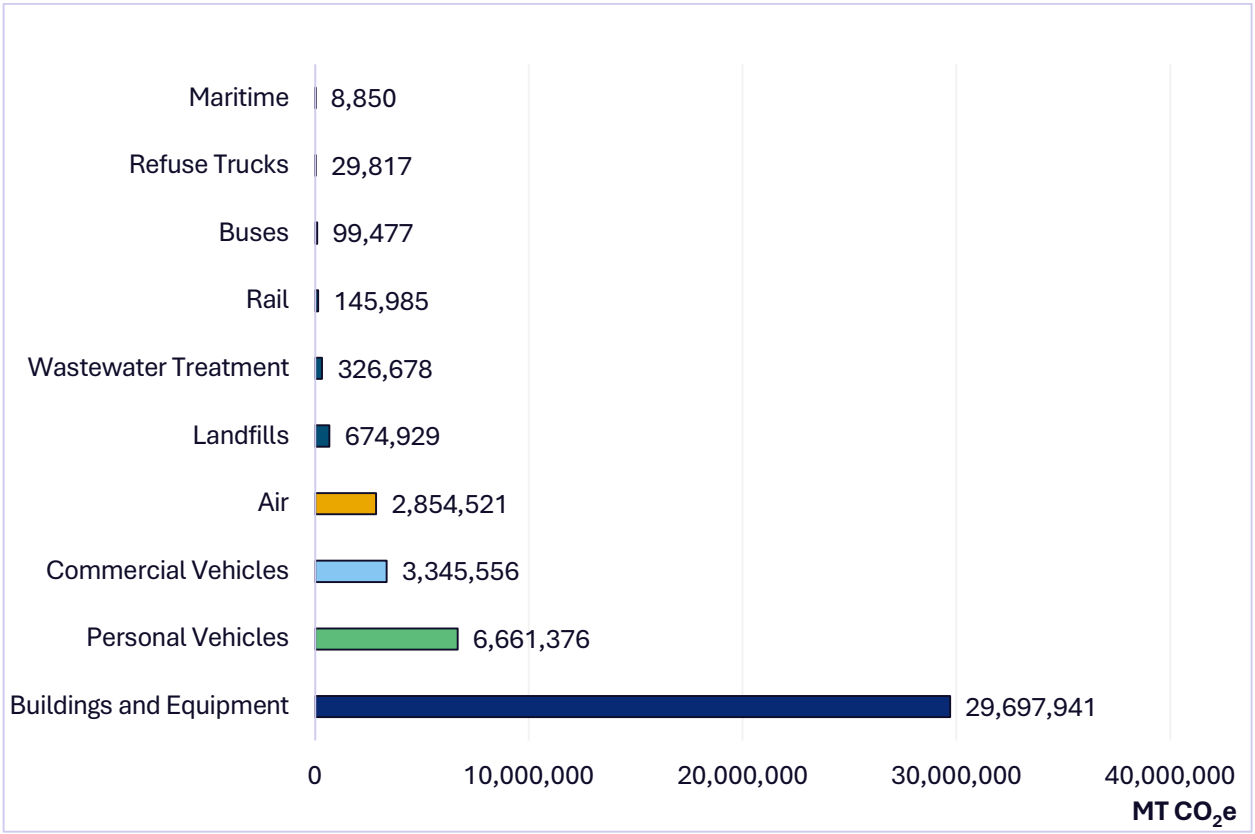


Figure 9. Emissions by Sub-Category in 2022 reported in MT CO2e.

2.3.2 Emissions by Source and Fuel

Fuels used in buildings and transportation are the main contributors to the region's emissions. Electricity accounts for 30% of the total emissions by source. Other Fuels is composed of industrial fuels.

2022 Emissions by Source and Fuel – Cincinnati MSA

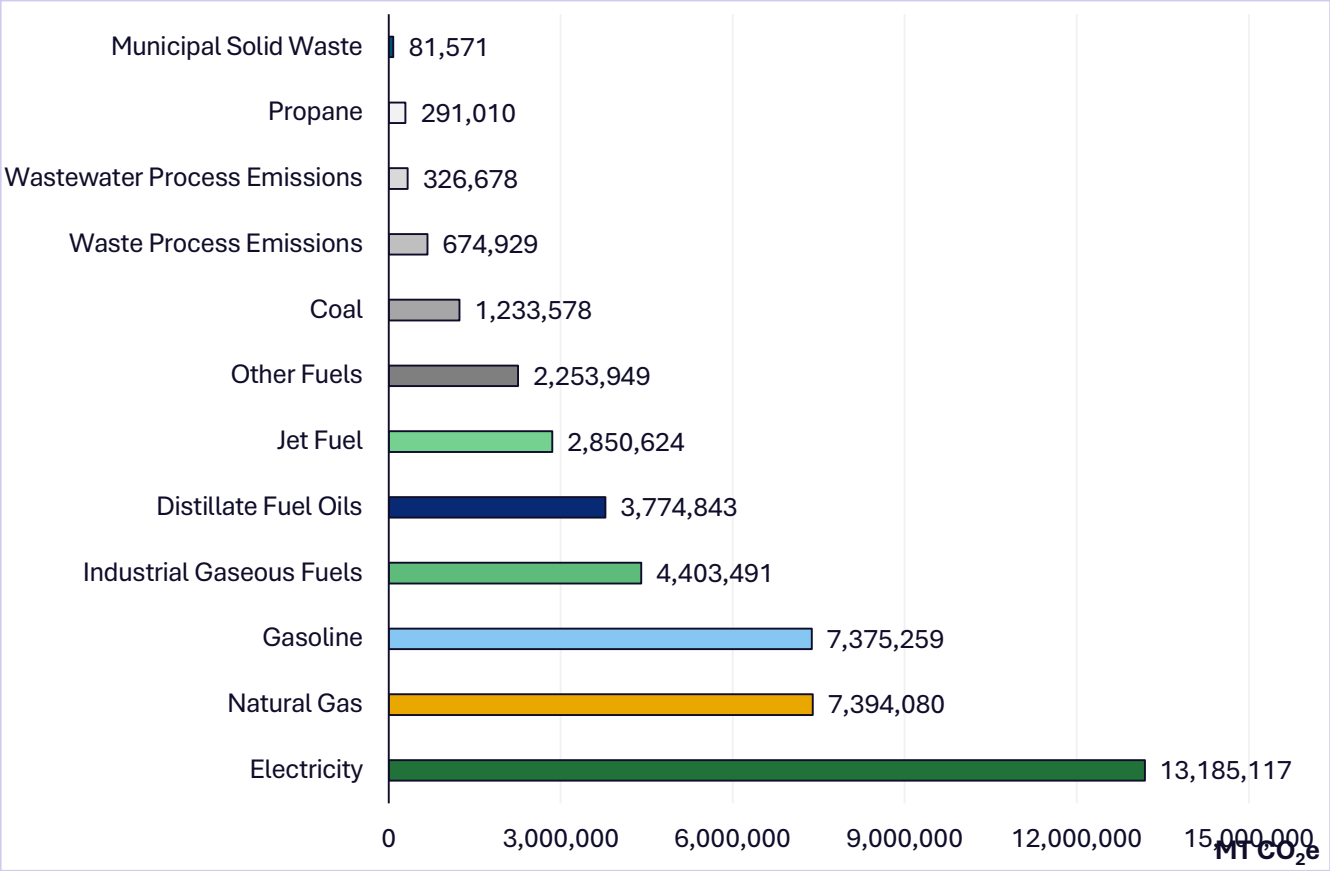


Figure 10. Emissions by Source and Fuel in 2022.

2.3.3 Data Limitations and Future Updates

As with any large-scale emissions inventory, data limitations exist due to the use of modeled or estimated values in some sectors. Continued collaboration with utilities, local governments, and federal partners will improve data accuracy over time.

The Cincinnati MSA intends to update this inventory regularly to monitor progress and assess the impact of implemented policies. Enhancements in data resolution, renewable energy tracking, and consumption-based (Scope 3) accounting will further refine the region's understanding of its emissions trajectory.

3. REDUCTION TARGETS

On October 15, 2025, the ThriveTogether Steering Committee met. At that meeting, the committee considered the information presented in Sections 4 and 5 of this document, deliberated, and set the following, non-binding targets for the reduction of greenhouse gas (GHG) emissions in the Cincinnati MSA:

Based on 2022 emissions,
By 2030, we will reduce annual emissions by

15%

By 2050, we will reduce annual emissions by

50%

4. BUSINESS-AS-USUAL GHG PROJECTIONS

Two GHG Projection Scenarios are developed for the OKI region. The first represents the Business As Usual (BAU) scenario where the ThriveTogether Playbook is not implemented and emissions are projected when no climate action is taken. The second scenario is the Implementation Scenario where the playbook is implemented, and mitigation projects are underway to complete actions to achieve GHG benefits for the region. Projections in the short term and long term are prepared for 2030 and 2050 respectively for both BAU and Implementation Scenarios.

The 2022 GHG Emissions Inventory was developed by UNPREDICTABLEcity and includes total GHG emissions for the OKI region in each sector. The resulting analysis of the BAU and Implementation Scenarios will use the 2022 baseline year as a starting point and for reference when comparing the two projection scenarios.

The BAU and Implementation Scenarios are developed for the OKI region to determine the outlook for 2030 and 2050. The foundation of these scenarios is based on research backed assumptions, trends, and data to calibrate the most accurate forecasts of the region. The State Inventory and Projection Tool was used to project emissions for the BAU Scenario, while other miscellaneous tools and methodologies were used to calculate emissions for the Implementation Scenario.

Sector	2022 Base Year Emissions ($MTCO_2e$)	Short Term BAU (2030) Emissions ($MTCO_2e$)	Long Term BAU (2050) Emissions ($MTCO_2e$)	Short Term Implementation Scenario (2030) Emissions ($MTCO_2e$)	Long Term Implementation Scenario (2050) Emissions ($MTCO_2e$)
Transportation	12,587,270	10,554,046	10,152,844	10,164,342	6,733,662
Electric Power	4,548,344	4,349,413	4,310,305	4,287,820	3,179,505
Buildings	14,190,494	13,751,604	13,702,403	13,190,320	9,377,767
Industrial	15,702,467	14,705,035	14,605,874	13,444,309	7,597,095
Waste	1,001,606	852,334	820,508	339,175	293,058
Agriculture	212,978	176,213	176,165	50,481	47,693
Carbon Removal	-3,145,370	-3,144,833	-3,143,994	-3,148,553	-3,259,318
Total	45,097,789	41,243,812	40,624,105	38,327,894	23,969,462

Table 2. Complete GHG Inventory for the region with 2022 representing the baseline year emissions data by sector. BAU and Implementation Scenario Projections by sector in the Short (2030) and Long (2050) Term.

4.1 BAU Projection Methodologies

There are two parts to the methodology used to calculate the GHG emissions from sectors in the BAU Scenario. The first part involved using the State Inventory and Projection Tool (SIT). The SIT Tool provided BAU projection data for each sector except Buildings and Carbon Removal. Buildings projection data was acquired from the SIT Tool by blending the Residential and Commercial emissions together to represent the Buildings sector. Carbon Removal projections were calculated using an estimate of wetland acres lost due to projected future development.

The second part of the methodology involves blending the data together from each state to represent the emissions reductions in the OKI region by 2030 and 2050. Projected GHG emissions by sector is calculated using data from the State Inventory projection

Tool (SIT) for Ohio, Kentucky, and Indiana. The data from the three states are weighted to calculate an emissions factor representing the OKI region. This method is used to produce emission projections for 2030 and 2050. These steps are all repeated for each individual sector to get the projected emissions for the BAU.

The Carbon Removal sector was not included in the SIT Tool, so a manual calculation was completed to determine the BAU Scenario Projection for this sector. The focus of this calculation is on forest and wetland acres lost by 2030 and 2050. It uses data from the U.S. Fish & Wildlife Service National Wetlands Inventory, attributing a factor of wetland acres lost per additional person in the region. Multiplying the wetland acres lost per person by the projected added population of 2030 and 2050 resulted in the projected amount of wetlands lost by 2030 and 2050. The carbon dioxide emitted per acre of wetland lost is calculated to determine the total GHG emissions projected for the Carbon Removal sector.

There are limitations to the data and equations used in the SIT Tool for the BAU scenario calculations. Historical data used to develop projections and trends have a degree of uncertainty and are designed to be used as a rough comparison of emissions for projections. Past trends are not guarantees of future performance. The introduction of unforeseeable changes such as new technologies and policies cannot be incorporated into past trends which drive these projections. Use of the SIT tool for state-level projections carries the assumption that the trends in our region's portion of each state would be similar to the state as a whole. The SIT tool is used since there are no region or county-level projections available. Despite these limitations and degrees of uncertainty, the SIT Tool utilizes data and estimation methodologies to construct a comprehensive emissions inventory.

The methodology used to complete the BAU scenario GHG emissions projection is incapable of encompassing all possible factors impacting GHG emissions in the OKI region by 2030 and 2050. The resulting GHG emissions projections can provide an understanding of what the future may look like, but it can't predict all the developments that will take place in the future.

4.2 BAU Projection Results

The BAU scenario projection illustrates what the region would look like if no climate action is taken. This scenario uses data, trends, and activities from the past few decades to project the future of electricity, transportation, buildings, and other trends that continue in the absence of any major changes or shifts.

Using the 2022 Inventory as the baseline, the total regional BAU projection estimates a 3.8 million MT CO2e decrease by 2030 and a 4.4 million MT CO_2e decrease between 2022 and 2050. The BAU Projection shows a total reduction in emissions of 8.6% by 2030, and 9.9% by 2050. The EPA Projection after 2030 has no significant emissions reductions in the BAU.

The Transportation sector has the greatest decline of GHG emissions in the BAU scenario of approximately 2.5 million MT CO_2e, with emissions decreasing by 19% by 2050. The Waste and Agriculture sectors see significant declines within their sectors as well with percent reductions of 18% and 17% respectively. Industrial has the second largest decrease in emissions of approximately 1.0 million MT CO_2e, representing a 7% reduction within the industrial sector. Buildings and Electric Power see reductions of 3.4% and 5.2% respectively. The Carbon Removal sector shows a minuscule increase in emissions due to the loss of wetlands and other natural areas as the population of the region expands (Figure 11). A summary of the total emissions per sector in the region by 2030 and 2050 in the BAU scenario projection is represented in the emissions table below (Table 3). Each sector from the BAU projection will be compared to the Implementation Scenario projection in the following section.

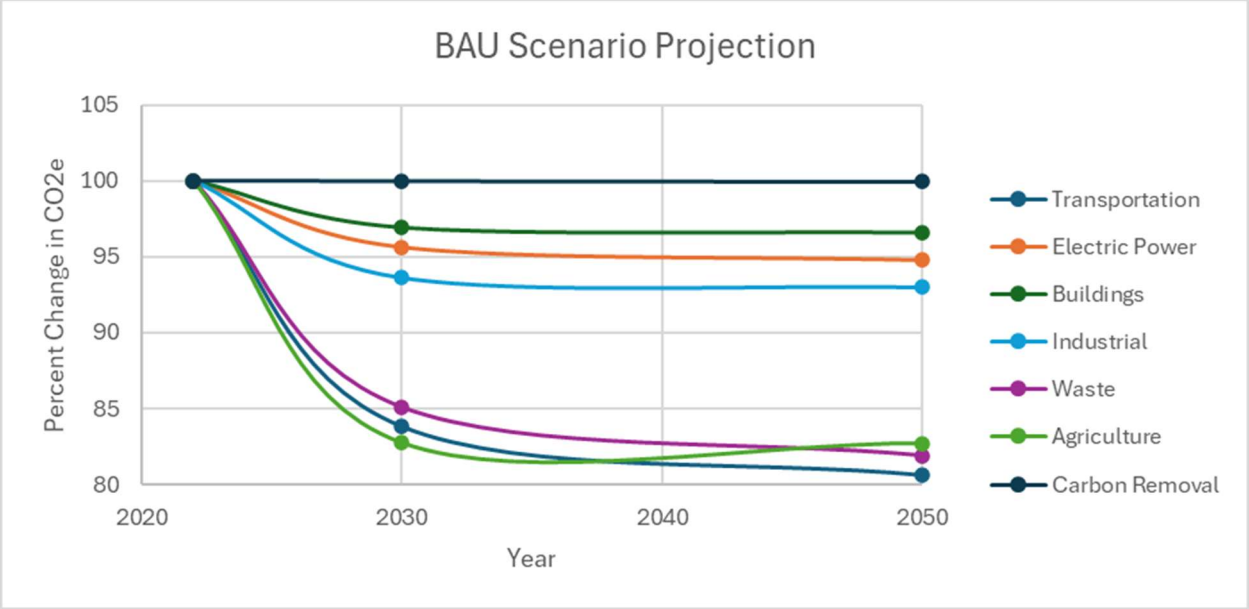


Figure 11. BAU Scenario Projection Plot by Percent Change in CO_2e for each Sector from 2022 to 2050.

Sector	2022 Base Year Emissions (MTCO2e)	Short Term BAU (2030) Emissions (MTCO2e)	Long Term BAU (2050) Emissions (MTCO2e)
Transportation	**12,587,270**	**10,554,046**	**10,152,844**
Electric Power	**4,548,344**	**4,349,413**	**4,310,305**
Buildings	**14,190,494**	**13,751,604**	**13,702,403**
Industrial	**15,702,467**	**14,705,035**	**14,605,874**
Waste	**1,001,606**	**852,334**	**820,508**
Agriculture	**212,978**	**176,213**	**176,165**
Carbon Removal	**-3,145,370**	**-3,144,833**	**-3,143,994**
Total	**45,097,789**	**41,243,812**	**40,624,105**

Table 3. BAU Scenario Projections by Sector in the Short (2030) and Long (2050) Term.

5. GHG EMISSION REDUCTION MEASURES & IMPLEMENTATION SCENARIO PROJECTIONS

The Implementation Scenario was created by calculating the emissions reductions of each implementation measure from the ThriveTogether Playbook and projecting those reductions to 2030 and 2050. The complete methodology and calculations for those implementation measures are included in the Appendix.

Each implementation measure in the Playbook is calculated following the same approach. A methodology was developed to reach a numerical goal representing the emissions reduction for the measure. Steps include identifying a GHG reduction estimate with units, acquiring measure-specific activity data, and determining models and tools which can be used for the calculation to quantify the final emissions reductions value. The total GHG emissions reductions from implementation measures is approximately 3.0 million MT CO2e by 2030, and 16.6 million MT CO_2e by 2050. GHG emissions reductions from the implementation scenario measures are further reductions on top of the BAU Scenario reductions. Emissions projections for the implementation scenario project the OKI region to drop from 45.0 million MT CO2e emissions in 2022 to 24.0 million MT CO_2e by 2050 (Figure 12).

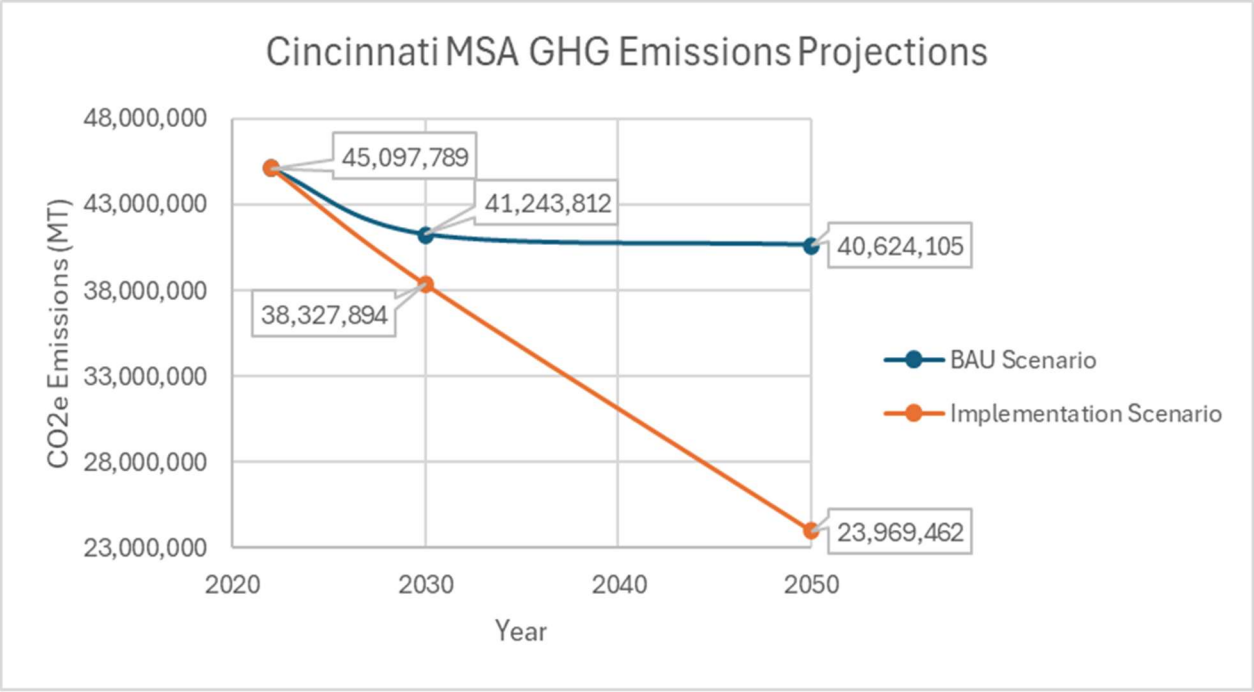


Figure 12. Projected GHG emissions reductions for the Cincinnati MSA in the BAU and Implementation Scenarios with data points for 2022, 2030, and 2050.

5.1 GHG Emission Reduction Measures Summary

The Implementation scenario GHG emissions projections further extends the emissions reductions from the BAU scenario to accumulate the total GHG emissions benefits when climate action is taken. There are seven sectors in the plan, each containing multiple measures for action to be taken in the region (Table 4).

Sector	Measure
Transportation	1.A Buildout a robust EV charging network
	1.B Convert public and private vehicle fleets to Electric or Alternative Fuel Vehicles
	1.C Encourage the use of transit, non-motorized vehicle, or walking for more trips within the region
	1.D Use technology, sound roadway network design, and policy to reduce areas of persistent traffic congestion
	1.E Support local development of sustainable aviation fuel
	1.F Support regional, intrastate, and interstate rail projects that move travelers and freight more efficiently
Electric Power	2.A Replace the region's streetlights with LED fixtures
	2.B Further develop renewable energy generation in the region
	2.C Help communities to educate businesses and residents on benefit of procuring electricity generated using clean and renewable energy sources
Buildings	3.A Improve the energy efficiency of local governments, schools, and non-profits in the region
	3.B Improve the energy efficiency of commercial buildings
	3.C Improve the energy efficiency of residential dwellings in the region
	3.D Adopt development patterns that are proven to be more energy-efficient and support energy efficient transportation

	3.E Involve citizens in the effort to reduce GHG emissions
Industrial	4.A Work to lower GHG emissions from large-scale emitters
	4.B Work towards developing a regional market for cleaner alternative fuels to power industrial processes like hydrogen, solar, geothermal, and nuclear
	4.C Work to improve industrial operations to be more energy efficient and use cleaner sources of energy
Waste	5.A Build an environment of collaboration among organizations involved in solid waste, recycling, composting, and food rescue to maximize efficiencies
	5.B Increase access to recycling for residents in multi-family buildings
	5.C Work to reduce methane released in the region
Agriculture	6.A Reduce fertilizer use in agricultural production
	6.B Increase local food production and markets
	6.C Increase use of farming methods that reduce GHG emissions
Carbon Removal	7.A Expand protections of the region's forested lands
	7.B Promote urban forestry as an important measure against the urban heat island effect
	7.C Increase wetland protection, restoration, and replacement
	7.D Support biochar research, development, and implementation

Table 4. GHG reduction measure summary by sector.

5.2 Implementation Scenario Projections

In the Implementation Scenario Projection, GHG emissions in the OKI region are expected to decline by 15% by 2030, and 47% by 2050. This is a significant increase from the BAU Scenario projection of 9% by 2030, and 10% by 2050. The implementation scenario projects a 6% and 37% reduction in emissions by 2030 and 2050 respectively, adding these reductions to those from the BAU to project the total GHG emissions

reductions for the region (Figure 13) From 2022 to 2030, the overall impact on the GHG emissions inventory from the implementation scenario is a reduction of about 3.0 million MT CO2e GHG emissions. The total emissions reduction from the implementation scenario by 2050 is 16.6 million MT CO_2e.

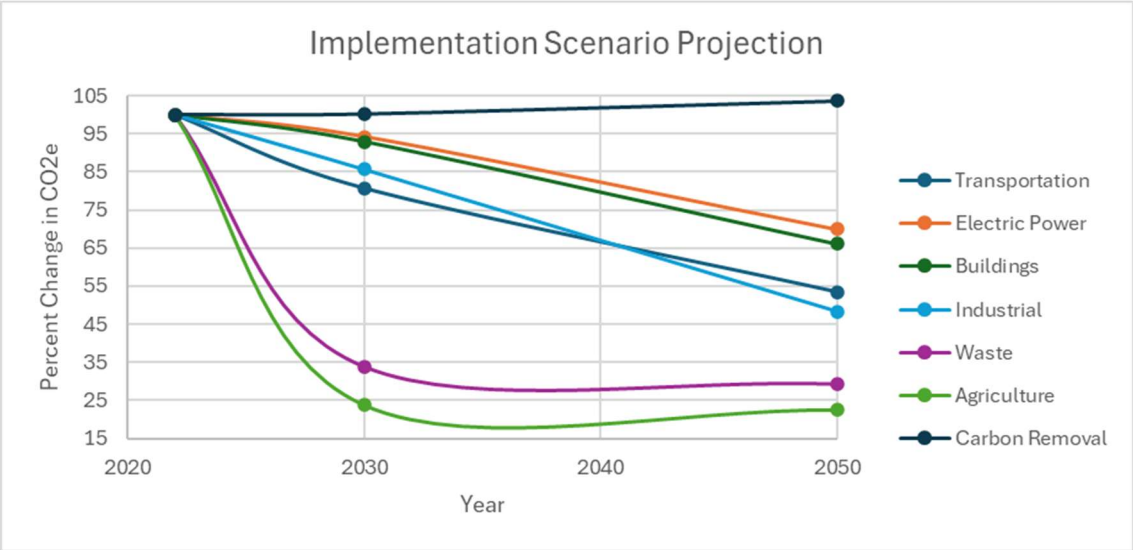


Figure 13. Implementation Scenario Projection Plot by Percent Change in CO2e for each Sector from 2022 to 2050.

5.3 Emission Reduction Measures

The table contained on the following pages detail the Implementation Measures and Associated Actions that make up the backbone of the ThriveTogether Playbook. The listing of these Measures and Actions are accompanied by specific information helpful to understanding the Measure's effect on emissions, co-benefits, benefits to LIDAC communities, potential effect on local jobs, key stakeholders, potential funding sources, local authority to implement the Measure, and metrics to track progress in implementing the Measure.

Following Table 5, this section summarizes the estimated emission reductions over the business-as-usual projections for each Sector. A full description of the estimated emission reductions for each Measure can be found in Appendix E.

Table 5: GREENHOUSE GAS REDUCTION MEASURES

Sector	Measure	Associated Actions	Timeframe	Regional GHG Benefits	Esimated Cost (2025 dollars)	LIDAC Benefits	Regional Co-benefits	Workforce Needs	Authority to Implement	Implementing Agency and Stakeholders	Funding Sources	Metrics to track progress
1. Transportation	1.A Buildout a robust EV charging network	1.A.1 Continue to track EV charging stations and EV registrations to reliably identify gaps and needs within the region's charging network	Ongoing	2030: 27,184 MT CO2e 2050: 358,560 MT CO2e	**$$$$** $10k-$200k per Level 3 port $3k-$6k per Level 2 port excluding site specific infrastructure	EV charging in LIDAC communities can reduce air pollution in targeted areas, create job opportunities and increase resident mobility.	**For measure**: Removal of airborne pollutants, increase in jobs/economic development	Total Transportation Sector Increase: +5906 Jobs (2030); +11,105 Jobs (2050); High Estimated Growth	Currently being done under local authority	**OKI** Drive Ohio Clean Fuels Ohio Transit agencies School Districts Local private school bus operators Local and county governments	Charging and Fueling Infrastucrture (CFI) Discretionary Grant Program (Federal) National Electric Vehicle Infrastructure (NEVI) Program (Federal) Alternative Fuel Vehicle Refueling Property Credit (Federal)	# EV chargers installed
		1.A.2 Continue to provide access to funding to help local governments, school districts, and parks provide EV charging points at public buildings, parks, airports, and other locations for public use.	Ongoing	Acess to public EV charging enables growth in use of private electric vehicles. Based on projections, the region will see an additional 30,710 EVs on the road in 2030 and 404,993 EVs by 2050.		Homeownership can be a barrier for energy transition. Expanding access to EV charging ports for public use can fill the disparity in access.			OKI distributes Carbon Reduction Program (CRP) funding for publicly-accessible EV charging stations as a competitive grant program.			
		1.A.3 Develop EV hubs that support transit ridership and/or public or private fleet vehicle operations including infrastructure needed to support charging lots.	Mid-term			Communities dependent on public transportation and supporting infrastructure is necessary to ensure reliable access.			Can be done under local authority			
		1.A.4 Work to streamline the permitting process for charging infrastructure to eliminate unnecessary expense and delay.	Short-term						Can be done under local authority			
	1.B Convert public and private vehicle fleets to Electric Vehicles	1.B.1 Support fleet EV and alternative fuel vehicle purchases for local government, school districts, and transit.	Mid-term	2030: 19,305 MT CO2e 2050: 68,455 MT CO2e	**$$$$** Cost of Hybrid Bus Cost of E-Bus Cost of Electric School Bus Cost of Electric Locomotives (From grant app)	Shifting to electric vehicle fleets facilitates infrastructure improvements and upgrades, creating work opportunities.	**For measure:** Removal of airborne pollutants, increase in jobs/economic development, positive impact in disaster preparedness	High Estimated Growth	Can be done under local authority	**OKI** ODOT Cooperative Contracts Program Drive Ohio Clean Fuels Ohio Transit agencies School Districts Local private school bus operators Local and county governments	Low or No Emission Grant Program (Federal) Clean School Bus Program (Federal)	# alternative fuel and electric fleet vehicles purchased
		1.B.2 Support use of battery electric locomotives in local rail freight operations.	Short-term	2030: 39 diesel transit buses replaced with hybrid, 500 municipal fleet vehicles replaced with EV, 335 diesel school buses replaced with electric, 22% of package and parcel deliveries completed by drone, and two diesel switching locomotives replaced with battery electric. By 2050: Whole fleet of transit and school buses transitioned to electric, 4,500 municipal, fire and police vehicles replaced with electric.		Improved resiliency in communities facing challenges maintaining power generation in extreme weather events, job creation.			Can be done under local authority			
		1.B.3 Provide case studies/examples to lower mystery and demonstrate effectiveness of low/zero emission vehicles to local governments and school districts.	Short-term			Education and community engagement in LIDAC communities, workforce, and infrastructure training opportunities, and community-led research.			Can be done under local authority			
		1.B.4 Support the future use of electric Advanced Air Mobility (AAM) vehicles to replace ground trips within the region through support for pilot projects and education.	Mid-term						Need FAA authorization of aircraft and flight plans			
	1.C Encourage the use of transit, non-motorized vehicle, or walking for more trips within the region	1.C.1 Improve bike and pedestrian connectivity through consistent investment so that residents can safely access the places they need to go and improve access to transit for longer trips.	Ongoing	2030: 297,772 MT CO2e 2050: 2,207,460 MT CO2e	**$$$$**	Improved bike and pedestrian connectivity in LIDAC residential areas improves resident accessibility to resources and needs	**For measure:** Increase in jobs/economic development, improvement to public health	Middle Estimated Growth	Can be done under local authority	**OKI,** Transit authorities, Tri-State Trails, Local and county government	Build Utilizing Investments to Leverage Development (BUILD) Grant Program (Federal) Pilot Program for Transit-Oriented Development Planning (Federal)	# miles of trail and sidewalk funded and constructed; growth of observed bicyle and pedestrians counts in the region
		1.C.2 Improve regional transit connectivity and service to provide an attractive, reliable, and efficient option for travel.	Ongoing	2030: 65 miles of new sidewalk and trail, 10% expansion of transit service through BRT, better service and connectivity, and new housing near transit, 150 new transit riders due to improved language services. 2050: 325 miles of new sidewalk and trail, 25% expansion of transit service, 150 new transit riders due to improved language services.		Increased access to essential services, jobs, education, and recreation while alleviating financial burdens for low-income individuals.			Can be done under local authority	Park districts, School districts, state DOTs		
		1.C.3 Use incentives to grow transit ridership to improve efficiency and reduce emissions.	Mid-term			Giving incentives for desired behaviors is a method of getting first-time customers and increasing the user base, and encouraging participation.			Can be done under local authority			
		1.C.4 Provide needed infrastructure support for Bus Rapid Transit, including transit centers and park & ride facilities.	Mid-term			Expansion of affordable public transit systems to connect low-income communities to new environments, education, resources and higher paying jobs.			Site developments subject to local zoning authority. ROW improvements subject to local authority or state DOT approval on state routes.			
		1.C.5 Provide improvements that make transit easier and more attractive to use, including language services for non-english speakers.	Ongoing			Assistance to those new to public transportation, materials to help familiarize people with the transit system in more many formats and languages.			Can be done under local authority			
		1.C.6 Develop more affordable and workforce housing close to good transit service.	Long-term			Aids in the creation of a connected community. Building affordable housing on or near transit lines offers access to employment, healthy food, schools, and downtown areas.			Subject to local zoning authority.			
	1.D Use technology, sound roadway network design, and policy to reduce areas of persistent traffic congestion	1.D.1 Continue to support the use of innovative intersections (for example: roundabouts) at appropriate intersections to reduce delay and avoid unnecessary signals.	Ongoing	2030: 45,443 MT CO2e 2050: 53,619 MT CO2e	**$$$$**	Less idling of cars in areas of high congestion and are shown to be safer for pedestrians and cyclists. In rural intersections roundabouts found significant reductions in crashes and injury related to crashes.	**For measure:** Improvement in public health, removal of airborne pollutants	Middle Estimated Growth	ROW improvements subject to local authority or state DOT approval on state routes.	**OKI** Local and county government state DOTs	Congestion Relief Grant Program (Federal)	OKI tracks conjestion and delay observed on major roadways in the region as part of its reporting on Performance Measures to FHWA and state DOTs.
		1.D.2 Provide for regular maintenance and timing of signalized intersections for best performance and encourage follow-up studies and adaptive management practices to minimize delay.	Mid-term	2030: 26 new roundabouts instead of signalized intersections, optimizing the operation and timing at 250 traffic signals per year, and 18% reduction in rush hour conjestion due to employers ajusting hours of manufacturing shift labor. 2050: 130 new roundabouts instead of signalized intersections, optimizing the operation and timing at 250 traffic signals per year, and 18% reduction in rush hour conjestion due to employers ajusting hours of		Delays and idling vehicles expel tons of carbon dioxide. Enhances safety as signal timing reduces abrupt stops.			ROW improvements subject to local authority or state DOT approval on state routes.			
		1.D.3 Support incident management time reduction	Mid-term			LIDAC rider data could show shorter trip times but they may spend a greater time accessing or waiting for transit and in moving vehicles, thus the entire trip's speed may be lower.			Can be done under local authority			
		1.D.4 Use data on trip origin/destination and traffic congestion to support reccomendations to large employers to adjust timing of shift changes.	Short-term						Can be done under local authority			
	1.E Support local development of sustainable aviation fuel	1.E.1 Advance efforts to develop and utilize sustainable aviation fuel via feasibility studies and/or infrastructure.	Long-term	2050: 720,000 MT CO2e Based on capturing 20% of the estimated impact of Kentucky's BDO Zone initiative.	**$$**	Creation of jobs, particularly in fields such as manufacturing, and research and development.	**For measure:** Promotes economic growth and jobs, improves energy resilience, improves air quality and health	High Estimated Growth?? Sustainable aviation facilities support thousands of jobs but they do not necessarily exist in our region yet	Need aircraft manufacturer and FAA approval?	**Aviation assocations,** CVG, Airlines and aircraft manufacturers	Fueling Aviation's Sustainable Transition via Sustainable Aviation Fuels (FAST-SAF) and Low-Emissions Aviation Technologies (FAST-Tech) Grant Program (Federal) Voluntary Airport Low Emissions Program (VALE) (Federal)	Progress will be monitored through CVG's involvement in the local development of sustainable aviation fuel.
	1.F Support regional, intrastate, and interstate rail projects that move travellers and freight more efficiently.	1.F.1 Support ongoing intra/interstate Amtrak projects. Develop proposal for regional system.	Long-term	2050: 11,088 MT CO2e	**$$**	Expands options for rural and smaller urban community citizens with increased transfer points. Aids in airport and highway congestion.	**For measure:** Diversifies transportation options, improves equity and access, improves air quality and health, promotes economic development in the region			**OKI**, ODOT, KYTC, INDOT, USDOT, private rail operators,	Consolidated Rail Infrastructure and Safety Improvements (CRISI) Program (Federal) National Railroad Partnership Program/Federal-State Partnership for Intercity Passenger Rail (FSP) Grant Program (Federal) Port Infrastructure Development Program (Federal)	Progress on planning and implementation of 3C+D rail project in Ohio and the increase in service along the Amtrack Cardinal route in Cincinnati.
		1.F.2 Implement programs to bridge the gap between rail travel and local destinations and movement while at the destination.	Long-term	Most recent estimates place the opening of a 3C+D passenger train service at 2035. Amtrack estimates of passenger use equate to between 10M and 20M passenger miles per year.		More transfer points and connectivity between rail and local travel will allow LIDAC communities. According to the 2010 census, 41.8 million Americans age 18+ have disabilities, 40 million are age 65+, and 32 million are living below the poverty level. Many of these people have very few mobility options to meet their basic travel needs.						

Table 5: GREENHOUSE GAS REDUCTION MEASURES

Sector	Measure	Associated Actions	Timeframe	Regional GHG Benefits	Esimated Cost (2025 dollars)	LIDAC Benefits	Regional Co-benefits	Workforce Needs	Authority to Implement	Implementing Agency and Stakeholders	Funding Sources	Metrics to track progress
2. Electric Power	2.A Replace the region's streetlights with LED fixtures	2.A.1. Seek and support funding through loans and grants to local govenments for the conversion of street lights to LED fixtures.	Mid-term	2030: 6,755 MT CO2e 2050: 33,775 MT CO2e 1,750 LED streetlight conversions per year.	$$$ ~$700 per LED fixture for standard roadway cobrahead	LED fixtures reduce the energy used by local governments and lowers local governments' operating expenses. This, in turn, leads to lower tax burden on every resident of the community.	**For measure:** Easing of energy cost burdens	Total **Sector** Increase: +3,877 jobs (2030) and +7,524 jobs (2050); Middle Estimated Growth	Can be done under local authority	**Local governments**, Duke Energy	Energy Efficiency and Conservation Block Grant (EECBG) (Federal)	# of street lights converted ; $ recieved through loans and grants to local governments for conversion of street lights
	2.B Further develop renewable energy generation in the region	2.B.1 Install solar panels to support local non-profits and community-based groups.	Mid-term	2030: 22,623 MT CO2e 2050: 710,445 MT CO2e	$$$$	Community solar projects are one way to help households without access to a rooftop to subscribe to solar.	**For measure:** Easing of energy cost burdens, positive impact in diaster preparedness	High Estimated Growth, but not necessarily applicable in our region yet	Community solar not currently permitted in Ohio, Kentucky, or Indiana	**Green Umbrella**, Cincinnati OES, Duke Energy, Energy Coalitions	Energy Improvements in Rural or Remote Areas (Federal) Grid Resilience and Innovation Partnerships (GRIP) Program (Federal) Long Duration Energy Storage Demonstration Initiative and Joint Program (Federal) Clean Energy Investment Tax Credit (ITC) (Federal) Renewable Electricity Production Credit (Federal)	# of interconnection agreements filed with Public Utilities Commission of Ohio and eqivalent data source for KY and IN, where applicable; # KW capacity from renewable sources; # of SolSmart Designated communities
		2.B.2 Support the implementation of a municipal virtual power plant in the region	Mid-term			Can provide energy in places of high demand, in extreme weather events and reduce overall energy costs			Must partner with a licensed utility.			
		2B.3 Support solar installations for local governments through financing options that are tailored for their situation	Mid-term	Estimate of $5M annually invested in on-site solar development from the public and non-profit sector; the development of a planned 3 Mw solar farm in Oxford by 2030; the development of a 1.5 Gw VPP by 2050; doubling of current hydropower generation in region by 2050; and increasing the amount of private solar capacity in the region 25% by 2030 and 300% by 2050.		Solar deployment has increased rapidly, allowing more communities to access the benefits of solar PV and begin in local planning such as resilience planning, sustainability planning, and climate action planning.			Net metering is not permitted in Kentucky. In Ohio, a maximum of 20% of the meter's usage can be sent to the grid under net-metering limits.			
		2.B.4 Continue the development of hydropower along the Ohio and Great Miami Rivers.	Mid-term			Governments are starting to notice that, when done right, hydropower offers immense potential to electrify rural communities with clean energy and support the expansion of other renewables.			Subject to approvals from Army Corp of Engineers. Similar projects have been approved on the Ohio and Great Miami Rivers.			
		2.B.5 Encourage the development of private solar installations, especially the utilization of large rooftops for solar or solar development on dormant landfills. Promote the co-benefits of agro-voltaics.	Mid-term			By installing solar on closed landfills, states and municipalities advance local solar energy while repurposing relatively large, vacant sites within communities with limited reuse potential.			Subject to net metering restrictions currently in place in Ohio, Kentucky and Indinana.			
		2.B.6 Increase adoption of SolSmart principles by area local governments to make the installation of solar easier and less costly in the region	Short-term			No cost technical assistance to communities to identify local energy priorities and strategies to make solar accessible and affordable.			Can be done under local authority			
	2.C Help Communities educate businesses and residents on benefit of procuring electricity generated using clean and renewable energy sources.	2.C.l Encourage renewable energy community aggregation programs.	Short-term	2030: 32,215 MT CO2e 2050: 386,580 MT CO2e	No direct costs for prioritizing renewable energy within aggregation programs.	Aggregated buying groups purchase gas and electric generation on behalf of the community at competitive prices and pass savings along to residents.	**For measure:** Easing of energy cost burdens, positive impact in disaster preparedness	Middle Estimated Growth	Energy aggregation only available in Ohio.	**Green Umbrella;** Power a Clean Future Ohio,	Rural Energy For America Program (REAP) (Federal) Rural Energy Savings Program (Federal) Low-Income Bonus Credit Program (Federal)	# of renewable energy community aggregation programs
		2.C.2 Increase the region's low and moderate income households' access to inexpensive renewable energy.	Mid-term			LIDAC communities have not historically been included in solar conversations. Savings on energy costs may be overlooked due to unfamiliarity.			More avenues open in Ohio through consumer energy choice and aggregation.			
		2.C.3 Advocate for states to readopt reasonable Renewable Portfolio Standards policies.	Mid-term	NREL projects the adoption of 100% renewable utility aggregation plans will increase nationally by 54% by 2030. This projection was applied to the current subscription to 100% renewable aggregation plans in the region. For 2050, the rate was assumed to be six times the current adoption rate.		Low-Income Bonus Credit Program, allowing the transition to wind and solar energy to be more affordable for families and communities			Authority to adopt RPS lies with each state government			
3. Buildings	3.A Improve the energy efficiency of local governments, schools, and non-profits in the region	3.A.1 Create a fiscally-positive revolving loan fund or grant opportunity to finance energy-efficient and/or solar improvements for local and county public entities (governments, schools, libraries, park districts, etc.) in the region.	Mid-term	2030: 124,247 MT CO2e 2050: 1,051,547 MT CO2e	$$$$	Funds would be used to finance energy-efficient improvements in public resources and services benefitting the public directly.	**For measure:** Easing of energy cost burdens, positive impact in disaster preparedness	Total Sector Increase: +5,285 (2030) and +11,047 (2050); Middle Estimated Growth	Can be done under local authority, programs often authorized through state legislation or federal funding	**Local governments,** school districts, non-profit organizations	Energy Efficiency and Conservation Block Grant Program (Federal) Renew America's Schools Grant (Federal)	Fund Establishment and Financial Health, Project Implementation and Impact, Financial and community outcomes, program growth and scalability
		3.A.2 Help connect non-profit organizations with funding for energy efficiency and solar.	Short-term			Connecting these frontline organizations to funding can allow for better distribution of funds throughout the community and community leadership in projects.			Can be done under local authority, programs often authorized through state legislation or federal funding			Outreach and Engagement, Funding Application Support, Funding Amounts Secured, Project Implementation, Capacity Building and Follow-up
		3.A.3 Conduct energy audits and make energy efficient building upgrades to public buildings	Short-term	Estimates for this measure are based on the region's 2024 CPRG Implementation Grant application. Reductions based on estimated improvements to 500,000 sf of buildings annually.		Upgrading energy systems in public buildings can increase resilience to outages and extreme weather events. Low-income communities are often more vulnerable to the impacts of climate change and less equipped to deal with disruptions to essential services			Can be done under local authority, programs often authorized through state legislation or federal funding			Audit Completion, Audit Findings & Recommendation, Upgrade Implementation, Energy Performance, Financial & Operational Outcomes, Stakeholder Engagement & Satisfaction
		3.A.4 Encourage electric & gas utilities to support benchmarking by enabling customers to automatically upload their energy usage data into approved benchmarking software platforms.	Mid-term									Utility Engagement, Customer Particpation, Data, accessibility, Intergration & Quality, Technology Implementation, Benchmarking Data, Usage & Outcomes, Stakeholders & Customer Feedback
		3.A.5 If local government underwrites energy audits, or if it requires audits as a condition of sale or at some other time, it should consider simultaneously creating a centralized database of energy efficiency scores for properties that have been audited. This would facilitate the targeting of lowest-performing buildings when creating programs to support/finance energy efficient retrofits, etc.	Mid-term									Policy & Program Adoption, Database Development and Usage, Data Quality & Completeness, Program Targetings & Outcomes, Stakeholders Engagement & Satisfaction
	3.B Improve the energy efficiency of commercial buildings	3.B.1 Adopt Energy Efficient Building standards	Mid-term	2030: 79,314 MT CO2e 2050: 298,714 MT CO2e	$$$$	Adopting standards influence practices. Regulators play a role in encouraging utilities to invest in equitable programs that reach low income communities. Comphension about how these programs fit into utility portfolios.	**For measure:** Easing of energy cost burdens, improvement in public health	Middle Estimated Growth	Kentucky and Indiana: No standards currently in place, has VOLUNTARY energy portfolio standard; Ohio: has energy portfolio standards established in S.B. 221	**Non-profit organizations**, local governments,	Energy Efficient Commercial Building Property (EECBP) (Federal) 179D Energy Efficient Commercial Buildings Tax Deduction (Federal)	Policy Adoption & Implementation, Compliance & Enforcement, Training & Capacity Building, Energy & Environmental Impact, Program growth & Public Awareness
		3.B.2 Support foundational work, such as the regional 2030 District as they develop methods to achieve building efficiency goals	Short-term	Projections based on meeting 2030 District goal for member buildings and maintaining that same level of progress through 2050 and for adopting a modest voluntary building energy efficiency standard for the Cincinnati CBD resulting in a 0.5% energy use reduction by 2030 and a 1% reduction by 2050.		Foundational work focused on reducing energy consumption, lowering carbon emissions, and improving overall building performance, which can lead to several direct and indirect benefits for these communities. Actively involving communities in the implementation of phases of energy effiecincy projects ensures needs and input is heard.			Can be done under local authority			Engagement & Support Activities, Development of methods & tools, Building Participation & Goal Setting, Capacity Building & Outreach, Energy & Environmnetal Outcomes - T**rack through 2030's regular reporting schedule with partners, periodic survey/review to assess adoption of methods. applciation of tech tools/software for project management**

Table 5: GREENHOUSE GAS REDUCTION MEASURES

Sector	Measure	Associated Actions	Timeframe	Regional GHG Benefits	Esimated Cost (2025 dollars)	LIDAC Benefits	Regional Co-benefits	Workforce Needs	Authority to Implement	Implementing Agency and Stakeholders	Funding Sources	Metrics to track progress
		3.B.3 Encourage electric & gas utilities to support benchmarking by enabling customers to automatically upload their energy usage data into approved benchmarking software platforms.	Mid-term									Utility Engagement & Commitment, Customer participation, Data Integration & Usage, Benchmarking Software adoption for Data reporting - **Track through Benchmarking software data reporting, survey customers & utilities, Stakeholders & Customer Feedback**
		3.B.4 Localities should consider a Benchmarking Ordinance and/or Building Performance Standard (BPS) for commercial buildings. (NOTE: BPS policies vary widely in design particulars, but often include both incentives to support compliance and penalties for non-compliance.)	Mid-term									Implementation & Compliance, Data Quality & Transparency, Policy Development & Adoption, Capacity Building & Stakeholders engagement, Environmental & Energy Outcomes - **Track through centralised database, peridic compliance audit, annual reports and excutive summary**
		3.B.5 Provide funding for essential foundational work that is precursor to most energy efficiency improvements, such as benchmarking training for building owners and free energy audits	Mid-term									Funding Allocation & Utilization, Training Delivery & Participation, Energy Audit Performance, Follow-up Actions, Outcome & Impacts - **Track through centralised audit report database, grant mgt/project tracking tools, regular progress reviews with funding recipients to report metrics**
		3.B.6 Look for opportunities to work with insurance and finance industries to develop financing products that favor energy efficiency and clean energy (e.g. Green Bank)										Parnership Development, Financing Product Development, Program Uptake & Impact, Mkt awareness & Education, Environmental & Economic Outcomes - **Track through CRM, data-sharing agreements with partners, reporting schedules with partners**
	3.C Improve the energy efficiency of residential dwellings in the region	3.C.1 Expand the number of households in the region served by the Home Weatherization Assistance Program	Mid-term	2030: 86,432 MT CO2e 2050: 291,168 MT CO2e	$$$$	Expansion of HWAP would contribute significant savings in overall energy consumption and rduction in energy bills for residents.	**For measure:** Easing of energy cost burdens, increase in jobs/economic development	High Estimated Growth	Can be done under local authority and through community action groups	**Workforce development programs**, Green Umbrella, County governments,	Community Development Block Grant (CDBG) Entitlement Program	Program reach & participation like nos of households served, Geographic & Demographic coverage, Program capacity & Resources, Energy savings & Environmental impacts - **Track through GIS, regular surveys, or followup interviews, centralised database of households served, collect energy use data before & after programs**
		3.C.2 Provide incentives to replace inefficient household appliances and HVAC equipment with new electric-based equipment (e.g. induction stoves, electric heat pumps and hot-water heaters)	Short-term	Assumes expanding HWAP program to serve an additional 2,000 households per year. This assumption is from the region's CPRG Implementation Grant Application and represents a 30% expansion of the HWAP reach in the region. Assumes revised zoning and building standards will result in 10% reduction in energy use by new construction housing units. Assumes 45 homes improved annually under local incentive programs at $18,000 of improvements each - matching the historical reach of the Hamilton County HIP program. Assume the expansion of the Mow Greener program at 25% per year through 2030 and then holding steady through 2050.		Provides LIDAC communities access to modern, efficient technology that otherwise would be cost prohibited.			Can be done under local authority			Program Participation, Incentive distribution, energy & emission impact. customer enegagement & awareness, program efficiciecy & equity
		3.C.3 Encourage the development of residential units that are more energy efficient / adopt enhanced energy efficiency standards	Mid-term			97% of excess energy burdens for renting households could be eliminated by bring homes to median standards.			Can be done under local authority, based on 2018 International Energy Conservation Code (IECC) and Residential Codes			Market & Community Impact, Stakeholders Engagement & Capacicty Buildigng, Enegy Performance, Construction & Retrofits, Policy & Program adoption **- Track through Local building departments & permits officers, utilities/energy auditors report on new building/retrofits, feedback from builders & residents through Survey & interviews**
		3.C.4 Incentivize energy-efficient improvements through linked deposit or tax abatement programs.	Mid-term						Can be done under local authority			Program Uptake & Participation, Financial Performance & Sustainability, Enrgy & Environmental Impact, Program Reach & Equity, Stakeholders satisfaction & Awareness - **Track through program database, energy performance data, financial reports, survey & interviews**
		3.C.5 Expand the MowGreener program in the region to electrify lawn care equipment	Short-term						Kentucky and Indiana: No formal MowGREENER program identified ; Ohio: has MowGreener program and can be done under local authority			Program Expansion & Participation, Equipment Adoption, Enviromenta Impact, Cost & Incentives, Community Engagement & Satisfaction - **Track through participants registration/data, sales/distribution data, periodic surveys, regular progress report from stakeholders**
		3.C.6 Look for ways to develop and/or expand cooperative purchasing programs for energy efficient or clean energy capital improvements										Program development & Expansion, Procurement Activity, Cost Savings & Efficiency Gains. Environmental Impact, Stakeholder engagement & Satifaction - **Track through centralised database, procurement & performnace data, surveys, feedbacks, periodic report summary of key metrics and program impacts**
		3.C.7 Encourage electric & gas utilities to support benchmarking by enabling customers to automatically upload their energy usage data into approved benchmarking software platforms.										Customer enrolment & Usage, Benchmarking platform Integration, customer engagement & satisfaction, utility participation & support, energy efficiency programs- **Track through periodic energy reports, energy benchmarking platforms, energy program managers**
		3.C.8 Provide funding for essential foundational work that is precursor to most energy efficiency improvements, such as benchmarking training for homeowners and free energy audits										Funding & Program Implementation, Participation & Reach, Qaulity & Outcomes of Training Audit, Capacity Building - **Track through survey/ feedback tools, periodic followup, regulat reports, centralised database**
	3.D Adopt development patterns that are proven to be more energy-efficient and support energy efficient transportation	3.D.1 Conserve embodied carbon in existing buildings by avoiding demolition of existing buildings where possible; consider tax incentives for developers to retrofit existing buildings in lieu of demolition and/or increase landfill fees for construction debris	Ongoing	2030: 271,291 MT CO2e 2050: 2,683,207 MT CO2e	$$	Prioritizing existing buildings, materials, and infrastructure, encouraging the use of low-carbon materials or the efficient use of materials, planning for deconstruction and reuse, reducing waste, and reducing the carbon impact of construction, are all ways that city officials are tackling embodied carbon.	**For measure:** Easing of energy cost burdens, improvement in public health	Middle Estimated Growth	Can be done under local authority	**Local governments**,	Urbanized Area Formula Grants -5307 (Federal) Urban and Community Forestry Program (Federal)	Demolition & Construction Data, Policy & Incentive Adoption, Retrofits Projects, Financial / Environmental Impacts, Stakeholder Engagement/Awareness - Track through Tax Authorities, Local Building Departments, Waste Mgt agencies, Usage of Carbon Calculators or Tools
		3.D.2 Promote transit oriented development zoning and incentives for this type of development	Short-term	UrbanCincy reports that an estimated 8,000 buildings may face demolition in Cincinnati by 2030. Science Direct estimates a 12-15% lifecycle carbon savings due to reuse of existing buildings over new construction. Assumed saving 30% of buildings under threat by 2030 and consistent annual savings through 2050. Assumes 10% growth in development of residential units within proximity to transit by 2030 and 20% growth by 2050 with total number of units capped at 46,597 (total new units projected by 2050 by OKI). Developing 180 acres of cluster-style development outside the urbanized area per year. Adopting energy efficiency standards for new construction.					Can be done under local authority			Policy & Regulatory Adoption, Incentive Programs Development & Use, Development Activity & Impact, Transit Ridership & Accessibility, Community & Stakeholder Engagement, Economic & Environmental Outcomes - **Track through zoning database, planning departments, GIS mapping, regular surveys/public engagement sessions**
		3.D.3 Adopt cluster-style development in rural areas to reduce infrastructure and preserve agricultural and forested lands	Mid-term			Cluster development provides multiple benefits to small and rural towns. This development style can preserve existing natural characteristics, contribute to community character, and increase available housing.			Can be done under local authority			Policy Adoption & Implementaion, Land Preservation, Infrastructure Efficiency, Housing & Community Impact, Environment & Land Use Outcome - **Track through Planning & Zoning records, GIS mapping of land preservation, local govt estimate of infrastructe cost/savings, survey/interviews, regularly review of environmental monitoring reports**
		3.D.4 Enhance energy standards for new construction to reduce the life-cycle carbon emissions of new buildings. Do this through the promotion of model codes to be adopted by applicable jurisdictions	Mid-term			Savings in energy costs for residents using new buildings and job opportunities associated industries.			Can be done under local authority, acceptances of IECC codes and amendments on state or local levels			Capacity Building & Outreach, Complaince & Enforcement, Policy Adoption & Implementation, Program Growth & Updates - **Track through Building permit database, training attendance & Outreach, regional/city policy adotion traker, periodic reviews**
		3.D.5 Install more roundabouts for more efficient traffic flow, reduced emissions, and improved safety										Traffic Flow Efficiency, Emission Reductions, Safety Improvements, Planing & Implementation, Cost & Maintenance - **Track through traffic data using sensor, GIS mapping of locations with roundabouts, Periodic survey, local transpotation & Safety Department - accident & emission data.**
		3.D.6 Invest in expanding tree canopy to mitigate urban heat island effects, reduce flood risk, and increase beauty										Tree Canopy Expansion, Urban Heat Island Mitigation, Flood Risk Reduction, COmmunity & Environmental Benefits. Maintenance & Survival rates - **Track through GIS mapping, Temp sensors, local health reports, surveys, tree inventory & survival rate & health monitoring database**

Table 5: GREENHOUSE GAS REDUCTION MEASURES

Sector	Measure	Associated Actions	Timeframe	Regional GHG Benefits	Esimated Cost (2025 dollars)	LIDAC Benefits	Regional Co-benefits	Workforce Needs	Authority to Implement	Implementing Agency and Stakeholders	Funding Sources	Metrics to track progress
	3.E Involve citizens in the effort to reduce GHG emissions	3.E.1 Hold events that build awareness and focus energy around reducing GHG emissions in the region	Short-term	Unable to find reliable studies of how much tangible impact public awareness campaigns boost other direct reduction measures.	$	Citizen involvement creates community investment in prohects around reducing GHG emissons. Events given individuals opportunities for education and participation.	**For measure:** Improved air quality and public health, easing energy burden, community engagement and social cohesion, economic development and jobs	Low Estimated Growth	Can be done under local authority	**Green Umbrella**	Locally Funded	Attendance Participation, Numbers of event and frequency, Engagement & Outreach, Content & Messaging Impact tracking, Follow-up & Outcomes - **Track through Surveys, event registrations, social media analytics, followup actions**
		3.E.2 Challenge residents of the region to reduce energy use and emissions through altering everyday behaviors (turning off lights, adjusting thermostats, commuting by biking or transit, etc) by creating a game that rewards such changes.										Engagement Metrics, Reward Distribution & Incentives, Behavior Chnage & Impact metric tracking, Program awareness & Reach, feedback/satisfaction - **Track through periodic participation surveys, energy saving programs, reward distributions tracking**
		3.E.3 Leverage existing coalitions (WeThrive, LiveWell) as community mobilizers (health in all policies).	Short-term			Existing coalitions have built trust in thier communities and can aid to education, faciliation, implementation and communication among local residents.			Can be done under local authority, with collaboartion from state health departments			Coalition Engagement & Activity, Community Outreach & Awareness, Policy Influence & Integration, Coalition enegagment & Activity, Outcomes & Building, Capacity Building - **Track through meeting logs/attendance, policy documents/meeting minutes, survey/interviews,event registration/feedback forms.**
4. Industrial	4.A Work to lower GHG emissions from large-scale emitters	4.A.1 Advance industrial decarbonization through participation in state, federal, and utility energy-efficiency programs such as DOE Better Plants Program, Energy Star Challenge, etc.	Short-term	2030: 85,471 MT CO2e (4 of 37 reporters, 10% reduction) 2050: 427,356 MT CO2e (20 of 37 reporters, 10% reduction)	$$$$	Industrial decarbonization will create cleaner air quality among communities dependent on these industries for jobs and economic opportunities.	**For measure:** Removal of airborne pollutants	Total **Sector** Increase: +4,641 (2030) and +8,885 (2050); Middle Estimated Growth	Can be done under local authority	**Air Quality Agencies**,	Qualifying Advanced Energy Project Credit (48C) Program (Federal)	% GHG Reduced by reporting facilities (https://ghgdata.epa.gov/flight); # of participants in energy efficiency programs
		4.A.2 Work with regional industries to collaborate around: - Green energy purchasing - Transportation - Building energy efficiency - Energy switching - Industrial parks where industries cluster to more efficiently share resources	Short-term									
	4.B Work towards developing a regional market for cleaner alternative fuels to power industrial processes like hydrogen, solar, geothermal, and nuclear	4.B.1 Convene a regional working group to explore potential cleaner energy sources for industrial users. The group should include an array of regional industries, utility and energy providers, civic and economic development leaders, and universities.	Short-term	2030: 705,153 MT CO2e (4.5% reduction, https://www.c2es.org/document/decarbonizing-u-s-power/) 2050: 2,350,508 MT CO2e (15% reduction, https://www.c2es.org/document/decarbonizing-u-s-power/)	$$$$	Hydrogen and hydrogen-based fuels can transport energy from renewables over long distances – from regions with abundant solar and wind resources to energy disadvantaged areas.	**For measure:** Positive impact in disaster preparedness	Low Estimated Growth	Can be done under local authority	**Green Umbrella**,	Regional Direct Air Capture (DAC) Hubs Program (Federal)	# of areas identified for carbon sequestration
		4.B.2 Identify areas in the region suited for carbon sequestration.	Short-term						Can be done under local authority			
	4.C Work to improve industrial operations to be more energy efficient and use cleaner sources of energy.	4.C.1 Work to improve the energy-efficiency and reduce GHG emissions from buildings and industrial processes through energy audits. Capture wasted heat to use in other operations.	Mid-term	2030: 470,102 MT CO2e (3% reduction) 2050: 4,230,915 MT CO2e (27% reduction, US DOE Energy Star Industrial Decarbination Study, 2018)	$$$$	Innovations in efficiency and methods aimed at reducing GHG emissions in industrial processes can create employment opportunities in rural and disadvantaged communities.	**For measure:** Improvement in public health, increase in jobs/economic development, easing of energy cost burdens	Middle Estimated Growth	Stricter energy codes cannot be made without state approval. Local governments have authority to enforce existing codes, retrofit public buildings, etc. Indiana holds renewable energy tax deduction (IC 6-1.1-12-35.5)	**Non-profit agencies**,	Industrial Training and Assessment Center Implementation Grant (Federal) Advanced Manufacturing Production Cedit (Federal)	% of GHG reduced from Scope 2 industrial emissions
		4.C.2 Electrify and improve the energy efficiency and operations of intermodal transition between truck, barge and rail to reduce emissions, reduce delay, and provide local industry better transportation access.	Mid-term			Benefits to LIDAC communities include improved enviromental conditions, health outcomes, economic opportunities and lower cost of goods.			Can be done to an extent under local authority, but state and federal coordination is essential (in hands of ODOT, Ports of Indiana, KYTC, etc.)			
		4.C.3 Use treated wastewater in "purple pipe" or stormwater retained on-site for uses that don't require drinking water.	Mid-term									
		4.C.4 Industry and local governments should adopt "green" procurement standards to reduce indirect carbon footprint										
5. Waste, Water, and Sustainable Materials Management	5.A Build an environment of collaboration among organizations involved in solid waste, recycling, composting, and food rescue to maximize efficiencies.	5.A.1 Create local Green Hubs to increase coordination and provide for more effective recycling, reuse, and organic waste diversion. Green Hubs should contain: - Refrigeration and packaging supplies for food rescue - Repair tools and materials - Sewing Machines - Sorting areas	Mid-term	2030: 430,442 MT CO2e 2050: 430,442 MT CO2e	$$$	Creating a local Green Hub can ehnance waste reduction efforts in low income communities through education and resources about waste minimization strategies.	**For measure:** Improvement in public health, easing of energy cost burdens, removal of airborne pollutants	Total **Sector** Increase: +5,495 (2030) and +10,301 (2050); Low Estimated Growth	Can be done under local authority	**Non-profit agencies**, R3source,	Composting and Food Waste Reduction (CFWR) Cooperative Agreements (Federal)	1. Organizations involved - extent of network 2. Residents served/reached 3. Material diverted from landfill
		5.A.2 Partner with local schools, governments, farms, and park districts to implement composting programs	Short-term	Assumes a Green Hub for reuse/recycling is established by 2030, a food resuce / food waste composting operation is established to divert food waste from the region's schools from the landfill, and existing food rescue efforts are boosted.		Partnering with local schools, goverments, and parks can benefit LIDAC communities by increasing access to composting and fresh food, strengthening partnerships through collaborative programming and creating local work opportunities.			Can be done under local authority, but under different regulations: -Kentucky: follow 401 KAR 48:200 and 401 KAR 45:100 -Ohio: follow Ohio Administraive Code Chapter 3745 -Indiana: follow Indiana Code 13-20-9 and 13-20-10			1. Food waste diverted from landfill 2. Residents participating in program 3. Accessibility - total communities/ neighborhoods served 4. Sustained efficacy
		5.A.3 Enhance tracking and reporting of food waste and rescued food in the region to identify roadblocks and opportunities to increase food rescue	Mid-term			Developing infratructure, incentives and systems of tracking and reporting to reduce food waste can translate to household savings, a reduction in food insecurity, and a significant reduction in GHG emissions.			Can be done under local authority			1. Establish baseline 2. Establish system for data collection 3. Participating residents 4. Establish goals 5. Sustained efficacy
		5.A.4 Convene a working group to advance food rescue efforts in the region that includes health and solid waste organizations, non-profits doing the work of food rescue, food merchants and producers, donors of food, and end users of rescued food.	Short-term									1. Participating organizations 2. Regularity - amount of meetings
		5.A.5 Establish partnerships with local food packagers for help in repacking donated food for distribution.	Short-term									1. Participating partners 2. Measured success in food recovery
		5.A.6 Develop educational products for key donation sources to facilitate the efficiency and growth of food donations – Producers, retailers, restaurants / caterers, public	Short-term									1. Residents / organizations reached 2. Measured success in food recovery
		5.A.7 Create programs to educate people on proper handling of refrigerants and provide incentives for proper handling (e.g. take-back programs)										1. Residents / organizations reached 2. Measured success in refrigerant management
	5.B Increase access to recycling for residents in multi-family buildings	5.B.1 Enact local policies to provide access to recycling service / containers at multi-family buildings	Short-term	2030: 11,258 MT CO2e 2050: 25,549 MT CO2e	$$	Providing access to recycling services and containers in LIDAC communities contirbutes to reduced waste management costs, reduced landfill use, improved public health, support of longer term sustainablity goals and equitable development.	**For measure:** Increase in jobs/economic development, removal of airborne pollutants	Middle Estimated Growth	Can be done under local authority	**County governments**,	Solid Waste Infrastructure for Recycling Grant Program (Federal)	1. Long-term policies enacted 2. Resident participation 3. Acessibility - amount of buildings served 4. Recyclable material diverted 5. Sustained efficacy
		5.B.2 Provide education through signage and communication that address the benefits of recycling and how to properly recycle items to avoid contaminating the recycling stream	Short-term	Assumes 15% increase in number of multi-family households with convienient access to recycling by 2030 and 50% increase by 2050. Also assumes continuing recycling drive events at current level.		Community engagement, involvement and investement in waste and reuse practices.			Can be done/is done under local authority			1. Residents reached 2. Measured success in decreased contamination rate 3. Measured increase in resident recycling participation

Table 5: GREENHOUSE GAS REDUCTION MEASURES

Sector	Measure	Associated Actions	Timeframe	Regional GHG Benefits	Esimated Cost (2025 dollars)	LIDAC Benefits	Regional Co-benefits	Workforce Needs	Authority to Implement	Implementing Agency and Stakeholders	Funding Sources	Metrics to track progress
		5.B.3 Counties should continue to provide regular household recycling events for most common and difficult to recycle items in areas convenient to multifamily housing	Short-term									1. Events held 2. Residents reached 3. Materials diverted 4. Range of materials diverted
	5.C Work to reduce methane released in the region	5.C.1 Capture methane from wastewater treatment facilities and landfills and use it to generate electricity or heat to help offset the energy needs of the facility	Mid-term	2030: 71,459 MT CO2e 2050: 71,459 MT CO2e	$$$$	Capturing methane from wastewater can create econmic and social benefits in disavantaged communities in the form of energy cost savings, improved air quality, job creation, energy security and infrastructure resiliency.	**For measure:** Easing of energy cost burdens, improvement in public health, positive impact in disaster preparedness	Middle to High Estimated Growth	Can be done under local authority	**Air Quality Agencies**,	Methane Emissions Reduction Program (Federal) Solid Waste Managment Grant (Federal)	1. Participating facilities 2. Methane captured 3. amount of energy "offset"
		5.C.2 Work to divert organic waste from the region's landfills	Mid-term	16% abatement potential by 2030 at the region's landfills. Little Miami Wastewater Treatment Plant new Anaerobic Digester Project with Methane Capture open by 2030. Opening of planned biochar facility before 2030.		Diverting organic waste from landfills improves air quality, lowers the volume of toxic wastes in the soil and waterways, aids in job creation, lowers waste management costs and improves the health of LIDAC communities.			Can be done under local authority			1. Waste diverted 2. Residents / communities served 3. Sustained efficacy
		5.C.3 Continue to work to reduce methane emissions at landfills	Short-term			Minority and low-income areas are more likely to find themselves home to landfills and hazardous waste sites. placement than higher income areas.			Can be done under local authority			1. Methane captured 2. Emissions reduced by captured methane "offsets"
		5.C.4 Maximize the use of existing digesters and assist facilities in the development of digestate into marketable products for agricultural uses	Mid-term			Composting organic waste on larger scales provide natural resource that can be recycled back into the soil and used to feed crops.			Can be done under local authority, but may need permits (Ohio Division of Surface Water and Air Pollution Control), or federal funding/support. Should comply with IDEM standards (Indiana)			1. Amount of biofuel and biochar produced 2. Associated offset emissions
		5.C.5 Process organic waste into biofuels and biochar	Mid-term			Rural and agricultural communities can benefit from soil improvement, habitat management, and renewable energy. Employment and educational opportunites will also emerge in research, development and engineering.			Can be done under local authority, depending on scale			1. Amount of biofuel and biochar produced 2. Associated offset emissions
6. Agricultural	6.A Reduce fertilizer use in agricultural production	6.A.1 Establish a program or business to produce and source compost for use in agricultural production	Mid-term	2030: 42,635 MT CO2e 2050: 71,058 MT CO2e	$$	Programs would reduce fertilizer dependency while improving soil health, and contibuting to healthier environment for residents.	**For measure:** Improvement in public health, easing of energy cost burdens	Total **Sector** Increase: +2,734 (2030); +6,369 (2050); Low to Middle Estimated Growth (would reduce input jobs, but increase demand for soil health services)	Can be done under local authority when new compositing facilities are registered (such as through IDEM or KY Division of Waste Management)	**County SWCDs**, County Farm Bureaus,	Conservation Reserve Program (CRP) (Federal) Climate-Smart Agriculture and Farm Loan Programs (Federal)	Use local Farm Bureau's to identify and market and track usage of compost
		6.A.2 Increase climate-safe practices such as cover crop use, no-till methods, crop rotation, alley-cropping, contour planting, and silvopasture	Mid-term	30% annual decrease in carbon emissions from cover crop, no-till, and reduced fertilizer use based on USDA projections for Ohio.								Survey the suppliers of cover crops and use surveys with farmers to track usage of best practices
		6.A.3 Facilitate farmer-to-farmer training and mentorship programs to support soil health education and maintenance	Mid-term									Have the county extension offices hold farmer to farmer training
	6.B Increase local food production and markets	6.B.1 Develop region-specific marketing and low GHG certification for local food products to allow farmers to monetize best practices	Short-term		$$	Support to local farmers, agricultural industry during transition, GHG reduction in food distribution. Increase resident access to food.	**For measure:** Improvement in public health, removal of airborne pollutants	Middle Estimated Growth	Can be done under local authority	**County SWCDs**, County Farm Bureaus,	Agriculture Innovation Center (AIC) Program (Federal) Value-Added Producer Grants (VAPG) (Federal) Farm to School Grant Program (Federal) Farmers Market Promotion Program (Federal) Senior Farmers Market Nutrition Program (SFMNP) (Federal)	Allow farmers to gain certification for low GHG practices in exchange for reduced costs on supplies and equipment purchases
		6.B.2 Explicitly label food options with region-specific certifications and growing methods	Mid-term						Can be done under local/state authority, environmental claims on labels are not required, but can be done voluntarily only if claims are substantiated			By using voluntary workers, through extension offices and libraries this can be a start
		6.B.3 Implement direct-to-consumer local food delivery methods, such as slow food carts	Mid-term									Promote having local markets and restaurants to use and advertise for local farmers to use product
	6.C Increase use of farming methods that reduce GHG emissions	6.C.1 Provide incentives to farmers to reduce carbon emissions from equipment	Short-term	2030; 185 MT CO2e 2050: 925 MT CO2e	$$$	Rural and agricultural communities will recieve, support, funding and education during transition to farming methods that reduce GHG emissions.	**For measure:** Easing of energy cost burdens	Middle Estimated Growth	Can be done/is being done under local authority but may have limits (KY: KADF On-Farm Energy Efficiency Incentives Program excludes mobile equipment like tractor)	**County SWCDs**, County Farm Bureaus,	Conservation Stewardship Program (CSP) (Federal) Conservation Innovation Grant (CIG) (Federal) Microloan Program (Federal)	Give farmers more access to low emission equipment through grant opportunites. Use region wide buying power for ruduced costs
		6.C.2 Reduce the risk to farmers in adopting new methods that reduce GHG emissions	Mid-term	Reduce emissions from equipment serving 10 farms by 20% by 2030 and emissions from equipment serving 50 farms by 20% by 2050.		Farmers do not have the resources or incentives for the intial costs of energy transiton, this is a key barrier to adopting regenreative practices.			Can be/is being done under local authority			
		6.C.3 Support education and workforce development to implement low emission AG and food servece / rescue	Mid-term						Can be done under local/school district authority			Promote education starting in local High Schools and using reginal Community Colleges to develope low GHG practices
7. Carbon Removal	7.A Expand protections of the region's forested lands	7.A.1 Increase the amount of trees and tree canopy in the region through well-designed afforestation efforts. The development and sale of Carbon Credits could be a vehicle to drive efforts	Mid-term	2030: 3,071 MT CO2e 2050: 7,784 MT CO2e Assumes preserving 30% of forested land at risk of removal due to development each year.	$$	To mitigate these environmental issues in disadvantaged communities is to design green parking lots with plenty of large tree canopy cover that provides shade along with stormwater interception and infiltration.	**For measure:** Improvement in public health	Total **Sector** Increase: +6,304 (2030) and +11,259 (2050); Low Estimated Growth	Can be done under state authority, local authority can support programs	**Green Umbrella**; Taking Root	Healthy Forests Reserve Program (HFRP) (Federal)	1. Total canopy increase (Surface Area) 2. Increases in disadvantaged community tree canopy 3. Reduced UHI 4. Stormwater runoff 5. Biodiversity of trees 6. Establish goals - such as the the 3x30x300 framework
	7.B Promote urban forestry as an important measure against the urban heat island effect	7.B.1 Encourage trees along roadway networks, sidewalks, and paths	Mid-term	2030: 649 MT CO2e 2050: 100,000 MT CO2e	$$$	More tree cover would lower disproportionately high levels of heat and pollution. Communities of color have 33% less tree canopy on average than majority white communities, the analysis revealed. And neighborhoods with 90% or more of their residents living in poverty have 41% less tree canopy than communities with only 10% or less of the population in poverty	**For measure:** Improvement in public health, removal of airborne pollutants	Low Estimated Growth	Can be done under local authority; Kentucky: requires permit for state roads (Vegetation Management Permit)	**Green Umbrella**; Taking Root	Urban and Community Forestry Program (Federal)	1. Total trees 2. Roads / etc serviced (miles) 3. Disadvantaged communities serviced 4. Reduced UHI 5. Stormwater runoff 6. Biodiversity of trees
		7.B.2 Require trees and landscaping in and around parking lots to reduce urban heat island impacts	Short-term	Assumes 20,000 trees planted along streets and in vicinity of parking lots per year due to municipal investment and zoning compliance.		Heat reductions in urban areas and air quality improvements will promote community well being.			Can be done under local/state authority			1. Total trees 2. Area serviced 3. Disadvantaged communities serviced 4. Reduced UHI 5. Stormwater runoff 6. Biodiversity of trees
		7.B.3 Implement tree preservation methods and maintenance through policy and funding support	Short-term									1. Policies implemented 2. Trees protected 3. Health of trees

Table 5: GREENHOUSE GAS REDUCTION MEASURES

Sector	Measure	Associated Actions	Timeframe	Regional GHG Benefits	Esimated Cost (2025 dollars)	LIDAC Benefits	Regional Co-benefits	Workforce Needs	Authority to Implement	Implementing Agency and Stakeholders	Funding Sources	Metrics to track progress
		7.B.4 Introduce and implement an education effort to boost public and private tree canopy – especially through preservation and maintenance	Short-term									1. Residents reached 3. Increased tree canopy (Surface area)
		7.B.5 Explore alternative forest implementation, such as food forests	Short-term									1. food forests planted 2. Amount of food grown and distributed 3. residents / communities reached
	7.C Increase wetland protection, restoration, and replacement	7.C.1 Work with local soil and water utilities to create landscapes that manage increased rain events. Look to green infrastructure as the primary method of reducing stormwater runoff, with grey infrastructure being used to supplement where needed.	Long-term	Included in 7.A	$	Support underserved landowners who face significant barriers in accessing USDA conservation assistance programs	**For measure:** Improvement in public health, positive impact in disaster preparedness	Middle Estimated Growth	Can be done under local authority	**County SWCDs**, County stormwater agencies,	Wetland Reserve Easement (WRE) (Federal) Wetland Reserve Enhancement Partnership (WREP) (Federal) Wetland Mitigation Banking Program (WMBP) (Federal)	1. Projects completed 2. Total runoff diverted 3. Area serviced (based on calculated maximum efficiency ratio of landscape to impervious surfaces) 4. Disadvantaged communities serviced
		7.C.2 Increase wetland protection and restoration	Mid-term			Wetland protections safegaurd water quality, mitigates the effects of extreme weather and flooding, and provides recreation opportunities.			Can be done under local/state authority, especially in partnership with state agencies			1. Amount of wetlands protected 2. Identify baseline for "restoration" 3. Amount of wetland's restored 4. Improvements in biodiversity
		7.C.3 Improve education on wetland protection and mitigation for lawmakers, community members, and developers	Mid-term									1. Residents / communities reached
		7.C.4 Implement policies and ordinances such as wetland setbacks or locally-implemented wetland mitigation projects	Mid-term									1. Policies implemented 2. Area protected
	7.D Support biochar research, development, and implementation	7.D.1 Support the research, development, and implementation of biochar, composting, food recovery, and other closed-loop sustainability practices	Mid-term	2050: 7,540 MT CO2e Assumes development of one regional facility producing 300 tons of biochar annually by 2050.	$$	CO2 reduction, waste management, soil fertility, water retention, bioremediation, stormwater treatment, and carbon sequestration	**For measure:** Improved soil health, improved crop yields, economic development and jobs.	Low to Middle Estimated Growth	Can be done under local authority	**Cincinnati OES**, Cincinnati Biochar Project,	Conservation Innovation Grant (CIG) (Federal)	1. amount of organic waste diverted from landfills 2. sustained efficacy
		7.D.2 Collaborate with larger institutions, such as local businesses and universities, to scale these practices	Mid-term									1. participating institutions 2. amount of organic waste diverted from landfills

5.3.1 Transportation Sector

Emissions in the Transportation sector decrease by approximately 16% and 19% in the BAU scenario by 2030 and 2050 respectively. In the Implementation scenario, emissions are reduced further to 19% by 2030, and emissions are significantly reduced to 46.5% by 2050. The total emissions reductions in the Transportation sector declined by 2.4 million MT CO_2e in the BAU scenario, primarily due to better performing vehicles in the region. In the Implementation scenario, development of EV charging stations across the region to support the transition from combustion vehicles to EVs projects over 400,000 EV vehicle registrations in the region by 2050. The trend towards EVs continues as public and private fleets convert to electric vehicles in the implementation scenario. School and transit buses are expected to complete the transition to electric; and 4,500 municipal, fire, and police vehicles are expected to be replaced by EVs by 2050. Approximately 325 miles of new sidewalk and 25% expansion of transit services are projected by 2050 to encourage bike, pedestrian, and transit use throughout the region. Policies and projects to improve traffic congestion in the region such as new roundabouts and optimizing the timing of traffic signals can reduce congestion significantly. Development of sustainable aviation fuel in Kentucky based on BDO zone initiatives can decrease emissions in the region by 720,000 MT CO_2e by 2050. It is estimated the 3C+D Amtrak passenger train will open around 2035, moving between 10 to 20 million passengers per year. These efforts across the region are projected to reduce emissions by an additional 3.4 million MT CO_2e by 2050.

5.3.2 Electric Power Sector

The Electric Power sector projects a decline of 4% by 2030, and 5% by 2050 in the BAU scenario which is a total reduction of approximately 240,000 MT CO_2e. Efforts to decrease emissions in the Implementation scenario results in a 5% decrease by 2030, and a 30% decrease in emissions by 2050. Street lighting retrofits can replace around 1,750 street lights with LED lights per year, reducing energy consumption for lighting substantially. Investments such as a planned 3 MW solar farm in the City of Oxford and a 1.5 GW virtual power plant in the region will increase zero-emission generation in the region. The amount of private solar capacity is expected to expand by 25% by 2030, and 300% by 2050. Renewable energy community aggregation programs are expected to increase by six times the current adoption rate by 2050. An additional 1.1 million MT CO_2e emissions are projected to be reduced in the OKI region by 2050 due to these changes in the Electric Power sector.

5.3.3 Buildings Sector

Buildings sector BAU scenario projects emissions to decrease by 3% by 2030, and a decline to 3.5% by 2050. The 7% and 34% reduction in emissions by 2030 and 2050 respectively in the implementation scenario can be attributed to energy efficiency improvements to 500,000 square feet of buildings per year across the region which can reduce electricity usage and emissions. Buildings voluntarily adopting energy efficiency standards and goals are projected to reduce total buildings emissions by 1% between 2022 and 2050. The Home Weatherization Assistance Program can decrease energy use in new housing by 10% and is expected to increase services to an additional 2,000 households per year. The MowGreener program, transitioning combustion mowers to electric mowers, is projected to expand by 25% per year until 2030, then continue to steadily increase through 2050. Approximately 15% of lifecycle carbon emissions can be avoided by reusing existing buildings, rather than demolishing them for new construction. 20% of new residential growth will be within proximity to transit by 2050. Development patterns outside the urban center will adopt cluster style developments to reduce emissions. The Implementation scenario for the Buildings sector is projected to reduce emissions by an additional 4.3 million MT CO_2e on top of the BAU emissions reductions of 488,000 MT CO_2e by 2050.

5.3.4 Industrial Sector

The Industrial sector experiences a 6% decrease between 2022 and 2030. Between 2022 and 2050 Industrial sector emissions will decrease by 7%, a 1.0 million MT CO2e decrease in the BAU scenario. The Industrial sector experiences the greatest reductions in emissions from the implementation scenario in the short and long term. Carbon sequestration, wastewater treatment projects, improvements in intermodal transport, and introducing energy audits are among activities that will contribute to the decline of industrial emissions by 14% by 2030. Further progress in these areas will lead to more emissions reductions by 2050. Decarbonization of the Industrial sector through the adoption of energy efficiency programs such as the Energy Star Challenge, and of alternative fuel sources to power industrial processes improves the energy efficiency of the sector and reduces GHG emissions by 51% by 2050. The 44% decrease in emissions of the Industrial sector from the BAU to the Implementation scenario represents 7.0 million MT CO_2e emissions reductions in the Implementation scenario projection.

5.3.5 Waste, Water, and Sustainable Materials Management Sector

Most of the emissions reductions from the Waste sector occur between 2022 and 2030. There is a 15% reduction in the Waste sector by 2030 in the BAU scenario, while there is a 66% reduction in the Waste sector by 2030 in the Implementation scenario. There is about an extra 4% decrease between 2030 and 2050 in both scenarios with an 18% decrease by 2050 in the BAU, and a 70% decrease in the Implementation scenario. The rapid reduction of emissions in the short term, and steady decline in the long-term projection is due to quick adoption of policies and projects underway in the region which will be put into place before 2030. The projection assumes the establishment of a Green Hub in the region for recycling and food waste diversion activities by 2030 which account for a substantial amount of the emissions reductions in this sector. A new biochar facility will open by 2030 and a new anaerobic digester project at the Little Miami Treatment Plant will capture methane and open by 2030 with 16% abatement potential. Policies and events in the region will increase the amount of multi-family households with access to recycling by 15% by 2030. The number of multi-family households with access to recycling is expected to increase to 50% by 2050. The Waste sector will decrease by 527,450 MT CO_2e by 2050.

5.3.6 Agriculture Sector

Similar to Waste, Agricultural sector emissions in both scenarios decrease significantly between 2022 and 2030, then emissions decline steadily between 2030 and 2050. In the BAU scenario the Agriculture sector decreases by 17%, while it decreases by 76% in the Implementation scenario by 2030. In both scenarios the Agriculture sector only decreases by an additional 1% by 2050. The projections explain these trends by showing massive rates of adoption of practices early, followed by a period where emissions reductions level out. Projections show a 30% annual decrease in emissions due to adoption of climate-safe agricultural practices such as cover crops, no-till, and reduced usage of fertilizers. Around 10 farms will reduce emissions by 20% by 2030 by using equipment which produces less emissions, and by 2050 20% of emissions from equipment will be reduced at 50 farms. These adoptions of lower emissions equipment and climate-safe agricultural practices will reduce emissions in the Agricultural sector in the Implementation scenario by 128,000 MT CO_2e by 2050.

5.3.7 Carbon Removal Sector

The Carbon Removal sector is the only sector with negative emissions in the GHG inventory. The GHG emissions in this sector are negative because it represents the carbon dioxide removed from the atmosphere in the region. In the BAU scenario emissions are increasing steadily. It will increase by less than a percent by 2050. It is increasing steadily due to the loss of wetland acres in the region to residential developments as the population of the region continues to expand. In the Implementation scenario the Carbon Removal sector decreases steadily by less than a percent by 2030, then decreases by about 4% by 2050. Afforestation programs will preserve 30% of wetlands and forested land in the region. Efforts to promote urban forestry projects with 20,000 trees planted along streets and parking lots to mitigate the urban heat island effect. These efforts will further reduce the Carbon Removal sector by an additional 115,000 MT CO_2e.

Sector	2022 Base Year Emissions ($MTCO_2e$)	Short Term Implementation Scenario (2030) Emissions ($MTCO_2e$)	Long Term Implementation Scenario (2050) Emissions ($MTCO_2e$)
Transportation	12,587,270	10,164,342	6,733,662
Electric Power	4,548,344	4,287,820	3,179,505
Buildings	14,190,494	13,190,320	9,377,767
Industrial	15,702,467	13,444,309	7,597,095
Waste	1,001,606	339,175	293,058
Agriculture	212,978	50,481	47,693
Carbon Removal	-3,145,370	-3,148,553	-3,259,318
Total	45,097,789	38,327,894	23,969,462

Table 6. Implementation Scenario Projections by Sector in the Short (2030) and Long (2050) Term.

6. BENEFITS ANALYSIS

Climate action goes beyond reducing greenhouse gas emissions. It also works to improve the everyday lives of people locally and globally. The ThriveTogether Comprehensive Climate Action Plan (CCAP) outlines 28 implementation measures across seven sectors, each designed to reduce emissions. These actions, however, bring additional, meaningful benefits. These benefits can be referred to as co-benefits.

By analyzing co-benefits, ThriveTogether partners aim to highlight how climate solutions can have additional, positive outcomes. The five main co-benefits are:

- Removal of airborne pollutants
- Easing energy cost burdens
- Improvement in public health
- Increase in jobs and economic development
- Positive effect on disaster preparedness.

These outcomes serve the larger community by embracing safe homes, healthy families, affordable living, and resilient communities.

Understanding and identifying co-benefits produced by each of the measures in the CCAP is extremely valuable. This analysis will delve into the relationship between each measure and its co-benefits, as to enhance the greater environment of the Cincinnati MSA for all who inhabit it.

6.1 Transportation Sector Co-Benefits

Measure 1.A Buildout a robust EV charging network

The development and expansion of a robust electric vehicle (EV) charging network in the Greater Cincinnati region will deliver significant environmental, social, and economic benefits, advancing regional goals in air quality, transportation, health, and equity.

1. Enhanced Air Quality and Public Health

- Increased EV adoption reduces tailpipe emissions of harmful pollutants such as nitrogen oxides (NO_x) and fine particulate matter (PM2.5), which are linked to respiratory and cardiovascular diseases.
- Electrification of public and school vehicle fleets further lowers local pollution, directly benefiting vulnerable communities and improving overall population health.

2. Improved Transportation Efficiency and Accessibility

- Data-driven planning optimizes charger locations, alleviating range anxiety and accelerating EV uptake.
- Development of EV hubs connected to transit systems encourages multimodal travel, reducing reliance on single-occupancy gasoline vehicles and decreasing vehicle miles traveled.
- Streamlined permitting accelerates infrastructure deployment, making clean transportation options more widely accessible.

3. Support for Equitable and Sustainable Communities

- Public investment in charging stations at schools, parks, and government buildings ensures equitable access to low-emission transportation across suburban and underserved neighborhoods.
- Environmental justice is promoted by prioritizing infrastructure distribution where it is most needed.

4. Economic and Housing Co-Benefits

- Reduced local air pollution contributes to healthier living environments, supporting quality housing and community wellbeing.
- The growth of EV infrastructure supports local economic development through job creation in manufacturing, installation, and maintenance sectors.
- Reduced dependence on imported energy, combined with Ohio's expanding renewable electricity generation, strengthens regional energy resilience.

Measure 1.B Convert public and private vehicle fleets to Electric Vehicles

Converting public and private vehicle fleets to electric or alternative fuels will reduce emissions, particularly in high-traffic areas, reduce children's exposure to diesel exhaust, reduces noise and congestion, and improves public health.

1. **Direct Emission Reductions:**

   Replacing internal combustion engine (ICE) vehicles with electric vehicles (EVs) or alternative fuel vehicles in public and private fleets—such as buses, trucks, vans, and service vehicles—

substantially cuts tailpipe CO_2 and other greenhouse gas emissions. Depending on the carbon intensity of the regional electricity grid, these emissions reductions can range from **30% to over 70%**. Similarly, electrifying local rail freight by replacing diesel locomotives with battery electric alternatives can reduce freight-related emissions by **40% to 80%**, while also improving energy efficiency per ton-mile.

2. **Health and Air Quality Benefits:**
   These emission reductions lead to significant improvements in regional air quality by lowering pollutants like nitrogen oxides (NOx) and particulate matter (PM), which are harmful to respiratory and cardiovascular health. Cleaner air reduces public health burdens, decreases healthcare costs, and contributes to a higher quality of life across communities, especially those near transportation corridors.
3. **Systemic and Transportation Benefits:**
   Electrification initiatives reduce noise pollution from vehicles and trains, enhance the efficiency and reliability of transit and freight systems, and support the decarbonization of a major emissions sector. The introduction of electric Advanced Air Mobility (AAM) vehicles, such as eVTOLs and drones, presents innovative alternatives for short-distance travel, potentially easing congestion, reducing idling emissions, and creating new low-carbon transit networks.
4. **Indirect and Multiplier Effects:**
   Providing case studies and pilot projects demonstrates the effectiveness of low and zero-emission vehicles, reducing uncertainty among local governments and school districts and accelerating broader adoption. This educational and leadership role fosters peer learning, encourages sustainable procurement practices, and drives investments in critical infrastructure like charging stations, amplifying emission reductions region-wide.
5. **Quality of Life and Housing:**
   Reduced pollution and noise enhance neighborhood livability, making communities more attractive and healthier places to live. Improvements in transportation options can increase accessibility and mobility, positively impacting housing equity by connecting residents to jobs, services, and amenities through cleaner, more efficient transit.

Measure 1.C Encourage the use of transit, non-motorized vehicle, or walking for more trips within the region

Encouraging the use of walking, biking, and transit use for travel within the region reduces emissions and improves air quality, reduces traffic congestion on roadways, improves safety and access for those who can't drive, and encourages active lifestyles and increased community engagement.

1. **Air Quality**
   - Shifting trips from private cars to transit, biking, and walking significantly reduces tailpipe emissions of greenhouse gases (CO_2) and harmful air pollutants such as nitrogen oxides (NOx) and particulate matter.
   - Lower emissions improve regional air quality, contributing to cleaner, healthier urban environments and reducing respiratory illnesses.

2. **Housing**
    - Development of affordable and workforce housing near high-quality transit supports compact, transit-oriented communities.
    - This reduces travel distances, lowers transportation costs for residents, and prevents urban sprawl.
    - Promotes equitable access to affordable housing near jobs and essential services.
3. **Safety**
    - Improved bike and pedestrian infrastructure enhances safe and convenient access to destinations and transit hubs.
    - Enhanced transit connectivity, including Bus Rapid Transit (BRT) and park & ride facilities, provides reliable, efficient alternatives to car travel.
    - Incentives and accessibility improvements increase transit ridership and reduce vehicle miles traveled (VMT), lowering congestion and carbon footprint.
    - Transitioning transit fleets to low-emission or electric vehicles further reduces transportation sector emissions.
4. **Quality of Life and Health**
    - Increased walking and biking promote active lifestyles, improving physical and mental health outcomes.
    - Safer, more accessible transit options reduce social isolation and improve mobility for underserved communities, enhancing social equity.
    - Reduced traffic congestion and pollution lead to quieter, more livable neighborhoods.
5. **Equity and Inclusion**
    - Providing language services and barrier removal ensures all community members, especially non-English speakers and underserved populations, can access transit.
    - Affordable housing near transit supports workforce stability and economic opportunity.
6. **Long-Term Sustainability**
    - These combined strategies establish sustainable land use patterns that lock in emissions reductions over decades.
    - Investments in multi-modal infrastructure create resilient transportation networks that can adapt to future growth and climate challenges.

Measure 1.D Use technology, sound roadway network design, and policy to reduce areas of persistent traffic congestion

Reduced traffic congestion reduces wasted emissions while saving time, improving economic output, improving air quality – especially in affected communities, and improving public health through better air quality and lower stress.

1. **Public Health Outcomes**
    - Reduced vehicle idling and smoother traffic flow lead to lower emissions of NOx, PM2.5, and other pollutants, improving respiratory health and reducing asthma and cardiovascular risks.
    - Fewer traffic incidents and improved intersection safety contribute to reduced injuries and fatalities.

- Enhanced incident management decreases emergency response times, improving outcomes for accident victims.

2. **Economic Benefits**
   - Reduced congestion and more reliable traffic flow save time for commuters and freight movement, increasing overall productivity.
   - Lower fuel consumption translates to direct cost savings for drivers and businesses.
   - Decreased traffic incidents reduce costs related to property damage, healthcare, and insurance.
   - Employer shift time adjustments optimize workforce efficiency, supporting local economic resilience.
3. **Increased Climate Resilience**
   - Reduced congestion and emissions contribute to **regional GHG emission reductions**, supporting climate action goals.
   - Smoother traffic flow reduces fuel consumption and reliance on fossil fuels, helping mitigate climate change impacts.
   - Adaptive traffic management improves system flexibility and responsiveness to extreme weather or emergencies.
4. **Other Environmental Benefits**
   - Decreased air pollution improves regional air quality, benefiting ecosystems and reducing urban heat island effects.
   - Lower noise pollution from reduced stop-and-go traffic enhances community well-being.
   - Support for non-peak travel through shift adjustments may encourage modal shifts to transit, biking, or walking, further reducing environmental footprints.

Measure 1.E Support local development of sustainable aviation fuel

High-Level Summary of Regional Benefits Supporting local development of sustainable aviation fuel

1. **Reduction of Lifecycle Carbon Emissions**
   - Significantly lowers GHG emissions compared to conventional jet fuels.
   - Helps meet regional climate targets by decarbonizing a traditionally hard-to-abate sector.
   - Supports the shift to a **low-carbon energy economy**, reducing regional climate change risks.
2. **Decarbonization of a Hard-to-Abate Sector**
   - Aviation is one of the few sectors where electrification is challenging—SAF offers a scalable, near-term carbon reduction pathway.
   - Drives innovation and adoption of cleaner technologies, paving the way for deeper decarbonization.
3. **Economic Growth and Job Creation**
   - Stimulates local **green industry development** and supply chains (feedstock production, fuel refining, logistics).

- Creates new skilled jobs in sustainable fuel production, research, and infrastructure.
- Attracts investment in clean energy sectors, boosting regional economic resilience.

4. **Energy Resilience and Diversification**
    - Reduces dependency on imported fossil fuels by enabling use of locally or regionally produced biofuels and synthetic fuels.
    - Enhances fuel supply security and price stability in aviation.
5. **Public Health and Air Quality Improvements**
    - Lowers emissions of harmful pollutants like particulate matter (PM), nitrogen oxides (NOx), and sulfur oxides (SOx) from aircraft engines.
    - Improves air quality, especially around airports and neighboring communities, reducing respiratory illnesses and other health risks.
    - Supports environmental justice by reducing pollution exposure in vulnerable and marginalized populations.
6. **Integration with Broader Climate and Energy Policies**
    - Aligns with regional sustainability plans, renewable energy goals, and carbon reduction initiatives.
    - Creates synergy with other transportation electrification and decarbonization efforts.
    - Encourages multi-sector collaboration for comprehensive climate action.
7. **Housing and Community Benefits**
    - Improved air quality and reduced noise pollution enhance livability and property values in surrounding neighborhoods.
    - Promotes equitable access to clean energy jobs and community investment through inclusive workforce development programs.
8. **Increased Climate Resilience**
    - Reduces climate-related risks associated with fossil fuel extraction and supply disruptions.
    - Supports regional adaptation by lowering overall emissions and improving ecosystem health.

Measure 1.F Support regional, intrastate, and interstate rail projects that move travelers and freight more efficiently.

Support for regional, intrastate, and interstate rail projects that increase the use of rail for trips reduces emissions over roadway and air travel, improves air quality and health, improves access and equity, and provides economic development opportunities.

1. Environmental & Climate Benefits

- **Shift from High-Emission Modes:**
    - Rail emits far less GHG per passenger mile or ton-mile than cars, trucks, or airplanes.
    - Expansion of Amtrak and regional rail encourages mode shift from road and air to rail, cutting fossil fuel use.
- **Reduced Congestion and Idling:**

    - Fewer vehicles on highways mean less traffic congestion, idling, and stop-and-go driving—reducing transportation-sector emissions.
- **Improved Energy Efficiency:**
    - Rail systems move more passengers or freight per unit of energy, increasing systemwide energy efficiency.
- **Support for Transit-Oriented Development (TOD):**
    - Rail corridors promote compact, mixed-use development near stations, reducing vehicle miles traveled (VMT) and further lowering emissions.

2. Public Health Benefits

- **Improved Air Quality:**
    - Fewer vehicle miles and reduced highway congestion lower particulate matter (PM2.5), nitrogen oxides (NOx), and ozone precursors.
    - Reduced exposure to traffic-related pollution improves respiratory and cardiovascular health.
- **Encouragement of Active Mobility:**
    - Rail-linked "last mile" options (walking, biking, transit) promote physical activity and improve overall community health.
- **Noise and Safety Improvements:**
    - Shifting freight and passenger travel from roadways to rail can reduce highway accidents and noise pollution in congested corridors.

3. Economic & Workforce Benefits

- **Job Creation and Regional Investment:**
    - Rail infrastructure development and maintenance create skilled construction and operations jobs.
    - Station-area investments catalyze local business growth and property value increases.
- **Travel and Freight Efficiency:**
    - Reduced travel time and fuel costs enhance regional competitiveness and logistics reliability.
- **Economic Connectivity:**
    - Strengthened connections among cities and regions expand labor markets and tourism opportunities.

4. Climate Resilience & Adaptation Benefits

- **Diversified, Low-Carbon Mobility Network:**
    - Rail provides a resilient transportation option less vulnerable to fuel price volatility or roadway disruptions.
- **Infrastructure Durability:**
    - Investment in modernized, climate-resilient rail corridors strengthens regional preparedness for extreme weather events.
- **Long-Term Sustainability:**
    - Supports state and regional goals for decarbonization, clean energy transition, and sustainable land use.

5. Multimodal Integration & Accessibility

- **"Last Mile" Connectivity:**
  - Linking rail to local transit, bike-share, and pedestrian systems enhances accessibility and reduces dependence on personal vehicles.
- **Modal Integration:**
  - Coordinated planning across modes enables seamless passenger and freight movement, maximizing efficiency and lowering emissions.

6.2 Electric Power Sector Co-Benefits

Measure 2.A Replace the region's streetlights with LED fixtures:

High-Level Regional Co-Benefits of Replacing Streetlights with LED Fixtures

1. **Public Health Outcomes**
   - Improved nighttime visibility enhances pedestrian and driver safety, reducing accidents and injuries.
   - Reduced light pollution minimizes disruption to human circadian rhythms and local wildlife habitats.
   - Lower air pollution from decreased power plant emissions supports better respiratory health, especially in vulnerable communities.
2. **Economic Benefits**
   - Significant energy cost savings for local governments free up funds for other community investments.
   - Reduced maintenance costs and longer-lasting fixtures decrease operational expenses and labor demands.
   - Job creation opportunities through LED installation projects and energy service contracts.
   - Bulk purchasing and regional coordination can lower overall project costs and increase procurement efficiency.
3. **Increased Climate Resilience**
   - Reduced electricity demand lessens grid stress, helping utilities manage peak loads and integrate more renewable energy.
   - Enables smart lighting controls that can adapt during emergencies or outages, improving community safety and resilience.
   - Supports regional climate goals by contributing measurable and sustained GHG emission reductions.
4. **Other Environmental Benefits**
   - Lower energy consumption reduces reliance on fossil fuel-based electricity, decreasing air and water pollution.
   - Decreased waste generation due to longer-lasting LED fixtures minimizes landfill use and resource extraction.

- Reduction in heat emitted by traditional streetlights contributes to mitigating urban heat island effects.

Measure 2.B Further develop renewable energy generation in the region

High-Level Regional Co-Benefits of developing more renewable energy generation.

1. **Public Health Outcomes**
   - Reduced air pollution and related respiratory/cardiovascular diseases by cutting fossil fuel power generation.
   - Lower heat island effect and improved urban microclimate through rooftop solar and agrivoltaics.
   - Enhanced community wellbeing from increased green spaces on dormant landfills used for solar.
2. **Economic Benefits**
   - Job creation in clean energy sectors: solar installation, hydropower development, VPP management, and agrivoltaics.
   - Cost savings for municipalities via virtual power plants (VPPs) optimizing energy use and lowering peak demand charges.
   - Increased energy affordability for local governments through tailored financing and SolSmart best practices.
   - Revitalization of dormant landfills as productive solar sites generating local revenue streams.
   - Diversified local economies through development of renewable energy infrastructure.
3. **Increased Climate Resilience**
   - Enhanced grid stability and reliability via virtual power plants balancing supply and demand in real-time.
   - Reduced vulnerability to extreme weather by decentralizing energy generation and incorporating hydropower and solar.
   - Promotion of agrivoltaics improves agricultural resilience by combining crop growth with solar energy production.
   - Strengthened regional energy independence through locally sourced renewable energy.
4. **Other Environmental Benefits**
   - Protection and restoration of river ecosystems via sustainable hydropower development along Ohio and Great Miami Rivers.
   - Reduced land use pressures by utilizing large rooftops and dormant landfills instead of undeveloped natural areas.
   - Promotion of biodiversity through agro-voltaic systems that combine solar panels with habitat-friendly agriculture.
   - Increased adoption of SolSmart principles lowers regulatory and permitting barriers, accelerating clean energy deployment with minimal environmental disruption.

Measure 2.C Help Communities educate businesses and residents on benefit of procuring electricity generated using clean and renewable energy sources.

High-Level Regional Co-Benefits of procuring electricity generated using clean and renewable energy sources.

1. **Public Health Outcomes**
   - Reduced air pollution from fossil fuel power plants lowers respiratory and cardiovascular illnesses.
   - Decreased emissions of harmful pollutants (e.g., particulate matter, NOx, SO_2) leading to fewer asthma attacks and hospital visits.
   - Improved community well-being through cleaner air and reduced heat island effects related to climate change.
2. **Economic Benefits**
   - Lower and more stable electricity costs for residents and businesses through renewable energy aggregation programs.
   - Increased disposable income for low- and moderate-income households by reducing energy burden.
   - Job creation and local economic growth in renewable energy installation, maintenance, and associated industries.
   - Enhanced energy independence reduces vulnerability to fossil fuel price fluctuations.
3. **Increased Climate Resilience**
   - Diversifying energy supply with renewables improves regional grid reliability and resilience to extreme weather.
   - Reduced greenhouse gas emissions help mitigate local climate change impacts, including extreme heat and flooding.
   - Community empowerment through education and engagement builds capacity for future climate adaptation efforts.
4. **Environmental Benefits**
   - Decreased water consumption and pollution compared to fossil fuel-based electricity generation.
   - Protection of natural ecosystems and biodiversity by reducing habitat disruption associated with mining and drilling.
   - Supports long-term sustainability goals by transitioning toward zero-carbon energy systems.
5. **Social Equity**
   - Expands equitable access to clean energy for underserved and vulnerable populations.
   - Encourages inclusive participation in energy decision-making and benefits sharing.
   - Helps close energy poverty and environmental justice gaps within the region.

6.3 Buildings Sector Co-Benefits

Measure 3.A Improve the energy efficiency of local governments, schools, and non-profits in the region

1. **Public Health Improvements**
    - Reduced air pollution from decreased fossil fuel energy use leads to fewer respiratory and cardiovascular diseases.
    - Improved indoor air quality in public buildings and schools through energy-efficient HVAC upgrades, enhancing occupant comfort and health.
    - Lower energy costs reduce financial stress for non-profits and public entities, indirectly supporting mental well-being.
2. **Economic Benefits**
    - Creation of a revolving loan fund or grant program generates local green jobs in energy auditing, construction, and solar installation sectors.
    - Long-term operational savings for local governments, schools, and non-profits free up budget resources for other community priorities.
    - Increased property values for energy-efficient buildings boost local tax revenues.
    - Stimulates local economies by keeping energy dollars within the region and reducing reliance on imported fuels.
3. **Increased Climate Resilience**
    - Energy-efficient buildings are more resilient to extreme weather by maintaining stable indoor temperatures during heat waves or cold snaps.
    - Reduced energy demand eases strain on the electric grid, lowering risks of outages during peak periods or emergencies.
    - Solar installations diversify energy sources, increasing regional energy security and reducing greenhouse gas emissions.
4. **Environmental Benefits**
    - Lower greenhouse gas emissions contribute directly to regional climate mitigation goals.
    - Reduced energy consumption decreases water usage and other environmental impacts associated with electricity generation.
    - Promotes sustainable land use by integrating solar in underutilized spaces such as rooftops and parking lots.
5. **Housing and Equity**
    - A centralized database of energy efficiency scores helps target retrofits to lowest-performing public buildings in underserved or vulnerable communities.
    - Equitable access to financing ensures non-profits and smaller local governments can participate fully, reducing disparities.
    - Energy cost savings improve affordability of public services and facilities, indirectly benefiting low-income populations.

6. **Data-Driven Program Efficiency**
    - Encouraging utilities to enable automated benchmarking improves accuracy and reduces administrative burden.
    - Centralized audit and benchmarking data facilitate targeted program design, maximizing impact and efficient allocation of resources.
    - Enhanced transparency builds stakeholder trust and engagement across the region.

Measure 3.B Improve the energy efficiency of commercial buildings

1. **Public Health Outcomes:**
    - Reduced air pollution from lower fossil fuel energy use, leading to better respiratory and cardiovascular health.
    - Improved indoor air quality through energy-efficient HVAC upgrades and better building envelopes.
    - Enhanced occupant comfort and productivity due to consistent indoor temperatures and lighting.
2. **Housing and Community Benefits:**
    - Potential spillover effects in mixed-use developments, improving energy performance in adjacent residential buildings.
    - Greater community resilience by reducing energy demand during extreme weather events, lowering blackout risks.
    - Creation of training and workforce development programs that support local job opportunities in energy efficiency sectors.
3. **Economic Benefits:**
    - Reduced operating costs for building owners and tenants through energy savings and lower utility bills.
    - Stimulates the local economy via job creation in construction, auditing, engineering, and green finance sectors.
    - Attracts private investment and lowers financing costs by integrating energy efficiency into underwriting and insurance products.
    - Incentives and penalties from Building Performance Standards (BPS) drive compliance and market transformation toward efficiency.
4. **Increased Climate Resilience:**
    - Enhanced building envelopes reduce vulnerability to extreme heat and cold, lowering energy system strain during peak demand.
    - Supports regional climate goals by substantially lowering GHG emissions associated with commercial buildings.
    - Benchmarking and performance standards provide data transparency, enabling targeted interventions and continuous improvement.
5. **Environmental Benefits:**
    - Decreased greenhouse gas emissions through reduced energy consumption and transition to cleaner energy sources.

- Less strain on regional electricity grids, facilitating integration of renewable energy.
- Reduction in water use is linked to energy production and building operations.

6. **Foundational & Systemic Benefits:**
   - Training and education build capacity for sustained energy efficiency improvements.
   - Streamlined data sharing (via utility-enabled automatic uploads) reduces administrative burdens and improves program effectiveness.
   - Collaboration with insurance and finance sectors promotes innovative green financing solutions, expanding access to capital for efficiency projects.

Measure 3.C Improve the energy efficiency of residential dwellings in the region

1. **Public Health Outcomes**
   - Reduced indoor air pollution and improved indoor air quality by replacing inefficient appliances and HVAC systems with cleaner electric alternatives.
   - Decreased exposure to combustion-related pollutants (e.g., from gas stoves and heaters), lowering respiratory and cardiovascular risks.
   - Enhanced thermal comfort during extreme weather, protecting vulnerable populations (elderly, children) from heat stress and cold exposure.
2. **Housing Benefits**
   - Increased energy affordability and reduced utility bills for households, especially low-income families served by weatherization and incentives.
   - Improved home durability and indoor comfort through weatherization and efficiency upgrades, reducing maintenance and health-related costs.
   - Promotion of equitable access to modern, efficient housing technologies and appliances.
3. **Economic Benefits**
   - Job creation in the local green economy through weatherization, appliance upgrades, and clean equipment manufacturing.
   - Stimulated local markets for energy-efficient products and services, including cooperative purchasing programs that lower costs.
   - Financial relief and incentives (linked deposit/tax abatements) that reduce upfront costs and encourage investment in energy improvements.
4. **Climate and Environmental Benefits**
   - Significant reductions in regional GHG emissions by lowering residential energy consumption and accelerating electrification of appliances and equipment.
   - Reduced reliance on fossil fuels, contributing to cleaner air and water in the region.
   - Enhanced adoption of renewable energy integration through energy-efficient building practices and benchmarking programs.
5. **Increased Climate Resilience**
   - Homes are better prepared to withstand climate extremes (heat waves, cold snaps) through improved insulation and efficient systems.
   - Reduced vulnerability of households to energy supply disruptions due to lower overall energy demand.

- Strengthened community capacity through foundational programs like energy audits and benchmarking training.

6. **Additional Benefits**
   - Empowered homeowners with energy data access and education, leading to more informed energy decisions and behaviors.
   - Scalable, replicable models for regional collaboration on energy efficiency that can be adapted by diverse communities.
   - Increased equity through targeted support for underserved and disadvantaged populations, ensuring no one is left behind in the clean energy transition.

Measure 3.D Adopt development patterns that are proven to be more energy-efficient and support energy efficient transportation

1. **Public Health Benefits**
   - Reduced air pollution and respiratory illnesses by lowering vehicle emissions through transit-oriented development and improved traffic flow (e.g., roundabouts).
   - Mitigation of urban heat island effects through expanded tree canopy, leading to fewer heat-related illnesses and improved mental health.
   - Safer roads and reduced traffic accidents due to roundabout installations.
2. **Housing & Community Benefits**
   - Preservation of existing affordable housing stock by incentivizing retrofits over demolition, reducing displacement risk.
   - Increased availability of diverse housing options in walkable, transit-friendly neighborhoods, improving accessibility and equity.
   - Cluster-style rural development maintains open space and agricultural lands, preserving community character and local food sources.
3. **Economic Benefits**
   - Lower construction and infrastructure costs by promoting cluster development and retrofitting existing buildings.
   - Job creation in green building trades, retrofit industries, and urban forestry initiatives.
   - Increased property values and attractiveness of neighborhoods with enhanced green spaces and improved transportation options.
4. **Climate Resilience & Environmental Benefits**
   - Reduced embodied carbon emissions by conserving existing buildings and diverting construction waste from landfills.
   - Decreased life-cycle carbon footprint of new buildings through adoption of enhanced energy standards and model codes.
   - Reduced flood risk and improved stormwater management from preserved natural landscapes and expanded tree canopy.
   - Enhanced biodiversity and ecosystem services through conservation of agricultural and forested lands.
5. **Transportation & Energy Efficiency Benefits**

- Reduced vehicle miles traveled (VMT) and associated emissions by encouraging compact, transit-oriented, and cluster developments.
- More efficient traffic flow and lower idling emissions through roundabout implementation.
- Support for clean energy use by integrating energy-efficient transportation infrastructure in planning.

Measure 3.E Involve citizens in the effort to reduce GHG emissions

1. **Public Health Outcomes**
   - Improved air quality from reduced energy use and vehicle emissions leads to fewer respiratory and cardiovascular illnesses.
   - Increased physical activity from biking or walking reduces obesity and chronic disease rates.
   - Enhanced mental well-being through community participation and a sense of shared purpose.
2. **Housing and Community Wellbeing**
   - Energy-efficient behaviors can lower utility bills, easing financial burdens on low- and moderate-income households.
   - Encourages retrofitting and efficiency upgrades, improving indoor air quality and comfort.
   - Strengthens social cohesion as communities collaborate on climate goals.
3. **Economic Benefits**
   - Cost savings for residents and local governments from reduced energy consumption.
   - Stimulates local green economies via demand for energy-efficient products and services.
   - Gamified challenges incentivize behavior change, potentially creating opportunities for local businesses and tech developers.
4. **Increased Climate Resilience**
   - Community awareness and readiness improve emergency preparedness and adaptive capacity.
   - Diverse coalitions (e.g., WeThrive, LiveWell) help address social determinants of health, making vulnerable populations more resilient to climate impacts.
   - Behavioral shifts reduce stress on the electric grid, enhancing system reliability during extreme weather.
5. **Environmental Benefits**
   - Lower GHG emissions contribute to mitigating climate change and its associated risks.
   - Reduction in energy demand decreases pressure on natural resources.
   - Promotes sustainable transportation choices, reducing traffic congestion and pollution.

6.4 Industry Sector Co-Benefits

Measure 4.A Work to lower GHG emissions from large-scale emitters

1. **Public Health Outcomes**
    - Reduced air pollutants (e.g., particulate matter, NOx, SO_2) improve respiratory and cardiovascular health in local communities.
    - Decreased toxic emissions lower risks of cancer and other chronic diseases associated with industrial pollution.
    - Enhanced indoor air quality in nearby housing due to cleaner industrial operations.
2. **Housing and Community Well-being**
    - Improved air and environmental quality raise property values and livability in neighborhoods near industrial zones.
    - Reduced noise and pollution exposure enhance quality of life for residents, especially in environmental justice communities.
3. **Economic Benefits**
    - Energy efficiency and decarbonization lower operational costs for industries, improving regional competitiveness.
    - Job creation in clean energy, energy efficiency retrofits, and emerging industrial technologies.
    - Attraction of new "green" businesses and investment to the region.
    - Shared industrial parks enable cost savings through resource and infrastructure sharing (e.g., cogeneration, waste heat reuse).
4. **Increased Climate Resilience**
    - Energy switching and efficiency reduce vulnerability to fuel price volatility and supply disruptions.
    - Collaborative resource sharing among clustered industries strengthens regional infrastructure reliability.
    - Enhanced capacity to meet stricter future regulations reduces compliance risks and supports long-term sustainability.
5. **Environmental Benefits**
    - Lower water and resource use through efficient industrial processes reduce regional water stress.
    - Reduced waste generation and better resource cycling within industrial parks minimize landfill use and pollution.
    - Increased green energy procurement accelerates regional transition to renewable energy sources.

Measure 4.B Work towards developing a regional market for cleaner alternative fuels to power industrial processes like hydrogen, solar, geothermal, and nuclear

1. **Public Health Outcomes**
    - Significant reduction in air pollutants (NOx, SOx, PM) and toxic emissions from fossil fuel combustion, improving respiratory and cardiovascular health.
    - Lower incidence of asthma and other pollution-related diseases in nearby communities.
    - Reduced exposure to hazardous chemicals through cleaner industrial processes.
2. **Housing and Community Well-being**
    - Cleaner air and water contribute to healthier living conditions, particularly benefiting vulnerable populations in industrial-adjacent neighborhoods.
    - Potential to revitalize economically depressed areas through green industry growth and reduced environmental hazards.
3. **Economic Benefits**
    - Creation of new, skilled jobs in emerging clean energy sectors and supply chains (e.g., hydrogen production, geothermal tech, nuclear operations).
    - Strengthening regional economic competitiveness by attracting clean technology investments and companies.
    - Development of local supply chains reduces energy costs and stabilizes fuel price volatility for industries.
    - Enhanced collaboration between industries, utilities, universities, and government fosters innovation and economic diversification.
4. **Increased Climate Resilience**
    - Diversification of energy sources reduces dependence on fossil fuels and vulnerability to fuel price shocks or supply disruptions.
    - Promotes long-term stability in industrial energy supply with lower carbon intensity, supporting regional climate goals.
    - Identification and development of regional carbon sequestration sites enhance ability to offset emissions and meet net-zero targets.
5. **Environmental Benefits**
    - Reduced greenhouse gas emissions contribute directly to mitigating climate change impacts regionally and globally.
    - Protection and restoration of natural habitats through strategic siting of renewable energy and sequestration projects.

      Promotes sustainable water use and waste management in industrial operations using cleaner fuels.
6. **Cross-Sector Collaboration and Innovation**
    - Convening diverse stakeholders fosters shared knowledge, aligns policies, and accelerates technology deployment.

- Strengthens regional governance capacity to implement integrated climate and energy strategies.

Measure 4.C Work to improve industrial operations to be more energy efficient and use cleaner sources of energy.

1. **Public Health Outcomes**
   - Reduced air pollution from cleaner energy sources and improved industrial efficiency lowers emissions of harmful pollutants (e.g., PM2.5, NOx), improving respiratory and cardiovascular health.
   - Decreased greenhouse gas emissions contribute to mitigating climate change–related health risks like heat stress and vector-borne diseases.
   - Enhanced indoor air quality in buildings through energy-efficient retrofits improves occupant well-being.
2. **Housing and Community Benefits**
   - Energy-efficient industrial practices can reduce neighborhood pollution burdens, benefiting nearby residential areas.
   - Reduced strain on local water supplies by reusing treated wastewater or stormwater supports sustainable community water access.
   - Green procurement policies promote healthier building materials and products, improving housing quality.
3. **Economic Benefits**
   - Energy audits and efficiency upgrades lower operational costs for industries, improving competitiveness and profitability.
   - Capturing wasted heat and electrifying intermodal logistics reduce fuel expenses and enable cost savings.
   - Improved intermodal transportation efficiency reduces delays and increases access to regional and national markets, attracting investment and supporting job growth.
   - Adoption of green procurement drives demand for sustainable products and local green businesses, fostering a green economy.
4. **Increased Climate Resilience**
   - Diversifying energy sources and reducing emissions improve regional ability to meet climate goals and adapt to regulatory changes.
   - Using treated wastewater and stormwater retention enhances water resource resilience during droughts and extreme weather.
   - Electrification and efficiency improvements reduce reliance on fossil fuels, buffering industries from fuel price volatility.

5. **Other Environmental Benefits**
   - Reduced greenhouse gas emissions and energy consumption lower the regional carbon footprint.

- Improved stormwater management decreases runoff and protects local waterways from pollution.
- Waste heat recovery decreases overall energy demand, conserving natural resources.
- Green procurement encourages sustainable sourcing, reducing indirect environmental impacts such as deforestation and mining.

6.5 Waste, Water, and Sustainable Materials Management Sector Co-Benefits

Measure 5.A High-Level Regional Co-Benefits of building an environment of collaboration among organizations involved in solid waste, recycling, composting, and food rescue to maximize efficiencies

1. **Public Health Outcomes**
   - Improved food security and nutrition for vulnerable populations through increased food rescue and redistribution.
   - Reduced foodborne illness risk by promoting safe handling and refrigeration standards.
   - Decreased exposure to landfill-related pollution and contaminants by diverting organic waste.
2. **Housing and Community Wellbeing**
   - Strengthened community networks through partnerships with local schools, farms, park districts, and nonprofits, fostering social cohesion.
   - Creation of inclusive green spaces (Green Hubs, Green Schoolyard and Healthy schools) that provide community resources like repair tools and skill-building opportunities.
   - Job and volunteer opportunities in food rescue, repair, and composting programs enhancing local engagement.
3. **Economic Benefits**
   - Cost savings for municipalities and businesses by reducing landfill tipping fees and waste management expenses.
   - Stimulated local economies through green jobs in waste diversion, packaging, repair, and educational outreach.
   - Resource efficiency gains by maximizing reuse, repair, and organic waste diversion, reducing the need for virgin materials.
   - Enhanced donor and retailer engagement leading to efficient surplus food management, reducing food loss and waste costs.

4. **Increased Climate Resilience and Environmental Benefits**
    - Reduced methane emissions from diverted organic waste decomposing in landfills—a potent short-lived climate pollutant.
    - Conservation of natural resources and reduction of GHG emissions through increased recycling, composting, and reuse.
    - Enhanced regional waste tracking enables better identification of inefficiencies and targeted climate action strategies.
    - Promotion of circular economy principles fostering long-term sustainability and resource resilience.
5. **Education and Capacity Building**
    - Improved awareness and knowledge on food rescue, composting, and refrigerant handling, leading to higher community participation and compliance.
    - Incentivizing proper refrigerant management reduces harmful emissions of ozone-depleting substances and GHGs.
    - Empowerment of key stakeholders (producers, retailers, public institutions) to scale donation and waste diversion efforts efficiently.

Measure 5.B Regional Co-Benefits of increasing access to recycling for residents in multi-family buildings

1. **Public Health Outcomes**
    - Reduces waste sent to landfills and incinerators, lowering local air and water pollution that can cause respiratory and other health issues.
    - Minimizes hazardous waste contamination in the environment by diverting recyclables properly.
    - Encourages cleaner communal living spaces, reducing pests and associated health risks in multi-family housing.
2. **Housing & Community Benefits**
    - Improves quality of life and resident satisfaction by providing easy access to recycling services and clear guidance.
    - Supports equitable waste management by addressing recycling barriers often faced by renters and underserved communities.
    - Enhances community engagement through education and outreach, fostering a culture of sustainability within dense housing areas.
3. **Economic Benefits**
    - Creates jobs in the recycling and waste management sectors, including collection, processing, and education roles.
    - Reduces municipal waste management costs by diverting materials from costly landfill disposal.

- Increases property values and marketability of multi-family buildings with strong sustainability features.
- Stimulates local markets through recovered materials that can be sold or reused in manufacturing.

4. **Increased Climate Resilience**
   - Decreases GHG emissions by diverting recyclables, reducing energy consumption in material production and landfill methane emissions.
   - Contributes to circular economy practices, making the region less dependent on virgin materials and more adaptable to supply chain disruptions.
   - Supports local governments' climate goals by addressing a key sector (residential waste) in emission reduction plans.
5. **Other Environmental Benefits**
   - Conserves natural resources by increasing the recovery of valuable materials (metals, plastics, paper).
   - Reduces litter and urban blight around housing complexes and neighborhoods.
   - Encourages waste reduction behaviors that can extend to other sustainable lifestyle practices.
6. **Community Event Benefits (Household Recycling Events)**
   - Provides convenient access to recycle bulky, hazardous, or hard-to-recycle items, preventing improper disposal.
   - Builds public awareness and participation in recycling through hands-on engagement.
   - Strengthens partnerships between counties, waste haulers, and residents, creating sustainable local waste infrastructure.

Measure 5.C Work to reduce methane released in the region

1. **Public Health Outcomes**
   - Reduced release of methane and associated volatile organic compounds (VOCs) improves **air quality**, lowering respiratory illnesses such as asthma and bronchitis.
   - Decreased odor and hazardous emissions near communities improve **quality of life** and reduce health disparities, especially in vulnerable or environmental justice neighborhoods.
2. **Housing and Community Well-being**
   - Reduced landfill methane leaks mitigate risks of **explosive hazards** and soil contamination near residential areas.
   - Enhanced environmental quality supports **property values** and community attractiveness.
3. **Economic Benefits**
   - Energy generated from captured methane offsets facility energy costs, lowering **operational expenses** and creating savings.
   - Development of marketable digestate products (e.g., biofertilizers) opens new **revenue streams** and promotes local **green economy** growth.

- Investment in organic waste processing infrastructure creates **green jobs** in waste management, renewable energy, and agricultural sectors.
- Biofuels and biochar production diversifies local energy sources, enhancing **energy independence**.

4. **Increased Climate Resilience**
   - Reduced methane emissions contribute significantly to lowering the region's **short-lived climate pollutant** footprint, slowing near-term warming impacts.
   - Organic waste diversion reduces landfill mass, lowering risks of leachate contamination and flooding from overburdened landfills.
   - Biochar application enhances soil carbon storage and water retention, improving **agricultural resilience** to drought and extreme weather.
5. **Other Environmental Benefits**
   - Mitigation of methane—a potent greenhouse gas—supports regional **climate goals** and compliance with state/federal regulations.
   - Diverting organics from landfills reduces **landfill footprint**, preserving land for other uses and protecting local ecosystems.
   - Enhanced anaerobic digestion processes reduce odor and nutrient runoff, protecting **water quality** in nearby watersheds.

6.6 Agriculture Sector Co-Benefits

Measure 6.A High-Level Regional Co-Benefits of Reducing Fertilizer Use in Agricultural production

1. **Public Health Outcomes**
   - Reduced nitrate and chemical runoff into local water sources, improving drinking water quality and lowering risks of waterborne diseases.
   - Decreased air pollution from ammonia and nitrous oxide emissions, benefiting respiratory health.
   - Lower exposure to harmful agrochemicals for farm workers and surrounding communities.
2. **Housing & Community Well-being**
   - Improved soil and water quality contributing to healthier living environments in rural and suburban areas.
   - Enhanced green spaces and agroforestry (silvopasture) that can reduce urban heat islands and improve neighborhood air quality.
3. **Economic Benefits**
   - Reduced input costs for farmers through decreased synthetic fertilizer use and increased use of locally sourced compost.
   - Development of a regional compost production business creating local jobs and stimulating rural economies.

- Increased farm productivity and resilience leading to more stable incomes over time.
- Potential for new market opportunities in regenerative and organic products.

4. **Increased Climate Resilience**
    - Enhanced soil carbon sequestration reducing atmospheric greenhouse gases.
    - Improved soil moisture retention and reduced erosion through cover crops, no-till, and contour planting — reducing vulnerability to droughts and floods.
    - Diversified cropping systems increase resilience against pests, diseases, and climate variability.
5. **Environmental Benefits**
    - Reduced nitrous oxide emissions, a potent greenhouse gas, through minimized synthetic fertilizer use.
    - Increased biodiversity in agricultural landscapes supporting pollinators and beneficial insects.
    - Improved water retention and reduced nutrient leaching protect local watersheds and aquatic ecosystems.
    - Promotion of agroforestry practices (alley-cropping, silvopasture) contributes to carbon storage and habitat restoration.
6. **Social & Educational Benefits**
    - Farmer-to-farmer training programs foster community knowledge sharing and empower local stewardship of land resources.
    - Strengthening social networks and collaboration among farming communities enhances adaptive capacity.

Measure 6.B Increase local food production and markets

1. **Public Health Outcomes**
    - Reduced nutrient runoff lowers water contamination, decreasing risks of drinking water pollution and harmful algal blooms that affect human health.
    - Lower fertilizer emissions cut air pollutants (like ammonia and nitrous oxide), improving respiratory health and reducing smog.
    - Increased availability of fresh, locally grown food promotes better nutrition and healthier diets.
2. **Housing & Community Well-being**
    - Healthier local ecosystems enhance livability and property values in rural and suburban areas.
    - Stronger connections between farmers and consumers foster community cohesion and support for local economies.
3. **Economic Benefits**
    - Certification programs create market premiums for farmers using sustainable practices, increasing their income.
    - Labeling and marketing of regionally certified products enhance consumer awareness and demand for low-carbon foods.

- Direct-to-consumer delivery systems (e.g., slow food carts) reduce transportation costs and emissions while expanding local food access.
- New jobs in local food marketing, distribution, and certification services stimulate rural and urban economies.

4. **Increased Climate Resilience**
    - Reduced fertilizer use decreases nitrous oxide emissions, a potent greenhouse gas, contributing to regional climate mitigation goals.
    - Promoting diverse local food production improves agricultural resilience to climate extremes and supply chain disruptions.
    - Lower dependence on synthetic fertilizers reduces vulnerability to volatile input prices and supply shortages.
5. **Other Environmental Benefits**
    - Less fertilizer runoff protects regional waterways, wetlands, and aquatic biodiversity.
    - Encouraging local food production reduces emissions related to long-distance food transport (food miles).
    - Supports soil health improvements and carbon sequestration in agricultural lands through sustainable farming practices.

Measure 6.C High-Level Regional Co-Benefits of Increasing use of farming methods that reduce GHG emissions

1. **Public Health Outcomes**
    - Reduced air pollution from lower fossil fuel use in equipment improves respiratory and cardiovascular health.
    - Decreased pesticide and fertilizer runoff protects water quality, reducing exposure to harmful chemicals.
    - Enhanced soil health can increase nutrient density in crops, improving food quality.
2. **Housing and Community Well-being**
    - Improved local air and water quality enhances overall living conditions in rural and neighboring urban areas.
    - Reduced odor and chemical exposure improves quality of life near agricultural zones.
3. **Economic Benefits**
    - Incentives and risk reduction encourage farmer adoption of sustainable practices, leading to cost savings on fuel and inputs.
    - New markets for carbon credits or eco-certified products increase farm income streams.
    - Workforce upskilling and training workers in sustainable agriculture and food rescue sectors promotes resiliency which mitigates risk and thus increases economic stability and growth.
    - Strengthened regional food systems support local economies and reduce dependence on long-distance supply chains.

4. **Increased Climate Resilience**
    - Practices such as cover cropping, agroforestry, and conservation tillage improve soil water retention and reduce erosion, buffering crops against drought and extreme weather.
    - Diversified crop systems and improved soil health enhance long-term productivity under changing climate conditions.
    - Reduced emissions from agriculture help mitigate regional climate change impacts.
5. **Environmental Benefits**
    - Lower methane and nitrous oxide emissions from improved manure and fertilizer management reduce potent GHGs.
    - Increased carbon sequestration in soils contributes to a regional carbon sink.
    - Food rescue efforts reduce organic waste in landfills, cutting methane emissions.
    - Biodiversity is supported through habitat-friendly farming practices.

6.7 Carbon Removal Sector Co-Benefits

Measure 7.A Expand protections of the region's forested lands

1. **Public Health Outcomes**
    - Improved air quality by filtering pollutants (PM2.5, ozone) → reduced respiratory and cardiovascular diseases.
    - Enhanced mental health and well-being through increased green space access.
    - Urban heat island mitigation → fewer heat-related illnesses during extreme heat events.
2. **Housing and Community Benefits**
    - Increased property values and neighborhood attractiveness linked to green spaces.
    - Reduced energy costs for homes through natural shading and cooling effects.
    - Enhanced community cohesion and recreational opportunities in forested areas.
3. **Economic Benefits**
    - Creation of green jobs in forestry management, tree planting, and carbon credit markets.
    - New revenue streams for landowners and municipalities through carbon credit sales, incentivizing conservation.
    - Boosted eco-tourism and outdoor recreation industries.
4. **Increased Climate Resilience**
    - Carbon sequestration helps to offset regional GHG emissions and meet climate targets.
    - Improved stormwater management and reduced flood risks via enhanced soil absorption.
    - Protection of biodiversity and wildlife habitat, increasing ecosystem stability.
5. **Other Environmental Benefits**

- Soil conservation reduces erosion and improves water quality in regional watersheds.
- Enhanced pollinator habitats supporting agriculture and native plant species.
- Increased regional biodiversity supporting overall ecosystem health.

Measure 7.B Promote urban forestry as an important measure against the urban heat island effect

1. **Public Health Outcomes**
   - Reduced heat-related illnesses and mortality by lowering ambient temperatures, especially benefiting vulnerable populations (elderly, children, low-income communities).
   - Improved air quality through pollutant absorption (ozone, particulate matter), reducing respiratory and cardiovascular diseases.
   - Enhanced mental health and well-being through increased access to green spaces and natural environments.
2. **Housing & Community Benefits**
   - Increased comfort and livability by lowering indoor temperatures, reducing reliance on air conditioning.
   - Enhanced property values and neighborhood desirability driven by greener streetscapes and well-maintained landscapes.
   - Promotion of equitable access to shade and greenery, addressing environmental justice concerns in underserved neighborhoods.
3. **Economic Benefits**
   - Energy savings for residential and commercial buildings by reducing cooling demand (lower utility bills).
   - Job creation in urban forestry maintenance, landscaping, and green infrastructure sectors.
   - Support for local food systems and economies through alternative forest implementations like food forests.
   - Cost savings from reduced health care burdens associated with heat stress and pollution-related illnesses.
4. **Increased Climate Resilience**
   - Mitigation of the urban heat island effect, reducing peak temperatures and extreme heat events.
   - Enhanced stormwater management through increased canopy cover, reducing runoff and flooding risks.
   - Carbon sequestration from trees contributing to regional GHG emission reductions.
   - Preservation of biodiversity by providing habitats for urban wildlife.
5. **Other Environmental Benefits**
   - Improved soil quality and erosion control through root systems and landscaping.
   - Increased aesthetic and cultural value of urban landscapes, fostering community pride and engagement.
   - Enhanced pollinator habitats supporting urban ecosystems.

Measure 7.C Increase wetland protection, restoration, and replacement

1. **Enhanced Climate Resilience**
    - Wetlands act as natural sponges, absorbing and slowly releasing stormwater, reducing flood risks from increased rain events.
    - Improved stormwater management reduces damage to infrastructure and homes during extreme weather.
    - Green infrastructure integration supports urban cooling, mitigating heat island effects during heatwaves.
2. **Public Health Improvements**
    - Reduced flooding lowers risk of waterborne diseases and mold-related respiratory issues.
    - Wetlands improve water quality by filtering pollutants and sediments, supporting cleaner drinking water sources.
    - Enhanced natural areas promote mental well-being and recreational opportunities for communities.
3. **Housing and Infrastructure Protection**
    - By managing stormwater naturally, wetlands reduce stress on grey infrastructure, lowering maintenance costs and preventing damage to roads, bridges, and homes.
    - Policies like wetland setbacks protect vulnerable properties from encroachment and erosion.
4. **Economic Benefits**
    - Wetland restoration creates jobs in conservation, construction, and maintenance sectors.
    - Cost savings from reduced flood damage and decreased reliance on expensive grey infrastructure.
    - Enhanced property values in areas with natural green space and flood protection.
5. **Ecosystem and Biodiversity Gains**
    - Wetlands provide critical habitat for fish, birds, and wildlife, supporting biodiversity.
    - Healthy wetlands support carbon sequestration, contributing to GHG reduction goals.
    - Improved water filtration enhances aquatic ecosystems and recreational fishing.
6. **Community Engagement and Education**
    - Increasing awareness among lawmakers, developers, and residents fosters stronger support for sustainable development practices.
    - Educated stakeholders are more likely to adopt and enforce policies such as wetland mitigation and setbacks.
    - Community involvement leads to stewardship programs and volunteer-driven restoration efforts.

7. **Integrated Water Management**
    - Collaboration with soil and water utilities ensures coordinated watershed management.
    - Prioritizing green infrastructure reduces stormwater runoff at source, alleviating pressure on sewer systems.
    - Combined green-grey infrastructure approach maximizes efficiency and effectiveness.

Measure 7.D Support biochar research, development, and implementation

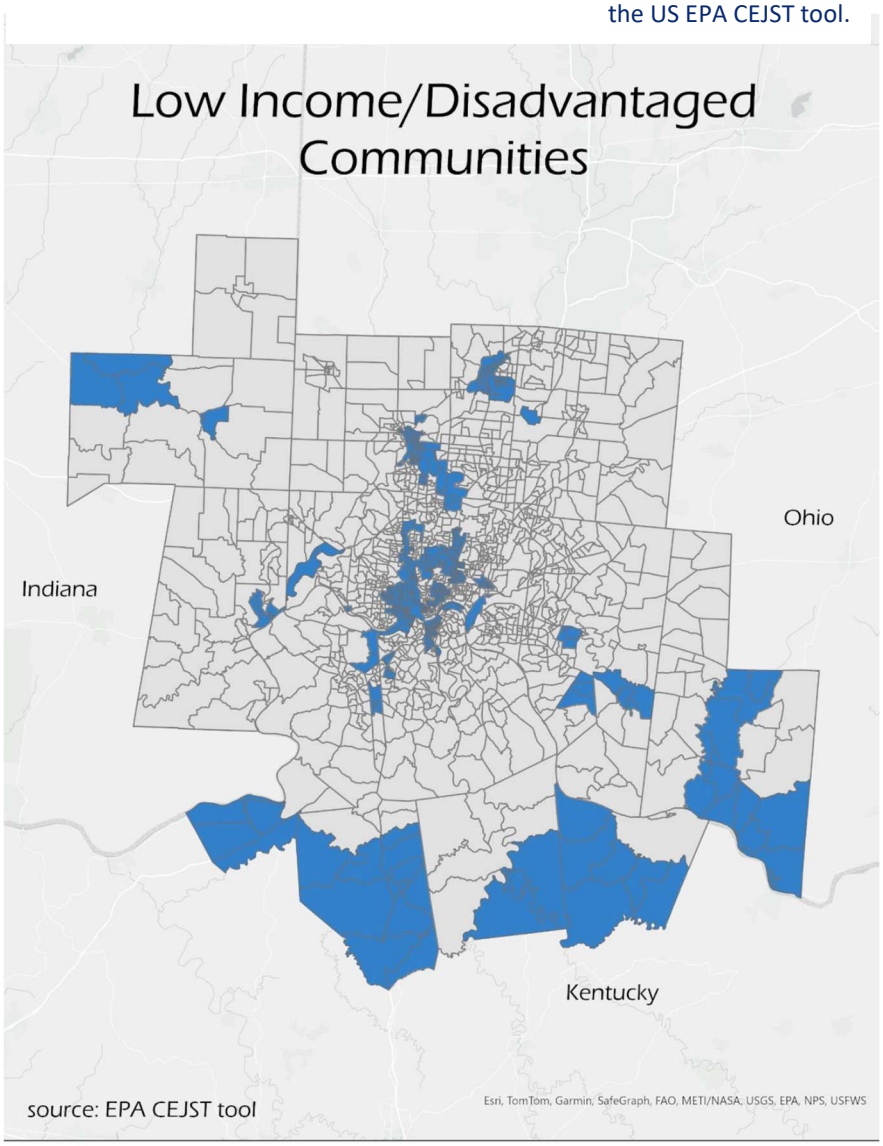
1. **Improved Soil Health and Agricultural Productivity**
    - Biochar enhances soil fertility, water retention, and nutrient cycling, boosting crop yields and reducing the need for chemical fertilizers.
    - Composting returns valuable organic matter to soils, supporting sustainable local food systems and urban agriculture initiatives.
2. **Reduced Greenhouse Gas Emissions**
    - Biochar sequesters carbon in soils for decades to centuries, lowering atmospheric CO_2.
    - Diverting food waste from landfills via composting and food recovery reduces methane emissions—a potent GHG.
3. **Enhanced Climate Resilience**
    - Healthier soils improve drought resistance and flood mitigation by enhancing water retention and reducing erosion.
    - Closed-loop systems reduce reliance on external inputs, buffering communities from supply chain disruptions.
4. **Public Health Improvements**
    - Reduced landfill waste decreases air and water pollution linked to waste decomposition.
    - Enhanced soil and food quality supports better nutrition and reduces exposure to harmful agrochemicals.
    - Lower methane emissions contribute to improved air quality and respiratory health.
5. **Economic Development and Job Creation**
    - Growing biochar and composting industries create local jobs in research, production, application, and waste management.
    - Partnerships with universities and businesses stimulate innovation, technology development, and regional green economy growth.
    - Food recovery programs reduce waste costs and improve food security for vulnerable populations.
6. **Waste Reduction and Circular Economy Advancement**
    - Promotes diversion of organic waste streams, lowering landfill use and tipping fees.
    - Supports circular economy principles, turning waste into valuable resources like soil amendments and energy.

7. **Housing and Community Benefits**
    - Urban agriculture supported by soil amendments can improve food access in underserved neighborhoods.
    - Community-based composting and biochar projects foster local engagement and environmental stewardship.
8. **Environmental Quality Enhancements**
    - Improved soil carbon stocks enhance biodiversity and ecosystem services.
    - Reduced chemical runoff protects local waterways and aquatic habitats.
    - Supports broader ecosystem restoration efforts.

7. LIDAC BENEFITS ANALYSIS

The following analysis depicts how emissions are driving major public health impacts across the Cincinnati metropolitan region, with particular focus on lower-income and disadvantaged (LIDAC) communities. The study evaluates 16 counties and 142 LIDAC census tracts across Ohio, Kentucky, and Indiana, assessing their vulnerability to six key climate-related health threats: heat-related illness, respiratory illness, vector-borne disease, water-borne illness, mental health impacts, and harms associated with extreme weather events. Ultimately, it concludes that LIDAC communities face disproportionately high exposure and vulnerability to these risks and therefore stand to benefit most directly from regional climate mitigation and resilience efforts.

Figure __: Map of LIDAC census tracts in the Cincinnati MSA as defined by the US EPA CEJST tool.



7.1 Defining LIDAC Communities and Study Area

The analysis relies on the EPA's Climate and Economic Justice Screening Tool (CEJST), which identifies LIDAC census tracts based on socioeconomic stressors and environmental burdens. Communities are classified as LIDAC when they exceed the 90th percentile in the CEJST's supplemental indices.

The study area covers 16 counties designated by the EPA as a single Consolidated Statistical Area, meaning they share common economic, demographic, and environmental conditions. These include five counties in Ohio (Hamilton, Clermont, Brown, Warren, and Butler), four in Indiana (Franklin, Ohio, Dearborn, Union), and seven in Kentucky (Kenton, Boone, Campbell, Gallatin, Bracken, Pendleton, Grant). Of all census tracts in these counties, 142 met LIDAC criteria.

While all communities face health risks from climate change, the scale, severity, and immediacy of these risks vary significantly. The localized nature of climate impacts makes regional analysis essential for identifying specific hazards and the communities most likely to face disproportionate harm.

7.2 LIDAC Engagement

To engage with LIDAC communities in the region, ThriveTogether leveraged the work of the Climate Safe Neighborhoods Partnership. The CSN Partnership is comprised of Groundwork Ohio River Valley and Green Umbrella, who is also a key ThriveTogether planning partner.

The Climate Safe Neighborhoods program is dedicated to exploring the relationship between historically disadvantaged communities and the current and predicted impacts of climate change. The Partnership works directly with frontline community members to identify solutions to address climate impacts and pollution. Through intentional engagement with residents in priority communities, the effort honors community members as subject matter experts in identifying local issues and co-creating community-based solutions. Since the Fall of 2023, Climate Safe Neighborhoods hosted Climate Advisory Groups in the Avondale and Winton Hills neighborhoods of Cincinnati, Norwood, OH, Covington, KY, and Newport KY. These groups were introduced to the ThriveTogether process and were activated to participate in the online engagement hub.

The ThriveTogether engagement partnership with Climate Safe Neighborhoods included 12 events with over 70 unique participants from frontline neighborhoods in Ohio and Kentucky. Details of this engagement are found in Appendix C.

7.3 Vulnerability Index Framework

To quantify and compare risks across the region, a vulnerability index was used. This index is grounded in case studies, literature reviews, and existing national and state frameworks, including the U.S. Climate Vulnerability Index and California's Climate Change and Health Vulnerability tools. The index incorporates three types of drivers:

- **Climate drivers:** heat islands, air quality, vector-borne disease, water-borne illness, mental health stressors, and extreme weather events.
- **Environmental drivers:** tree canopy coverage, surface imperviousness, pollution exposure, wastewater discharges, flood risk, etc.
- **Socioeconomic drivers:** age, income, disability, pre-existing health conditions, access to healthcare, linguistic or social isolation, and other factors affecting both vulnerability and exposure.

The climate, environmental, and socioeconomic drivers were then categorized as vulnerability or exposure factors. Vulnerability factors (e.g., age, health status) measure how severely a person or community could be affected, while exposure factors (e.g., proximity to highways or flood zones) measure how likely they are to encounter the threat. The index allows systematic comparison across census tracts and helps identify the communities at greatest risk from each climate-health impact.

7.4 Climate Drivers and Health Impacts

Climate impacts are overarching factors which have been identified as likely to be the most prevalent and detrimental events for the region in the future. These include heat islands, air quality, vector-borne diseases, water-borne illness, mental health, and extreme weather events. Connected with these most of these climate impacts were health impacts. This included heat related illness for heat islands, respiratory illness for air quality, stress, anxiety, suicide, post-traumatic stress disorder (PTSD), drug use, and smoking for mental health, and long term and short-term health damage for extreme weather events. Vulnerability factors are those that make certain populations more vulnerable to the given effect. Exposure factors are those which make it more likely that certain populations will experience this effect. A summary of the drivers and associated health impacts can be found below in Table 7.

Table 7 : Climate Drivers and Associated Health Impacts in the Cincinnati Region

Climate and health impacts	Vulnerability factors	Exposure factors
Heat islands *Heat related illness*	Income, age, disabled, pre-existing health conditions	Increased temperature, time of day/ year, reduced tree canopy, poor building structure/ zoning
Air Quality *Respiratory illness*	Age, asthma, pre-existing health conditions	Mobile source emissions (proximity to highways), industry
Vector borne diseases	Pre-existing health conditions, access to health care, access to information, age	Exposure to vectors, changing habitat and breeding grounds
Waterborne illness	Pre-existing health conditions, access to health care, low access to potable water	Topography, risk of flooding, wastewater discharge, stream miles
Mental health, incidences of stress, anxiety, suicide, PTSD, drug use, smoking	Occupational exposure, income and family size, education, age, socially and linguistically isolated individuals	Access to green space, food deserts, access to quality and affordable health care, population growth, heat islands, extreme temperatures, extreme weather events
Extreme weather events, damage to general health for short and long term	Low income, lack of insurance, zero car, elderly, disabled, access to internet	Risk of fire, flood, natural disaster, damage to buildings, location, topography

7.4.1 Heat Islands and Heat-Related Illness

The Urban Heat Island (UHI) effect—driven by high pavement coverage, low tree canopy, concentrated human activity, and poor building design—produces significantly higher local temperatures in urbanized areas. The study draws on a 2021 NASA-supported assessment showing that daytime temperatures in Cincinnati and Covington were more than 8°F higher than in surrounding rural areas.[11]

[11] https://appliedsciences.nasa.gov/what-we-do/projects/assessing_urban_heat_in_the_cincinnati_and_covington_area_using_nasa_earth_observations

Climate projections indicate that ambient temperatures will rise from an average of 63 °F in the 2020s to roughly 68 °F by the 2050s. Higher temperatures increase risks of heat stroke, cardiovascular strain, dehydration, and respiratory stress. Vulnerable populations include older adults, young children, people with chronic illness, and low-income residents who may lack access to air conditioning or cooling centers.

Census tract data reveal that LIDAC communities have 6% more impervious surface coverage than the regional average, reflecting higher exposure to heat. LIDAC communities already show elevated heat-related illness rates (63.7 per 100,000, compared to 49.2 regionally). Mortality models for Hamilton County indicate that heat-related deaths due to heart attacks and strokes could rise by 4.5% and 2.5%, respectively, by 2050.

The counties most impacted by UHI effects include Campbell, Kenton, Clermont, and Hamilton for LIDAC tracts, and Boone, Campbell, Kenton, and Hamilton for non-LIDAC tracts.

7.4.2 Air Quality and Respiratory Illness

Air pollution—especially particulate matter (PM2.5)—poses major health risks by exacerbating asthma, COPD, lung cancer, and heart disease. Exposure is influenced by industrial emissions, traffic pollution, temperature, and climate-driven increases in wildfire smoke. Cincinnati has a long history of air quality challenges and ranks among the top 25 U.S. cities for annual particle pollution.[12] The region also has unusually high COPD prevalence.

The analysis shows that LIDAC communities experience worse air quality and greater vulnerability:

- LIDAC tracts average in the **83rd percentile** for PM2.5 concentrations, vs. the regional **81st**.
- Low-income LIDAC tracts with asthma rank in the **49th percentile**, compared to **14th** regionally.
- LIDAC tracts are far more likely to be located in the **90th percentile** or above for traffic exposure (14% of tracts vs. 4% regionally).

[12] https://www.lung.org/research/sota/city-rankings/most-polluted-cities

The most affected LIDAC counties include Boone, Campbell, Kenton, Pendleton, Butler, Hamilton, and Warren, with similar patterns—though lower frequencies—seen in several non-LIDAC tracts.

7.4.3 Vector-Borne Disease

Vector-borne diseases (VBDs) such as Lyme disease, West Nile virus, Rocky Mountain spotted fever, and Ehrlichiosis are rising nationwide due to warming temperatures, longer warm seasons, and expanding habitats for ticks and mosquitoes.

In the 2024 Ohio Vector-borne Disease Surveillance Update, conducted by the Ohio Department of Health (ODH) Zoonotic Disease Program, evidence was found of VBDs in counties in the Cincinnati metropolitan region. The report summarizes surveillance data showing:

- West Nile-positive mosquitoes in Hamilton and Clermont Counties.
- Lyme-infected ticks in Butler, Hamilton, Clermont, and all Kentucky counties studied.
- Rapid increases in Lyme disease cases statewide in Ohio—from 63 cases in 2013 to 1,297 in 2023.

The number of days each year with high temperatures above 90°F have increased from 35 to 63 for both LIDAC and non-LIDAC communities, reflecting an environment increasingly conducive to vector transmission.

LIDAC tracts in Boone, Campbell, Gallatin, Grant, Kenton, Pendleton, Brown, Butler, Clermont, and Hamilton counties show the highest vector-borne disease vulnerability.

7.4.4 Water-Borne Illness

Water-borne disease (WBD) risks stem from contaminated drinking water, recreational exposure, agricultural runoff, wastewater discharge, and flood-related contamination. Common illnesses include E. coli infection, Legionnaires' disease, giardiasis, and salmonellosis.

CDC data show waterborne outbreaks across the tri-state region, particularly clusters of Legionnaires' disease. While the frequency of E. coli outbreaks is similar between LIDAC and regional communities, other structural vulnerabilities show sharp disparities:

- LIDAC tracts are more likely to contain leaking underground storage tanks (55th percentile vs. 46th regionally).
- Flood risk is unevenly distributed across LIDAC communities.
- Lower-income neighborhoods often have older water systems and limited access to potable water.

Counties with high WBD exposure in LIDAC tracts include Dearborn (IN), Boone (KY), Grant (KY), Kenton (KY), Butler (OH), and Hamilton (OH).

7.4.5 Mental Health Impacts

The connection between climate factors and mental health—while complex and multifaceted—is significant. Stress, depression, anxiety, PTSD, substance use, and smoking can all worsen under climate-driven stressors such as heat extremes, population pressures, food insecurity, poor access to green space, and trauma from extreme events.

Research shows benefits of green space and strong correlations between food deserts and psychological distress.[13,14] Low educational attainment, unemployment, chronic disease, and caregiving burdens also elevate risk.[15,16]

LIDAC communities face substantial socioeconomic stressors:

- Life expectancy averages **71 years**, compared to **76** regionally.
- LIDAC communities average in the **71st percentile** for unemployment (vs. **43rd** regionally).

These disparities heighten both chronic and acute mental health burdens.

---

[13] **https://www.f.gov/media/blog/2017/11/28/improving-urban-health-through-green-space**

[14] **https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6608701/**

[15] https://pubmed.ncbi.nlm.nih.gov/36345690/

[16] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9901051/#:~:text=The%20risk%20of%20being%20diagnosed,lead%20to%20improved%20mental%20health.

The counties most vulnerable in LIDAC tracts include Campbell, Kenton, Butler, and Hamilton, with similar risks in several non-LIDAC tracts such as Boone.

7.4.6 Extreme Weather Events

Extreme weather hazards in the region include heat waves, cold waves, storms, tornadoes, flooding, drought, and landslides. FEMA's National Risk Index rates Hamilton and Butler counties as having the highest risk (relatively moderate), while most others fall into low or very low risk categories.

Climate change is projected to increase the frequency and severity of these events, producing widespread economic losses and community disruptions.
LIDAC communities face heightened exposure and limited adaptive capacity due to:

- Older or poorer-quality housing
- Lower insurance coverage rates
- Reduced access to transportation and communication tools
- Greater difficulty evacuating or relocating
- Barriers to post-disaster recovery

LIDAC tracts show higher exposure to future flood risk (51st percentile vs. 42nd for the region), though expected building loss is similar between groups.

The counties with the highest LIDAC vulnerability scores include Dearborn and Franklin (IN), Bracken, Gallatin, Kenton, Pendleton (KY), and Brown and Butler (OH).

7.5 Conclusion

Across all six climate-health impact categories, LIDAC communities in the Cincinnati metropolitan region face significantly higher vulnerability and exposure than regional averages. While impacts vary across counties and tracts, the pattern is consistent: climate change intensifies existing inequities. Communities with lower incomes, more environmental burden, limited access to healthcare, and structural disadvantages are already experiencing disproportionate health impacts, and these disparities are expected to widen.

Of the 16 counties evaluated, Butler, Hamilton, Grant, Brown, Franklin, Gallatin, Bracken, and Pendleton each have over 25% of their populations living within LIDAC tracts. Climate mitigation and resilience strategies targeted toward these communities will offer substantial co-benefits, improving both public health and environmental equity across the region.

The analysis underscores that reducing regional emissions, improving environmental quality, investing in infrastructure, and enhancing access to healthcare and green space will not only slow climate change but also directly protect the health and well-being of the region's most vulnerable residents.

A more thorough report of the LIDAC impacts and potential benefits from efforts to reduce emissions can be found in Appendix F.

8. WORKFORCE PLANNING ANALYSIS

The shift towards sustainability is becoming increasingly fundamental within public, private, and nonprofit entities of the Ohio-Kentucky-Indiana region. This shift sparks a change in the greater workforce landscape, particularly pertaining to the growth and availability of green jobs. According to the U.S. Bureau of Labor Statistics, green jobs are referred to as jobs that produce goods or services which seek to aid the environment, conserve natural resources, or make production processes more environmentally sound. Most, but not all, green jobs can be divided into five groups: energy from renewable sources, energy efficiency, pollution reduction/removal and recycling and reuse, natural resource conservation, and environmental compliance/education/training.[17] These jobs support the region's long-term economic growth and vitality.

On a national level, efforts to combat climate change have helped to create jobs. According to a 2024 article from the Environmental and Energy Study Institute, there were more than 4.2 million climate jobs in 2022. The same study split these jobs into different groups. The first group includes energy efficient jobs, like HVAC, Energy Star Appliances, Energy Efficient Lighting, and more. This group supported 2.2 million jobs in 2022. The next group, energy transmission, distribution, and storage jobs, supported nearly 850,000 jobs as of 2022, including electricity transmission and distribution, battery storage, and smart grid roles. The renewable energy groups, including careers in solar, wind, and hydropower, supported nearly 547,000 jobs in the United States in the same year. Other groups include jobs in clean transportation and in adaptation and resilience.[18] While these groups support smaller numbers than the other three groups, their efforts are still significant and increasing over time as more climate-resilient measures are being implemented.

For example, the U.S. Department of Energy published a United States Energy & Employment Report in 2024. This report detailed the breakdown of climate-related jobs, especially in the energy sector. It discusses how investments in clean energy have had

[17] The BLS Green Jobs Definition : U.S. Bureau of Labor Statistics

[18] https://www.eesi.org/papers/view/fact-sheet-climate-jobs-2024

strong growth in recent years, where energy sector jobs grew 3% in 2023, outpacing overall U.S. employment by 50%. Since the job loss caused by the 2020 COVID-19 pandemic, jobs in clean energy have increased by 400,000–a growth rate of 12.8%.[19]

The international market for renewable energy technologies and innovations is estimated to be worth $23 trillion by 2030. Green jobs are instrumental in enhancing economic and social vitality in the long-term, allowing for well-paying, stable jobs across the United States.[20]

The Occupational Information Network posts numerous job titles when searching the text "green jobs". Of these listings, many were designated with a "bright outlook" status, meaning they are anticipated to grow rapidly within the next few years. These "bright outlook", green jobs are: sustainability specialists, training and development specialists, architects (except landscape and naval), financial and investment analysts, chief sustainability officers, plumbers, pipefitters, steamfitters, mechanical engineers, industrial ecologists, range managers, and climate change policy analysts. Other green jobs listed, not considered to have a bright outlook, include energy engineers (not wind and solar), career/technical education teachers (postsecondary), production workers, sales representatives, and environmental economists.[21]

The Bureau of Labor Statistics also gave insights into the fastest growing occupations across the United States. This list of 20 is based on projections for employment between the years 2023 to 2033. The occupation with the highest growth rate is wind turbine service technicians, whose growth rate is 60%, with a median pay (2024) of $62,580. The next highest ranked occupation are solar photovoltaic installers, with a growth rate of 48% and a median pay of $51,860. Data scientists are ranked 4th, with 36% growth and a median pay of $112,590. Finally, of the twenty jobs listed, epidemiologists are projected to have a growth rate of 19%, with a median pay of $83,980[22]. Four of the twenty fastest-growing jobs are classified as green jobs. Between the same time span,

[19] https://www.energy.gov/sites/default/files/2024-10/USEER%202024_COMPLETE_1002.pdf

[20] Job Creation and Economic Growth | Department of Energy

[21] O*NET OnLine

[22] https://www.bls.gov/ooh/fastest-growing.htm

the Bureau of Labor Statistics identifies occupations expecting to see the highest number of new jobs created. Of this list, construction workers, electricians, and other forms of manual laborers are expected to see major growth in terms of their number of workers.[23]

8.1 Methodology

The following analysis details the current workforce landscape, driven by the anticipated increase in green jobs, within the 16-county region spanning Ohio, Kentucky, and Indiana (known as the Metropolitan Statistical Area, or MSA). The information in this analysis is adapted from the Cincinnati Green Workforce Landscape Analysis and uses other external sources, such as Census data, to detail the region's current workforce landscape and make future projections. It will include insights into how many jobs, particularly green jobs, can be attributed into seven identified sectors: transportation, electric power, buildings, industrial, waste/water/sustainable materials management, agricultural, and carbon removal. It will also include any potential shortcomings in projected workforce capacity in each sector.

In this research, jobs within each individual implementation measures within each sector were identified. These were jobs that could be considered green jobs and would be needed to advance the sector. Once the list of roughly 100 jobs was compiled, the jobs were then narrowed into broader NAICS categories. It is important to note that other jobs may be necessary for full completion of each implementation measure outside of these identified job codes. From here, 44 NAICS job codes were identified and projected from 2020 into the years 2030, 2040, and 2050.

Historical employment data for these job categories were acquired from the Quarterly Census of Employment and Wages (QCEW) database for all years between 2014 and 2024. The historical share and smoothed changes of these industries compared to the regional overall employment over the same period was calculated and used in conjunction with the BLS projections for any employment projections available. Data from Woods and Poole was used for projected regional employment for future years 2030, 2040, and 2050. However, this assessment will only directly examine short-term growth by 2030 and long-term growth by 2050. The share of the regional employment

[23] https://www.bls.gov/ooh/most-new-jobs.html

for future years for each job pathway was estimated based on the smoothed change in shares during the 2014 to 2024 changes. After the share changes are applied for each forecast year, total employment was calculated by multiplying the estimated share by the overall regional employment.

Of the 44 job codes, in 2020, total green jobs stood at 59,180 full-time equivalent positions. By 2030, this number rises to 72,100, or a 21.83% increase. It rises again to 84,244 by 2050, a 42.36% increase from 2020. This growth can be attributed not only to growth in environmental sectors, but also to population/economic growth within the region. Regarding the share of green jobs in overall regional employment, these 44 job codes will comprise 4.9% of total regional employment in 2020 and will jump to 5.26% by 2050. This growth will be broken down sector by sector later in this report. As many sectors require similar qualities and most jobs are required in more than just one sector, many jobs overlap across sectors.

8.2 Current Workforce Landscape

Currently, the region's workforce is made up of an array of many different occupational sectors. By compiling 2023 county-level census data on workforce breakdowns, averages of each sector were taken to find the most populated occupations within the 16-county Metropolitan Statistical Area.

From these averages, the most populated job sector is educational services & healthcare, and social assistance occupations, accounting for 22.7% of the employed regional population, aged 16 and older. This is followed by manufacturing (15.5%), retail trade (11.1%), professional, scientific, and management, and waste management occupations (9.4%), transportation & warehousing, and utilities (8.1%), arts & entertainment, and recreation, accommodation, and food services (7.7%), construction (7.6%), public administration (4.2%), and agriculture, fishing, wholesale retail, and all other industries (6.3%). This current work breakdown structure is illustrated in the figure below.

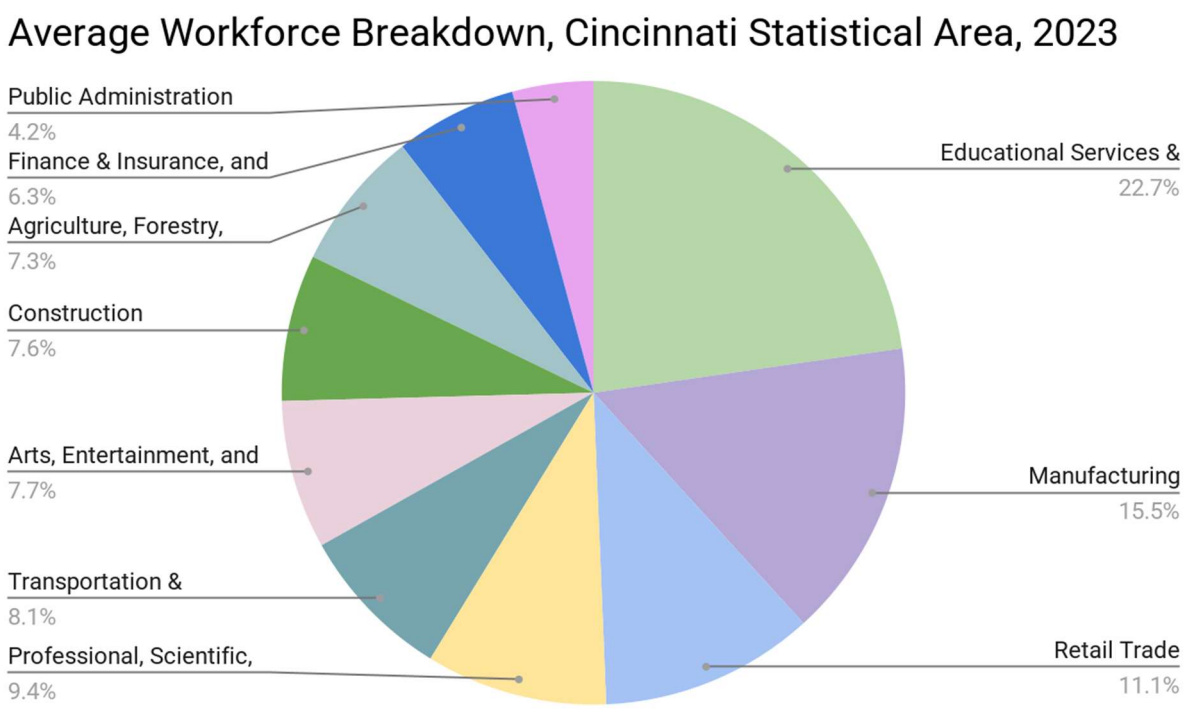


Figure 15: Workforce Breakdown Cincinnati Statistical Area. Data sourced from county-level 2023 American Community Survey 5-Year Estimates, U.S. Census Bureau

It is important to note that these created jobs should also be fruitful, quality jobs. According to the Department of Labor, quality jobs should follow various criteria, known as "Good Job Principles". These principles include recruitment and hiring, benefits, empowerment and representation, job security and working conditions, organizational culture, pay, and skills and career advancement.[24] As various measures are implemented within the region, along with the creation of green jobs. Green jobs are often growing faster than most other job sectors and often pay above the average U.S. wage of $59,428 ($53,840 average wage among Ohio, Kentucky, and Indiana).[25]

As previously mentioned, quality jobs should, at minimum, provide workers with a livable wage. MIT's Living Wage Calculator estimates the local wage rate that a full-time employee would need to cover their basic needs. The estimations consider factors including average costs of food, medical, housing, taxes, transportation, and more to find the living wage. As of 2025, within the Cincinnati Metropolitan Statistical Area (MSA), the average living wage for single adults with no children is $20.92/hour, or

[24] Increasing Employer and Workforce System Customer Access to Good Jobs

[25] Average Salary By State – Forbes Advisor

approximately $41,840/year, assuming an individual works 40 hours per week for 50 weeks a year. Within this region, Hamilton County has the lowest livable wage at $19.81/hour and Union County has the highest livable wage at $23.45/hour.

To compare, families with two adults (both working) and an average of 2 children (1.92 birthrate average in the Midwest), the average living wage for each adult is $25.94/hour or $51,880/year–a combined income of $103,760.[26]

8.3 Investment into Green Workforce

The seven sectors identified by ThriveTogether will work cohesively and independently to ensure green jobs are either created or adapted to meet specific needs in each individual sector. Employment projections suggest that **6,977 new green jobs will be created by 2030** in the Cincinnati MSA and **15,463 jobs by 2050**.

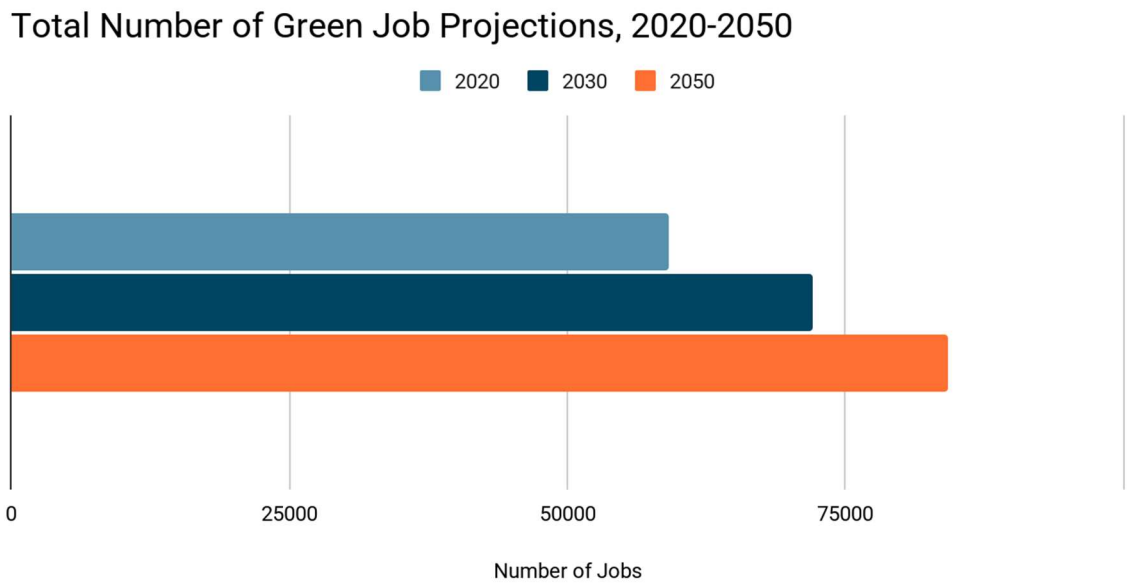


Figure 16: Total Number of Green Jobs in the Cincinnati MSA, from projections

The Cincinnati Green Workforce Landscape Analysis, a regional report based on the City of Cincinnati's 2023 Green Cincinnati Plan goals, estimated that green investments across their sectors could create between 5,885 (low estimate) and 17,236 (high estimate) total new jobs.[27]. This data suggests higher, but agreeable, job growth within

[26] Living Wage Calculator

[27] Appendix-VI (4).xlsx

the region when compared to ThriveTogether's plan. This could be attributed to different methodologies for data collection and projections and/or the various sectors each is evaluating. For example, the Green Cincinnati Plan offers eight sectors for evaluation: buildings and energy, city operations, community activation, food, mobility, natural environment, resilience and climate adaptation, and zero waste. Comparatively, ThriveTogether identifies seven sectors, which will be discussed further as each of its greenhouse gas reduction strategies are delved into.

8.3.1 Transportation

In implementing changes in the transportation sector to reduce greenhouse gas emissions, various measures are going to be taken, which may call for the need to increase or adapt the current workforce, including:

1. Build out a robust EV charging network
2. Convert public and private vehicle fleets to electric
3. Encourage the use of transit, non-motorized vehicle, or walking for more trips within the region
4. Use technology, sound roadway network design, and policy to reduce areas of persistent traffic congestion
5. Support local development of sustainable aviation fuel
6. Support regional, intrastate, and interstate rail projects that move travellers and freight more efficiently

The six implementation measures in the transportation sector will not only reduce greenhouse gas emissions, but also shape a demand for many jobs. These include civil engineers, battery manufacturers, data analysts, and urban or transportation planners.

These measures would allow the region to undergo a profound transformation, embracing electrification, mobility, and sustainable infrastructure. In 2020, the transportation sector supported roughly 22,364 green jobs. By 2030, this number is projected to increase to 28,270, an increase of 5,906 jobs. By 2050, employment is expected to reach 33,469, showing a total growth of 11,105 jobs. This is a 49.66% increase in employment compared to 2020 levels.

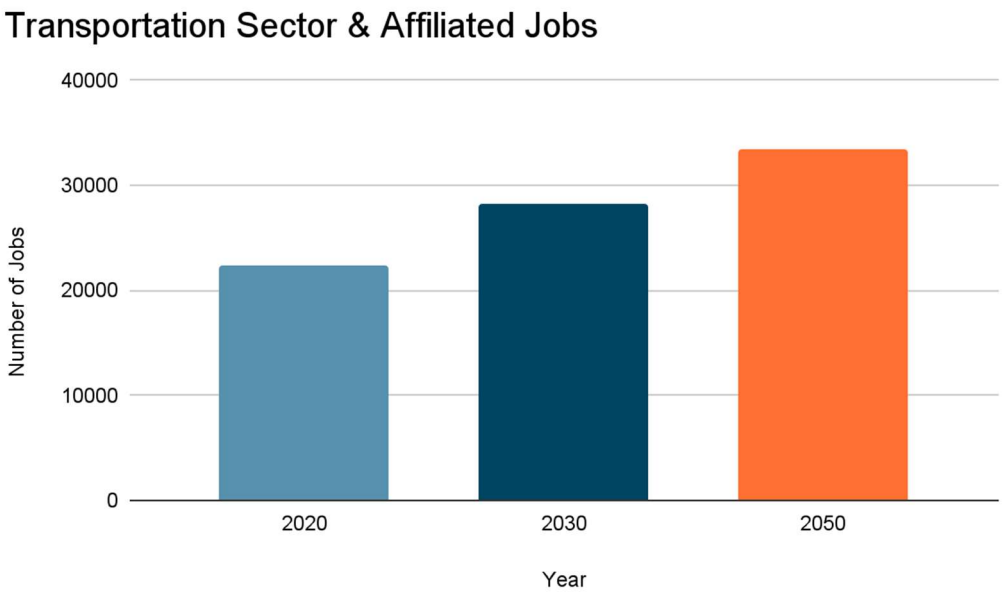


Figure 17: Transportation Sector Jobs in the Cincinnati MSA, from projections

8.3.2 Electric Power

The electric power sector encompasses various measures in its pursuit to reduce greenhouse gas emissions on a large scale. The electric power sector is central to the region's decarbonization goals, with a strong emphasis on renewable energy generation, grid modernization, and energy efficiency. These specific measures include:

1. Replace the region's streetlights with LED fixtures
2. Further develop renewable energy generation in the region
3. Help communities, businesses, and residents procure electricity generated using clean and renewable energy sources

In 2020, the sector had 19,774 related green jobs. By 2030, this number is expected to grow to 23,651, an increase of 3,877 jobs. By 2050, employment is projected to reach 27,298, reflecting a total increase of 7,524 jobs, a 38.06% increase. This expansion of jobs can be attributed to the region's desire to move to a smarter, cleaner grid. This creates a demand for workers skilled in electricity trades, battery storage, smart grid technologies, and renewable energy systems. Therefore, investments in training and certification, particularly in electrical trades, will be critical in sustaining this job growth.

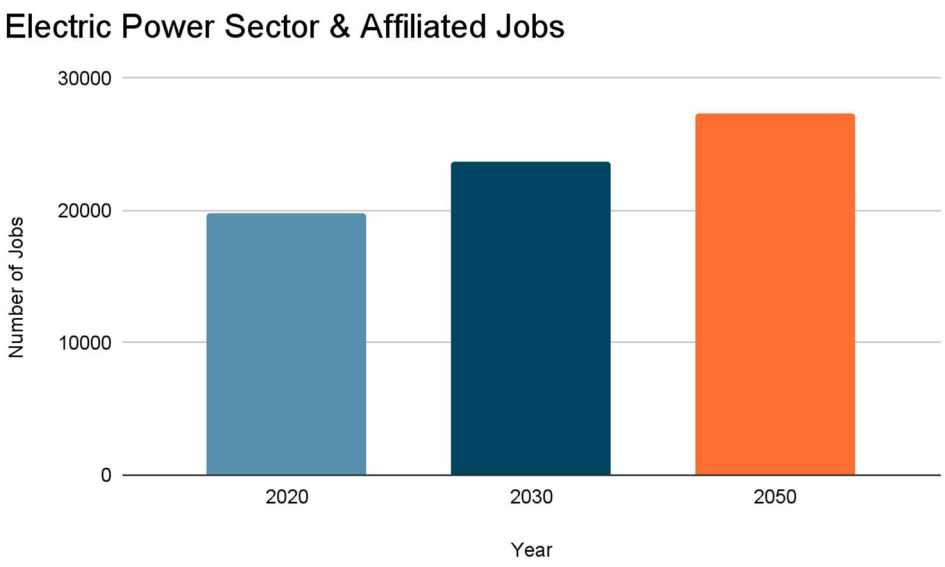


Figure 18: Electric Power Sector Jobs in the Cincinnati MSA, from projections

8.3.3 Buildings

The buildings sector aims to combat greenhouse gas emissions by improving the sustainability patterns across the MSA. It aims to do so by:

1. Improve the energy efficiency of local governments, schools, and nonprofits in the region
2. Improve the energy efficiency of commercial buildings
3. Improve the energy efficiency of residential dwellings in the region
4. Adopt development patterns that are proven to be more energy-efficient and support energy efficient transportation
5. Involve citizens in the effort to reduce GHG emissions

In 2020, this sector accounted for 33,548 green jobs. By 2030, employment relating to this sector is projected to rise to 40,833, an increase of 5,285 jobs. By 2050, the sector anticipates 46,595 jobs, a total increase of 11,047 jobs–showing 30.99% growth from 2020.

Key jobs in this sector include HVAC specialists, electricians, plumbers, architects, building inspectors, and urban planners. Many of these roles are accessible through trade schools and apprenticeships, making them ideal for workforce development initiatives targeting underserved populations. The building sector, however, also offers jobs in green design, smart building technologies, and community engagement. Thus,

expanding access to training in sustainable construction or LEED certification will be essential to meet this sector's growing labor demands.

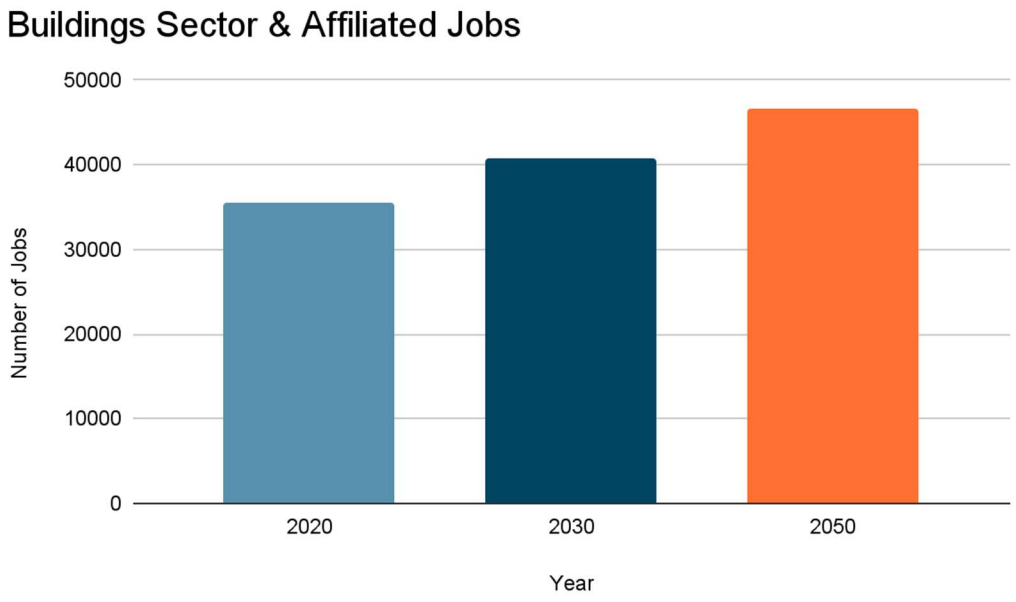


Figure 19: Buildings Sector Jobs in the Cincinnati MSA, from projections

8.3.4 Industrial

The industrial sector is complex in its proposed measures to combat greenhouse gas emissions through reductions in manufacturing and heavy industry. However, by supporting job growth and tackling measures cohesively, it can be successful. Its measures are:

1. Work to lower the GHG emissions from large-scale emitters
2. Develop infrastructure to connect the region to mega-regional clean hydrogen hubs (Appalachian and Midwest)
3. Work to improve industrial operations to be more energy efficient and use cleaner sources of energy

In 2020, jobs relating to this sector stood at 19,966. By 2030, this number is projected to increase to 24,607, an increase of 4,651 jobs. By 2050, jobs are expected to reach 28,851, showing a total increase of 8,885 jobs–44.52% growth from 2020 rates.

As industries adopt cleaner technologies and processes, there will be a growing need for electricians, civil engineers, construction workers, environmental consultants, and those who are trained in emissions monitoring and sustainable manufacturing.

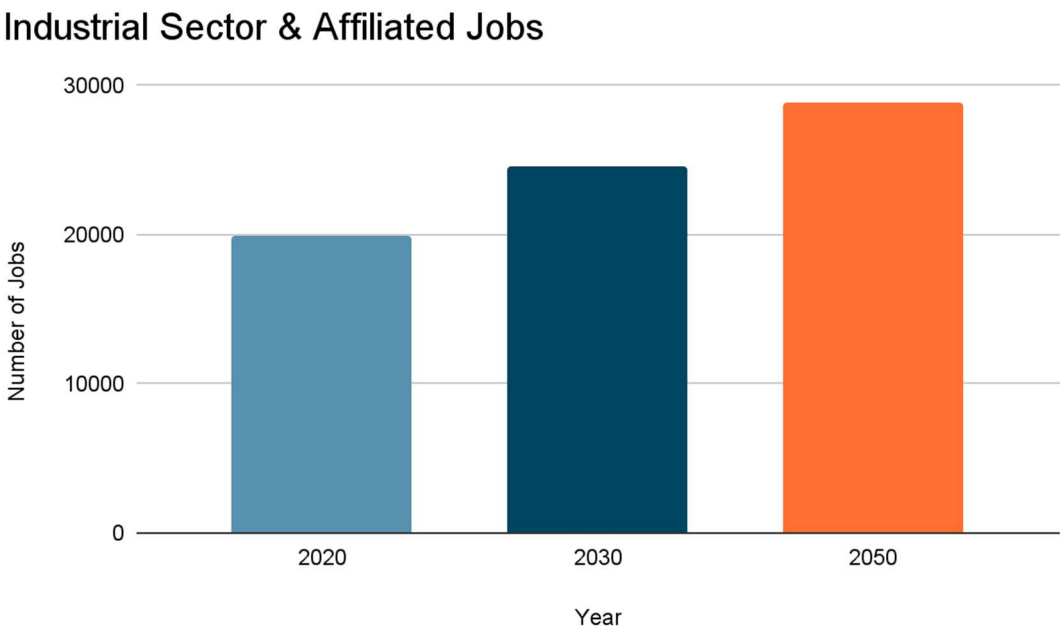


Figure 20: Industrial Sector Jobs in the Cincinnati MSA, from projections

The industrial sector offers quality employment opportunities and is well-suited for reskilling workers from traditional manufacturing roles. Expanding and enhancing partnerships with technical colleges and industry organizations is key in preparing the region's workforce in this sector.

8.3.5 Waste, Water, and Sustainable Materials Management

The waste, water, and sustainable materials management sector requires collaboration to tackle various measures and enhance job creation. It reflects the growing importance of a circular economy and sustainable resource management. Its measures are:

1. Build an environment of collaboration among organizations involved in solid waste, recycling, composting, and food rescue to maximize efficiencies
2. Increase access to recycling for residents in multi-family buildings
3. Make recycling convenient, provide clear communication, and educate residents
4. Work to reduce methane released in the region

In 2020, the sector's goals supported 19,429 relevant jobs. By 2030, employment is projected to increase to 24,924, an increase of 5,495 jobs. By 2050, the sector could employ 29,730 workers, representing a total increase of 10,301 jobs. This is a 52.99% growth from 2020.

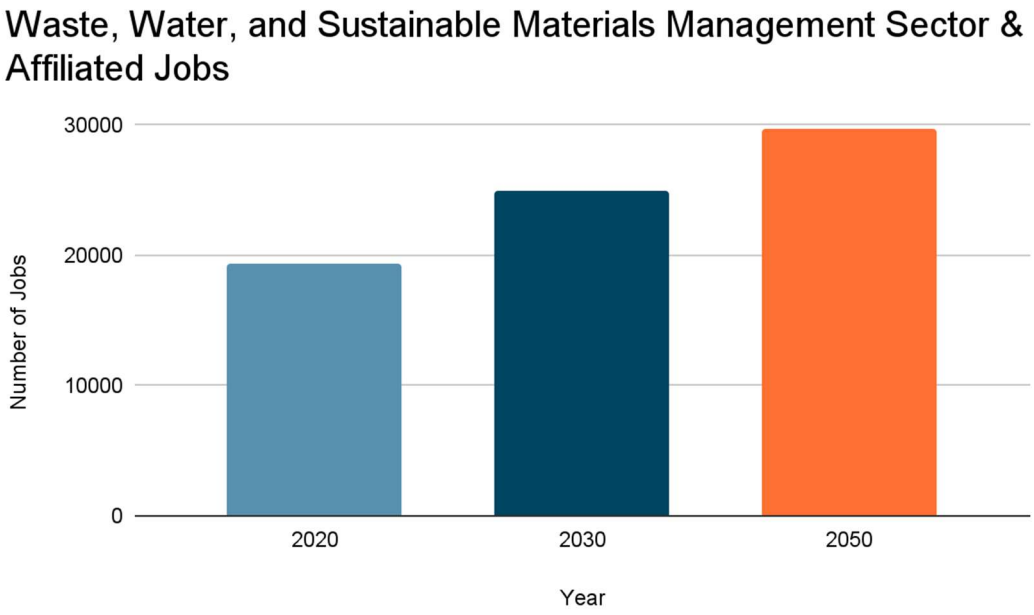


Figure 21: Waste Sector Jobs in the Cincinnati MSA, from projections

Jobs in this sector include solid waste collectors, water treatment specialists, supply chain managers, community food coordinators, and many more. Of these jobs, many roles are accessible with minimal formal education requirements but may still require specialized training or certifications. Investment in development programs focused on environmental education and waste management technologies will be critical in supporting this sector's growth.

8.3.6 Agricultural

The agricultural sector seeks to enhance the capacity of both rural and urban landscapes within the region through sustainable farming practices and local food systems. Its implementation measures include:

1. Reduce fertilizer use in agricultural production
2. Increase local food production and markets
3. Increase use of farming methods that reduce GHG emissions

As of 2020, this sector has 24,378 related green jobs. By 2030, this number is projected to increase to 27,112, an increase of 2,734 jobs. By 2050, employment is likely to grow again to 30,747, making a total increase of 6,369 jobs, a 26.13% growth from 2020.

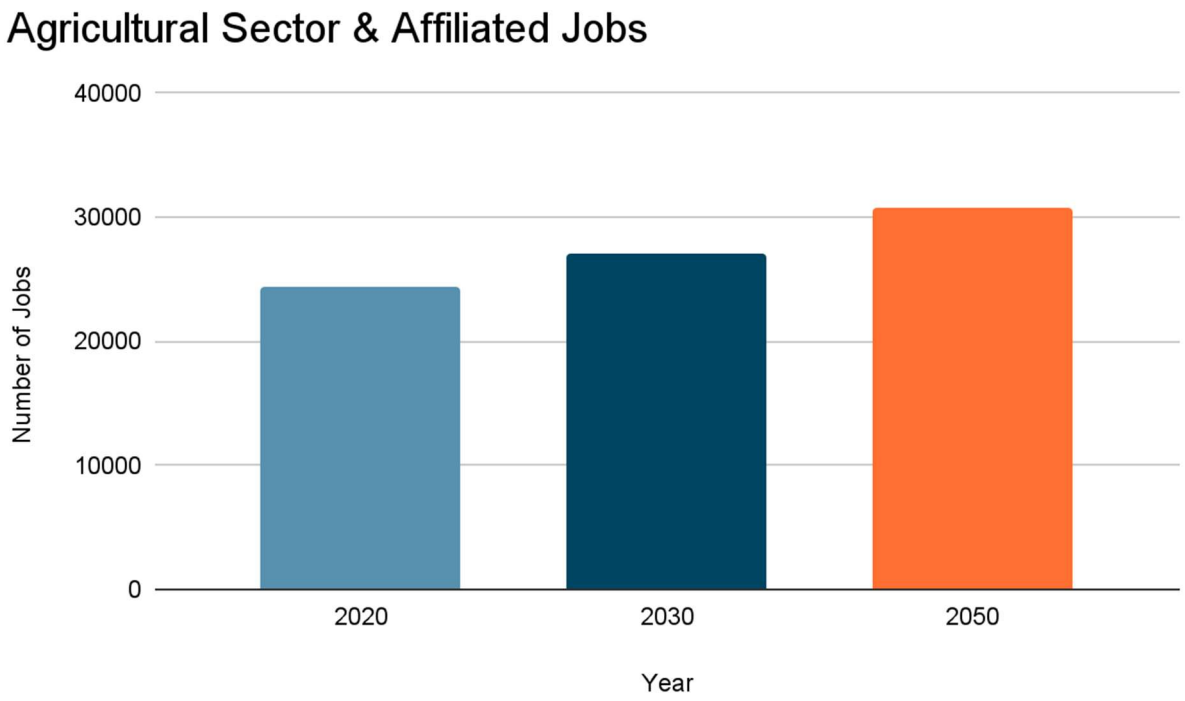


Figure 22: Agricultural Sector Jobs in the Cincinnati MSA, from projections

Key occupations in this sector include conservationists, farmers, farm managers, environmental consultants, retailers, and food system coordinators. This sector also includes roles in urban agriculture and community-supported agriculture programs that are growing in both urban and rural areas. As the sector modernizes and develops, there will be a need for employees trained in sustainable land management and climate-resilient farming techniques. Supporting connections between agricultural extension services, community colleges, and local food networks will be vital in shaping a resilient agricultural sector and reducing the sector's emissions.

8.3.7 Carbon Removal

The final sector seeking to reduce greenhouse gas emissions on a regional scale is carbon removal. This sector is a critical aspect of ThriveTogether's greenhouse gas reduction strategy, with a focus on nature-based climate solutions and innovative carbon capture strategies. Carbon removal can be achieved through the following measures:

1. Expand protections of the region's forested lands
2. Promote urban forestry as an important measure against the urban heat island effect
3. Increase wetland protection and restoration

4. Support biochar research, development, and implementation

Main jobs in this sector include foresters/arborists, hydrologists, environmental/climate scientists, GIS specialists, and more. Many, but not all, of these jobs require specialized education or training in ecology, environmental sciences, or geospatial analytics. However, the sector offers both high-skill and entry-level employment opportunities. Expanding access to environmental education and field-based training programs will be essential in building a workforce capable of scaling carbon removal solutions across the region.

In 2020, this sector will have 21,938 green jobs. By 2030, this is expected to increase to 28,242, an increase of 6,304 jobs. By 2050, it is expected to increase to 33,197, making for a total increase of 11,259 jobs. This presents a 51.32% growth from 2020.

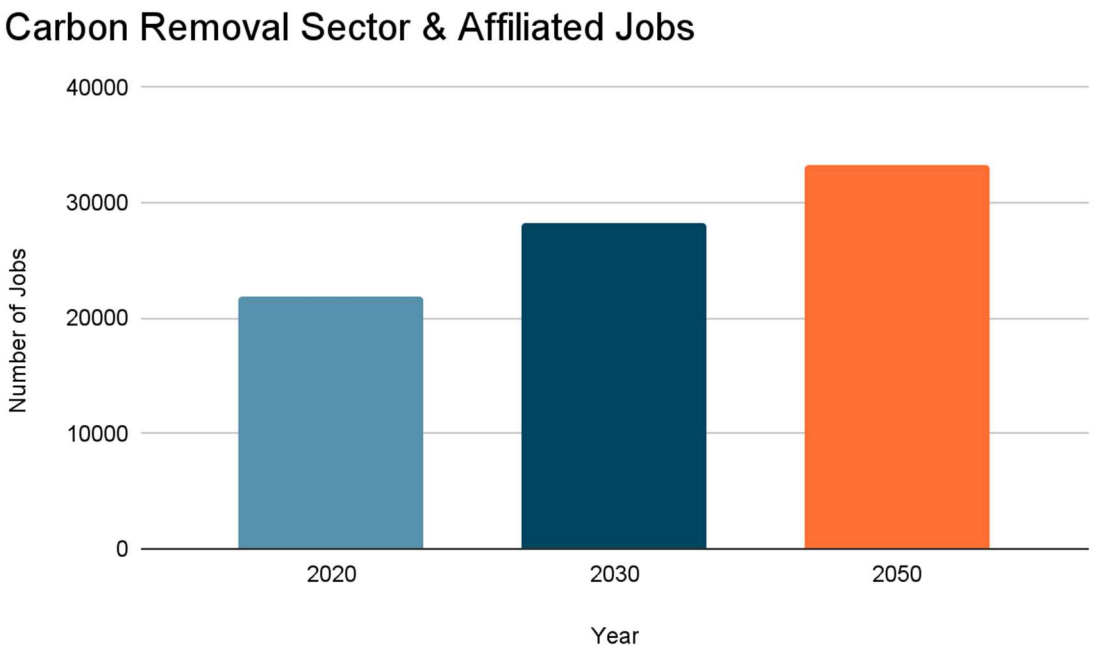


Figure 23: Carbon Removal Sector Jobs in the Cincinnati MSA, from projections

8.4 Overall Findings

Of the jobs listed, some skills are growing in importance in the workforce. These skills include technical/engineering, data and technology, communication and outreach, and, largely, hands-on and trade skills. While many of these jobs require certain professional skills, some jobs are considered to be "low-skill", meaning that they have minimal

educational or professional requirements. Many of these jobs, however, will require a certification or apprenticeship before fully beginning work. These “low-skill” jobs include, but are not limited to: installation technicians and electricians, construction crews, railway workers, landscapers, urban forestry workers, waste collection and recycling technicians, landfill operations workers, and weatherization and insulation technicians.

From 2020 to 2050, most new positions (considered to be “green jobs”) are in the fields of HVAC specialists and plumbers, electrical engineers and installation technicians, engineers and scientists, retailers, waste collection employees and managers, and water system specialists and technicians. Many of these jobs are relatively “low-skill”, but require a training or apprenticeship. Ensuring that these training courses are adequate and available within the region will become essential as the measures proposed are pursued. The chart below details job growth by sector.

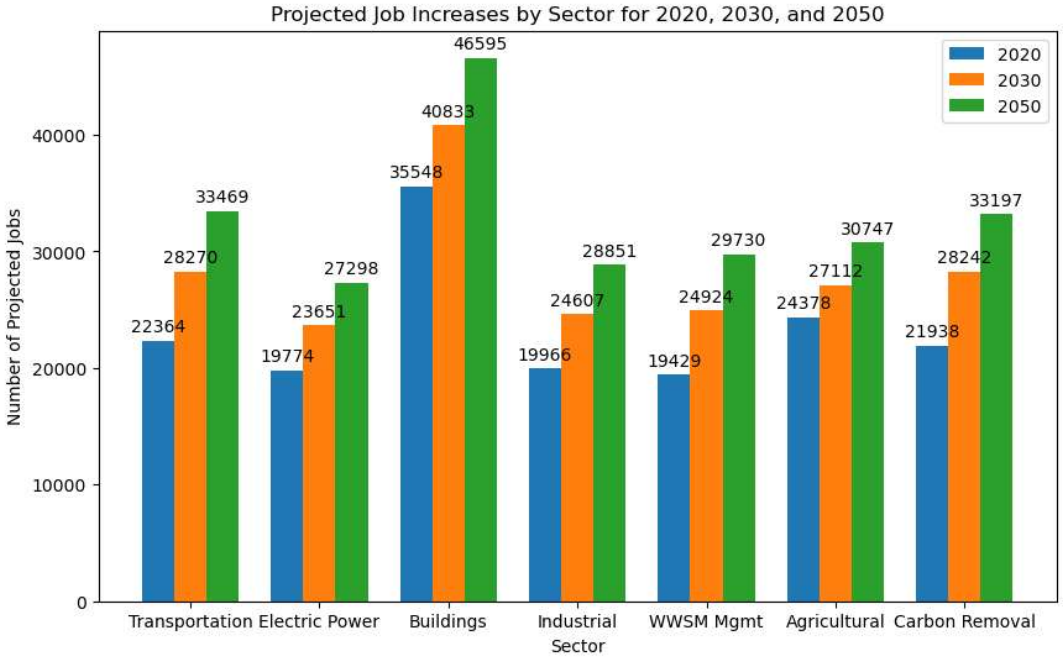


Figure 24: Projected Job Increases by Sector, 2020, 2030, and 2050.

8.5 Job Growth Challenges within the Cincinnati Region

There can be a variety of factors which can inhibit the expansion of green jobs in the regional workforce. The first of which involves a limited understanding of green jobs among the public. Often, green jobs can be perceived as unviable, either due to a lack of training or the misconception that green jobs are low-paying. This can create

difficulties in attracting workers, harming the transition into climate-resiliency. [28] Regions must ensure that, as they transition, they build adequate messaging about the availability, requirements, and opportunities that come with green jobs.

Another factor which may inhibit individuals or communities from transitioning to green jobs includes barriers inherent to any job-seeking opportunity. This especially impacts lower-income individuals. Barriers can include inadequate access to transportation or obtaining a valid driver's license, unaffordable childcare, limited skills, criminal records, and more. Another important barrier can be disparities in education. This is especially pertinent when considering math proficiency. The need for electricians is vast. However, many electrical positions require employees to pass a math proficiency test, proving to be a difficult career for many, especially those without a high school diploma.

A large challenge that arises when considering job growth and the expansion of a green economy include the need for a workforce transition. This means that many jobs will be phased out, replaced, or adapted into new ones. This shift would require additional training for employees, often from outsourced groups who are knowledgeable in the new skill being taught. One example of this struggle includes that transition away from fossil fuels, such as coal mining, and into renewable energy. A common misconception is that this transition will deplete the coal mining industry and the numerous jobs it provides, especially in the Appalachian region. However, many of these jobs are going to be adapted into renewable energy jobs, such as installing and maintaining solar panels or wind turbines.

8.6 Pathways to Green Jobs

As the Cincinnati MSA transitions its workforce to tackle climate change and carbon emissions, so too must its entry points for climate-resilient careers. Each of the seven sectors hold accessible points of entry for workers of all backgrounds.

- Skilled Trades (Electricians, HVAC Technicians, Plumbers, Construction Crews, etc.): Require certification or apprenticeship, typically offered through local programs like IBEW-NECA or Elite Welding Academy (see below)

[28] **https://www.nesta.org.uk/report/understanding-barriers-to-participation-in-the-green-labour-market/full/**

- Technical Professions (Engineers, GIS Specialists, Climate Scientists, etc.): Typically require a 2-4 year degree, with strong regional options at schools like Cincinnati State Technical and Community College or the University of Cincinnati (see below)
- Field-Based Roles (Urban Forestry Workers, Arborists, Water Technicians, etc.): Many start with on-the-job training or short-term credentials, seek out a local American Job Center to discover next steps (see Appendix __ for list of the region's educational resources)

8.7 Recommendations

To successfully implement these greenhouse gas reduction measures within the seven sectors and foster workforce development and economic viability, it is essential that all regional actors, large scale and small scale, work together to meet the demands which this green transition illustrates. This could be done by following some of the following recommendations.

1. **Enhance public outreach and education:** The current public understanding of green jobs acts as a major barrier. Partnerships between the media, schools, and community organizations to promote green job pathways and training will be necessary to ensure citizens are willing and able to enter these roles.

2. **Expand Access to "Low Barrier to Entry" Green Job Training :** The job sectors which will see the most growth are the trades (HVAC specialists, electricians, plumbers, etc.). These jobs are "low-skill", meaning they may not require high levels of education, but do require certifications, training, or apprenticeships. Available programs should seek to expand their offerings to accommodate a higher demand for those joining the trades. Additionally, barriers such as lack of funding or transportation problems may inhibit potential job candidates from obtaining the training they need. Therefore, providing stipends, methods of transportation, or even childcare assistance could help reduce access barriers.

3. **Leverage and Coordinate Existing Resources:** The Cincinnati MSA already has a strong network of universities, trade schools, and service providers to combat green career barriers. Creating a centralized hub to coordinate training, job placement, and employer engagement between employers, education/training facilities, and citizens could be beneficial in supporting overall workforce development.

Other recommendations included in the Green Cincinnati Plan's Workforce Assessment Report and recognized as appropriate recommendations and next steps. To read more about these recommendations, please view the Cincinnati Green Workforce Landscape Analysis report.

9. APPENDIXES

Appendix A: Youth Engagement Report 111

Appendix B: Senior Engagement Report 161

Appendix C: Climate Safe Neighborhoods Engagement Report 189

Appendix D: GHG Inventory Methodology 233

Appendix E: Implementation Scenario Projections Notes 237

Appendix F: LIDAC Analysis Report 249

Appendix G: Workforce Analysis Addendum 278

ThriveTogether

A Sustainability Playbook for Greater Cincinnati

COMMUNITY ENGAGEMENT

Youth Engagement Report

Abstract

Environmental Protection Agency's (EPA) creation of the Climate Pollution Reduction Grant (CPRG) program helped meet emerging needs for regional collaboration in climate action. This program fostered partnerships among local governments in the pursuit of reducing greenhouse gas emissions by having partner organizations and governments draft Climate Action Plans for their region.

One recipient of CPRG funding is the Greater Cincinnati Region. Comprised of members from Ohio Kentucky Indiana Regional Council of Governments (OKI), Southwest Ohio Air Quality Agency, Northern Kentucky Area Development District, the Indiana University Environmental Resilience Institute, the City of Cincinnati's Office of Environment and Sustainability, and Green Umbrella, Thrive Together is a collection of local governments, educational institutions, non-profits, and businesses committed to creating Climate Action Plans for the Greater Cincinnati Metropolitan Statistical Area.

To create Climate Action Plans grounded in the wants and needs of the residents it serves, Thrive Together undertook a community engagement process targeting key demographic groups, like people under the age of 25. The Thrive Together team strived to integrate young people's perspective on environmental issues and their proposed solutions into a Comprehensive Climate Action Plan for the Greater Cincinnati region.

To do so, the Thrive Together team created a virtual engagement platform and hosted in-person workshops at schools. These channels gathered young people's thoughts on the environmental issues facing the region, potential solutions to these issues, and barriers to implementing solutions. The responses from these engagement methods show the environmental topics of greatest significance to young people, like Green Spaces or Education & Advocacy. Young people also proposed sustainability initiatives or investments the Greater Cincinnati Region should prioritize.

Through this effort, young people can inform future sustainability initiatives and ensure that the interests, passions, and ideas of young people are represented in local planning processes.

Table of Contents

Abstract >>> 2

Acknowledgements >>> 4

Introduction >>> 5

- Priority Climate Action Plan 6
- Current Youth Engagement 7

Purpose & Objective >>> 8

Partners >>> 9

Methodology >>> 11

- Virtual Engagement 11
- In-Person Engagement 14
- Data Processing 17

Project Schedule >>> 20

Findings >>> 21

Discussion >>> 26

- Waste, Water, & Sustainable Materials Management 26
- Green Spaces 29
- Education & Advocacy 31
- Transportation 34
- Agriculture 37
- Electric Power 38
- Buildings 39
- Carbon Removal 39
- Industrial 40
- No Category 40
- Barriers 41

Recommendations & Conclusion >>> 43

References >>> 48

Appendix A >>> 49

Acknowledgements

The Thrive Together Youth Engagement Report was made possible by the engaged young people of the Greater Cincinnati Metropolitan Statistical Area. They shared their ideas, hopes, and experiences to this report and offered a new perspective to be incorporated in the Comprehensive Climate Action Plan. Thank you to all participants in the youth engagement process. A special thanks to the following organizations for their commitment to the project.

City of Cincinnati, Office of Environment and Sustainability
Howard Miller, Environmental Manager
Lauren Clark, Public Ally
Rachel Bickett, Sustainability Project Coordinator

Green Umbrella
Bamidele Osamika, Regional Climate Collaborative Manager
Cynthia Walters, Green Schoolyards Manager
Van Sullivan, Senior Director of Programs and Climate Strategy
Nobi Kennedy, Regional Climate Collaborative Coordinator

Ohio Kentucky Indiana Regional Council of Governments

University of Cincinnati, Leaders for Environmental Awareness and Protection

Miami University

World Affairs Council

Sierra Club, Young Professionals Group

Covington Classical Academy

Thomas More University

Saint Xavier High School

Cincinnati State

Thrive Together Youth Engagement Report prepared by:
Lauren Clark, City of Cincinnati, Office of Environment and Sustainability

Introduction

In 2023, the Greater Cincinnati Metropolitan Statistical Area (MSA) was awarded a federal CPRG from the EPA. Through this grant, the EPA supported local governments in their efforts to make Climate Action Plans that drive down regional greenhouse gas emissions.

OKI convened local players, like city and county government officials, utility providers, community-based organizations, and educational institutions, to begin drafting these Climate Action Plans under the title Thrive Together. Thrive Together represents some of the diverse priorities, expertise, and opinions of the Greater Cincinnati MSA.



Figure 1. Map of counties included in the Cincinnati MSA

Thrive Together drafted a Priority Climate Action Plan (PCAP) in 2024; this document provided an overview of greenhouse gas emissions in the region and highlighted some near-term, high-priority, implementation-ready measures to reduce greenhouse gas emissions. The PCAP was the first step in creating the Comprehensive Climate Action Plan (CCAP) to be finished in December of 2025. The CCAP will establish long-term emissions reduction strategies identified through engagement with key stakeholders, like residents, technical experts, and local government officials.

Priority Climate Action Plan

Key Point

Through this collaboration, Thrive Together created a Greenhouse Gas Inventory for the region and a Priority Climate Action Plan

The Greenhouse Gas Inventory conducted by Thrive Together found the region emitted 43.8 million metric tons of carbon dioxide equivalents (MT CO2e) in 2022. Per capita emissions for the region are 19.5 MT CO2e, which is slightly higher than per capita emissions nationally in 2021. The industrial sector accounted for 35% of total emissions in 2022, followed closely by the transportation sector at 30%. The residential and commercial sectors contributed 19% and 16% of emissions respectively. Buildings and equipment were the source of a majority (65%) of emissions, with personal vehicles the second largest source but only accounting for 15% of emissions (Thrive Together, 2024).

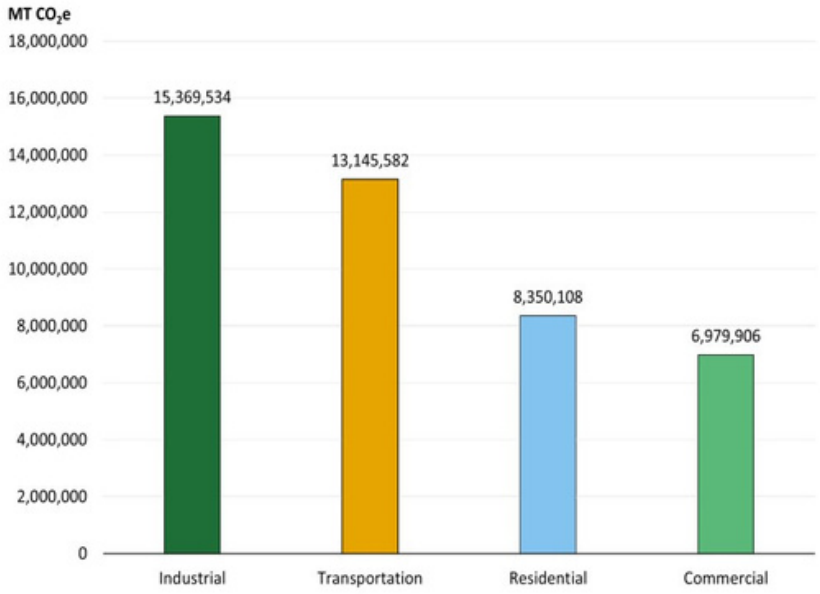


Figure 2. Emissions by Analysis Sector for the Greater Cincinnati MSA

Using the Greenhouse Gas Inventory, Thrive Together created the Priority Climate Action Plan (PCAP) outlining the key areas of improvement to drive down greenhouse gas emissions. The sectors focused on in the PCAP are Transportation, Electric Power, Buildings, Industrial, Agriculture, Carbon Removal and Waste, Water & Sustainable Materials Management.

Current Youth Engagement

Thrive Together is not the first attempt to include young people in the decision-making process for environmental issues.

Other programs, like Groundwork Ohio River Valley's Youth Environmental Council and the City of Cincinnati's Seeds of Change Youth Climate Action Fund, are prime examples of young people influencing decision making or leading projects in Cincinnati.

The Youth Environmental Council is comprised of high school-aged residents engaged in local planning efforts, like the creation of the City of Cincinnati's Green Cincinnati Plan. The Youth Environmental Council is an opportunity for young people to influence the decisions local governments make regarding climate and the environment.

For young people less interested in local government, the City of Cincinnati offers youth grants through its Seeds of Change Youth Climate Action Fund. These micro-grants help fund the environmental projects young people would like to implement in their neighborhood. Seeds of Change youth grants give young people the chance to create tangible changes for the betterment of the local environment; some examples of projects include outreach efforts to increase residential composting, the construction of community gardens, and an educational campaign on the importance of a local park.

These campaigns are built on the knowledge and hard work of engaged young people; Thrive Together and other local governments should tap into the skills and insights of young people to see tangible change in their communities.

Purpose & Objective

Purpose

Identify:

- climate hazards young people face
- their proposed solutions
- barriers they face when implementing climate solutions.

Objective

Identify representative youth climate action priorities

Partners

The Thrive Together team consists of members from Green Umbrella, the City of Cincinnati's Office of Environment and Sustainability, Ohio Kentucky Indiana Regional Council of Governments (OKI), Southwest Ohio Air Quality Agency, Northern Kentucky Area Development District, and the Indiana University Environmental Resilience Institute.

Green Umbrella is the Cincinnati Region's climate collaborative focused on bridging silos to deliver sustainability solutions to the region.

A close partner of Green Umbrella and author of a city-wide climate action plan, the City of Cincinnati's Office of Environment and Sustainability brings their experience in engaging residents in the planning process to Thrive Together.

OKI Regional Council of Governments is the Metropolitan Planning Organization for the region focused on addressing regional transportation, planning and environmental needs.

Southwest Ohio Air Quality Agency is a division of the Hamilton County Environmental Services and a leader in monitoring and regulating industrial air emissions for five counties around Cincinnati.

Northern Kentucky Area Development District is a multi-county planning and development organization for eight counties in northern Kentucky, five of which are covered by Thrive Together's scope.

The Environmental Resilience Institute at Indiana University partners with stakeholders across Indiana to research and co-create resilience and climate solutions.

The partners under Thrive Together bring their expertise on the topics and communities of concern to the planning process. Through their diverse perspectives, Thrive Together is well-positioned to create a holistic CCAP suitable for use by any municipality in the Cincinnati MSA.

The Youth Engagement team under Thrive Together was comprised of two team members from both Green Umbrella and the City of Cincinnati's Office of Environment and Sustainability.

This small subsect of Thrive Together focused their efforts on engaging young people across the region while other members of Thrive Together launched similar campaigns for various demographic groups.

Though Thrive Together members from Green Umbrella and the City of Cincinnati coordinated engagement, the completion of this project is impossible without the willingness to collaborate shown by partner organizations.

These partners gave Thrive Together the necessary channels to talk with young people and record their insights on the future of climate action in the region.

The Thrive Together team would like to thank the following organizations for their participation:

- University of Cincinnati – Leaders for Environmental Awareness and Protection
- Miami University
- World Affairs Council – International Education Summit
- Sierra Club Young Professionals Group
- Covington Classical Academy
- Cincinnati State – Environmental Engineering Technology students
- Thomas More University
- St. Xavier High School – Environmental Action Club

Methodology

The Thrive Together youth engagement effort was comprised of three main phases:



Virtual Engagement

To fulfill the virtual engagement phase, Thrive Together team members used an online civic engagement platform used during creation of the PCAP, Go Vocal. Go Vocal positions itself as a community engagement platform helping to "[make] public decision-making more inclusive, participatory, and responsive" (Go Vocal, n.d.). A page on Thrive Together's Go Vocal called "Youth Voices for Climate Action" was created specifically to reach young people.

The Youth Voices for Climate Action page had five sub-pages, each correlating to a phase of engagement. The first page and phase of engagement was "Introducing the Comprehensive Climate Action Plan;" this provided context to users regarding the development of the CCAP and showcased examples of climate action like increasing tree canopy rates, opting for renewable energy, and composting. The intention of this page and phase was to familiarize young people with the project and climate action and call for their involvement in future phases of the project.

The second phase of engagement was "Voice Your Opinions." This page allowed users to submit their ideas on climate action planning by filling out a questionnaire; appendix A details the questions included in the questionnaire. The focal prompt in the questionnaire asked users to "describe a single topic of concern or environmental problem you see in your community and a potential solution to fix this problem." Users then could select their ideas' impact level and difficulty level using a

multiple-choice question. The questionnaire also included a text box to explain your answers to the impact and difficulty questions, a text box to describe any barriers or limitations young people face when undertaking climate action, and an option to add a relevant image. Users could also add their location, such as their town, zip code, or county. This feature would allow us to map ideas and try to understand the geographical distribution of participants.

Once a user submitted an idea, any image included in their response and their answer to the focal prompt was posted on the main "Voice Your Opinions" page. Other users could then browse all submitted ideas. This feature led naturally to the next phase.

The third phase of online engagement was entitled "Support Your Favorite Ideas" and asked users to distribute five votes across all the submitted ideas. This voting mechanism served as a way for users to uplift their favorite ideas and prioritize them as a community.

The final phase of online engagement was a page called "Your Impact" on which this report and any other communications about the virtual and in-person findings will be posted.

During the three-month period of in-person engagement, high-level reports of each workshop were shared on a separate Go Vocal page entitled "Workshop Results." These preliminary reports included any available pictures from the workshop and three notable ideas from the workshop. The "Workshop Results" page shared the "Most Popular Idea," the "Idea with the Biggest Impact," and an "Honorable Mention" to briefly showcase ideas that were central to the conversation during each workshop. The intention of this page was to make the "Youth Voices for Climate Action" page more interactive in hopes of driving engagement.

Concurrently to the Youth Voices for Climate Action page, another page called "Local Champion Recruitment" asked users if they wanted to take a more active role in our engagement process. Users could indicate that they want to become a local champion and further our outreach by hosting an in-person workshop themselves or sharing our Go Vocal page on their social media.

Despite the effort put into creating Go Vocal, no responses were submitted during the Voice Your Opinions phase and only one Local Champion was recruited. However, the timing of the Local Champion recruitment was aligned with the pause on federal EPA funding for CPRG work and nothing came of this lead.

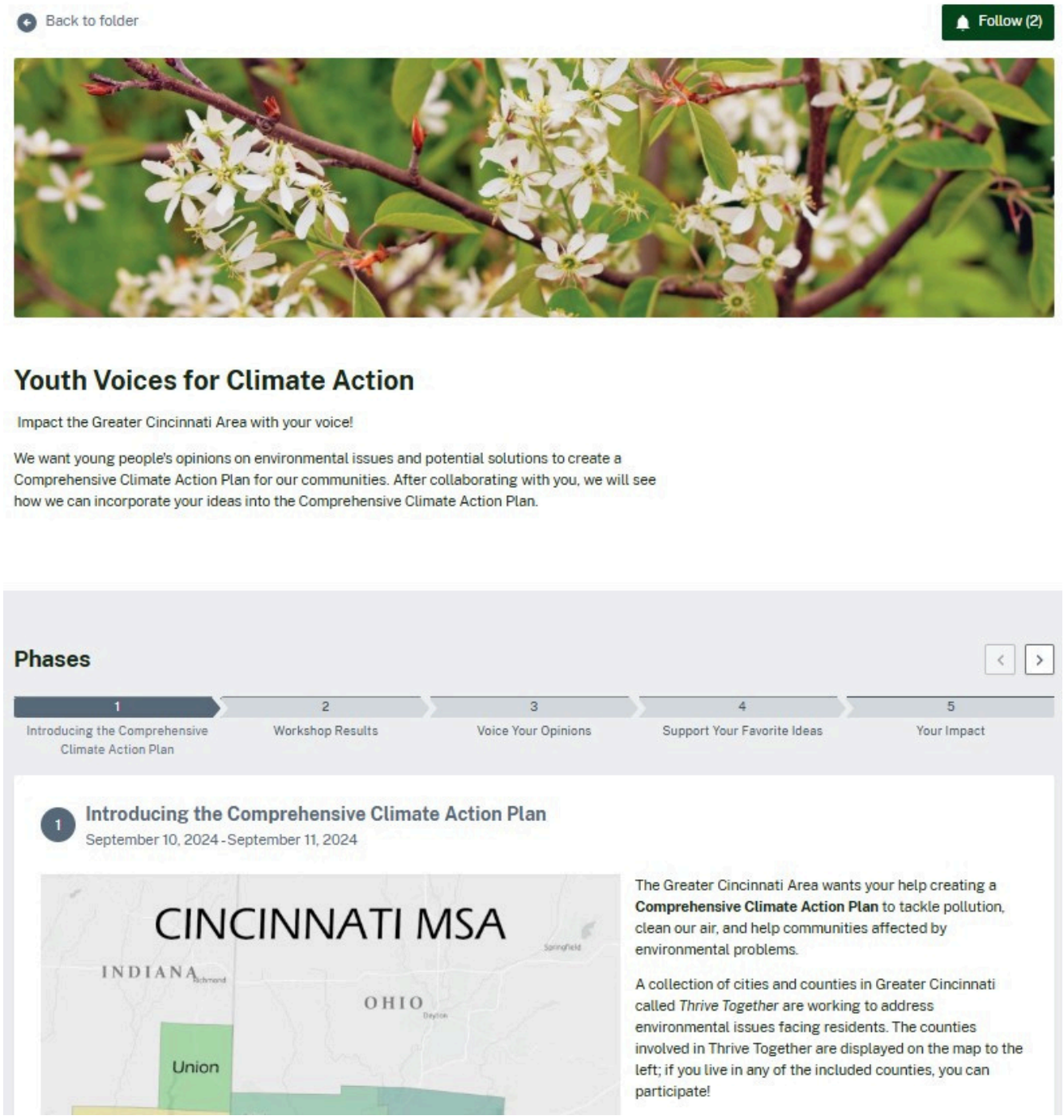


Figure 3. Screenshot of the Youth Voices for Climate Action Go Vocal page

In-Person Engagement

The more successful engagement method was in-person workshops. The Thrive Together team relied heavily on current community partners to identify spaces to host in-person workshops with young people.

Before scheduling workshops with young people, the Thrive Together team had an introductory meeting with partners to determine if hosting a workshop was feasible. During this meeting, partners were familiarized with the CCAP and the agenda and format of the workshop. This was an opportunity for partners to make suggestions and decide if pursuing a workshop was in the best interest of the young people they work with.

From September 2024 to January 2025, the Thrive Together team had 18 such meetings with partners interested in hosting a workshop. The partners ranged from public libraries and local nonprofits to college professors and after-school club organizers.

Despite the broad range of partners initially contacted, the Thrive Together team had the most success engaging with educators, students, and other support staff at schools. Ultimately, this engagement resulted in 8 in-person workshops.

Meeting Partner	Number of Participants	County
University of Cincinnati - LEAP	8	Hamilton
Miami University	39	Butler
World Affairs Council	7	Campbell
Sierra Club - Young Professionals Group	9	Hamilton
Covington Classical Academy	12	Kenton
Cincinnati State	10	Hamilton
Thomas More University	17	Kenton
Saint Xavier High School	8	Hamilton

Table 1. Workshop Inventory

These workshops were 45 minutes to hour long sessions run entirely by Thrive Together team members at the partners' site. The Thrive Together team followed a similar structure in each meeting, only changing slight information based on the age of participants and the location of the workshop.

For high school-aged participants, an additional presentation slide defining climate change and providing examples of its impact was included. For workshops in or adjacent to the City of Cincinnati, slides introducing the City of Cincinnati's Seeds of Change grant program were included as an opportunity for students to get funding for environmental problems.

Figure 5 below succinctly describes the content of each workshop.

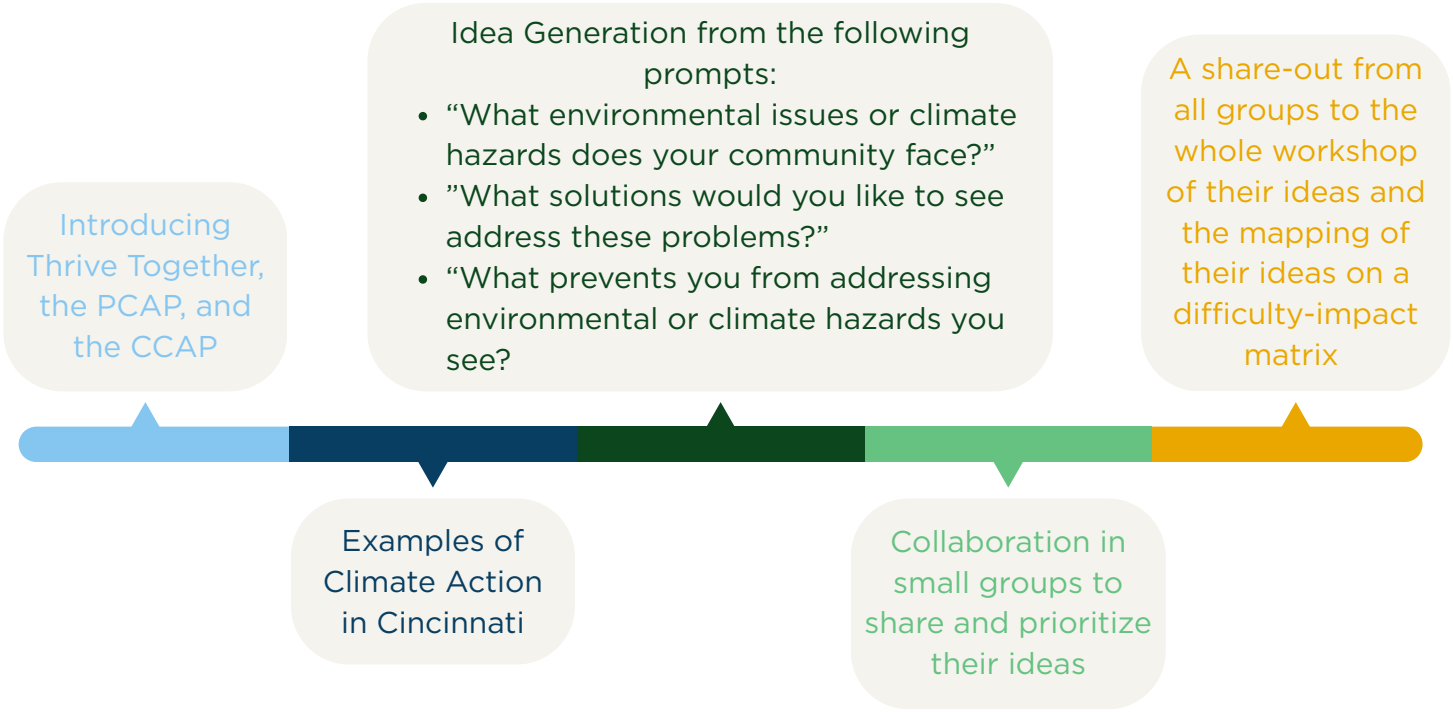


Figure 4. In-person Engagement Workshop Structure

This information was presented using a slides presentation, but additional materials for transcribing ideas were provided at workshops. This included sticky notes for each student and large posters hung around the room.

During the idea generation phase of the workshops, participants were asked to use sticky notes to organize their thoughts. This entailed writing each problem and solution pairing on a separate sticky note and writing each barrier on a separate sticky note. In this way, participants were prompted to think of a solution for each problem and separate their ideas for easier use later in the workshop.

During the share-out phase, participants divided into small groups of three to six and discussed their ideas. As a group, they identified priority ideas of high importance and posted them on a difficulty-impact matrix. As participants posted their priority ideas on the matrix, they described their ideas to the workshop and fielded questions from other participants.



Figure 5. Participants categorizing sticky notes with their ideas written on them

All problem-solution sticky notes that were not prioritized and shared on the difficulty-impact matrix were posted on a separate poster labelled “Problems & Solutions” and all barrier sticky notes were posted on a separate poster labelled “Barriers.”

Data Processing

Following the workshops, the Thrive Together team began processing the qualitative data provided by participants. Each idea submitted on a sticky note was recorded and categorized based on the sectors identified in the PCAP; these sectors include:

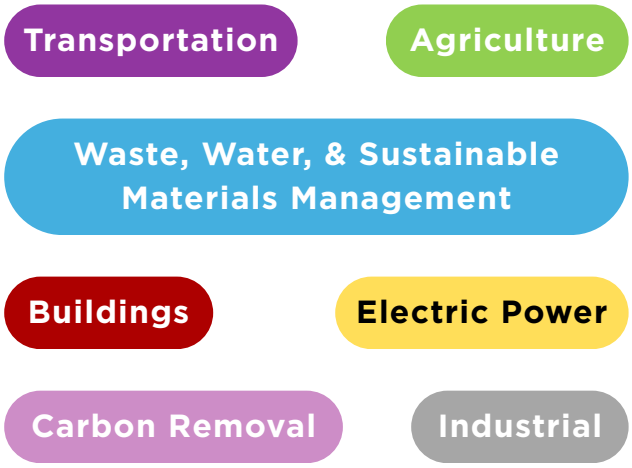


Figure 6. Analysis sectors identified in the PCAP

The PCAP does not offer a definition on any of the categories; the only information the PCAP includes on the categories is the reduction measures associated with each category. The reduction measures are goals to reduce greenhouse gas emissions; for example, Measure 2.B under the Electric Power category is "Further develop renewable energy generation in the region" (Thrive Together, 2024).

After an initial categorization of ideas based on the above sectors, the Thrive Together team noticed a large percentage of ideas did not fall into any category. While there will naturally be ideas outside of the categorization system, two additional categories were identified based on participants' responses.

These categories are Greenspace and Education & Advocacy. Responses that did not fall into any of the established categories were labelled "No Category."



Figure 7. Categories created by the Thrive Together team based on workshop results

Given the establishment of the two new categories, all responses were revised to ensure their alignment with their assigned category. This included a major recategorization of ideas from Carbon Removal to Greenspaces

Following the logic of the PCAP, Carbon Removal implementation methods focused on sequestering carbon in forested land and wetlands. Participants did suggest preserving forested lands and wetlands, but not with the intention of sequestering carbon.

Based on the conversations of the workshops, the category Carbon Removal did not speak to the true motivation behind many participants' ideas regarding topics like reforesting areas, preserving land, or creating parks. The impetus of these ideas for participants was to increase residents' exposure to nature and incorporate more greenery into the built environment.
Under this logic, the Thrive Together team recategorized these ideas as Greenspaces, as the underlying desire of these ideas is to increase greenspaces in the region. This motivation is distinctly different from the motivation to sequester carbon, as would be suggested by categorizing these ideas under the Carbon Removal category.

Ideas categorized under Carbon Removal were limited to those ideas whose primary intention was to reduce or sequester carbon emissions such as ideas to introduce a carbon tax.

A basic analysis of the categorization of responses showed the percentage of ideas in each category, both for priority responses and for total responses.

Each category was then broken into sub-categories based on the themes that emerged from the responses. These sub-categories were determined by Thrive Together team members based on their experiences hosting workshops and engaging in conversation with the participants. For those categories with high number of responses and diversity of responses three to six sub-categories were created. Each idea in the category was then sub-categorized and another analysis showed the share of ideas in each sub-category.

Sub-categories could not be established for some categories because the number of responses was low or all ideas focused on similar issues and need not be sub-categorized.

Ideas mapped on the difficulty-impact matrix during workshops required greater processing to quantify the impact and difficulty levels ascribed to them by participants. To do so, the Thrive Together team applied a graph over the difficulty-impact matrix.

The range and domain of the graph are both (-1,1) with ideas of high impact and high difficulty correlating to x- and y-values ranging from 0.4 to 1, medium impact and medium difficulty correlating to x- and y-values ranging from -0.3 to 0.3, and low impact and low difficulty correlating to x- and y-values ranging from -0.4 to -1. In doing so, a quantitative analysis of the ascribed impact and difficulty of ideas was possible.

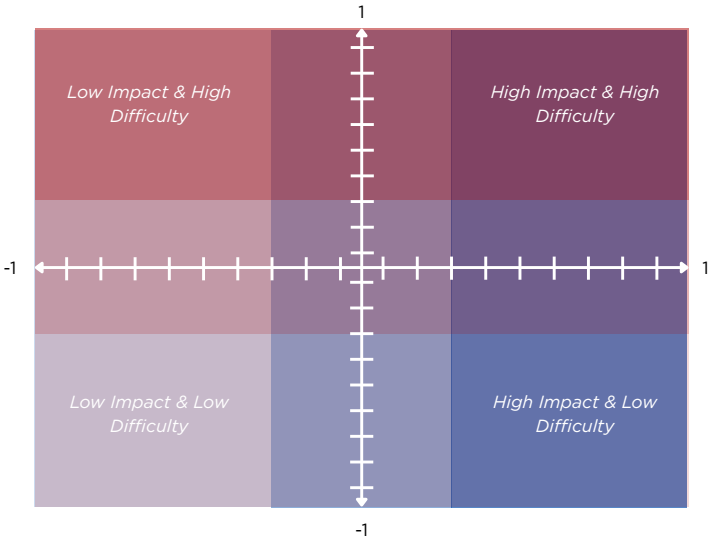


Figure 8. Impact Difficulty Matrix with the corresponding ranges for high, medium, and low

Priority ideas were further analyzed using a Chi-Square test for independence. In this calculation, Thrive Together team members tested if there was a statistically significant correlation between idea category and impact level, idea category and difficulty level, and difficulty level and impact level.

The data processing required for analyzing barriers was less comprehensive than that of problem and solution responses. After compiling all workshop results, the Thrive Together team read through the barriers identified by participants. Major themes or commonalities were noted and used to craft categories of the barriers. The categories created under barriers include:



Figure 9. Barrier categories created by the Thrive Together team based on workshop results

Having established a list of barrier categories, the Thrive Together team re-analyzed all barriers and categorized them accordingly. Those responses that did not fit into an established category were designated as having "No Category."

Project Schedule

Below is a Gantt Chart displaying the timeline for the different phases of engagement and data processing. It is worth noting that gaps in in-person engagement align with holidays in which students are absent from school.

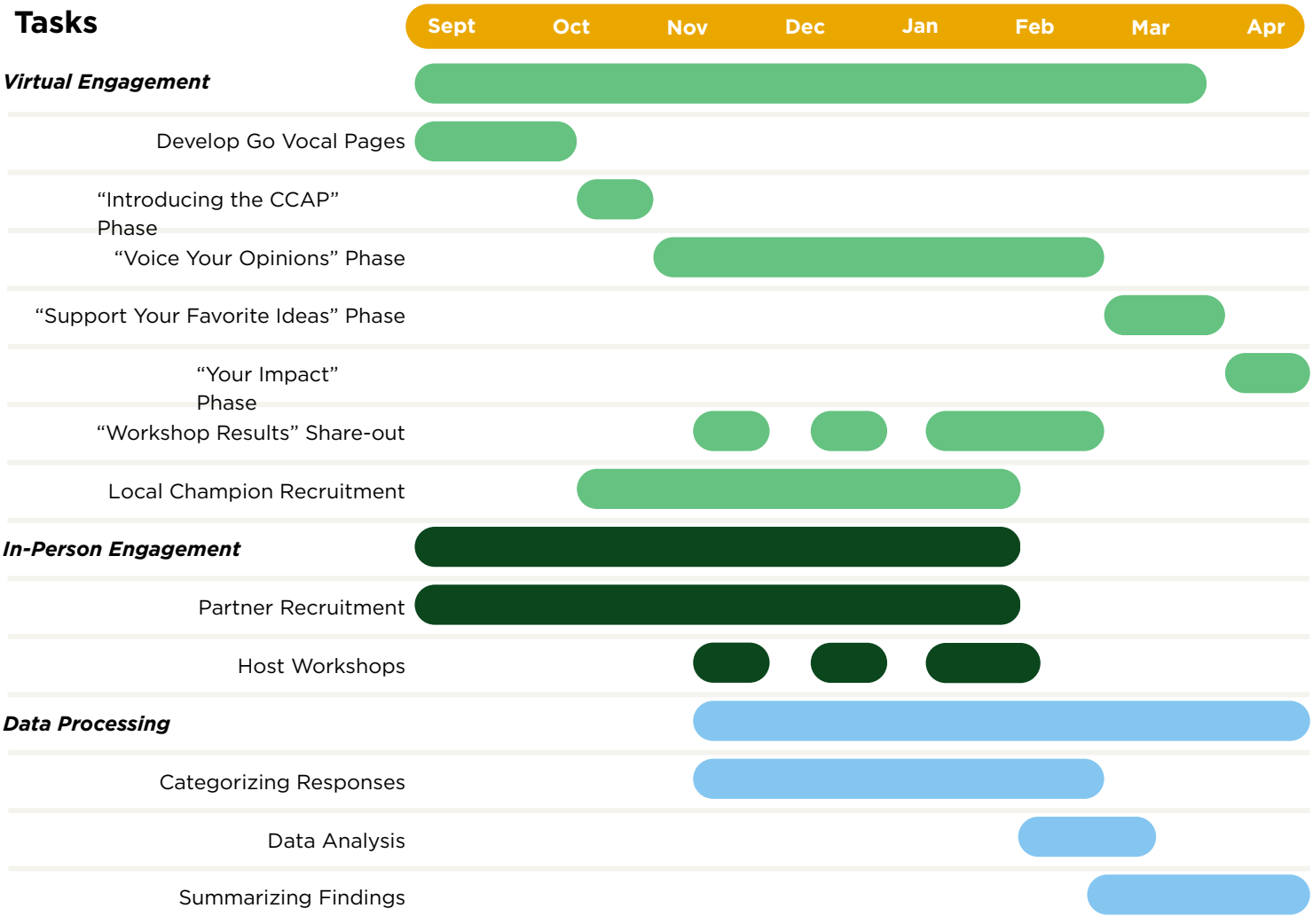


Figure 10. Gantt Chart of Virtual Engagement, In-person Engagement, and Data Processing

Findings

Of the total ideas suggested by participants, Waste, Water, & Sustainable Materials Management was the category with the greatest share of ideas with 31% of total ideas. The categories not included in the PCAP but added after workshop completion, Greenspaces and Education & Advocacy, have the second (15%) and third (14%) highest share of ideas, respectively. Responses falling into the "No Category" category account for 11% of total responses. Notably, participants did not generate any ideas categorized under Industrial. The Figure 11 shows the share of total ideas in each category.

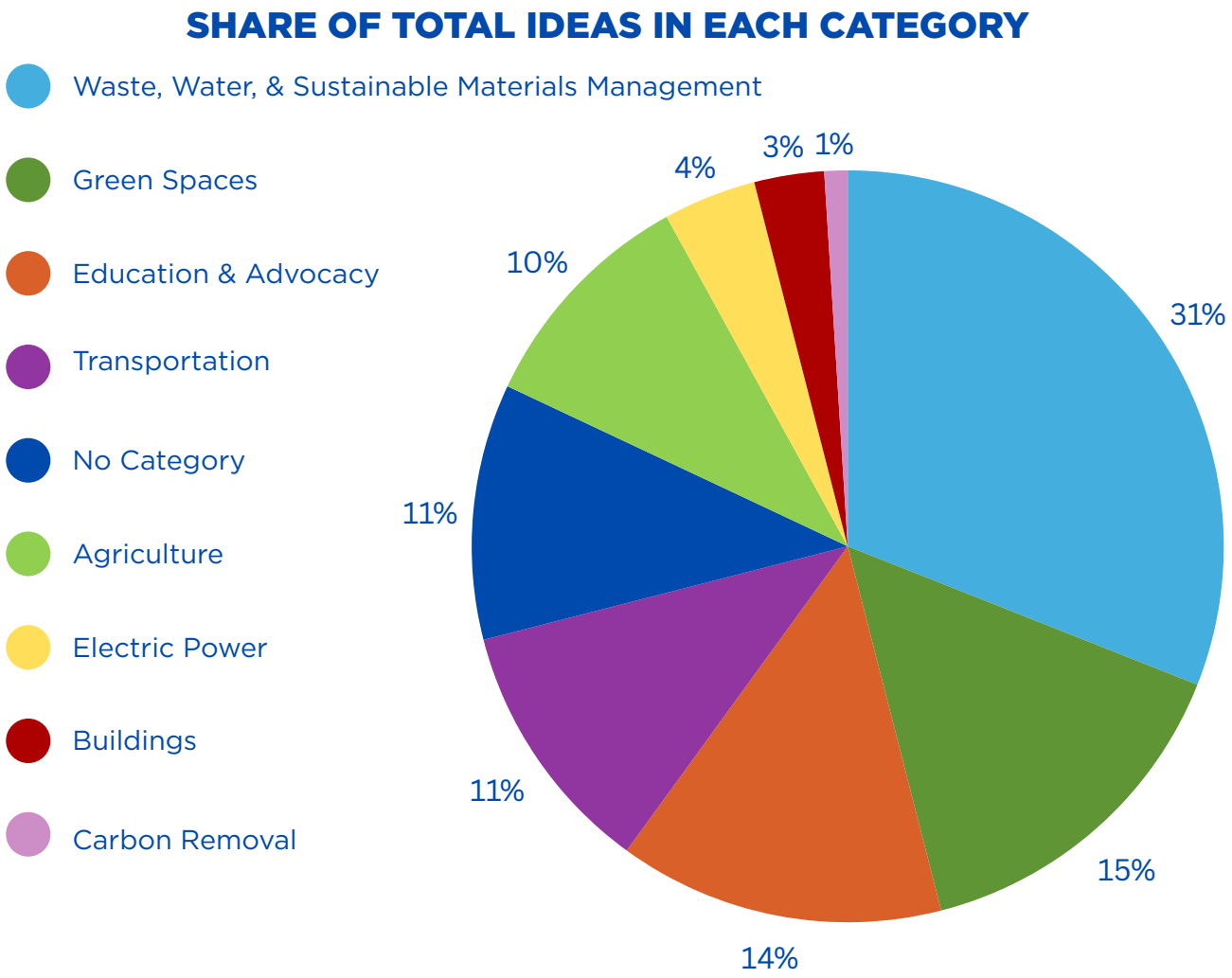


Figure 11. Pie Chart depicting Share of Total Ideas in Each Category

The share of priority ideas in each category mirrors the share of total ideas in each category. The most notable difference is Transportation ideas jump in the rankings of most discusses category. When considering all responses, Transportation is the fourth most discussed category; when considering only priority responses, Transportation is the second most discussed category.

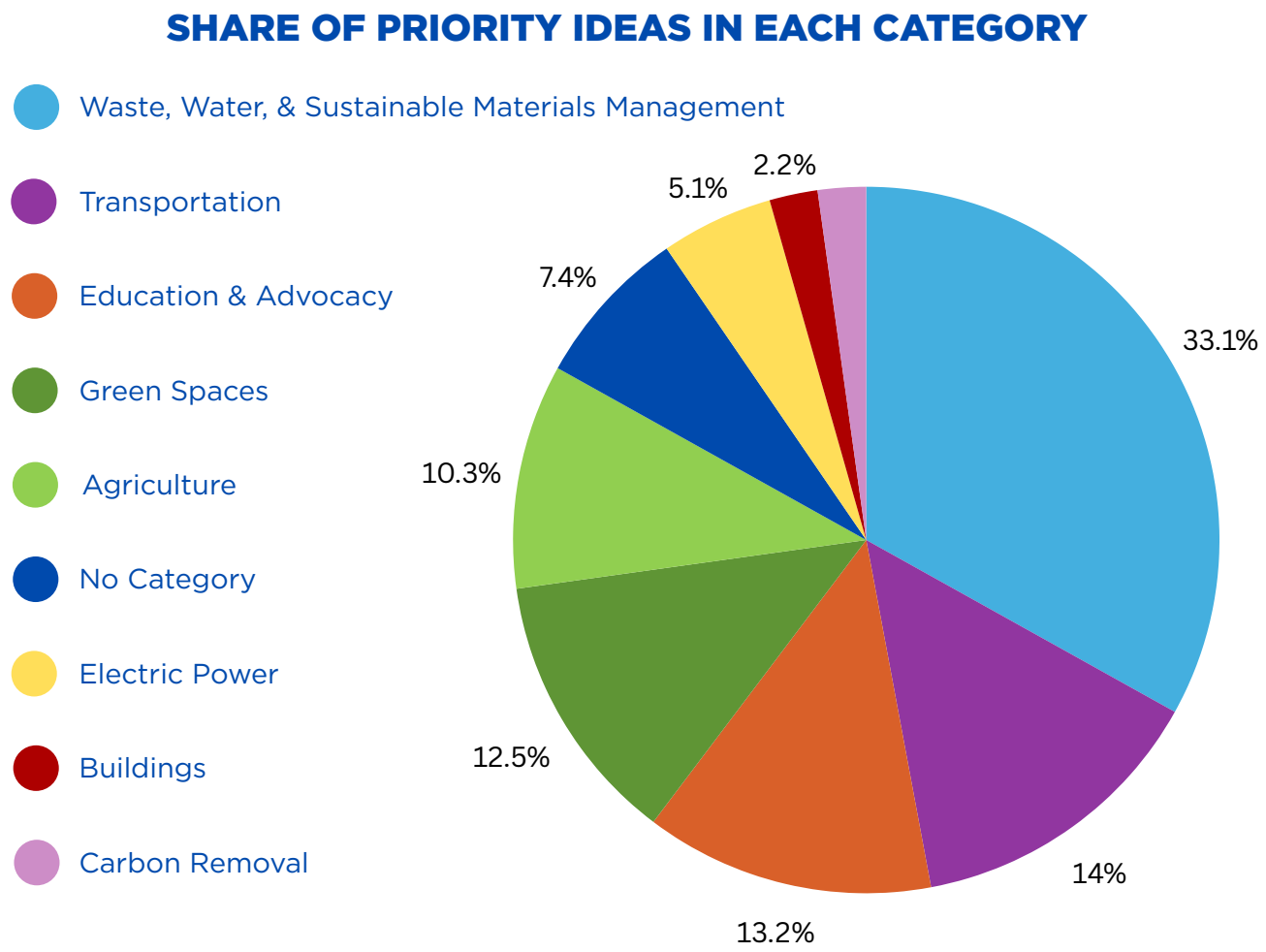


Figure 12. Pie Chart depicting Share of Priority Ideas in Each Category

The Thrive Together team was interested in whether certain categories were seen by participants as having a specific impact or difficulty correlated with them.

To test this, a Chi-Square test for independence was run. The hypotheses tested during this analysis were "there is a correlation between an idea's category and the difficulty level ascribed to it" and "there is a correlation between an idea's category and the impact level ascribed to it."

Using an alpha level of 0.05 (meaning there is only a 5% chance of a false positive result), both chi-square values of the respective hypotheses were lower than the critical values.

Therefore, we cannot accept either hypothesis and it is clear there is no correlation between an idea's category and its impact level or difficulty level in the eyes of participants.

Further Chi-Square tests for independence were run to determine if there was a statistically significant correlation between an idea's impact level and its difficulty level. Using the alpha level of 0.05, the Thrive Together team tested the hypothesis and found the chi-square value to be higher than the critical value.

This means that there is a correlation between an idea's impact level and difficulty level.

However, the R^2 value is only 0.0828, indicating a weak correlation between impact level and difficulty level.

Figure 13 displays all priority ideas mapped based on their impact level and difficulty level and the trendline based on these values.



Figure 13. Impact Difficulty Matrix with all priority responses plotted with trend line

An analysis of the sub-categories revealed the sub-category with the highest number of total responses was Pollution. Of Pollution responses, 28% were considered high impact. Other sub-categories with high response rates include Public Transportation, Farming Practices, and Land Conservation. Figure 14 shows a complete breakdown of the responses by sub-category.

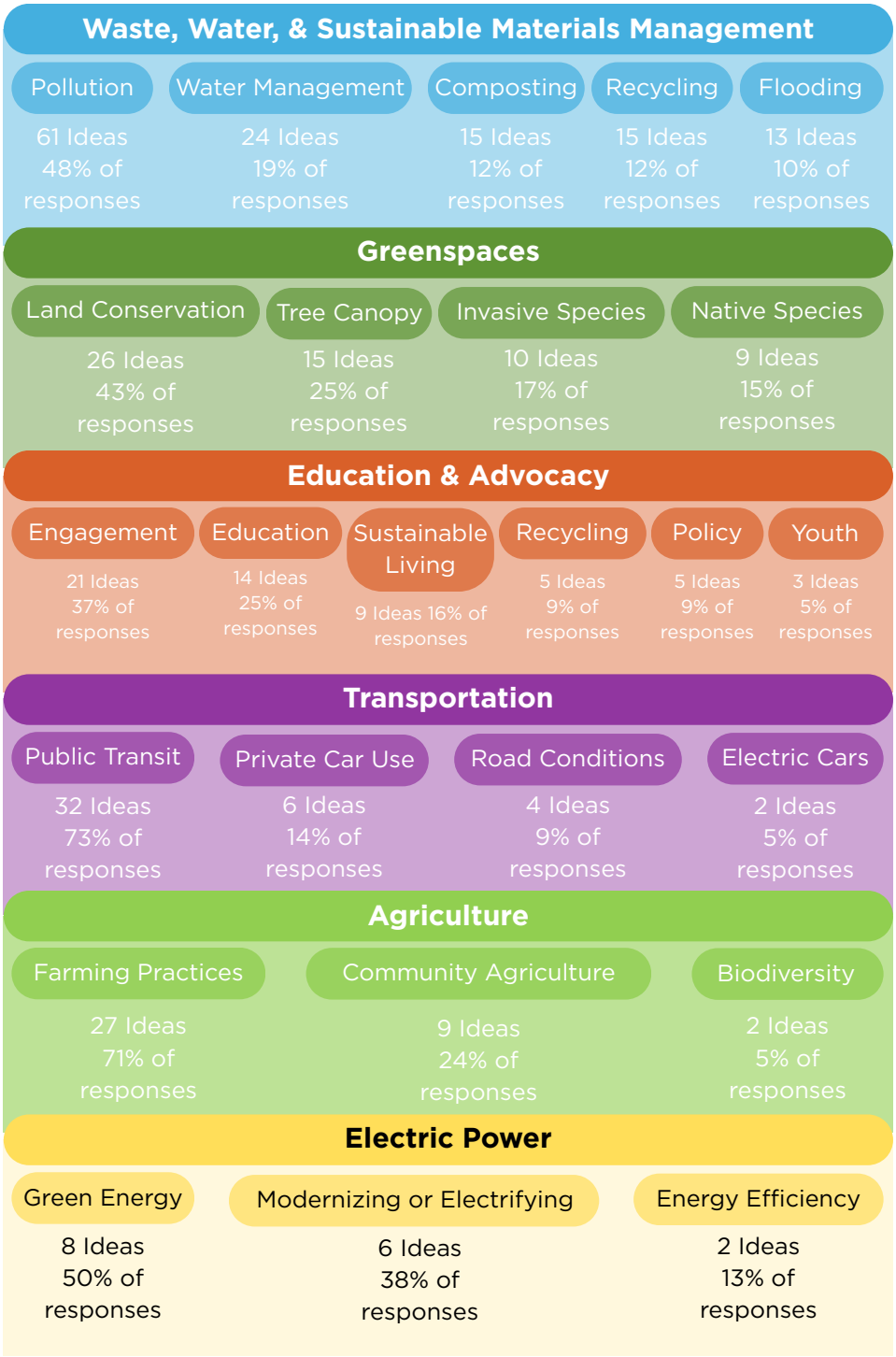


Figure 14. Breakdown of sub-categories and their response rate

The most frequently mentioned barrier type by participants is Public Attitude; these responses account for nearly a quarter of all barriers. Other barriers that constituted large shares of responses include Money, Knowledge, and Politics. See Figure 15 below for additional information on the percentage of barriers responses in each category.

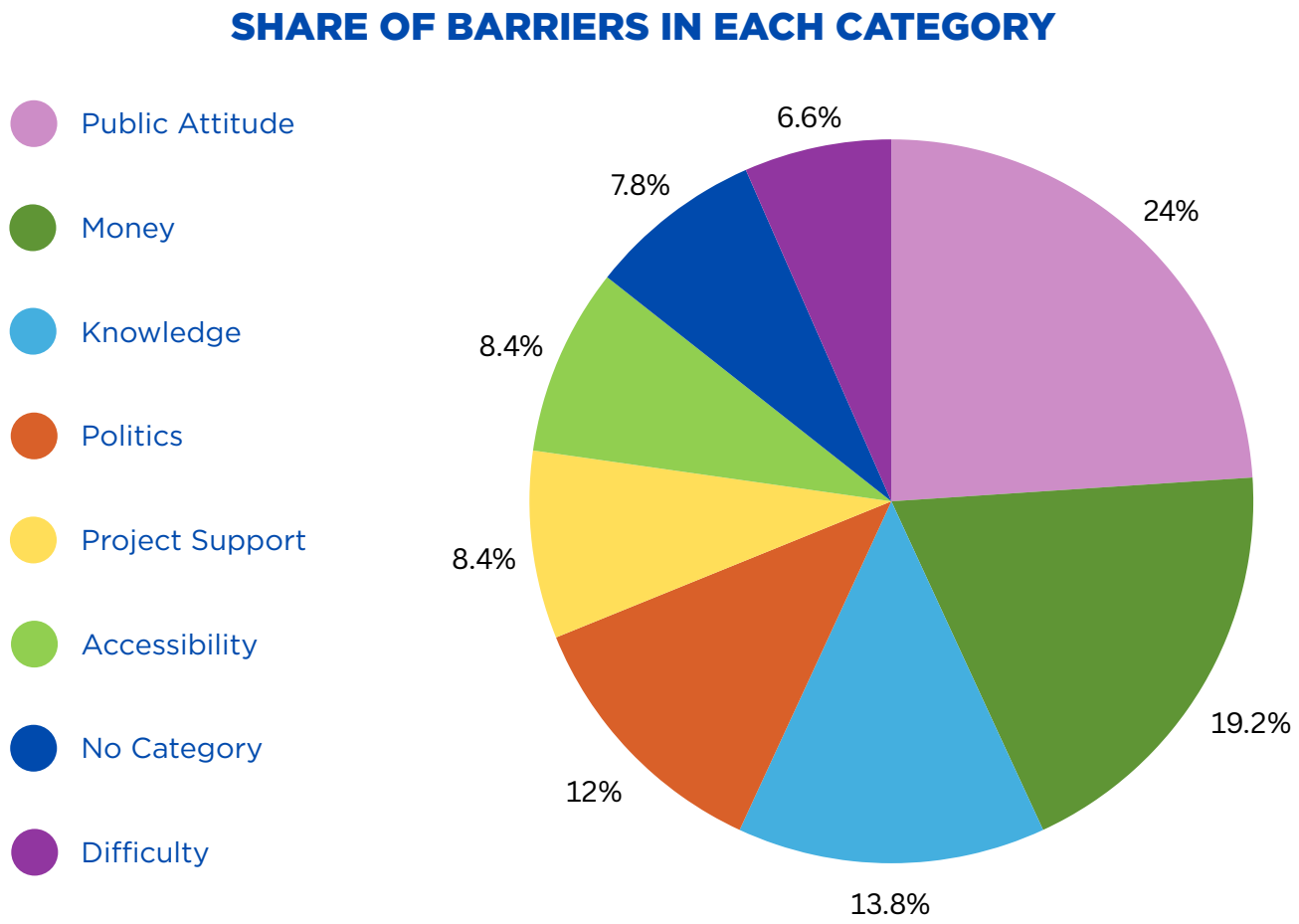


Figure 15. Pie Chart depicting Share of Barriers in Each Category

Discussion

Waste, Water, & Sustainable Materials Management

The category that young people talk about the most, Waste, Water, and Sustainable Materials Management, accounts for 31% of total responses and 33% of priority responses. Waste, Water, & Sustainable Materials Management is a broad category, which may account for its prevalence during discussion. However, it is also one of the first topics people learn about regarding the environment. It may be that young participants are most familiar with topics like littering and recycling and therefore suggest more ideas related to Waste, Water, & Sustainable Materials Management compared to other categories. Regardless of why this topic is discussed so often, young people found multiple ways to address these issues and demonstrated deep care for solving problems related to pollution and the region's waterways.

Pollution

Pollution ideas make up 48% of total Waste, Water, & Sustainable Materials Management responses.

Participants cite over-consumption, littering, waste reaching waterways, and single-use plastics as problems the region is facing. To remedy these issues, participants suggest reducing single-use plastics, organizing volunteer or paid groups to pick-up litter, and improving accessibility to trash cans in public spaces.

Unsurprisingly, participants reference pollution on school campuses frequently. They claim single-use plastics and the poor placement of trash and recycling bins contribute to high rates of litter on campus.

They suggest installing more trash and recycling bins in highly visible and high traffic areas; special attention should be paid to ensure recycling bins are as convenient as trash bins. Responses under the Education & Advocacy category also mention the importance of easy-to-understand signage regarding recycling at recycling bins.

Water Management

Water Management is another topic of concern for participants. It constitutes 19% of Waste, Water, & Sustainable Materials Management responses, making it the second most common sub-category in this category.

Common problems cited in these responses include combined sewer overflows, storm water runoff, and depletion of water sources. Much of the conversation about water management pertains to combined sewer overflows, particularly at the workshop with University of Cincinnati LEAP students.

Participants suggest separating the combined sewer and establishing a hotline residents can call when facing overflow issues. Another suggestion is to integrate green infrastructure into urban areas to catch storm water and reduce the amount of storm water runoff.

On a personal level, participants feel people have a responsibility to install more water-efficient home appliances and practice water conservation habits at home. These water-efficient appliances are seen to prevent the depletion of water sources.

Composting

Composting is tied for the third most mentioned sub-category under Waste, Water, and Sustainable Materials Management with 12% of total responses.

Participants feel school food waste is a missed opportunity for composting. They also suggest introducing curb-side compost collection or community-wide composting centers to make composting more convenient.

Recycling

Recycling also accounts for 12% of responses under Waste, Water, and Sustainable Materials Management. This relatively small share of responses regarding recycling may be in part due to the share of responses about recycling education that were categorized under Education & Advocacy. Therefore, it is important to understand the young people's ideas about recycling are more common than the statistic mentioned above may indicate.

Specific recycling issues participants mention include the lack of recycling bins in public spaces and the confusing nature of recycling standards. To remedy these issues, participants suggest the same solutions mentioned under the Pollution sub-category discussion: more public recycling bins and improved signage.

Flooding

Flooding is the sub-category with the fewest responses under Waste, Water, & Sustainable Materials Management, only comprising 10% of responses. Participants feel erosion is contributing to the impact of floods and should be corrected with increased vegetation in riparian zones and green infrastructure.

Green Spaces

The second most discussed category, Greenspaces, makes up 15% of total responses and 13% of priority responses. This is notable because it is not a category originally identified in the PCAP. However, students continually came back to the importance of greenspace because of its positive impact on human health and well-being, neighborhood feel, biodiversity rates, and environmental quality. Participants expressed that greenspaces are climate solutions with co-benefits beyond carbon sequestration.

Land Conservation

Analysis of the Greenspaces responses shows the Land Conservation sub-category constitutes 43% of ideas in this category. Land Conservation ideas broadly address the restoration and conservation of land in urban areas and in areas experiencing suburban development.

Participants feel urban areas do not have adequate access to well-maintained green spaces and that this results in poor air quality, mental health impacts for urban residents, and urban heat island effects. To alleviate these issues, participants suggest increasing the density of parks in urban areas by reusing vacant land as greenspaces.

For suburban areas, Land Conservation responses focus on the impacts of development on habitat continuity; participants note issues of habitat fragmentation and biodiversity loss that could be addressed by conserving land and protecting apex predators.

While solutions proposed under Land Conservation focus on maintaining critical ecosystems, the effects of these solutions are quite varied. Participants claim Land Conservation solutions not only preserve habitats, but also ensure biodiversity, improve mental health for those around the conserved land, improve air quality, and promote reuse of vacant land. These co-benefits of Land Conservation serve as further justifications for preserving land and expanding green spaces in the eyes of participants.

Tree Canopy

Tree Canopy is the sub-category with the second highest share of responses under Greenspaces.

Again, participants feel that urban heat island effects are an issue to be addressed; increasing tree canopy on school campuses and on rooftops is one proposed strategy to do so. Participants also recommend offering incentives for property owners to maintain trees on their land.

Invasive Species & Native Species

Invasive Species and Native Species ideas make up the remaining 32% of Greenspaces responses.

Participants see the removal of invasive species and their replacement with native species as a key strategy for improving the health of greenspaces. Riparian zones, along medians and roads, and vacant land are prime locations for native species planting from participant's perspective. In doing so, participants feel that these initiatives will positively impact biodiversity, pollinator populations, and erosion issues.

Education & Advocacy

Education & Advocacy is the third most discussed topic, garnering 14% of total responses and 13% of priority responses.

However, this is the category that generated the highest number of sub-categories, indicating the diversity of ideas participants have regarding the topic.

Engagement

Of the sub-categories, Engagement has the highest share of responses.

Participants focus on climate action through service in these responses. They mention the importance of volunteer opportunities, especially to combat litter and invasive species.

Participants also feel that engaging diverse community members in any environmental effort is crucial; they feel that some demographic groups, specifically low-income people and the youth, do not have adequate input on decisions impacting their community. Inviting diverse voices into the planning and decision-making process is seen as a first step in addressing environmental inequalities.



Figure 16. Children engaged in community gardening

Environmental Education

Environmental Education accounts for a quarter of Education & Advocacy responses, making it the second most discussed sub-category.

Participants feel people do not care about environmental issues because they have not been educated on them. 43% of Environmental Education ideas relate to people's lack of information or care for issues.

To combat this, participants suggest sharing information on local environmental issues in newspapers, online, and through campaigns. It is important that this education caters to all groups, including young people, those in health care and government, and those that deny the problems exist. Participants feel it would be more effective if this education did not place blame on people for environmental issues and presented issues in a palatable way by avoiding politicized buzz words.

Some environmental issues participants think should be focused on in Education & Advocacy include pollution, especially light pollution, climate change, extreme weather, and endangered species.

Sustainable Living

The third-most discussed Education & Advocacy sub-category is Sustainable Living. Responses in this sub-category focus on education on the daily habits individuals can adopt to live more sustainably.

Some Sustainable Living practices participants think the public should be educated on are opting for vegetarian food options, using public transportation, and shopping second-hand. Participants suggest second-hand shopping to mitigate the impacts of overconsumption; 33% of Sustainable Living responses mention overconsumption.

Recycling

The Recycling sub-category under Education & Advocacy complements the Recycling sub-category under Waste, Water, & Sustainable Materials Management; the latter addresses the infrastructure improvements that could be made to the recycling system while the former addresses the necessary education on recycling to increase the public's recycling abilities.

Participants see recycling as a confusing topic that most people, especially young people and school administrators, need education on. A simple education method identified by participants is informational signage and displays at recycling bins to indicate what can and cannot be recycled

Policy

Responses under the Policy sub-category match the share of Recycling responses, both making up 9% respectively of Education & Advocacy responses. Policy ideas are notable in that 60% of them are priority ideas and all the priority Policy ideas are designated as high difficulty by participants. This statistic and conversation in workshops reveal that participants find interfacing with the government to pass legislation difficult and improbable, but of high impact if done successfully. Participants mention needing policy to address fertilizer runoff on farms and invasive species.

Youth-Focused

Given the target demographic of the workshops, it is not surprising that Youth-Focused responses emerge as a theme under Education & Advocacy.

Participants feel it is important to bring environment-focused education into schools with interactive, hands-on workshops touching on issues like climate change.

Transportation

Despite being the fourth-most discussed category broadly with only 11% of total responses, Transportation was the second-most discussed category of priority responses.

The emphasis on Transportation priority ideas reflects the findings of the Greenhouse Gas Inventory; the analysis placed transportation as the second biggest emitter of greenhouse gases for the region in 2022. Around 30% of all emissions were generated by transportation.

Due to the high level of priority responses under the Transportation category provided by participants, it would seem young people are aware of the role the sector plays in emitting greenhouse gases.



Figure 17. Riders boarding a METRO bus in Cincinnati

Public Transit

The most critical sub-category established under Transportation is Public Transit. Public Transit responses make up 73% of Transportation responses with a total of 32 ideas under this sub-category. This makes it the second-most discussed sub-category across all categories, only falling behind the sub-category of Pollution.

Public Transit is seen as both a source of problems and an important solution. Participants feel that Public Transit has poor ridership rates because of its unreliability, confusing nature, and limited reach into suburban and rural areas.

Despite the challenges, Public Transit plays a key role in driving greenhouse gas emissions down; participants see it as an alternative for single car use the limits air pollution and traffic.

To improve ridership rates and reap the benefit of Public Transit. Participants propose improving Public Transit by expanding bus lines into suburban and rural areas, increasing the reliability and cleanliness of buses, and expanding rail options like AMTRAK, the Connector, and the defunct City of Cincinnati Subway.

Special attention is paid to the difficulties students have with navigating Public Transit; participants want to see lower fares for students and increased routes around schools.

Private Car Use

The second most discussed sub-category under Transportation is Private Car Use. Private Car Use is blamed for increased traffic and air pollution. While most attempts to remedy these issues focus on Public Transit, some participants suggest disincentivizing driving with mechanisms like congestion pricing and toll roads.

Road Conditions & Electric Vehicles

Road Conditions and Electric Vehicles sub-categories emerged under the Transportation category, but with limited responses.

As participants weigh the potential for increases in extreme weather caused by climate change, Road Conditions become a source of problems for the region. Suggestions under the Road Conditions sub-category, like improving infrastructure's preparedness for extreme weather, do not drive greenhouse gas emissions down but better prepare the region for predicted challenges.

Electric Vehicles are sparsely mentioned except to suggest making them more accessible to limit the use of internal-combustion engine vehicles.

Agriculture

Amassing only 10% of total and priority responses, Agriculture is the fifth-largest category.

Farming Practices

However, the sub-category Farming Practices has one of the highest amount of responses of all sub-categories. Farming Practices responses account for 71% of Agriculture responses.

A vast swath of these responses focuses on fertilizer runoff and eutrophication. Participants commonly cite these as issues and blamed agriculture for harmful algal blooms. To address fertilizer runoff, participants propose increasing regulation of agricultural practices to limit tilling fields and cap the amount of nitrogen-based fertilizer applied to fields. They also recommend increasing the width of riparian zones to reduce the amount of fertilizers and pesticides reaching bodies of water.

Community Agriculture

Community Agriculture makes up almost a quarter of Agriculture responses. Most of these responses are motivated by a desire to fight food insecurity; participants see food insecurity as a major problem and cite it as an issue in 71% of responses. To lessen food insecurity, participants suggest community gardens, mobile trucks to bring produce into food deserts, and co-op grocery stores and farmers' markets prioritizing locally grown food.

Biodiversity

Biodiversity ideas constitute only a small share of Agriculture responses. However, they echo the ideas mentioned under the Land Conservation sub-category regarding the need to address biodiversity loss. Declining biodiversity because of agriculture is seen as an issue that could be solved by increasing regulations on pesticides and fertilizers.

Electric Power

The final category with enough responses to sub-categorize, Electric Power accounts for 4% of total responses and 5% of priority responses.

Green Energy

Half of Electric Power responses fall into the Green Energy sub-category.

Participants have concerns about air quality, extreme heat, and climate change that inspire their Green Energy responses. To address these issues, participants suggest using “clean” or “green” energy sources, like solar and hydroelectric.

Modernizing or Electrifying & Energy Efficiency

Other responses under Electric Power can be sub-categorized into Modernizing or Electrifying and Energy Efficiency.

Modernizing or Electrifying responses suggest that individual homes and the broader electrical grid are outdated and inefficient. Participants suggest improving the power grid to support incoming green energy generation to address issues at a national level. For individual property owners, participants propose subsidies for electric appliances and solar panels.

During discussion, participants mentioned the difficulties renters face when trying to improve their electricity use and limit greenhouse gas emissions from their appliances. To solve issues for renters, participants suggest stricter policies for rental owners when renovating homes to ensure the incorporation of electric appliances.

Energy Efficiency responses were similar, but more focused on how personal habits can reduce energy use. Participants suggest common practices to save energy and money like unplugging appliances not in use or turning off lights.

Buildings

One of the least discussed categories, Buildings, only accounts for 3% of total responses and 2% of priority responses.

Participants worry about the age and quality of their homes contributing to problems like indoor air quality and lead pipes; suggestions center around replacing lead pipes and weatherizing buildings. Conversation regarding buildings was quite limited given the participants' age and small likelihood of owning homes.



Figure 18. Buildings in Cincinnati

Carbon Removal

Participants seldom discuss the topic of Carbon Removal explicitly; only 1% of total responses and 2% of priority responses fall under the Carbon Removal category. Of those responses 80% cited Climate Change or global warming as an issue. However, participants are split on tactics to address this. Some suggest a carbon tax while others opt for increasing the amount of trees.

Industrial

Notably, participants did not generate any ideas that fell into the Industrial category.

No Category

Of the ideas shared by participants, 11% of total responses and 7% of priority responses were not able to be categorized based on the established system.

These ideas are diverse, but participants commonly cite landslides, light pollution, and urban heat island. While these ideas may align with other categories, they cannot be categorized due to the specific nature of the solution correlated with each issue. At times, no solution is provided and it was not clear to the Thrive Together team how the participant intends to solve the issue, which would allow it to be categorized. Other ideas under No Category do not address environmental issues or are too niche to fall into another category.

Barriers

Common barriers to undertaking climate action or seeing progress in climate action identified by participants include Public Attitude, Money, Knowledge, Politics, Project Support, Accessibility, and Difficulty.

Public Attitude

Public Attitude is the most common barrier in the eyes of young people. Nearly a quarter of all barrier responses fall under this category. Participants think the public does not care about environmental issues and are generally apathetic towards the cause. The workshop conversations suggest this reduces the amount of people willing to help an initiative, forming another barrier for getting things done. Others say the public is helpless and unable to remediate environmental issues; one participant reported "not feeling like anything I do makes a difference." A feeling of hopelessness characterizes some of these responses.

Important barrier to a participant:

"Not feeling like anything I do makes a difference"

Money

Money was second-most cited barrier, accounting for 19% of all barrier responses. Money is seen as a barrier for implementing projects and for improving the sustainability of personal habits.

Some participants identified specific purchases that burdened them like electric vehicles, vegan or organic food, and green energy.

Knowledge

Knowledge was identified as a barrier particularly impactful when young people try to launch projects. One participant said, "I am stopped by the fact that I don't know how to do the work required."
Young people seem overwhelmed by the prospect of beginning an environmental initiative and frequently said they do not know where to start. These responses are to be expected given the number of participants that propose increasing environmental education and volunteer opportunities for young people under the Education & Advocacy category.

Politics

Politics also limits climate action in the eyes of participants. Participants cite conflicting agendas and political division as an impediment to progress. Others mention the inaccessible nature of government officials, claiming it is difficult to have their voice heard if they cannot reach elected officials. Some ideas proposed by participants are stopped by their legality; participants mentioned preemption doctrines and the legality of certain projects, like community solar.

Project Support & Accessibility

Project Support is seen as a crucial component of ensuring project success. However, many young people saw lack of support as a common barrier. Young people feel that they do not have the manpower or staff bandwidth to complete projects. Likewise, Accessibility of resources is critical to project implementation. Students identified accessibility of resources and education as a limit on their idea execution.

Difficulty

The final barrier with the least amount of responses is Difficulty. Difficulty includes the challenges young people face when launching and maintaining a project; participants feel that it is hard to make an impact on a large scale.

Recommendations & Conclusion

During our discussions with young people about their vision for climate action in the Cincinnati region two major sources of climate action emerged: local governments and schools. Both are seen as key players in driving progress in climate action and engaging young people in the process.

Some of the recommendations below are categorized based on their audience: either school administrators and teachers or local government officials. However, there are common strategies both groups can take to mitigate the barriers young people face when undertaking climate action.

School Administrators & Teachers

The framing of schools as centers for environmental change and youth empowerment is unsurprising; young people are particularly attune to ways their school campuses could become more sustainable. Participants spoke frequently about problems they face on campus, like of administrative barriers and a lack of control over their surroundings.

However, young people saw great potential in their schools to make an impact on their local environment and the attitudes young people have regarding sustainability. To better accomplish these feats, young people suggest schools:

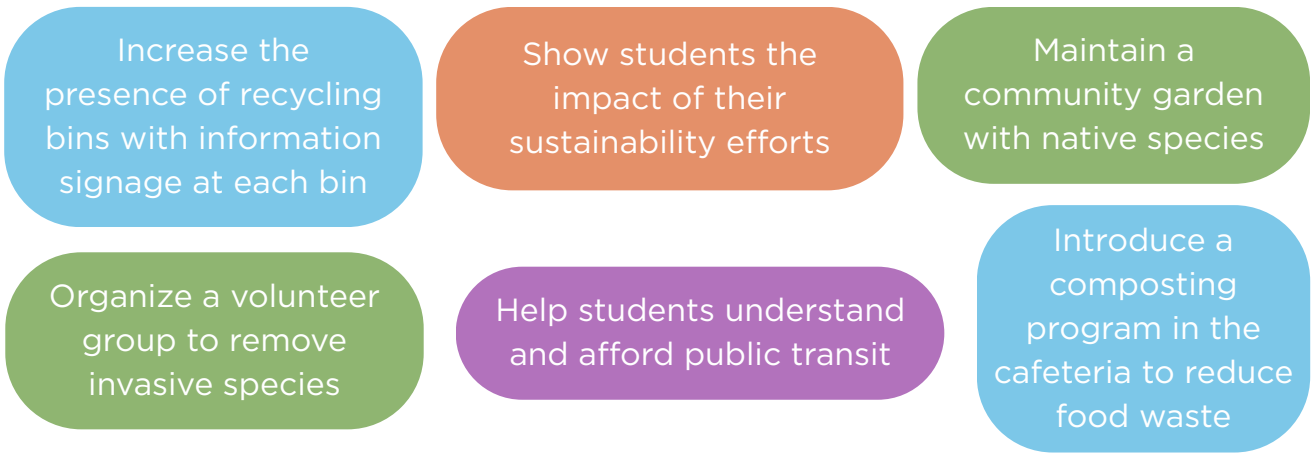


Figure 19. Suggestions for schools to engage students in environmental topics

Local Governments

The other critical partner in climate action and youth empowerment in the eyes of young people is the local government. Municipalities included in Thrive Together and others wanting to draft climate action plans should draw from the insights of young people. In doing so, local governments and planning authorities can create change grounded in communities' ideas and foster a deeper relationship with the communities they intend to serve.

These core ideas surfaced from Thrive Together's conversations with young people and should be included in the CCAP:

POLLUTION IS A KEY ISSUE FOR YOUNG PEOPLE

They mention the prevalence of litter on school campuses, along roads, and in waterways. Participants suggest limiting the use of single-use plastics, organizing groups to pick up litter, introducing more trash cans and recycling bins in public spaces, and preventing pollution from entering waterways.

PUBLIC TRANSIT IS SEEN AS BOTH A SOURCE OF PROBLEMS AND A SOLUTION

The problematic nature of public transit, such as its unreliability and limited routes were deemed issues that need to be addressed to improve ridership. However, the positive impacts of public transit are equally important; young people noted increased public transit use can decrease private car use and the emissions that follow. Participants want to increase ridership of public transit by offering education on how to ride, extending routes into suburban or rural areas, and lowering student fares.

LAND CONSERVATION IS A CLIMATE SOLUTION WITH CO-BENEFITS

Young people talked about the importance of interweaving green spaces into the built environment. These solutions are seen as crucial in increasing residents' access to green spaces, improving their health, and protecting biodiversity. They proposed preserving parks, rewilding vacant land, and maintaining wild land during suburban development to maintain critical ecosystems and protect species.

Improving the opportunities young people have to learn about environmental issues or get hands-on volunteering experience is a good way to engage more young people in this work. Interactive learning opportunities that young people are interested in include invasive species removal, native species planting, riparian zone conservation, and community garden care. Incorporating environmental education and volunteer days focused on these topics could be a great way to engage young people.

EDUCATION AND ENGAGEMENT ARE THE FOUNDATION OF CLIMATE ACTION

Barriers

While some barriers, like public attitudes towards environmental issues, are difficult to address, other barriers young people face could be mitigated by proper support from local or school leaders.

Commonly cited barriers include money and knowledge.

If local government or school administrators want to see more young people engaged in environmental work, it behooves them to address the educational and financial barriers that prevent young people from implementing sustainability-focused projects.

To help with knowledge gaps, local leaders and school faculty need to guide students or young people in the project visioning and planning phases. Help young people identify problems and solutions they see in their community and create workplans to implement these solutions.

Supporting students through this planning phase will hopefully give them the guidance and confidence they need to follow through on their ideas.

After a successful planning phase, young people need to secure funding for their ideas. Local governments and schools should support young people in their efforts to shore up funding.

One method is to provide them with avenues to fundraise or secure grants from philanthropic sources. However, students can gain direct and easier access to capital if schools or local governments are willing to fund their ideas. Providing project grants, even micro-grants like the City of Cincinnati's Seeds of Change Youth Climate Action Fund program, is a method of funding youth-led projects. Small grant programs give young people the money they need for small scale projects and build their experience in applying for grants and managing budgets.

Future Research

Curiously, participants did not suggest any ideas that fell into the Industrial category despite the PCAP finding that the industrial sector accounted for 35% of all MTCO2e emitted in the region in 2022.

To better understand this gap in ideas, further research should be conducted to understand the viewpoints of young people as it relates to industrial emissions. The Thrive Together team is particularly interested in the questions of:

- What perceptions do young people have of the industrial sector's historical and modern role in greenhouse gas emissions?
- Do young people think the industrial sector is an effective channel at reducing greenhouse gas emissions?
- What information or messages about industrial emissions are young people receiving?

References

Go Vocal. (n.d.). About Us. Go Vocal. https://www.govocal.com/about-us

Thrive Together. (2024). Greater Cincinnati: Priority Climate Action Plan. https://www.cincinnati-oh.gov/oes/climate/climate-pollution-reduction-grant-cprg-phases1/cprg-pcap/

Appendix A

Questions included in the questionnaire under the "Voice Your Opinions" phase on Go Vocal.

Question 1. Title
(Open text box)
Question 2. Author (optional)
(Open text box)
Question 3. Description - Describe a single topic of concern or environmental problem you see in your community and a potential solution to fix this problem.

If you have additional concerns and solutions, please submit a separate form for each idea. This makes it easer to vote for your favorites later!

(Open text box)
Question 4. Solution Difficulty
How difficulty would it be to implement your proposed solution?

Think about things like"
- How many people would have to work on this?
- What technology would we need?
- How many resources or materials would we need?
- How much would it cost?
- How long would it take?
- Would it disrupt people's lives?

(Given multiple choice options of "Very easy," "Easy," "Neither," "Difficult," and "Very difficult.")
Question 5. Solution Impact
How much of an impact would your proposed solution make if implemented?

Think about things like:
- How many people does this affect?
- How much does it affect people's everyday lives?
- How does this affect the environment?

(Given multiple choice options of "Very big impact," "Big impact," " Moderate impact," "Small impact," "Very small impact," and "No impact.")

Question 6. Explain (optional)
Please explain your responses to the previous two questions.

In other words, why did you choose the level of difficulty and level of impact you chose for your potential solution?

If you said it had a big impact, why does it have a big impact?

If you said it was easy, why is it easy?

(Open text box)
Question 7. Your Experience (optional)
Please describe what impacts your ability to engage in Climate Action.

What is keeping you from making the differences you want to see?

Think about barriers, limitations, or difficulties you face in addressing environmental issues.

For example, you might find it hard to address an environmental issue in your community because you don't have the time or resources to take on a project.

(Open text box)
Images and Attachments
Have an image of your idea or concern?

Drop it here!
Question 8. Images (optional)
This image will be the face of your project when it comes time to vote on your favorite ideas, so choose wisely!

(Image uploader)
Mapping
Adding your location can help us identify neighborhoods that need our attention.
Question 9. Location
Please put your town, zip code, or county.

(Dropdown menu)

APPENDIX B: SENIOR ENGAGEMENT REPORT

ThriveTogether

A Sustainability Playbook for Greater Cincinnati

COMMUNITY ENGAGEMENT

Senior Engagement Report

Abstract

Environmental Protection Agency's (EPA) creation of the Climate Pollution Reduction Grant (CPRG) program helped meet emerging needs for regional collaboration in climate action. This program fostered partnerships among local governments in the pursuit of reducing greenhouse gas emissions by having partner organizations and governments draft Climate Action Plans for their region.

One recipient of CPRG funding is the Greater Cincinnati Region. Comprised of members from Ohio Kentucky Indiana Regional Council of Governments (OKI), Southwest Ohio Air Quality Agency, Northern Kentucky Area Development District, the Indiana University Environmental Resilience Institute, the City of Cincinnati's Office of Environment and Sustainability, and Green Umbrella, Thrive Together is a collection of local governments, educational institutions, non-profits, and businesses committed to creating Climate Action Plans for the Greater Cincinnati Metropolitan Statistical Area.

To create Climate Action Plans grounded in the wants and needs of the residents it serves, Thrive Together undertook a community engagement process targeting key demographic groups, like people over the age of 50. The Thrive Together team strived to integrate senior people's perspective on environmental issues and their proposed solutions into a Comprehensive Climate Action Plan for the Greater Cincinnati region.

To do so, the Thrive Together team created a virtual engagement platform and hosted in-person workshops at senior centers. These channels gathered senior's thoughts on the environmental issues facing the region, potential solutions to these issues, and barriers to implementing solutions. The responses from these engagement methods show the environmental topics of greatest significance to seniors, like Green Spaces or Education & Advocacy. Seniors also proposed sustainability initiatives or investments the Greater Cincinnati Region should prioritize.

Through this effort, seniors can inform future sustainability initiatives and ensure that the interests, passions, and ideas of young people are represented in local planning processes.

Table of Contents

Abstract 2

Acknowledgements 4

Introduction 5

Priority Climate Action Plan 6

Current Senior Engagement 7

Purpose & Objective 8

Partners 9

Methodology 10

Virtual Engagement 10

In-Person Engagement 12

Discussion 16

Transportation 16

Trees and Carbon Removal 18

Buildings and Homes 20

Waste and Recycling 22

Findings 24

Appendix A

Acknowledgements

The Thrive Together Senior Engagement Report was made possible by the engaged seniors of the Greater Cincinnati Metropolitan Statistical Area. They shared their ideas, hopes, and experiences to this report and offered a new perspective to be incorporated in the Comprehensive Climate Action Plan. Thank you to all participants in the senior engagement process. A special thanks to the following organizations for their commitment to the project.

City of Oxford
Reena Murphy, Sustainability Coordinator

Meals on Wheels Southwest OH & Northern KY
Bre Williams, Programs Manager

Northern Kentucky Area Development District
Jeff Thelen, Transportation Services Manager

Ohio Kentucky Indiana Regional Council of Governments
5310 Oversight Team

Introduction

In 2023, the Greater Cincinnati Metropolitan Statistical Area (MSA) was awarded a federal CPRG from the EPA. Through this grant, the EPA supported local governments in their efforts to make Climate Action Plans that drive down regional greenhouse gas emissions.

OKI convened local players, like city and county government officials, utility providers, community-based organizations, and educational institutions, to begin drafting these Climate Action Plans under the title Thrive Together. Thrive Together represents some of the diverse priorities, expertise, and opinions of the Greater Cincinnati MSA.

Thrive Together drafted a Priority Climate Action Plan (PCAP) in 2024; this document provided an overview of greenhouse gas emissions in the region and highlighted some near-term, high- priority, implementation-ready measures to reduce greenhouse gas emissions. The PCAP was the first step in creating the Comprehensive Climate Action Plan (CCAP) to be finished in December of 2025. The CCAP will establish long-term emissions reduction strategies identified through engagement with key stakeholders, like residents, technical experts, and local government officials.



Figure 1. Map of counties included in the Cincinnati MSA

Priority Climate Action Plan

Key Point

Through this collaboration, Thrive Together created a Greenhouse Gas Inventory for the region and a Priority Climate Action Plan

The Greenhouse Gas Inventory conducted by Thrive Together found the region emitted 43.8 million metric tons of carbon dioxide equivalents (MT CO2e) in 2022. Per capita emissions for the region are 19.5 MT CO2e, which is slightly higher than per capita emissions nationally in 2021. The industrial sector accounted for 35% of total emissions in 2022, followed closely by the transportation sector at 30%. The residential and commercial sectors contributed 19% and 16% of emissions respectively. Buildings and equipment were the source of a majority (65%) of emissions, with personal vehicles the second largest source but only accounting for 15% of emissions (Thrive Together, 2024).

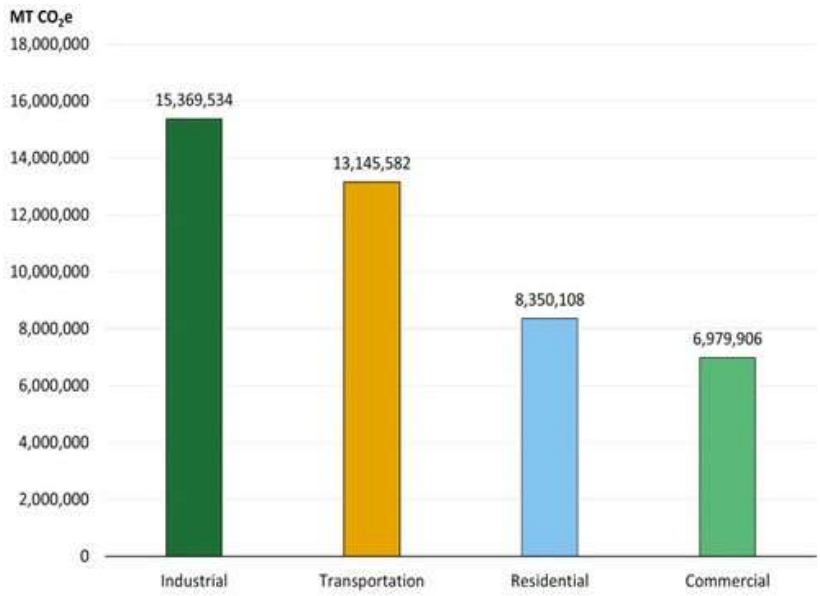


Figure 2. Emissions by Analysis Sector for the Greater Cincinnati MSA

Using the Greenhouse Gas Inventory, Thrive Together created the Priority Climate Action Plan (PCAP) outlining the key areas of improvement to drive down greenhouse gas emissions. The sectors focused on in the PCAP are Transportation, Electric Power, Buildings, Industrial, Agriculture, Carbon Removal and Waste, Water & Sustainable Materials Management.

Current Senior Engagement

Seniors are engaged in the decision-making process for regional issues, particularly with respect to regional transportation and mobility improvements.

In 2007, OKI formed the OKI 5310 Oversight Team to help advise and guide staff on program management and planning efforts required by 49 U.S.C. section 5310 Enhanced Mobility of Seniors & Individuals with Disabilities. This Team includes seniors as well as organizations providing transportation services to senior populations. Significant outreach engaging seniors for input on transportation planning efforts have occurred with the development and updating of the Coordinated Public Transit Human Services Transportation Plan required by Section 5310 and updated for the Greater Cincinnati region on a four year lifecycle since 2007. This engagement has included surveying, both hard copy and online, and in person workshop events. A key to this engagement has been the collaboration of organizations serving seniors including nursing home facilities, demand service transportation providers, meals on wheels program providers, and other social service providers.

Thrive Together partner organization, the Northern Kentucky Area Development District (NKADD), provides expertise and resource solutions to improve quality of life for older adults, caregivers, individuals with disabilities and staff in Aging and Disability Services. This includes support for the Aging and Disabilities Resource Center (ADRC) a program of the Older Americans Act. The ADRC supports older adults, caregivers, and individuals with disabilities by providing information, referrals, and access to services such as caregiver support, in-home care, nutrition programs, senior centers, legal aid, and benefits counseling. NKADD continuously engages seniors in program activities and in the development of regional planning activities.

Purpose & Objective

Purpose

Identify:

- climate hazards senior people face their proposed solutions
- barriers they face when implementing climate solutions.
-

Objective

Identify representative senior climate action priorities

Partners

The Thrive Together team consists of members from Green Umbrella, the City of Cincinnati's Office of Environment and Sustainability, Ohio Kentucky Indiana Regional Council of Governments (OKI), Southwest Ohio Air Quality Agency, Northern Kentucky Area Development District, and the Indiana University Environmental Resilience Institute.

Green Umbrella is the Cincinnati Region's climate collaborative focused on bridging silos to deliver sustainability solutions to the region.

A close partner of Green Umbrella and author of a city-wide climate action plan, the City of Cincinnati's Office of Environment and Sustainability brings their experience in engaging residents in the planning process to Thrive Together.

OKI Regional Council of Governments is the Metropolitan Planning Organization for the region focused on addressing regional transportation, planning and environmental needs.

Southwest Ohio Air Quality Agency is a division of the Hamilton County Environmental Services and a leader in monitoring and regulating industrial air emissions for five counties around Cincinnati.

Northern Kentucky Area Development District is a multi-county planning and development organization for eight counties in northern Kentucky, six of which are covered by Thrive Together's scope.

The Environmental Resilience Institute at Indiana University partners with stakeholders across Indiana to research and co-create resilience and climate solutions.

The partners under Thrive Together bring their expertise on the topics and communities of concern to the planning process. Through their diverse perspectives, Thrive Together is well-positioned to create a holistic CCAP suitable for use by any municipality in the Cincinnati MSA.

Methodology

The Thrive Together youth engagement effort was comprised of three main phases:



Virtual Engagement

In collaboration with Meals on Wheels Southwest OH & Northern KY (MoW), a series of engagement sessions were scheduled utilizing tablet devices MoW provides to recipients to aid with communications such as scheduling changes. A goal of MoW is to encourage more use and activities with the tablets and a variety of programming events have been developed for seniors to interact through the tablets. Four 1-hour sessions were scheduled and promoted through MoW website, newsletter and recipient correspondence. The agenda for these sessions included introductions, a slide presentation explaining the CPRG program and the purpose of the session engagement, followed by a series of questions designed to initiate conversations among participants and both individual and community actions related to emissions and potential methods for emission reductions.

Despite some interest from tablet owners, only 1 individual tuned in for a session and not a senior. We encouraged the attendee to tune into a future session hoping for more participants.

After having no participants in any of the sessions, we evaluated our promotion strategy to ensure the information regarding the sessions had been received by our target audience. Promotion outlets included:

- MoW social media (LinkedIn, Facebook, Instagram)
- MoW email listserv, newsletter
- Affordable and/or senior housing
- Cincinnati Hamilton Public Library
- Campbell and Kenton County Public Library
- PrimeWise (eventbrite page)
- Giving Voice Foundation (newsletter)
- Cincinnati Nature Center (newsletter)
- Jewish Family Foundation (newsletter)
- CityBeat

During the same time period, other topics used for tablet programming included skill development sessions and interest program such as ballet fundamentals. The climate change topic did not attract an audience on the tablets, therefore, the partners decided to move on to in-person engagement techniques.



Figure 1 - Tablet Session Promotional Flyer

Hybrid Engagement

Based on lack of virtual participation, the Thrive Together team pivoted the final event to a hybrid event held at the Roselawn Senior Center in Cincinnati. A team member facilitated in person discussion as the Thrive Together partner organizations presented slides remotely to the participants. A single virtual participant attended the event, as well. A series of discussion questions were posed as participants shared their views. This event was concluded with the hardcopy questionnaire used for the in-person events.

In-Person Engagement

The more successful engagement method was in-person workshops. The Thrive Together team relied heavily on the Meals on Wheels team to determine most active and most appropriate venues.

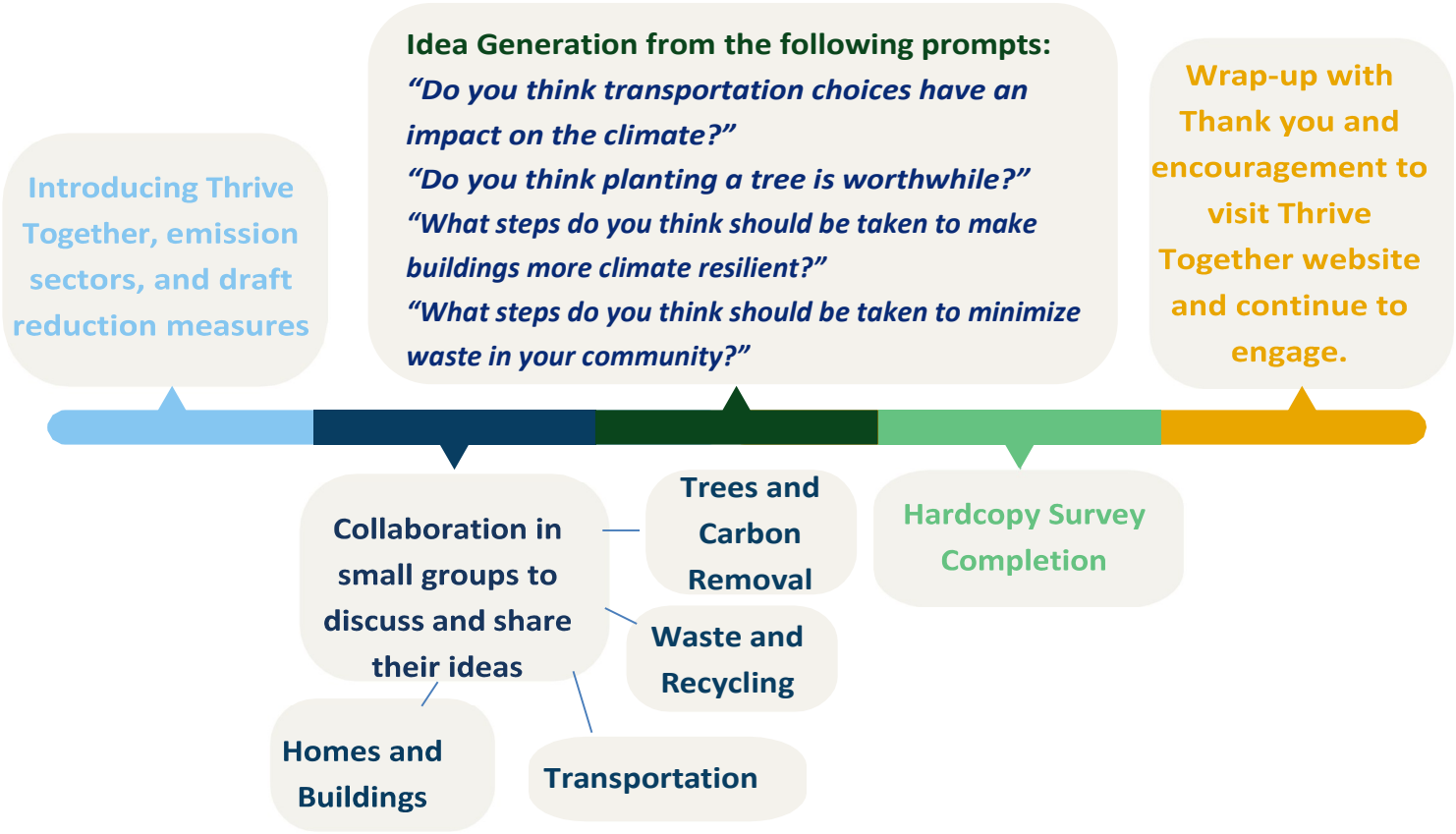
From August through September 2025, the Thrive Together team held in-person workshops in four locations spanning urban, suburban and rural communities.

Meeting Partner	Number of Participants	County
Roselawn Senior Center	15	Hamilton
City of Oxford and Oxford Senior Center	24	Butler
Green Township Senior Center	15	Hamilton

Table 1. Workshop Summary

These workshops were hour long sessions run entirely by Thrive Together team members at the partners' site. The Thrive Together team followed a similar structure in each meeting.

Figure 4. In-person Engagement Workshop Structure



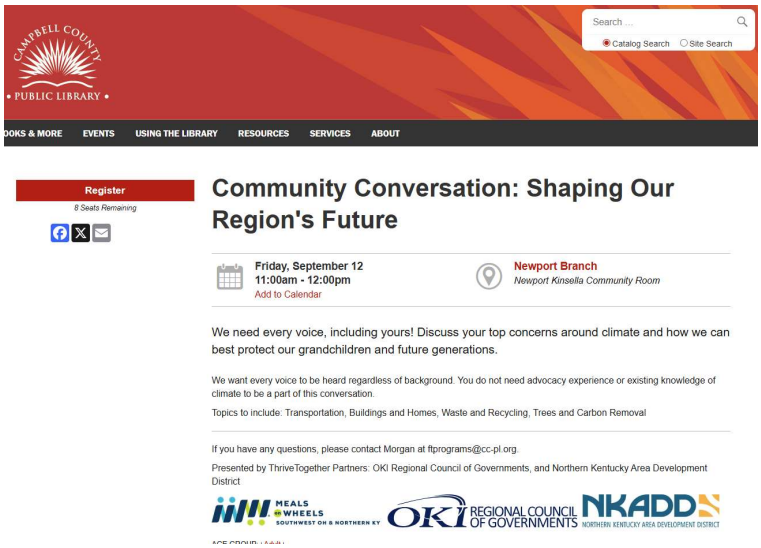
During the discussion phase of the workshops, participants were asked spend time in each of the four topic discussion areas located in the room. Thrive Together partners facilitated discussion in each area and documented all conversations. At 10-minute intervals, participants were asked to move on to the next topic area. Depending on the mobility ability of the participants, facilitators either moved to each discussion area or participants were asked to move to other tables.

Following the fourth discussion round, participants were provided a hard-copy questionnaire for their completion. Questionnaires were gathered by Thrive Together partners as participants left the workshop.





Figure 2 - Workshop Participants



Discussion

Transportation

Do you think transportation choices have an impact on the climate?
There was general consensus that transportation has a major impact on climate. The use of public transit, including buses and rail, and converting these to EV and alternative fuel sources would have emissions benefits.
One participant said they would love to see a trains system like places have in other parts of the world – mentioning Norway specifically.
Converting fleets to EV including USPS, emergency fleets, buses, Amazon and other carriers was suggested for improving emissions. Other forms of fuel and energy besides electric like Hydrogen and nuclear.
Taking advantage of carpooling and park & ride options especially for people who live outside of the city (comment was made at Oxford event). Ride share programs for medical trips.
A suggestion to lower the speed limit back to 55mph.
Emissions from buses can be smelled in the air

Does the community support low carbon transportation with walking paths, enhancing bike lanes or public transportation?
There was general consensus by participants that their community does support but most participants would like to see much more. Examples included:

- Miami University pays for free public transit or Oxford.
- Need for build out of more non-motorized transportation including protected Bike and Walking paths.
- Need for longer distance bikeways. Would like to see Shared use paths to get to Hamilton and Middletown. Also a US27 by-pass with multi use paths was suggested.
- An easier way to plan for and use public transportation to be able to get to Cincinnati and even the Greater Cincinnati Airport. There is no easy way now.

Possible grant opportunities for more senior transit and expand Metro Access program. Metro Now will take you to the bus stop but a need for more door to door transportation.
Would like to see a focus on places without access and have more elderly options and examples of education on what is available and how to use public transportation.
Make it possible to get to areas outside of local trips. Downtown or across the county.
Need for smaller power stations for neighborhoods and smaller cities.

Have extreme weather events impacted your ability to travel safely, reliably or consistently?
Most said yes to this although some said to was not a big factor.
With extreme weather events it makes it hard to plan a trip if there is flooding or washed out roads.
Fear of infrastructure damage as well as power/grid going out was mentioned.
Most weather events that disrupt transportation are winter weather events.

Trees & Carbon Removal

Participants clarified that Urban Forestry encompasses all tree canopy, both public and private trees in a community. Suggestions regarding strategies for increasing urban forestry were shared by participants, including:

- Five acre residential tracts are predominantly found surrounding the community and are mostly kept as mown lawn – could be an opportunity for increasing forest canopy. Education regarding energy and cost savings for forestry vs lawn.
- Clustered land use patterns would encourage more space for forest canopy and could be done with zoning.
- HOAs can be allies but need education regarding urban forest benefits.
- Privately owned land will be a thrust for increased canopy.
- Green infrastructure strategies like rain gardens and native plantings help reduce stormwater.
- Parking lots are opportunities for more planting – even if only with columnar trees allowing for views to buildings.
- School yard plantings are opportunity locations – also enables educational opportunities.
- More trees can be placed in riparian corridors.
- Shaded parking spaces are the prime/sought after spaces in a lot.
- Some developments do plant trees but most don't – opportunity for increasing.

Participants shared specific thoughts regarding tree species selections, maintenance considerations, common threats and other plant-based carbon reduction strategies, including:

- Oak is pinnacle for ecosystem benefits
- Prairie also has the ability to sequester carbon (in soil).
- Green roof strategies also provide opportunities for heat island reductions
- Green roofs have potential.
- Right tree, right place is critical.
- Maintenance is key to longevity.
- Need list of appropriate trees – oaks provide the best ecosystem benefits.
- Deer prevent many trees from maturing – overpopulation requires culling.
- Not all trees are equal. Right tree – right place.
- Silver maple lesson – were solution for elms but proved to not be good.
- Dad grew red maples and gave/sold to people
- Notice certain types of trees dying lately - mainly evergreens. Not sure what is causing but shouldn't this type of thing make the news? Why is there no information about this and its

causes available?
- There are times when trees do need to be removed for utility repair.
- Trees falling and leaf debris are concerns.
- Lack of maintenance is a big issue to homeowners
- Shade is a positive benefit
- Street trees planted in new neighborhood 25 years ago are now beautiful.
- Proper soil is critical to trees - can't just plant anywhere.

Several examples of community successes and best practices were shared by participants, including:
- Hamilton is great model for other urban tree canopy programs
- Regulate existing tree canopy to preserve/protect and require replacement
- Zoning codes can be an opportunity for street tree and parking lot tree requirements, tree surveys.
- Miami University ties to Miami Nation could learn about native American involvement regarding trees.
- MetroParks of Butler County are making efforts to expand the canopy.
- SWCD plant distributions have long-term impacts.
- Wild Ones – a local group promoting native trees/plants can serve as a model.
- The city could regulate tree planting requirements.
- Incentivize property owners to plant more trees.
- Parks need more shade.
- Stop building so many subdivisions and removing trees (eg Trailside)
- Colerain has seen significant tree canopy reduction with development since mid 1980s
- Kuliga Park is a great example of cooling effect of tree canopy - always cooler there than outside areas.
- Development should require tree plantings in parking lots - and not just trees, but more greenspace, too.
- Germany and Costa Rica are examples of strict national laws regarding tree removal.
- Memorial tree programs seem popular
- Arbor Day tree programs are good for those that can plant more trees
- education/awareness is needed regarding canopy benefits and threats.
- Engaging youth in tree planting makes a forever impression
- Grandparents used to whitewash tree trunks - don't recall the reason, but was a very popular thing to do/see at homes.
- If a developer takes 1 tree down they should plant 2.

Buildings and Homes

Have you experienced any changes made in your community to decrease carbon footprint, like through energy efficient lighting or weatherization?

- In general, groups discussed how it's difficult to see energy efficiency and weatherization.
- City street lights LED conversion has been recognized
- Economic challenge for homeowners for EE replacements — cash outlay needed
- Challenge identifying TRUSTED contractors for the community with expertise (not the telemarketers)
- Energy audit program with City, IES, PUSH, Seniors
- State weatherization program – aware it exists but haven't heard stories of people actually accessing and using the funds
- TSD doing LED conversions
- Noticed additional residential solar adoption
- Motion detection lights in and around homes
- Hot water heater wraps as weatherization
- Noticed residential adoption of heat pumps
- Potential to engage Butler Tech in audits and weatherization assistance?

Are you worried about how poor insulation or aging buildings may affect your health, during weather events like heat waves or cold snaps?

- In general, the groups did not feel like their health would be personally effected by poor insulation or aging buildings, but they expressed concerns for vulnerable groups in our community during weather events (i.e. seniors, those with medical devises, mobile home residents).
- Concerns about power outages due to cold/heat and the impacts of being without power
- Less concerned about health and more with economic costs of old building / no insulation
- Felt that leaky gas appliances were more of a concern for health – i.e. natural gas leaks
- Felt building age / insulation impacted quality of life more than health explicitly
- Noted AI concerns with energy costs
- Noted winter impacts more noticeable than summer impacts (i.e. you can feel a draft more clearly in winter than hot air coming in in summer)

- Shared stories of sprinkler systems causing flooding after the pipes froze and burst
- Noted concerns with stormwater management and general water damage

What steps do you think should be taken to make buildings more climate resilient?

- Ventilation
- Weatherization
- Economic incentives
- Trees for cooling and wind break
- Climate smart landscaping
- Reflective roofs
- Green roofs
- Solar ready orientation for subdivisions and new builds
- Expanding solar adoption – at all scales
- Stricter regs on new buildings / going beyond ORC
- Utilizing repurposed materials in builds
- Stormwater management
- Less paving – noted they like the new(ish) trees along 27 in the ROW
- Weather shelters, especially heating, cooling, and tornadoes

Waste and Recycling

Have you observed more people in your community engaging in composting, recycling, or reuse of single-use materials? In public or at home?

- Wanted to see more diversion at businesses and multifamily
- Wants to see more services from Rumpke
- Senior Center does have recycling/compost at some events
- Mandatory curbside composting
- Drop off compost bins appear full
- Orange bag
- Noted “groundhog day” effect of being a college town with perpetual new stuff, waste, and people

Are you concerned about how waste-related pollution, like from landfill emissions or plastic waste, could impact your health?

- Microplastics
- Plastic water bottles
- Illegal dumping and littering
- Deposits wanted for glass
- Concerns about sanitation with compost
- Concerns for soil pollution and waterways
- Concerns for hazardous waste going into landfills
- Concerned about synthetic fiber in clothing
- Plastics as alternative use for petrochemicals

Are you aware of any local programs or services which make recycling, reuse, or composting more accessible?

- City bin distribution early 2025
- Cohen recycling
- Senior Center education/reduction
- Orange bags
- City drop off
- County engineer for free bulb recycling
- Inaccessible hazardouswaste disposal
- Extended producer responsibility needed
- City yard waste collection
- Free recycling at Miami
- Prescription drop off at OPD
- Neighborhood share online
- Sharefest
- Thread Up (Thrift store, locally owned)

What steps do you think should be taken to minimize waste in your community?

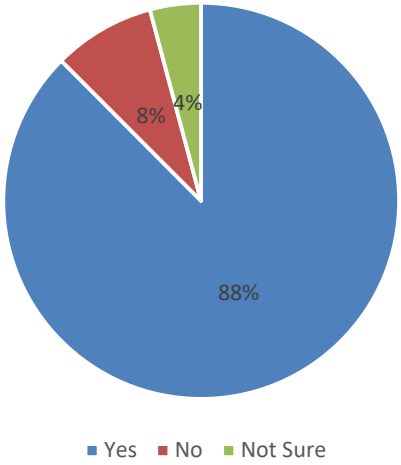
- Continuous education (media, multiple sources)
- Compulsory compost
- School education
- Public recycling bins on the street — like the corner trash bins
- Furnish student rentals
- Bottle bill

Questionnaire Findings

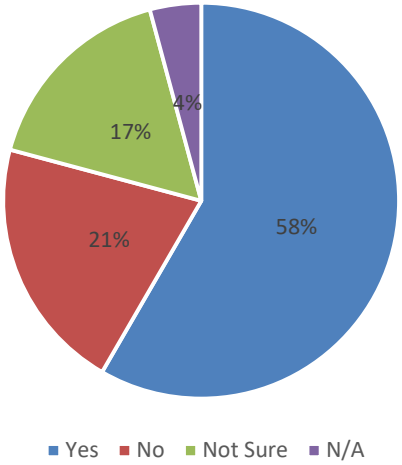
A hardcopy questionnaire was conducted following each workshop. 9 questions organized by 5 topic areas were asked by the survey.

Personal Experiences and Observations

1. Have you noticed any changes in the weather or temperature where you live over the past few decades?

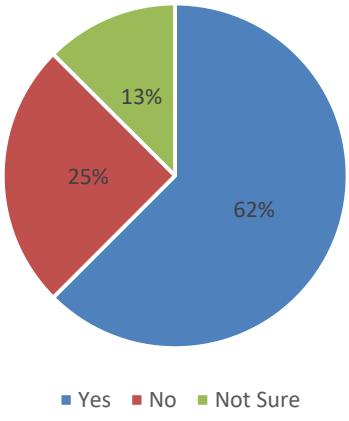


2. Have you noticed any changes in the natural environment around you (e.g. changes in plant or animal life)?

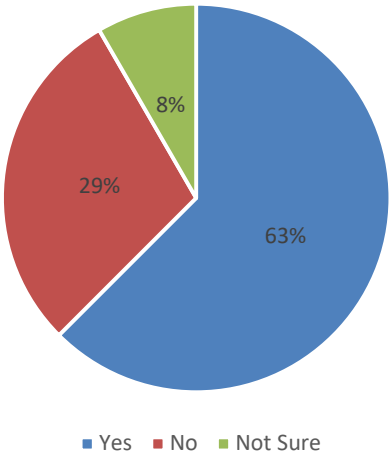


Health and Well-Being

1. Are you concerned about the impact of climate change on your health, particularly those with pre-existing conditions?

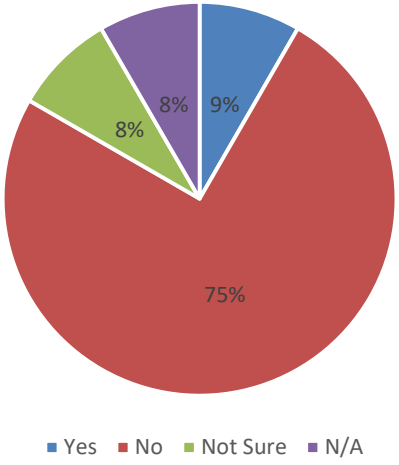


2. Have you experienced any health issues that can be attributed to climate change?

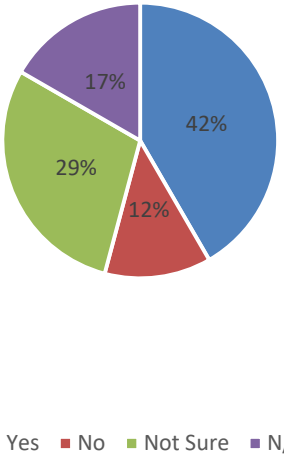


Community and Social Impact

1. Are you involved in any community initiatives related to climate change or sustainability?

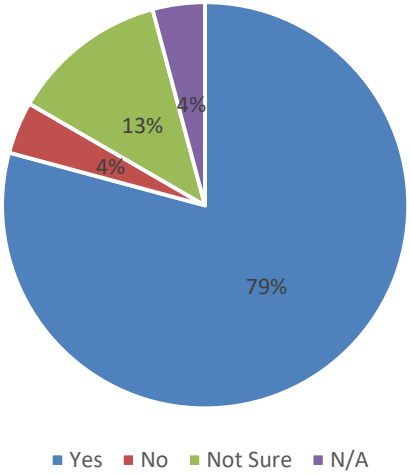


2. Does your community actively engage in sustainability initiatives?



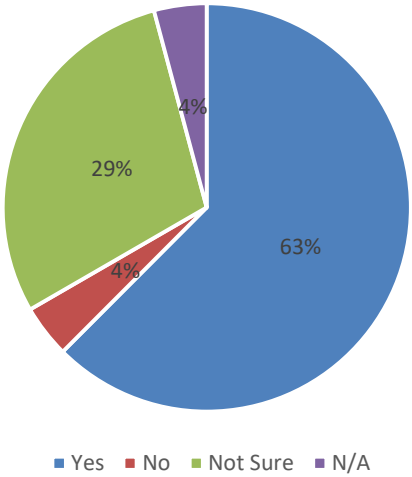
Financial Impacts

1. Do you think that increased costs for energy, insurance, and home repairs due to climate change strain the financial security of seniors, especially those on fixed incomes?

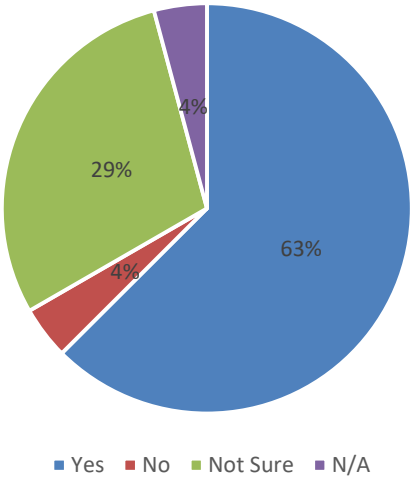


Future Concerns and Preparedness

1. Are you worried about the future impacts of climate change on yourself, your family, or your community?



2. Do you think steps should be taken to prepare for the future impacts of climate change?



Recommendations & Conclusion

MORE CONCERNED WITH COSTS OF INEFFICIENCY THAN HEALTH IMPACTS

There was general consensus among participants that their health had not been impacted by climate change nor were they worried this would occur. Concerns focused on the cost of inefficient energy loss.

Agreeing with Thrive Together youth engaged, seniors recognized the need for more accessible and convenient public transit as a way to reduce emissions by reducing trips.

EXPAND TRANSIT OPTIONS WITH MORE DOOR TO DOOR SERVICES

STRATEGICALLY EXPAND TREE CANOPY

Seniors agreed that the benefits of tree canopy necessitate its increase regionally. Expanded tree canopy should be strategically accomplished by determining the most beneficial locations, using the most appropriate tree species, and committing to plant and maintain canopy for generational benefit – not just aesthetic add-ons to site development.

Continuous education is necessary for the public to understand the benefits of actions that reduce emissions including composting, travel choices, and home fuel uses. Technology changes necessitate continuous learning as we better understand the impacts of our actions and, more importantly, the ways in which we can improve our own energy efficiencies.

CONTINUING EDUCATION IS KEY TO CHANGING BEHAVIORS.

Appendix A

Hard copy questionnaire administered at each senior workshop

Thank you for attending our session! Please take a few minutes to complete the survey below.

Personal Experiences and Observations

1. Have you noticed any changes in the weather or temperature where you live over the past few decades?

☐ Yes ☐ No
☐ Not sure

2. Have you noticed any changes in the natural environment around you (e.g. changes in plant or animal life)?

☐ Yes ☐ No
☐ Not sure

Health and Well-Being

1. Are you concerned about the impact of climate change on your health, particularly those with pre-existing conditions?
   - ☐ Yes
   - ☐ No
   - ☐ Not sure
2. Have you experienced any health issues that can be attributed to climate change?

**This can include complications from air pollution, sun exposure, intense heat, etc.*

- ☐ Yes
- ☐ No
- ☐ Not sure

Community and Social Impact

1. Are you involved in any community initiatives related to climate change or sustainability?
   - ☐ Yes
   - ☐ No
   - ☐ Not sure
2. Does your community actively engage in sustainability initiatives?

** This could include enhancing public transportation, tree plantings, recycling services, etc.*

- ☐ Yes
- ☐ No
- ☐ Not sure

Financial Impacts

1. Do you think that increased costs for energy, insurance, and home repairs due to climate change strain the financial security of seniors, especially those on fixed incomes?
   - ☐ Yes
   - ☐ No
   - ☐ Not sure

Future Concerns and Preparedness

1. Are you worried about the future impacts of climate change on yourself, your family, or your community?
   - ☐ Yes
   - ☐ No
   - ☐ Not sure
2. Do you think steps should be taken to prepare for the future impacts of climate change?
   - ☐ Yes
   - ☐ No
   - ☐ Not sure

APPENDIX C: CLIMATE SAFE NEIGHBORHOODS ENGAGEMENT REPORT

ThriveTogether

A Sustainability Playbook for Greater Cincinnati

COMMUNITY ENGAGEMENT

Climate Safe Neighborhoods Report

AUTHORS:

Green Umbrella

- **Van Sullivan, Senior Director of Program & Climate Strategy**
- **Bamidele Osamika, Regional Climate Collaborative Manager**
- **Nobi Kennedy, Regional Climate Collaborative Coordinator**

Groundwork Ohio River Valley

- **Kelsey Hawkins-Johnson, Climate Safe Neighborhoods Director**
- **Sydney Rosenthal, Climate Safe Neighborhoods Coordinator**
- **Tiffany Harvey, GIS Analyst**

Climate Safe Neighborhoods

About Climate Safe Neighborhoods

Climate Safe Neighborhoods is a national effort through Groundwork USA to identify neighborhoods that are more vulnerable to the effects of climate change because of racial and social injustices, spread awareness and educate residents in those neighborhoods, and ignite action towards climate resilience. Climate Safe Neighborhoods explores the relationship between historical race-based housing segregation and the current and predicted impacts of climate change. Effective community engagement is important for creating better policies and programs, addressing inequality, and building resilient communities.

What are the goals?

1. **Explore and communicate the relationship between the climate crisis and institutionalized racism.**
2. **Support the capacity of residents to self-advocate for more equitable distribution of resources.**
3. **Develop and implement short-term mitigation measures for extreme heat and flooding.**
4. **Impact policy to prioritize equitable climate resiliency.**

Climate Safe Neighborhoods Partnership of Greater Cincinnati

The Climate Safe Neighborhoods Partnership is a joint effort between Groundwork Ohio River Valley and Green Umbrella designed to develop equitable community engagement processes that center the voices and priorities of historically underserved communities in climate planning. Together, Groundwork and Green Umbrella also support the implementation of neighborhood-level projects, and the incorporation of climate justice into regional policies and government activities in Greater Cincinnati. This partnership has helped involve residents in the City of Cincinnati of Lower Price Hill in 2021, Roselawn and Bond Hill in 2022, Beekman Corridor in 2023, Avondale in 2023, Winton Hills and West End in 2025 and others. More cities, towns and neighborhoods within the region are expected to benefit from these initiatives as we collaborate with residents within the region to develop a climate action plan to address climate change.

About the Community Advisory Group Model

The Community Advisory Group (CAG) is a paid focus group that will create a Neighborhood Climate Action Plan (or Climate Resilience Plan) for Cincinnati's most vulnerable neighborhoods that addresses issues like flooding, heat, and air pollution. The CAG will understand how the neighborhoods' history resulted in increased climate vulnerability, develop climate adaptation strategies for the specific needs of the community, and influence the development of a Greater Cincinnati regional climate action plan, which will encourage city, county, and state governments to take action on climate justice initiatives.

The CAG model was created in partnership by the City of Cincinnati Office of Environment and Sustainability, Green Umbrella, & Groundwork Ohio River Valley. The CAG was designed as a focus group to execute Climate Safe Neighborhood's three goals:

1. **Engage residents in conversations about climate change concerns and adaptation methods unique to their neighborhoods, arming them with the knowledge to advocate for resources.**
2. **Raise awareness of the relationship between a neighborhood's history and current climate-related issues.**
3. **Strengthen local government climate planning process by creating neighborhood-level action plans that prioritize community voices and needs.**

Neighborhood Resilience Plan is Action

Throughout the course of the meetings, residents learn about climate change, its impact, and the current initiatives towards resiliency at the community and governmental level. One of the outcomes or deliverables of the meetings is the Neighborhood Action Plan. With contributions from each member of the Community Advisory Group, the Plan is to:

1. **Advocate for resources and funding for community needs**
2. **Serve as recommendations for project implementation efforts by community members, partners and funders**
3. **Uplift community voices for equitable decision making by city officials.**

Community Advisory Group

Community Advisory Group - Avondale, a neighborhood in the City of Cincinnati

Introduction

- **Avondale is one of Cincinnati's most densely populated neighborhoods, centrally located near the Uptown district and key employment hubs including UC and four major hospitals.**
- **Despite its proximity to institutions that can support education, employment, and healthcare, the community faces persistent socioeconomic challenges.**

- **Population decline of 18% since 1980 has contributed to demographic shifts and community strain.**

Demographics & Socioeconomic Indicators

- **Population: ~12,000 residents, 78% African American**
- **Households: ~6,900; nearly two-thirds of family households are female-headed.**
- **Median household income: $23,000-$27,000, with nearly 47.6% of families below poverty line.**
- **High rates of poverty correlate with crime, housing instability, and low homeownership.**

Health Indicators

- **Local access to healthcare institutions presents opportunities, but socioeconomic stress and built environmental hazards contribute to poor health outcomes.**
- **Avondale is ranked 36 which is about 0.32% in the educational attainment index compared to other neighborhoods in Cincinnati.**
- **These conditions increase vulnerability to climate-related stressors (e.g., heat, air quality, chronic disease burdens).**

Ecosystem & Infrastructure Indicators

- **Tree canopy coverage is modest at 18%.**
- **Avondale is highly urbanized, with limited green space and aging infrastructure.**
- **Vulnerabilities include heat island effects, impervious surface dominance, and reduced ecological resilience.**
- **Infrastructure challenges compound risks from extreme weather and environmental hazards.**

Top 5 Ranked Priorities

- **Food Access**
- **Green space**
- **Tree planting**
- **Financial investment**
- **Increase community engagement**

Key Takeaways for Climate Action

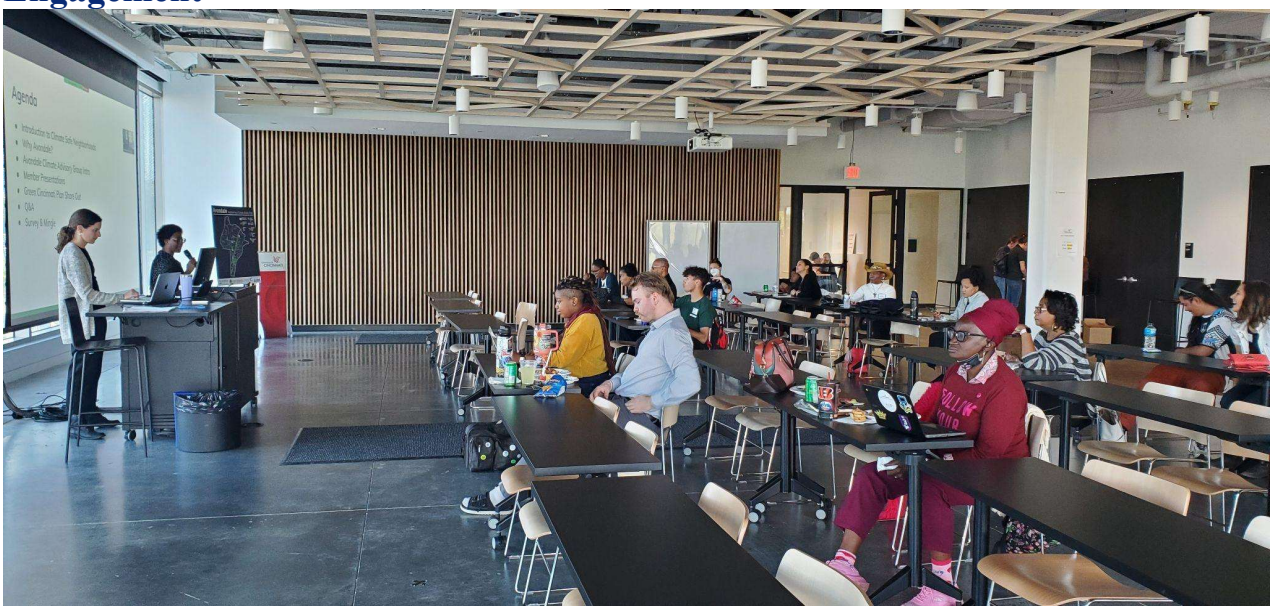
- **Climate action in Avondale must address intertwined social, economic, and health vulnerabilities alongside environmental stressors.**
- **Leveraging the neighborhood's proximity to major healthcare and educational institutions can drive climate-health partnerships.**
- **Expanding green infrastructure, improving housing resilience, and addressing mobility gaps are key strategies.**

- **Active community leadership provides a foundation for equitable and inclusive climate planning.**
- **Climate solutions must be integrated with poverty reduction, education access, and public health initiatives.**

Participants List

Jewell F
Jennifer F
Damien L
Cyrina T
Diana
Stephanie K
Elizabeth H
Kathy H
Sandra J

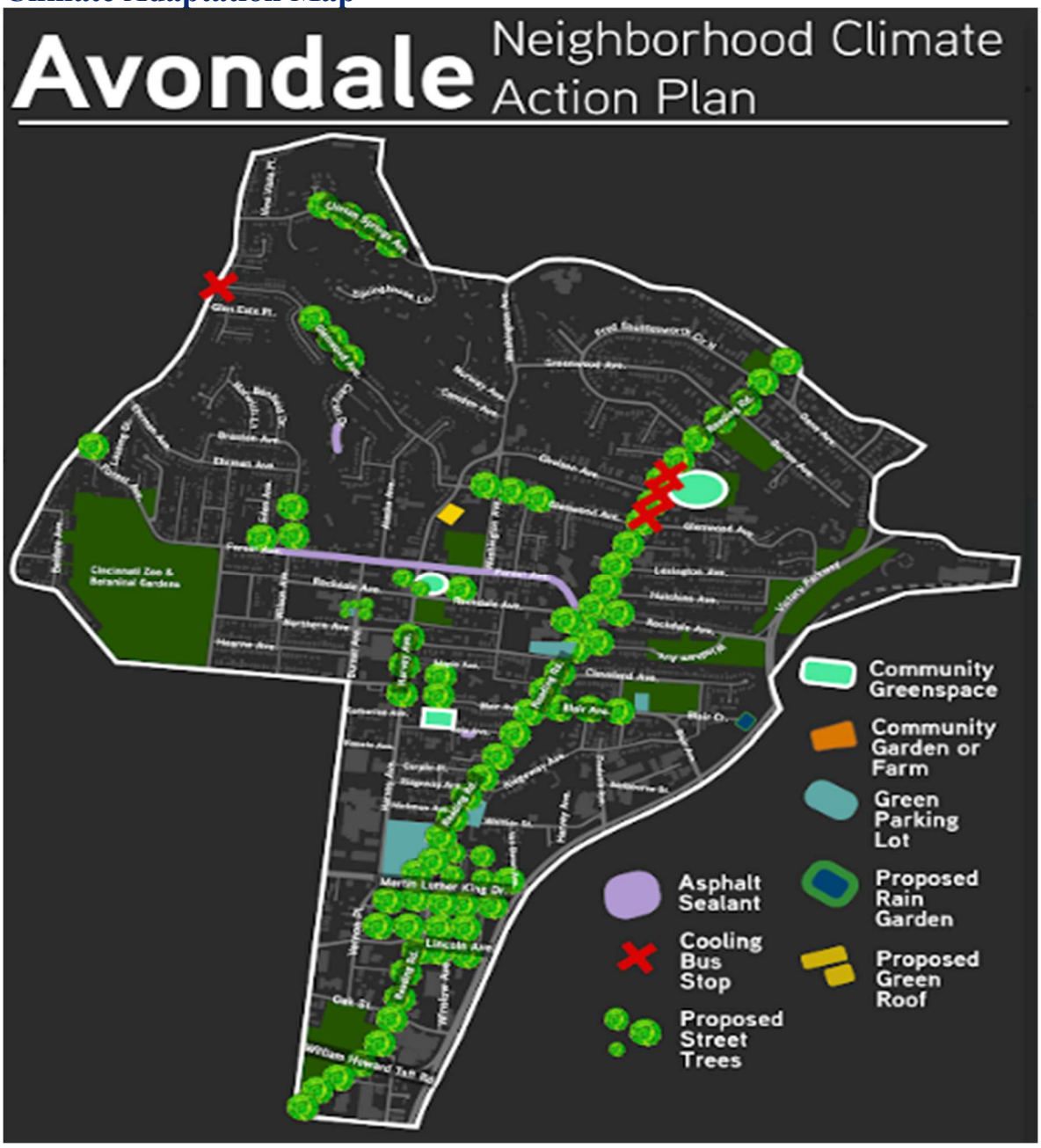
Engagement



Climate Impact Map



Climate Adaptation Map



More information about Avondale's data, metrics and maps can be found on [CSN Resilience Hub website]

Community Advisory Group - City of Norwood, Ohio

Introduction

- **Norwood, formerly Sharpsburg, emerged in the 1800s as a rural settlement and became a key suburb of Cincinnati.**
- **Growth accelerated with railroad expansion (1866–1881), industrialization, and incorporation as a city in 1902.**
- **The early 20th century saw major industrial employers including General Motors, Sears' prefabricated homes, and the U.S. Playing Card Company.**

- **Racial exclusion and segregation were documented throughout the early-to-mid 1900s, with Norwood identified as a possible "sundown town."**

- **After the 1980s industrial decline—marked by GM and LeBlond factory closures—the city transitioned to a retail and office-based economy, anchored by Rookwood developments and university-led mixed-use projects.**

Demographics & Socioeconomic Indicators

- **The population remains predominantly White (73–83% across key census tracts).**

- **Life expectancy is relatively high: 81–83.6 years across Wards 1 and 4.**

- **Poverty rates exceed national averages—ranging from 17% to 26.5% depending on the census tract.**

- **Both Wards 1 and 4 are identified as disadvantaged under federal screening tools due to economic and environmental vulnerability.**

Health Indicators

- **Chronic health issues include elevated high blood pressure (25–36%), consistent across census tracts.**

- **Despite strong life expectancy, residents experience above-average air pollution exposure, contributing to long-term cardiovascular and respiratory risks.**

- **Health outcomes are influenced by historic industrial emissions and ongoing exposure to particulate matter (PM2.5).**

Ecosystem & Infrastructure Indicators

- **Tree canopy coverage is modest. In Ward 1 it was 13.51% and 13. 27% in Ward 4.**

- **PM 2.5 exposure ranks in the 75th–81st national percentile, indicating persistent air quality concerns.**

- **Urban infrastructure has shifted from manufacturing to dense commercial and retail corridors, increasing impervious surface coverage.**

- **Historic loss of green space, highway construction (Norwood Lateral), and industrial redevelopment have shaped current land-use patterns and heat vulnerability.**

Key Takeaways for Climate Action

- **Air Quality & Public Health: Prioritize pollution reduction strategies and air quality monitoring in high-exposure zones.**
- **Urban Greening: Expand tree canopy, green corridors, and stormwater infrastructure to offset impervious surfaces and improve resilience.**
- **Equity & Inclusion: Address historic racial exclusion through equitable access to clean air, green spaces, and energy-efficient housing.**
- **Economic Transition: Support sustainable redevelopment and workforce training aligned with clean industry growth.**
- **Community Engagement: Build partnerships with residents and institutions to integrate environmental justice and health co-benefits into local climate planning.**

Top 5 Ranked Priorities

Creating solutions to address the following priorities Issues:

- **Green Spaces & Trees**
- **Planning and sustainable development**
- **Flooding**
- **Energy efficiency and renewable energy**
- **Housing/gentrification**

Participant list

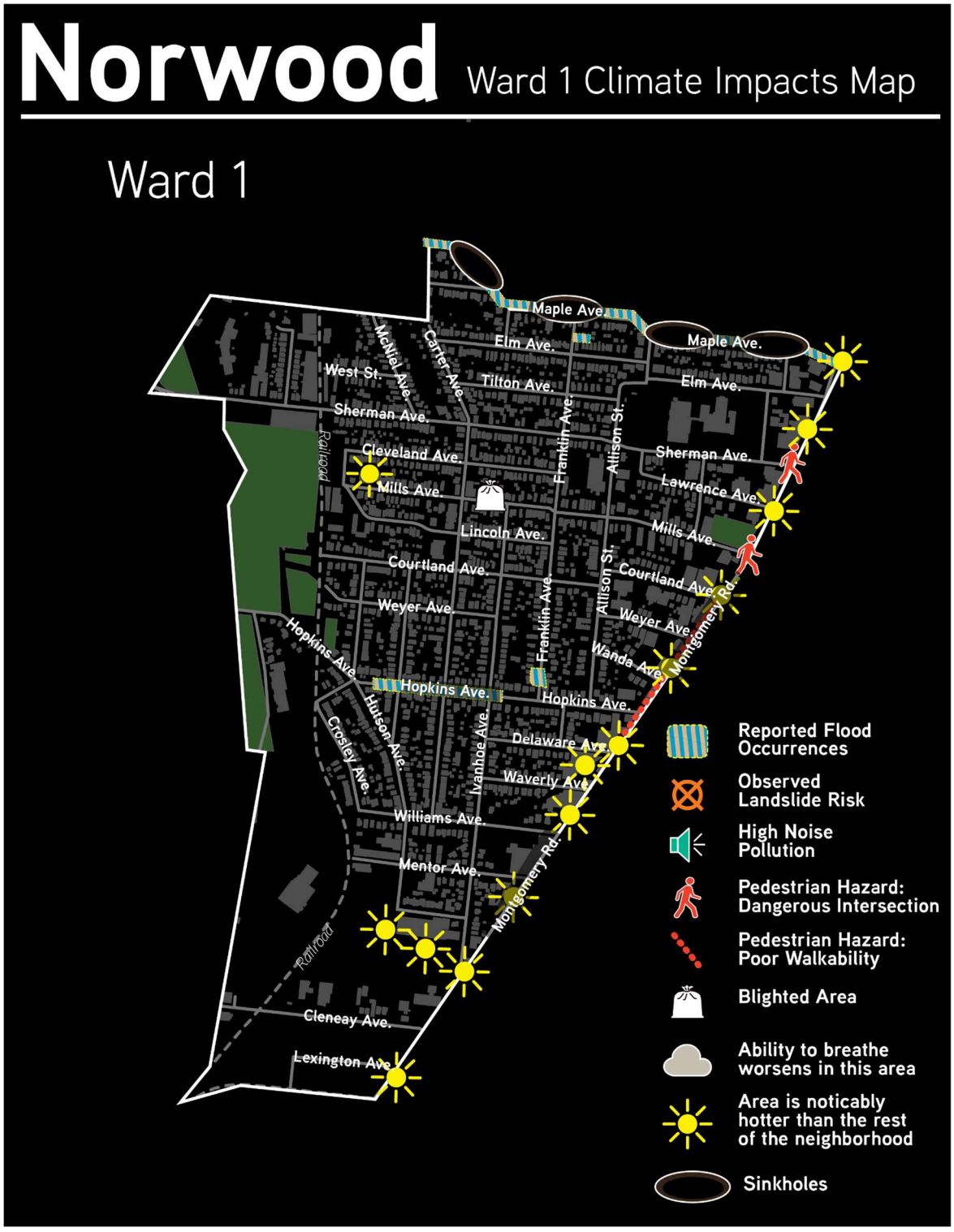
Dana B
Nikki G
Jennifer P
Amanda M
Krista S
Nikita F
Alison
Sarah S
David

Engagement

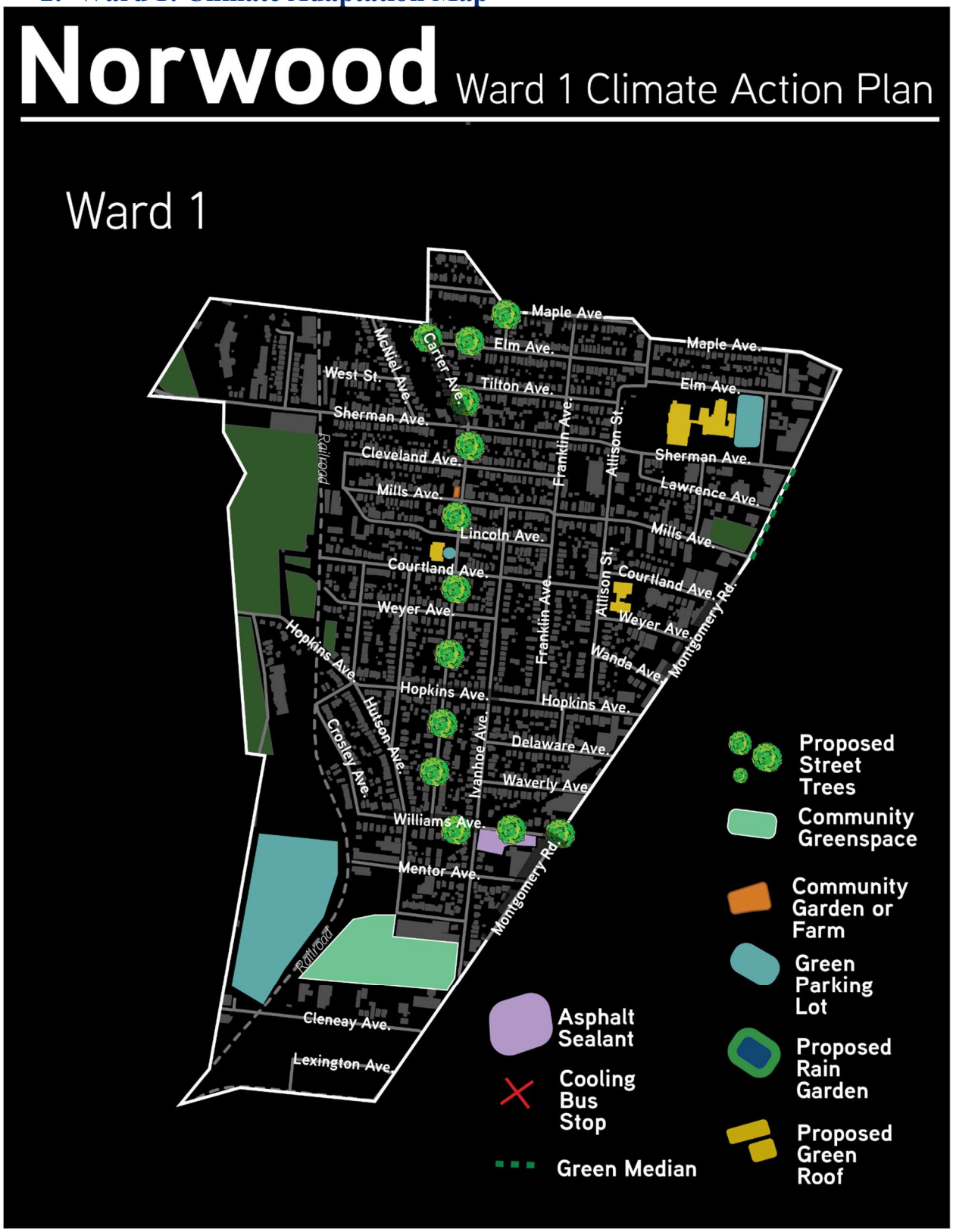


Targeted Neighborhoods

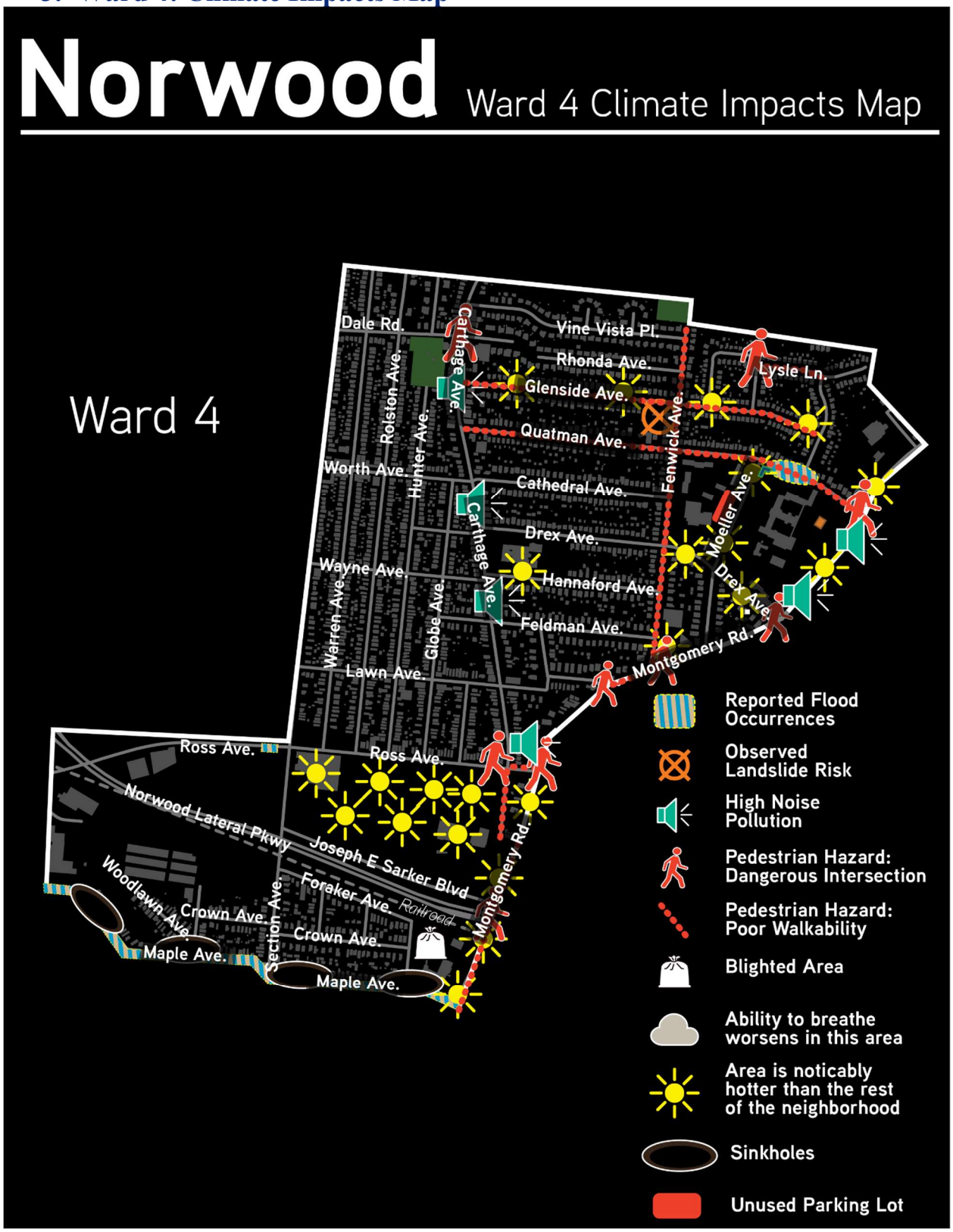
1. Ward 1: Climate Impacts Map



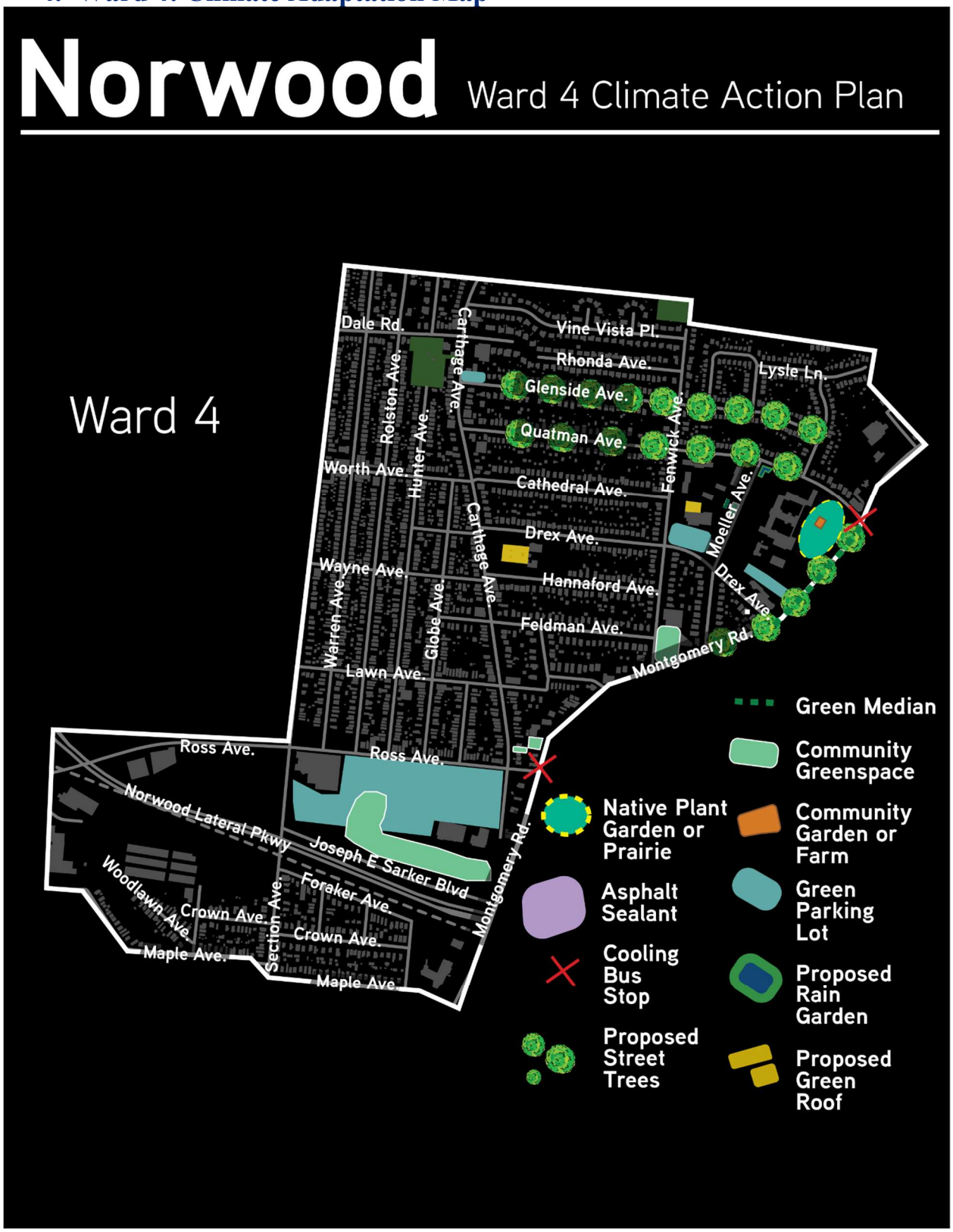
2. Ward 1: Climate Adaptation Map



3. Ward 4: Climate Impacts Map



4. Ward 4: Climate Adaptation Map



More information about City of Norwood's data, metrics and maps can be found on [CSN Resilience Hub website]

Introduction

Historical Context:

- Areas of Eastside, Helentown, and Austinburg were redlined in the 1930s, historically limiting home financing.
- These areas also experienced systemic education and housing segregation, contributing to long-term inequities.
- They are federally designated disadvantaged Census Tracts due to environmental, climate, and socioeconomic burdens.

Demographics & Socioeconomic Indicators:

- High poverty and limited vehicle access contribute to socioeconomic vulnerability.
- These tracts are at or above thresholds for multiple socioeconomic burdens, reinforcing climate and health risks.

Health Indicators:

- Residents face elevated health risks, including high exposure to PM 2.5 (percentiles 78–95), which can affect lungs and heart.
- Combined with other health burdens, the population is particularly sensitive to climate-related stressors.

Ecosystem & Infrastructure Indicators:

- Tree canopy is extremely low (15.5–19.9%), reducing shade and increasing flood and heat risks.
- Low vegetation cover contributes to higher temperatures, poor air quality, and increased flooding.

Top 5 Ranked Priorities

- Air quality
- Urban flooding
- Landslides//soil erosion
- Food access
- Extreme heat

Key Takeaways for Climate Action:

- Climate vulnerability scores are high (5.78–8.37 out of 10), reflecting compounded environmental, health, and socioeconomic risks.
- Priorities include increasing tree canopy and green infrastructure, reducing air pollution, and addressing flooding and heat stress in this community.
- Austinburg and the Eastside neighborhoods suffer from combined sewer overflows (CSO's).

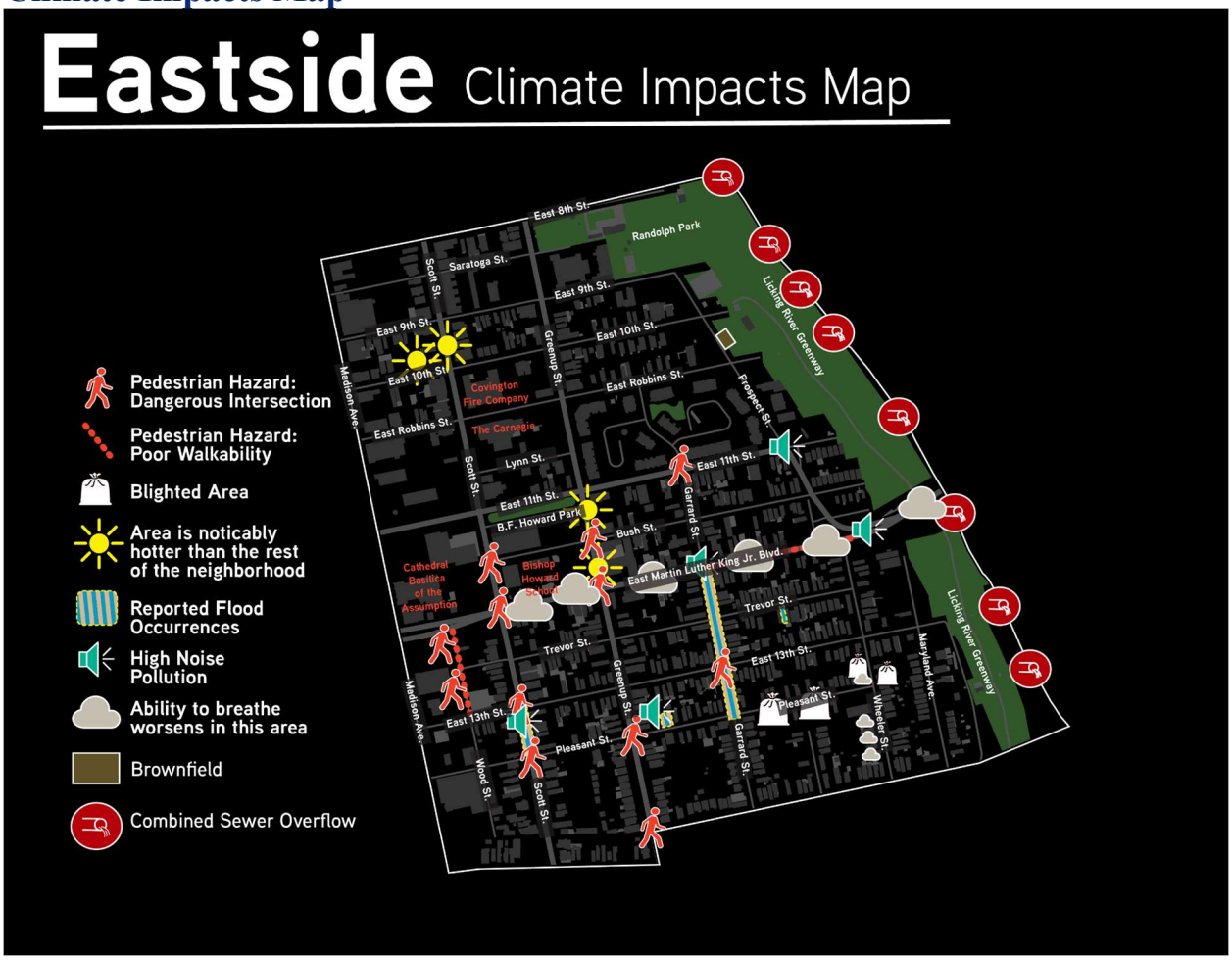
Engagement



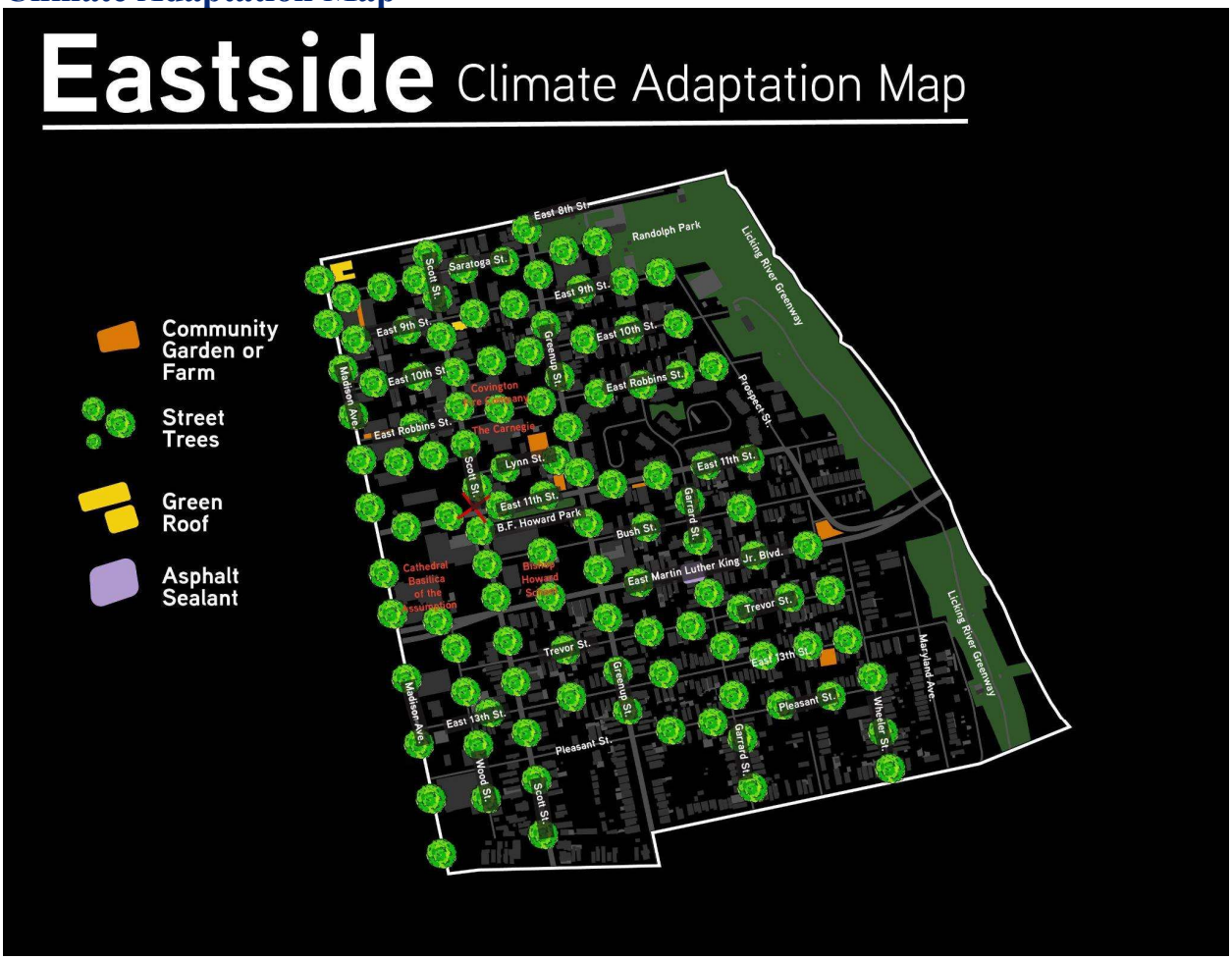
Targeted Neighborhoods

Eastside, Helentown, Austinburg

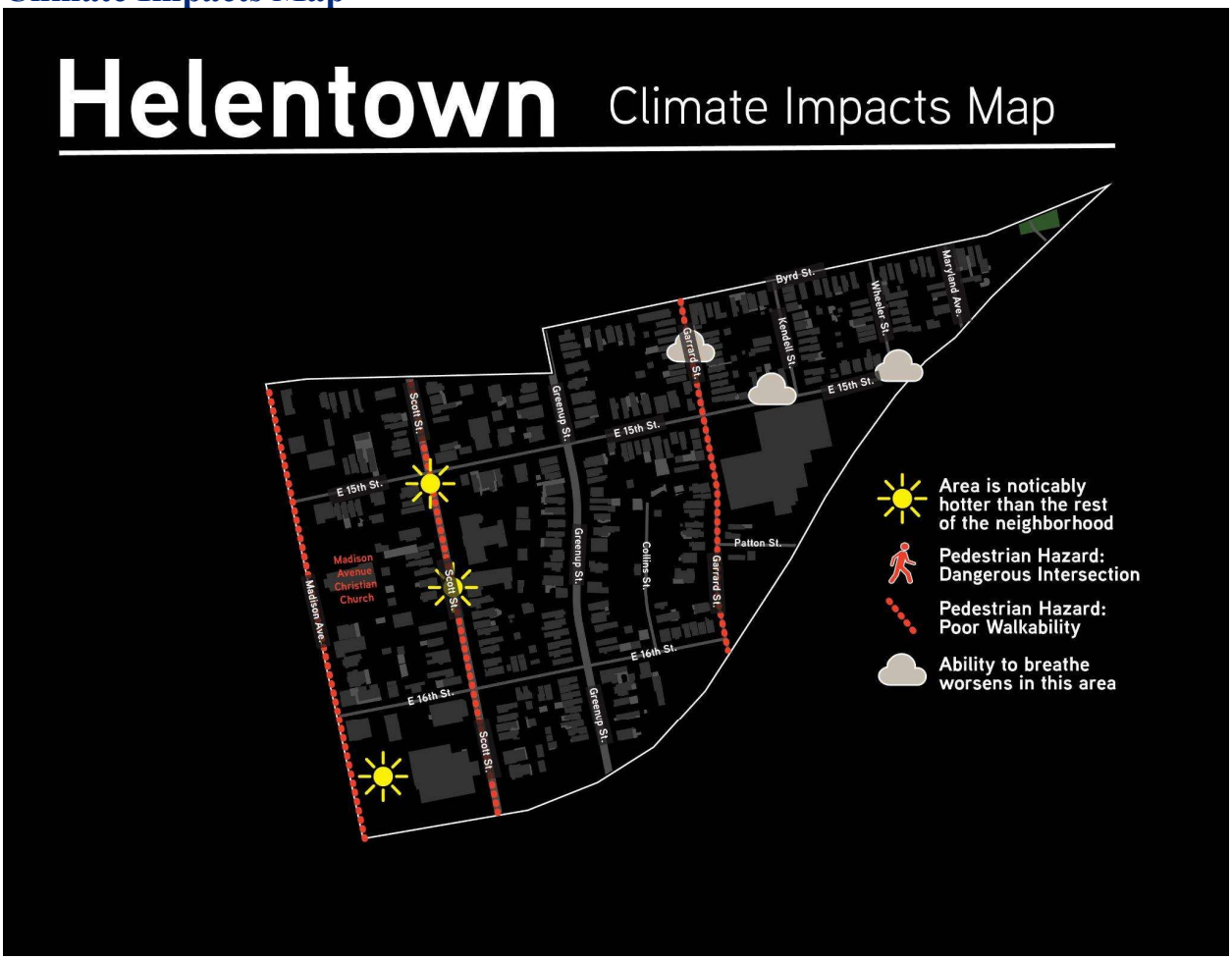
Climate Impacts Map



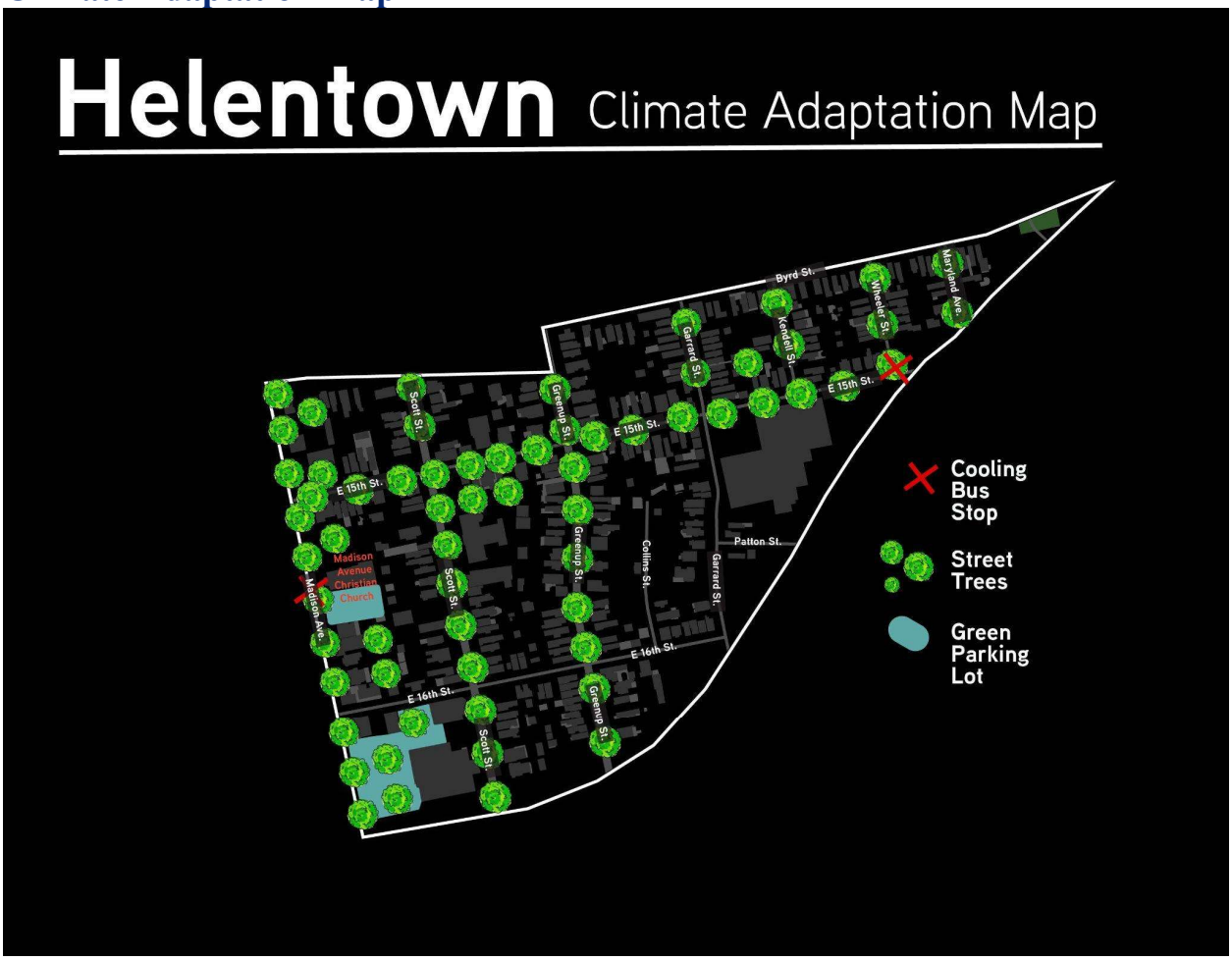
Climate Adaptation Map

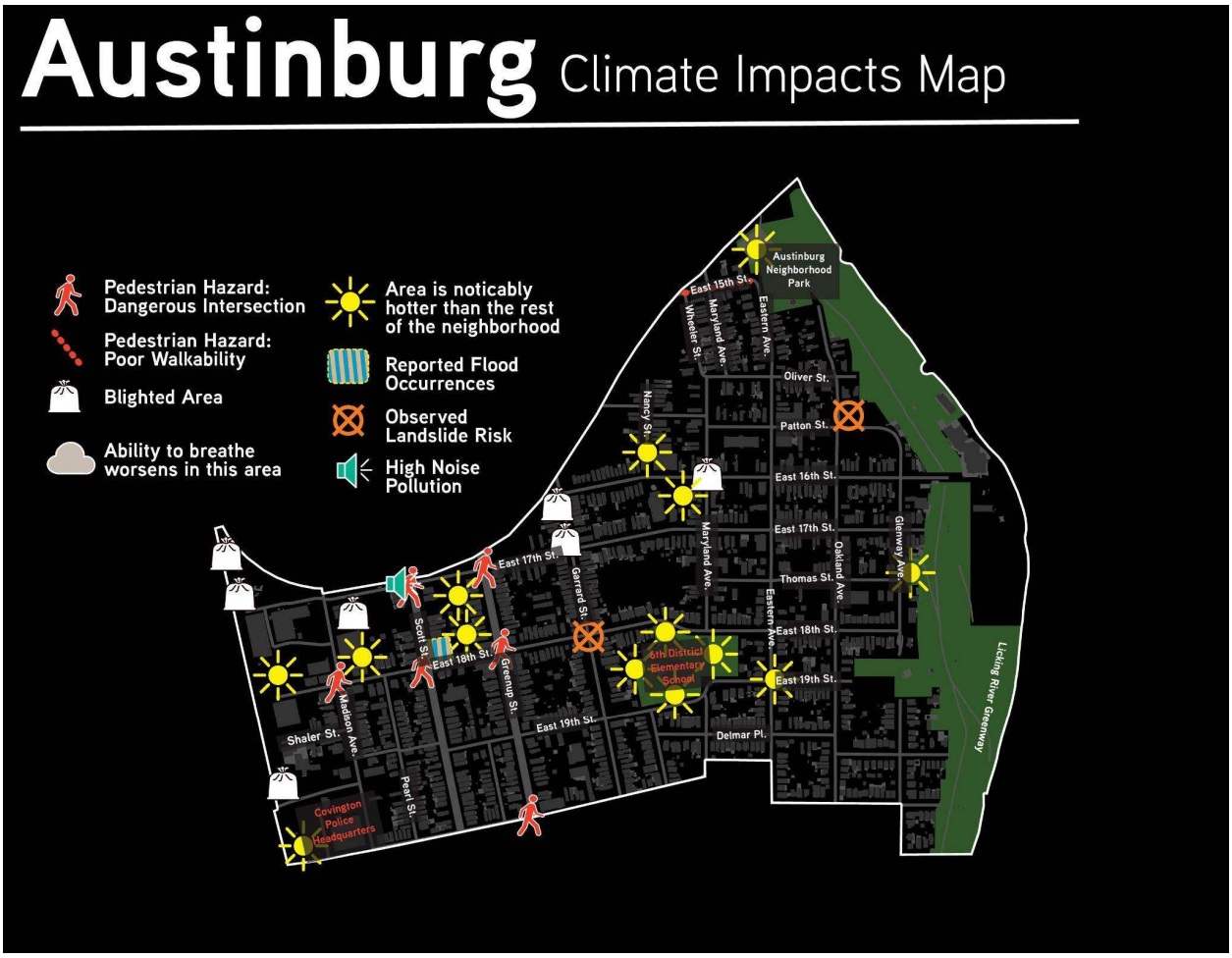


Helentown
Climate Impacts Map

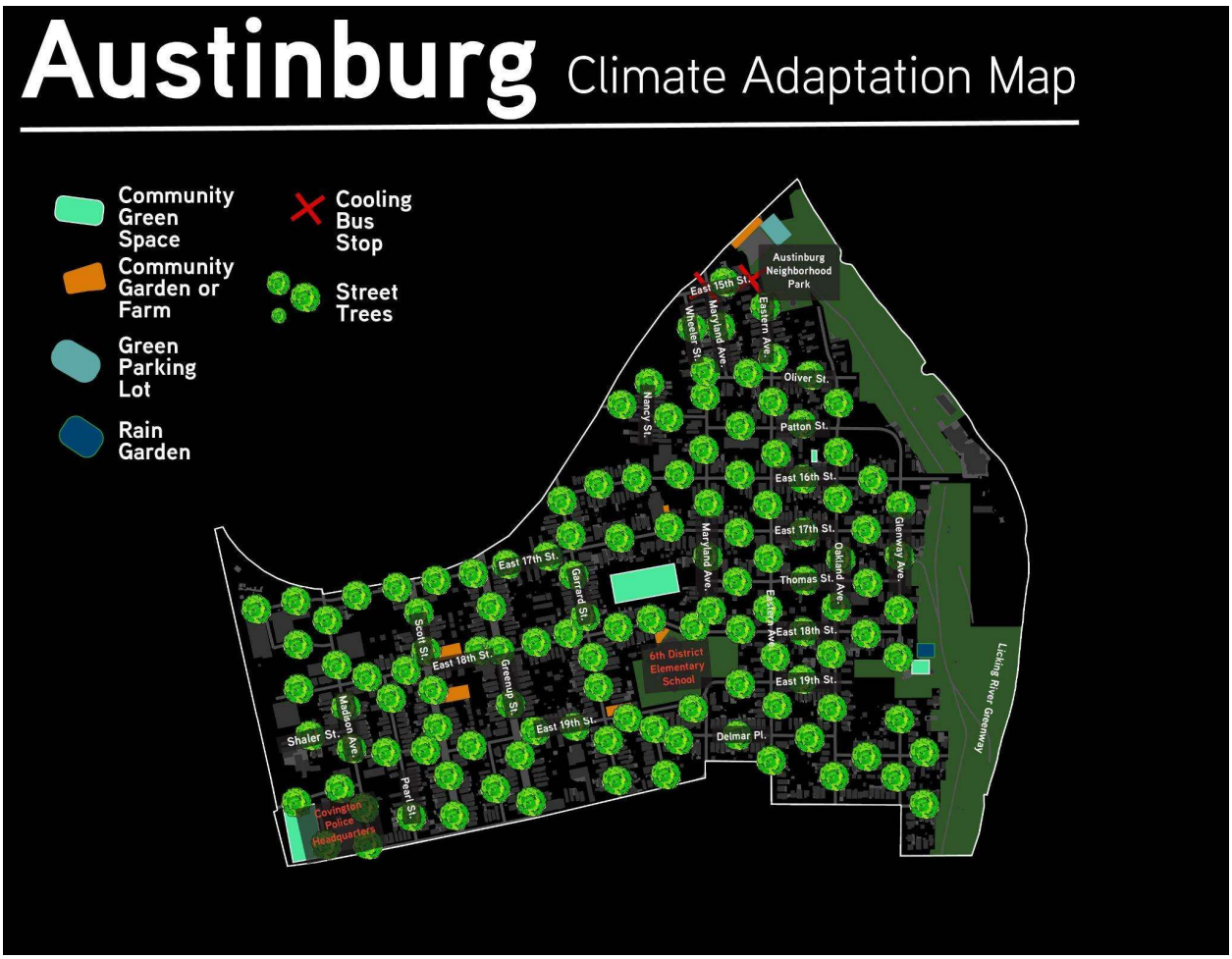


Climate Adaptation Map




Austinburg Climate Impacts Map
Pedestrian Hazard: Dangerous Intersection
Pedestrian Hazard: Poor Walkability
Blighted Area
Ability to breathe worsens in this area
Area is noticably hotter than the rest of the neighborhood
Reported Flood Occurrences
Observed Landslide Risk
High Noise Pollution
Austinburg Neighborhood Park
East 15th St.
Wheeler St.
Maryland Ave.
Eastern Ave.
Oliver St.
Nancy St.
Patton St.
East 16th St.
East 17th St.
Maryland Ave.
Oakland Ave.
Glenway Ave.
Thomas St.
Eastern Ave.
East 18th St.
East 19th St.
Delmar Pl.
6th District Elementary School
Licking River Greenway
East 17th St.
Garrard St.
Scott St.
East 18th St.
Greenup St.
Madison Ave.
Shaler St.
East 19th St.
Pearl St.
Covington Police Headquarters

Climate Adaptation Map



More information about City of Covington's data, metrics and maps can be found on [CSN Resilience Hub website]

COMMUNITY ADVISORY GROUP - Winton Hills, a neighborhood in the City of Cincinnati , Ohio

Introduction

Historical Context

- **Rolling Ridge, Wooden Shoe Hollow and undeveloped/agricultural land were annexed in 1911 and formed Winton Hills.**
- **The community experienced demographic changes in the 1960s–1970s, becoming predominantly Black as middle-class families migrated out.**
- **Industrial decline, disinvestment, and environmental hazards marked much of the mid–20th century, though community-led revitalization began in the 1980s.**

Demographics & Socioeconomic Indicators

- **Current population: 4,961 residents, predominantly Black.**
- **Nearly half (47.3%) of residents are 17 years or younger.**
- **Life expectancy is 73.1 years.**
- **Socioeconomic challenges include high poverty (61.5%) and limited health insurance access (17.7% uninsured).**

Health Indicators

- **Significant prevalence of asthma, obesity, and diabetes.**
- **Environmental factors contribute to respiratory and chronic disease risks.**
- **Residents face higher-than-average exposure to pollution-related health burdens.**

Ecosystem & Infrastructure Indicators

- **Tree canopy coverage ranks 21st citywide, with strong greenspace presence (9th in parks, 6th in greenness).**
- **Heat island exposure ranked 26th with moderate vulnerability (heat index 0.54).**
- **Residents face very high proximity to hazardous waste sites, water pollution, and moderate cancer/respiratory risks from air pollution.**

Top 3 Ranked Priorities

- **Food Access**
- **Planning and Sustainable Development**
- **Energy Efficiency and Renewable Energy**

Key Takeaways for Climate Action

- **Prioritize pollution mitigation, especially hazardous waste and water quality.**

- **Expand tree canopy and green infrastructure to offset urban heat and impervious surface exposure.**
- **Address environmental justice concerns by targeting health disparities linked to air and water pollution.**
- **Strengthen community resilience through equitable health, housing, and climate adaptation strategies.**
- **Build on community-led revitalization to support sustainable, inclusive redevelopment.**
- **Youth CAG group showcased a higher understanding of climate change and the connection between climate and racial equity and systemic racism, as well as a higher understanding of climate resiliency efforts in their community. Their confidence in their ability to influence climate resilience efforts also increased.**

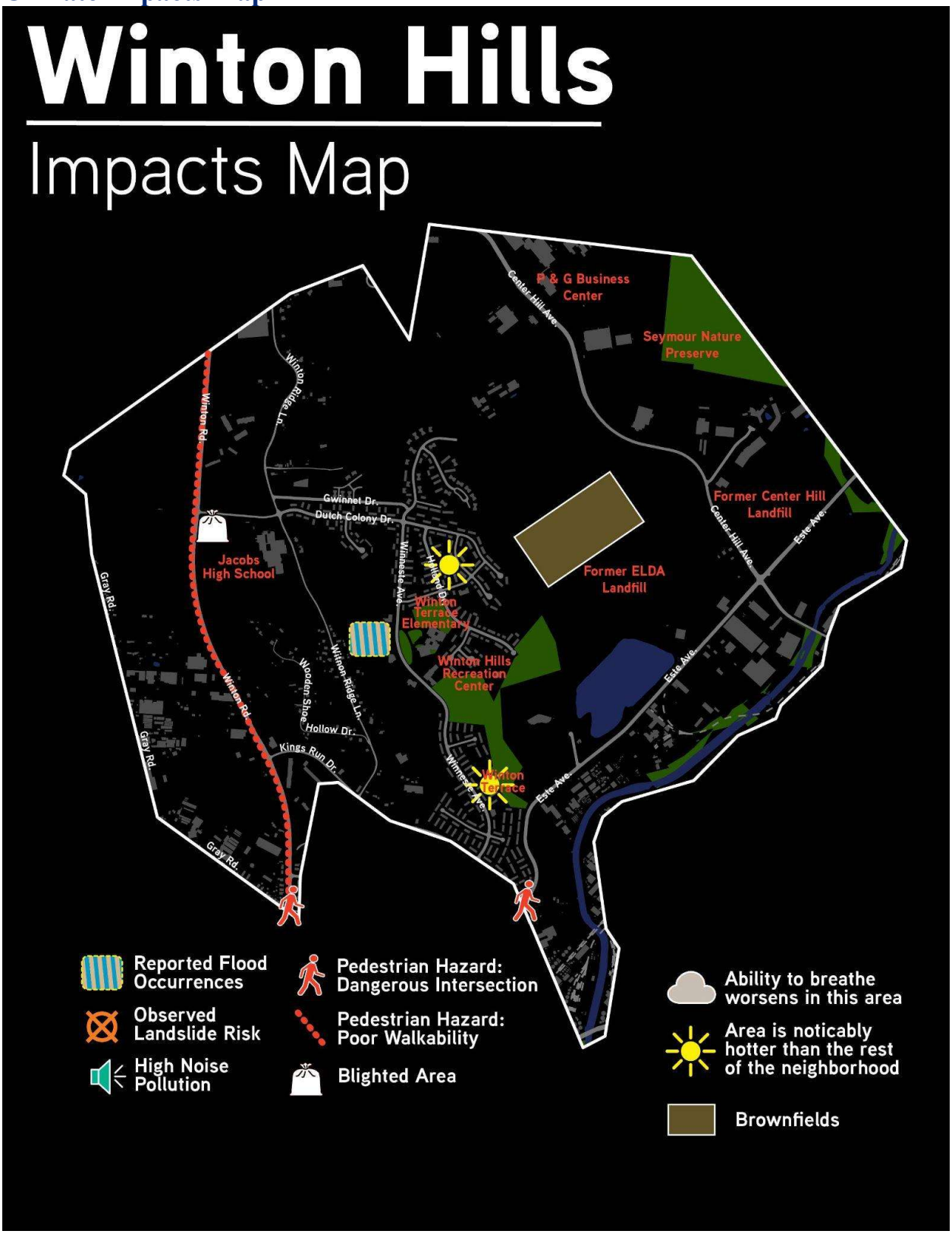
Participants List

Dalonna P
Dominic R
KeyShaun K
De'Angelo B
Dionte L
Dontae W
Emyiah M
Kenneth S
Jay'ionna D
Thylen S
Chris G
Ja'Braila T
Daminica C
Larelle Bandy
Angela G
Yemarishet M
Eileen F
Naim M
Obalaye M

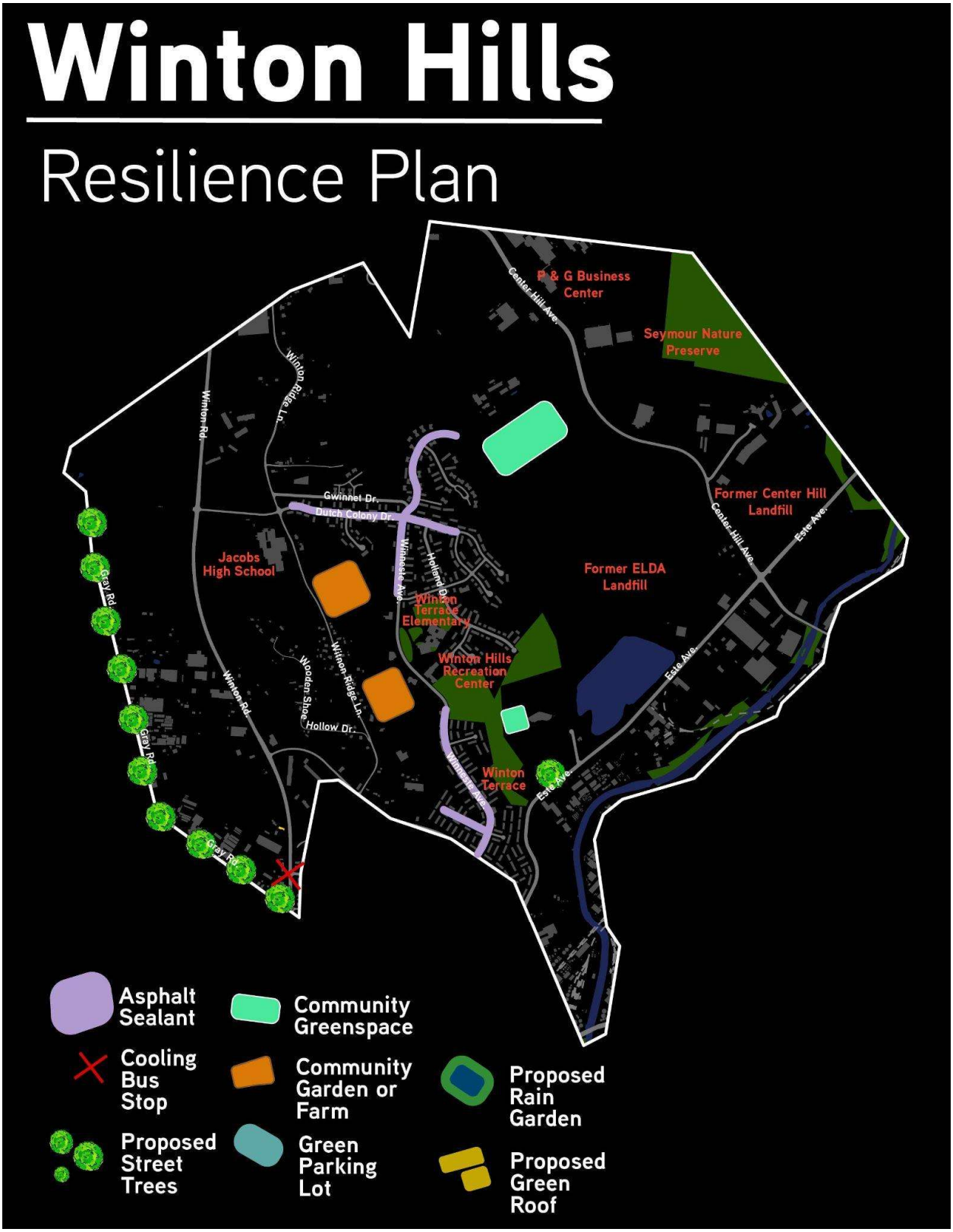
Engagement



Targeted Neighborhood Climate Impacts Map



Climate Adaptation Map



More information about Winton Hills' data, metrics and maps can be found on [CSN Resilience Hub website]

COMMUNITY ADVISORY GROUP - West End, a neighborhood in the City of Cincinnati, Ohio
Introduction

West End Neighborhood – Climate Action Plan Highlights

Historical Context:

- **Once a major industrial hub and center of Black culture in Cincinnati, the West End thrived from the 1870s to 1940s with strong community institutions.**
- **Mid-20th century urban renewal projects, including I-75 construction and Queensgate industrial development, displaced over 25,000 residents, causing lasting economic decline and loss of cultural centers.**
- **Recent development pressures, including TQL Stadium, continue to raise displacement concerns, despite a Community Benefits Agreement for resident-led investments and workforce opportunities.**

Demographics & Socioeconomic Indicators:

- **Population: ~5,658 residents, with 28% under 17 years.**
- **Poverty rate: 48.8%; 25.8% of residents lack access to a vehicle.**
- **Active community organizations and ongoing planning efforts, such as the West End Speaks Plan and Housing Study.**

Health Indicators:

- **Life expectancy: 71.3 years.**
- **High prevalence of obesity (50%), high blood pressure (47.3%), and asthma (14.7%).**
- **Many residents face barriers to healthcare access.**

Ecosystem & Infrastructure Indicators:

- **Tree canopy cover: 0.4%; greenness of land surfaces: 17.6%; impervious surfaces: 75%.**
- **Urban heat island exposure affects 2.16% of residents.**
- **Environmental conditions highlight the need for green infrastructure, heat mitigation, and resilient urban planning.**

Top 5 Ranked Priorities

- **Creating more Greenspace like parks and planting more trees**
- **Addressing Gentrification and Creating affordable Housing**
- **Addressing Flooding Issues**
- **Ensuring Good Air Quality**
- **Food Insecurity**

Key Takeaways for Climate Action:

- **Address health disparities and improve access to green spaces, particularly spaces to grow food.**
- **Prioritize community-led planning to mitigate displacement from development.**
- **Invest in urban greening, tree canopy expansion, and heat island reduction strategies.**
- **Integrate socioeconomic and environmental interventions to enhance resilience and equity in the neighborhood.**
- **Increased education efforts for the youth to learn about environmental impact early on.**
- **Improvements are needed for community park spaces.**

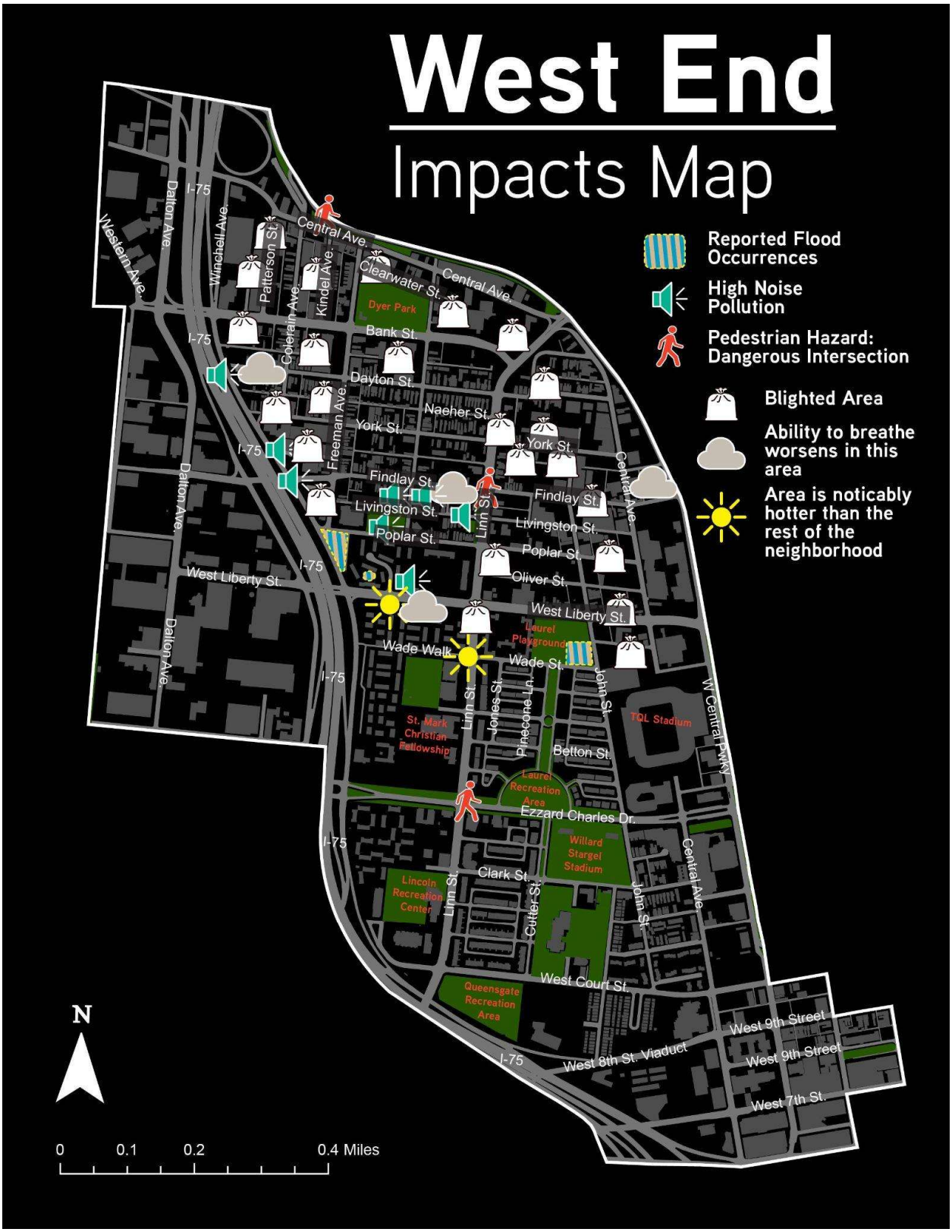
Participants List

Mildred P
Shelia N
Dormonta H
Thelma H
Glenis A
Marcello M
Kei'ontae P
Scarlett H
Bryant P
Marc C
Torry Y

Engagement



Targeted Neighborhood - West End
Climate Impacts Map



Climate Adaptation Map



More information about West End's data, metrics and maps can be found on [CSN Resilience Hub website]

Climate Safe Neighborhoods Lite

CLIMATE SAFE NEIGHBORHOODS LITE - City of Dayton, Kentucky

Introduction
Historical Context:
The riverside areas of Dayton were redlined in the 1930s, originally cited as flood-prone zones but effectively restricting home financing for residents. These historical policies have contributed to present-day lower income levels and worse health outcomes in these neighborhoods.

Demographics & Socioeconomic Indicators:
Dayton contains two federally designated disadvantaged Census Tracts, which meet thresholds for environmental, climate, and socioeconomic burdens. These tracts experience high poverty and limited access to resources, reflecting long-term structural inequities.

Health Indicators:
Riverside Census Tracts show elevated health risks, including higher exposure to diesel particulates, which contribute to asthma, heart disease, and lung cancer. Vulnerable populations are disproportionately affected by environmental and climate-related health hazards.

Ecosystem & Infrastructure Indicators:
Vegetation and tree canopy cover in riverside Census Tracts are extremely low (5.11%–5.79%), exacerbating flooding, heat, and poor air quality. Climate vulnerability scores for Dayton's tracts range from 3.37 to 6.82 on a 0–10 scale, indicating moderate to high susceptibility to climate impacts.

Key Takeaways for Climate Action:

- **Historical redlining has contributed to present-day socioeconomic and health disparities.**
- **Disadvantaged tracts face compounded climate, environmental, and health burdens.**
- **Low tree canopy and vegetation increase exposure to heat, flooding, and poor air quality.**
- **Targeted interventions in these tracts—such as greening initiatives, flood mitigation, and air quality improvements—are critical to equitable climate resilience.**

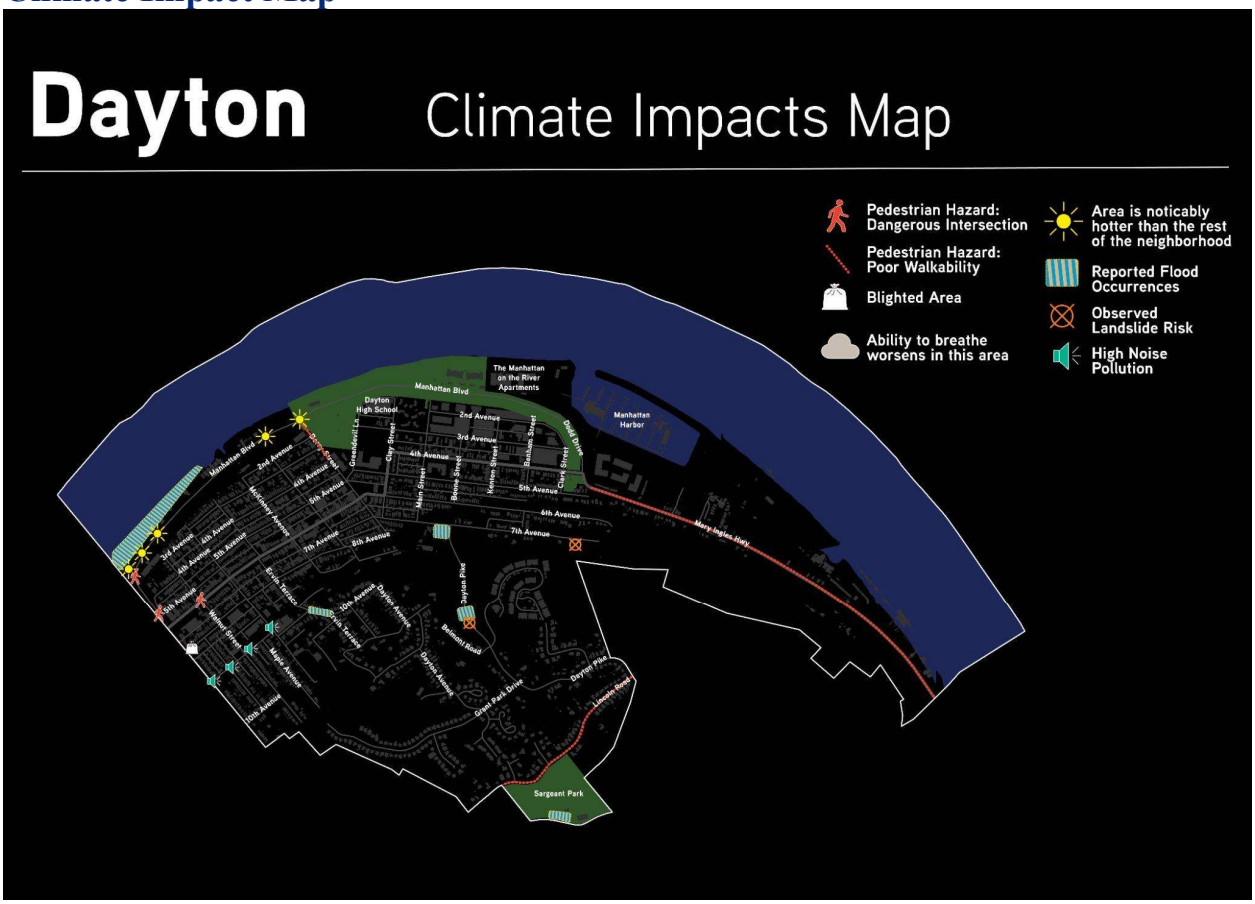
Engagement



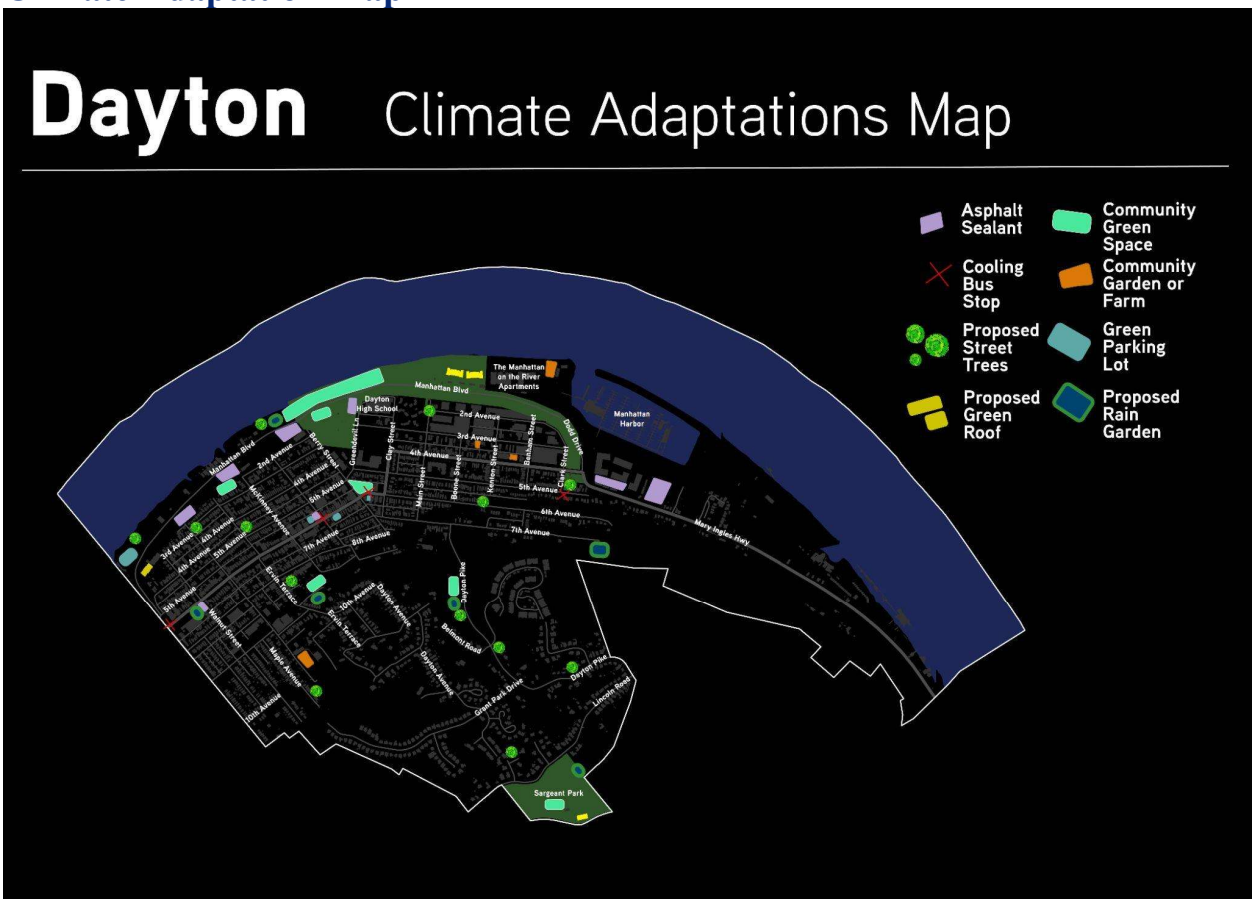
Targeted Tracts:

- 051101
- 051200

Climate Impact Map



Climate Adaptation Map



More information about West End's data, metrics and maps can be found on CSN Resilience Hub website

2024 CLIMATE SAFE NEIGHBORHOODS LITE - City of Newport(West side), Kentucky

Introduction

Historical Context

- **Flood-prone areas in West Newport were redlined in the 1930s.**
- **In 2022, real estate prices reflected historical disinvestment: $277,000 in non-redlined areas vs. $165,000 in redlined areas.**
- **Several federally designated disadvantaged Census Tracts exist in West Newport, indicating combined environmental, climate, and socioeconomic burdens.**

Demographics & Socioeconomic Indicators

- **West Newport contains multiple disadvantaged tracts facing high environmental and socioeconomic challenges.**
- **Vulnerability analysis scores range from 6.1–8.21 out of 10, signaling high climate risk.**

Health Indicators

- **Residents experience elevated exposure to PM 2.5, with national percentiles at 90, 88, 78, and 62.**
- **Air quality concerns increase risk for respiratory and cardiovascular conditions.**

Ecosystem & Infrastructure Indicators

- **Tree canopy coverage is extremely low (4.4%–6.3%), contributing to higher local temperatures, increased flooding, and reduced air quality.**
- **Low vegetation cover exacerbates vulnerability to flooding**

Key Takeaways for Climate Action

- **Historical disinvestment and redlining have amplified environmental and socioeconomic risks.**
- **Flooding, low tree canopy, and poor air quality are key climate vulnerabilities.**
- **Priority actions should focus on increasing green infrastructure, reducing air pollution exposure, and addressing inequities in climate resilience.**
- **There is a need for higher connection to policy, project funding and awareness on climate action**

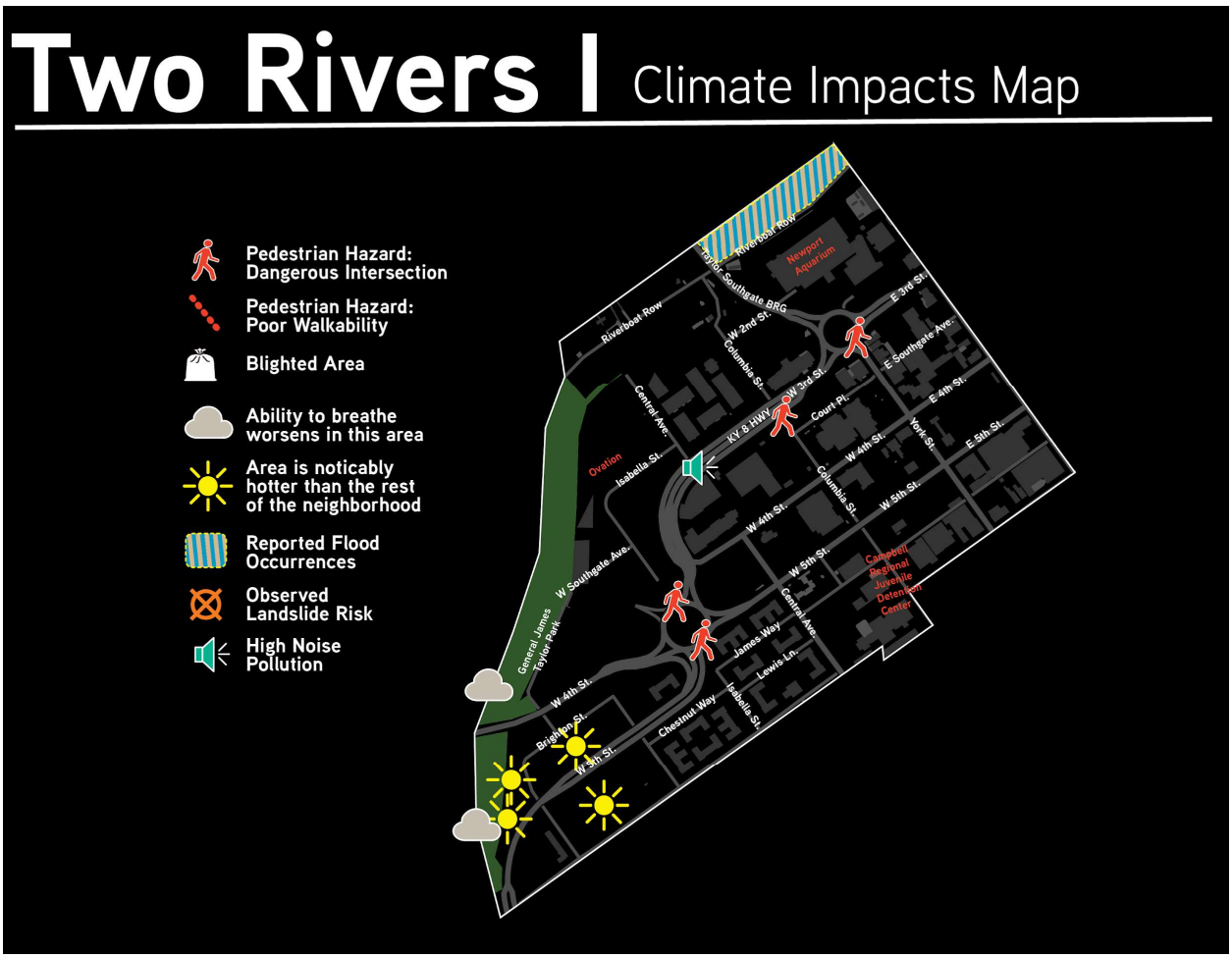
Engagement



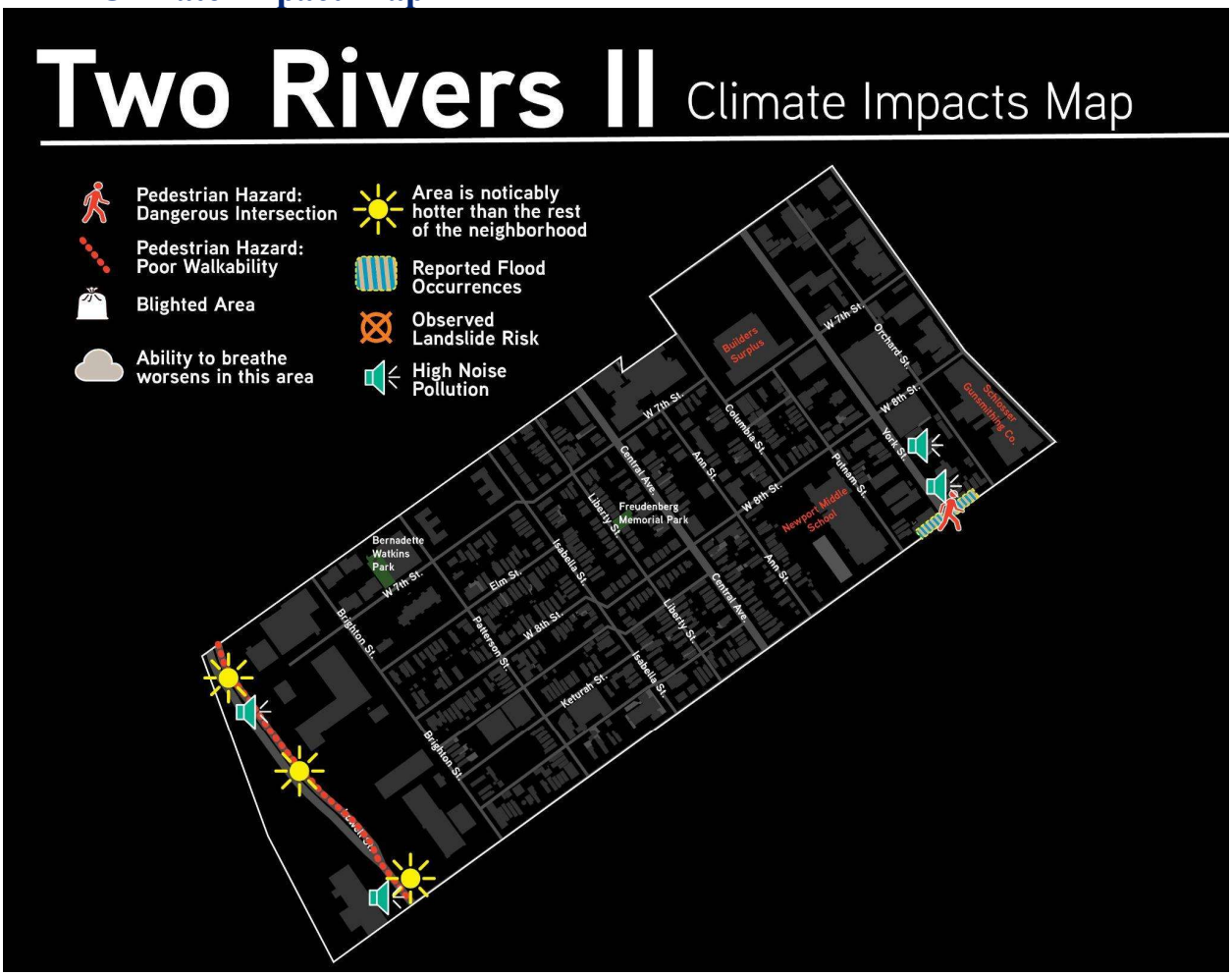
Target Neighborhoods:

1. **Two Rivers 1**

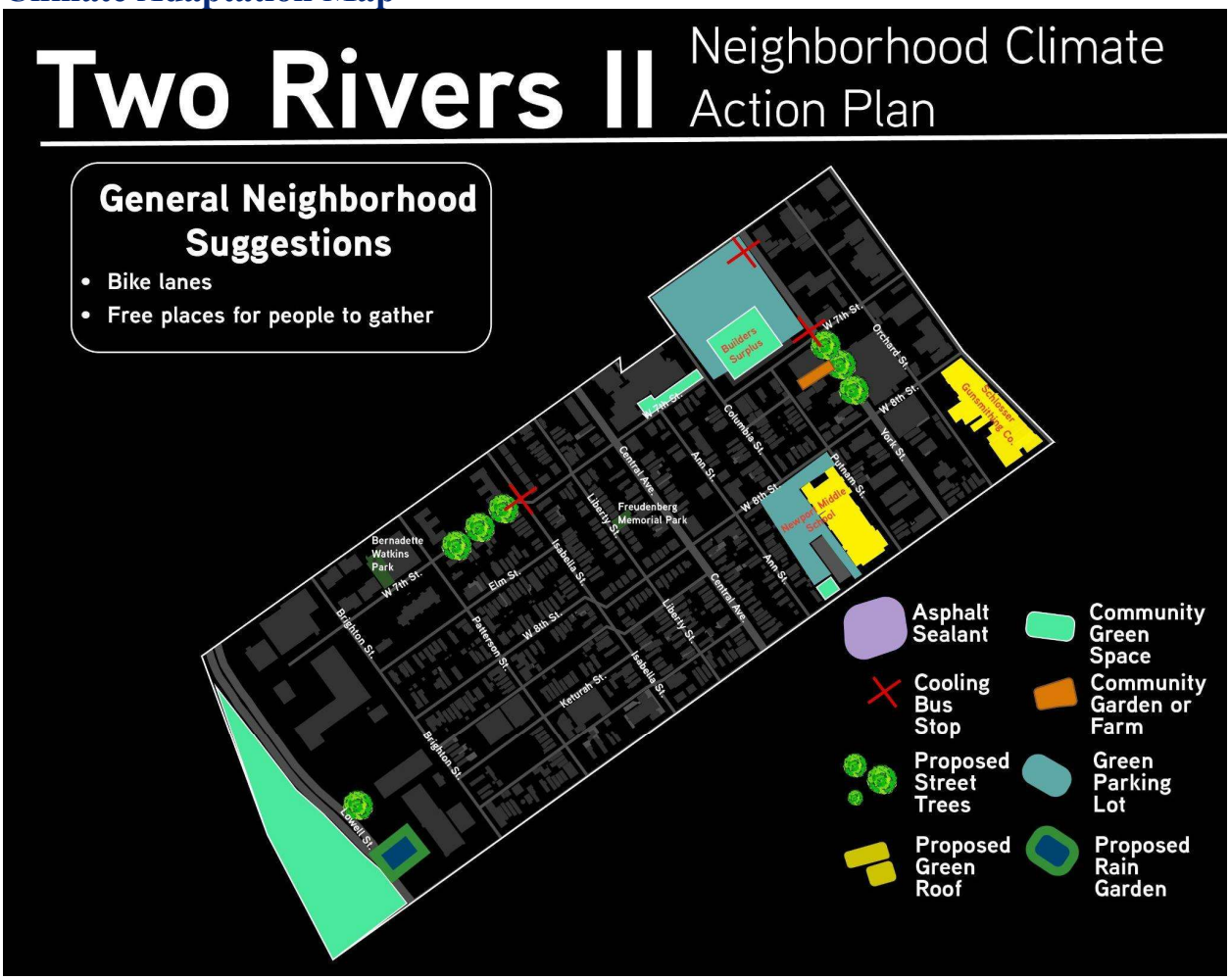
Climate Impact Map



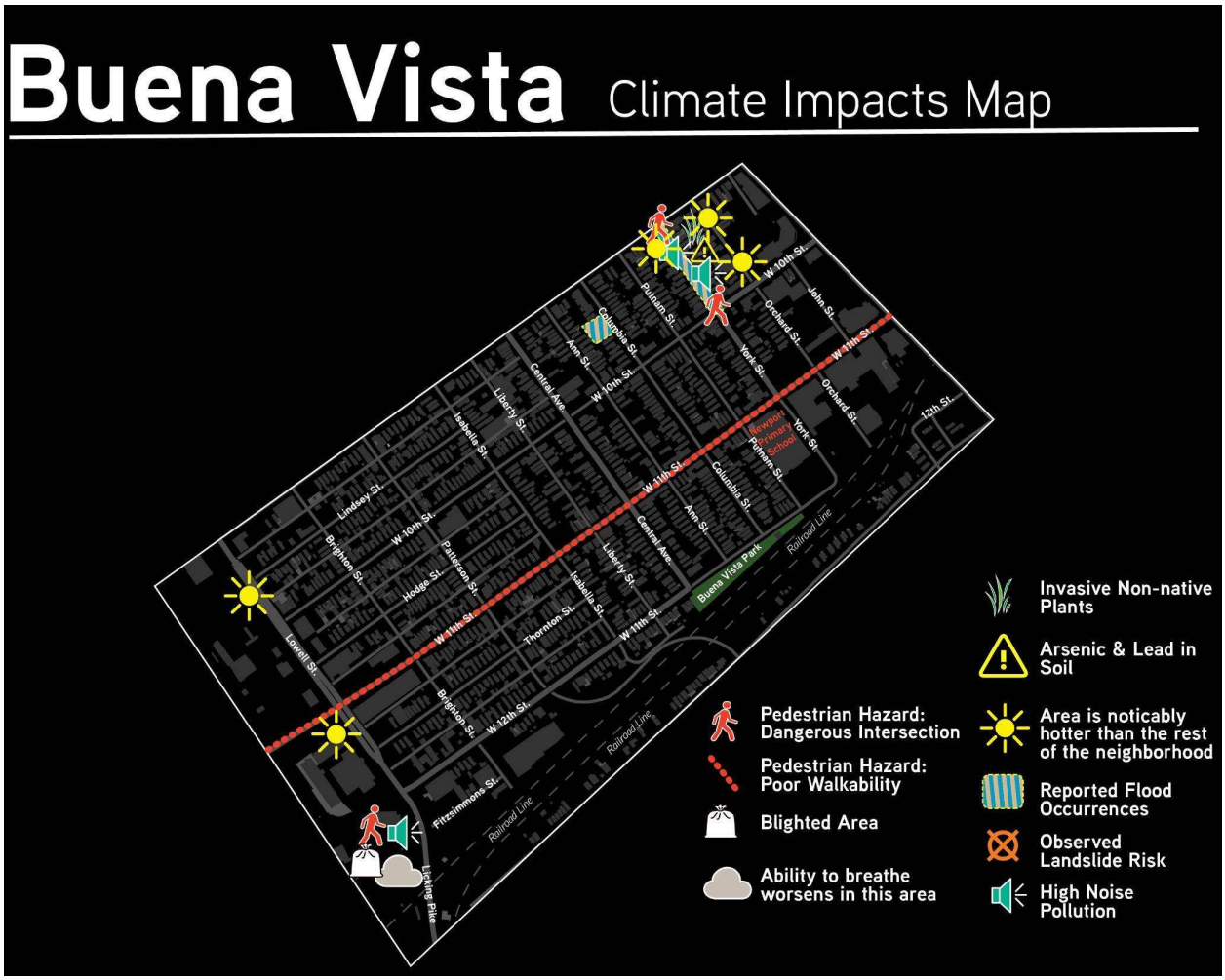
2. Two Rivers 2
Climate Impact Map



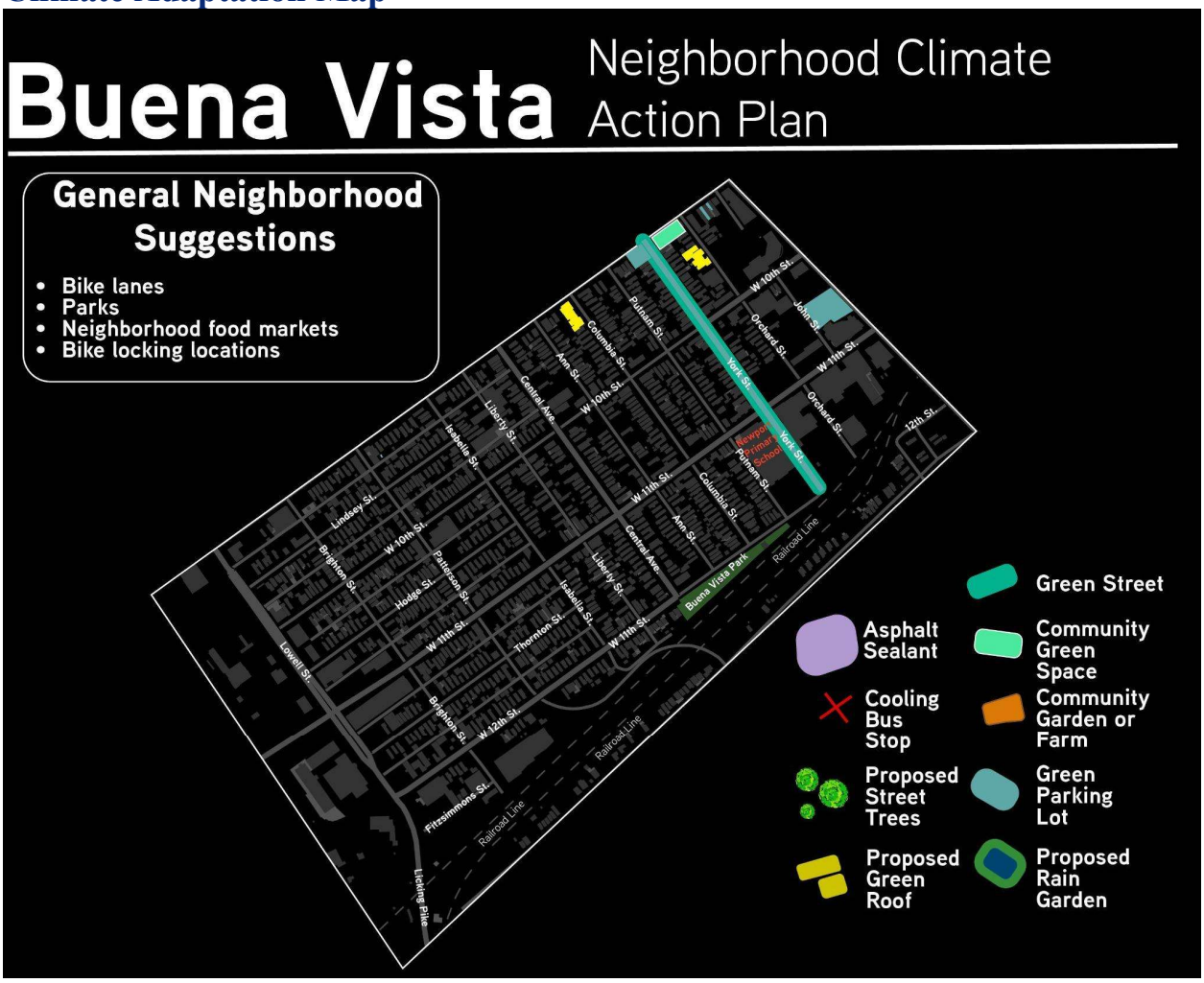
Climate Adaptation Map



3. Buena Vista
Climate Impact Map



Climate Adaptation Map



More information about data, metrics and maps can be found on [CSN Resilience Hub website]

Credits, Resources and Citations

1. https://www.groundworkorv.org/programs/climate-safe-neighborhoods/
2. https://greenumbrella.org/
3. Thrivetogether: A Sustainability Playbook for Greater Cincinnati
4. Centre for Great Neighborhoods of Covington
5. Keep Covington Beautiful
6. ReNewport
7. Keep Norwood Cool - Participatory mapping activity || engagement
8. https://www.angelfire.com/ia2/mounds/index.html
9. Center for Great Neighborhoods of Covington
10. City of Covington Urban Forestry
11. City of Dayton Parkboard
12. Westside Citizens Coalition

13. Northern Kentucky Urban & Community Forestry Council

14. https://www.angelfire.com/ia2/mounds/norwood.html,

15. https://sites.rootsweb.com/~ohnhs2/BriefHistory.html

16. https://sites.rootsweb.com/~ohnhs2/date2000s.html

17. https://justice.tougaloo.edu/sundowntown/norwood-oh/

18. Cincinnati Climate Equity Indicator Report 2021 -

APPENDIX D: GHG INVENTORY METHODOLOGY

Greenhouse Gas Inventory Methodology

The development of the greenhouse gas (GHG) inventory required several different approaches in order to build a full picture of emissions within the region. Whenever available, actual energy consumption values or reported emissions values were used. When these data were not available, consumption estimates were developed in order to provide a foundation for creating emissions estimates. These processes are detailed below.

Mobile Combustion

On Road

Energy consumption, vehicle type, and vehicle miles traveled (VMT) are the main drivers of on road emissions. Due to the difficulty in acquiring consistent on-road data across counties within Indiana, Kentucky, and Ohio, on-road emissions for the PCAP were developed by projecting 2020 National Emissions Inventory (NEI) values using the growth in statewide energy consumption for each particular fuel. The growth rate was calculated using 2020 and 2022 transportation fuels data found in the US Energy Information Administration's State Energy Data System (US EIA SEDS). When 2022 data were not available, they were projected based on the average annual growth rate for 2015-2021 for each individual fuel.

The US EPA's Motor Vehicle Emissions Simulator (MOVES) model was used to improve the GHG inventory for the CCAP. County level results were attributed to census tracts for the dashboard based on road miles and usage patterns.

Off Road

Energy consumption and type of transportation are the main drivers of off road emissions. Off road emissions estimates employ energy consumption values developed by UNPREDICTABLEcity at the county level. Generally, state-level energy consumption values provided by the US EIA are downscaled to the local-level based on known local data. When possible, actual local energy consumption values replace estimates. This methodology was developed as part of the 2015 Franklin County (Ohio) Energy Study, and has since been used to develop emissions estimates for the Ohio Air Quality Development Authority, Power a Clean Future Ohio, the Energy Foundation, and fifteen greenhouse gas inventories for local governments throughout Ohio.

Air

Attribution of kerosene-type jet fuel is based on departures from individual airports as reported by the Federal Aviation Administration (FAA) and the US Bureau of Transportation Statistics (US BTS).

Aviation gasoline, primarily used in small propeller planes, is attributed based on registered single-engine aircraft.

Energy consumption values are then multiplied by the corresponding emission factor as presented on the US EPA's Emission Factor Hub. 1

Rail

Trains are assumed to use diesel fuel or electricity. Electricity consumption for trains is often captured in US EIA Form-861 under the "Transportation" sector. No transportation electricity consumption was reported for the region.

Diesel consumption is based on rail-miles travelled for passenger and freight rail, fuel tables 4-25 and 4-18 from the US BTS, and local rail line information. Energy consumption values are then multiplied by the corresponding emission factor as presented on the US EPA's Emission Factor Hub.

Maritime

The maritime industry is assumed to be the primary source of residual fuel consumption in the transportation sector. Fuel consumption estimates are developed by taking the state level total for residual fuel (as found in US EIA SEDS) and attributing consumption based on the number of docks and their use, as noted in the US BTS's Citizen Connect database and local information. Energy consumption values are then multiplied by the corresponding emission factor as presented on the US EPA's Emission Factor Hub.

Electric Power Consumption

Actual county-level electricity consumption values were made available by Duke in counties where they operate. US EIA Form-861 provides electricity consumption values for municipal utilities. When these data encompassed the entirety of a county's electricity consumption, they were then multiplied by the US EPA eGRID factor provided for the corresponding subregion. All counties in Ohio and Indiana are within the Reliability First Corporation West (RFCW) subregion. All Kentucky counties are within the Southeast Reliability Corporation Tennessee Valley (SRTV) subregion. US EPA's most recent line loss value was for 2022; 4.5% for the Eastern United States.

When an entire county's electricity consumption could not be aggregated with available data, estimates were produced for the residential, commercial, and industrial sectors using downscaled state-level data provided by US EIA SEDS database. Residential energy consumption estimates were developed based on housing type, fuel use, and average energy consumption values provided by US EIA in the Residential Energy Consumption Survey. Energy consumption values are then multiplied by the corresponding emission factor as presented on the US EPA's Emission Factor Hub.

Commercial and Industrial estimates were developed based on square footage, building use, and information provided in US EIA's Commercial and Manufacturing Energy Surveys. Energy

consumption values are then multiplied by the corresponding emission factor as presented on the US EPA's Emission Factor Hub. When emissions values were reported to US EPA through the GHGRP, they replaced estimates for individual buildings.

Stationary Combustion

Natural Gas

Actual county-level natural gas consumption values were made available by Duke in counties where they operate. When these data encompassed the entirety of a county's electricity consumption, they were then multiplied by the corresponding emission factor as presented on the US EPA's Emission Factor Hub.

When an entire county's natural gas consumption could not be aggregated with available data, estimates were produced for the residential, commercial, and industrial sectors using downscaled state-level data provided by US EIA SEDS database. Residential energy consumption estimates were developed based on housing type, fuel use, and average energy consumption values provided by US EIA in the Residential Energy Consumption Survey. Energy consumption values are then multiplied by the corresponding emission factor as presented on the US EPA's Emission Factor Hub. 2 Commercial and Industrial estimates were developed based on square footage, building use, and information provided in US EIA's Commercial and Manufacturing Energy Surveys. Energy consumption values are then multiplied by the corresponding emission factor as presented on the US EPA's Emission Factor Hub. When emissions values were reported to US EPA through the GHGRP, they replaced estimates for individual buildings.

Other Fuels

Estimates were produced for the residential, commercial, and industrial sectors using downscaled state-level data provided by US EIA SEDS database. Residential energy consumption estimates were developed based on housing type, fuel use, and average energy consumption values provided by US EIA in the Residential Energy Consumption Survey. Energy consumption values are then multiplied by the corresponding emission factor as presented on the US EPA's Emission Factor Hub. Commercial and Industrial estimates were developed based on square footage, building use, and information provided in US EIA's Commercial and Manufacturing Energy Surveys. Energy consumption values are then multiplied by the corresponding emission factor as presented on the US EPA's Emission Factor Hub. When emissions values were reported to US EPA through the GHGRP, they replaced estimates for individual buildings.

Fugitive Emissions

Emissions from natural gas that leaks from pipes and equipment was estimated as 0.5% of total natural gas consumption. This value was then multiplied by the emissions factor for natural gas released into the air without combustion. Fugitive emissions were attributed to the geography where consumption occurred.

Tree Canopy Benefits

Carbon sequestration occurring as a result of tree growth was estimated by aligning 2023 National Land Classification Database (NLCD) Tree Canopy Cover (TCC) geospatial datasets with economic sector datasets, as well as census tract data. Total acreage of tree canopy by sector by census tract was then multiplied by the average carbon sequestration per acre factor for the region.

Agricultural Emissions

Emissions resulting from agricultural activities were estimated based on US EPA's standard guidance for sub-state estimates. State-level data are scaled to the county level based on the State GHG Inventory and local information provided by the USDA's National Agricultural Statistics Service (NASS).

Renewable Energy Credits (RECS)

The region purchases a significant amount of RECS via local electricity aggregation programs and also generates RECS through solar facilities. When known, RECS were included in net-calculations only.

Waste

Waste emission values were taken directly from the US EPA's GHGRP. Additional landfills not included in the GHGRP exist but may not be in operation. 3

Wastewater

Wastewater emission estimates were developed using the US EPA's Local Greenhouse Gas Inventory Tool, Wastewater module. All known wastewater treatment facilities were assessed to have aerobic or anaerobic digestion capacity. Estimates on their population served were developed. Default data are used for other required data inputs. Facility information is aggregated to the county level and processed in LGGIT.

APPENDIX E: IMPLEMETATION SCENARIO PPROJECTIONS NOTES

Transportation Sector

1.A Buildout a robust EV charging network

- Currently a ratio of 15 EV registrations per charging port in the region.
- The one charging port to 15 EV registrations ratio was compared to reported ratios at the state level from other regions. Comparisons validate that this ratio is reasonable for the region.
- Projections from BloombergNEF indicate that 27% of new passenger vehicle purchases by 2030 will be EVs. It further projects 88% of new passenger vehicle purchases will be EVs by 2050.
- A gradual, incremental increase in EV registrations is applied to the region based on the rate of EV purchases increasing over time from the current 8% to 27% in 2030 and to 88% in 2050. These percentages are applied to project the total number of EVs in the region, which comes out to an additional 30,710 EVs by 2030, and 404,993 EVs by 2050. The number of charging ports in the region are projected to maintain the 1 to 15 ratio. The ratio requires 2,047 new charging ports by 2030, and 27,000 new charging ports by 2050 to maintain the charger ratio.
- The difference in GHG emissions emitted per passenger vehicle to EV is calculated to determine the GHG emissions reduction per vehicle transition. Each passenger vehicle emits 4.11 MT CO2e per year, while each EV emits 3.22 MT CO_2e per year. The total GHG emissions reduced per passenger vehicle transition to EV is 0.89 MT CO_2e per year. The emissions reductions per charging port, 15 EVs per charging port, is a reduction of 13.28 MT CO2e.

  Emissions Reduced per year:
  2030: 27,184 MT CO_2e
  2050: 358,560 MT CO_2e

1.B Convert public and private vehicle fleets to Electric Vehicles

- Conversion projects in the region pushing the electrification of vehicles include diesel transit buses to hybrid, municipal fleet vehicles to EV, diesel school buses to EV, diesel locomotives to battery electric, and trucks to drone deliveries.
- Cincinnati set a goal to purchase 400 new EVs for their fleet by 2030 in the Green Cincinnati Plan. 500 municipal vehicles are projected to be replaced with EV by 2030. 4,500 municipal vehicles will be replaced with EVs by 2050. Each vehicle emits 4.11 MT CO2e per year, while each EV emits 3.22 MT CO2e per year. The total GHG emissions reduced per vehicle transition to EV is 0.89 MT CO2e per year.

- Projections from Petermann show buses have an average lifespan of 12 years. 1/12 of a fleet is replaced each year. This is used to project the regional transition of diesel to electric buses between 2022 to 2030 and 2050. 39 Diesel transit buses will be replaced with hybrid buses, and 335 diesel school buses will be replaced with electric buses by 2030. Transit and School Bus fleets will undergo complete fleet transition to electric by 2050. Diesel buses emit 83.3 MT CO_2e per year and hybrid buses emit 68.7 MT CO_2e per year. The total emissions reductions from transitioning to a hybrid bus is 14.59 MT CO_2e. Transitioning from a diesel to electric bus reduces emissions by 10.81 MT CO_2e per year.
- Two diesel locomotives in Cincinnati are being replaced with battery electric. The projected emissions reductions for switching from diesel to battery electric locomotive is 23.62 MT CO_2e per year. Navigant projects 22% of deliveries in the region will be completed by drones by 2030. The GHG emissions reduction when deliveries are completed through drones instead of diesel trucks is 370 grams CO_2e per package.

Emissions Reduced per year:
2030: 19,305 MT CO_2e
2050: 68,455 MT CO_2e

1.C Encourage the use of transit, non-motorized vehicle, or walking for more trips within the region

- The region has funding to develop 65 miles of new trail by 2030 and 325 miles of new trail by 2050.
- The Handbook for Analyzing Greenhouse Gas Emissions Reductions, Assessing Climate Vulnerabilities, and Advancing Health and Equity calculated that 10.77 MT CO2e emissions are reduced per mile per year of new trail.
- Projections show an expansion of transit ridership for Metro, TANK, and BCRTA services. 10% expansion of transit services through Bus Rapid Transit (BRT) by 2030, and a 25% expansion in BRT by 2050. The total number of new trips is 1,830,000 by 2030 and 4,575,000 by 2050 in the region.
- Improving language services for transit riders is projected to increase ridership by 150 new riders by 2050. Increasing the amount of affordable housing units near transit services can increase transit ridership by 10%. Each new rider will reduce emissions by 0.15 MT CO2e per trip in the region.

Emissions Reduced per year
2030: 297,772 MT CO2e
2050: 2,207,460 MT CO2e

1.D Use technology, sound roadway network design, and policy to reduce areas of persistent traffic congestion

- The region will replace 26 signalized intersections with roundabouts by 2030, and 130 traffic signals by 2050. 250 traffic signals per year will be optimized to improve the operation and timing in the region. Employers adjusting hours of shift labor is projected to reduce congestion by 18%.
- Approximately five roundabouts will be developed in the region every year. 26 new roundabouts are projected to be completed by 2030, and 130 new roundabouts are projected to be completed by 2050 in the region. The emissions reductions annually per roundabout is 78.80 MT CO2e.
- The study Simulation and Optimization of Traffic Lights for Vehicles Flow in High Traffic Areas reports that wait times can be reduced by 30% when adjusting the timing of traffic signals. Over the course of a year there is on average 29,930 hours of delay per traffic signal. Reducing this delay by 30% can reduce emissions by 27.93 MT CO2e per traffic signal per year.
- In the region, approximately 532,068 vehicles on the road are due to shift work. Adjusting the starting and ending hours of shift work for ⅓ of shift workers can reduce drivers on the road during rush hour by 177,356 drivers. The total emissions per driver during rush hour in the region is 96 lbs CO2e annually.

Emissions Reduced per year
2030: 45,443 MT CO2e
2050: 53,619 MT CO2e

1.E Support local development of sustainable aviation fuel

- Kentucky conducted a feasibility study identifying Bioeconomy Development Opportunity (BDO) Zones. The study identifies 18 zones which have potential to be developed into biofuels biomanufacturing plants.
- BDO Zones have the potential to reduce GHG emissions by 200,000 MT CO2e per plant. Assuming the capture rate of the 18 BDO Zones is 20%, approximately four BDO Zones will be captured and attract biomanufacturing plants.

Emissions Reduced per year
2050: 720,000 MT CO2e

1.F Support regional, intrastate, and interstate rail projects that move travelers and freight more efficiently

- Amtrak expansion of the Cleveland-Columbus-Dayton-Cincinnati (3C+D) corridor is estimated to open and begin service in 2035. An economic impact study of the expansion projects passenger use between 10 million to 20 million passenger miles per year.
- The distance of the 3C+D corridor is 250 miles, and Amtrak estimates that 40,000 to 80,000 new passengers will use the 3C+D corridor every year. The annual passenger miles was projected by taking the number of miles of the route and multiplying it by the number of new passengers. An average of 60,000 new passengers is used for the projection.
- The amount of CO2e emissions for diesel is applied to determine the GHG emissions from Amtrak. 0.15 kg CO2e emissions for diesel per passenger mile traveled. This value is subtracted from the emissions produced from 60,000 single occupancy vehicles that transitioned to riding Amtrak in order to calculate the total emissions reduced value.

  Emissions Reduced per year
  2050: 11,088 MT CO2e

Electric Power Sector

2.A Replace the region's streetlights with LED fixtures

- The region will convert 1,750 street lights to LED fixtures per year. The total number of conversions by 2030 and 2050 is 8,750 and 43,750 LED streetlight conversions respectively.
- Each LED streetlight saves 2.4 kWh per day, which is 876 kWh saved annually. The EPA Greenhouse Gas Equivalencies Calculator is used to convert the kWh savings to emissions reductions.
- The total GHG emissions reduced per LED streetlight conversion is 0.772 MT CO2e per year.

  Emissions Reduced per year
  2030: 6,755 MT CO2e
  2050: 33,775 MT CO2e

2.B Further develop renewable energy generation in the region

- Approximately five million dollars will be invested in community solar development projects per year. The increased amount of private solar capacity will increase by 25% by 2030, and 300% by 2050 in the region.

- One 5 kW solar system can produce 6,713 kWh per year within the region. A 5 kW system can reduce emissions by 5.9 MT CO2 per year. The amount of funding in the region for solar projects can reduce emissions by 243 MT CO2e per year.
- A planned 3 MW solar farm in Oxford will be developed by 2030. The project will reduce emissions by 4,150 MT CO2e per year.
- Development of a 1.5 GW Virtual Power Plant (VPP) will be completed in the region by 2050. The VPP will reduce GHG emissions by 1,321.5 MT CO2e per year.
- The current hydropower generation in the region will be doubled by 2050 through development of a new project which will have approximately 105 MW capacity.

Emissions Reduced per year
2030: 22,623 MT CO2e
2050: 710,445 MT CO2e

2.C Help communities to educate businesses and residents on benefit of procuring electricity generated using clean and renewable energy sources

- Community aggregation program adoption rates from NREL projections are used to calculate the emissions avoided from joining renewable energy aggregation programs.
- The adoption of 100% renewable utility aggregation plans will increase nationally by 54% by 2030. The projection is applied to the current subscription to 100% renewable aggregation plans in the region. The adoption rate is projected to increase six times the current adoption rate by 2050.
- The kWh saved from transitioning to renewable utility aggregation plans is calculated to determine the total GHG emissions reductions in CO2e.

Emissions Reduced per year
2030: 32,215 MT CO2e
2050: 386,580 MT CO2e

Buildings Sector

3.A Improve the energy efficiency of local governments, schools, and non-profits in the region

- Based these projections on the 2024 CPRG Implementation Grant application. Funding opportunities for local governments and nonprofits will reduce emissions through LED light replacements, solar projects, and energy efficiency upgrades.
- Regional goal to make improvements to 500,000 sqft of buildings annually. Improvements to buildings will reduce energy consumption by 15%.

- Total energy consumption of commercial buildings is 22.5 kWh per sqft per year. The total energy consumption of 500,000 sqft is 11,250,000 kWh per year. That's a total of 56,250,000 kWh improved by 2030, and 281,250,000 kWh improved by 2050.

  Emissions Reduced per year
  2030: 124,247 MT CO2e
  2050: 1,051,547 MT CO2e

3.B Improve the energy efficiency of commercial buildings

- Adoption of a voluntary building energy efficiency standard for the Cincinnati Central Business District will result in a 0.5% decrease in emissions by 2030, and a 1% decrease in emissions by 2050. The Cincinnati 2030 District is committed to reducing emissions across 28.2 million sqft.
- The UnpredictableCities Dashboard reports the total emissions of the Cincinnati Central Business District of 62,826.87 MT CO2e. 0.05% and 1% emissions reductions are taken from these emissions to represent the voluntary building energy efficiency standard adoption by 2030 and 2050 respectively.
- 22.5 kWh are consumed per sqft of buildings per year. The total kWh consumed by the committed 28.2 million sqft by the Cincinnati 2030 District is 634,500,000 kWh by 2030. Energy efficiency improvements to the 28.2 million sqft will reduce 15% of the kWh consumed. The total reduction in energy consumed is 89,633,261 kWh by 2030, and 338,204,549 kWh by 2050.

  Emissions Reduced per year
  2030: 79,314 MT CO2e
  2050: 298,714 MT CO2e

3.C Improve the energy efficiency of residential dwellings in the region

- Projections show a 30% expansion of the Home Weatherization Assistance Program (HWAP), representing an additional 2,000 homes serviced per year.
- 10% reduction in energy use in new construction can be attributed to revised zoning and building standards. The emissions reductions per new house constructed is approximately 2.25 MT CO2e. Regional projections show approximately 28,000 new homes constructed by 2030, and 61,000 new homes constructed by 2050.
- The HIP loan program is used as a reference to project the improvement of 45 homes per year. Energy efficient home improvements will reduce emissions by 60 MT CO2e per home.

- The MowGreener program is projected to expand by 25% per year through 2030, and hold steady through 2050. Every combustion lawnmower replaced with a battery power lawnmower reduces 0.05 MT CO2e emissions per replacement. A total of 6,013 lawnmowers by 2030 and 36,013 lawnmowers by 2050 are projected to be replaced.

  Emissions Reduced per year
  2030: 86,432 MT CO2e
  2050: 291,168 MT CO2e

3.D Adopt development patterns that are proven to be more energy efficient and support energy efficient transportation

- Reports from UrbanCincy project 8,000 buildings potentially face demolition in Cincinnati by 2030. Science Direct estimates approximately 12% of lifecycle carbon emissions can be saved by reusing existing buildings and avoiding new construction.
- Assume 30% of these buildings can avoid demolition by 2030, and consistent annual emissions reductions to 2050. 30% of the 8,000 buildings facing demolition are 2,400 buildings saved.
- Development of residential units in close proximity to transit services projects 10% growth by 2030, and 20% growth by 2050. OKI housing projections estimate approximately 46,500 additional households by 2050. 0.15 MT CO2e emissions reduced per new transit rider per trip.
- Adoption of energy standards for construction of new buildings can reduce energy consumption by 10%.
- Developing 180 acres of rural areas with cluster development instead of conventional development. Conventional development emits 95.04 MT CO2e per acre of development, while cluster development emits 59.7 MT CO2e per acre of development by 2050. Implementing cluster style development on 180 acres of land in rural areas can reduce emissions by 28.05 MT CO2e per acre by 2030, and 35.33 MT CO2e per acre by 2050.

  Emissions Reduced per year
  2030: 271,291 MT CO2e
  2050: 2,683,207 MT CO2e

3.E Involve citizens in the effort to reduce GHG emissions

- Unable to find reliable studies of how much tangible impact public awareness campaigns boost other direct reduction measures.

Industrial Sector

4.A Work to lower GHG emissions from large scale emitters

- Participation in energy efficiency programs such as the Energy Star Challenge can reduce 10% of emissions from industries adopting these programs in the region.
- Four industries are projected to join the program by 2030. 20 industries are projected to join the program by 2050. Approximately 21,500 MT CO2e emissions reductions are estimated per industry adopting energy efficiency programs.

Emissions Reduced per year
2030: 85,471 MT CO2e
2050: 427,356 MT CO2e

4.B Work towards developing a regional market for cleaner alternative fuels to power industrial processes like hydrogen, solar, geothermal, and nuclear

- Opportunities to develop cleaner energy sources for industrial processes can significantly reduce emissions in the region. Progression towards green hydrogen hubs expanding hydrogen fuel use in the region can provide fuels to industrial users.
- Decarbonizing U.S. Power projects a 4.5% and 15% reduction in emissions by 2030 and 2050 respectively from carbon sequestration and transitioning to cleaner, more efficient fuels in industrial operations.

Emissions Reduced per year
2030: 705,153 MT CO2e
2050: 2,305,508 MT CO2e

4.C Work to improve industrial operations to be more energy efficient and use cleaner sources of energy

- The U.S. DOE Energy Star Industrial Decarbonization Study projects 3% and 27% emissions reductions by 2030 and 2050 respectively. Energy audits of buildings and industries will reduce energy inefficiencies, reducing GHG emissions.
- Electrification and energy efficiency improvements to intermodal operations will reduce emissions in the region. Replacing combustion engines with electric batteries can reduce emissions by approximately 1,600 MT CO2e per year from intermodal operations.

Emissions Reduced per year
2030: 470,102 MT CO2e
2050: 4,230,915 MT CO2e

Waste, Water, and Sustainable Materials Management Sector

5.A Build an environment of collaboration among organizations involved in solid waste, recycling, composting, and food rescue to maximize efficiencies.

- Assumes the establishment of a recycling Green Hub in the region by 2030. Food waste composting operations and food rescue efforts are implemented to divert the amount of food waste sent towards landfills.
- The EPA GHG Equivalencies Calculator reports that each ton of waste recycled instead of landfilled reduced emissions by 2.83 MT CO2e. Projections of the region show that new households recycling will produce approximately 100 tons of recycled material. New households with access to composting in the region will divert 21.75 tons of waste from landfills in the region. 0.48 MT CO2e emissions reductions per ton of food waste diverted from households.
- The Hamilton County Residential Waste Study data is used to develop projections for food waste composted in the region. 25% of additional food waste is composted by 2029. After 2029 the amount of food waste composted remains constant.
- The Green Cincinnati Plan set a goal to decrease food going to landfills by 50% by 2030. Assuming this goal is reached, approximately 6,000 tons of food waste will be diverted by 2030.

Emissions Reduced per year
2030: 430,442 MT CO2e
2050: 430,442 MT CO2e

5.B Increase access to recycling for residents in multi-family buildings

- Projections assume 15% of multi-family households in the region will acquire convenient access to recycling by 2030. The number of multi-family households with access to recycling will increase by 50% from 2030 to 2050. Recycling drive events are projected to continue across the region, further contributing to the amount of recycled material.
- The number of multi-family households which will gain access to convenient recycling in the region will be approximately 15,000 by 2030 and 50,000 by 2050. Multi-family households recycle about 0.14 tons of recycled material per year. Each ton of recycled material from multi-family households will reduce emissions by 2.89 MT CO2e.

Emissions Reduced per year
2030: 11,258 MT CO2e
2050: 25,549 MT CO2e

5.C Work to reduce methane released in the region

- IOPscience journal reported a 16% abatement potential at landfills by 2030. Regional projections of landfills in the region show an emissions reduction of approximately 50,000 MT CO2e by 2030, and no additional reductions by 2050.
- The Little Miami Wastewater Treatment Plant new Anaerobic Digester Project with Methane Capture will open by 2030. This new treatment facility will reduce GHG emissions by 20,000 MT CO2e.
- A new biochar facility is planned to open in Cincinnati by 2030. The biochar facility will produce 1.5 tons of biochar per day, 547.5 tons annually. Each ton of biochar produced will reduce emissions by 2.35 MT CO2e.

Emissions Reduced per year
2030: 71,459 MT CO2e
2050: 71,459 MT CO2e

Agricultural Sector

6.A Reduce fertilizer use in agricultural production

- USDA projections for Ohio show that implementation of cover crops, no till, and reduced fertilizer application practices will decrease emissions by 30% annually. Each year, the amount of fertilizer used decreases by 30% the previous year's amount up to 2030.

Emissions Reduced per year
2030: 42,635 MT CO2e
2050: 71,058 MT CO2e

6.B Increase local food production and markets

- Unable to find reliable studies of how much tangible impact increased delivery and marketing for local food products boost other direct reduction measures.

6.C Increase use of farming methods that reduce GHG emissions

- Providing incentives on equipment upgrades to farmers can reduce emissions by 20% per farm. New equipment through incentives can serve 10 farms by 2030, and 50 farms in the region by 2050.
- On average, each farm emits 10 MT CO2e annually. The GHG emissions reduction per farm due to equipment upgrades is 2 MT CO2e.

Emissions Reduced per year
2030: 185 MT CO2e
2050: 925 MT CO2e

Carbon Removal Sector

7.A Expand protections of the region's forested lands

- Goal to preserve 30% of forested land and wetlands at risk of removal due to development in the region.
- The U.S. Fish and Wildlife Service reports the net vegetation wetland loss between 2009 and 2019. Applying the U.S population growth between 2009 and 2019 produces the vegetated wetland acres lost per person. Converting national projections to regional projections results in 0.0295 vegetated wetland acres lost per person in the region.
- OKI population projections estimate an additional 44,931 people in the region by 2030, and an additional 113,923 people in the region by 2050. Multiplying the population growth in the region by the regional vegetated wetland acres lost per person in the region gives the total vegetated wetland acres lost. The total vegetated wetland acres lost is 1,325.9 acres by 2030, and 3,360.7 acres lost by 2050.
- Preserving 30% of the vegetated wetland acres by 2030 and 2050 will result in 435.83 and 1,105.05 vegetated wetland acres preserved by 2030 and 2050 respectively. The emissions reductions per vegetated wetland acre preserved is 3.309 MT CO2e per year.

Emissions Reduced per year
2030: 3,071 MT CO2e
2050: 7,784 MT CO2e

7.B Promote urban forestry as an important measure against the urban heat island effect

- 20,000 trees will be planted per year along streets across the region through municipal investments and zoning compliance.
- Every new tree planted will reduce emissions by 0.0065 MT CO2e per year. Assumes 15 year old trees will reduce emissions by 0.2 MT CO2e per year.
- Planting 20,000 trees per year will result in 100,000 trees planted by 2030, and 500,000 trees planted by 2050.

Emissions Reduced per year
2030: 649 MT CO2e
2050: 100,000 MT CO2e

7.C Increase wetland protection, restoration, and replacement

- GHG emissions reduction is included in the emissions calculation for 7.A.

7.D Support biochar research, development, and implementation

- Assumes development of a regional facility producing biochar in the region. The facility would produce 300 tons of biochar per year. 300 tons of biochar requires the collection and use of 1,300 metric tons of biomass per year. Carbon abatement from diverting biomass waste reduces emissions by 1.16 MT CO2e per metric ton of biomass.
- The total GHG emissions reductions from biochar and biomass is 1,508 MT CO2e per year at the facility. The facility is projected to be developed and operational by 2050.

Emissions Reduced per year
2050: 7,540 MT CO2e

APPENDIX F: LIDAC ANALYSIS REPORT

Examining Health Impacts from Climate Drivers on LIDAC in the Cincinnati Metropolitan Area

Table of Contents

Table of Contents	2
Executive Summary	3
Introduction	3
Vulnerability Index	5
Heat Islands	8
Air Quality	10
Vector- borne Disease	2603
Water-borne Illness	2625
Mental Health	**Error! Bookmark not defined.**7
Extreme Weather Events	20
Conclusion	2699
References	22
Appendix	30

Executive Summary

Introduction, Objective, Methodology, Key Findings, Recommendations, Conclusion

The following analysis, performed by the Ohio-Kentucky-Indiana Regional Council of Governments, depicts how climate change impacts public health, especially regarding lower income and disadvantaged (LIDAC) communities. The following information was derived from various sources, largely including the partnership work of Scioto Analysis and Green Umbrella (a regional climate collaborative), where 16 counties and 142 census tracts in the Cincinnati Metropolitan region were analyzed according to projected climate-enhanced major disease categories: heat related illness, respiratory illness, vector borne disease, water borne illness, increased mortality, and mental health. This particular analysis focuses on the climate-based roots of these illnesses, including urban heat islands, air quality, vector- borne disease, water-borne illness, mental health, and extreme weather events. This study found that there is a correlation between these climate drivers and related health impacts specifically on LIDAC communities, compared to regional averages. The purpose of this analysis is to encourage regional entities to reduce carbon emissions and health equity. As a result, the study aims to show how reducing emissions in the region would directly benefit overall human health, especially for individuals and groups within LIDAC tracts.

Introduction

The designation of lower income and disadvantaged communities (LIDAC) is a key feature of the US Environmental Protection Agency (EPA)'s Climate Pollution Reduction Grants (CPRG) Program. Under the goals and objectives of this program, LIDAC communities can be defined at the census tract level using the supplemental indexes provided by the EPA's Climate and Economic Justice

Screening Tool (CEJST).[29] These supplemental indexes both environmental and socioeconomic information, under which LIDAC communities are those that fall above the 90th percentile.[30] Ensuring that LIDAC communities are identified in an objective and comprehensive manner helps to solidify a higher standard of analysis as well as encourage a more accurate view of projected effects of climate drivers on human health in these tracts.

In the instance of this analysis, the census tracts which will be examined are distributed across three states in the Cincinnati metropolitan area, covering a total of 16 counties. The EPA identifies these 16 counties as a broader Consolidated Statistical Area (CSA), meaning that the Ohio-Kentucky-Indiana region holds similarities in terms of their economies, populations, and pollution patterns[31]. These include Hamilton, Clermont, Brown, Warren, Butler counties in Ohio, Franklin, Ohio, Dearborn, and Union counties in Indiana, and Kenton, Boone, Campbell, Gallatin, Bracken, Pendleton, and Grant counties in Kentucky. Based on the aforementioned criteria, 142 census tracts were identified within this region as LIDAC to be examined in this study.



While every county, city, and state is vulnerable to effects on human health as a result of various climate impacts, each jurisdiction and its residents are affected differently. Therefore, it is necessary to do an examination of the Cincinnati metropolitan area on its own to identify which climate drivers likely pose the largest threat, as well as to identify the census tracts which are

[29] https://www.epa.gov/system/files/documents/2023-05/LIDAC%20Technical%20Guidance%20-%20Final_2.pdf

[30] https://www.epa.gov/ejscreen/ejscreen-map-descriptions#supp

[31] https://archive.epa.gov/airquality/ozonepollution/designations/web/pdf/r45_cincy_tsd_final.pdf#:~:text=On%20December%209%2C%202011%2C%20EPA%20initiated%20the,designate%20one%20partial%20county%20in%20Indiana%2C%20three

disproportionately vulnerable to harm from these threats. Ultimately, this will help inform preparation efforts in the region.

Over the course of this analysis, six climate impacts will be analyzed. These include urban heat islands, air quality, vector- borne disease, water-borne illness, mental health, and extreme weather events. These climate impacts were selected by a joint group of staff between OKI Regional Council of Governments, the metropolitan planning organization for the region, and Green Umbrella, a regional climate collaborative. This was done over the course of multiple conversations based on research of historical and future projected conditions in the region. Within analysis of these impacts, data will be presented which discusses connections with various environmental, climate, and socio-economic drivers. Then, this will be analyzed within the Cincinnati region and LIDAC tracts. A vulnerability index created for use in this analysis will be used to quantify the risk of harm to census tracts based on each factor in order to compare and contrast risk, as well as identify the most vulnerable communities. Using this data and index, maps will be presented which demonstrate the risk to human health in LIDAC communities based on climate drivers in the region.

Vulnerability Index

The purpose of establishing this index is to examine the data collected in a more comprehensive and holistic manner to ensure more perspectives are included, as well as to be able to identify communities most at risk to detrimental harm from climate impacts.

The vulnerability index used in this analysis was created based on an analysis of case studies and literature reviews which examine connections between climate and human health.

To provide supplemental information to the work of the joint OKI and Green Umbrella group tasked with identifying climate and health impacts, other resources which identify common impacts that are examined in vulnerability studies were consulted. Specifically, one literature review

enumerated many of the most common climate change impacts, health outcomes, and social vulnerability measures included in climate vulnerability studies. By comparing these factors with the ones provided by the joint group, it helped reinforce scope and identify the necessary knowledge to proceed with analysis.[32]

The starting point for constructing the numerical structure of the index was the U.S. Climate Vulnerability Index, created by the Environmental Defense Fund, Texas A&M University, and Darkhorse Analytics. This index determines overall climate vulnerability of counties and tracks in the United States based on community baselines and climate impact topics, which have various different subcategories. This is then compared to a national vulnerability percentile for a larger scope.[33] Analyzing this index helped to identify which categories to examine in this analysis, and the connections between community level factors and climate vulnerability. To establish the vulnerability analysis itself, the California Department of Public Health's Climate Change and Health Vulnerability interactive platform was used to examine how to map and display connections between sensitivity and exposure based loosely on their framework.[34] The statewide lens of this analysis helped inform the depth and scope of this analysis and provide a much needed contrast to the wide national lens.

The joint groups settled on the criteria which would be analyzed in this study after reading these sources. This included climate and health as categories of impacts, and climate, environmental and socioeconomic as categories of drivers. Climate impacts are overarching factors which have been identified to likely be the most prevalent and detrimental events for the region in the future. These include heat islands, air quality, vector-borne diseases, water-borne illness, mental health, and

---

[32] https://www.cdph.ca.gov/Programs/OHE/Pages/CC-Health-Vulnerability-Indicators.aspx#:~:text=Climate%20Change%20and%20Health%20Vulnerability%20Assessment%20Framework&text=A%20climate%20change%20and%20health,related%20environmental%20exposures%20or%20hazards.

[33] https://map.climatevulnerabilityindex.org/map/cvi_overall/usa?mapBoundaries=Tract&mapFilter=0&reportBoundaries=Tract&geoContext=State

[34] https://www.cdph.ca.gov/Programs/OHE/Pages/CC-Health-Vulnerability-Indicators.aspx#:~:text=Climate%20Change%20and%20Health%20Vulnerability%20Assessment%20Framework&text=A%20climate%20change%20and%20health,related%20environmental%20exposures%20or%20hazards.

extreme weather events. Connected with these most of these climate impacts were health impacts. This included heat related illness for heat islands, respiratory illness for air quality, stress, anxiety, suicide, post-traumatic stress disorder (PTSD), drug use, and smoking for mental health, and long term and short-term health damage for extreme weather events. The climate, environmental, and socioeconomic drivers were then categorized as vulnerability or exposure factors. Vulnerability factors are those that make certain populations more vulnerable to the given effect. Exposure factors are those which make it more likely that certain populations will experience this effect. In the index, vulnerability factors are found on the X axis while exposure factors are on the Y. The breakdown of the drivers per category can be found below in fig.1.

Fig.1

Climate and health impacts	Vulnerability factors	Exposure factors
Heat islands *Heat related illness*	Income, age, disabled, pre-existing health conditions	Increased temperature, time of day/ year, reduced tree canopy, poor building structure/ zoning
Air Quality *Respiratory illness*	Age, asthma, pre-existing health conditions	Mobile source emissions (proximity to highways), industry
Vector borne diseases	Pre-existing health conditions, access to health care, access to information, age	Exposure to vectors, changing habitat and breeding grounds
Water borne illness	Pre-existing health conditions, access to health care, low access to potable water	Topography, risk of flooding, waste water discharge, stream miles

Mental health, incidences of stress, anxiety, suicide, PTSD, drug use, smoking	Occupational exposure, income and family size, education, age, socially and linguistically isolated individuals	Access to greenspace, food deserts, access to quality and affordable health care, population growth, heat islands, extreme temperature, extreme weather events
Extreme weather events, damage to general health short and long term	Low income, lack of insurance, zero car, elderly, disabled, access to internet	Risk of fire, flood, natural disaster, damage to buildings, location, topography

Heat Islands

The heat island effect, often known as the Urban Heat Island (UHI) effect, is a well-documented phenomenon which describes a correlation between urban areas and higher temperatures, where the surrounding areas are not experiencing the same extreme levels of heat. The lack of natural landscape (such as tree cover), increase in less reflective materials (such as pavement),city planning, heat generated by humans, and simply climatic conditions can all contribute to this effect.[35] Communities suffering from the heat island effect are often burdened by issues associated with increased energy use and decreased water and air quality. The excessive temperatures in heat islands can cause significant harm to humans, especially those already at risk. Specifically, the elderly, the young, low-income demographics, chronically ill and disabled individuals, and outdoor laborers are all at increased risk to health impacts from heat related illnesses and harm.[36]

[35] https://www.epa.gov/heatislands/learn-about-heat-islands

[36] https://www.epa.gov/heatislands/heat-island-impacts

As the effects of climate change spread across the nation and country, those who currently are experiencing the urban heat island effect can expect to see an increase in both the number of heat waves and length of extreme heat days. This is likely to exacerbate the current issues that are faced disproportionately, and put more individuals at risk to harm.[37]

Already this effect has been documented in Cincinnati. In 2021 a study done with NASA, Groundwork USA, and Groundwork Ohio River Valley found that temperatures in Cincinnati and Covington were 8.32 degrees Fahrenheit warmer during the day than in nearby areas not clarified as urban, and 4.97 degrees Fahrenheit warmer at night.[38] To coincide, data from the census tracts suggests that there are going to be higher ambient temperatures for the Cincinnati metropolitan region. For example, the average ambient temperature experienced in the 2020s was 17 degrees Celsius. This number is estimated to increase to 20 degrees Celsius by the 2050s.

When investigating the further vulnerability of the greater Cincinnati area, a multitude of impacts and drivers were considered. Based on the literature reviewed and the discretion of the working group, the climate impact, the heat island effect, is connected with the health impact, heat related illness. Additionally, risk of this effect is driven by increased temperatures, the time of day and season, the tree canopy present, rates of impervious surface or cropland, building structure and zoning, income level, age, general health condition, and income. In order to analyze this using the vulnerability index, data was pulled from census tracts and OKI resources.

In particular, according to census tract data, LIDAC communities experience a higher share of local land area which is covered by impervious surfaces or cropland–6% more than experienced on the regional level. Also, the aforementioned 3 degrees Celsius increase in ambient temperature could indicate, for Hamilton County, that the number of heat-related deaths are also likely to increase. In 2019, mortality due to heart attacks and strokes in Cincinnati occurred at 174.1 and 49.3 deaths

[37] https://www.epa.gov/heatislands/climate-change-and-heat-islands

[38] https://appliedsciences.nasa.gov/what-we-do/projects/assessing_urban_heat_in_the_cincinnati_and_covington_area_using_nasa_earth_observations

(respectively). By 2050, this could increase by 4.5% (7.8 excess deaths) for heart attacks and 2.5% (1.2 excess deaths) for strokes. As a whole, heat related illness per 100,000 for LIDAC communities particularly was higher than the overall region, standing at 63.7, compared to the regional 49.2.

**Add data, map, impact scores, and identify most vulnerable areas*

Based on the provided information and analyzed data, the counties most impacted by urban heat islands and their subsequent health impacts include Campbell County, KY, Kenton County, KY, Clermont County, OH, and Hamilton County, OH (LIDAC tracts) and Campbell County, Kentucky, Boone County, KY, Kenton County, KY, and Hamilton County, OH (non-LIDAC tracts). These areas are estimated to feel the largest impacts in terms of ambient temperature change and surface areas covered by impervious surfaces/cropland.

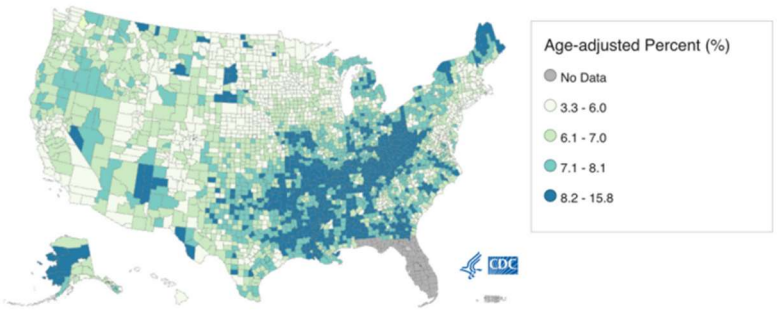
Air Quality

Air quality is a key aspect of maintaining a healthy environment and community. Poor air quality can be caused by natural or anthropogenic pollution. For example, mobile emissions from cars and freight, or pollution from industry emissions. One of the most common pollutants discussed is particulate matter (PM) which is a combination of various chemicals from both anthropogenic and natural sources. PM 2.5 is the most common type of PM discussed, and is especially dangerous to human health due to its small size and ability to infiltrate respiratory systems. These pollutants can cause respiratory illnesses or exacerbate previous ailments. Therefore, those with pre-existing health conditions (like asthma), the young, the elderly, and those with low educational awareness about how to protect themselves are the most vulnerable. Additionally, communities that are residing near areas with high exposure levels to mobile sources, such as highways, or industry, such as factories, are disproportionately at risk for poor air quality and respiratory illness.[39] Historically, Cincinnati has

[39] https://www.niehs.nih.gov/health/topics/agents/air-pollution

faced issues with air quality. In 2024, a report by the American Lung Association found that Cincinnati was in the top 25 cities across the country in highest levels of year round particle pollution.[40] The Cincinnati metropolitan area also holds a relatively high COPD incidence when compared to the nation, as observed in the map above.

There is also a documented relationship between air quality and climate change. This will increase the risk of respiratory illness and associated harm in the future. Increased temperatures and precipitation can increase levels of PM and other pollutants in the air which have effects on human health. Extreme weather events which are likely to increase in frequency and severity as a result of climate change, are also connected, specifically wildfires and the smoke they produce.[41] In order to analyze the vulnerability of communities in the region to poor air quality and respiratory illness, data was collected on age, asthma rates , pre-existing health conditions, and exposure to mobile sources and industry.



Data sources: The model-based estimates were generated using data from BRFSS 2021 and ACS 2017-2021, and 2021 Census county population estimates.

The collected data presents many interesting correlations. For example, it found that LIDAC communities experience slightly higher PM 2.5 in the air by percentile compared to the overall region, where LIDAC tracts score in the 83rd percentile, but the overall region in the 81st. LIDAC communities are more impacted by asthma, when they are also low income compared to regional levels. LIDAC communities score in the 49th percentile whereas the broader, regional communities land in the 14th. LIDAC are also more likely to have greater than or equal to

[40] https://www.lung.org/research/sota/city-rankings/most-polluted-cities

[41] https://www.epa.gov/climateimpacts/climate-change-impacts-air-quality#:~:text=Climate%20change%20can%20affect%20air,level%20ozone%20in%20some%20areas.&text=Ground%2Dlevel%20ozone%20is%20also,trapping%20heat%20in%20the%20atmosphere.

90th percentile standing regarding residential traffic proximity and are also low income–14% of LIDAC and only 4% regionally). This data coincides with the hypothesis that LIDAC communities in the Cincinnati metropolitan region will experience greater health impacts than the broader, regional community as climate change worsens. This is especially pertinent when considering air quality, pollution patterns, and subsequent health impacts.

Based on the provided information, the LIDAC tracts most vulnerable to air quality risks include Boone County, KY, Campbell County, KY, Kenton County, KY, Pendleton County, KY, Butler County, OH, Hamilton County, OH, and Warren County, OH. While the frequencies are much lower, they are not absent in non-LIDAC tracts. Impacted counties under this tract include Boone County, KY, Bracken County, KY, Campbell County, KY, Pendleton County, KY, Butler County, OH, and Hamilton County, OH. This information is largely based on analysis of above 80th percentile PM 2.5 concentrations and above 90th percentile coronary heart disease incidence among adults aged 18 or older.

Vector-borne Disease

Vector-borne diseases (VBDs), are diseases that are transmitted by living agents such as mosquitoes, ticks, and fleas, which are becoming an increasingly common threat in the United States. There are a plethora of different conditions which fall under this category, many of which can be life threatening.[42] These include lyme disease, west nile virus, rocky mountain spotted fever, dengue fever, zika, ehrlichiosis, and malaria.

In the 2024 Ohio Vector-borne Disease Surveillance Update, conducted by the Ohio Department of Health (ODH) Zoonotic Disease Program, evidence was found of VBDs in counties in the Cincinnati metropolitan region. Hamilton and Clermont counties had mosquitos which tested positive for West Nile virus. Butler and Hamilton counties had black legged ticks which facilitate the

[42] https://www.cdc.gov/vector-borne-diseases/about/index.html

spread of various tick-borne diseases. Lyme disease cases were found in Butler, Hamilton, and Clermont County, and Ehrlichiosis, a Lone Star Tick borne disease, was found in Warren county.[43] In surveillance by the Kentucky Department of Public Health, Rocky Mountain Spotted Fever cases have also been identified in Boone, Kenton, Grant, and Pendleton County. Ehrlichiosis has been found in Campbell, Boone, and Kenton County. Lyme disease has been found in every Kentucky county in the region of this study.[44] In Indiana, Mosquitoes with west nile virus have been identified, and in 2023 they were found in every county in the region of this study. Ticks with lyme disease and human cases were found in every Indiana county of this study, and cases of rocky mountain spotted fever and ehrlichiosis were found in Dearborn county in 2023.[45] Information from the Scioto Analysis and the Cincinnati Health Department states that there were 63 cases of lyme disease in Ohio in 2013, but this number has increased to 590 by 2021 and 1,297 cases in 2023[46]. Many of these cases occur in rural areas likely due to higher frequencies of outdoor labor. This incidence increase suggests that increased temperatures and climate impacts are playing a critical role in the frequency of vector-borne disease in the region.

These diseases can be extremely dangerous for not only the health of individuals but for communities as a whole.[47] The rate of infection and spread of VBDs is affected by a multitude of factors. Suburban growth and change in land use can increase rates of exposure, especially to ticks. Travel, within the United States and internationally, can increase the amount of invasive species in a community, such as ticks and mosquitoes, or introduce a new species entirely. New varieties of mosquitoes and ticks which are more likely to transmit certain diseases are predicted to enter

[43] https://odh.ohio.gov/know-our-programs/zoonotic-disease-program/news/vectorborne-disease-update

[44] https://ky-dph.maps.arcgis.com/apps/Cascade/index.html?appid=5e1d359ccbf149989186585cf9f41bf1

[45] https://www.in.gov/health/idepd/zoonotic-and-vectorborne-epidemiology-entomology/vector-borne-diseases/tick-borne-diseases/

[46] https://www.cincinnati-oh.gov/health/chd-news/tickborne-diseases-in-ohio/#:~:text=In%202023%2C%20Ohio%20reported%201%2C297,checks%2C%20and%20removing%20ticks%20promptly.

[47] https://www.hhs.gov/ash/osm/innovationx/vector-borne-disease-national-strategy/index.html

territories which have been previously unaffected as a result of climate change. Individuals who are exposed to VBDs have different physiological responses based on a variety of factors, therefore there are certain populations that are more vulnerable to contracting these diseases and experiencing significant harm as a result. These include the young and the elderly, the immunocompromised, those with pre-existing health conditions, outdoor workers, and low-income individuals who face barriers in acquiring health care or receiving education about VBDs. Current predictions by climatologists state that climate change is likely to lead to an increase in both the seasonal timing and geographic spread of vectors and VBDs, largely due to changes in temperature and precipitation. [48] For example, current days of infection above 90 for both LIDAC and broader, regional communities have increased from 35 to 63, showing the increased prevalence and severity of vector-borne disease.

LIDAC tracts within counties more frequently experience days of infection over 90 equal to or greater than 63 days. These counties are Boone County, KY, Campbell County, KY, Gallatin County, KY, Grant County, KY, Kenton County, KY, Pendleton County, KY, Brown County, OH, Butler County, OH, Clermont County, OH, and Hamilton County, OH. Based on this information, it can be speculated that the LIDAC tracts within these counties are more vulnerable to vector-borne illness. However, these impacts are not exclusive and will likely be felt amidst tracts on the regional level, especially over time.

Water-borne Illness

Waterborne illnesses can come from a wide variety of sources and have many different health impacts. Therefore, tracking illnesses associated with water can be challenging. However, it is known based on current research that water-borne illness can be contracted from exposures associated with recreational and drinking water, as well as other environmental exposures. These can be from

[48] https://health2016.globalchange.gov/vectorborne-diseases

polluted water itself or from consuming food products from the aforementioned water source. The pathogens, including parasites, bacteria, and viruses, found in these waters can cause harm to the intestines, skin, and respiratory system. The most common symptoms of waterborne illness include nausea, vomiting, and diarrhea. [49] Diarrhea, giardiasis, dysentery, typhoid fever, E. Coli infection, salmonellosis, and Legionnaires' disease are some of the most common illnesses associated with water. [50] According to the National Outbreak Reporting System (NORS) managed by the Center for Disease Control and Prevention (CDC), between 2017 and 2021 Ohio experienced 16 waterborne outbreaks, with the most common form being Legionnaires' disease, accounting for 7 of the outbreaks. Indiana experienced 2, one Legionnaires' disease and one from E. Coli. Kentucky experienced 2, both forms of Legionnaires' disease. [51] It is important to note, however, that between LIDAC communities and the broader region, there is not much change in the likelihood of E. Coli outbreaks–an increase of 24% for LIDAC tracts and 23% regionally. This may be due to the sentiment that Ohio, Kentucky, and Indiana experience a relatively low frequency of drinking-water associated outbreaks, according to 2015-2020 data provided by the National Outbreak Reporting System.[52]

While tracking the origin of outbreaks and illnesses can be difficult, there are certain factors which have been identified to increase the risk of human exposure to water-related illness. These include runoff from residential areas, urban areas, and agriculture, as well as more frequent and heavy precipitation. These factors also contribute to water pollution and algal blooms, which can lead to increased surface temperatures in the ocean and increase climatic change, which in turn increases precipitation and temperature. Additionally, low-income areas with old infrastructure are more likely to experience failure in water infrastructure, and therefore have increased vulnerability to exposure

[49] https://odh.ohio.gov/know-our-programs/outbreak-response-bioterrorism-investigation-team/resources/waterborne

[50] https://www.niehs.nih.gov/research/programs/climatechange/health_impacts/waterborne_diseases#:~:text=Some%20common%20water%2Drelated%20illnesses,Coli%20infection%2C%20and%20salmonellosis.

[51] https://wwwn.cdc.gov/norsdashboard/

[52] https://www.cdc.gov/mmwr/volumes/73/ss/ss7301a1.htm#F1_down

to waterborne illness. Data shows that LIDAC communities have a higher likelihood of having leaky underground storage tanks for their water supply, where LIDAC communities land in the 55th percentile and the overall regional community in the 46th. Low lying areas and areas near bodies of water are also at increased risk for flooding and therefore have a higher risk, a phenomenon only predicted to worsen as a result of climate change in coming years. Communities which have reduced access to potable water are also more susceptible to these diseases and, similar to VBDs, age and pre-existing health conditions can also make individuals more likely to contract diseases and face more extreme harm. Those with reduced access to health care are also at increased risk for harm if they are exposed to a water-borne illness, due to lack of quality or rapid care. [53]

Areas in the region with greater than 80th percentile near wastewater discharge, making them more vulnerable to water-borne illnesses occur within both LIDAC and regional census tracts. Counties holding impacted LIDAC tracts include Dearborn County, IN, Boone County, KY, Grant County, KY, Kenton County, KY, Butler County, OH, and Hamilton County, OH. The counties with impacted regional tracts are even more widespread, impacting Dearborn County, IN, Boone County, KY, Campbell County, KY, Kenton County, KY, Butler County, OH, Clermont County, OH, Hamilton County, OH, and Warren County, OH. It is important to note, however, that there are more non-LIDAC census tracts overall, which may account for the higher frequency for regional tracts compared to LIDAC tracts.

Mental Health

Mental health as a field of study has a large range of variability and has many parts which are often more subjective than the other areas examined in this study. Therefore, providing a concrete analysis of factors connecting climate factors to mental health can prove to be a challenging

[53] https://health2016.globalchange.gov/water-related-illness#figure-164

endeavor. Regardless, there are many drivers and impacts which can be analyzed to further investigate the issue. The mental health issues most at question here include, but are not limited to, stress, depression, anxiety, PTSD, drug use, and smoking.

Identifying the drivers of these health impacts can prove challenging. However, there are certain factors which have been found to increase risk of experiencing such issues. For example, researchers have found correlations between access to green space and increased mental wellbeing, often reducing stress and symptoms of depression and anxiety. Green spaces also often serve as a facilitator for social interaction, which can also reduce negative mental health impacts. This is a resource which is often limited in urban environments especially. [54]

There are other environmental factors that can affect mental health as well. For example food deserts, which are low-income areas with reduced access to healthy and affordable foods, have been found to have a correlation with worsening food insecurity. [55] Many studies and literature reviews have found a correlation between food insecurity and increased indicators of psychological distress including depression, anxiety, stress, and issues with sleep. [56] Additionally, low-income areas are disproportionately likely to face barriers in accessing affordable and quality health care. This can make it both more difficult to receive care for mental issues and substance abuse and also can add stress.[57] There have also been many studies exploring connections between increased rates of mental distress to population growth and urbanization, including increased stress [58] and rates of anxiety disorders.[59]

A continuous theme in these drivers is increased risk to low-income individuals for mental illness, especially those in urban environments. However, there are many other socio-economic

[54] https://www.f.gov/media/blog/2017/11/28/improving-urban-health-through-green-space

[55] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6608701/

[56] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7282962/

[57] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5192088/

[58] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2996208/

[59] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5374256/

drivers which have been found to be connected with mental illness. For example, in occupations with high stress and low job control there has been found to be connections with increased rates of depression and anxiety[60]. There have also been connections between low educational attainment and depression, PTSD, and anxiety[61], pre-existing and chronic health conditions and depression[62], and various illnesses for the young [63]and elderly[64]. There is also literature exploring how the predicted effects of climate change may contribute to an increased likelihood of suffering from mental illness. This includes the effects of extreme temperatures and UHIs on mental health, increased risks of PTSD, anxiety, and depression in the wake of extreme weather events[65], and increased risk of substance abuse[66].

Research suggests that 54% of adults and 45% of children suffer from depression after living through a natural disaster. In regard to LIDAC communities, they can experience mental health issues rooting from lower life expectancy, for example. This is where LIDAC communities have an average life expectancy of 71 compared to the regional 76. They also rank in a higher unemployment percentile, at the 71st compared to the regional 43rd. As unemployment can be linked to deterred mental health, this statistic shows how LIDAC communities can also feel higher mental health impacts from various different sectors.

Overall, the most vulnerable areas for climate-driven mental illness occur in both LIDAC and regional tracts. The most impacted counties, for LIDAC tracts, are Campbell County, KY, Kenton County, KY, Butler County, OH, and Hamilton County, OH. Regionally, the highest impacted tracts are located in Campbell County, KY, Kenton County, KY, Boone County, KY, Butler County, OH, and

[60] https://pubmed.ncbi.nlm.nih.gov/36345690/

[61]https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9901051/#:~:text=The%20risk%20of%20being%20diagnosed,lead%20to%20improved%20mental%20health.

[62] https://www.nimh.nih.gov/health/publications/chronic-illness-mental-health

[63] https://www.cdc.gov/childrensmentalhealth/data.html

[64] https://www.cdc.gov/aging/pdf/mental_health.pdf

[65] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4446935/

[66] https://health2016.globalchange.gov/mental-health-and-well-being

Hamilton County, OH. This information is drawn from data provided on life expectancies equal to or lower than 71 (when the regional average is 76) and unemployment rates which lie at or above the 90th percentile.

Extreme Weather Events

Extreme weather events are events which either have a very low probability of occurring at a certain location or at a certain time, and are often intense. These include heatwaves, freezes, storms with heavy rainfall, tornadoes, cyclones, hurricanes, floods, droughts, and wildfires. [67] According to the National Risk Index (NRI) developed by the Federal Emergency Management Agency (FEMA), of the counties included in this analysis, Butler and Hamilton in Ohio have the highest risk indexes of experiencing extreme weather events at a designation of relatively moderate. The other counties in Ohio in this study, Clermont, Brown and Warren all had ratings of relatively low. In Kentucky, Kenton, Boone, Campbell and Pendleton counties were relatively low, while Gallatin, Bracken, and Grant counties were very low. Of all Indiana counties in this study the risk was designated as very low. The risk index was calculated by multiplying the expected annual loss by the social vulnerability, and then dividing this by the community resilience. This was done at both the county and census tract level, and then compared to state and national scores. The hazard types which were given the highest risks across the Cincinnati metropolitan area were cold waves, heat waves, landslides, lightning, strong winds, tornados, and winter weather.[68] All of these hazards are likely to increase in frequency and severity as a result of climate change.[69] The Midwest has been identified as one of the regions with

[67] https://www.climatehubs.usda.gov/content/extreme-weather

[68] https://hazards.fema.gov/nri/map#

[69] https://science.nasa.gov/climate-change/extreme-weather/

the highest expected future financial loss and damages as a result of climate change by the EPA, mainly to roads and bridges.[70]

The health impacts of these extreme weather events are unequally distributed among communities and individuals. Low-income communities are often disproportionately harmed by these events, largely because of reduced access to health care, poor or degrading infrastructure, reduced access to news and technology, and lower rates of insurance holders. These can all affect mobility and ability to evacuate in a timely manner, or at all. Low income communities also have less resources to fall back on, and will likely take longer to recover and may face long term increases in unemployment and homelessness rates.[71] The elderly and those with pre-existing health conditions are also more at risk as they have more difficulty evacuating and acquiring supplies[72], as well as are more susceptible to waterborne illness which have an increased risk of exposure following flooding events and storms. Certain locations and topographies are also affected differently, for example low lying areas are more susceptible to flooding.[73] All of these factors contribute to an increase in mental and physical harm to LIDAC communities who experience extreme weather events. There are many more impacts and drivers involved in extreme weather events than can be enumerated here, but across them a strong connection has been documented between disadvantaged communities and climate driven harm.

The data from the census tracts show that LIDAC communities have more share of properties at risk of flood in thirty years (51st percentile) than the regional average (42nd percentile). While there are some discrepancies, there are only slight differences between LIDAC and regional communities regarding extreme weather events. For example, there is not much change observed

[70] https://toolkit.climate.gov/regions/midwest/community-vulnerability-and-adaptation

[71] https://nca2018.globalchange.gov/

[72] https://health2016.globalchange.gov/extreme-events

[73] https://www.niehs.nih.gov/research/programs/climatechange/health_impacts/weather_related_morbidity

between expected building loss due to natural hazard (61st percentile LIDAC, 60th percentile regionally).

Based on the given information, LIDAC tracts in each involved state will be impacted by extreme weather events. LIDAC tracts in Dearborn County, IN, Franklin County, IN, Bracken County, KY, Gallatin County, KY, Kenton County, KY, Pendleton County, KY, Brown County, OH, and Butler County, OH can be considered vulnerable to this threat based upon their expected building loss percentile (above 70) from the Natural Hazards Risk Index.

Conclusion

This analysis sought to discuss how climate change has exacerbated negative health impacts in the Cincinnati Metropolitan area. It did so by evaluating six climate drivers: heat islands, air quality, vector-borne illness, water-borne illness, mental health, and extreme weather events – each of which present a myriad of negligible health impacts. The findings of this analysis include a solidification in research which discusses how climate change is going to worsen human health over time. This research also unveiled how, in many cases, climate impacts are felt by LIDAC communities on a more extreme level than the rest of the region. Of the 16 counties evaluated in the census tracts, Butler Co., Hamilton Co., Grant Co., Brown Co., Franklin Co., Gallatin Co., Bracken Co., and Pendleton Co. hold over 25% of their populations within LIDAC tracts. While each county, LIDAC or non-LIDAC, may feel these effects differently, based upon a variety of factors, each of them are likely to experience climate-charged health impacts on their populations in some way, especially as time progresses.

References

Air Pollution and Your Health. (n.d.). National Institute of Environmental Health Sciences. https://www.niehs.nih.gov/health/topics/agents/air-pollution

Assessing Urban Heat in the Cincinnati and Covington Area using NASA Earth Observations | NASA Applied Sciences. (n.d.). Retrieved July 17, 2024, from http://appliedsciences.nasa.gov/what-we-do/projects/assessing_urban_heat_in_the_cincinnati_and_covington_area_using_nasa_earth_observations

Bell, J. E., Herring, S. C., Jantarasami, L., Adrianopoli, C., Benedict, K., Conlon, K., Escobar, V., Hess, J., Luvall, J., Garcia-Pando, C. P., Quattrochi, D., Runkle, J., & C. J. Schreck, I. I. I. (2016). Ch. 4: Impacts of Extreme Events on Human Health. In *The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment* (pp. 99–128). U.S. Global Change Research Program, Washington, DC. https://health2016.globalchange.gov/extreme-events

Benefits Analyses: Low Income and Disadvantaged Communities. EPA. (2023, April 27). https://www.epa.gov/system/files/documents/2023-05/LIDAC Technical Guidance - Final_2.pdf

Bergmans, R. S., Sadler, R. C., Wolfson, J. A., Jones, A. D., & Kruger, D. (2019). Moderation of the Association Between Individual Food Security and Poor Mental Health by the Local Food Environment Among Adult Residents of Flint, Michigan. *Health Equity*, *3*(1), 264–274. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6608701/

CDC. (2022, June 3). *Data and Statistics on Children's Mental Health | CDC*. Centers for Disease Control and Prevention. https://www.cdc.gov/childrensmentalhealth/data.html

CDC. (2024, June 26). *About Vector-Borne Diseases*. Vector-Borne Diseases. https://www.cdc.gov/vector-borne-diseases/about/index.html

Center for Disease Control and Prevention and National Association of Chronic Disease Directors. (2008). The State of Mental Health and Aging in America Issue Brief 1: What Do the Data Tell Us?. CDC. https://www.cdc.gov/aging/pdf/mental_health.pdf

City of Cincinnati Health Department. (2024). Prevention and Early Detection Are Effective Tools Against Tickborne Disease. *City of Cincinnati.* https://www.cincinnati-oh.gov/health/chd-news/tickborne-diseases-in-ohio/#:~:text=In%202023%2C%20Ohio%20reported%201%2C297,checks%2C%20and%20removing%20ticks%20promptly.

Community Vulnerability and Adaptation | U.S. Climate Resilience Toolkit. (n.d.). Retrieved July 17, 2024, from https://toolkit.climate.gov/regions/midwest/community-vulnerability-and-adaptation

Demange, P. A., Boomsma, D. I., van Bergen, E., & Nivard, M. G. (2024). Evaluating the causal relationship between educational attainment and mental health. *MedRxiv*, 2023.01.26.23285029. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9901051/#:~:text=The%20risk%20of%20being%20diagnosed,lead%20to%20improved%20mental%20health.

Division, I. D. E. & P. (2023, May 17). *Tick-Borne Diseases*. Infectious Disease Epidemiology & Prevention Division. https://www.in.gov/health/idepd/zoonotic-and-vectorborne-epidemiology-entomology/vector-borne-diseases/tick-borne-diseases/

Dodgen, D., Donato, D., Kelly, N., Greca, A. L., Morganstein, J., Reser, J., Ruzek, J., Schweitzer, S., Shimamoto, M. M., Tart, K. T., & Ursano, R. (2016). Ch. 8: Mental Health and Well-Being. In *The Impacts of Climate Change on Human Health in the United States: A Scientific*

Assessment (pp. 217–246). U.S. Global Change Research Program, Washington, DC. https://health2016.globalchange.gov/mental-health-and-well-being

Extreme Weather—NASA Science. (n.d.). Retrieved July 17, 2024, from https://science.nasa.gov/climate-change/extreme-weather/

Gruebner, O., A. Rapp, M., Adli, M., Kluge, U., Galea, S., & Heinz, A. (2017). Cities and Mental Health. *Deutsches Ärzteblatt International*, *114*(8), 121–127. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5374256/

Health (ASH), A. S. for. (2022, January 26). Vector-Borne Disease National Strategy. https://www.hhs.gov/ash/osm/innovationx/vector-borne-disease-national-strategy/index.html

Health, D. of P. (n.d.). *California Department of Public Health*. Retrieved July 17, 2024, from https://www.cdph.ca.gov/Programs/OHE

Health Impacts of Extreme Weather. (n.d.). National Institute of Environmental Health Sciences. Retrieved July 17, 2024, from https://www.niehs.nih.gov/research/programs/climatechange/health_impacts/weather_related_morbidity

Hodgkinson, S., Godoy, L., Beers, L. S., & Lewin, A. (2017). Improving Mental Health Access for Low-Income Children and Families in the Primary Care Setting. *Pediatrics*, *139*(1), e20151175. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5192088/

Howell, J., & Elliott, J. R. (2019). Damages Done: The Longitudinal Impacts of Natural Hazards on Wealth Inequality in the United States. *Social Problems*, *66*(3), 448–467. https://academic.oup.com/socpro/article-abstract/66/3/448/5074453?redirectedFrom=fulltext&login=false

Improving Urban Health through Green Space | USDA. (n.d.). Retrieved July 17, 2024, from https://www.usda.gov/media/blog/2017/11/28/improving-urban-health-through-green-space

Map | National Risk Index. (n.d.). https://hazards.fema.gov/nri/map#

Most Polluted Cities | State of the Air. (n.d.). https://www.lung.org/research/sota/city-rankings/most-polluted-cities

Myers, C. A. (2020). Food Insecurity and Psychological Distress: A Review of the Recent Literature. *Current Nutrition Reports*, *9*(2), 107–118. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7282962/

National Outbreak Reporting System (NORS) Dashboard | CDC. (n.d.). Retrieved July 17, 2024, from https://wwwn.cdc.gov/norsdashboard/

Ohio Vectorborne Disease Surveillance Update | Ohio Department of Health. (n.d.). Retrieved July 17, 2024, from https://odh.ohio.gov/know-our-programs/zoonotic-disease-program/news/vectorborne-disease-update

Overall Climate Vulnerability in The U.S. (n.d.). The U.S. Climate Vulnerability Index. Retrieved July 17, 2024, from https://map.climatevulnerabilityindex.org/map/cvi_overall/usa?mapBoundaries=Tract&mapFilter=0&reportBoundaries=Tract&geoContext=State

Padhy, S. K., Sarkar, S., Panigrahi, M., & Paul, S. (2015). Mental health effects of climate change. *Indian Journal of Occupational and Environmental Medicine*, *19*(1), 3–7. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4446935/

Scioto Analysis. Climate Health Equity: Analyzing the Impacts of Climate Change on Health Outcomes in Greater Cincinnati. *Green Umbrella Regional Climate Collaborative,* 1-21.

Seidler, A., Schubert, M., Freiberg, A., Drössler, S., Hussenoeder, F. S., Conrad, I., Riedel-Heller, S., & Starke, K. R. (2022). Psychosocial Occupational Exposures and Mental Illness. *Deutsches Arzteblatt International*, *119*(42), 709–715. https://pubmed.ncbi.nlm.nih.gov/36345690/

Srivastava, K. (2009). Urbanization and mental health. *Industrial Psychiatry Journal*, *18*(2), 75–76. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2996208/

Tickborne Disease in Kentucky. (n.d.). Retrieved July 17, 2024, from https://ky-dph.maps.arcgis.com/apps/Cascade/index.html?appid=5e1d359ccbf149989186585cf9f41bf1

Trtanj, J., Jantarasami, L., Brunkard, J., Collier, T., Jacobs, J., Lipp, E., McLellan, S., Moore, S., Paerl, H., Ravenscroft, J., Sengco, M., & Thurston, J. (2016). Ch. 6: Climate Impacts on Water-Related Illness. In *The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment* (pp. 157–188). U.S. Global Change Research Program, Washington, DC. https://health2016.globalchange.gov/water-related-illness

Understanding the Link Between Chronic Disease and Depression—National Institute of Mental Health (NIMH). (n.d.). Retrieved July 17, 2024, from https://www.nimh.nih.gov/health/publications/chronic-illness-mental-health

US Department of Agriculture. (n.d.). Extreme weather. Extreme Weather | USDA Climate Hubs. https://www.climatehubs.usda.gov/content/extreme-weather

US EPA, O. (2008, March 27). *Cincinnati, Ohio-Kentucky-Indiana Area Designations for the 2008 Ozone National Ambient Air Quality Standards*. https://archive.epa.gov/airquality/ozonepollution/designations/web/pdf/r45_cincy_tsd_final.pdf#:~:text=On%20December%209%2C%202011%2C%20EPA%20initiated%20the,designate%20one%20partial%20county%20in%20Indiana%2C%20three

US EPA, O. (2014a, June 17). *Climate Change and Heat Islands* [Overviews and Factsheets]. https://www.epa.gov/heatislands/climate-change-and-heat-islands

US EPA, O. (2014b, June 17). *Heat Island Impacts* [Overviews and Factsheets]. https://www.epa.gov/heatislands/heat-island-impacts

US EPA, O. (2014c, June 17). *Learn About Heat Islands* [Overviews and Factsheets]. https://www.epa.gov/heatislands/learn-about-heat-islands

US EPA, O. (2015, June 3). *EJScreen Map Descriptions* [Collections and Lists]. https://www.epa.gov/ejscreen/ejscreen-map-descriptions

US EPA, O. (2022, October 19). *Climate Change Impacts on Air Quality* [Overviews and Factsheets]. https://www.epa.gov/climateimpacts/climate-change-impacts-air-quality

Appendix

Term	Definition
EPA	The United States Environmental Protection Agency
CPRG	The EPA's Climate Pollution Reduction Grants program
LIDAC	Low Income and Disadvantaged Communities
CEJST	Climate and Economic Justice Screening Tool
UHI	Urban Heat Island
PM	Particulate Matter
VBD	Vector-borne Disease
ODH	Ohio Department of Health
NORS	National Outbreak Reporting System
CDC	Centers for Disease Control and Prevention
PTSD	Post-traumatic Stress Disorder
NRI	National Risk Index
FEMA	Federal Emergency Management Agency
CSA	Consolidated Statistical Area

The table above displays all acronyms used with their corresponding definitions.

IDENTIFIED LIDAC CENSUS TRACTS

Table - LIDAC Census Tracts source: EJ Screen

18029080300	39017011123	39061008300
18047969700	39017012200	39061008400
18047969900	39017012300	39061008501
21015070301	39017012700	39061008502
21015070311	39017013000	39061008601
21023950200	39017013100	39061008800
21023950300	39017013200	39061009200
21037050100	39017013400	39061009300
21037050500	39017013500	39061009400
21037050600	39017013600	39061009500
21037051101	39017013900	39061009600
21037051200	39017014000	39061009700
21037053200	39017014100	39061009800
21077960101	39017014400	39061009902
21081920200	39017014600	39061010002
21081920300	39017014700	39061010003
21081920400	39025041102	39061010004
21117060300	39025041701	39061010005
21117060700	39025041800	39061010202
21117060900	39061000200	39061010300
21117061000	39061000900	39061010500
21117061200	39061001100	39061010700
21117061400	39061001600	39061010900
21117064400	39061001700	39061011000
21117065000	39061002200	39061021602
21117065100	39061002300	39061021603
21117065600	39061002800	39061021604
21117066900	39061003600	39061021802
21117067000	39061003700	39061021900
21117067100	39061003800	39061022200
21191930300	39061003900	39061022301

39015951400	39061004702	39061022700
39015951600	39061005500	39061023201
39015951700	39061005600	39061023400
39015951800	39061006000	39061025200
39017000100	39061006100	39061025300
39017000200	39061006300	39061025401
39017000300	39061006400	39061025500
39017000400	39061006600	39061025700
39017000500	39061006800	39061026200
39017000600	39061006900	39061026300
39017001100	39061007300	39061026400
39017010500	39061007700	39061026700
39017010906	39061007800	39061026900
39017010909	39061007900	39061027000
39017011004	39061008000	39061027100
39061027400	39061008100	39061027200
		39165031700

ThriveTogether

A Sustainability Playbook for Greater Cincinnati

WORKFORCE ANALYSIS ADDENDUM

Existing Local Education Resources

Many resources are available in the region which can work to educate the public. These include higher education universities, public resources, trade schools, etc. These can be used to prepare individuals for various green jobs, to gain technical and educational skills to further their preparedness.

Universities

Ohio

- University of Cincinnati (Cincinnati, OH): a public research university with numerous nationally-ranked programs offering undergraduate and graduate degrees
- Xavier University (Cincinnati, OH): a private, Jesuit university offering undergraduate and graduate programs in various fields
- Miami University (Oxford, OH): a public research university offering over 200 majors and minors
- Mount St. Joseph University (Delhi Township, OH): a private, Catholic university offering undergraduate and graduate programs
- University of Cincinnati, Clermont (Batavia, OH): a satellite campus of the public University of Cincinnati offering many programs in-person or online

Kentucky

- Northern Kentucky University (Highland Heights, KY): a public university offering flexible undergraduate and graduate programs in various disciplines
- Thomas More University (Crestview Hills, KY): a private, Catholic university offering undergraduate and graduate programs and research opportunities

Indiana

- University of Southern Indiana (right outside Evansville, IN): a public university offering undergraduate and graduate degrees in over 130 study areas
- Indiana University, Southeast (New Albany, IN): a regional campus of the public Indiana University best known for their undergraduate degree programs in business, nursing, and education

Community Colleges or Trade Schools

Ohio

- Great Oaks Institute of Technology and Career Development (Cincinnati, OH and Mildford, OH): a less than two-year career and technical school which offers certificate degrees
- Fortis College (metropolitan Cincinnati, OH): a provider of career education and training in fields including nursing, medicine, dentistry, and skilled trades like HVAC and welding
- IBEW-NECA Electrical Training Center (Cincinnati, OH): an electrical construction training and apprenticeship program in the Greater Cincinnati & Northern Kentucky Area

- Elite Welding Academy (West Chester Township, OH): a trade school specializing in comprehensive welding training
- Cincinnati State Technical and Community College (Cincinnati, OH): a public technical and community college, offering accessible education for an associate's degree, a bachelor's degree, or technical certificates, including education services in nursing, environment, engineering, and more

Kentucky

- Enzweiler Building Institute (Boone County, KY): a trade school specializing in apprenticeship training in various skilled construction trades
- Gateway Community and Technical College (Covington, KY): a public community college through the Kentucky Community and Technical College System

Indiana

- Lincoln Tech (Indianapolis, IN): a private provider of hands-on training in automotive and skilled trade professions
- Ivy Tech Community College (Lawrenceburg, Indianapolis, and New Castle, IN): a public community college system with degrees in nursing, manufacturing, and other trades

Public Educational Resources

Ohio

- Cincinnati Public Schools Aspire Program: a literacy education program for adults, offering free day and evening courses
- Ohio Virtual Academy (OHVA): a full time, online public school for grades K-12
- Ohio Digital Learning School (ODLS): a tuition free, full-time online public school for grades 9-12

Kentucky

- Kentucky Virtual Academy (KYVA): a full time online public school for grades K-12

Indiana

- Hoosier Indiana College and Career Academy (HCCA): a full-time online public school for grades K-12

Other Public Educational Resources

- OSHA Training Services Inc.: provides OSHA training classes, including 10 and 30 hour certifications anywhere in the United States
- TrainUp: virtual training marketplace, offering environmental trainings and courses
- Solar Design and Installation Training (SETO)
    - Safer Foundation Solar Energy Demand Skills Training Project: a national program seeking to train individuals through classroom training, hands-on lab experience, and real world installations to prepare them for sales, design, and installation work within the solar industry
    - North American Board of Certified Energy Practitioners (NABCEP) Certification: a nonprofit professional certification that ensures individuals and companies hold the knowledge and skills necessary to implement renewable energy projects

    - REA Solar Job Resource Center: a marketplace for job seekers searching for a career in the solar industry
- Department of Labor Registered Apprenticeship Program: an industry-driven career pathway for employers to develop and prepare their future workforce through paid apprenticeship programs
- American Job Centers: free resources, located nationally, to aid job seekers and employers to gain employment and training services
    - Regionally, American Job Centers can be found at OhioMeansJobs Clermont County, Campbell County Public Library, Pendleton County Public Library, and more

Regional Job Quality Initiatives

- The Talent Collaborative of Greater Cincinnati (TCGC): a regional, tri-state workforce development initiative which serves employees, employers, and job seekers in enhancing job quality and attracting and retaining talent
- Co-op Cincy: a regional organization whose mission is to shape an economy that works for all, ensuring green construction and climate-resilient jobs are an influential as possible
- The Women's Fund of the Greater Cincinnati Foundation: a regional organization to perform research surrounding pay equity and created an employer toolkit, which helps to support, stabilize, and retain lower-wage employees
- The Workforce Innovation Center at the Cincinnati USA Regional Chamber: manages a Career Board which allows employers to display their benefits and special perks

Other Workforce Preparedness Resources

- Brighton Center (Northern Kentucky): a nonprofit organization aiding individuals and families towards self-sustainment, offering a variety of employment and workforce services
- Building Value, LLC (Cincinnati, OH): a social enterprise which seeks to create sustainable training and career opportunities in construction and aid in recycling, reclaiming, and repurposing building materials
- Earn and Learn (Greater Cincinnati, Northern Kentucky, and Indiana): a sect of the Greater Cincinnati Apprenticeship Council, providing career opportunities in union skilled trades apprenticeship programs across the region
- Groundwork Ohio River Valley (Cincinnati, OH): an environmental nonprofit which seeks to train high school students by involving them in trail maintenance around the city
- Greater Cincinnati Apprenticeship Council (Cincinnati, OH): a collection of Union Skilled Trades Apprenticeship Program in Greater Cincinnati, Northern Kentucky, and Indiana, giving guidance in career opportunities in carpentry, HVAC, plumbing, and more
- Independent Electrical Contractors (Cincinnati, OH): an organization seeking to connect individuals and companies to succeed in the electrical service industry through education and the sharing of knowledge between professionals, offers 4-year electrical training apprenticeships
- Habitat for Humanity of Greater Cincinnati (Cincinnati, OH): offers a 4 week Construction Training Program to train and prepare individuals for the construction industry

- Greater Cincinnati Environmental Educators: an umbrella organization composed of environmental education organization and parks within the Ohio, Kentucky, Indiana region and hosts a career fair for opportunities for training and jobs
- One Dearborn (Lawrenceburg, IN): a sector of WorkOne, seeking to address workforce needs in Dearborn County and prepare individuals for employment

Workforce Investment Boards and Councils (all counties): boards available for use in each of the sixteen counties of the Cincinnati MSA who work to build resilient communities through workforce development *(see* **Addendum III** *for county breakdown)*

Addendum I: *Counties Included in the Cincinnati Metropolitan Statistical Area*

- Kentucky: Boone County, Bracken County, Campbell County, Gallatin County, Grant County, Kenton County, Pendleton County
- Ohio: Brown County, Butler County, Clermont County, Hamilton County, Warren County
- Indiana: Dearborn County, Franklin County, Ohio County, Union County

Addendum II: *Breakdown of County-Level Living Wage Data, from MIT's Living Wage Calculator*

County Name	**Living Wage**
Boone County, KY	$22.48/hour
Bracken County, KY	$19.85/hour
Campbell County, KY	$20.86/hour
Gallatin County, KY	$20.13/hour
Grant County, KY	$20.36/hour
Kenton County, KY	$20.41/hour
Pendleton County, KY	$19.92/hour
Brown County, OH	$20.26/hour
Butler County, OH	$21.18/hour
Clermont County, OH	$21.03/hour
Hamilton County, OH	$19.81/hour
Warren County, OH	$22.60/hour
Dearborn County, IN	$20.55/hour
Franklin County, IN	$21.19/hour
Ohio County, IN	$20.62/hour

Union County, IN	$23.45/hour
AVERAGE:	$20.92/hour

Addendum III: *Workforce Investment Boards/Councils, by County*

County Name	**Organization**
Boone County, KY	Northern Kentucky Workforce Investment Board (through NKADD) NKADD – NKADD
Bracken County, KY	Tenco Workforce Development Board What To Expect – TENCO Career Center
Campbell County, KY	Northern Kentucky Workforce Investment Board (through NKADD) NKADD – NKADD
Gallatin County, KY	Northern Kentucky Workforce Investment Board (through NKADD) NKADD – NKADD
Grant County, KY	Northern Kentucky Workforce Investment Board (through NKADD) NKADD – NKADD
Kenton County, KY	Northern Kentucky Workforce Investment Board (through NKADD) NKADD – NKADD
Pendleton County, KY	Northern Kentucky Workforce Investment Board (through NKADD) NKADD – NKADD
Brown County, OH	Workforce Development Area 1: Adams, Brown, Pike, and Scioto Counties
Butler County, OH	BCW/Workforce Development Board Home - BCW Workforce
Clermont County, OH	BCW/Workforce Development Board Home - BCW Workforce
Hamilton County, OH	Workforce Council of Southwest Ohio Home - Workforce Council of Southwest Ohio
Warren County, OH	BCW/Workforce Development Board Home - BCW Workforce
Dearborn County, IN	Southeast Indiana Workforce Investment Board Region 9 | Southeast Indiana Workforce Investment Board

Franklin County, IN	Southeast Indiana Workforce Investment Board Region 9 | Southeast Indiana Workforce Investment Board
Ohio County, IN	Southeast Indiana Workforce Investment Board Region 9 | Southeast Indiana Workforce Investment Board
Union County, IN	Southeast Indiana Workforce Investment Board Region 9 | Southeast Indiana Workforce Investment Board

Addendum IV: *Links to Resources Listed*

Resource	**Link**
University of Cincinnati	https://www.uc.edu/
Xavier University	https://www.xavier.edu/
Miami University	https://miamioh.edu/index.html
Mount St. Joseph University	https://www.msj.edu/
University of Cincinnati, Clermont	https://ucclermont.edu/
Northern Kentucky University	https://ucclermont.edu/
Thomas More University	https://www.thomasmore.edu/
University of Southern Indiana	https://www.usi.edu/
Indiana University, Southeast	https://southeast.iu.edu/index.html
Great Oaks Institute of Technology and Career Development	https://www.greatoaks.com/
Fortis College	https://www.fortis.edu/campuses/ohio/cincinnati.html
Elite Welding Academy	https://eliteweldingacademy.com/

IBEW-NECA Electrical Training Center	https://www.electricaltc.org/
Cincinnati State Technical and Community College	https://www.cincinnatistate.edu/
Enzweiler Building Institute	https://buildinginstitute.com/
Gateway Community and Technical College	https://gateway.kctcs.edu/
Lincoln Tech	https://www.lincolntech.edu/campus/indianapolis-in
Ivy Tech Community College	https://www.ivytech.edu/
Cincinnati Public Schools Aspire Program	https://www.cps-k12.org/our-community/adult-education/aspire
Ohio Virtual Academy	https://ohva.k12.com/?expb=cro-q3-2025
Ohio Digital Learning School	https://odls.k12.com/?expb=cro-q3-2025
Kentucky Virtual Academy	https://kyva.k12.com/?expb=cro-q3-2025
Hoosier Indiana College and Career Academy	https://hcca.k12.com/
OSHA Training Services, Inc.	http://www.oshatrainingservices.com/
TrainUp	https://www.trainup.com/
North American Board of Certified Energy Practitioners Certification	https://www.nabcep.org/

REA Solar Job Resource Center	https://www.solarenergy.jobs/
Department of Labor Registered Apprenticeship Program	https://www.apprenticeship.gov/employers/registered-apprenticeship-program
American Job Centers	https://www.careeronestop.org/localhelp/americanjobcenters/find-american-job-centers.aspx
Groundwork Ohio River Valley	Home - Groundwork ORV
Habitat for Humanity Construction Training Program	Construction Training Program | Habitat for Humanity of Greater Cincinnati
Independent Electrical Contractors	Electrician Jobs in Cincinnati, OH | IEC
Greater Cincinnati Apprenticeship Council	Earn And Learn | Apprenticeship Programs
Greater Cincinnati Environmental Educators	GCEE Site
Building Value, LLC	Building Value | Sustainable Deconstruction. Sustainable Careers.
Talent Collaborative of Greater Cincinnati	Talent Collaborative of Greater Cincinnati | National Fund for Workforce Solutions
Co-op Cincy	Co-op Cincy
The Women's Fund of the Greater Cincinnati Foundation	Women's Fund - Women's Fund
Workforce Innovation Center at the Cincinnati	Employer Perks - Workforce Innovation Center

USA Regional Chamber	
Brighton Center	Brighton Center | A Community of Support
One Dearborn	One Dearborn, Inc – Economic Development for Dearborn County, Indiana
Earn and Learn	Earn And Learn

References

Bottorf, C. and Wong, B. (2024). Average Salary By State. *Forbes Advisor.* Average Salary By State – Forbes Advisor

Bremner, G. and Stojanov, J. (2024). Understanding Barriers to Participation in the Green Labour Market. *NESTA.* Understanding barriers to participation in the green labour market | Nesta

Jacobs, H., et al. (2023). Cincinnati Green Workforce Landscape Analysis. *City of Cincinnati*. 2025_Cincinnati-Green-Workforce_FINAL.pdf

Massachusetts Institute of Technology. (2025). Living Wage Calculator. *MIT.* Living Wage Calculator

Occupational Informational Network (O*NET Online). (2023). *National Center for O*NET Development.* O*NET OnLine

Pouy, Nicole. (2024). Fact Sheet, Climate Jobs. Environmental and Energy Study Institute (EESI). Fact Sheet | Climate Jobs (2024) | White Papers | EESI

United States Bureau of Labor Statistics. (2013). The BLS Green Jobs Definition. *U.S. Bureau of Labor Statistics.* The BLS Green Jobs Definition : U.S. Bureau of Labor Statistics

United States Department of Energy. (2023). Job Creation and Economic Growth. *U.S. Department of Energy.* Job Creation and Economic Growth | Department of Energy

United States Department of Energy, Office of Energy Efficiency and Renewable Energy. (2019). Solar Energy Demand Skills Training Program. *U.S. Department of Energy.* PowerPoint Presentation

United States Department of Energy. (2024). United States Energy and Employment Report 2024. *U.S. Department of Energy.* USEER 2024_COMPLETE_1002.pdf

United States Department of Labor. (2023). Increasing Employer and Workforce System Customer Access to Good Jobs, 4-7. *Employment and Training Administration Advisory System, U.S. Department of Labor*. Increasing Employer and Workforce System Customer Access to Good Jobs