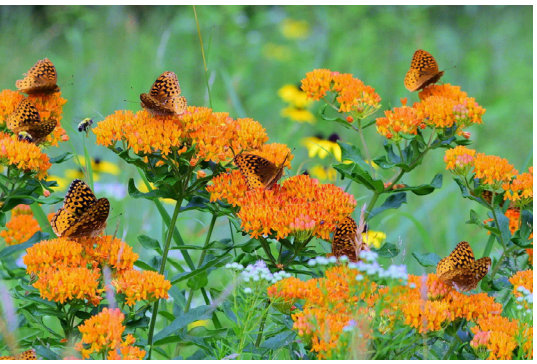


JANUARY 2024

HARTFORD-EAST HARTFORD-MIDDLETOWN PRIORITY CLIMATE ACTION PLAN

CRCOG

Lower Connecticut River Valley Council of Governments

Dewberry

This plan has been funded wholly by the United States Environmental Protection Agency (EPA) under assistance agreement #00A01410 to the Capitol Region Council of Governments (CRCOG). The contents of this document do not necessarily reflect the views and policies of the EPA, nor does the EPA endorse trade names or recommend the use of commercial products mentioned in this document.

The measures contained herein should be construed as broadly available to any entity in the Hartford-East Hartford-Middletown Metropolitan Statistical Area (MSA) eligible for receiving funding under the EPA's Climate Pollution Reduction Grant (CPRG) program and other funding streams, as applicable.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF APPENDICES

EXECUTIVE SUMMARY

The U.S. Environmental Protection Agency's (EPA) Climate Pollution Reduction Grant (CPRG) program provides funding to U.S. states, regions, territories, and tribes, to make meaningful plans to reduce green house gases (GHGs) and other harmful air pollutants. The program funds planning work to identify potential measures to reduce GHG emissions regionally, as defined in this Priority Climate Action Plan (PCAP) and the forthcoming Comprehensive Climate Action Plan (CCAP). The CPRG Implementation Phase will fund projects through a competitive grant process.

This document, the PCAP for the Hartford-East Hartford–Middletown metropolitan statistical area (MSA), has been created by the Capitol Region Council of Governments (CRCOG) and the Lower Connecticut River Valley Council of Governments (RiverCOG). The planning area for the region comprises 60 communities, and over 1.2 million residents. The region is located in the middle of the state, and contains a mix of urban, suburban and rural communities, including the state's capitol. The MSA primarily contains municipalities within CRCOG and RiverCOG with some additions from neighboring COGs (**Figure 1**).

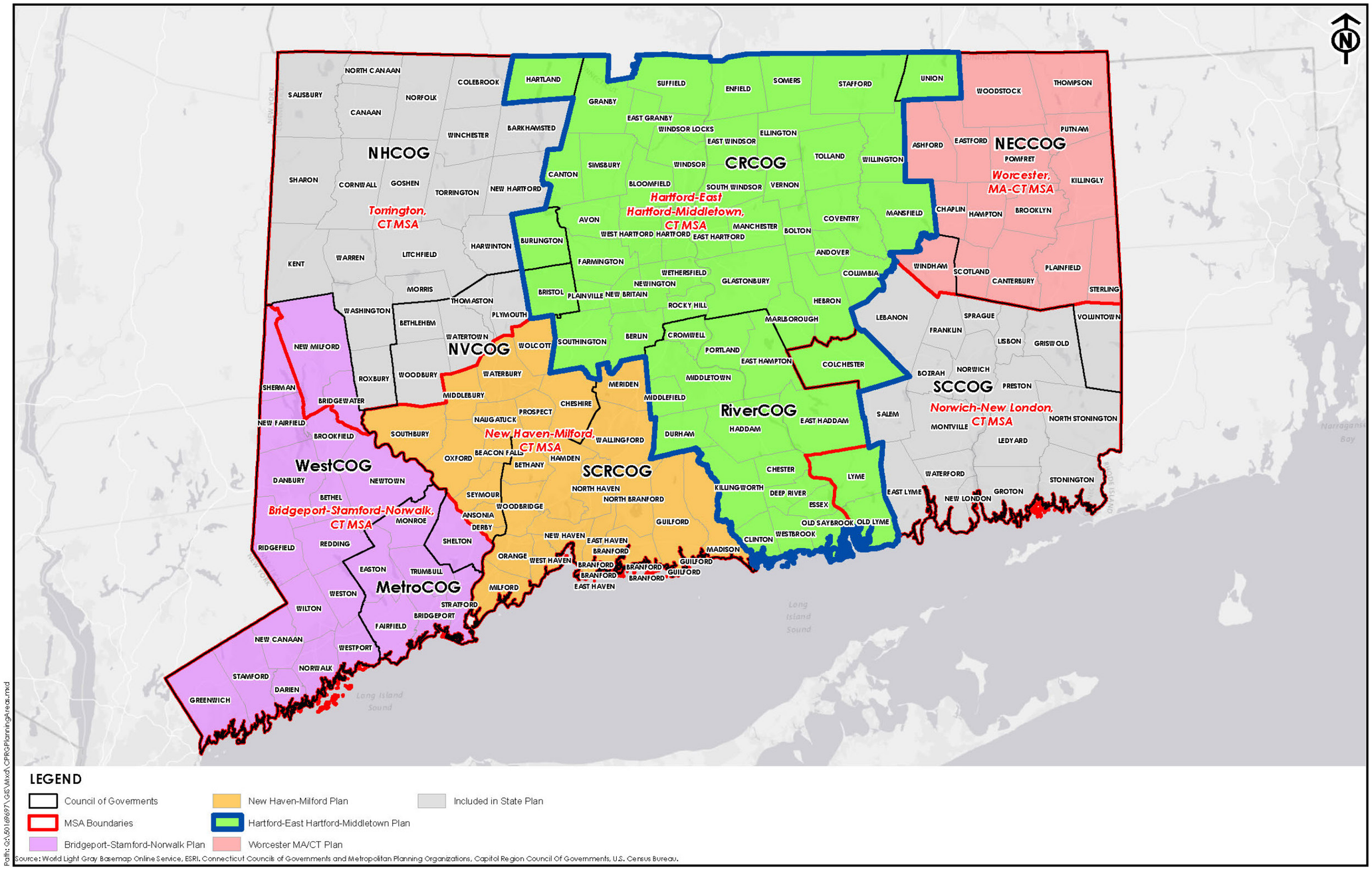
The PCAP is a product of:

- Comprehending the region's current greenhouse gas (GHG) emissions through a GHG inventory prepared by the University of Massachusetts – Amherst (UMass – Amherst),
- Understanding what GHG reduction measures municipalities are currently undertaking through a series of virtual and in-person stakeholder meetings,
- Engaging stakeholders at the municipal, state, and local level to further develop and refine GHG reduction measures – with a particular focus on engaging local residents in low income and disadvantaged communities (LIDACs), and
- Reviewing planning documents at the state, regional and local levels to see how the GHG reduction measures proposed in this document align with planning efforts and goals.

The PCAP is focused on **short-term, implementable** GHG reduction measures that are a priority for the region. Any measure seeking EPA implementation funding **must be included in the PCAP**, whether the COG or a municipality submits the grant application.

This PCAP highlights twelve GHG reduction measures grouped into six key sectors identified by the EPA: Electricity Generation, Transportation, Agricultural/ Natural & Working Lands, Waste & Materials Management, Commercial/Residential Buildings, and Industrial sectors.

Figure 1: Boundary of the Hartford-East Hartford-Middletown MSA (blue). All of CRCOG and nearly all of RiverCOG are included in the MSA. Additionally, several municipalities from four other COGs are also included in this MSA.



Sector	Priority Measure
ELECTRICITY GENERATION	E1 Install solar panels on residences owned by municipal housing authorities E2 Install solar panels, add battery storage and develop microgrids on buildings and properties owned by municipalities (e.g. schools, town halls, parking lots)
TRANSPORTATION	T1 Convert light duty municipal fleets to electric vehicles (EV)/hybrids, install municipal changing infrastructure, and switch municipal gas-powered equipment, such as leaf blowers, to electric T2 Install public EV charging infrastructure and fund maintenance of EV charging infrastructure T3 Encourage municipality-owned and privately-owned school buses switch to 20 percent biodiesel (B20) as an interim measure with a long-term focus on converting light duty municipal fleets to electric vehicles (EV)/hybrids T4 Pursue recommended improvements for at least one of the six transit corridors highlighted in *Metro Hartford RapidRoutes Transit Priority Corridors Study* T5 Develop and implement roundabout projects across the region, with a focus on LIDAC T6 Encourage mode shift across the region with complete streets projects that make it safer and easier to bike and walk for all users
AGRICULTURAL/ NATURAL & WORKING LANDS	N1 Increase urban tree canopy in municipalities across the region
WASTE & MATERIALS MANAGEMENT	W1 Establish and expand residential and academic food waste diversion programs and examine ways to increase utilization of anaerobic digestion
COMMERCIAL/ RESIDENTIAL BUILDINGS	B1 Expand the region's commercial and residential energy audit programs and provide support for implementation B2 Undertake energy efficiency upgrades to municipal buildings

Figure 2: View of the Hartford skyline from across the Connecticut River.

Figure 3: Pedestrians crossing the street near the University of Connecticut in Downtown Hartford.

The PCAP is comprised of the following sections:

GHG Emissions Inventory
UMass - Amherst has developed a statewide inventory of major sources of GHG emissions, including those within the Hartford–East Hartford–Middletown MSA. The inventory covers the Electricity Generation, Transportation, Agricultural/ Natural & Working Lands, Waste & Materials Management, Commercial/Residential Buildings, and Industrial sectors. The inventory was prepared using the following data resource(s):

- Connecticut Department of Transportation;
- Energize CT;
- Flight;
- US Energy Information Administration;
- American Community Survey;
- OSMnx Python Package;
- Connecticut Department of Energy & Environmental Protection;
- United States Department of Agriculture;
- Local Greenhouse Gas Inventory Tool;
- Connecticut National Pollutant Discharge Elimination System (NPDES) Permits; and
- 2015 Land Cover Number and Charts (University of Connecticut).

The inventory shows that in 2021, the baseline year, the region's total emissions were 8,665,858 metric tons of carbon dioxide equivalents ($MTCO_2e$) with the Transportation sector the highest emitter.

Priority GHG Reduction Measures
The 12 GHG reduction measures, noted above, were developed based on the GHG emissions inventory and stakeholder coordination. The measures were prioritized based on whether they met the following criteria: (1) the measure is implementation ready, meaning that the design work for the policy, program, or project is complete enough that a full scope of work and budget can be included in a CPRG implementation grant application; (2) the measure can be completed in the near term, meaning that all funds will be expended, and the project completed, within the five-year performance period for the CPRG implementation grants; (3) the measure advances state priorities and (4) the measure is consistent with the Justice40 Initiative, helping to advance equity and provide benefits to the region's LIDACs.

Low Income and Disadvantaged Communities Analysis
The implementation of the measures included in this PCAP are anticipated to provide significant benefits to LIDACs. This section identifies the LIDACs within the region covered by this PCAP, the climate change risks and vulnerabilities faced by these communities, how CRCOG and RiverCOG meaningfully engaged with LIDACs in the development of this PCAP, and how the two COGs will continue to engage into the future. The section also covers the anticipated benefits and "disbenefits" the proposed measures will have on LIDACs.

Figure 4: Harbor Park in Middletown, CT.

Review of Authority to Implement
Recognizing that implementation will occur more quickly if authority to implement the measures already exists, this section discusses whether local entities have the authority to implement the 12 PCAP measures. It shows that for most measures, local authority to implement the measures is already in the hands of local municipalities. However, for certain measures, coordination with state agencies or work with private sector partners will be required to implement the measures.

Coordination and Outreach
This section highlights the state, municipal, and resident stakeholder engagement conducted while writing the PCAP. Starting in October 2023, over 15 in-person and/or virtual meetings were held with state, regional, and local officials and local residents. Meetings ranged from small focus groups with residents in LIDACs to virtual meetings with state agency partners and local municipal officials. As part of the public outreach, there were two virtual public comment meetings for this document. There will be online engagement efforts facilitated using tools such as an Environmental Systems Research Institute (ESRI) Storymap.

The appendices include profiles for each of the 12 priority GHG reduction measures (**Appendix A**), a comprehensive list of proposed GHG reduction measures (**Appendix B**), a list of stakeholders engaged (**Appendix C**), a list of identified LIDACs (**Appendix D**), a list of regional public housing agency websites (**Appendix E**), supporting information for the GHG inventory (**Appendix F**), and GHG inventory data and assumptions (**Appendix G**).

The CPRG process does not end with the PCAP or implementation grant application. In **2025**, the Comprehensive Climate Action Plan (CCAP) is due to EPA, and in **2027**, a Status Report is due. These documents will be discussed in more detail in the pages that follow. More significantly, the work to reduce GHG emissions and improve air quality for communities across the region did not start with this effort nor will it end with the CPRG program. Communities and individuals across the region are deeply engaged in reducing their GHG emissions and planning for more equitable, decarbonized futures.

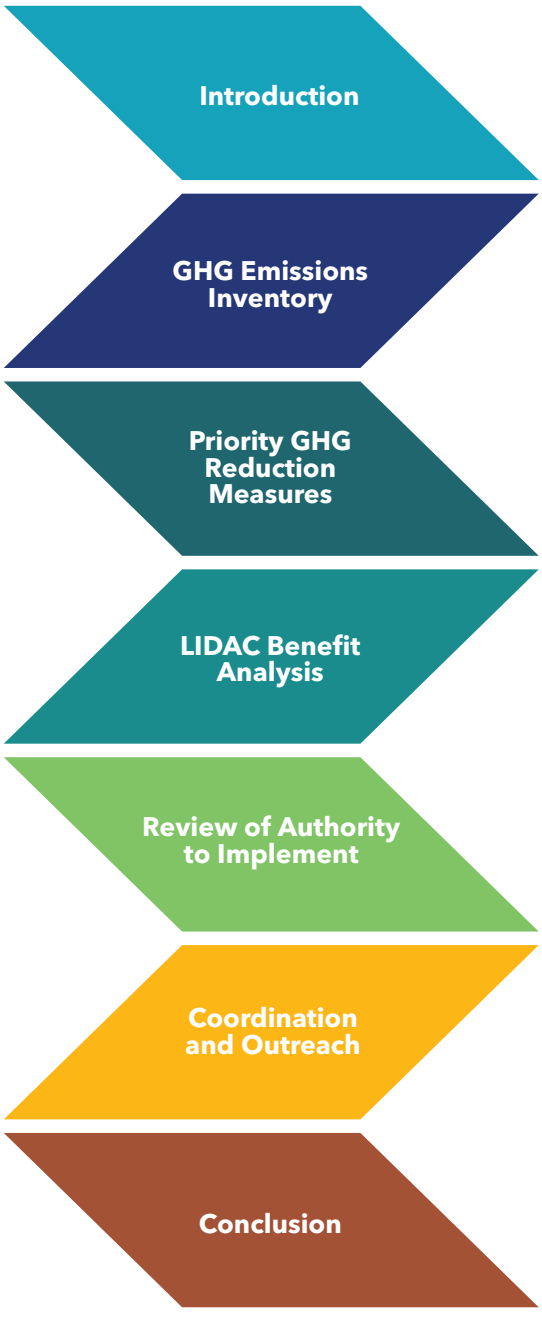
INTRODUCTION

CRCOG has partnered with RiverCOG to produce this PCAP. This document highlights measures that reduce pollutant emissions, create high-quality jobs, encourage economic growth and improve the quality of life for all those who live, work, and go to school in the Hartford-East Hartford-Middletown MSA.

This region, home to more than 1.2 million residents, is located in the middle of the state, and contains a mix of urban, suburban and rural communities, including the state's capitol. The planning area for the PCAP primarily contains municipalities within CRCOG and RiverCOG with some additions from neighboring COGs. This MSA contains a total of 57 municipalities, but three additional municipalities were added to the geographic scope of this plan (**Figure 1**). A more detailed discussion on the geographic limits and demographics of the COGs is included further below.

The following page contains a list of all priority GHG reduction measures identified in the PCAP. These measures are discussed in more detail in **Appendix A**.

PCAP SECTIONS



Sector	Priority Measure	Priority Measure Description
ELECTRICITY GENERATION	**E1** Install solar panels on residences owned by municipal housing authorities	**E1** There are 18 public housing authorities in the CRCOG region and 8 in the RiverCOG region. Recognizing that installing solar panels on these homes would not only add to the region's generation of clean, renewable energy but also considerably lower energy costs for residents, CRCOG and RiverCOG would work with housing authorities to aid in the installation of solar panels on these homes.
	E2 Install solar panels, add battery storage and develop microgrids on buildings and properties owned by municipalities (e.g. schools, town halls, parking lots)	**E2** Municipalities across the region have noted their progress in installing solar panels on municipal buildings and schools. This measure looks to increase these efforts as well as broaden the focus from structures (e.g. schools, town halls) to adding solar canopies to municipal assets such as parking lots. This measure would prioritize these efforts in LIDAC but would be applicable to any of the region's 60 cities and towns.
TRANSPORTATION	**T1** Convert light duty municipal fleets to EV/hybrids, install municipal changing infrastructure, and switch municipal gas-powered equipment, such as leaf blowers, to electric	**T1** Municipalities across the region would be encouraged to convert their light duty fleets to EV/hybrids, or to pilot these vehicles to see if a fleet conversion is an option. EV charging infrastructure for municipal vehicles would also be installed to assist with the transition to EV. In addition, recognizing that common municipal equipment other than vehicles also use gas, such as leaf blowers, municipalities would be encouraged to switch to electric powered equipment. This measure would prioritize these efforts in LIDAC but would be applicable to any of the region's 60 cities and towns.
	T2 Install public EV charging infrastructure and fund maintenance of EV charging infrastructure	**T2** Communities across the region are in different stages of planning for electric vehicles. Some communities, such as West Hartford, have done studies, while other communities have or are about to install their first public chargers. To incentivize the switch to EV, municipalities across the region would collaborate in the installation of public EV charging. This measure would also fund measures to maintain the public EV charging.
	T3 Encourage municipality-owned and privately-owned school buses switch to 20 percent biodiesel (B20) as an interim measure with a long-term focus on converting light duty municipal fleets to EV/hybrids	**T3** Realizing the impact of diesel pollution on some of the region's most vulnerable populations – school aged children – as an interim measure, municipality-owned and privately-owned school buses would be encouraged to switch to 20 percent biodiesel. Longer term, municipalities that own their own bus fleet will look to convert their fleet to electric/hybrid buses. However, many municipalities contract out this service, leaving the choice of school bus fleet to the private operators that run the buses. To incentivize private operators to switch to electric/hybrid buses, municipalities could install charging that operators can use for school bus fleets. This measure would prioritize these efforts in LIDAC (school bus routes and/or bus storage yards) but would be applicable to any of the region's 60 cities and towns.
	T4 Pursue recommended improvements for at least one of the six transit corridors highlighted in *Metro Hartford RapidRoutes Transit Priority Corridors Study*	**T4** CRCOG's Metro Hartford RapidRoutes Transit Priority Corridors Study published in September 2022 highlights six bus routes in LIDAC (Hartford, East Hartford) and non-LIDAC (Bloomfield, West Hartford). Improvements to bus routes could reduce idling, provide more reliable service and encourage mode shift.
	T5 Develop and implement roundabout projects across the region, with a focus on LIDAC	**T5** The environmental benefits of roundabouts include improving traffic flow and reducing idling, as well as being safer for pedestrians. A regional study completed by CRCOG created a scalable, replicable methodology that is currently being pursued by the CTDOT statewide. The study identified the top 100 locations where roundabouts were recommended. Of these locations, 38 roundabouts in LIDAC were recommended.
	T6 Encourage mode shift across the region with complete streets projects that make it safer and easier to bike and walk for all users	**T6** Mode shift projects, such as the addition of sidewalks, bike lanes, and other complete streets elements, can encourage people to leave their cars and switch to active transportation and public transit. These types of projects provide a plethora of benefits including individual health, neighborhood beautification and regional environmental benefits. This measure looks to implement these projects across the region. This measure would prioritize these efforts in LIDAC but would be applicable to any of the region's 60 cities and towns. Some projects that are likely to be undertaken include Manchester's Downtown Manchester Improvements Project, a project still in its concept development phase that could include a road diet, roundabouts, cycle track, and public space, New Britain's Myrtle Street Improvements, a corridor in which significant community development investment is planned but which is lacking complete streets infrastructure, and Middletown's Complete Streets Initiative Master Plan 2023. which highlights proposed multi-use trails, recommended bike routes and priority bike routes.
AGRICULTURAL/ NATURAL & WORKING LANDS	**N1** Increase urban tree canopy in municipalities across the region	**N1** This measure would seek to increase the urban tree canopy in municipalities across the region, with a focus on the region's LIDAC. The measure focuses on planting trees on municipal-owned properties, including city/town owned rights-of-way. Unlike the other measures that look to decrease emissions, this measure acts as a carbon sink: the planted trees will absorb CO_2.
WASTE & MATERIALS MANAGEMENT	**W1** Establish and expand residential and academic food waste diversion programs and examine ways to increase utilization of anaerobic digestion	**W1** Municipalities across the region are undertaking food diversion programs from establishing residential compost pickups, to giving away backyard compost bins, to enacting unit-based pricing pilots (which encourage the reduction of household garbage). Academic institutions also have established waste reduction programs. This measure would expand and support current efforts underway as well as assist with the establishment of new efforts across the region. Understanding that not all food waste can be composted, this measure also seeks to expand use of the region's fully operational anaerobic digestor in converting unused calories into biogas.
COMMERCIAL/ RESIDENTIAL BUILDINGS	**B1** Expand the region's commercial and residential energy audit programs and provide support for implementation	**B1** Homeowners across the region have worked with Energize Connecticut, an initiative sponsored by Connecticut and utility providers, to save energy. Two popular programs are the Home Energy Solutions (home energy audits) and the Small Business Energy Advantage (assessment of small business's energy use). This measure would focus on LIDAC and low-income homeowners to help increase awareness of the program. In addition, because one factor that may discourage more residents from taking part in the audits is the lack of funding to do the audits' recommendations, this measure would provide support for the implementation of the recommendations.
	B2 Undertake energy efficiency upgrades to municipal buildings	**B2** Municipalities across the region have undertaken energy efficiency upgrades to municipal buildings. This measure would build upon this work, with a focus on LIDAC. Energy efficiency upgrades could include switching to LED lighting, upgrading building equipment such as boilers, fixing leaks, and adding insulation.

Background

CLIMATE CHANGE IN CONNECTICUT AND NEW ENGLAND

The International Panel on Climate Change recorded an average global temperature increase by about 1.5°F (0.8°C) between 1901 and 2016, contributing to sea-level rise and changes in precipitation frequency and intensity. Evidence consistently points to human activities, particularly greenhouse gas emissions, as the dominant cause for these increases, without any credible evidence to support natural explanations for the warming. Earth's climate can be expected to continue changing through this century and beyond. Regional assessments predict that the Northeastern United States will be especially vulnerable to impacts of climate change.

Climate change is projected to result in the following impacts to the State of Connecticut:

- More frequent and intense precipitation
- Sea level rise
- Extreme temperatures

Figure 5: Storm damage in January 2024.

More Frequent and Intense Precipitation

- Average annual precipitation in the Northeast U.S. increased 10% from 1895 to 2011.
- The Northeast United States is experiencing the fastest rise in extreme precipitation events in the country. Precipitation from extremely heavy storms has increased 70% since 1958.
- Wind patterns are changing across the United States due to warming temperatures. On the East Coast, this may increase the landfall potential and intensity of tropical storms.
- Warmer winters may result in less frequent but more intense snow and ice events.

Sea Level Rise

- The Connecticut Institute for Resilience & Climate Adaptation (CIRCA) projects that sea level rise for the state could increase 1.5 feet by 2040 and up to 3 feet by 2100 under current emissions trends.[2]
- By 2080, Connecticut could lose up to 24,000 acres of land due to sea level rise.
- Sea level rise will cause high-tide coastal flooding that is not associated with storm events.

Extreme Temperatures

- The average annual air temperature in Connecticut has increased by 2.2°F since the beginning of the 20th century. This is twice as fast as much of the contiguous U.S.
- The City of Hartford is projected to experience up to 51 days over 100°F between the years 2040 and 2069 under a high emissions scenario.[1]
- Heat waves will be longer, more frequent, and impact larger areas. The greatest impacts will be in urban areas with dense construction, traffic, and few green spaces.

PAST STATE, REGIONAL, AND LOCAL CLIMATE INITIATIVES

The State of Connecticut has been addressing the reality of climate change with legislative and executive steps forward since 2001. A timeline below highlights significant initiatives taken at the state level:[3]

AUGUST 2001
New England Governors and Eastern Canadian Premiers (NEG/ECP) Climate Change Action Plan.

A first-of-its-kind international agreement to reduce GHG emissions.

AUGUST 2003
Connecticut Greenhouse Gas Inventory (1990-2000).

Connecticut's first statewide GHG inventory.

JANUARY 2005
Connecticut Climate Change Action Plan.

Connecticut's first climate action plan, driven by regional goals set by the NEG/ECP agreement.

DECEMBER 2005
Connecticut and Seven States Sign Regional Greenhouse Gas Initiative (RGGI) Memorandum of Understanding (MOU).

Established a cap-and-trade program for power sector CO_2 emissions and a RGGI framework.

OCTOBER 2008
Connecticut Global Warming Solutions Act.

Established mandatory GHG reduction targets at 10% below 1990 levels by 2020 and 80% below 2001 levels by 2050

JULY 2011
CT Department of Energy and Environmental Protection (CT DEEP) Established.

Consolidated environmental and energy policy under one organization.

JULY 2011
CT Climate Change Preparedness Plan.

Set forth adaptation strategies for crucial CT economic sectors and highlighted public health vulnerabilities to climate change.

NOVEMBER 2017
Sustainable CT Launch.

Statewide initiative that supports equitable, resilient communities.

DECEMBER 2018
Connecticut Joins Nine States and D.C. to Cap GHG Pollution from Transportation.

Regional policy to cap and reduce emissions from transportation and invest in resilient infrastructure.

APRIL 2019
EO-1 Establishes GreenerGovCT.

Sets goals for state agency sustainability, including 45% GHG reduction below 2001 levels and 25% reduction in waste disposal from 2020 baseline

SEPTEMBER 2019
EO-3 Re-Establishes Governor's Council on Climate Change.

Expanded Governor's Council on Climate Change (GC3), which was tasked to consider climate change adaptation and resilience.

DECEMBER 2021
EO 21-3 Calls for 23 Actions to Reduce Carbon Emissions.

Directs state executive branch agencies to take action to reduce carbon emissions and adapt to the climate crisis. DEEP Climate Resilience Fund established.

NOVEMBER 2023
CTDOT completes the state's Carbon Reduction Strategy (CRS) with funding from the Bipartisan Infrastructure Law.

The CRS identifies projects and strategies to support the reduction of transportation emissions.

Figure 6: Installation of public bicycle racks on Hillside Road in Mansfield, CT.

At the regional and local level, municipalities across the region have been actively working towards addressing climate change. For example, some of the work completed by the City of Hartford includes the following:[2]

- **2012:** City Advisory Commission on the Environment Holds Environmental Summit.
- **2013:** City Commits to be a Clean Energy Community. Calls for reduction of energy use by 20% in 2018.
- **2016:** Climate Stewardship Council Created by Planning & Zoning Commission. First Hartford Climate Action Plan begins to be drafted.
- **2017:** City of Hartford adopts Climate Action Plan. Six action areas identified: Energy, Food, Landscape, Transportation, Waste, and Water. Office of Sustainability created.

In addition, the Sustainable CT program offers a Climate Leader designation, celebrating municipalities that are reducing harmful greenhouse gas emissions and preparing their communities for the impacts of climate change, while saving money, improving public health, and building community. The Climate Leader Designation is optional for Bronze and Silver certified communities and required for Gold certification.

Figure 7: Members at a COG meeting.

ABOUT THE HARTFORD-EAST HARTFORD-MIDDLETOWN MSA

According to the U.S. Census Bureau, a MSA must contain an urban area with a population of at least 50,000. A MSA contains an urban area along with neighboring communities that are fundamentally tied to the urban core both socially and economically. In Connecticut, there are six MSAs:

1. Worcester, MA MSA
2. Norwich-New London MSA
3. Hartford-East Hartford-Middletown MSA
4. New Haven-Milford MSA
5. Torrington MSA
6. Bridgeport-Stamford-Norwalk MSA

While Connecticut is divided into eight counties, the state does not have a legislative county-level government. The geographical boundaries and names of its counties serve to describe areas of the state and do not hold any local influence or power with regard to local policies or functions. Local government in Connecticut exists solely at the municipal level. This is discussed in **Review of Authority to Implement**.

Connecticut has nine COGs which serve as further subdivisions of the MSAs. Each is listed below:

1. Northeastern COG (NECCOG)
2. Southeastern COG (SCCOG)
3. Capitol Region COG (CRCOG)
4. Lower CT River Valley COG (RiverCOG)
5. South Central COG (SCRCOG)
6. Naugatuck Valley COG (NVCOG)
7. Northwest Hills COG (NHCOG)
8. Metropolitan COG (MetroCOG)
9. Western COG (WestCOG)

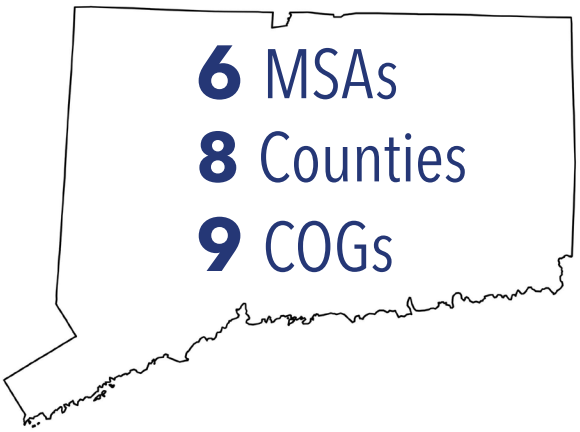


Figure 8: View of the City of Hartford from Route 2.

COGs operate as planning regions within Connecticut that allow municipalities with similar concerns to collaborate and address them cooperatively. COGs also facilitate the coordination of state level programs and plans.*

CRCOG is the lead organization for the Hartford-East Hartford-Middletown MSA and is partnering with RiverCOG to cover the entire MSA geography comprised of 60 municipalities.**

Please refer to **Figure 1** for a map of the Hartford-East Hartford-Middletown MSA and COGs.

Figure 9: A regional summit meeting.held by RiverCOG.

Figure 10: Community members attending a ceremony for a new public transit bus.

* Chapter 50, Section 4-124j of the General Statutes of Connecticut (CGS) grants municipalities of each planning region the authority to create COGs. Chapter 295, Section 16a-4a of the CGS grants the Secretary of the Office of Policy and Management (OPM) the authority to establish or change the boundaries of planning regions. In August of 2019, OPM Secretary McCaw pursued Census Bureau approval of a proposal that would identify Connecticut's nine COGs as county statistical equivalents for Census data published in the future. In response, the Census Bureau published a notice of the proposal in the Federal Register on December 14, 2020. When this occurred, COGs were deemed as county equivalents when applying for county level federal grants. The final federal register notice on this matter was published on June 6, 2022, granting the original 2019 request. Per this publication, all future Census Bureau operations and publications will use the nine COG boundaries, names, and codes by 2024. The only exceptions to this are publications and other datasets that were published before June 1, 2022.

** The towns of Colchester, Lyme and old Lyme were included despite being outside of the Hartford-East Hartford-Middletown MSA. Lyme and Old Lyme are part of RiverCOG. and Colchester is part of SCCOG. In addition, within the Hartford-East Hartford-Middletown MSA, there are towns which are within the MSA but part of a COG other than CRCOG and RiverCOG. Specific instances include Hartland and Burlington (NHCOG), Bristol (NVCOG), and Union (NECCOG).

CRCOG COMMUNITIES

In order to understand the greenhouse gas reduction measures proposed in the following pages and the measures' impacts on the MSA communities, it is important to understand the communities that comprise CRCOG and RiverCOG. CRCOG contains 38 municipalities and provides a number of services for municipalities within the COG including Transportation, Administration & Finance, Regional Planning/Development, & Public Safety. It is the largest COG by area at 1,027.3 square miles of land. CRCOG's mission statement is as follows:[4]

> "The Capitol Region Council of Governments (CRCOG) leads as a catalyst to enhance the quality of life, vibrancy, and vitality of the Greater Hartford region. CRCOG provides planning, programs, and services to its member municipalities and is the region's designated Metropolitan Planning Organization (MPO). CRCOG is a strong advocate for the region and regional solutions."

Based on U.S. Census Bureau 5-year 2018-2022 American Community Survey (ACS) data, CRCOG has a total population of 977,165. The population of the state is 3,611,317 which means CRCOG residents represent 27% of the State's population. 5.2% of the population in CRCOG is under 5 years old and 17.1% is 65 years of age or older. These percentages are similar to the values at the State level, approximately 5% and 17% respectively. Minority populations within the CRCOG account for 39.3% of the population. At the state level, minority populations account for 36.1% of the state's total population. The median household income for CRCOG is $88,190 compared to $90,213 for the state. Within CRCOG, 386,549 housing units are occupied while 27,411 units are vacant. Statewide, there are 1,409,807 housing units occupied and 121,525 units vacant. Lastly, roughly 11% of the population in CRCOG is living below the federal poverty level compared to 10% statewide. See **Table 1** for a comparison of these demographics.

EPA's Environmental Justice Screening and Mapping Tool (EJScreen) was also consulted for CRCOG demographic statistics. EJScreen uses 2017-2021 ACS data. Per EJScreen, 24% of the population within CRCOG is low income. Additionally, 6% of the population is unemployed and 13% have disabilities. The average life expectancy for Connecticut residents within CRCOG is 81 years and 25% of the population is linguistically isolated.

CRCOG residents represent **27%** of the state population

Figure 11: Commuters during the morning rush.

Table 1: CRCOG and CT Demographic Data

CENSUS DATA	CRCOG	STATE OF CONNECTICUT
Total Population (Table B01003)	977,165 total residents	3,611,317 total residents
Age Distribution (Table B01001)	Under 5 years old = 5.2% 65 years old and up = 17.1%	Under 5 years old = 4.8% 65 years old and up = 17.4%
Race (Hispanic or Latino Origin by Race) (Table B03002)	Black = 11.7% American Indian/Alaska Native = 0.1% Asian = 5.8% Native Hawaiian/Other Pacific Islander = 0% Some other race alone = 0.5% Two or more races = 3.3% Hispanic/Latino = 17.9% Total Minority Population = 39.3%	Black = 9.9% American Indian/Alaska Native = 0.1% Asian = 4.7% Native Hawaiian/Other Pacific Islander = 0% Some other race alone = 0.6% Two or more races = 3.4% Hispanic/Latino = 17.4% Total Minority Population = 36.1%
Median Household Income (Table B19013)	$88,190	$90,213
Occupancy Status (Table B25002)	Vacant = 27,411 Occupied = 386,549 % vacant = 7.1%	Vacant = 121,525 Occupied = 1,409,807 % vacant = 8.6%
Ratio of Income to Poverty Level (Table C17002)	11% of residents in CRCOG are living below the poverty line	10% of residents in Connecticut are living below the poverty line

As identified by EJScreen, the top five pollutants/sources of pollution are:

1. Wastewater discharge (89th percentile in CT)
2. Toxic releases to air (81st percentile in CT)
3. Risk Management Program (RMP) facility proximity (76th percentile in CT)
4. Traffic proximity (74th percentile in CT)
5. Underground storage tanks (73rd percentile in CT)

In addition, municipalities within the CRCOG are above the 80th percentile in the country for toxic releases to air, hazardous waste proximity, ozone (ppb) and wastewater aischarge.

CRCOG is within the 78th percentile for asthma in the state and in the 84th percentile in the country. There is a greater risk of flooding than wildfire in municipalities within CRCOG. In terms of critical service gaps, 12% of the population lacks access to broadband internet as opposed to the state average of 11%. Lastly, housing burden, lack of transportation access, and food deserts are present within this COG.

RIVERCOG COMMUNITIES

RiverCOG originated from the combination of 15 regional planning organizations (RPOs) and the Connecticut River Estuary Regional Planning Agency (CRERPA). The COG has an area of 443 square miles of land. RiverCOG was formed in 2012 from a voluntary merger of the Midstate (8 towns) and Connecticut River Estuary (9 towns) regional planning organizations (RPO). RiverCOG 's focus is on providing regional planning, transportation, land use, land conservation, agriculture, and economic development services, amongst others, for their 17 member municipalities. RiverCOG describes their activities as follows:

> "To provide dynamic regional services, including planning for and building upon the economic and environmental resources and values that make the lower Connecticut River valley unique. Through recommendations from our guiding Regional Plan of Conservation and Development, we strive to preserve, enhance, and provide access to the green spaces and qualities of our region."

Based on the U.S. Census Bureau 5-year 2018-2022 ACS data, RiverCOG has a total population of 175,244. The population of the state is 3,611,317 which means RiverCOG residents represent roughly 5% of the State's population.

4% of the population in RiverCOG is under the age of 5, while 21% is 65 years of age or older. Comparatively, 5% of the population in Connecticut is under the age of 5, while 17% is 65 years of age or older. The minority population within RiverCOG totals 18.7% of the population and the median household income for RiverCOG is $99,742. Statewide, the population of minority groups totals 36.1% of the total population and the median household income is $90,213. RiverCOG contains 73,084 occupied housing units, while 9,534 remain vacant. Connecticut in comparison has 1,409,807 housing units occupied and 121,525 units vacant. Lastly, roughly 6% of the population in RiverCOG is living below the federal poverty level compared to 10% statewide. See **Table 2** for a comparison between this COG and the state.

EJScreen was also consulted for RiverCOG demographic statistics. Per EJScreen, 17% of the population within RiverCOG is low income. Additionally, 5% of the population is unemployed and 11% have disabilities. The average life expectancy for Connecticut residents within RiverCOG is 81 years and 10% of the population is linguistically isolated. As identified by EJScreen, the top five pollutants/sources of pollution are:

RiverCOG residents represent **5%** of the state population

1. Wastewater Discharge (94th percentile in CT)
2. RMP Facility Proximity (70th percentile in CT)
3. Ozone, ppb (67th percentile in CT)
4. Superfund Proximity (63rd percentile in CT)
5. Traffic Proximity (55th percentile in CT)

Additionally, the municipalities within the RiverCOG are above the 95th percentile in the country for ozone (ppb) and above the 85th percentile for wastewater discharge.

Table 2: RiverCOG and CT Demographic Data

CENSUS DATA	RIVERCOG	STATE OF CONNECTICUT
Age Distribution (Table B01001)	Under 5 years old = 4% 65 years old and up = 21%	Under 5 years old = 4.8% 65 years old and up = 17.4%
Total Population (Table B01003)	175,244 total residents	3,611,317 total residents
Race (Hispanic or Latino Origin by Race) (Table B03002)	Black = 4.4% American Indian/Alaska Native = 0.1% Asian = 3.4% Native Hawaiian/Other Pacific Islander = 0% Some other race alone = 0.2% Two or more races = 3.6% Hispanic/Latino = 7% Total Minority Population = 18.7%	Black = 9.9% American Indian/Alaska Native = 0.1% Asian = 4.7% Native Hawaiian/Other Pacific Islander = 0% Some other race alone = 0.6% Two or more races = 3.4% Hispanic/Latino = 17.4% Total Minority Population = 36.1%
Median Household Income (Table B19013)	$99,742	$90,213
Occupancy Status (Table B25002)	Vacant = 9,534 Occupied = 73,084 % vacant = 11.5%	Vacant = 121,525 Occupied = 1,409,807 % vacant = 8.6%
Ratio of Income to Poverty Level (Table C17002)	6% of residents in RiverCOG are living below the poverty line	10% of residents in Connecticut are living below the poverty line

RiverCOG is within the 56th percentile for cancer in the state and in the 74th percentile in the country. There is a greater risk of flooding than wildfire in municipalities within RiverCOG. In terms of critical service gaps, the percentage of the population lacking access to broadband internet is equivalent to the state average. Lastly, housing burden, lack of transportation access, and food deserts are also present within this COG.

Figure 12: The historic Witch Hazel Plant in Essex, CT.

Plan Purpose

The U.S. EPA's CPRG program provides $5 billion in funding for states, local governments, tribes and territories to develop plans to meaningfully reduce GHG emissions and other air pollutions. The CPRG has two components: $250 million for planning grants and $4.6 billion for competitive implementation grants. Each state could receive $3 million in planning funding and each of the 67 most populous metropolitan areas receive $1 million.

The CPRG planning work has three phases:

- Priority Climate Action Plan (PCAP, this document) – due to the EPA March 1, 2024;
- Comprehensive Climate Action Plan (CCAP) – due in 2025; and
- Status Report – due in 2027

Between the submission of the PCAP to the EPA and the CCAP, there is an opportunity for certain jurisdictions to apply to the EPA for funds for an implementation grant. Implementation grant applications are due April 1, 2024 and projects put forward in the applications must be included in the PCAP.

The CPRG is unique in its examination of climate and air pollution from a cross-sector approach as well as its commitment to environmental justice and President Biden's Justice40 initiative. The CPRG program, including the implementation grants, is focused on sustainability and carbon emissions reduction, not resilience. This means that while urban canopy or forestry management projects are eligible projects given that they would capture carbon, a seawall is not.

Finally, it is critical to note that while the CPRG's PCAP and CCAP provide and will provide thoughtful, deep evaluations of potential GHG and air pollution reduction measures, these documents are planning products, not legislative requirements. It is up to the people of the Hartford-East Hartford–Middletown region and the residents of the state of Connecticut to make the measures on these pages a reality.

Figure 13: Community members kayaking.

Process and Approach to Developing the PCAP

As noted above, the CPRG is comprised of three planning documents and one grant competition. The PCAP provides a list of near-term (2025 – 2030), implementation-ready measures aimed at lessening GHG pollution. This document includes analyses of benefits these measures would have on LIDACs and the impact these measures would have on lessening air pollution.

All entities covered by a submitted PCAP may submit an application for the implementation grant if the project is included in the list of PCAP carbon reduction measures. Implementation grant applications are due one month after the PCAP is due. The EPA plans on awarding 30-115 grants, between $2 million and $500 million each. EPA has stated the following about the grant applications:

- Each eligible applicant is limited to submitting two grant applications, one as individual, one as lead for a coalition
    - Applicants may participate in more than one coalition, only lead one
- EPA anticipates ensuring diverse geographic coverage for awards
    - No more than two state level applications in one state
    - No more than two MSA applications in one MSA
    - No more than two Tribal applications within one Tribe
    - No more than two Territorial applications within one Territory

This PCAP was developed by examining the current sources of GHG emissions in the region and by engaging stakeholders at the municipal, state, and residential level to determine both what is currently being done to lower GHG pollution and what measures residents and local governments would like to see. The PCAP measures also build upon current studies undertaken by CRCOG and RiverCOG. The **Greenhouse Gas Emissions Inventory** section discusses the findings of the GHG emissions inventory and the **Coordination and Outreach** section details stakeholder engagement performed. Stakeholders in this process include members of the Climate Technical Advisory Committee (CTAC), comprised of regional municipal staff and employees in state agencies, Sustainable CT, a non-profit created by Connecticut towns to advance their sustainability efforts, state agencies including the Connecticut Department of Transportation (CTDOT) and the Connecticut Equity and Environmental Justice Advisory Council (CEEJAC), municipal staff from local governments in the two COGs' regions, and an equity coach who worked with local residents of LIDACs. Two surveys were sent out, one to municipal officials and one to residents.

Figure 14: Outdoor meeting held by RiverCOG.

Measures were developed based on current work underway and by areas of interest expressed by municipal officials and residents. The GHG emissions inventory's findings – specifically, transportation's large share of emissions – helped start conversations but it was also recognized that "GHG saved was GHG saved" – emissions could be tackled from all sectors and still impact the region's overall emissions. Measures that support or deepen current high performing, popular programs were prioritized, given the PCAP's focus on near-

Figure 15: Intersection in Buckland, CT.

term, implementation ready projects. Measures that offer benefits to the area's underserved communities were prioritized, and the voices of the LIDAC residents were amplified through the work with the equity coach. Through numerous in-person and virtual meetings, measures were discussed and workshopped with groups of people – sometimes municipal official-only conversations, sometimes resident-only conversations, and sometimes, conversations that included both groups.

It is important to note that while the PCAP's measures focus on near term implementable projects, the CCAP will look more broadly at measures. All GHG reduction measures discussed during the stakeholder engagement in developing the PCAP are included in **Appendix B**.

Figure 16: Commuters during the morning rush in Hartford.

GREENHOUSE GAS EMISSIONS INVENTORY

UMass - Amherst has developed a statewide inventory of major sources of GHG emissions, including those within the Hartford-East Hartford–Middletown MSA. This inventory was prepared using the following data resources:

- Connecticut Department of Transportation;
- Energize CT;
- Flight;
- US Energy Information Administration;
- American Community Survey;
- OSMnx Python Package;
- Connecticut Department of Energy & Environmental Protection;
- United States Department of Agriculture;
- Local Greenhouse Gas Inventory Tool;
- Connecticut NPDES Permits; and
- 2015 Land Cover Number and Charts (University of Connecticut).

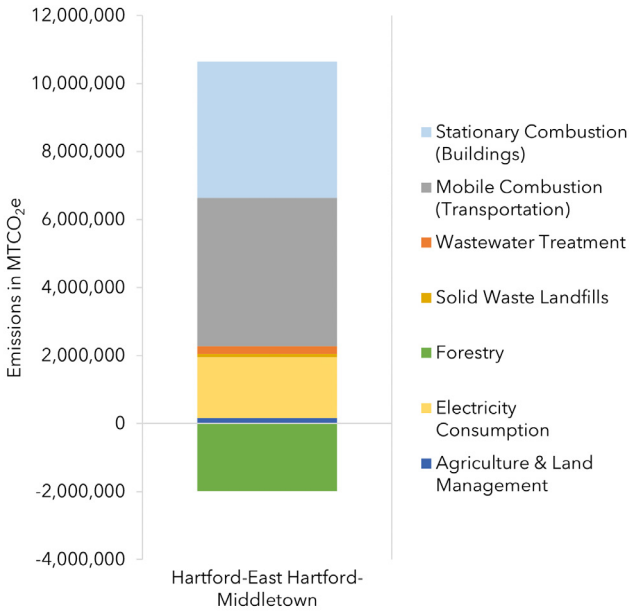
Detailed methodology and quality assurance procedures for preparation of this inventory are contained in **Appendix F**.

The Connecticut GHG emissions inventory includes the following sectors and gases:

Table 3 details GHG emissions in metric tons (MT) of carbon dioxide equivalents (CO_2e) for all economic sectors. These data are also displayed in **Figure 17** below.

Table 4 details emissions of specific GHGs across all economic sectors in MT CO_2e.

Figure 17: GHG emissions for the Hartford-East Hartford-Middletown MSA.



Sectors:

1. Mobile Combustion (Transportation)
2. Electricity Consumption
3. Solid Waste Landfills
4. Stationary Combustion (Buildings)
5. Agriculture and Land Management
6. Wastewater Treatment
7. Forestry

Gases:

1. Carbon dioxide (CO_2)
2. Methane (CH_4)
3. Nitrous Oxide (N_2O)

Table 3: Hartford-East Hartford–Middletown MSA GHG emissions in MT CO_2e by Sector.

SECTOR	SUBSECTOR	YEAR	TOTAL EMISSIONS (MT CO_2E)
Mobile Combustion (Transportation)	Automobiles	2021	1,558,471
	Buses	2021	30,649
	Motorcycles	2021	55,503
	Trucks	2021	2,710,721
	Total		**4,355,344**
Electricity Consumption	Commercial/Industrial	2021	914,548
	Residential	2021	875,671
	Total		**1,790,219**
Solid Waste Landfills	Landfill fuel combustion	2021	476
	Landfill methane	2021	96,186
	Total		**96,662**
Stationary Combustion (Buildings)	Commercial	2020	1,600,473
	Industrial	2020	347,809
	Residential	2020	2,064,354
	Total		**4,012,636**
Agriculture & Land Management	Manure fertilizer	2017	638
	Organic fertilizer	2017	338
	Synthetic fertilizer	2017	165,942
	Total		**166,918**
Wastewater Treatment	**Total**	2021	**227,553**
Forestry	Coniferous forest	2015	-288,634
	Deciduous forest	2015	-1,570,298
	Forested wetland	2015	-124,816
	Total		**-1,983,747**
Grand Total			**8,665,585**

Table 4: Hartford-East Hartford–Middletown MSA GHG emissions in MT CO_2e by Gas. *(Note that not all component GHGs were calculated for all sectors and subsectors. "NC" denotes that the value was not calculated.*

SECTOR	SUBSECTOR	YEAR	CO_2 EMISSIONS (MT CO_2E)	CH_4 EMISSIONS (MT CO_2E)	N_2O EMISSIONS (MT CO_2E)
Mobile Combustion (Transportation)	Automobiles	2021	1,548,753	850	8,868
	Buses	2021	30,586	5	58
	Motorcycles	2021	55,503	0	0
	Trucks	2021	2,708,827	147	1,747
	Total		**4,343,670**	**1,002**	**10,673**
Electricity Consumption	Commercial/Industrial	2021	907,011	3,027	4,510
	Residential	2021	868,454	2,898	4,318
	Total		**1,775,465**	**5,925**	**8,828**
Solid Waste Landfills	Landfill fuel combustion	2021	NC	NC	NC
	Landfill methane	2021	NC	NC	NC
	Total		NC	NC	NC
Stationary Combustion (Buildings)	Commercial	2020	2,059,985	1,318	3,051
	Industrial	2020	NC	NC	NC
	Residential	2020	NC	NC	NC
	Total		**2,059,985**	**1,318**	**3,051**
Agriculture & Land Management	Manure fertilizer	2017	NC	NC	NC
	Organic fertilizer	2017	NC	NC	NC
	Synthetic fertilizer	2017	NC	NC	NC
	Total		NC	NC	NC
Wastewater Treatment	**Total**	2021	NC	NC	NC
Forestry	Coniferous forest	2015	NC	NC	NC
	Deciduous forest	2015	NC	NC	NC
	Forested wetland	2015	NC	NC	NC
	Total		NC	NC	NC
Grand Total			**8,179,120**	**8,245**	**22,552**

Figure 18: View of a golf course in autumn in Connecticut.

Assumptions and Methodology

The analysis was set in 2021, which serves as the baseline year. A baseline year sets a starting point for emissions levels against which reductions can be quantified by percentage. It identifies main emissions sources, informs where proposed measures may be targeted, and measures progress towards reduction goals. For some emissions sectors, the underlying data sets were not available for 2021 and/or data from previous years was used.

A report prepared by UMass - Amherst detailing assumptions and methodology for the GHG inventory is included as **Appendix G**. This technical document details the sources of activity data (e.g., residential electricity consumption), how that data was calculated into emissions, and all assumptions and conversion factors used in the process.

Figure 19: View of a truss bridge across a frozen river in winter.

PRIORITY GHG REDUCTION MEASURES

The measures in this section have been identified as "priority measures" for the purposes of pursuing funding through CPRG implementation grants. This list is not exhaustive of the regions' priorities. Instead, the selected priority measures included in this PCAP meet the following criteria:

- The measure is **implementation ready**, meaning that the design work for the policy, program, or project is complete enough that a full scope of work and budget can be included in a CPRG implementation grant application.
- The measure can be **completed in the near term**, meaning that all funds will be expended, and the project completed, within the five-year performance period for the CPRG implementation grants.
- The measure **advances state priorities**.

For each priority measure, **Appendix A** to this PCAP provides additional details about the following information:

- An estimate of the cumulative GHG emission reductions from 2025 through 2035;
- An estimate of the cumulative GHG emission reductions from 2025 through 2050;
- Key implementing agency or agencies;
- Implementation schedule and milestones;
- Geographic scope;
- Metrics for tracking progress;
- Co-benefits;
- Impacts on low-income and disadvantaged communities; and
- Authority to implement.

Table 5 summarizes CRCOG and RiverCOG's PCAP priority GHG reduction measures.

For more information on CRCOG and RiverCOG's other plans for reducing GHG emissions, see:

- CRCOG Plan of Conservation and Development
- RiverCOG Plan of Conservation and Development
- CRCOG Metropolitan Transportation Plan
- RiverCOG Metropolitan Transportation Plan
- Municipal Plans of Conservation and Development throughout the Hartford MSA.

Figure 20: View from the Connecticut Science Center in Hartford, CT.

Table 5: Hartford–East Hartford–Middletown PCAP Priority Measures

PRIORITY MEASURE	GHG ASSUMPTIONS	ESTIMATED CUMULATIVE GHG EMISSION REDUCTIONS ($MTCO_2E$)		IMPLEMENTING AGENCY OR AGENCIES	GEOGRAPHIC SCOPE
		2025-2035	2025-2050		
E1) Install Solar Panels on Homes Owned by Municipal Housing Authorities	Assuming 10,000 residents (approximately 3,000 homes) receive solar installations equal to their annual electricity consumption	72,732	207,420	Municipal housing authority & municipal government	LIDACs & MSA
E2) Install solar panels , add battery storage and develop microgrids on buildings and properties owned by municipalities (e.g. schools, town halls, parking lots)	Assuming solar installed on the remaining approximately 200 schools	95,143	284,168	Municipal government	LIDACs & MSA
T1) Convert Light Duty Municipal Fleets to EV/ Hybrids; Install Municipal Charging Infrastructure; Switch Municipal Gas-Powered Equipment to Electric	Assuming 1,000 light-duty fleet vehicles replaced with EVs	70,400	202,400	Municipal government	LIDACs & MSA
T2) Install public EV charging infrastructure and fund maintenance of EV charging infrastructure	Further analysis pending	TBD	TBD	Municipal governments & EV charging partners	LIDACs & MSA
T3) Encourage municipality-owned and privately-owned school buses switch to 20 percent biodiesel (B20) as an interim measure with a long-term focus on converting light duty municipal fleets to EV/ hybrids	Assuming 300 school buses converted to B20 biofuel blend	8,493	24,417	Municipal governments, school districts, bus companies, and EV charging partners	LIDACs & MSA
T4) Pursue Recommended Improvements for At Least One of the Six Transit Corridors Highlighted in Metro Hartford RapidRoutes Transit Priority Corridors Study	Further analysis pending	TBD	TBD	CTDOT & municipal governments	Bloomfield, East Hartford (includes LIDACs), Hartford (includes LIDACs), and West Hartford

PRIORITY MEASURE	GHG ASSUMPTIONS	ESTIMATED CUMULATIVE GHG EMISSION REDUCTIONS ($MTCO_2E$)		IMPLEMENTING AGENCY OR AGENCIES	GEOGRAPHIC SCOPE
		2025-2035	2025-2050		
T5) Develop and Implement Roundabout Projects Across the Region with a focus on LIDACs	Further analysis pending	TBD	TBD	Municipal governments & CTDOT	LIDACs & MSA
T6) Encourage mode shift across the region with complete streets projects that make it safer and easier to bike and walk for all users	Further analysis pending	TBD	TBD	Municipal governments & CTDOT	LIDACs & MSA
N1) Increase Urban Tree Canopy in Municipalities Across the Region	Assuming 100,000 trees planted	14,352	37,752	Municipal governments	LIDACs & MSA
W1) Establish and expand residential and academic food waste diversion programs and examine ways to increase utilization of anaerobic digestion	Assuming 10,000 tons of waste diverted to local composting facilities	61,308	153,271	Municipal governments, CRCOG Solid Waste Working Group & Quantum Biopower (anaerobic digester company)	LIDACs & MSA
B1) Expand the region's commercial and residential energy audit programs and provide support for implementation	Assuming audits lead to a 1% overall reduction in residential and commercial electricity consumption	152,169	420,702	Municipal governments	LIDACs & MSA
B2) Undertake Energy Efficiency Upgrades to Municipal Buildings	Further analysis pending	TBD	TBD	Municipal governments	LIDACs & MSA

LOW-INCOME AND DISADVANTAGED COMMUNITIES ANALYSIS

The implementation of the measures included in this PCAP are anticipated to provide significant benefits to LIDACs. This section identifies all LIDACs within the MSA covered by this PCAP; how CRCOG and RiverCOG meaningfully engaged with LIDACs in the development of this PCAP; and how the two COGs will continue to engage these communities in the future.

The White House Council on Environmental Quality's Climate and Economic Justice Screening Tool (CEJST) uses 5-year American Community Survey data from 2015-2019. CEJST indicates that there are eight LIDACs within the MSA governed by CRCOG and RiverCOG. The eight communities are: Bristol, East Hartford, Enfield, Hartford, Manchester, Middletown, New Britan, and Vernon (**Figure 22**). The population within all the communities identified as LIDACs is 206,969. Per 2015-2019 Census Data, the total population for the MSA was 1,056,614. Thus, the population residing in LIDACs during this period represented 19.6% of the total MSA population.

Looking at data more recent than the CEJST shows that the population of LIDACs increased, along with the region's population. The 5-year ACS data (2018 - 2022) show that 17% of the region's population resides in LIDACs. The census tracts that compose the eight LIDACs all have minority populations that exceed 30%. Additionally, CEJST considered nearly all of the census tracts identified to be low income. With two exceptions, the adjusted percent of individuals below the 200% Federal Poverty Line is less than 70%. Furthermore, many of the census tracts identified by CEJST contain communities where 10% or more of the population is linguistically isolated and/or living below the Federal Poverty Line.

Understanding that increasing GHG emissions lead to increasing climate change impacts, an examination of climate change threats to the LIDACs was undertaken. Per the *2019-2024 CRCOG Natural Hazard Mitigation Plan Update*[5], the most common climate risks for CRCOG include flooding, severe winter storms, and high wind events (i.e. tornadoes and hurricanes). Per the *2021 Lower Connecticut River Valley Hazard Mitigation Plan Update*[6], the most significant climate risks for RiverCOG include flooding, severe weather (i.e. thunderstorms, hail, and downbursts), high wind events (i.e. tornadoes and hurricanes), severe winter storms and tree infestation. Climate risks[7] for each of the eight LIDACs identified by CRCOG for the region are summarized in **Table 6**.

Figure 21: The Little Poland neighborhood in New Britain, CT.

Figure 22: CRCOG and RiverCOG Justice40 (CEJST LIDACs)

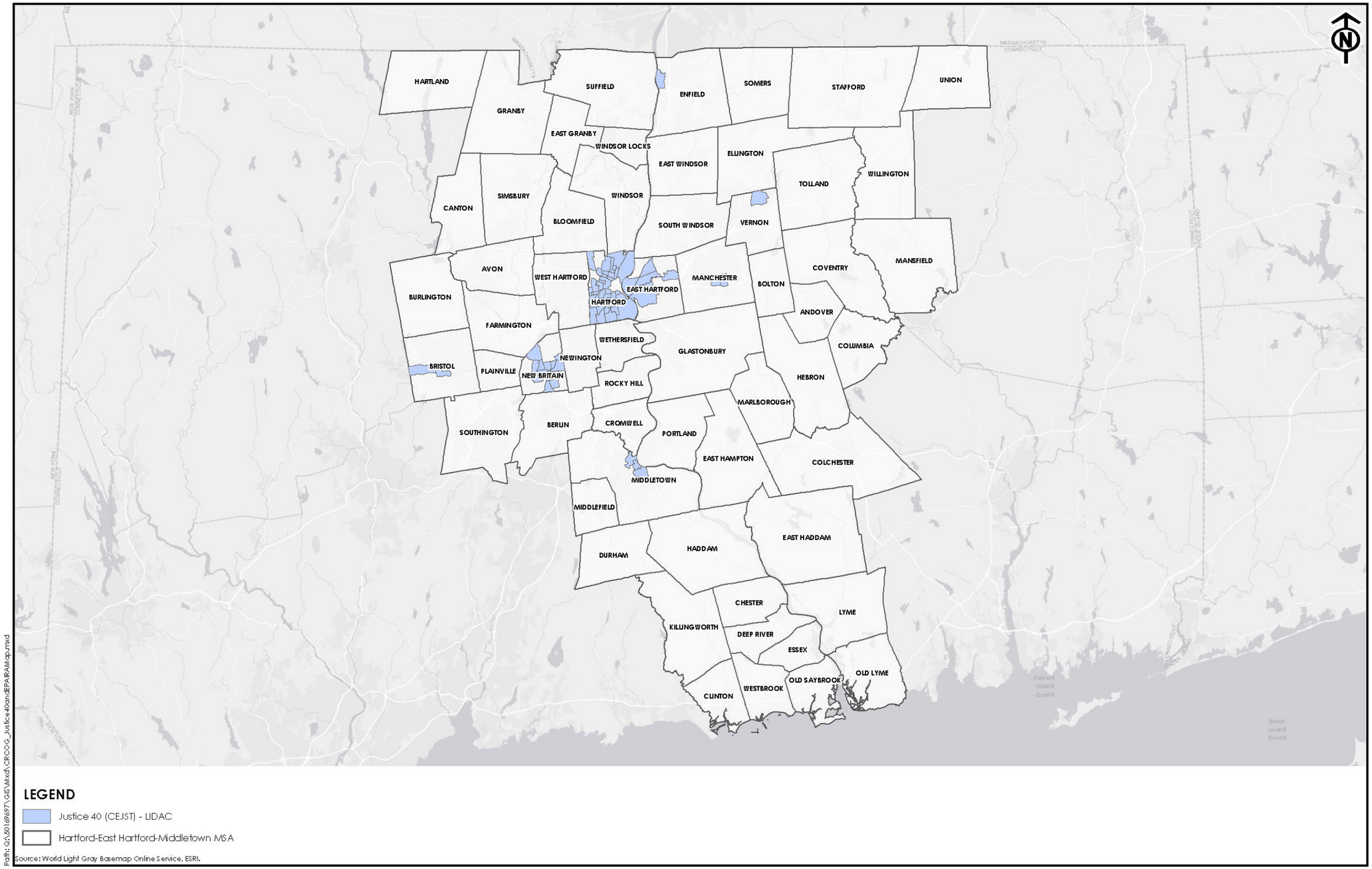


Table 6: Hartford-East Hartford-Middletown MSA identified LIDACs

LIDACS	CENSUS TRACT(S)	CLIMATE RISKS/ VULNERABILITIES
Hartford[2]	Census Tracts 5001, 5002, 5003, 5004, 5005, 5009, 5012, 5013, 5014, 5015, 5017, 5018, 5023, 5024, 5025, 5026, 5027, 5028, 5029, 5030, 5031.01, 5031.02, 5033, 5035, 5037, 5038, 5041, 5042, 5043, 5045, 5048, 5049, 5244, 5245.01, 5247, 9801	Need for sustainable/clean energy, excessive heat, air quality, emission reductions, food security, severe storms and wind events (tornadoes & hurricanes), severe winter weather, flooding, and minor risk of wildfire
East-Hartford[8]	Census Tracts 5102, 5103, 5104, 5106, 5112	Flooding, severe winter weather, severe storms and wind events, moderate risk of wildfires to residential properties, and major risk of excessive heat
New Britain[9]	Census Tracts 4153, 4155, 4156, 4158, 4159, 4160, 4161, 4162, 4163, 4166, 4167, 4171 & 4172	Severe winter weather, moderate flooding risk, minor wildfire risk, major risk of severe storms and wind events, air quality, emission reductions, and major risk of excessive heat
Middletown[10]	Census Tracts 5411, 5417 & 5418	Water conservation, need for sustainable/clean energy, major risk of flooding, severe winter weather, major risk of severe storms and wind events, moderate risk of wildfire, and major risk of excessive heat
Bristol[11]	Census Tracts 4057 & 4061	Brownfield remediation, water conservation, invasive species management, severe winter weather, moderate risk of flooding, moderate risk of wildfire, major risk of severe wind events, and major risk of excessive heat
Manchester[11]	Census Tracts 5147 & 5148	Moderate risk of flooding, major risk of severe wind events, need for clean/sustainable energy, water quality, moderate wildfire risk, and major risk of excessive heat
Vernon[12]	Census Tract 5302	Flooding, severe wind events, severe winter weather, water quality, need for pollution reduction, and improvements to public infrastructure
Enfield[13]	Census Tract 4806	Major risk of flooding, soil erosion, water quality, reduction of impervious surfaces, moderate wildfire risk, major risk of severe wind events, need for clean/ sustainable energy, moderate risk of severe heat, and risk of the loss of endangered and threatened species

Identification of and Engagement with Low-Income and Disadvantaged Communities

CRCOG and RiverCOG identified LIDACs within the Hartford-East Hartford–Middletown MSA using the CEJST, as discussed above. Understanding the need to engage with residents of LIDACs proactively and productively to develop measures that would benefit these communities, CRCOG contracted with an equity coach through Sustainable CT.

It is important to note that the engagement done to develop PCAP measures is just the beginning. As the CCAP is due to the EPA in 2025, engagement for the CCAP will build upon the relationships, discussions, and work started in the PCAP.

Support from the equity coach included:

- Creation and implementation of a a plan to engage and inform low-income/ disadvantaged community members in the eight CEJST-identified LIDACs.
- Assistance provided to municipal staff in identifying and connecting with low-income communities and connecting residents and municipal staff to create working collaborations and incorporate community identified priorities.
- Utilization of existing relationships in these communities as well as built new relationships specifically tailored to the CPRG. For example, the equity coach connected with key community members and community groups in Enfield, a LIDAC they had not worked in before.

A summary of the equity coach's engagement is provided below.

October 2023 - Outreach and introductions to identified municipal contacts

During the month of October, the equity coach connected with municipal representatives from Hartford, Manchester, Bristol and Enfield to discuss their current and previous outreach to their low-income and marginalized communities. These meetings involved standard equity coaching and brainstorming as well as information gathering. The equity coach engaged

Equity Coach Profile: Kamora's Cultural Corner

Kamora's Cultural Corner (KCC) provides both a metaphoric and physical space to learn to use the gifts and privileges of communities' unique and shared identities. Approaching cultural humility through a Black, Queer, and Afrocentric perspective, KCC creates and navigates Brave Spaces with the intention of building and supporting organic community connections.

Through experiential education, lecture, facilitated conversation, and consultation, clients identify where issues of identity and equity need to be addressed, how to create the conditions to best address them, and then how to shift attitudes and behaviors so that any new changes or policies are successful.

As an organization that values Brave Spaces and experiential education, KCC offers clients and member organizations access to The Sterling Street Sanctuary Labyrinth and Nature Reserve. Programming at the Sanctuary is as diverse as KCC's clientele and can range from workshops or team building projects for organizations, private consultations, and Brave Space events where diverse groups of clients and community members come together in Brave Spaces for various workshops, events and Thinking and Doing Days.

volunteers in identifying and connecting with residents in the eight identified towns.

November 2023 - Outreach and community education

Through the equity coach's networks, as well as municipal suggestions and connections, two online Zoom community meetings were held to share information and discuss community needs and concerns around climate/environmental concerns. The equity coach maintains a weekly food outreach program that supports residents in all of the identified towns, except for Vernon. Delivery volunteers for this program asked residents in those towns about their ideas and concerns for their towns and invited them to join the Zoom and in-person meetings. This event was developed to build on existing relationships between community members and CRCOG and RiverCOG staff. Residents were also asked to fill out the CRCOG public survey, which solicited feedback on community priorities to reduce GHG emissions. Housing, as an umbrella issue, came up often; however, the top three issues of concern turned out to be:

1) alternative/solar energy,

2) waste management and recycling, and

3) community greenspaces and gardens.

Residents also shared many concerns around barriers, including skepticism that their needs or concerns would be incorporated into a larger plan.

December 2023 - Face to face community meetings and engagement

Along with the equity coach's weekly continued food distribution outreach, they held two face-to-face community meetings, one at the Free Center in Middletown and another at The Mansion in Hartford, where residents were asked to share their needs and ideas as well as examples of programs that have or have not worked.

The head of the Middletown recycling program attended the second in-person meeting. She discussed the need for every individual to be aware of the waste they produce and their effect on the waste cycle, while giving expertise on day-to-day operations and costs of waste management for the municipality.

Waste and recycling continued to come up in the equity coach's engagements as an issue that people wanted to address and were already working on in different capacities.

Figure 23: A community meeting facilitated by the equity coach.

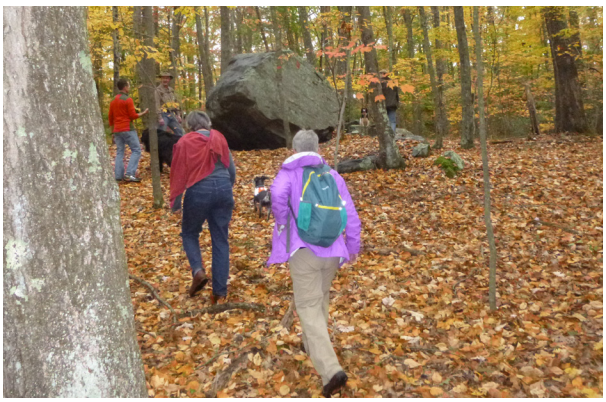
Technology also came up as a topic during the group discussion. Some felt as if it was necessary to adapt using technology to strengthen community, accessibility, and efficiency. However, this was opposed by others who felt as though technology was becoming too overwhelming and a return to more community-based initiatives would prove to be more meaningful and fulfilling for the everyday resident. Residents from Manchester were also in attendance and cited finding comfort in the proximity and walkability Manchester

offers them, and that walkability is an effective way to be sustainable while fostering a sense of community.

Housing was another topic that came up during the meeting. Some felt that housing was not being upgraded, maintained, or built to be energy efficient at a quick enough rate. A concern was also raised that affordable housing was not being built at an appropriate rate either and stated that more needs to be done to meet the basic needs of individuals before we can begin to care about other things such as recycling and technology.

On December 27, 2023, the equity coach invited community members, municipal staff, and CRCOG stakeholders to come together for a Thinking and Doing Day (T&DD) for a theoretical collaborative exercise woven into the equity coach's Kwanzaa event. The exercise involved small groups collaborating on finding ways to connect with 'hard to find' communities and community members as well as discussing where and how to invest 4 million dollars in the environmental health of their community. The event was documented by David Jackson, who live painted through the workshop. His completed work and artist statement will be shared with all of the participants and will be used as a starting point in future community conversations.

Figure 24: Focus group and dogwalking meeting held in autumn by RiverCOG.



Thinking and Doing Days include a collective learning component, an introduction to cultural humility through I.D.E.A. and a community conversation where members share information and practice cultural humility. These sessions are invaluable in the early stages of creating trusting collaborations with disparate groups.

January 2024 - Follow-up conversations/ consultations for community members and municipal staff

The equity coach facilitated a Zoom meeting with municipal staff, LIDAC residents, and stakeholders on January 16, 2024. A mix of elected officials/staff/town representatives from Manchester, East Hartford, Hartford, Middletown, and New Britain were in attendance. Participants listened to an overview of the planning work and measures discussed to date. Subsequently, smaller breakout groups by municipality allowed attendees to discuss the measures in more detail and provide feedback. In addition to connecting residents with their elected officials/ town reps, it also connected residents to CRCOG/RiverCOG, which will help facilitate further participation throughout the PCAP and CCAP planning process.

In addition to the outreach done by the equity coach, an overview of additional coordination and outreach done by CRCOG and RiverCOG is outlined in **Coordination and Outreach**.

Impact of PCAP Implementation on Low-Income and Disadvantaged Communities

Table 7 lists the LIDACs anticipated to be affected by implementation of each priority measure included in this PCAP. Anticipated benefits or potential disbenefits associated with GHG reduction measure implementation are summarized in this section. Specific methods and assumptions for quantitative assessment of benefits associated with each priority measure are described in **Appendix A**.

ANTICIPATED BENEFITS AND DISBENEFITS

Three broad benefits of the proposed measures were determined:

1. Energy Efficiency
2. Improvements to Public Health/Community Development
3. Improvements to Transportation

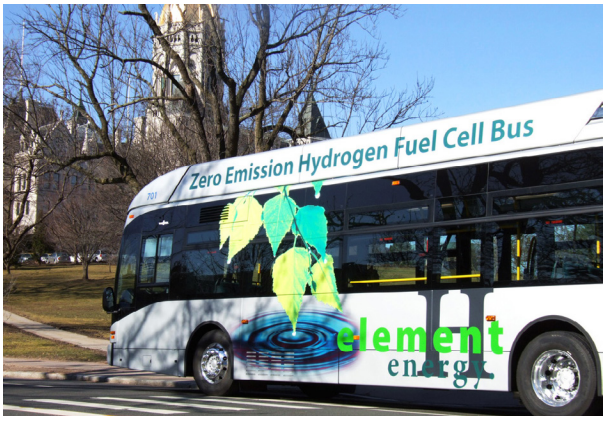
Energy Efficiency

A third of the priority climate measures are related to improving energy efficiency within buildings through upgrades. As part of these improvements, energy audit programs will be expanded. Anticipated benefits from these measures include: new jobs created in LIDACs from clean energy job training programs or apprenticeship programs, decreased energy costs for the residents and the municipal government and contributions to reducing the overall emission of GHGs. These priority measures are designed to foster renewable energy sources and reduce the burden on the grid.

Improvements to Public Health/ Community Development

The next set of four measures relates to improving public health. Transitioning school buses to EV/hybrid reduces the amount of harmful exhaust that children are exposed to. Additionally, installing charging stations supports this transition. Developing mode shift projects to make it safe to participate in active transportation improves public safety, reduces vehicle miles traveled (VMT) and has the added bonus of improving health outcomes in the community. Increasing urban tree canopy coverage assists in combating severe sun exposure/heat, improves air quality, and reduces the severity of flooding with the introduction of green space. Lastly, food waste diversion programs reduce waste generation, reduce emissions from decomposing waste and improve soil quality. This is especially important in regions where agriculture is practiced and/ or erosion is an issue.

Figure 25: CTtransit hydrogen fuel cell bus.



Improvements to Transportation

Finally, the last set of priority measures concern improvements to transportation systems, infrastructure and fleet vehicles. Converting municipal fleets and equipment from diesel to electric has the dual benefit of reducing GHG emissions and diesel particulates while they are in use and pushing municipalities to pursue more environmentally friendly fuel sources. Installing charging station serves to support this transition into clean energy. Investing and improving public transit increases the number of viable transportation options in the minds of residents and reduces GHG emissions as well as VMT. Implementing roundabout projects improves traffic flows, as well as improving both pedestrian/cyclist and motorist safety by forcing vehicles to travel at slower speeds at intersections.

CRCOG and RiverCOG will continue to engage LIDACs throughout the implementation process and into the CCAP and Status Report plans. As noted in the **Coordination and Outreach** section, public outreach materials will include an ESRI StoryMap, social media posts, and fact sheets. Additional engagement with residents of LIDACs will be critical in developing the implementation grant. During the CCAP phase, outreach may include items such as presentations to community members, a public comment meeting, sector-based meetings, website material updates, and refinement of public outreach tools developed during the PCAP. Feedback will be used to refine measures and identify new measures for the CCAP.

Table 7: LIDACs Affected by Priority GHG Reduction Measures

PRIORITY GHG REDUCTION MEASURE	AFFECTED LIDAC CENSUS TRACTS	BENEFITS	DISBENEFITS
E1) Install Solar Panels on Homes Owned by Municipal Housing Authorities	Tracts: 5005, 5009, 5013, 5014, 5033, 5247, 5102, 5103, 5104, 5106, 5112, 4166, 4167, 4171, 4163, 5417, 4057, 4061, 5302, & 4806	• Generates renewable power for homeowners in LIDAC tracts, potential for savings on utility bills • Contributes to the reduction of GHG emissions	• High upfront cost may discourage installation
E2) Install Solar Panels, add Battery Storage and Develop Microgrids on Buildings and Properties Owned by Municipalities (e.g. schools, town halls, parking lots)	All	• Generates renewable power for municipalities in LIDAC tracts • Potential for savings on utility bills • Contributes to the reduction of GHG emissions	• High upfront cost
T1) Convert Light Duty Municipal Fleets to EV/ Hybrids; Install Municipal Charging Infrastructure; Switch Municipal Gas-Powered Equipment to Electric	All	• Reduces the volume of harmful emissions from fleet vehicles in EJ communities • Potential to improve air quality • Installing more chargers decreases range anxiety and may encourage the purchase of a personal electric/ hybrid vehicle • Fleet vehicles become independent from fossil fuels	• Upfront cost • Reluctance/resistance to transition • Significant benefits won't be seen until a larger percentage of the fleet switches over to EVs • Need for a maintenance system/ program
T2) Install Public EV Charging Infrastructure and Fund Maintenance of EV Charging Infrastructure	All	• Decreases range anxiety • Adds inventory to EV charging infrastructure • Charging availability encourages residents to make the switch to EVs	• Significant benefits won't be seen until a larger percentage of the population switches over to EVs and EVs become more affordable

PRIORITY GHG REDUCTION MEASURE	AFFECTED LIDAC CENSUS TRACTS	BENEFITS	DISBENEFITS
T3) Encourage Municipality-Owned and Privately-Owned School Buses Switch to 20% Biodiesel as an Interim Measure with a Long-Term Focus on Converting Light-Duty Municipal Fleets to EV/Hybrids	All	• Vehicles become independent from fossil fuels • Buses release far less emissions in residential neighborhoods en route to pick up children • Improvements to air quality over time	• Significant benefits won't be seen until a larger percentage of the bus stock switches over to EVs • May have difficulties finding an all-electric/hybrid private company
T4) Pursue Recommended Improvements for At Least One of the Six Transit Corridors Highlighted in Metro Hartford RapidRoutes Transit Priority Corridors Study	All or at least some of the following tracts: 5102, 5104, 5112, 5009, 5013, 5018, 5244, 5014, 5017, 5035, 5037, 5031.01, 5031.02, 5033, 5030, 5003, 5005, 5028, 5029, 5041, 5043, 5049, 5001, 5002, 5023, 5024, 5025	• Service frequency (stop spacing) and reliability improve regardless of the line • LIDACs will receive improvements (high quality bus stops, bus lanes, signal priority) which will serve to increase the convenience of taking the bus instead of driving (reduction in VMT) • Level boarding areas will allow for quicker boarding and improve passenger accessibility	• High cost may mean that the project is done in phases or scaled back • If scaled back then some LIDACs will not benefit • Increases the number of buses on the road (only an issue if not EVs)
T5) Develop and Implement Roundabout Projects Across the Region with a focus on LIDACs	All	• Improves traffic flow (less idling, cuts down on air pollution) • Discourages speeding and ultimately contributes to fewer collisions • Improves cyclist/pedestrian safety and can encourage mode shift	• Contextually may not make sense in all LIDACs • Existing land use patterns or geometric design limitations may make installation challenging, putting off benefits
T6) Encourage Mode Shift Across the Region with Complete Streets Projects that Make it Safer and Easier to Bike and Walk for All Users	All	• Potentially reduces VMT • Reduces the number of vehicle on vehicle and vehicle on person collisions • Reduces the number of road fatalities • Encourages active transportation (which has health benefits)	• Benefits from bike infrastructure will only be realized if a significant portion of the community owns a bike • Increased cost to LIDAC municipality for maintenance
N1) Increase Urban Tree Canopy in Municipalities Across the Region	All	• Provides shade from the sun • Improves air quality • Reduces heat island effect • Reduces impervious surface • Potential to reduce severity of flooding	• Unsuitable trees may become or invite invasive species • May worsen seasonal allergies • May impact local budgets for maintenance

PRIORITY GHG REDUCTION MEASURE	AFFECTED LIDAC CENSUS TRACTS	BENEFITS	DISBENEFITS
W1) Establish and Expand Residential and Academic Food Waste Diversion Programs and Examine Ways to Increase Utilization of Anaerobic Digestion	All	• Reduce waste and emissions from landfills • Improvements to soil quality • Improvements to water quality • Potential to coordinate with existing/future facilities to generate energy • Local waste handling may reduce transportation emissions for out-of-state trips, benefitting LIDACs in other states	• Requires high initial installation cost • May have a high operational cost (anaerobic) • Requires large expanses of land • Permitting considerations with State or other entities • Picking up food waste may increase VMT on local roads
B1) Expand the Region's Commercial and Residential Energy Audit Programs and Provide Support for Implementation	All	• Provides ways to improve energy efficiency • Potential to create additional jobs necessary to complete audits and energy improvements in a timely manner	• Focus is on audits, showing potential improvements, not realizing improvements
B2) Undertake Energy Efficiency Upgrades to Municipal Buildings	All	• Provides ways to improve energy efficiency • Creates opportunities to improve existing energy/building codes	• Focus is on audits, showing potential improvements, not realizing improvements

REVIEW OF AUTHORITY TO IMPLEMENT

Recognizing that the ability to move expeditiously on GHG reduction measures is tied to the authority to implement each measure, CRCOG and RiverCOG have reviewed the existing statutory and regulatory implementation authority for each priority measure described in this PCAP. For any priority GHG reduction measure where authority must still be obtained, this section contains a discussion in **Table 9** of the steps to be taken to move forward on the measure.

Overall Authority to Implement

Table 8 highlights the governing bodies in Connecticut and their respective areas of oversight. This table focuses on who or what entity might enact a potential GHG emission measure. The "Type" column shows the specific area the entity has control over (e.g. the governor's powers extend statewide and "Bus Service" displays all of the state's transit providers).

Table 8: Authority to Implement in Connecticut

TYPE	GOVERNING BODY	AREA(S) OF OVERSIGHT
State	Governor Ned Lamont	Various statewide
	Lt. Governor Susan Bysiewicz	Various statewide
	CTDPH	Public health
	CTDECD	Economic/community development
	CTDEEP	Energy & environmental protection
	CTDEEP Climate Resilience Fund	Responsible for providing grants to help regional, municipal, and neighborhood-level Connecticut communities with respect to planning and developing climate resilience projects
	CTCEQ	Environmental quality
	CTOHS	Healthcare/health equity
	CTCHRO	Human rights/equal opportunity
	CTDOT	Transportation infrastructure and bus system
	CTGWC	Strategy and policy for workforce development
	Governor's Office of Policy and Management (OPM)	Oversees state and local Plans of Conservation and Development (POCDs), state's clearing house for geographical information and oversees some funding to local governments
	Department of Administrative Services (DAS)	Oversees the state building code among other codes, certifications and state programs.

TYPE	GOVERNING BODY	AREA(S) OF OVERSIGHT
County	N/A, CT does not have a legislative county-level government	No authority to implement any measures
Regional	CRCOG	MPO and regional program coordinator
	RiverCOG	MPO and regional program coordinator
Municipal	Various local crograms, committees, departments, councils	Mayoral, public works, transportation, engineering, planning/zoning, community development, public health, environmental conservation, inland wetlands
Private/Public Utility	Various companies, dependent on municipality	Known utility providers by town
Bus Service	CTtransit	Bus operations (overseen by CTDOT)
	RiverValley Transit	Bus operations
	Northwestern CT Transit District	Bus operations
	Greyhound	Privately-owned bus operations
	Peter Pan Bus Service	Privately-owned bus operations
Private Energy	Energize Connecticut	Energy efficiency initiative
	Southern Connecticut Gas Company	Natural gas service provider
	Connecticut Natural Gas Corporation	Natural gas service provider
	Connecticut Green Bank	Investment in clean energy
	Eversource	Energy company (electric, gas, & water service)
Rail Service	CTRail, Amtrak, & Metro-North Railroad, Shoreline East	Rail providers in the state (state, bistate authority, national)

Authority to Implement Priority Measures

Table 9 shows all the priority GHG reduction measures and the entities with current authority to implement each measure. It also identifies if the authority to implement the GHG reduction measure exists at the local level. If the implementing authority is not currently authorized to implement the GHG reduction measures, the final column on the chart shows the steps to be taken to enable the authority to implement the measure.

Figure 26: Park and ride in Buckland, CT.

Table 9: Priority GHG Reduction Measures and Authority to Implement

PRIORITY MEASURE	ENTITY TO IMPLEMENT	AUTHORITY TO IMPLEMENT EXISTS AT LOCAL LEVEL?	IMPORTANT CONSIDERATIONS AND/OR STEPS IF NO AUTHORITY TO IMPLEMENT
E1) Install Solar Panels on Homes Owned by Municipal Housing Authorities	Municipal Housing Authorities	Yes	N/A
E2) Install Solar Panels, add Battery Storage and Develop Microgrids on Buildings and Properties Owned by Municipalities (e.g. schools, town halls, parking lots)	Municipalities	Yes	While the measure could be undertaken at the local level, Connecticut imposes statewide caps for the generation of solar power on certain structures. Adding solar to municipal buildings would be subject to these caps.
T1) Convert Light Duty Municipal Fleets to EV/Hybrids; Install Municipal Charging Infrastructure; Switch Municipal Gas-Powered Equipment to Electric	Municipalities	Yes	N/A
T2) Install Public EV Charging Infrastructure and Fund Maintenance of EV Charging Infrastructure	Municipalities	Yes	N/A
T3) Encourage Municipality-Owned and Privately-Owned School Buses Switch to 20% Biodiesel as an Interim Measure with a Long-Term Focus on Converting Light-Duty Municipal Fleets to EV/Hybrids	Municipalities and private bus companies	Municipalities have the authority to install charging to incentivize school bus operators to switch to electric/hybrid buses. However, for many municipalities, a private operator owns and operates school buses.	In issuing future requests for proposals, for school bus contracts, municipalities could prioritize fleets that use B20 or are electric/hybrid.

PRIORITY MEASURE	ENTITY TO IMPLEMENT	AUTHORITY TO IMPLEMENT EXISTS AT LOCAL LEVEL?	IMPORTANT CONSIDERATIONS AND/OR STEPS IF NO AUTHORITY TO IMPLEMENT
T4) Pursue Recommended Improvements for At Least One of the Six Transit Corridors Highlighted in Metro Hartford RapidRoutes Transit Priority Corridors Study	CTtransit, respective municipalities	Authority over CTtransit bus routes controlled by CTtransit (CTDOT). However, municipalities' coordination and partnership required	Building off work done on the study, CRCOG, CTtransit, and respective municipalities will need to work together to select the route(s) to develop.
T5) Develop and Implement Roundabout Projects Across the Region with a focus on LIDACs	Municipalities, CTDOT	Yes	If roundabout is on a road managed by CTDOT, coordination with CTDOT would be required.
T6) Encourage Mode Shift Across the Region with Complete Streets Projects that Make it Safer and Easier to Bike and Walk for All Users	Municipalities	Yes	If a mode shift project is on a road managed by CTDOT, coordination with CTDOT would be required.
N1) Increase Urban Tree Canopy in Municipalities Across the Region	Municipalities	Yes	N/A
W1) Establish and Expand Residential and Academic Food Waste Diversion Programs and Examine Ways to Increase Utilization of Anaerobic Digestion	Municipalities	Yes – but coordination required with private companies	To incorporate anaerobic digestion in a timely manner, municipalities would need to work with existing anaerobic digestion facilities and carting companies.
B1) Expand the Region's Commercial and Residential Energy Audit Programs and Provide Support for Implementation	Municipalities and private utility companies	Yes – but coordination required with private companies	Many municipalities note that the commercial and residential energy audits are performed by Energize Connecticut, an initiative sponsored by the state and private utility companies. To expand these audits, coordination between CRCOG, RiverCOG, the municipalities and Energize Connecticut should occur.
B2) Undertake Energy Efficiency Upgrades to Municipal Buildings	Municipalities	Yes	N/A

COORDINATION AND OUTREACH

From early on in the CPRG process, stakeholders across multiple levels in Connecticut have established a productive, collaborative framework for this program. At a regional level, the Western Connecticut Council of Governments has convened an inter-governmental working group (IGWG) consisting of other CPRG participating COGs in Connecticut: CRCOG and RiverCOG (Hartford MSA), South Central Regional and Naugatuck Valley (New Haven MSA), and Connecticut Metropolitan and Western Connecticut (Bridgeport MSA). At the State level, the Department of Energy and Environmental Protection (CT DEEP) and Office of Policy and Management (CT OPM) have been involved (and are the State's primary points of contact). The IGWG has established standing meetings to facilitate information sharing and peer learning. CRCOG and RiverCOG's function as the MPO for their respective regions and this role will ensure close communication with the CTDOT and other state agencies.

Closer to home, CRCOG and RiverCOG have undertaken extensive engagement of local municipal staff and leaders. Individual residents were engaged through public meetings, a region-wide survey for all residents, and an equity coach to amplify the voices of LIDAC residents.

This section describes the framework the COGs used to support robust and meaningful engagement strategies to ensure comprehensive stakeholder representation.

Identification of Stakeholders

CRCOG and RiverCOG identified stakeholder's representative of the entities, groups, and individuals who may be impacted by implementation of this PCAP. Stakeholders included, without limitation:

- Other state agencies;
- Other metropolitan planning organizations;
- Economic development organizations;
- Utilities;
- Local elected officials;
- Community-based organizations;
- LIDACs
- Other interested organizations; and
- Residents of Connecticut.

To identify stakeholders, CRCOG and RiverCOG drew upon their experience working in the region and contacted local elected officials, community organizations, and advocacy organizations known to be interested in clean energy infrastructure and practices. The list of identified stakeholders as of the publication of this PCAP is included in **Appendix C**. CRCOG and RiverCOG will update this list of stakeholders as needed.

Figure 27: Pedestrians commuting during the morning rush in Hartford, CT.

Interagency and Intergovernmental Coordination

Key agencies identified for interagency and intergovernmental coordination include:

- CT DEEP
- CT Department of Emergency Services and Public Protection (DESPP)
- CTDOT
- CT OPM
- Governor's Council on Climate Change (GC3)
- State COGs

Both CRCOG and RiverCOG utilized their existing relationships with local municipalities, state agencies and private companies (such as utility providers) to assist with the development of this PCAP. Stakeholders were engaged in a series of meetings, detailed in the Outreach and Coordination Documentation Table, below. Subawards were issued to UMass - Amherst for the GHG inventory, and to Sustainable CT, which has been an important non-profit partner in the effort to advance the equity work. Created by towns to help advance their sustainability efforts, Sustainable CT is a voluntary certification program to recognize thriving and resilient Connecticut municipalities, regardless of size, geography, or resources.

As discussed earlier in the PCAP, stakeholders across multiple levels in Connecticut established a productive, collaborative framework for this program. CRCOG and RiverCOG have coordinated and will continue to coordinate closely with the CTDOT, as they just completed the development of its Carbon Reduction Strategy via their Infrastructure Investment and Jobs Act (IIJA) activities.

In addition to the IGWG, CRCOG established a Climate Technical Advisory Committee (CTAC) to help guide the planning process for the MSA. The group is comprised of the communities that provided letters of support (Hartford, East Hartford, New Britain, Manchester, Middletown, and West Hartford), RiverCOG, and Sustainable CT. The CTAC has met regularly throughout the PCAP phase to guide the planning process and receive updates from sub awardees on deliverables progress. The CRCOG team will continue to collaborate with the CTAC throughout the CCAP and Status Report development process as well.

Figure 28: View of the Farmington River.

Outreach Plan

The key to successful long-term solutions often starts with robust stakeholder engagement. Public outreach has/will include elements of the following:

- Community meetings across the state with options for in-person and video conference participation.
- Online surveys targeted to municipal staff and the public.
- Online resources such as the State CPRG webpage, CRCOG and RiverCOG webpages.
- Targeted LIDAC outreach with an equity coach (Kamora's Cultural Corner).
- Other public outreach materials such as an ESRI StoryMap.
- Public comment period and two separate public comment period public meetings on the draft plan.

Below is an overview of the outreach completed to date.

- In-person and virtual sector-based stakeholder meetings
  - A virtual stakeholder meeting was held on 11/14/2023. This statewide webinar, sponsored by the Connecticut Conference of Municipalities (CCM) explained EPA's new Climate Pollution Grant program and its deliverables, including both the planning and implementation phases. It was hosted and facilitated by the three CT COGs acting as the lead agencies for their respective regions – CRCOG (Hartford-East Hartford-Middletown MSA), SCRCOG (New Haven-Milford MSA) and MetroCOG (Bridgeport-Stamford-Norwalk MSA).

Figure 29: Commuters waiting at a bus shelter.

  - Staff from the CT DEEP were also in attendance to answer questions about the State's plan. The intent was to obtain preliminary feedback from both municipal leaders and various emission sector experts to inform development of the regional PCAP and CCAP. After an overview, the meeting featured breakout rooms by both emissions sector and MSA geography, with the intent to identify key implementation priorities and opportunities for collaboration. They were organized by the major greenhouse gas emission sectors, as defined by EPA.
  - An in-person meeting co-hosted by CRCOG and the Sustainable West Hartford Commission in West Hartford on 11/27/2023. The purpose of the meeting was to provide an overview of the CPRG program and offer participants an opportunity to exchange ideas and information, discuss potential implementation projects, and identify opportunities for collaboration. Municipalities with previous or existing sustainability and clean energy commissions or working groups were encouraged to attend. Each town in attendance was given a chance to share their current GHG reduction measures and encouraged to talk to their respective commissioners and elected officials in order to provide a complete list of projects for the plan.
  - A hybrid in-person/virtual meeting was held in Middletown on 12/5/2023. Similar to the West Hartford meeting, the purpose of the meeting was to provide an overview of the CPRG program and offer participants an opportunity to exchange ideas and information, discuss potential implementation projects, and identify opportunities for collaboration. Each town in attendance was given a chance to share their current GHG reduction measures and encouraged to talk to their respective commissioners and electeds in order to provide a complete list of projects for the plan.
  - A virtual CTAC meeting was held on 12/19/2023. The purpose of the meeting was to provide a general project status update for CTAC partners and solicit feedback on GHG reduction measures provided to date.
  - Two virtual drop-in sessions were held on 12/19/2023 and 12/20/2023. CRCOG and RiverCOG staff hosted the two virtual informational sessions to answer questions from municipal staff in the Hartford-East Hartford-Middletown region about potential municipal priority measures.
  - Another virtual CTAC meeting was held on 1/5/2024. The purpose of the meeting was to provide an update on the schedule and key dates, review the proposed priority measures, and solicit final feedback on how implementation ready the measures were.

Figure 30: Community participants at a PCAP meeting in West Hartford in December 2023.

- A virtual Connecticut Equity and Environmental Justice Council (CEEJAC) meeting was held on 1/9/2024. The meeting included the COGs, members of the CEEJAC, an advisory panel to CT DEEP, and members of the public. The meeting highlighted the process the COGs are using to develop measures.
- An intergovernmental virtual meeting was held 1/10/2024. The meeting included representatives from CT DEEP, CTDOT, CT Green Bank, Avangrid, CT OPM, and over 15 towns within the region. The meeting highlighted the schedule of the work and solicited final feedback on how implementation ready the measures were.
- A virtual public meeting was held 1/16/2024. The meeting included members of the public from LIDACs. The purpose of the meeting was to provide an overview of the PCAP and CCAP processes and connect members to the planning staff.

- Municipal and public facing surveys.
  - CRCOG created and distributed a survey for municipal leaders in the Hartford MSA requesting input on potential GHG reduction measure for inclusion in the PCAP. This survey was live from 12/13/2023 through 1/11/2024.
  - A public facing survey was created by CRCOG and distributed in the Hartford MSA requesting input on potential GHG reduction measure for inclusion in the PCAP. This survey went live on 12/13/2023. Any feedback received by 1/11/2024 was analyzed and included in the PCAP if relevant. If feedback was received after that date, it will be analyzed and included in the CCAP.
- Materials will be created to support the PCAP outreach effort. These materials include content for the public to consume on its own (e.g. an ESRI Storymap that can engage the public) as well as content that can be utilized by municipalities to increase awareness about the PCAP work (e.g. social media posts can be posted by municipalities across the region). Materials developed will include
  - Website content;
  - ESRI StoryMap; and
  - Fact Sheets.

Outreach and Coordination Documentation

Table 10 provides a log of interagency and intergovernmental coordination and stakeholder and public engagement efforts associated with development of this PCAP. Meeting and outreach materials and resources are available at in the CRCOG Regional Climate Action Plan and the RiverCOG Regional Climate Action Plan.

Additional meetings are planned during the public comment period and will be added and summarized in the Final PCAP.

Table 10: Outreach and Coordination Log

DATE	TOPIC	ORGANIZATIONS INVOLVED	COORDINATION /OUTREACH METHOD	LOCATION	OUTCOME(S) AND NEXT STEPS
October 2023	LIDAC engagement	KCC, Hartford, Manchester, Bristol, Enfield	In-person meetings	Various locations	Equity coaching and brainstorming as well as information gathering for subsequent outreach.
November 14, 2023	CPRG Program and Priority Measures	Connecticut Conference of Municipalities (CCM), CRCOG, MetroCOG, SCRCOG, CT DEEP, EPA	Zoom	Virtual/Zoom	Outcomes included an understanding of the PCAP and the collection of a preliminary list of priority measures.
November 27, 2023	CPRG Program and Priority Measures	Public/municipal meeting	In-person	West Hartford	Outcomes included an understanding of the PCAP and the collection of priority measures.
December 5, 2023	CPRG Program and Priority Measures	Public/municipal meeting	In-person and virtual	Middletown	Outcomes included an understanding of the PCAP and the collection of priority measures.
December 2023	LIDAC engagement	Public meeting	In-person	Middletown, Free Center	Waste and recycling continued to come up in KCC's engagements as an issue that people wanted to address and were already working on in different capacities
December 2023	LIDAC engagement	Public meeting	In-person	Hartford, The Mansion	Waste and recycling continued to come up in KCC's engagements as an issue that people wanted to address and were already working on in different capacities
December 19, 2023	CPRG Program and Priority Measures	CTAC Meeting	Virtual	Virtual/Microsoft Teams	Outcomes included an understanding of the PCAP and the collection of priority measures.
December 19, 2023	CPRG Program and Priority Measures	Public/municipal meeting	Virtual	Virtual/Microsoft Teams	"Drop-In" virtual session for municipal staff/local elected officials to learn more about the CPRG, PCAP, and share projects they are working on. Outcomes included further clarification of the PCAP and measures.

DATE	TOPIC	ORGANIZATIONS INVOLVED	COORDINATION /OUTREACH METHOD	LOCATION	OUTCOME(S) AND NEXT STEPS
December 20, 2023	CPRG Program and Priority Measures	Public/municipal meeting	Virtual	Virtual/Microsoft Teams	"Drop-In" virtual session for municipal staff/local elected officials to learn more about the CPRG, PCAP, and share projects they are working on. Outcomes included further clarification of the PCAP and measures.
December 27, 2023	LIDAC engagement	Public meeting	In-person		Outcome included ideas on how to better connect with communities and ideas/ understanding of how to positively impact the environmental health of their community.
January 5, 2024	CPRG Program and Priority Measures	CTAC	Virtual	Virtual/Microsoft Teams	Outcomes included a final list of priority measures to be included in the PCAP.
January 9, 2024	CPRG Program and Priority Measures	CEEJAC	Virtual	Virtual/Microsoft Teams	Outcomes included an understanding of the PCAP and CCAP process and understanding of priority measures in each COGs PCAP.
January 10, 2024	CPRG Program and Priority Measures	Intergovernmental	Virtual	Virtual/Microsoft Teams	Outcomes included a final list of priority measures to be included in the PCAP.
January 16, 2024	LIDAC Engagement	Public meeting	Virtual	Virtual/Zoom	Outcomes included an understanding of the PCAP and CCAP process and understanding of priority measures. In addition, connecting LIDAC residents to those in charge of the planning process.

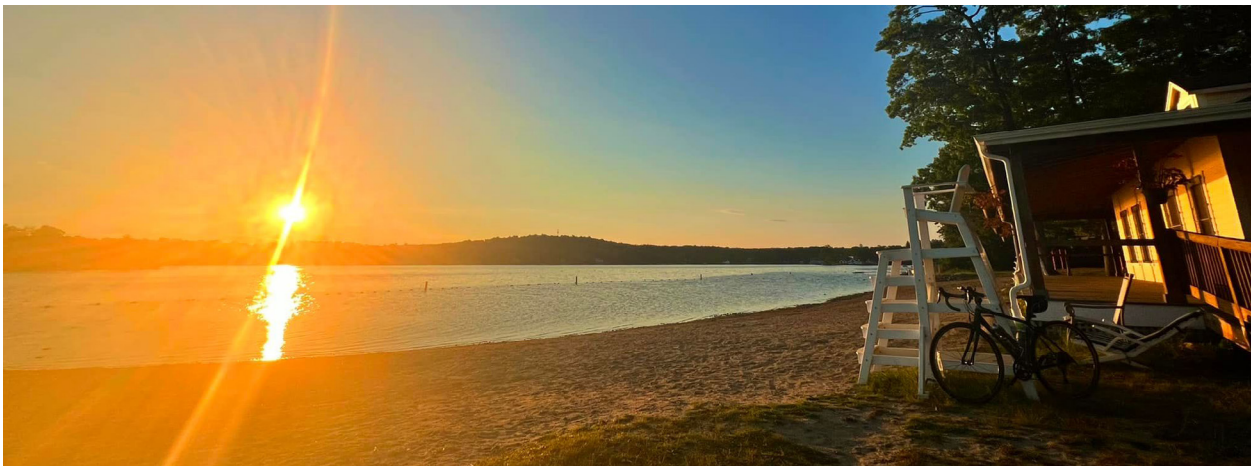


Figure 31: Sunset on Lake Pocotopaug in East Hampton, CT.

CONCLUSION

This PCAP is the first deliverable under the CPRG planning grant awarded to CRCOG. Through the PCAP, the region's GHG emissions were inventoried and established, residents and municipal leaders were engaged, and priority, near-term, implementation-ready measures to lower the region's GHG and other air pollutants were developed.

The planning, engagement, taking action to reduce GHG emissions, investment in sustainable infrastructure, technologies and practices will continue. These initiatives build our economy and enhance life for all in the region. In April 2024, CRCOG anticipates applying or joining a coalition to fund one or more of the projects listed in this PCAP. Stakeholder engagement will be critical for refining the grant application.

CPRG planning efforts will continue and be broadened with the CCAP and status report. In 2025, CRCOG and RiverCOG will publish the CCAP that establishes equitable and sustainable strategies that reduce emissions across all sectors. The CCAP will include near- and long-term emissions projections, a suite of emission reduction measures, a robust analysis of measure benefits, plans to leverage federal funding, and a workforce planning analysis. CRCOG and RiverCOG anticipate robust public engagement on developing the strategies to pursue in the CCAP. In 2027, CRCOG and RiverCOG will publish a status report that details implementation progress for measures included in the PCAP and CCAP, any relevant updates to PCAP and CCAP analyses, and next steps and future budget and staffing needs to continue implementation of CCAP measures.

If you have questions about this PCAP or suggestions for the upcoming CCAP and status report, contact Kyle Shiel, Principal Planner at kshiel@crcog.org.

AUGUST 1, 2023
EPA planning grant awarded to CRCOG and RiverCOG

MARCH 1, 2024
PCAP submittal to EPA

APRIL 1, 2024
Implementation grant application submittal to EPA

2025
CCAP submittal to EPA

2025-2030
Priority measure implementation

2027
Status report submittal to EPA

APPENDIX A

Proposed Measures

E1: Install Solar Panels on Homes Owned by Municipal Housing Authorities

Summary

There are 18 public housing authorities in the CRCOG region and eight in RiverCOG. Recognizing that installing solar panels on these homes would not only add to the region's generation of clean, renewable energy but, also considerably lower energy costs for residents, CRCOG and RiverCOG would work with Housing Authorities to aid in the installation of solar panels on these homes. This would benefit the region's most financially vulnerable households as well as serve as a tool to get residents interested in clean energy. Significantly, while Connecticut has placed caps on non-residential solar generation, there are no caps on residential solar.

It is anticipated that this measure will occur primarily at public housing sites within the census tracts CRCOG identified in the eight LIDAC towns. Please see **Table 7** (LIDACs Affected by Priority Measures) for a list of the census tracts anticipated to be affected. A list of municipal housing authority websites is included as **Appendix E**.

Progress Metrics

- kW capacity installation
- Percent of housing installation

GHG Emissions Reductions

Residential electricity consumption is a large source of emissions within the region producing 875,000 $MTCO_2e$ of GHG emissions. This is over 10% of all emissions. Transitioning existing electricity consumption to renewable solar power would have a large impact. The average Connecticut resident consumes approximately 3,600 kilowatt hour (kWh) per year. If this were produced by on-site residential solar, it would reduce emissions by nearly 0.9 $MTCO_2e$ per resident. Targeting just 10,000 residents (0.2% of the State's population), many of whom live in multi-resident households, would reduce emissions from residential electricity consumption by 1%.

Furthermore, establishing emissions-free renewable electricity provides a further opportunity as the electrification of building systems continues to move forward. Residential stationary combustion produces over 2,000,000 $MTCO_2e$ of GHG emissions, nearly half from heating oil. As heating oil as well as natural gas are slowly phased out and replaced with electric-powered heating systems, powering them with renewable rooftop solar will eliminate emissions from this sector entirely.

ESTIMATED GHG EMISSION REDUCTIONS*	
2025 through 2035	2025 through 2050
72,723 $MTCO_2e$	207,420 $MTCO_2e$

* Assuming 10,000 residents (approximately 3,000 homes) receive solar installations equal to their annual electricity consumption.

Figure 32: Worker installing a solar panel.

Co-Benefits

- Reduced electricity cost for residents or reduced rent burden if the housing authority pays for residents' electricity
- Improved air quality from reduction in natural gas and heating oil byproducts

Impacts on LIDACs

Generating renewable power for homeowners in LIDAC tracts while providing an opportunity for savings on utility bills. This measure contributes to the reduction of GHG emissions.

Key Implementing Agencies

- Municipal housing authority
- Municipal government
- Solar companies

Authority to Implement

- Municipalities enacting measure have the authority to implement the measure.

IMPLEMENTATION SCHEDULE		
01/2025	Project Kickoff	Begin planning phase and site identification
01/2026	Project Planning Complete	Complete planning phase
01/2027	10% Completion	Implementation
01/2028	35% Completion	Implementation
06/2028	Progress Report	Check in on progress and timing
01/2029	65% Completion	Implementation
01/2030	100% Completion	Project completion

E2: Install Solar Panels, add Battery Storage and Develop Microgrids on Buildings and Properties Owned by Municipalities

Summary

Municipalities across the region have noted their progress in installing solar panels on municipal buildings and schools. Municipalities across the region have noted their progress in installing solar panels on municipal buildings and schools. This measure looks to increase these efforts as well as broaden the focus from structures (e.g. schools, town halls) to adding solar canopies to municipal assets such as parking lots.

Municipal buildings and properties in all eight LIDACs (Hartford, East Hartford, New Britain, Middletown, Bristol, Manchester, Vernon & Enfield) will be the primary targets under this measure but would be applicable to any of the region's 60 cities and towns. Other municipally owned properties and buildings outside of the LIDACs may also be considered.

Figure 33: Middletown City Hall GIS tool to map municipal properties.

Progress Metrics

- kW capacity installation
- Percent of municipal buildings upgraded

GHG Emissions Reductions

Municipality owned properties present a strong opportunity for installing rooftop or canopy solar. These underutilized assets have low barriers to implementation and can be developed at a large scale, building on previous and current efforts. Within the region, nearly 90 schools have solar installations with an average size of a 200 kW array. Targeting just the remaining approximately 200 public and public charter schools with similarly sized systems would reduce emissions from the electricity generation sector by close to 1%.

Buildings aside, municipalities maintain public parking facilities that are ripe for solar canopies. For example, just the main parking lot for the Middletown city hall could support a 358 kW solar array, reducing emissions by 116 $MTCO_2e$ per year. An aggressive roll-out across the parking facilities of all municipalities would have a significant emissions reduction impact.

ESTIMATED GHG EMISSION REDUCTIONS*	
2025 through 2035	2025 through 2050
95,143 $MTCO_2e$	284,168 $MTCO_2e$

* Assuming solar installed on the remaining approximately 200 schools.

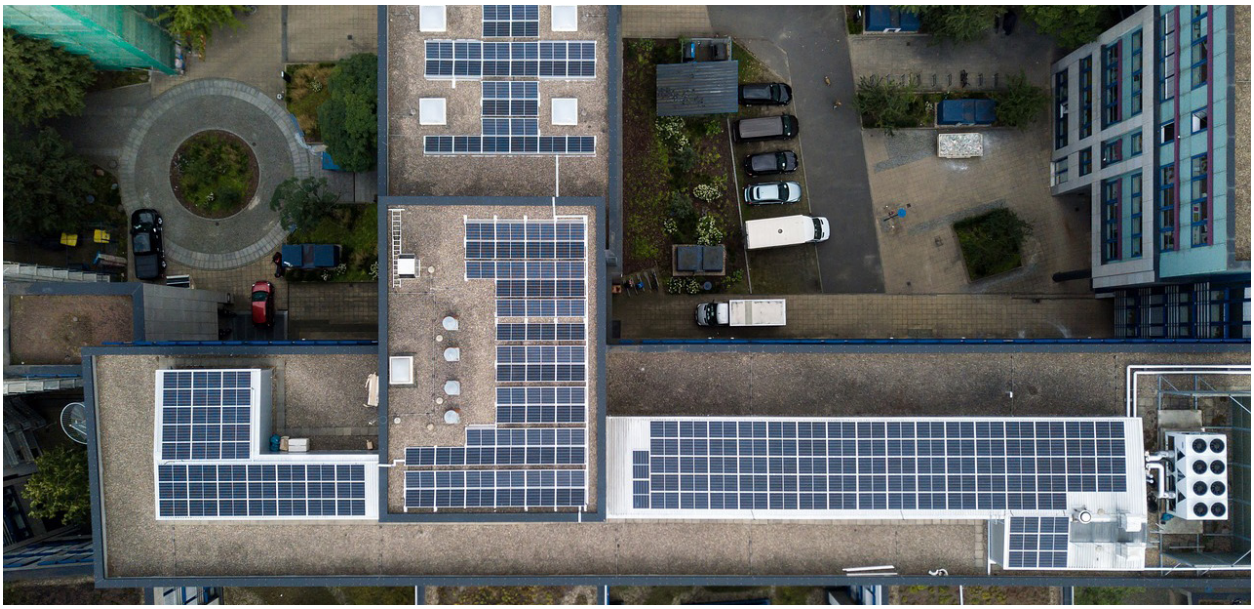


Figure 34: Aerial view of rooftop solar panels on a building.

Co-Benefits

- Reduced electricity cost for municipality and reallocation towards other programs (e.g. energy audit implementation)
- Improved air quality from reduction in natural gas and heating oil byproducts

Impacts on LIDACs

Generating renewable power for the Municipalities with LIDAC tracts while providing an opportunity for savings on utility bills. This measure contributes to the reduction of GHG emissions.

Key Implementing Agencies

- Municipal government
- Utility companies

Authority to Implement

Municipalities enacting measure have the authority to implement the measure.

IMPLEMENTATION SCHEDULE		
01/2025	Project Kickoff	Begin planning phase and site identification
01/2026	Planning Complete	Complete planning phase
01/2027	20% Completion	Implementation
01/2028	50% Completion	Implementation
06/2028	Progress Report	Check in on progress and timing
01/2029	85% Completion	Implementation
01/2030	100% Completion	Project completion

T1: Convert Light Duty Municipal Fleets to EV/Hybrids, Install Municipal Charging Infrastructure, Switch Municipal Gas-Powered Equipment to Electric

Summary

Municipalities across the region would be encouraged to convert their light duty fleets to EV/hybrids, or to pilot these vehicles to see if a fleet conversion is an option. EV charging infrastructure for municipal vehicles would also be installed, which is required for the transition to EV. LIDACs would be prioritized. This measure is highlighted in the 2020 Electric Vehicle Roadmap for Connecticut and the City of Hartford's Climate Action Plan. Finally, recognizing that common maintenance equipment, such as leaf blowers, also use gas, municipalities would be encouraged to switch to electric powered equipment. Westport, Connecticut has banned gas-powered leaf blowers[15] and Norwalk, Connecticut has limited their use.[16]

All municipalities within the region would be affected by this measure. Specific targets for this measure are the eight LIDACs.

Progress Metrics

- Percent of fleet converted
- Number/type of maintenance equipment converted

GHG Emissions Reductions

Municipalities maintain large vehicle fleets and are good targets for electrification. They are typically located with centralized infrastructure ideal for installing chargers and have consistent use patterns. Replacing an average new light-duty vehicle (e.g. a typical sedan used by municipal police departments) with an EV would avoid approximately 9 $MTCO_2e$ of mobile emissions each year. Installing EV charging infrastructure also paves the way for the future electrification of heavy-duty or specialized vehicles such as large trucks and snowplows where EV technology is only nascent but rapidly developing. And while equipment such as leaf blowers and lawn mowers may seem a minor concern, they have a profound impact on emissions due to their inefficient two-stroke engines. In Connecticut in 2020, lawn and garden equipment produced 306,528 $MTCO_2e$ alone, not to mention emissions of other GHGs and damaging criteria air pollutants.[14] Eliminating these sources would have a large beneficial impact on GHG emissions within the region.

ESTIMATED GHG EMISSION REDUCTIONS*	
2025 through 2035	2025 through 2050
70,400 $MTCO_2e$	202,400 $MTCO_2e$

* Assuming 1,000 light-duty fleet vehicles replaced with EVs.

Figure 35: Police vehicle parked on a street.

Co-Benefits

- Reductions in air and noise pollution
- Streamlined electrification for heavy-duty fleet vehicles

Impacts on LIDACs

Reduces the volume of harmful emissions from current fleet vehicles as they traverse EJ communities. This measure will have the long-term effect of improving air quality and noise pollution in residential areas. Additionally, installing more charging stations will decrease range anxiety experienced by municipal employees and may encourage the purchase of a personal electric/hybrid vehicle. Ultimately, the main benefit of this measure is that municipal fleet vehicles become independent from fossil fuels.

Key Implementing Agencies

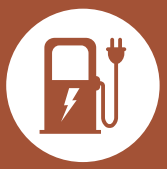
- Municipal governments

Authority to Implement

Municipalities enacting measure have the authority to implement the measure.

IMPLEMENTATION SCHEDULE		
01/2025	Project Kickoff	Begin planning phase and site identification
01/2025	Planning Complete	Complete planning phase
01/2026	20% Conversion	Fleet procurement
01/2027	40% Conversion	Fleet procurement
06/2028	60% Conversion	Fleet procurement
01/2029	80% Conversiron	Fleet procurement
01/2030	100% Conversion	Fleet procurement

T2: Install Public EV Charging Infrastructure and Fund Maintenance of EV Charging Infrastructure



Summary

Communities across the region are in different stages of planning for electric vehicles. Some communities, such as West Hartford, have done studies, while other communities have or are about to install their first public charging infrastructure. To incentivize the switch to EV, municipalities across the region would collaborate in the installation of public EV charging. This measure would also fund measures to maintain the public EV charging. This measure is aligned with the state of Connecticut's "Deploy electric vehicle chargers statewide to support light-duty and medium-heavy duty fueling needs." The 2020 Electric Vehicle Roadmap for Connecticut notes, "After analyzing pathways for GHG reduction, the Governor's Council on Climate Change (GC3) identified transportation electrification via wide-scale EV deployment to be among the primary solutions for achieving the state's statutorily required economy-wide GHG reductions targets of 45 percent and 80 percent below 2001 levels by 2030 and 2050, respectively. [. . .] As one of several states signing onto the Zero-Emission Vehicle Memorandum of Understanding (ZEV MOU), Connecticut has committed to an ambitious goal of putting 125,000 to 150,000 EVs on the road by 2025."[17] Connecticut's draft National Electric Vehicle Infrastructure (NEVI) plan- Connecticut''s Charging Ahead Plan: A Strategy to Expand Public Electric Vehicle Charging has been submitted to the Federal Highway Administration in July 26, 2022. The NEVI plan notes that Phase 1 prioritizes building out the state's Electric Alternative Fuel Corridors (I-84, I-91, I-95, I-395). The plan also notes public interest in Routes 6, 8, 9, and the Merritt Parkway. In addition, this measure aligns with the state's recent award of $14.6 million from the Federal Highway Administration's Charging and Fueling Infrastructure Program for FY 2022 and 2023. This measure is also highlighted in the City of Hartford's Climate Action Plan.

This measure will focus on the eight LIDACs identified, but is applicable to all communities within the region.

Progress Metrics

- Total number of EV charging infrastructure installed
- Number of EV charging infrastructure installed per mile of roadway
- Number of users
- Output of charging infrastructure and estimated vehicle miles traveled

GHG Emissions Reductions

Transportation is the leading sector of emissions, accounting for over half the region's 8,665,585 $MTCO_2e$ of emissions. While it is imperative to reduce this source, effective measures require foresight and planning. Installing public EV charging infrastructure in the near-term will have a long-term impact by supporting and increasing the uptake of EVs. While this measure is difficult to quantify, EV charging infrastructure will increase the adoption rate of EVs and support the market shift to low carbon means of transportation.

ESTIMATED GHG EMISSION REDUCTIONS*	
2025 through 2035	2025 through 2050
TBD	TBD

* Further analysis pending.

Figure 36: Pavement marking indicating an electric vehicle charging location.

Co-Benefits

- Adds to EV charging stations to Connecticut's inventory

Impacts on LIDACs

This measure is anticipated to decrease range anxiety for drivers of EVs, add much needed EV charging infrastructure, and encourage residents to make the switch to EVs.

Key Implementing Agencies

- Municipal governments
- EV charging partners

Authority to Implement

Municipalities enacting measure have the authority to implement the measure.

IMPLEMENTATION SCHEDULE		
01/2025	Project Kickoff	Begin planning phase and site identification
06/2025	Planning Completion	Complete planning phase
01/2026	25% Installation	Implementation
01/2027	75% Installation	Implementation
01/2028	100% Installation	Implementation
06/2028	Follow-up study	Evaluate effectiveness and use trends of project
01/2030	100% Conversion	Project completion

T3: Encourage Municipality-Owned and Privately-Owned School Buses Switch to 20% Biodiesel (B20) as an Interim Measure with a Long-Term Focus on Converting Light-Duty Municipal Fleets to EV/Hybrids

Summary

Realizing the impact of diesel pollution on some of the region's most vulnerable populations – school aged children – as an interim measure, municipality-owned and privately-owned school buses would be encouraged to switch to 20 percent biodiesel. Longer term, municipalities that own their own bus fleet will look to convert their fleet to electric/hybrid buses. However, many municipalities contract out this service, leaving the choice of school bus fleet to the private operators that run the buses. To incentivize private operators to switch to electric/hybrid buses, municipalities will install charging that operators can use for school bus fleets.

This measure would prioritize these efforts in LIDACs (school bus routes and/or bus storage yards) but would be applicable to any of the region's 60 cities and towns. This measure aligns with the State of Connecticut's PCAP measure "Replace existing school buses with zero-emission vehicle school buses in environmental justice communities." This measure is also highlighted in the City of Hartford's Climate Action Plan.

While there will be an emphasis on this measure within the LIDACs, this effort is applicable to any community in the region.

Progress Metrics

- Percent of fleet converted
- Number of communities, including LIDACs served by electric/hybrid buses
- Number of riders using buses
- Number of EV charging infrastructure installed

GHG Emissions Reductions

School buses are a good opportunity for electrification and alternative fuels due to their constant use and distance patterns and centralized operations. They also run on diesel fuel which have a high emissions factor of not only GHGs, but other criteria air pollutants as well. electrifying a single school bus would reduce emissions by approximately 20 MT CO_2 e annually. This is a 75% reduction even when accounting for emissions associated with electricity consumption. Switching to a less-carbon intensive diesel and biofuel blend is a short-term option. Using a 20% biofuel and diesel mix (B20) would reduce emissions by 3.5 MT CO_2e per bus annually.

ESTIMATED GHG EMISSION REDUCTIONS*	
2025 through 2035	2025 through 2050
8,493 $MTCO_2e$	24,417 $MTCO_2e$

* Assuming 300 school buses converted to EVs, including emissions from electricity

Figure 37: School bus on Day Hill Rd in Windsor, CT.

Co-Benefits

- Fuel cost savings
- Air pollution reductions
- Noise pollution reduction

Impacts on LIDACs

School vehicles become independent/less reliant on fossil fuels. Buses release far less emissions in residential neighborhoods enroute to pick up children which ultimately contributes to the improvement of air quality over time.

Key Implementing Agencies

- Municipal governments
- School districts
- EV charging/bus procurement companies

Authority to Implement

Municipalities have the authority to install charging to incentivize school bus operators to switch to electric/hybrid buses. However, for many municipalities, a private operator owns and operates school buses.

IMPLEMENTATION SCHEDULE		
01/2025	Project Kickoff	Begin planning budget and procurement schedule.
06/2025	Planning Complete	Determine approach for fleet conversion and/or EV charger installation/B20 switch.
01/2026	20% Conversion/ Installation	Fleet procurement/EV charger installation/B20 switch
01/2027	40% Conversion/ Installation	Fleet procurement/EV charger installation/B20 switch
01/2028	60% Conversion/ Installation	Fleet procurement/EV charger installation/B20 switch
01/2029	80% Conversion/ Installation	Fleet procurement/EV charger installation/B20 switch
01/2030	100% Conversion/ Installation	Project Completion

T4: Recommended Improvements for At Least One of the Six Transit Corridors Highlighted in *Metro Hartford RapidRoutes Transit Priority Corridors Study*

Summary

CRCOG's *Metro Hartford RapidRoutes Transit Priority Corridors Study* (published in September 2022) highlights six bus routes in LIDACs (Hartford, East Hartford) and non-LIDACs (Bloomfield, West Hartford) communities. Improvements to bus routes could reduce idling, provide more reliable service and encourage mode shift. This measure would continue the partnership between CRCOG and CTDOT and look to make improvements to at least one of the six recommended corridors. This measure is highlighted in several recent planning documents including CRCOG's *Metropolitan Transportation Plan, 2023 – 2050* and CT DEEP's *1990 – 2021 Connecticut Greenhouse Gas Emissions Inventory*, as well as the Greater Hartford Mobility Study.

While the scope for this measure is limited to the Hartford-East Hartford area, the bus service is open to the public. It is anticipated that this measure primarily impact anywhere between 1 and 6 bus lines within the census tracts identified in **Table 7**.

Progress Metrics

- Bus travel vs. idling time
- Number of riders

GHG Emissions Reductions

Quantifying the emissions reductions from improved bus service is challenging, however, there are many drivers. Most important is that improved service will entice more riders to the system in a mode shift from other forms of transit, for example, single-occupancy vehicles. Service can be improved by increasing the frequency and hours of operations of buses, and also speed and efficiency. This can be accomplished by consolidating stops, signal priority, and dedicated bus lanes. Aside from mode shift, less idling of buses while stuck in traffic also has an emissions reduction benefit. While detailed traffic and corridor studies are needed, improving bus service has the potential for substantial emissions reduction on a per passenger basis.

ESTIMATED GHG EMISSION REDUCTIONS*	
2025 through 2035	2025 through 2050
TBD	TBD

* Further analysis pending.

Figure 38: CTfastrak buses in New Britain, CT.

Co-Benefits

- Improved traffic flow
- Air pollution reductions
- Improved economic connectivity

Impacts on LIDACs

Service frequency (through stop spacing) and reliability improves regardless of the line that is chosen. LIDACs will receive improvements (high quality bus stops, bus lanes, signal priority) which will serve to increase the convenience and likelihood of residents taking the bus instead of driving. This measure is anticipated to contribute to a reduction in VMT and increase in connectivity within the Hartford-East Hartford area. Level boarding areas will allow for quicker boarding and improve passenger accessibility.

Key Implementing Agencies

- CTDOT
- Municipal governments

Authority to Implement

Authority over CTtransit bus routes controlled by CTtransit (CTDOT). However, municipalities' coordination and partnership required.

IMPLEMENTATION SCHEDULE		
01/2025	Kickoff	Begin pilot route selection phase.
06/2025	Pilot route(s) selection	Select pilot route(s) and begin planning and design phase.
04/2027	Complete planning and design for pilot route(s)	Complete planning and design for pilot route(s) and begin construction
04/2029	Complete construction	Construction completed for pilot route(s)
01/2030	Complete program evaluation	Report evaluating program outcomes and lessons learned for scaling to additional transit corridors

T5: Develop and Implement Roundabout Projects Across the Region

Summary

The environmental benefits of roundabouts include improving traffic flow and reducing idling, as well as being safer for pedestrians.[18] A regional study completed by CRCOG created a scalable, replicable methodology that is currently being pursued by the CTDOT statewide. The study identified the top 100 locations where roundabouts were recommended. Of these locations, 38 roundabouts in LIDACs were recommended .

Progress Metrics

- Number of roundabouts installed
- Intersection AADT before and after
- Reduction in idling time

GHG Emissions Reductions

Quantifying the emissions reductions from roundabouts is challenging, however, there are many drivers in ways to reduce emissions. Most important is that reconfigured intersections will improve the mobility and flow of traffic. Roundabouts help lower emissions by decreasing congestion and encouraging traveling at slower speeds. While detailed traffic and corridor studies are needed, roundabouts have the potential for substantial emissions reduction.

ESTIMATED GHG EMISSION REDUCTIONS*	
2025 through 2035	2025 through 2050
TBD	TBD

* Further analysis pending.

Figure 39: Construction of a roundabout in New Britain, CT.

Figure 40: Cars driving on a roundabout in Ellington, CT.

Co-Benefits

- Reduced air pollution
- Reduced traffic light electricity/maintenance

Impacts on LIDACs

Discourages speeding and contributes to reductions in collisions. This measure also improves cyclist/pedestrian safety and improves the flow of traffic.

Key Implementing Agencies

- CTDOT
- Municipal governments

Authority to Implement

Municipalities enacting measure have the authority to implement the measure.

IMPLEMENTATION SCHEDULE		
01/2025	Kickoff	Begin planning phase and site identification
04/2026	Complete Planning and design	Complete planning and design phase, begin construction
01/2028	50% Construction Completion	Implementation
04/2029	100% Construction Completion	Implementation
01/2030	Post-Evaluation	Evaluation report

T6: Encourage Mode Shift Across the Region with Complete Streets Projects that Make it Safer and Easier to Bike and Walk for All Users

Summary

Mode shift projects, such as the addition of sidewalks, bike lanes, and other complete streets elements, can encourage people to leave their cars and switch to active transportation and transit. These types of projects provide a plethora of benefits including individual health, neighborhood beautification, and regional environmental benefits. This measure looks to implement projects across the region. This measure would prioritize these efforts in LIDACs but would be applicable to any of the region's 60 cities and towns.

Some projects that are likely to be undertaken include Manchester's Downtown Manchester Improvements Project, a project still in its concept development phase that could include a road diet, roundabouts, cycle track, and public space, New Britain's Myrtle Street Improvements, a corridor in which significant community development investment is planned but which is lacking complete streets infrastructure, and Middletown's Complete Streets Initiative Master Plan 2023 which highlights proposed multi-use trails, recommended bike routes and priority bike routes. Also significantly, these projects are aligned with the State's recent new complete streets design criteria, which builds upon the State's existing complete streets policy.[19] This measure is highlighted in a number of recent planning documents including CRCOG's *Metropolitan Transportation Plan, 2023 – 2050* and CT DEEP's *1990 – 2021 Connecticut Greenhouse Gas Emissions Inventory*.

Progress Metrics

- Number of projects
- Miles of trails/bike routes installed
- Number of automobile-pedestrian crashes
- Before vs. after annual average daily traffic (AADT)

GHG Emissions Reductions

Quantifying the emissions reductions from complete streets is challenging, however, there are many drivers in ways to reduce emissions. Most important is that reconfigured transit corridors will induce a mode shift from other forms of transport such as single-occupancy vehicles. With the added infrastructure associated with complete streets, individuals will be more likely to choose walking or biking for more trips and for longer trips. While detailed traffic and corridor studies are needed, complete streets has the potential for substantial emissions reduction.

ESTIMATED GHG EMISSION REDUCTIONS*	
2025 through 2035	2025 through 2050
TBD	TBD

* Further analysis pending.

Figure 41: A cyclist on a bicycle path in New Britain, CT.

Co-Benefits

- Air pollution reduction
- Public access to green spaces
- Improved public health

Impacts on LIDACs

Reduces the number of vehicle on vehicle and vehicle on pedestrian collisions. Will also reduce the number of road fatalities. This measure encourages active transportation and provides opportunities to reduce VMT.

Key Implementing Agencies

- Municipal governments

Authority to Implement

Municipalities enacting measure have the authority to implement the measure.

IMPLEMENTATION SCHEDULE		
01/2025	Kickoff	Begin planning phase and site identification
06/2025	Complete Planning and design	Complete planning and design phase, begin construction
04/2027	50% Construction Completion	Implementation
04/2029	100% Construction Completion	Implementation
01/2030	Post-Evaluation	Evaluation report

N1: Increase Urban Tree Canopy in Municipalities Across the Region

Summary

This measure would seek to increase the urban tree canopy in municipalities across the region, with a focus on the region's LIDACs. The measure focuses on planting trees on municipal-owned properties, such as along street right of way, on municipal property, including city/town owned rights-of-way. Unlike the other measures that look to decrease emissions, this measure acts as a carbon sink: the planted trees will absorb CO_2. Importantly, the State currently has a grant program which could help provide funding for municipalities interested in this effort. CT DEEP's Urban Forest Equity Grant Program provides funds in multiple grant rounds through 2026 to local governments and other bodies to increase the urban tree canopy.[20] This measure is aligned with the State of Connecticut's PCAP measure, "Plan trees in urban areas to increase carbon storage and mitigate pollution in underserved communities." This measure is also aligned in recent planning documents, including the City of Hartford's Climate Action Plan and CT DEEP's *1990 – 2021 Connecticut Greenhouse Gas Emissions Inventory*.[21]

This measure would see the most impact in urban settings and is anticipated to be implemented in both LIDACs and the region as a whole.

Progress Metrics

- Number of trees planted (by species and diameter)
- Number of sites selected

GHG Emissions Reductions

Trees and vegetation are well-known carbon sinks. Carbon sinks absorb and sequester CO_2 removing it from the atmosphere and eliminating its global warming impact. The amount of carbon sequestered by natural forested areas in the region is nearly equivalent to the emissions from all stationary residential sources. A typical urban street tree can absorb up to 26 lbs of CO_2e annually. Over a period of 25 years, this equates to nearly 0.3 MT CO_2e sequestered. Planting 100,000 trees would effectively reduce emissions by 38,000 $MTCO_2e$.

ESTIMATED GHG EMISSION REDUCTIONS*	
2025 through 2035	2025 through 2050
14,352 $MTCO_2e$	37,752 $MTCO_2e$

* Assuming 100,000 trees planted.

Figure 42: Community members sitting on benches under shade trees in Middletown, CT.

Co-Benefits

- Reduction in urban heat island effect
- Resilience to extreme heat waves
- Improved air quality
- Improved wildlife habitat and connection

Impacts on LIDACs

Provides vulnerable residents with shade from the sun, improves air quality and reduces the impact of the urban heat island effect. This measure also has the benefits of reducing impervious surface, potentially reduce the severity of flooding events with the introduction of green space and wildlife habitat connectivity.

Key Implementing Agencies

- Municipal governments

Authority to Implement

Municipalities enacting measure have the authority to implement the measure.

IMPLEMENTATION SCHEDULE		
01/2025	Kickoff	Project budgeting, location selection, and planning
06/2025	Planning completed	Select types of trees and develop workforce plan
06/2026	40% Planting	Begin planting
01/2027	Progress Report	Evaluate planting success
01/2027	80% Planting	Implementation
01/2028	100% Planting	Project completion

W1: Establish and Expand Residential and Academic Food Waste Diversion Programs and Examine Ways to Increase Utilization of Anaerobic Digestion

Summary

Municipalities across the region are undertaking food diversion programs from establishing residential compost pickups, to giving away backyard compost bins, to enacting unit-based pricing pilots (which encourage the reduction of household garbage). Academic institutions also have established waste reduction programs. This measure would expand and support current efforts underway as well as assist with the establishment of new efforts across the region. Understanding that not all food waste can be composted, this measure also seeks to expand use of the MSA's fully operational anaerobic digestor in converting unused calories into biogas.

This measure is aligned with the State of Connecticut's PCAP measure, "Provide funding to municipalities to implement food scraps diversion programs, including grants to construct the infrastructure necessary to divert food scraps from landfills and incineration." This measure is also highlighted in recent planning documents including *Taking Action on Climate Change and Building a More Resilient Connecticut for All*, Governor's Council on Climate Change (GC3), Phase 1 Report: Near-Term Actions[22] and the City of Hartford's Climate Action Plan.

This measure will establish anaerobic digestion and residential food waste diversion programs in communities within both the RiverCOG and CRCOG. LIDACs will be prioritized.

Progress Metrics

- Pounds/tons of food waste diverted

GHG Emissions Reductions

Waste is a unique challenge for the region and the state of Connecticut as whole. There are no active landfills for general waste within the state, so any waste produced must be transported to landfills in neighboring states, sometimes hundreds of miles. This produces significant transportation emissions as the waste is hauled to its final destination out of state via diesel trucks., Switching to a composting program is an opportunity to reduce the required transport and thus reduce emissions. Simply diverting only 10,000 tons of compostable waste from out of state disposal to a local in-state processing facility would reduce emissions by over 6,000 $MTCO_2e$ annually. Another option, anaerobic digestion would similarly reduce emissions by 5,000 $MTCO_2e$ annually for the same amount of waste.

ESTIMATED GHG EMISSION REDUCTIONS*	
2025 through 2035	2025 through 2050
61,308 $MTCO_2e$	153,271 $MTCO_2e$

* Assuming 10,000 tons of waste diverted to local composting facilities.

Figure 43: Produce at an outdoor farmer's market in Chester, CT.

Co-Benefits

- Provision of compost for local gardens
- Opportunity for local restaurants to save on food disposal costs
- Reduction in landfill usage
- (Anaerobic digestion) Source of biofuel to be sold/used

Impacts on LIDACs

This measure provides a means to reduce waste/emissions from landfills and improve soil quality.

Key Implementing Agencies

- Municipal governments
- CRCOG Solid Waste Working Group
- Quantum Biopower (anaerobic digester company)

Authority to Implement

To incorporate anaerobic digestion in a timely manner, municipalities would need to work with existing anaerobic digestion facilities and carting companies.

IMPLEMENTATION SCHEDULE		
01/2025	Kickoff	Project budget and planning
01/2026	Complete compost diversion planning	May include expansion of existing pilots
06/2027	Complete anaerobic digestion planning	Explore facility installation or contracting services of a regional/state facility
01/2028	Complete compost diversion implementation	Expanded pilots and/or new programs
01/2029	Evaluation of uptake	Quantify residential usage and cost-benefit of anaerobic digestion facility installation or services
01/2030	Project Completion	May include future plans for anaerobic digestion

B1: Expand and Enhance the Region's Commercial and Residential Energy Audit Programs and Provide Support for Implementation

Summary

Homeowners across the region have worked with Energize Connecticut, an initiative sponsored by Connecticut and utility providers, to save energy. Two popular programs are the Home Energy Solutions (home energy audits) and the Small Business Energy Advantage (assessment of small business's energy use). This measure would focus on LIDACs and low-income homeowners to help increase awareness of the program. In addition, because one factor that may discourage more residents from taking part in the audits is the lack of funding to do the audits' recommendations, this measure would provide support for the implementation of the recommendations.

This measure is aligned with the State of Connecticut's PCAP measure "Support increased adoption of heat pumps statewide." This measure is also highlighted in the City of Hartford's Climate Action Plan.

Within the LIDACs identified, this measure would educate homeowners on energy audits and the Eversource Program. This measure is also applicable to communities outside of the LIDACs but within the region.

Progress Metrics

- Number of households audited
- Reduction in household electricity/water usage

GHG Emissions Reductions

Audits are the key first step to improving energy efficiency and therefore reducing emissions. Audits identify areas for energy improvements and inform decisions on replacement measures such as new boilers, heat pumps, or improved insulation. An energy efficiency improvement of just 1% would reduce commercial and residential emissions by 20 $MTCO_2e$ annually.

Furthermore, energy audits and the ensuing efficiency projects often lead to the electrification of building systems, with a potentially larger emissions reduction impact. Residential stationary combustion produces over 2,000,000 $MTCO_2e$ of GHG emissions, nearly half from heating oil. As heating oil as well as natural gas are slowly phased out and replaced with electric-powered heating systems, emissions may reduce even further.

ESTIMATED GHG EMISSION REDUCTIONS*	
2025 through 2035	2025 through 2050
152,169 $MTCO_2e$	420,702 $MTCO_2e$

* Assuming audits lead to a 1% overall reduction in residential and commercial electricity consumption.

Figure 44: Government representative touring a manufacturing plant in Durham, CT.

Co-Benefits

- Job creation potential
- Community engagement and potential spillover effects to other measures

Impacts on LIDACs

Improve outreach and education on energy efficiency and create opportunities to improve existing energy/building codes.

Key Implementing Agencies

- Municipal governments

Authority to Implement

Many municipalities note that the commercial and residential energy audits are contracted by Energize Connecticut, an initiative sponsored by the state and private utility companies. To expand these audits, coordination between CRCOG, RiverCOG, the municipalities and Energize Connecticut should occur.

IMPLEMENTATION SCHEDULE		
01/2025	Kickoff	Begin planning and budgeting
06/2025	Complete Planning	Set goal for how many households complete audit
01/2026	25% Goal Achieved	Progress towards goal of households completing audit
01/2027	50% Goal Achieved	Progress towards goal of households completing audit
06/2027	Evaluation and additional outreach	Assess progress towards meeting audit goal
01/2028	75% Goal Achieved	Progress towards goal of households completing audit
01/2029	100% Goal Achieved	Project completion

B2: Undertake Energy Efficiency Upgrades to Municipal Buildings

Summary

Municipalities across the region have undertaken energy efficiency upgrades to municipal buildings, such as town halls. This measure would build upon this work, with a focus on municipal buildings in LIDACs. Note that this measure does not include improvements to schools. Energy efficiency upgrades could include switching to LED lighting, upgrading building equipment such as boilers, fixing leaks and adding insulation. This measure is highlighted in the City of Hartford's Climate Action Plan.

Municipal buildings within LIDACs will be examined and upgraded to become more energy efficient. This measure applies broadly to municipal buildings within the MSA.

Progress Metrics

- Number of buildings upgraded
- Number of LEDs (or similar upgrades) installed
- Reduction in water/electricity/refrigerant usage

GHG Emissions Reductions

Energy efficiency improvements such as new energy efficient boilers, heat pumps, or improved insulation are a key strategy to reducing emissions. An energy efficiency improvement of just 10% would equate to a 10% emissions reductions.

Furthermore, energy efficiency projects often lead to the electrification of building systems, with a potentially larger emissions reduction impact. As high-emissions heating oil as well as natural gas are slowly phased out and replaced with electric-powered heating systems, emissions may reduce even further, especially as more renewable electricity sources come online.

ESTIMATED GHG EMISSION REDUCTIONS*	
2025 through 2035	2025 through 2050
TBD	TBD

* Further analysis pending.

Figure 45: Lighting in an office meeting room.

Co-Benefits

- Energy/water cost savings
- Reduction in light pollution

Impacts on LIDACs

Improve energy efficiency within municipal buildings and create opportunities to cut utility costs.

Key Implementing Agencies

- Municipal governments

Authority to Implement

Municipalities enacting measure have the authority to implement the measure.

IMPLEMENTATION SCHEDULE		
01/2025	Project Kickoff	Begin planning phase and identification of sites
06/2026	Planning Complete	Implementation
06/2027	20% Complete	Implementation
06/2028	50% Complete	Check in on progress and timing
07/2028	Progress Report	Implementation
06/2029	85% Complete	Implementation
01/2030	100% Complete	Project completion

APPENDIX B

Comprehensive Proposed Measure List

SECTOR	MEASURE
Agricultural/Natural & Working Lands	Pollinator gardens
	Urban agriculture / pocket parks
	EV farming equipment / equipment share
	Solar - farms
	Sustainable municipal gardens
	Land preservation (open space/forest and farmland)
	Nature-based rights of way
	EBT farm-to-table program
	Carbon sequestration (saline aquifers, giant air filters, ionic liquids) - all programs include job training opportunities
	Establish state-owned food distribution centers to streamline distribution of local produce
	Collaborate with grocery chains to redirect close-to-expiration produce
	Develop educational programs to inform EBT recipients of benefits of locally sourced, fresh produce
	Support fair pricing for farms
	Urban tree canopy
Commercial/Residential Buildings	Energy retrofits - residential audits/projects
	Energy retrofits - muni audits/projects
	Energy retrofits - rental property programs
	Geothermal
	Energy modeling survey
	Green building standards / updated building codes
	Green/cool roofs
	AC vouchers for vulnerable communities

SECTOR	MEASURE
Commercial/Residential Buildings	Incentives for green building adoption
	Public awareness and education for property owners, developers
	Workshops on green building standards for architects and builders
	Financial literacy workshops for renters to transition to homeowners
	Job training in green construction
	Water conservation / water energy nexus
	Energy retrofits - residential audits, health and safety focus
	Energy efficiency programs (Conservation and Load Management Program)
	Heat pumps
	Networked geothermal
Industrial	Energy efficiency program
	Renewable energy
	Workforce development
Transportation	Rest stops with charging for electric bus charging and solar bus stations
	Muni EV fleet/equipment conversion
	Transit-oriented development (TOD) - funding
	Transit-oriented development (TOD) - zoning
	Train and bus route improvements
	Bus rapid transit
	HOV lanes - replace with BRT
	HOV lanes - replace with natural areas
	Green corridors in city/town streets
	Sustainable interstate rest stops (including workforce development/green jobs)
	Public shelters for buses
	Complete streets / bike/ped infrastructures
	Muni biofuel fleet

SECTOR	MEASURE
Transportation	EV chargers
	EV school buses
	Micromobility
	EV incentive pathways
	EV transit buses
	Idle reduction truck-mounted attenuators (TMAs)
Waste & Materials Management	Commercial composting
	Backyard composting
	Litter mitigation
	EV hauling trucks / rail
	Institutional / business composting program
	Producer responsibility programs
	Landfill methane capture
	EV garbage trucks
	Unit-based pricing
	Use of MIRA site for trash-to-energy destination
	Adopt cutting-edge incineration technology
	Use heat generated from incineration to produce clean and renewable power
	Landfill solar
	Anaerobic digester incineration plant
	Residential composting program (curbside)
	Residential composting program (drop off)

APPENDIX C

Identified Stakeholder List

STAKEHOLDER GROUP	MEETING(S) ATTENDED
ACEC	11/27/23
Avangrid	1/10/24
Town of Avon	11/27/23
Town of Berlin	1/10/24
Town of Bloomfield	11/27/23
Blue Earth Compost	11/14/23
City of Bridgeport	11/14/23
Brookfield Energy Advisory Board	11/14/23
Town of Chester	12/19/23; 12/20/23
Town of Clinton	12/20/23
Connecticut Housing Finance Authority	11/14/23
Connecticut Department of Energy & Environmental Protection	11/14/23; 1/10/24
Connecticut Department of Transportation	11/14/23; 1/10/24
Connecticut Equity and Environmental Justice Advisory Committee	12/19/23; 1/9/24
Connecticut Green Bank	11/14/23; 12/19/23; 1/10/24
Connecticut League of Conservation Voters	11/14/23
Connecticut Office of Policy and Management	12/19/23; 1/5/24; 1/10/24
Connecticut Resource Conservation and Development	11/14/23; 12/19/23; 1/5/24
Town of Cromwell	12/5/23
Town of East Hartford	12/19/23; 1/5/24

STAKEHOLDER GROUP	MEETING(S) ATTENDED
Energy Futures Group	11/14/23
Energy News Network	11/14/23
U.S. Environmental Protection Agency	11/14/23
Town of Essex	1/10/24
Town of Fairfield	11/14/23
Town of Glastonbury	1/10/24
Town of Granby	1/10/24
Town of Haddam	12/5/23; 1/10/24
City of Hartford	11/14/23; 11/27/23; 12/19/23
Town of Hebron	1/10/24
Town of Killingworth	1/10/24
Town of Mansfield	11/14/23
Town of Manchester	11/14/23; 11/27/23; 12/19/23; 1/5/24; 1/10/24
Town of Marlborough	1/10/24
MetroCOG	11/14/23
Town of Middlefield	11/14/23
City of Middletown	11/14/23;12/5/23
City of New Britain	12/19/23
City of New Haven	11/14/23
NHCOG	11/14/23
City of Norwalk	11/14/23
City of Norwich	11/14/23

STAKEHOLDER GROUP	MEETING(S) ATTENDED
NVCOG	11/14/23
Town of Old Lyme	1/10/24
Town of Oxford	11/14/23
People's Action for Clean Energy	11/14/23; 11/27/23
Town of Portland	12/5/23; 1/10/24
Town of Rocky Hill	11/14/23; 11/27/23
SCRCOG	11/14/23
Town of Simsbury	11/27/23
Town of Southington	1/10/24
City of Stamford	11/14/23
Sustainable CT	11/14/23; 12/19/23
Sustainable Fairfield	11/14/23
Sustainable West Hartford	11/14/23; 11/27/23; 12/19/23; 1/5/24
Town of Tolland	1/10/24
University of Connecticut	11/14/23
Town of West Hartford	11/14/23; 11/27/23; 12/19/23; 1/5/24
WestCOG	11/14/23
Town of Windsor	11/14/23; 11/27/23; 1/10/24
Town of Woodbridge	11/14/23

APPENDIX D

Identified LIDAC Census Tracts

Hartford Census Tracts	East Hartford Census Tracts	New Britain Census Tracts	Middletown Census Tracts	Bristol Census Tracts	Manchester Census Tracts	Vernon Census Tract	Enfield Census Tract
5001	5102	4153	5411	4057	5147	5302	4806
5002	5103	4155	5416	4061	5148		
5003	5104	4156	5417				
5004	5106	4158					
5005	5112	4159					
5009		4160					
5012		4161					
5013		4162					
5014		4163					
5015		4166					
5023		4167					
5024		4171					
5025		4172					
5026							
5027							
5028							
5029							
5030							
5031.01							
5031.02							
5033							
5035							
5037							
5038							
5041							
5042							
5043							
5045							
5048							
5049							
5244							
5245.01							
5246							
5247							
9801							

APPENDIX E

Connecticut Public Housing Agency Websites

COG	PUBLIC HOUSING AGENCY & WEBSITE
CRCOG	Bloomfield Housing Authority
	Canton Housing Authority
	East Hartford Housing Authority
	Enfield Housing Authority
	Farmington Housing Authority
	Glastonbury Housing Authority
	Hartford Housing Authority
	Hartford, City of Housing Authority
	Manchester Housing Authority
	Mansfield Area Housing Authority
	New Britain Housing Authority
	Newington Housing Authority
	South Windsor Housing Authority
	Vernon Housing Authority
	West Hartford Housing Authority
	Wethersfield Housing Authority
	Windsor Housing Authority
	Windsor Locks Housing Authority
NVCOG*	Bristol Housing Authority
RiverCOG	Clinton Housing Authority
	Deep River Housing Authority
	East Hampton Housing Authority
	Essex Housing Authority
	Middlefield Housing Authority
	Middletown Housing Authority
	Portland Housing Authority
	Westbrook Housing Authority

* The Town of Bristol is included in the PCAP.

APPENDIX F

Quality Assurance Project Plan and Emissions Inventory Supporting Documentation

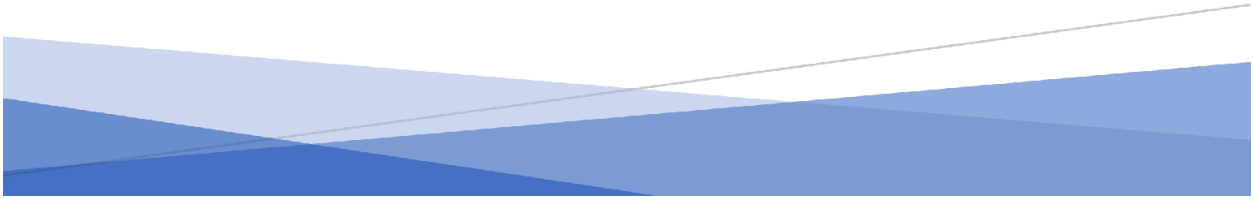
Climate Pollution Reduction Grants Program:

Hartford-East Hartford-Middletown MSA Quality Assurance Project Plan Grant #00A01410

Prepared by the Capitol Region Council of Governments

November 3, 2023

Revised November 16, 2023



QA#24024

1. Project Management (Group A)

1.1. Title and Approval Page

Quality Assurance Project Plan for
Climate Pollution Reduction Grants -Planning Grants
Hartford-East Hartford-Middletown MSA
Grant #00A01410

Prepared by:
Kyle Shiel, Principal Planner, Capitol Region Council of Governments

241 Main Street
4th Floor
Hartford, CT 06106-5310

Prepared for:
US EPA Region 1
5 Post Office Square
Suite 100
Boston, MA 02109

November 1, 2023

APPROVALS: ~~Type your text~~

Type your text

Kyle Shiel, Principal Planner, CRCOG (Project Manager) Date: November 16, 2023
11/16/23

Mahsa Arabi, Research Assistant ,University of Massachusetts (QA Manager): Date: November 21, 2023

Mahsa Arabi

USEPA Region 1 Grants Project Officer: Laura Berman Date: <add date of approval>

USEPA Region 1 Quality Assurance Manager: Nora Conlon Date: <add date of approval>

QAPP Revision History

Revision No.	Description	Author	Date
1	Original Version	Kyle Shiel	11/1/2023
2	Revision Version 1	Maureen Goulet	11/16/2023

1.2. Table of Contents[1]

[1] For grantees who are not familiar with using MS Word's TOC functions, please review the video at https://www.youtube.com/watch?v=0cN-JX6HP7c. Accessed on 6/23/2023.

List of Tables

List of Exhibits

Abbreviations

CAA	Clean Air Act
CFR	Code of Federal Regulations
CCAP	Comprehensive Climate Action Plan
CPRG	Climate Pollution Reduction Grant
EPA	U.S. Environmental Protection Agency
GHG	Greenhouse Gas
GHGRP	Greenhouse Gas Reporting Program (40 CFR Part 98)
ICR	Information Collection Request
NEI	EPA's National Emissions Inventory
OAR	EPA Office of Air and Radiation
PCAP	Priority Climate Action Plan
PM	Project Manager
PO	EPA Project Officer for Grant
POP	Period of Performance

POR	EPA Project Officer's Representative
PWP	Project Work Plan
QA	Quality Assurance
QAM	Quality Assurance Manager
QAMD	Quality Assurance Manager Delegate
QAPP	Quality Assurance Project Plan
QC	Quality Control
QCC	Quality Control Coordinator
LGGIT	Community - GHG Inventory Tool (provided by the EPA)
TL	Task Leader
CRCOG	Capitol Region Council of Governments
RiverCOG	Lower Connecticut River Council of Governments
UMass	University of Massachusetts Amherst
NARS(L)	Networks for Accessibility, Resilience, and Sustainability Laboratory
DEEP	The CT Department of Energy and Environmental Protection

1.3. Distribution List

This section presents the primary staff who will be working on the project. These staff will be identifying existing[2] data resources for evaluation and potential use under the project or serving in project-specific roles for implementing the Quality Assurance Project Plan (QAPP). The listing in **Table 1.1** includes staff responsible for implementing independent internal quality management steps and staff serving in external oversight roles.

This QAPP and, as applicable, all major deliverables relying on existing data will be distributed to the staff presented in **Table 1.1.** Additionally, this QAPP will be provided to any unlisted staff who are assigned to perform work under this project. A secured copy of this QAPP will be maintained in the project files under CRCOG's "*Climate Pollution Reduction Grant*" folder.

Table 1.1 QAPP Distribution List

Name	**Organization**	**Role**
Laura Berman	US EPA, Region 1	EPA Project Officer (PO) or PO Representative (POR)
Nora Conlon	US EPA, Region 1	EPA Quality Assurance Manager or Delegate
Matt Hart	CRCOG	Grantee Sr. Approver, Executive Director
Kyle Shiel	CRCOG	Grantee Project Manager (PM), Principal Planner
Maureen Goulet	CRCOG	Grantee Deputy Project Manager (DPM), Principal Program Manager
Camille Barchers	UMass	Assistant Professor, Landscape Architecture and Regional Planning
Jimi Oke	UMass	Assistant Professor, Civil and Environmental Engineering
Jimi Oke	UMass Amherst	Grantee Task 1 Leader, *Assistant Professor, Civil and Environmental Engineering*
Jimi Oke	UMass Amherst	Grantee Task 2 Leader, *Assistant Professor, Civil and Environmental Engineering*
Jimi Oke	UMass Amherst	Grantee Task 3 Leader, *Assistant Professor, Civil and Environmental Engineering*
Jimi Oke	UMass Amherst	Grantee Task 4 Leader, *Assistant Professor, Civil and Environmental Engineering*
Jimi Oke	UMass Amherst	Grantee Task 5 Leader, *Assistant Professor, Civil and Environmental Engineering*

[2] The term "existing data" is defined by the EPA's *Environmental Information Quality Policy* (CIO 2105.3) as "… data that have been collected, derived, stored, or reported in the past or by other parties (for a different purpose and/or using different methods and quality criteria). Sometimes referred to as data from other sources." The term "secondary data" may also be used to describe "existing data" in historical EPA quality-related documents.

Mahsa Arabi	UMass Amherst	Grantee Quality Assurance Manager, *Graduate Assistant*
Peiyao Zhao	UMass Amherst	Graduate Research Assistant
Megan Jouflas	Lower Connecticut River Council of Governments	Grantee Subaward Recipient & Partnering Agency

1.4. Project/Task Organization

The primary personnel responsible for implementation of this project are the CRCOG Project Manager (PM), and the Quality Assurance Manager (QAM), and Task Leaders (TLs), which will include representatives from the University of Massachusetts and the University of Massachusetts Center for Resilient Metro-Regions (CRM). Other personnel will include representatives from the Lower Connecticut River Council of Governments (RiverCOG). Their duties are outlined briefly in this section. The project QAM is a representative from the University of Massachusetts and is independent of the unit generating the data, which is the UMass CRM..

Kyle Shiel is the CRCOG PM and will provide senior-level oversight as needed. The PM is responsible for CRCOG's technical and financial performance as well as maintaining communications with the EPA to ensure mutual understanding of grant requirements, EPA expectations, and conformity with EPA quality procedures; managing oversight and conduct of project activities including allocation of resources to specific tasks; ensuring that quality procedures are incorporated into all aspects of the project; developing, conducting, and/or overseeing QA plans as necessary; ensuring that any corrective actions are implemented; operating project activities within the documented and approved Quality Assurance Project Plan; and ensuring that all products delivered to the EPA are of specified type, quantity, and quality. Maureen Goulet is the CRCOG Deputy PM. The Deputy PM supports the PM with the responsibilities described above.

Dr. Jimi Oke from the University of Massachusetts Center for Resilient Metro-Regions (CRM) will serve as the TL for each technical task required to complete a baseline emissions inventory for the sector(s) under the task. After completion of the GHG Inventory, CRCOG will utilize the UMass CRM to develop options for potential emissions reductions with estimated potential impacts per option, and to develop uncertainty estimates for each reduction estimate. The TL is responsible for the day-to-day technical activities under their assigned task, including planning, reporting, and controlling of technical and financial resources allocated to the task by the PM. Accordingly, the TL is primarily responsible for implementing the Quality Program and this QAPP on task-level assignments.

Task-level management system. For each of the major deliverables under each task, the assigned TL will review all QA-related plans and reports and is responsible for transmitting them to the QA Manager (or delegate) for review and approval. Each TL is responsible for ensuring that quality procedures are implemented at the task level and for maintaining the official, approved, task-level QAPP content. The TL will discuss any concerns about quality or any proposed revisions to task-level QAPP content with the QA Manager (or delegate) and PM or DPM to identify, resolve, or preclude problems or to amend task-level plans, if necessary. In addition, the TL will work with the CRCOG PM/DPM and the QA Manager to identify and implement quality improvements. The CRCOG PM is responsible for ensuring the consistency of similar or related QA measures across tasks, and the TLs are responsible for overseeing task-level work performed by technical staff and providing assurance that all required QA/QC procedures are being implemented.

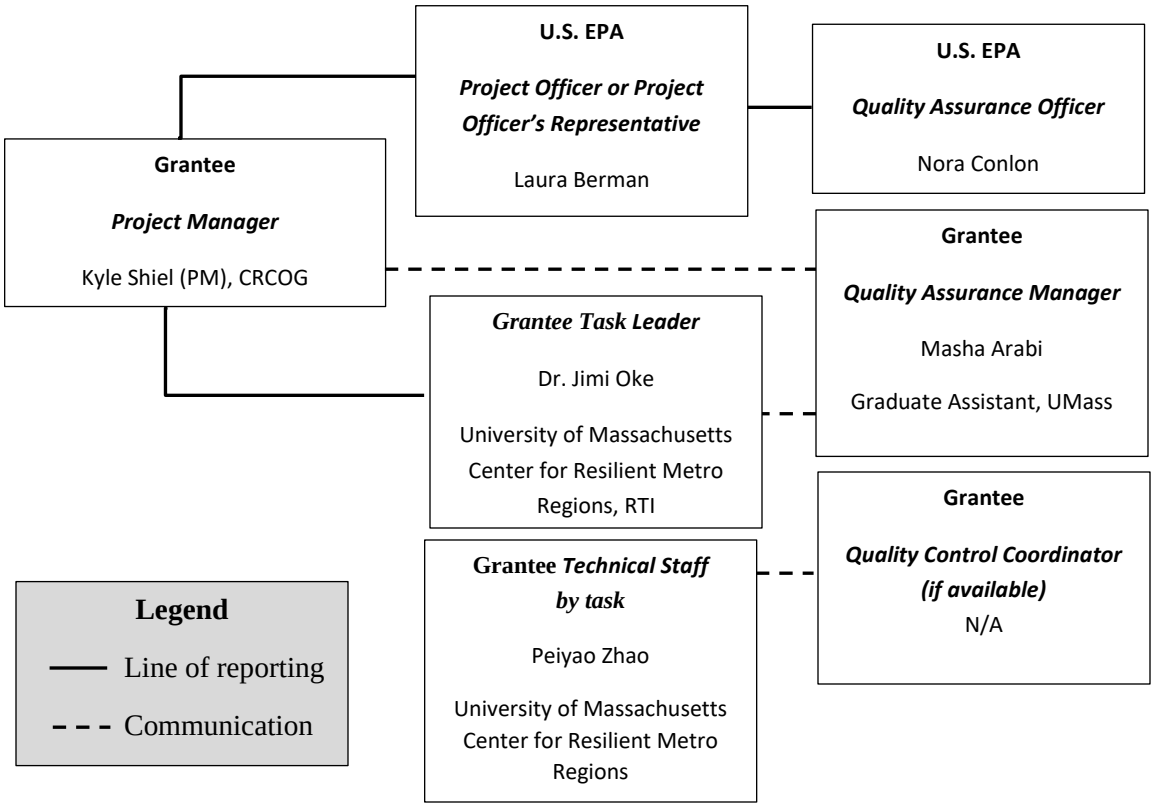
Project-level management system. Tasks are expected to proceed concurrently, in parallel. The PM will maintain close communications with each TL and ensure any difficulties encountered or proposed changes at the task level are reviewed for implications on other similar or related tasks. The PM is also responsible for communicating progress or difficulties encountered (across all tasks) to the EPA PO or POR, who provides the EPA's primary oversight function for this project at EPA OAR/ EPA Region 1 and is responsible for review and approval of this QAPP and any future revisions. The PM (with support from TLs and assigned CRCOG and/or UMass technical staff) will be responsible for consulting with the EPA PO or POR, on planning, scheduling, and implementing the QA/QC for all project deliverables and obtaining required EPA approvals.

The QA Manager, Mahsa Arabi, is a Research Assistant from the University of Massachusetts and is responsible for overseeing the quality system, monitoring and facilitating QA activities on tasks, and generally helping the SRCCOG PM and TL understand and comply with EPA QA requirements. Ms. Arabi will not be involved in data collection or analyses, which will be completed by Dr. Jimi Oke and Peiyao Zhao from the University of Massachusetts CRM. At the request of the CRCOG PM, Ms. Arabi is responsible for conducting periodic independent audits of this project's QA program, Ms. Arabi will produce written documentation of the audit results and recommendations.

In addition, QC functions will be carried out by other technical staff and will be carefully monitored by the PM, who will work with the QA Manager to oversee this plan and implement quality improvements. For work done under this project, technical staff may include persons with expertise in the local residential, commercial, and industrial activities. Technical staff may also include persons with expertise in air pollution engineering, technical reviewers, database specialists, quality auditors, and technical editors. The PM will ensure that technical staff do not review work in a QA capacity for which they were a primary or contributing author. **Exhibit 1** presents the organizational chart for the project.

(This space is intentionally left blank)

Exhibit 1. Project Organization[3]



[3] Under the EPA's QAPP standard (CIO 2105-S-02.0, section 3) the organization chart must also identify any contractor relationships relevant to environmental data operations.

1.5. Problem Definition / Background

Under this project, CRCOG and their subaward recipients, the Center for Resilient Metro-Regions (CRM) at the University of Massachusetts – Amherst (UMass) and our partnering organization – the Lower Connecticut River Council of Governments (RiverCOG) will identify, evaluate, and utilize existing data resources[4] to develop a local inventory of the major sources of greenhouse gas (GHG) emissions within the Hartford-East Hartford-Middletown Metropolitan Statistical Area (MSA). That inventory data will then be used to develop a Priority Climate Action Plan (PCAP). This QAPP focuses on the handling of environmental information under sector-specific tasks by technical staff charged with completing the following subtasks in a future planning project implemented in accordance with this QAPP:

1. Develop a comprehensive GHG inventory for the largest sources within each sector,
2. Develop options for reducing emissions within each sector,
3. Develop estimates or ranges of estimates for reductions achievable under each option (CCAP),
4. Develop uncertainty analyses for each option's emissions reduction estimate, and
5. Present these analyses and options in technical reports consistent with the deliverables required under the CPRG planning grants.

The GHG inventory will utilize many of the EPA's available tools including the Local – GHG Inventory Tool (LGGIT), facility-specific GHG data published by the EPA in the Facility Level Information on Greenhouse gases Tool (FLIGHT), data reported to the EPA's Greenhouse Gas Reporting Program (GHGRP), EPA's National Emissions Inventory (NEI), DOE's State and Local Planning for Energy (SLOPE) Platform, the Global Protocol for Community-Scale (GPC) Greenhouse Gas Inventories, the Local Government Operations (LGO) Protocol, and/or 3rd party data or tools, together with any independent, sector-specific estimates prepared by CRCOG and/or our subaward recipients, Center for Resilient Metro-Regions at UMass-Amherst. The FLIGHT and GHGRP datasets can be downloaded and filtered by state, city, county, and/or zip code.

Any independent local or MSA estimates or ratios (e.g., electricity usage per customer-by-customer class) will be compared to corresponding federal, state, or local estimates for validation, as available. Significant differences between primary estimates and validation estimates will be evaluated and discussed in the inventory report with the underlying data and methodologies used for the estimates. As applicable, the local inventory will include the following sources and gases (divided into the Residential, Commercial/Institutional, Industrial, and Energy Generation sectors):

---

[4] https://www.epa.gov/ghgreporting/data-sets
[5] https://www.epa.gov/ghgreporting/data-sets
[6] https://www.energy.gov/scep/slsc/state-and-local-planning-energy-slope-platform
[7] Under international GHG inventory protocols this category is called "Land use, land-use change, and forestry."
[8] https://www.epa.gov/statelocalenergy/local-greenhouse-gas-inventory-tool . https://www.eia.gov/electricity/data/eia861/
[9] National Renewable Energy Laboratory. "[Data Set Title (e.g., Battery Storage Capital Costs)]," *State and Local Planning for Energy*, accessed 7/22/2023, https://maps.nrel.gov/slope.
[10] EPA, *Environmental Information Quality Policy*, CIO 2105.3, 03/07/2023 (p. 8) provides common examples of environmental information used to support the EPA's mission at https://www.epa.gov/system/files/documents/2023-04/environmental_information_quality_policy.pdf.
[11] https://www.epa.gov/statelocalenergy/local-greenhouse-gas-inventory-tool

LGGIT Source Categories	*Greenhouse Gases (across all sectors)*
1. Mobile Combustion 2. Stationary Combustion 3. Electricity Consumption 4. Solid Waste 5. Urban Forestry 6. Agriculture & Land Management 7. Water Use 8. Waste Generation 9. Wastewater Treatment	carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), fluorinated gases (F-gases) including hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6)

1.5.1. Rationale for Selection of Sectors

For each sector included in the local inventory, **Table 1.2** briefly describes why the sector was included in the inventory and the relative significance of the sector in terms of the magnitude of air emissions from existing inventories, the associated geographic distribution of the sources, and recent trends in readily available activity data for the source category.

Table 1.2 Rationale for Sector Selection

Sectors Included in Inventory	**Rationale for Including in GHG Inventory**
Mobile combustion	Transportation activities were the largest source (29 percent) of total U.S. greenhouse gas emissions in 2021. From 1990 to 2021, transportation CO_2 emissions from fossil fuel combustion increased by 19 percent. Transportation activities occur in all communities.
Electricity consumption	The electric power sector accounted for 25 percent of total U.S. greenhouse gas emissions in 2021. Power generation and/or consumption occurs among all communities.
Urban forestry[5]	This sector includes fluxes of carbon from activities such as converting forests to agricultural use and practices that remove CO_2 from the atmosphere and store it in long-term carbon sinks like forests. In 2021, the net CO_2 removed from the atmosphere by natural and working lands was 12% of total U.S. greenhouse gas emissions. Between 1990 and 2021, total carbon sequestration in this sector decreased by 14%, primarily due to a decrease in the rate of net carbon accumulation in forests, as well as an increase in CO_2 emissions from urbanization.
Agriculture & land management	Agriculture accounted for about 10 percent of U.S. greenhouse gas emissions in 2021, and agricultural soil management was the largest source of N_2O emissions. Enteric fermentation was the largest source of CH_4 emissions.
Stationary combustion (including for	In 2021, the commercial and residential sectors accounted for 7 and 6 percent of total U.S. greenhouse gas emissions, respectively. Emissions from the commercial and residential sectors have increased since 1990. Total residential and commercial greenhouse gas emissions, including direct and indirect emissions, in 2021 have

[12] https://www.epa.gov/ghgreporting/data-sets

commercial and residential heating)	increased by 2% since 1990. In 2021, an increase in heating degree days (0.5 percent) increased energy demand for heating in the residential and commercial sectors, however, a 1.8 percent decrease in cooling degree days compared to 2020 reduced demand for air conditioning in the residential and commercial sectors.
Solid waste and waste generation	This sector includes landfills, composting, and anaerobic digestion. Landfills were the third largest source of anthropogenic methane emissions in 2021, and landfills accounted for 1.9 percent of total U.S. greenhouse gas emissions.
Wastewater treatment	Wastewater treatment, both domestic and industrial, was the third largest anthropogenic source of N_2O emissions in 2021, accounting for 5.2 percent of national N_2O emissions and 0.3 percent of total U.S. greenhouse gas emissions. Emissions from wastewater treatment increased by 6.1 MMT CO_2e (41.6 percent) since 1990 as a result of growing U.S. population and protein consumption.
Water	This sector includes indirect emissions associated with the electricity used to deliver water to local communities.

1.5.2. Decisions to be Made

The EPA's recommended tool for local GHG inventories (the LGGIT) covers categories of GHG emissions by source category (e.g., mobile combustion, stationary combustion, electricity consumption, solid waste, etc.). The LGGIT provides many default values to facilitate developing local estimates using methods consistent with the Global Protocol for Community-Scale GHG Emissions. UMass CRM plans to use the LGGIT as a starting point in order to ensure completeness for all required data. UMass CRM also plans on utilizing an enhanced and more automated tool based on their written code but building on computations embedded in this tool. There are four primary decisions to be made under each task of this project for each source category, and each Task Leader will be charged with the following decisions::

1. Determine (for each major activity) if the LGGIT estimate, a different federal estimate or tool, or a non-federal estimate should be used for the local GHG baseline estimate.
2. Determine the best options for reducing emissions of air pollution and achieving the following Congressional objectives under the Inflation Reduction Act:
    a. Reduce climate pollution while supporting creation of good jobs and lowering energy costs for families.
    b. Accelerate work addressing environmental injustice and empowering community driven solutions in overburdened neighborhoods.
    c. Deliver cleaner air by reducing harmful air pollution in places where people live, work, play, and go to school.
3. Develop an estimate or a range of estimates for reductions achievable under each option.
4. Estimate the uncertainty of the emissions reduction estimate(s) or ranges under each option.

1.5.3. Actions to be Taken, Action Limits, and Expected Outcomes

Initially, local estimates will be derived using the LGGIT tool for each source category. Subsequently, CRCOG may elect to supplement estimates derived using the LGGIT with estimates for each source category from existing local inventories, existing local activity data, or from other EPA or state resources. If more than one estimate is derived from different tools or data sources, CRCOG and our Subawardee, UMass, will compare the estimates for validation. The rationale for including any emissions

estimates that show significant discrepancies from state or federal estimates will be documented in the community's GHG inventory report along with the underlying data and calculation methodology..

When identifying the best options for reducing air pollution, CRCOG and their consultant will consider the activities affecting the largest numbers of residents and families, businesses, recreation areas, and schools. Options may include potential reductions in task-level activities impacting nonattainment areas and impacting residential, commercial, and school districts near the largest sources of air pollution. CRCOG expects that each task will produce up to 10 options for sector-specific emissions reduction projects for further consideration by management and policymakers.

1.5.4. Reason for Project

The baseline GHG inventory and options analyses developed under this local community project will be utilized by CRCOG and RiverCOG for planning purposes to support the Hartford-East Hartford-Middletown (CT) MSA's development of the following three CPRG planning deliverables:

- Hartford-East Hartford-Middletown MSA's (CT) **Priority Climate Action Plan** (PCAP), which is due March 1, 2024. This plan will include near-term, implementation-ready, priority GHG reduction measures and is a prerequisite for any implementation grant.
- Hartford-East Hartford-Middletown MSA's **Comprehensive Climate Action Plan** (CCAP), which is due in 2025. This plan will review all sectors that are significant GHG sources or sinks, and include both near- and long-term GHG emission reduction goals and strategies.
- Hartford-East Hartford-Middletown MSA's **Status Report** on progress towards goal, which is due in 2027 (not applicable to tribes or territories). This progress report will include updated analyses, plans, and next steps for key metrics.

This QAPP describes in detail the necessary QA and QC requirements and technical activities that will be implemented to ensure the baseline GHG inventory and the sector-specific emissions reduction options are reliable for the PCAP and CCAP. As necessary, revisions to the QA and QC requirements defined in this QAPP will be updated in the 2027 Status Report.

1.5.5. Relevant Clean Air Act Mandates and Authorizations

The inventory produced under this project will support the deliverables required under EPA's Climate Pollution Reduction Planning Grants. The inventory will be used to evaluate opportunities for reducing GHG emissions from all major-emitting sources including both mobile source categories and stationary source categories. This project will include the fundamental research necessary to evaluate and plan new programs (and amendments to existing Clean Air Act [CAA] programs) for reducing emissions from fossil fuel combustion activities. Many activities in the GHG inventory (and subsequent emissions reductions options analyses) include major sources of criteria and toxic pollutants. Accordingly, the purpose of this project (to evaluate and plan for reductions in GHG emissions, including reductions from usage or production of fossil fuels) is also consistent with the following statutory mandates and authorizations under Clean Air Act Title I:

- ***§ 7403. Research, investigation, training, and other activities***
  (a) Research and development program for prevention and control of air pollution
  The Administrator shall establish a national research and development program for the prevention and control of air pollution ….
  (1) conduct, and promote the coordination and acceleration of, research, investigations … and studies related to the causes … extent, prevention, and control of air pollution;

(2) encourage, cooperate with, and render technical services and provide financial assistance to air pollution control agencies and other appropriate public or private agencies, institutions, and organizations, and individuals in the conduct of such activities ….

(b) Authorized activities of Administrator in establishing research and development program
In carrying out the provisions of [paragraph (a)] the Administrator is authorized to–

(1) collect and make available, through publications and other appropriate means, the results of and other information, including appropriate recommendations by him in connection therewith, pertaining to such research and other activities;….

(2) make grants to air pollution control agencies … for purposes … in subsection (a)(1) ….

- ***§ 7404. Research related to fuels and vehicles***
  (a) Research programs; grants; ….
  The Administrator shall give special emphasis to research and development into new and improved methods, having industry-wide application, for the prevention and control of air pollution and control of air pollution resulting from the combustion of fuels… he shall–
  (1) conduct and accelerate research programs directed toward development of improved , cost-effective techniques for–
  (A) control of combustion byproducts of fuels, ….
  (B) improving efficiency of fuels combustion so as to decrease atmospheric emissions ….

- ***§ 7405. Grants for support of air pollution planning and control programs***
  (a) Amounts; limitations; assurances of plan development capability.
  (1)(A) The Administrator may make grants to air pollution control agencies … in an amount up to three-fifths of the cost of implementing programs for the prevention and control of air pollution …. For the purpose of this section, "implementing" means any activity related to the planning, developing, establishing, carrying out, improving, or maintaining of such programs….
  (C) With respect to any air quality control region or portion thereof for which there is an applicable implementation plan under section 7410 … grants under subparagraph (A) may be made only to air pollution control agencies which have substantial responsibilities for carrying out such applicable implementation plan.

1.6. Project / Task Description

An example schedule of deliverables for the technical tasks (Tasks 1-5) for GHG inventory QAPPs is presented in **Tables 2.1** through **2.5.** The work to be performed under this project involves preparing a local GHG emissions inventory for the Hartford-East Hartford-Middletown (CT) MSA. The organization of the work is based on the use of the EPA's Local – GHG Inventory Tool (LGGIT)[6] under the following sector-specific tasks:

Task 1: Local inventory of mobile combustion GHG emissions.

Task 2: Local inventory of electric power consumption (indirect) GHG emissions.

Task 3: Local inventory of solid waste GHG emissions.

Task 4: Local inventory of GHG emissions from other sectors.

- 4.1 Stationary combustion
- 4.2 Agriculture and land management
- 4.4 Waste generation

[6] https://www.epa.gov/statelocalenergy/local-greenhouse-gas-inventory-tool .

4.5 Water
4.6 Wastewater treatment

Task 5: Local inventory of urban forestry resources.

For each sector-specific task, **Tables 2.1–2.5** provide planned activities and a schedule of deliverables for use by communities preparing GHG inventories. The EPA's LGGIT, other resources, and answers to frequently asked questions are also located on the Local GHG Inventory Tool Page Greenhouse Gas Data and Resources webpage.[7] The LGGIT User's Guides provide a summary of required data inputs for each module (Table 1 of each LGGIT User's Guide).

Table 2.1 Technical Task Descriptions for Task 1.

Tasks and Deliverables	Schedule
Task 1. Mobile Combustion (Transportation)	
GHG Inventory & Tool Decision: 1. The PM or TL will assign staff to download the EPA's Local – GHG Inventory Tool (LGGIT) at https://www.epa.gov/statelocalenergy/local-greenhouse-gas-inventory-tool and use that tool to estimate emissions from mobile combustion sources. 1. Staff will read the [Introduction] worksheet and the [Read Me] worksheet to become familiar with the organization of the tool and the tool's terminology. Staff will become familiar with Rows 42 through 59 of the [Read Me] sheet that reflect a brief summary of the steps necessary to complete the calculations for each sector. Additionally, staff can reference the LGGIT User's Guide for the Community Module that is included within the downloaded zip file. 2. Staff will complete the four (4) initial setup steps on the [Control Sheet]. 3. Staff will review Chapter 7 - Transportation in the GPC GHG Emissions Inventories, and/or Chapter 7 - Vehicle Fleet in the LGO Protocol. If possible, staff will obtain from a state or local motor vehicle agency, the most recent listing of vehicles registered at addresses located in the MSA including (as available) year-manufactured, make, model, body style, fuel, and description. 4. In the LGGIT: Community Module [community_ghg_inventorytool.xlsm], staff will use the [Mobile-Entry] sheet to load the community's or MSA's population of fossil-fueled motor vehicles. Staff will prepare an aggregated listing (i.e., listing of sets of vehicles with counts by vehicle type, model, year, and fuel) for all of registered vehicles and an estimate of the average fuel consumed for each set of similar vehicles. 5. The TL or PM will assign the QAM member who did not support steps 1-5 of this task to complete a QC review. Staff will independently review the original source data for all inputs and supporting calculations used to populate the [Mobile-Detail Calcs] sheet. Staff will also complete an independent review of all inputs to the LGGIT and complete independent calculations for at least 2 types of vehicles (as directed by the	Within 14 days of QAPP approval by EPA. .

[7] Ibid.

Table 2.1 Technical Task Descriptions for Task 1.

Tasks and Deliverables	Schedule
Task 1. Mobile Combustion (Transportation)	
PM or TL) on the [Mobile-Detail Calcs] sheet. The assigned QC staff member will also be directed to compare the LGGIT-based estimate to the estimate published in the EPA's National Emissions Inventory (NEI) and available using the *Data Queries* tool at https://www.epa.gov/air-emissions-inventories/2020-nei-supporting-data-and-summaries. This NEI query tool provides national, state, county, and tribal emissions estimates for mobile sources. Post-GHG Inventory Tasks: 6. In the GHG inventory report or in a separate report based on the GHG inventory, CRCOG will include a listing of options for emissions reductions from this sector that may include one or more of the following components or other components (that are not listed below) that assigned staff may identify during preparation of the inventory in the future during implementation of this task: a. The specific source categories and activities affected by the proposed option. b. The quantity of GHG emissions reduced by the options with an associated uncertainty estimate. c. The quantity of criteria emissions reduced by the options with an associated uncertainty estimate. d. The quantity of toxic air pollutant emissions (as defined under applicable local, state or federal rules for air toxics) reduced by the option with an associated uncertainty estimate. e. The number of people living in any nonattainment areas where the option would reduce emissions (regardless of the specific pollutant triggering nonattainment). f. A description of any benefits that the option will impart to communities with known environmental injustice issues such as close proximity to major transportation corridors.	

Table 2.2 Technical Task Descriptions for Task 2.

Tasks and Deliverables	Schedule
Task 2. Electric Power Consumption	
GHG Inventory & Tool Decision: 1. The PM or TL will assign a staff member to use the EPA's LGGIT tool [community_ghg_inventorytool.xlsm] and to verify that the four (4) initial steps required	Within 28 days of QAPP

Table 2.2 Technical Task Descriptions for Task 2.

Tasks and Deliverables	**Schedule**
Task 2. Electric Power Consumption	
on the [Control Sheet] have been completed. 2. Staff will review Chapter 6.5 - Calculating Emissions from Grid-Supplied Energy Consumption in the GPC GHG Emissions Inventories, and/or Chapter 6.2 - Electricity Use in the LGO Protocol. 3. Staff will obtain total electricity consumption data for the community or MSA from one or more of the following local, state, or federal resources to be used for the baseline estimate or QC validation of the baseline estimate: a. Summaries of metered consumption obtained from the local electric utilities that serve the community or MSA by customer class. b. EIA Form 861 data published by the DOE and available at https://www.eia.gov/electricity/data/eia861/. c. The State and Local Planning for Energy (SLOPE) model datasets available at https://maps.nrel.gov/slope/about. Note these data are published as electricity usage in the units of MMBtu/year for the entire county. Estimates are provided for residential, commercial, and institutional customer classes. These data will be converted to kilowatt-hours per year prior to entry into the LGGIT tool. The projections available in this tool (for future years) may also be used for estimating emissions reductions associated with options listed for the electric utility sector. 4. Staff will use the [Electricity-Entry] sheet of the EPA's LGGIT tool. Staff will read the explanation of the *Data Entry & Calculations* starting in cell A3. Staff will enter the data for each chosen entity. These entities may be of any scale as chosen by the grantee (e.g., the entire community by sector; individual building, such as a commercial or institutional facility; or a set of similar facilities (e.g., a group of similar residential units). For groups of similar units, when entering the *Unit Description* in cell C10 of the [Electricity-Entry] sheet, staff will include in the description the number of units that were included when the *electricity purchased (kWh)* value was summed or otherwise calculated for entry into cell C16. Staff will document in the inventory each calculation with associated units of measure for each record added on the [Electricity-Entry] sheet in a manner similar to the following example:	approval by EPA.

A	B	C		D
Count of Units in Set	**Set Description**	**Avg. Annual kWh Used (per Unit)**		**Annual Usage (All Units)**
1000	Single-family home	750 kWh	=	750,000 kWh
		(Single-family home) (1 Year)		Year

Staff will document the source of the MW-hr usage per customer entered in column C.

5. Staff will determine if EIA Form 861 at https://www.eia.gov/electricity/data/eia861/ includes one of the following types of data that may be useful for estimating or validating the usage per customer entered in column C of step 2:

a. The community's or MSA's total electricity usage. (See ***Attachment 1*** for some

Table 2.2 Technical Task Descriptions for Task 2.

Tasks and Deliverables	**Schedule**
Task 2. Electric Power Consumption	

of the service territories included under EIA Form 861),

b. The service territory or territories that include the community or MSA. (See the EIA Form 861 file entitled [Service_Territory_2020.xlsx] for a listing of the utilities that serve each county in the United States,

c. A service territory adjacent to the community or MSA with similar usage patterns that may be comparable to the community's or MSA's estimate, or

d. Make a determination that there are no data under EIA Form 861 that are relevant to estimating or validating local usage per customer in column C of step 2.

6. If the community locates EIA 861 electricity data relevant to estimating or validating local usage, staff will include in the inventory the following values from EIA Form 861 to reflect electricity usage per customer most similar to local usage:

EIA 861 Column Name	**EIA Form 861 Value**
Year of Data	
Utility Name	
Utility Number	
State	
BA Code	
Residential Sales (MW-hrs)	
Residential Customers	
Commercial Sales (MW-hrs)	
Commercial Customers	
Industrial Sales (MW-hrs)	
Industrial Customers	
Transportation Sales (MW-hrs)	
Transportation Customers	

7. In the GHG inventory report or in a separate report based on the GHG inventory, include a listing of options for emissions reductions from this sector that includes the following components:

a. The specific source categories and activities affected by the proposed option.

b. Quantity of GHG emissions reduced by the options with an associated

Table 2.2 Technical Task Descriptions for Task 2.

Tasks and Deliverables	Schedule
Task 2. Electric Power Consumption	
uncertainty estimate. c. Quantity of criteria emissions reduced by the options with an associated uncertainty estimate. d. Quantity of toxic air pollutant emissions (as defined under applicable local, state or federal rules for air toxics) reduced by the option with an associated uncertainty estimate. e. Number of people living in any nonattainment areas where option would reduce emissions (regardless of pollutant triggering nonattainment). a. Description of any benefits that the option will impart to communities with known environmental injustice issues such as close proximity of the community to an affected source under the option that emits toxic air pollutants.	

Table 2.3 Technical Task Descriptions for Task 3.

Tasks and Deliverables	Schedule
Task 3. Solid Waste (Landfills)	
1. The PM or TL will assign technical staff to develop estimates for this source using the LGGIT's [Solid Waste Control] and [Solid Waste-Entry] worksheets. (The [Solid Waste-Entry] worksheet only provides locations to enter data after the [Solid Waste-Control] worksheet is populated.) 2. Staff will review Chapter 8 - Waste in the GPC GHG Emissions Inventories, and/or Chapter 9 - Solid Waste Facilities in the LGO Protocol. 3. On the LGGIT's [Solid Waste Control] worksheet, staff will enter the total number of landfills in the community, the landfill name, whether or not the landfill has a landfill gas (LFG) collection system, and if the LFG collection system is partial or comprehensive (definitions are provided). 4. On the [Solid Waste Entry] sheet, staff will enter the following data per landfill type: a. For landfills without a LFG collection system, staff will obtain and enter the annual quantities of waste deposited into the landfill for the life of the landfill, and the opening and closing years of the landfill. The instructions then provide the option to click on a link that takes you to the LGO Protocol Landfill Emissions Tool, where this data is entered. b. For landfills with a comprehensive LFG collection system, staff will obtain and	Within 30 days of QAPP approval by EPA.

Table 2.3 Technical Task Descriptions for Task 3.

Tasks and Deliverables	Schedule
Task 3. Solid Waste (Landfills)	
enter the annual amount of landfill gas collected. c. For landfills with a partial LFG collection system, staff will obtain and enter the annual amount of landfill gas collected and the ratio of uncollected surface area over the collected surface area. 5. In the inventory report or in a separate report based on the inventory, include a listing of options for emissions reductions from this sector that includes the following components: a. The specific source categories and activities affected by the proposed option. b. The quantity of GHG emissions reduced by the options with an associated uncertainty estimate. c. The quantity of criteria emissions reduced by the options with an associated uncertainty estimate. d. The quantity of toxic air pollutant emissions (as defined under applicable local, state or federal rules for air toxics) reduced by the option with an associated uncertainty estimate. e. The number of people living in any nonattainment areas where the option would reduce emissions (regardless of the specific pollutant triggering nonattainment). f. A description of any benefits that the option will impart to communities with known environmental injustice issues such as close proximity of the community to an affected source under the option that emits toxic air pollutants.	

Table 2.4 Technical Task Descriptions for Task 4.

Tasks and Deliverables	**Schedule**
Task 4. Inventory of GHG Emissions for Other Sources	
1. The PM or TL will assign the primary technical staff member(s) to use the EPA's LGGIT tool and the following worksheets to develop the primary estimates for other sectors. **Other Sources** / **LGGIT Worksheet(s)** Stationary combustion: [Stationary-Entry] [Stationary-Data] [Stationary-Calcs] Agriculture & land management: [Agriculture & Land Management] Water: [Water] Wastewater treatment: [Wastewater-Control] [Wastewater-Entry] [Wastewater-Calcs] Waste generation (disposal external to community's geopolitical boundary): [Waste Production] 2. After the primary LGGIT calculations are complete, the PM, TL or QAM will assign a QC staff member to complete the following steps: a. Review the original source(s) of data for all inputs to the LGGIT tool. b. Validate that values from original source(s) were correctly entered into the primary LGGIT tool. c. Populate a blank version of the LGGIT tool with the inputs in a QC version. d. Compare the outputs of the primary version of the LGGIT versus the QC version of the LGGIT. e. Compare source listing LGGIT's [Summary-Emissions] sheet to previous inventories published by community or by neighboring or similar communities to determine if any major sources of GHGs were omitted from the inventory. f. Document findings and submit findings to the PM, TL and QAM for resolution. g. Document steps taken to resolve any findings. 3. In the GHG inventory report or in a separate report based on the GHG inventory, include a listing of options for emissions reductions from this sector that includes the following components: a. The specific source categories and activities affected by the proposed option. b. The quantity of GHG emissions reduced by the options with an associated uncertainty estimate. c. The quantity of criteria emissions reduced by the options with an associated uncertainty estimate.	Within 49 days of QAPP approval by EPA.

Table 2.4 Technical Task Descriptions for Task 4.

Tasks and Deliverables	**Schedule**
Task 4. Inventory of GHG Emissions for Other Sources	
d. The quantity of toxic air pollutant emissions (as defined under applicable local, state or federal rules for air toxics) reduced by the option with an associated uncertainty estimate. e. The number of people living in any nonattainment areas where the option would reduce emissions (regardless of the specific pollutant triggering nonattainment). a. A description of any benefits that the option will impart to communities with known environmental injustice issues such as close proximity of the community to an affected source under the option that emits toxic air pollutants	

Table 2.5 Technical Task Descriptions for Task 5.

Tasks and Deliverables	Schedule
Task 5. Urban Forestry (Natural Working Lands and Forestry)	
1. The PM or TL will assign technical staff to develop estimates for this sector using the LGGIT's [Urban Forestry] worksheet. 2. In order to estimate the areas of land with similar percentages of tree cover, staff will use a web-based mapping application to develop a listing of tree-covered tracts of land (i.e., polygons) with the following attributes: a. Identifier describing area (e.g., Area 1 between Crooked Creek and boundary). b. Sector (residential, commercial/institutional, industrial, energy generation) c. Total area in square kilometers (km^2). d. Percentage of area with tree cover based on local estimate. 3. For each sector, staff will calculate weighted percentage tree cover using **Equation 1.** **Equation 1** for weighted percentage of tree cover for a sector: $$\frac{\sum_{i=1}^{i=30}(km2ofareai)(\%treecoverofareai)}{\sum_{i=1}^{i=30}(km2i)}$$ Where: i = 1 to 30 — Designates 30 tree covered areas in a sector on local lands. km^2 of area i — The measured area (in square kilometers) of area i. % tree cover of area i — The estimated percentage of tree cover for area i. $\sum_{i=1}^{i=30}(km2i)$ — The denominator is the total combined area of all 30 areas within the sector. 4. For each sector on the LGGIT's [Urban Forestry] worksheet staff will enter total area for the sector in column C rows 11 through 14 and enter weighted % tree cover in Column D. 5. For the two sectors with the largest areas of tree cover, the QAM will assign a QC staff member who did not support steps 1 through 4, to develop independent estimates and to complete the following QC steps: a. Review the original source(s) of data for all inputs to the primary LGGIT tool. b. Validate correct entry of values from original source(s) into the primary LGGIT. c. Populate a blank version of the LGGIT tool with the inputs in a QC version. d. Compare the primary outputs of the LGGIT versus the QC version of the LGGIT. e. Compare the listing of resources by sector on the LGGIT's [Summary-Emissions] sheet to previous inventories published by the locality or by neighboring or similar localities to identify any major discrepancies. f. Document findings and submit findings to the PM, TL, and QAM for resolution. g. Document steps taken to resolve any findings. 6. In the inventory report or in a separate report based on the inventory, include a listing of	Within 63 days of QAPP approval by EPA.

Table 2.5 Technical Task Descriptions for Task 5.

Tasks and Deliverables	Schedule
Task 5. Urban Forestry (Natural Working Lands and Forestry)	
options for emissions reductions from this sector that includes the following components: a. Specific source categories and activities affected by the proposed option. b. Quantity of GHG emissions reduced by option with uncertainty estimate. c. Quantity of criteria emissions reduced or mitigated (such as by adsorption of PM2.5 on leaf surfaces) by the option with an associated uncertainty estimate. d. The number of people living in any nonattainment areas where the option would reduce emissions or improve air quality conditions by providing shade to urban heat islands (regardless of the specific pollutant triggering nonattainment). e. A description of any benefits that the option will impart to communities with known environmental injustice issues such as providing windbreaks to communities in close proximity to sources of nuisance dust (e.g., dirt roads used for mining operations). f. The number of schools, miles of roadways, or public traffic counts at major commuting destinations that would be positively affected by options that include planting of trees or other vegetation.	

1.7. Quality Objectives / Criteria

The primary objectives for this project are to develop reliable inventories for each of the GHG-emitting sectors in Hartford-East Hartford-Middletown (CT) MSA and to identify options for reducing emissions from those sectors. Accordingly, all quality objectives and criteria are aligned with these objectives. The quality system used for this project is the joint responsibility of the CRCOG PM, Task Leaders, and the QA Manager. As discussed in Section 1.4, an organizationally independent QA Manager from the University of Massachusetts will maintain oversight of all required measures in this QAPP. QC functions will be carried out by technical staff and will be carefully monitored by the responsible Task Leaders, who will work with the QA Manager to identify and implement quality improvements. All activities under this project will conform to this QAPP and any and all issues that might arise will be presented to the PM and DPM. Staff at CRCOG will work with Subaward Recipients to address issues raised and seek solutions.

1.7.1. Data Quality, Management, and Analyses

For this project, UMass will use a variety of QC techniques and criteria to ensure the quality of data and analyses. Data of known and documented quality are essential components for the success of the project, as this data will be used to inform the decision-making process for the PCAP and CCAP as discussed in Section 1.5.4. The table in **Appendix A** lists by task the specific QC techniques and criteria that are part of this QAPP.

The data quality objectives and criteria for this project are accuracy, precision, bias, completeness, representativeness, and comparability. *Accuracy* is a measure of the overall agreement of a measurement to a known value. It includes a combination of random error (precision) and systematic error (bias). *Precision* is a measure of how reproducible a measurement is or how close a calculated estimate is to the actual value. *Bias* is a systematic error in the method of measurement or calculation. If the calculated

value is consistently high or consistently low, the value is said to be biased. Our goal is to ensure that information and data generated and collected are as accurate, precise, and unbiased as possible within project constraints. It is not anticipated that this project will include primary data collection. Generally, existing data and tools provided by the EPA and other qualified sources will be used for project tasks. A subject matter specialist familiar with technical reporting standards (such as a permit writer or compliance engineer with knowledge of the community's facilities operating in the sector) will be used to QA all data utilized for developing the local GHG inventory. UMass will verify the accuracy of all data by checking for logical consistency among datasets. All existing environmental data shall meet the applicable criteria defined in CFR and associated guidance, such as the validation templates provided in the *EPA QA Handbook Volume II*.

Uncertainty can be evaluated using a few different approaches. The most useful uncertainty analysis is quantitative and is based on statistical characteristics of the data such as the variance and bias of estimates. In a sensitivity analysis, the effect of a single variable on the resulting emissions estimate generated by a model (or calculation) is evaluated by varying its value while holding all other variables constant. Sensitivity analyses will help focus on the data that have the greatest impact on the output data. Additional statistical tests may be utilized depending on the need for more or less rigorous tools and on the specific project activity being evaluated.

When available, data originally gathered using published methods whose applicability, sensitivity, accuracy, and precision have been fully assessed, such as EPA reference methods, will be preferred and considered to be of acceptable quality. Project decisions may be adversely impacted if, for example, existing data were used in a manner inconsistent with the originator's purpose. Metadata can be described as the amount and quality of information known about one or more facets of the data or a dataset. It can be used to summarize basic information about the data (e.g., how, why, and when the existing data were collected), which can make working with specific data or datasets easier and provides the user with more confidence. Metadata are valuable when evaluating existing data, as well as when planning for collection primary data that may be required in the future. However, the effort needed to locate and obtain original source materials can be costly. Accordingly, a graded approach to planning will be applied and ongoing discussions with the EPA will be held to determine what magnitude and rigor of QA effort are appropriate and affordable for the project.

For the data analysis completed under this project, analytical methods will be reviewed to ensure the approach is appropriate and calculations are accurate. Spreadsheets will be used to store data and complete necessary analyses. Design of spreadsheets will be configured for the intended use. All data and methodologies specific to each analysis will be defined and documented. Tables and fields will be clearly and unambiguously named. Spreadsheets will be checked to ensure algorithms call data correctly and units of measure are internally consistent. Hand-entered or electronically transferred data will be checked to ensure the data are accurately transcribed and transferred.

The draft inventory will be evaluated for GHG-emitting-sector and geographic completeness. CRCOG, and their sub-award recipient UMass will utilize the framework of sectors in the EPA's LGGIT tool, previous local inventories, or previous inventories completed by similar communities to ensure that the inventory prepared under this project includes all major GHG-emitting sectors. To ensure the inventory is geographically complete, the draft inventory will also be submitted for review by CRCOG staff and those in the community who are familiar with all activities subject if necessary, The review of the draft inventory will be to ensure compliance with local or federal standards issued under Title I of the CAA to ensure that all major-emitting, local activities are included in the inventory. Feedback on the draft inventory will be submitted within 15 days of receipt and be issued electronically via email.

Representativeness is a qualitative term that expresses the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition. Staff at CRCOG will ensure that UMass CRM use the most complete and accurate information available to compile representative data for the community's GHG-emitting activities.

Data comparability is a qualitative term that expresses the measure of confidence that one dataset can be compared to another and can be combined for the decision(s) to be made. UMass CRM will compare datasets when available from different sources to check the quality of the data. This QA step will also ensure that any highly correlated datasets or indicators are identified. Supporting data, such as information on reference methods used and complete test reports, are important to ensure the comparability of emissions data.

1.7.2. Document Preparation

All documents produced under this project will undergo an internal or external QC review (whichever is appropriate at that time), prior to submission to the EPA PO. QC will be performed by individuals with sufficient knowledge in the preparation and methodology of the produced documents. The technical reviewer will review the document for accuracy and integrity of the technical methodologies, analyses, and conclusions.

An editorial review of all final documents will be performed. Editors will verify clarity, spelling, and grammatical correctness, and ensure documents are free of typographical errors. Editors will verify that references are cited correctly. This will include a comparison against the original documents.

The *QC Documentation Form* (**Appendix B**) will be used to track the approval process. The form must be completed and signed for all document deliverables. The signatures required include those of the TL and technical and editorial reviewers. Completion of this form certifies that technical review, editorial review, and all required QC procedures have been completed to the satisfaction of the TL and QAM. Copies of these signed forms will be maintained in the project files.

1.8. Special Training / Certifications

All CRCOG and UMass staff assigned to work on this project shall have appropriate technical and QA training to properly perform their assignments also known as "tasks 1-5". UMass staff serving in the QAM role under this project will have completed a training course on QA/QC activities similar to the course available at https://www.epa.gov/quality/training-courses-quality-assurance-and-quality-control-activities. The PM and all TLs under this project will have completed an online training course on air emissions inventories on the Air Knowledge website at https://airknowledge.gov/EMIS-SI.html.

If training is required for new staff or for particular segments of the GHG inventory, the PM in coordination with the associated TL will identify available training resources for the inventory segment and incorporate the required training into the project schedule.

1.9. Documents and Records

CRCOG will document in electronic form (as well as hard copy) QC activities for this project. The TL is responsible for ensuring that copies of all completed QC forms, along with other QA records (including this QAPP), will be maintained in the project files. Project files will be retained by CRCOG for at least five (5) years after the completion of the CCAP and Status Reports. The types of documentation that will be prepared for this project include:

- Planning documentation (e.g., QAPP)
- Implementation documentation (i.e., Review/Approval Forms and QC records)
- Assessment documentation (i.e., audit reports and independent calculations).

Detailed documentation of QC activities for a specific task or subtask will be maintained using the *QC Documentation Form* shown in **Appendix B**. This form will document the completion of the QC techniques planned for use on this project as listed in the table in **Appendix A**. One or more completed versions of these forms, as necessary, will be maintained in the project files. The types of documents and activities for which QC will be conducted and documented may include raw data, data from other sources such as data bases or literature, data entry into the LGGIT tool, calculations necessary to transform raw data into forms required for LGGIT entry, and comparisons of primary estimates with QC estimates.

Technical reviews will be used along with other technical assessments (i.e., QC checks) and QA audits to corroborate the scientific defensibility of any data analyses. A technical review is a documented critical review of a specific technical work product. It is conducted by subject matter experts who are collectively equivalent (or senior) in technical expertise to those who performed the work. Given the nature of the deliverables under this project, a technical review is an in-depth assessment of the assumptions, calculations, extrapolations, alternative interpretations, and conclusions in technical work products. Technical review of proposed methods and associated data will be documented in the *QC Documentation Form* shown in **Appendix B**. The form will include the reviewer's charge, comments, and corrective actions taken.

Additionally, CRCOG has developed and instituted document control mechanisms for the review, revision, and distribution of QAPPs. Each QAPP has a signed approval form, title page, table of contents, and an EPA-approved document control format (see header at top of the page). The distribution list for this QAPP was presented in **Table 1.1**. During the course of the project, any revision to the QAPP will be circulated to everyone on the distribution list, as well as to any additional staff supporting this project. Any revision to the QAPP will be documented in a QAPP addendum, approved by the same signatories to this QAPP, and circulated to everyone on the distribution list by the CRCOG PM.

At this time, CRCOG does not believe this project will collect or handle personally identifiable information (PII) subject to the Privacy Act of 1974. However, if during the course of this project technical staff determine that PII is required to support project objectives, CRCOG will meet all requirements of the Privacy Act of 1974. **Appendix C** indicates the status of our determination regarding applicability of the Privacy Act of 1974 under this project.

2. Existing Data Acquisition and Management Protocols (Group B)

2.1. Sampling Process Design

2.1.1. Need and Intended Use of Data Used

As indicated in **Tables 2.1 – 2.5**, a wide range of data for a diverse set of GHG-emitting activities is necessary to prepare a local inventory. Existing data resources may include sector-specific or facility-specific GHG emissions estimates, emissions factors, or activity data for use with emissions factors. The experimental design for this inventory project relies on the EPA's LGGIT tool together with independent estimates prepared by CRCOG-assigned QC staff. Existing data resources (including but not limited to data from previously completed inventories) will be utilized when possible, to develop GHG emissions estimates that are comparable to the LGGIT estimates. Subsequently, estimates for each source category will be compared to available federal or state data.

.

2.1.2. Identification of Data Sources and Acquisition

The following data sources will be evaluated for use under each task to develop estimates for the major-emitting sectors in the Hartford-East Hartford-Middletown MSA or for use in validation of estimates:

- Task 1:
  - Vehicle registration data from the State of Connecticut Department of Motor Vehicles – where available
  - State or federal averages on vehicle miles traveled and miles per gallon from the U.S. Department of Transportation.
  - National Emissions Inventory (NEI) county-level estimates for mobile sources.
- Task 2:
  - U.S. Department of Energy's (DOE's) SLOPE Platform which reports county-level electricity usage in million British thermal units.
  - DOE's EIA Form 861 which reports sub-county-level usage in MWh and customer counts as reported by the different distribution utilities operating within each county.
  - Electricity consumption by customer class obtained directly from Eversource and United Illuminating.
- Task 3:
  - Number of community landfills and information on landfill gas (LFG) collection systems, as applicable, from Connecticut Department of Energy & Environmental Protection.
  - Landfill emissions data reported to the EPA's GHGRP.
- Task 4:
  - Data published by the EPA under the Greenhouse Gas Reporting Program for fossil fuel consumption by customer class from Eversource, United Illuminating and other utilities that serve municipalities within the MSA.
  - County-level natural gas consumption data from DOE's SLOPE Platform;
  - Wastewater management data from local water utility(ies).
- Task 5:
  - Area calculations from web-based map applications. Tree cover estimates from local surveys or forestry databases.

2.2. Quality Control

All data operations conducted for this project will involve existing, non-direct measurement data. All data received will be reviewed by a senior technical staff member at UMass CRM and the TL to assess data quality and completeness before their use. In addition to reviewing and assessing the data collected, all data entered into spreadsheets and all calculations completed for analyses will be reviewed by a senior staff at UMass CRM. The TL reviewer will evaluate the approach to ensure the methods are appropriate and have been applied correctly to the analysis. The TL will request that the QAM reviewer will also confirm all data were entered correctly and that calculations are complete and accurate. Any data entry and calculation errors will be identified and corrected. Data tables prepared for the draft and final reports will be checked against the spreadsheets used to store the data and complete the analysis.

Where calculations are required to assess the data/datasets, QC calculations will be performed using computer spreadsheets and calculators to reduce typographical or translation errors–mathematical/ statistical calculations are performed using spreadsheets or software programs with predefined formulas and functions. CRCOG and/or UMass will ensure that any manipulations performed on the data/dataset were done correctly. Such calculations could involve statistical checks to look for data outliers. One approach, for example, that may be used to identify outliers or unusual data points is sorting a datasheet for one or more data variables. This approach is a simple but effective way to highlight unusually high or low values. Graphing data using boxplots, histograms, and scatterplots is another method that may be used to identify gaps in the data (missing data), outliers, or unusual data points. Another approach that may be used is the use of Z-scores, which can quantify the unusualness of an observation when data follow a normal distribution. A Z-score for a particular value indicates the number of standard deviations above and below the mean that the value falls. For example, a Z-score of 2 indicates that an observation is two standard deviations above the average while a Z-score of -2 indicates the value is two standard deviations below the mean. A Z-score of zero represents a value that equals the mean. As appropriate, UMass CRM staff will also use hypothesis tests to find outliers, or an interquartile range (IQR) to calculate boundaries for what constitutes minor and major outliers. The methods used will be driven by the scale and type of data. CRCOG will review and determine if additional outlier detection methods are to be used based on the initial review of the data. Identified outliers will be highlighted to the PM, TL, QAM, or delegate with options for treatment.

2.3. Non-direct Measurements for GHG Inventory and Options Identification

All data operations conducted on this project will involve existing, non-direct measurement data. All existing data received will be reviewed by UMass TL and senior staff to assess data quality and completeness before their use.

Consistent with the EPA's QA requirements, this QAPP describes the procedures that will be used to ensure the selection of appropriate data and information to support the goals and objectives of this project. Specific elements addressed by this QAPP include:

- Identifying the sources of existing data,
- Presenting the hierarchy for data selection,
- Describing the review process and data quality criteria,
- Discussing quality checks and procedures should errors be identified, and
- Explaining how data will be managed, analyzed, and interpreted.

Data presented in the GHG inventory will be traced to its source (e.g., database input and output). Key resources include data collected by the EPA (e.g., GHGRP data), and data from EPA-approved data

sources (e.g., Department of Energy and other federal data sources) and data from Connecticut state and local agencies. These sources may include primary literature (i.e., peer-reviewed journal articles and reports) or databases. CRCOG may also seek to use approved existing sources (e.g., handbooks, databases) and/or make additional requests to state agencies for data that may not be publicly available for retrieval (this could include DMV registration data, stationary combustion data from Eversource/UI etc.). Original sources for all information and data contained in the document will be included in a list of references with appropriate citations. When peer-reviewed literature or EPA-approved data sources cannot be used, TL will document and highlight any significant limitations to the data sources used.

CRCOG and UMass CRM will document information regarding each dataset and our rationale/selection criteria for selecting the data sources used in the inventory where appropriate. The TL will be responsible for overseeing and confirming the selection of the data for the project tasks.

Table 3.1 provides a hierarchy for data quality when identifying and reviewing available sources of data and information. When evaluating data resources, efforts will be made to identify and select data sources that most closely conform to the highest ranked criteria. Data quality metrics and documentation may not be provided by each source, and as necessary, we may consult with subject matter experts from permitted facilities or trade associations operating in the Hartford-East Hartford-Middletown MSA to qualify data for use to meet project objectives.

Any available data quality information will be reviewed by UMass CRM and project advisors when necessary. TL at UMass CRM will ensure the documentation of all data sources used as well as any significant limitations of utilized data or information to ensure that the data are appropriate for their intended use. The TL will review the approach for selecting and compiling data and report issues to the PM where appropriate; the review will include examination of the data sources and the intended use of the data as well as any shortcomings. The TL is responsible for verifying the usability of data and related information and will report this information to the PM.

Table 3.1 Existing Data Quality Ranking Hierarchy

Quality Rank	**Source Type**
Highest	Federal, state, and local government agencies
Second	Consultant reports for state and local government agencies
Third	NGO studies; peer-reviewed journal articles; trade journal articles; conference proceedings
Fourth	Conference proceedings and other trade literature: non-peer-reviewed
Fifth	Individual estimates (e.g., via personal communication with vendors)

CRCOG and UMass will work primarily with EPA’s available tools and data retrieval systems and ensure that all data used for the project are appropriate for their intended use. The main criteria that will be used in the selection of the data are the vintage and quality of the data (based on peer review). The quality of the data will consider the credibility of the source, and the QA documentation provided by the data source. The TL will consult the PM on the availability of alternative datasets, suitability of the selected data for the intended purpose, and agreement with LGGIT estimates. If the TL identifies

shortfalls in available data, they will request access to this data and PM will provide to the best of their ability.

CRCOG and UMass CRM will use the Secondary Data Quality Ranking Hierarchy when identifying and reviewing available sources of data and information. The source types in **Table 3.1** appear in the order in which they are likely to meet the data quality criteria. For example, federal government data are more likely to be from a credible source, thoroughly reviewed, suitable, available, and representative, and any exceptions to these data criteria are likely to be noted in the government data, providing transparency. Data from individuals are expected to be less reliable, not peer reviewed, and may not be suitable or representative of local activities.

If it is determined that data meeting the fourth (i.e., conference proceedings and other trade literature: non peer-reviewed) or fifth (i.e., individual estimates such as personal communications with vendors) level compose the best or only available data source, the TL will include in the inventory a description of these data with associated limitations for review and approval by the PM and QAM.

These measures of data quality will be used to judge if the data are acceptable for their intended use. In cases where available data do not or may not meet data quality acceptance criteria, the TL will include in the inventory a discussion for review and approval by the PM and QAM explaining how emissions estimates that relied on such data compare to LGGIT estimates.

The TL and PM will also consider, for example, the age (i.e., date of the source dataset) and the representativeness of the data and will include in the inventory report for review and approval by the PM and QAM any quality concerns or uncertainties introduced with use of these data, such as data gaps or inconsistencies with other sources. Any data source utilized that is older than 10 years will specifically be flagged in the inventory report.

Representativeness will be evaluated by determining that the emissions or activity data are descriptive of conditions in the United States, that the data are current, and that the data are descriptive of similar processes within Hartford-East Hartford-Middletown MSA. Any incomplete datasets will be identified, and deficiencies will be evaluated to determine if data are missing or confusing and if they meet secondary-use quality objectives.

Key screening criteria will be used to screen the sources identified. The CRCOG PM will provide oversight to the screening process to ensure sources collected are the most relevant and meet quality requirements. Available data and information from the selected sources will be compiled and relevant summary information will be extracted out of the information sources to develop the required output for each of the project tasks.

2.3.1. Criteria for Accepting Existing Data for Intended Use

The criteria for determining if the data are acceptable for use in developing the local inventory will be based on the following:

- Data Source – *Was the data originated by a credible source that is generally accepted as the experts or authority in the relevant field?*
- Transparency – *Are the data collection, cleaning, and calculation methods and assumptions clearly documented?*
- Data Completeness – *Is the data reasonably complete? If the data isn't complete, are there explanations for why, and can reasonable assumptions be made to fill in data gaps?*

2.3.2. Criteria for Options Identification

Review of activities under each task and identification of options for emissions reductions to be considered by policymakers will be based on the following criteria:

1. Quantity of reductions in emissions of climate pollution under the option.
2. Number of jobs likely to be created by the option.
3. Environmental justice benefits of the project including the number of people living in overburdened neighborhoods that will benefit from the option.
4. Quantity of reductions in criteria and toxic air pollutants that can be achieved by option.
5. Number of people living, working, recreating, and going to school in the area(s) benefiting from the option.

2.4. Data Management

Data management procedures include file storage and file transfer. All project and data files will be stored on UMass CRM servers and backed up on CRCOG project servers where necessary. Files will be organized and maintained by the TL in folders by project, task, and function, including a system of file labeling to ensure version control. Any files containing confidential business information will be stored on secure computers. The TL will make sure that staff are trained and adhere to the project file organization and version control labeling to ensure that files are placed in consistent locations. All files will be backed up each night to avoid loss of data. Data are stored in various formats that correspond to the software being used. As necessary, data will be transferred using various techniques, including email, File Transfer Protocol, or shared drives. Typically, records will be archived once the project is completed. Record retention times will be based on contractual and statutory requirements or will follow CRCOG practices for storing materials for a minimum of 5 years after the end of the period of performance (POP). Multiple project staff are granted access rights to the archived file system for each project. Records may be retrieved from archived file system by the TL, PM, or other project staff with access during the records retention period. As soon as allowed by applicable regulations or the grant agreement, records will be destroyed according to CRCOG policies and procedures. For any sensitive information that is gathered under the project, CRCOG's policy is consistent with EPA–recommended methods of destruction, which include degaussing, reformatting, or secure deletion of electronic records; physical destruction of electronic media; recycling; shredding; incineration; and pulping. Should the grant specify some other manner of disposition (e.g., transfer to the client), CRCOG will comply with that directive. As noted above, CRCOG has developed a file naming convention/nomenclature for electronic file tracking and record keeping. Foremost, all files must be given a short but descriptive name.

Similarly, files that have undergone a review by an independent, qualified person will include, at the end of the filename, the initials of the reviewer along with the date reviewed and version number, as a way to track which staff person(s) reviewed the file and when. Final versions will be indicated by whole numbers (e.g., version 1.0). Final versions of documents that undergo revisions will be labeled version X.1 for the first set of revisions. While the document is under review, subsequent draft versions will increase incrementally (e.g., 1.2, 1.3, 1.4) until a revised final version is complete (e.g., version 2.0).

In the event data retrieval is requested and to prevent loss of data, all draft and final file versions will be retained electronically—that is, superseded versions will not be deleted.

Note that changes made to deliverables will be documented using the software's *track changes* feature, which allows a user to track and view all changes that are made to the document version. All deliverable reviews will be documented in a QC Documentation Form (see **Appendix B**) for the project. This form will be maintained in the project files.

For this project, it is not anticipated that any special hardware or software will be used. General software available through the Microsoft Suite including Excel, PowerPoint, Access, and Word will be sufficient to perform the work (described in **Tables 2.1 – 2.5)** for this project. If additional software is required by relevant staff, including UMass CRM, purchase will be based on approval from PM.

Assessment and Oversight (Group C)

CRCOG is committed to preparing a comprehensive and reliable inventory of GHG emissions for the Hartford-East Hartford-Middletown MSA. Under this project CRCOG's management team has dedicated the necessary resources to ensure the delivery of an inventory that can be relied upon for future policy decisions for the region and beyond. Accordingly, under this project, we will concurrently implement existing quality management systems that CRCOG has previously utilized for submissions to the EPA under Title I of the Act where task-level deliverables will be subjected to required, regular reviews (e.g., quarterly) to ensure that technical, financial, and schedule requirements of this project are consistent with the EPA PO's and QAM's expectations for handling and producing deliverables that reflect high-quality environment data. This section discusses Elements C1 (assessments and response actions) and C2 (reporting) applicable to this project.

.

2.5. Assessments and Response Actions

The QA program includes periodic review of data files and draft deliverables. The essential steps in the QA program are as follows:

1. Identify and define the problem
2. Assign responsibility for investigating the problem
3. Investigate and determine the cause of the problem
4. Assign and accept responsibility for implementing appropriate corrective actions
5. Establish the effectiveness of and implement the corrective action
6. Verify that the corrective action has eliminated the problem.

The TL will provide day-to-day oversight of the quality system. Periodic project file reviews will be carried out by the QA Manager, at least once per year to verify that required records, documentation, and technical review information are maintained in the files. The QAM will ensure that problems found during the review are brought to the attention of the TL and PM when necessary. All issues will be corrected immediately, and documentation will be provided to the PM. All nonconforming data will be noted, and corrective measures to bring nonconforming data into conformance will be recorded.

The TLs and QA Manager are responsible for determining if the quality system established for the project is appropriate and functioning in a manner that ensures the integrity of all work products. All technical staff have roles and will participate in the corrective action process. Corrective actions for errors found during QC checks will be determined by the TL and, if necessary, with direction from the QA Manager or PM, as appropriate. The originator of the work will make the corrections and will note on the QC form that the errors were corrected. A reviewer or TL, not involved in the creation of the work, will review the corrections to ensure the errors were corrected. Any problems noted during audits will be reviewed and corrected by the QA Manager and discussed with the TL as needed. Depending on the severity of the deficiency, the TL may consult the QA Manager and stop work until the cited deficiency is resolved. Deficiencies identified and their resolution will be documented in monthly project reports, as applicable. The QA Manager and TL will comply and respond to all internal and EPA audits on the project, as needed. The QA Manager will produce a report outlining any corrective actions taken.

2.6. Reports to Management

The periodic quarterly progress reports (to the EPA PO) required in the grant agreement will be reviewed by the PM's manager Caitlin Palmer, Director of Regional Planning & Development and Pauline Yoder, Chief Operating Officer, CRCOG to ensure the project is meeting milestones and that the resources committed to the project are sufficient to meet project objectives. These periodic progress reports will describe the status of the project, accomplishments during the reporting period, activities

planned for the next period, and any special problems or events including any QA/QC issues. Reports to the EPA will be drafted by the PM and distributed accordingly to all relevant staff.

Any QC issues impacting the quality of a deliverable, the project budget, or schedule will be identified and promptly discussed with the assigned TL and the PM or QAM as appropriate. All significant findings will be included in monthly reports with the methods used to resolve the specific QC issue or the recommendations for resolution for consideration by the EPA's PO or designee.

Data Validation and Usability (Group D)

2.7. Data Review, Verification, Validation

All work conducted under this project will be subject to technical and editorial review. When existing data for the same GHG-emitting activity are available from multiple sources, the background information documents will be reviewed for all sources to determine the dataset that is the most representative of local operations. Additionally, the inventory report will include the vintage of the existing data resource and preference will be given to the most recent dataset that is representative of similar GHG-emitting local activities. Reviews will be conducted by the assigned QAM who is a person not directly involved in the production of the deliverable at UMass. The term "validation" refers to whether the data meet the QAPP-defined user requirements while the term "verification" refers to whether conclusions can be correctly drawn from the data. The quality of data used and generated for the project will be reviewed and verified at multiple levels by the project team at UMass CRM prior to submission to the CRCOG PM or DPM. This review will be conducted by the TL with specific, applicable expertise. All original and modified data files will be reviewed for input, handling, and calculation errors. Additionally, all units of measure will be checked for consistency. Any potential issues identified through this review process will be evaluated and, if necessary, data will be corrected, and analysis will be revised as necessary, using corrected data. These corrections will be documented in project records. These measures of data quality will be used to judge whether the data are acceptable for their intended use. In cases where available data do not or may not meet data quality acceptance criteria, the TL will document these findings in the inventory along with corrective actions or use of alternative data sources.

2.8. Verification and Validation Methods

As a standard operating procedure, all data (retrieved and generated) will be verified and validated through a review of data files by the TL. A checklist of QC activities for deliverables under this project is provided as **Appendix A**. Forms for documenting QC activities and review of deliverables are included in **Appendix B**. Documentation of calculations will be included in spreadsheet work products and in supporting memoranda, as appropriate.

The TL is responsible for day-to-day technical activities of tasks, including planning, data gathering, documentation, reporting, and controlling technical and financial resources. The TL is the primary person responsible for quality of work on tasks under this project and will approve all-related plans and reports. These reports will be transmitted by the TL to the QAM for review and final approval will be conducted by the CRCOG PM.

Source data will be verified and validated through a review of data files by the technical staff, and ultimately the TL. Reviews of analyses will include a thorough evaluation of content and calculated

values. All original and modified data files will be reviewed for input, handling, and calculation errors. Additionally, all measurement units will be checked for consistency. Any potential issues identified through this review process will be evaluated, errors corrected, and analysis repeated using the corrected data. All corrections will be documented in project records.

Source data will be verified and validated through a review of data files by the technical staff, and ultimately the TL. Typical data verification reviews can include checks of the following:

- Data sources are clearly documented,
- Calculations are appropriately documented,
- All relevant assumptions are clearly documented,
- Conclusions are relevant and supported by results,
- Text is well-written and easy to understand.

The documented review process will be stored with deliverables for the project. For the narrative describing the methodologies used for the inventory, all comments on drafts will be clearly and concisely summarized including a description of how substantive issues raised by commenters were resolved.

As discussed in Section 1.7, QC objectives include verification that data in database tables are stored and transferred correctly, algorithms call data correctly, units are internally consistent, and reports pull the required data. These data management issues will be addressed as part of the QC checks of data acquisition and document preparation.

For this project, it is not anticipated that any special data validation software will be required. However, where calculations are required to assess the data/datasets, calculations will be performed using computer spreadsheets (like Excel spreadsheets with predefined functions, or formulas) and calculators to reduce typographical or translation errors. General software available through the Microsoft Suite including Excel, PowerPoint, Access, and Word will be sufficient to perform the work as described in Section 1.6 for this project. If additional software is required by relevant staff, including UMass CRM, purchase will be based on approval from PM.

2.9. Reconciliation with User Requirements

All data (retrieved and generated) and deliverables in this project will be analyzed and reconciled with project data quality requirements. To ensure deliverables meet user requirements, the TL will review all data and deliverables throughout the project to ensure that the data, methodologies, and tools used meet data quality objectives, are clearly conveyed, and represent sound and established science. The TL will regularly report the status of this review the CRCOG PM.

CRCOG will review each project with the EPA at the planning stage to ensure the approach is fundamentally sound and will meet the project objectives. The TL will evaluate data continuously during the life term of the project to ensure they are of sufficient quality and quantity to meet the project goals. Prior to submission of draft and final products, the TL will make a final assessment to determine if the objectives have been fulfilled in a technically sound manner. This final assessment will be presented to the PM and final approval will be issued after that final review. If applicable, assumptions made in preparing project analyses will be clearly specified in the inventory.

As discussed in Section 1.7.1, uncertainty can be evaluated using a few different approaches. The most useful uncertainty analysis is quantitative and is based on statistical characteristics of the data such as the variance and bias of estimates. In a sensitivity analysis, the effect of a single variable on the resulting emissions estimate generated by a model (or calculation) is evaluated by varying its value while holding all other variables constant. Sensitivity analyses will help focus on the data that have the greatest impact on the output data. Additional statistical tests may be utilized depending on the need for more or less rigorous tools and on the specific inventory activity being evaluated.

.

3. References

EPA, Chief Information Officer's Policy Directive on Information Technology / Information Management available at EPA IT/IM Directive: Environmental Information Quality Policy, Directive # CIO 2105.3

EPA, *Chief Information Officer's Policy Directive on Information Technology / Information Management: Quality Assurance Project Plan (QAPP) Standard*, Directive # CIO 2105-S-02.0. Available at https://www.epa.gov/irmpoli8/quality-assurance-project-plan-qapp-standard. Accessed on 7/24/2023.

EPA, EPA-454/B-17-001, *Quality Assurance Handbook for Air Pollution Measurement Systems, Ambient Air Quality Monitoring Program, Volume II*. Available at https://www3.epa.gov/ttnamti1/files/ambient/pm25/qa/Final%20Handbook%20Document%201 17.pdf. Accessed on 6/23/2023.

EPA, Fact Sheet: Areas where differences between state GHG inventories and the EPA's Inventory of U.S. GHG Emissions and Sinks by State: 1990-2020 estimates may occur. Available at https://www.epa.gov/system/files/documents/2022-03/fact-sheet-differences-epa-and-offical-state-ghgi.pdf. Accessed on 6/23/2023.

EPA, US GHG Inventory by State. Available at https://www.epa.gov/ghgemissions/state-ghg-emissions-and-removals. Accessed on 6/23/2023.

EPA, GHG Reporting Program Facility-level Local Information. Available at https://ghgdata.epa.gov/ghgp/main.do. Accessed on 7/18/2023.

EPA, Data reported to EPA's Greenhouse Gas Reporting Program (GHGRP) at https://www.epa.gov/ghgreporting/data-sets

EPA, National Inventory at https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2021

EPA, Publications, Tools, and Data for State, Local, and Tribal Governments at https://www.epa.gov/statelocalenergy/publications-tools-and-data-state-local-and-tribal-governments. Accessed on 7/27/2023.

EPA, Fuel heating values and CO2 emission factors at eCFR :: 40 CFR Part 98 -- Mandatory Greenhouse Gas Reporting

EPA, Global warming potentials at https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-98/subpart-A?toc=1

USDA, Forest Service at https://www.fs.usda.gov/research/treesearch/62418

US DOT, Federal Highway Administration Transportation Statistics at https://www.fhwa.dot.gov/policyinformation/statistics/2021/vm1.cfm

Appendix A: Example Check Lists of Quality Control Activities for Deliverables

Tasks and Deliverables	Quality Control Procedures
Task 1. Mobile Combustion (Transportation)	
Local inventory of GHG emissions from mobile sources with documentation of the following QC activities: (1) narrative report describing data sources and QC measures for data acquisition steps, (2) description of methodology and QC measures for validated proper implementation of methodology, and (3) documentation of QAPP implementation. (4) listing of emissions reductions options are present with documentation of rationale for each option.	1. Comparison of local estimate of average miles travelled per year and average miles per gallon (by vehicle type) versus state and national averages.

Vehicle Type	Local Avg Miles/yr	QC Avg Miles/yr	MPY Statistics*	Local Avg Miles/gal	QC Avg Miles/gal	MPG Statistics
Passenger Car (Gasoline)			Signed Bias ±X.XX% Variance Y.YY%		24.1	Signed Bias ±X.XX% Variance Y.YY%
Passenger Truck (Gasoline)					18.5	
Heavy-duty (Gasoline)					10.1	
Motorcycle (Gasoline)					50	
Passenger Car (Diesel)					32.4	
Passenger Truck (Diesel)					22.1	
Heavy-duty (Diesel)					13.0	

* Precision and bias calculations will be in accordance with the EPA's Data Assessment Statistical Calculator (DASC) Tool available at https://www.epa.gov/sites/default/files/2020-10/dasc_11_3_17.xls with the community's estimate taken as the measured value and the LGGIT value taken as the audit value.

2. For any values used in local inventory that differ from the state average MPY or the national average MPG by more than <+/- 5>%, the community will provide an explanation of why local factors may differ from state or national averages.

3. Ensure the GWPs used for the local estimate and the LGGIT estimate are on the same basis. The LGGIT tool uses AR5 GWP (e.g., methane GWP = 28).

4. Review by TL or senior technical reviewer—analytical methods / results are explained clearly, technical terms are defined, conclusions are reasonable based on information presented, and level of technical detail is appropriate.

5. Editor review—verify or remediate draft deliverables to ensure clear, error-free writing.

Tasks and Deliverables	**Quality Control Procedures**

Task 2. Electric Power Consumption

Local inventory of GHG emissions from electric power consumption with documentation of the following QC activities:

(1) narrative report describing data sources and QC measures for data acquisition steps,

(2) description of methodology and QC measures for validated proper implementation of methodology, and

(3) documentation of QAPP implementation.

(4) listing of emissions reductions options are present with documentation of rationale for each option.

1. Compare (a) the local estimate in inventory *versus* (b) data from SLOPE[8], state averages, or other data resources available from DOE such as Form EIA 861 data. Use a table similar to the table below to assess precision and bias of the local estimates versus estimates derived from SLOPE, state averages, or representative EIA 861 data, if available:

Power Consuming Sector	Initial Local Estimate (Metric Tons CO_2e)	QC Estimate based on SLOPE Data Viewer: Net Electricity and Natural Gas Consumption (Metric Tons CO_2e)	Statistics*
Residential			Signed Bias ±X.XX%
Commercial			
Industrial			
Transportation			Variance Y.YY%
Other			

* Precision and bias calculations will be in accordance with the EPA's Data Assessment Statistical Calculator (DASC) Tool available at https://www.epa.gov/sites/default/files/2020-10/dasc_11_3_17.xls with the community's estimate taken as the measured value and the SIT value taken as the audit value.

2. SLOPE data are provided in million British thermal units (MMBtu's) of electricity usage, EIA 861 usage data are provided in megawatt-hours (MWh), but the LGGIT inputs for electricity usage must be in kilowatt-hours (kWh). When comparing any two datasets, ensure that the units of measure are converted to a consistent basis prior to making the comparison.

3. Ensure the GWPs used for the local estimate and the independent estimate are on the same basis.

4. Technical review of methods, calculations, and underlying datasets—data are appropriate for intended use, data are complete and representative and current, data sources documented, analytical methods are appropriate, and calculations are accurate.

5. Review by TL or senior technical reviewer—analytical methods and results are explained clearly, technical terms are defined, conclusions are reasonable based on information presented, and level of technical detail is appropriate)

6. Editor review—writing is clear, free of grammatical and typographical errors.

[8] National Renewable Energy Laboratory. "[Data Set Title (e.g., Battery Storage Capital Costs)]," *State and Local Planning for Energy*, accessed 7/22/2023, https://maps.nrel.gov/slope.

Tasks and Deliverables	Quality Control Procedures
Task 3. Solid Waste (Landfills)	
Local inventory of GHG emissions from landfills with documentation of the following QC activities: (1) narrative report describing data sources and QC measures for data acquisition steps, (2) description of methodology and QC measures for validated proper implementation of methodology, and (3) documentation of QAPP implementation. (4) listing of emissions reductions options are present with documentation of rationale for each option.	1. Comparison of (a) independent local inventory *versus* (b) landfill data from FLIGHT. Use a table similar to the table below to assess precision and bias of the local inventory versus QC estimates: Solid Waste (Landfills) / Initial Local Estimate (Metric Tons CO_2e) / FLIGHT Data (Metric Tons CO_2e) / Statistics* for Area Comparisons North Elm Landfill East Hill Landfill Landfill No. 1 (closed) … Signed Bias ±X.XX% Variance Y.YY% * Precision and bias calculations will be in accordance with the EPA's Data Assessment Statistical Calculator (DASC) Tool available at https://www.epa.gov/sites/default/files/2020-10/dasc_11_3_17.xls with the community's estimate taken as the measured value and the SIT value taken as the audit value. 2. When comparing any two datasets, ensure that the units of measure are converted to a consistent basis prior to making the comparison. 3. Ensure the GWPs used for the local estimate and independent estimate are on the same basis. 4. Ensure data are appropriate for intended use, data are complete and representative and current, data sources are documented, analytical methods are appropriate, and calculations are accurate. Include any QC findings and reconciliation. 5. Review by TL or senior technical reviewer—analytical methods and results are explained clearly, technical terms are defined, conclusions are reasonable based on information presented, and level of technical detail is appropriate) 6. Editor review—writing is clear, free of grammatical and typing errors.

Tasks and Deliverables	Quality Control Procedures
Task 4. GHG Emissions for Other Sources	
Local inventory of GHG emissions from the community's other sources with documentation of the following QC activities: (1) narrative report describing data sources and QC measures for data acquisition steps, (2) description of methodology and QC measures for validated proper implementation of methodology, and (3) documentation of QAPP implementation. (4) listing of emissions reductions options are present with documentation of rationale for each option.	1. Comparison of (a) local emissions estimates in inventory *versus* (b) available federal or state estimates for the same source categories (e.g. SLOPE, FLIGHT, etc.). 2. For any values used in local inventory that are inconsistent with federal or state values, the table below will be utilized to assess precision and bias of the local inventory versus the federal or state estimates: 3. When comparing any two datasets, ensure that the units of measure are converted to a consistent basis prior to making the comparison. 4. Ensure the GWPs used for the local estimate and independent estimate are on the same basis. 5. Technical review of methods, calculations, and underlying datasets—data are appropriate for intended use, data are complete and representative and current, data sources documented, analytical methods are appropriate, and calculations are accurate. 6. Review by TL or senior technical reviewer—analytical methods and results are explained clearly, technical terms are defined, conclusions are reasonable based on information presented, and level of detail appropriate. 7. Editor review: writing is clear, free of grammatical and typographical errors.

Other Sectors	Initial Local Estimate (Metric Tons CO_2e)	QC Estimate (Metric Tons CO_2e)	Statistics*
Stationary combustion			Signed Bias ±X.XX% Variance Y.YY%
Agriculture & land management			
Waste generation			
Water			
Wastewater treatment			
Other			

* Precision and bias calculations will be in accordance with the EPA's Data Assessment Statistical Calculator (DASC) Tool available at https://www.epa.gov/sites/default/files/2020-10/dasc_11_3_17.xls with the community's estimate taken as the measured value and the SIT value taken as the audit value.

Appendix B: Example QC Documentation Form

CRCOG
Documentation of QA Review and Approval of Electronic Deliverables

Approvals on this form verify that all technical and editorial reviews have been completed and the deliverable meets the criteria for scientific defensibility, technical and editorial accuracy, and presentation clarify as outlined in the Quality Assurance (QA) Project Plan, QA Narrative, Quality Management Plan, and/or according to direction from the EPA PO.

Client:	EPA Region 1
Grant Number:	00A01411
EPA Project Officer:	Laura Berman
Project Name:	Hartford-East Hartford-Middletown MSA CPRG Program
Grantee Org.	Capitol Region Council of Governments (CRCOG)
Project Manager:	Kyle Shiel, CRCOG

QA Form Details

Item Number	File Name	Deliverable Description	Date Sent to Client	Deliverable		Document Originator	QA Review Information				QA Review Information			
	(Copy the name of the file reviewed)			(Draft)	(Final)		(ReviewType)	(ReviewerName)	(Date Review was Performed)		(Have all Findings Been Resolved?)	(Originator Signature)	(Reviewer Signature)	(File Location)
01				☐	☐		***Technical***				☐ Yes			
02				☐	☐		***Technical***				☐ Yes			
03				☐	☐		***Technical***				☐ Yes			
04				☐	☐		***Technical***				☐ Yes			
05				☐	☐		***Technical***				☐ Yes			
06				☐	☐		***Technical***				☐ Yes			

`

Appendix C: Compliance with Requirements Under the Privacy Act of 1974

Important Note about Personally Identifiable Information (PII)

The Privacy Act of 1974 (5 U.S.C. § 552a) mandates how federal agencies maintain records about individuals. Per OMB Circular A-130, Personally Identifiable Information (PII) is "information that can be used to distinguish or trace an individual's identity, either alone or when combined with other information that is linked or linkable to a specific individual."

EPA systems/applications that collect PII must comply with EPA's Privacy Policy and procedures to guard against unauthorized disclosure or misuse of PII in all forms. For more information click here. If PII are collected, then the QAPP will describe how the PII are managed and controlled.

Personally identifiable information (PII):

Please verify one of the following two options by checking the corresponding box:

1. This project **will not** collect Personally Identifiable Information (PII) ☒:
2. This project **will** collect Personally Identifiable Information (PII): ☐

This QAPP will comply with 5 U.S.C. § 552a and EPA's Privacy Policy.

Past Plans that May Inform the PCAP: Our PCAP will complement several Connecticut studies and strategies that have been completed and identified by CTDEEP. CRCOG, coordinating entities, and our selected consultant will review these documents as part of the initial PCAP research and for consideration in the QAPP. CRCOG and our Coordinating Entities have also identified regional and local plans that should also be reviewed to inform the Bridgeport-Stamford MSA PCAP. These include:

Study Plan/Title	Geography	Description	Issue Date
Clean Freight Corridors Study (NYMTC)	MAP Forum – CT, NJ, NY & PA	Identified roadways to advance high-efficiency, low-emission alternative technologies for the freight transportation mode.	April 2022
2030 VMT Goals and Strategies (CTDOT)	Connecticut	A strategy and plan of investments to achieve the state's Vehicle Miles Traveled [VMT] reduction target.	2023
Metropolitan Transportation Plan 2023-2050 (CRCOG)	Capitol Region	A federal requirement, the MTPs identify opportunities to improve regional mobility, and will guide development of a transportation system that is not only accessible, safe, and reliable, but also contributes to the economy and to a high quality of life.	March 2023 (draft)
Metropolitan Transportation Plan 2023-2050 (RiverCOG)	RiverCOG		March 2023 (draft)
1991-2021 Connecticut Greenhouse Gas Emissions Inventory (CT DEEP)	Connecticut	The Department of Energy and Environmental Protection (DEEP) provides a report card on 30 years of GHG emissions in the state, from 1990 to 2020, and tracks progress toward the state's statutory GHG emission-reduction targets.	April 2023
Governor's Council on Climate Change (GC3) Phase 1 Report	Connecticut	Monitor and report on the state's implementation of the greenhouse gas emissions (GHG) reduction strategies set forth in the previous Governor's Council on Climate Change	January 2021
Electric Vehicle Roadmap for Connecticut (2020)	Connecticut	A comprehensive strategy for accelerating the deployment of electric vehicles (EVs) through policies and regulatory tools	2020
Short Term Disposal Solutions & Waste Diversion Continuous Improvement Study	CRCOG	A study to explore regional and improved efficiency in waste management for municipalities.	February 2023

Study Plan/Title	Geography	Description	Issue Date
(CRCOG)			
City of Hartford Climate Action Plan	City of Hartford	This Climate Action Plan provides a starting point for our collective action by presenting a roadmap for Hartford to become a global leader in environmental stewardship. It will help us stop harming our planet and start adapting to changes already occurring, so that we can shape a more healthy, vibrant, and resilient city.	September 2017
CRCOG Plan of Conservation & Development	CRCOG	The Capitol Region Plan of Conservation and Development: Vibrant. Green. Connected. Competitive. is a general guide for the future conservation and development of the greater Hartford area.	May 2014
RiverCOG Plan of Conservation & Development	RiverCOG	The Regional Plan of Conservation and Development (RPOCD) is a visionary land use plan intended to identify and address issues of regional concern; making recommendations for cooperative, voluntary action.	2021
Comprehensive Economic Development Strategy (RiverCOG)	RiverCOG	A Comprehensive Economic Development Strategy for CRCOG and RiverCOG and includes climate mitigation targets for energy supplies, transportation, and city design.	April 2023
Comprehensive Economic Development Strategy (CRCOG)	CRCOG		September 2023
Hazard Mitigation Plan (RiverCOG)	RiverCOG	An HMP identifies natural hazards (including climate change) that impact the region as well as municipal strategies to mitigate these impacts.	August 2021
Hazard Mitigation Plan (CROG)	CRCOG		August 2019

APPENDIX G

Emissions Inventory Assumptions and Methodology

Tracking Emissions for Regional Climate Action

Report

Prepared By:

Peiyao Zhao
Graduate Research Assistant

Jimi Oke, Assistant Professor
Principal Investigator

University of Massachusetts Amherst
130 Natural Resources Road, Amherst, MA 01003

Acknowledgments

Disclaimer

The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein.

Table of Contents

List of Tables

List of Figures

List of Acronyms

Acronym	Expansion
VMT	Vehicle Miles Travelled
MPG	Miles per Gallon
EIA	Energy Information Administration
EPA	Environmental Protection Agency
FHWA	Federal Highway Administration
GHG	Greenhouse Gases
EFs	Emissions Factors
LGGIT	Local Government Greenhouse Gas Inventory Tool
FLIGHT	Facility Level Information on GreenHouse gases Tool
GHGRP	Greenhouse Gas Reporting Program
MSA	Metropolitan Statistical Area
DEEP	Department of Energy & Environmental Protection
ACS	American Community Survey
USDA	United States Department of Agriculture
NPDES	National Pollutant Discharge Elimination System
CTDOT	Connecticut Department of Transportation
DOT	U.S. Department of Transportation

Introduction

1.1 Research questions and objectives

Connecticut has been a pioneer in addressing global warming and climate change through its extensive effort in greenhouse gas tracking and reduction spanning two decades. According to the latest Greenhouse Gas Emissions Inventory report from the Department of Energy & Environmental Protection, the key sectors that contribute to the GHG emissions are transportation, electric power, waste, stationary combustion, agriculture. The transportation sector, also referred to as "mobile combustion", was the largest emitter over the past 30 years, contributing to 40% of the total emissions in 2019. Following closely is the stationary combustion (residential, commercial, and industrial), accounting for 40% of total emissions, while electric power sector witnessed a decline due to the expansion of nuclear energy. Emissions from agricultural and waste sector play a relatively smaller role. Lastly, 60% land in this state comprises forest land which serves as a large carbon dioxide sequestration reservoir. According to the statistics, forests can absorb between 4-40 tons of carbon dioxide per year per hectare. The goal of this study is to estimate GHG emissions in Connecticut from a regional and local level and to show the emissions breakdown and trajectory forecasting, which is important to for identifying factors that more relevant to emissions in each sector and proposing mitigation strategies to reduce the emissions.

Data and Methodology

1.2 Study area

The inventory is prepared for three metropolitan statistical areas (MSAs) in Connecticut, namely New Haven-Milford (New Haven area), Hartford-east Hartford-Middletown (Hartford area), and Bridgeport-Stamford-Norwalk (Bridgeport area). Connecticut is in the northeast part of the United States, with a total population of 3,611,317 and total housing units of 1,531,332 in 2022. Figure 1 displays a heat map illustrating the population distribution of each town in this state. The black lines delineate the boundaries of each MSA. The Bridgeport area is situated in the southwestern part of Connecticut. It encompasses cities such as Bridgeport, Stamford, and Norwalk, and is positioned along the Long Island Sound coastline. The Hartford area is in the central and central-northern part. It includes cities such as Hartford, East Hartford, and Middletown, situated within the broader region of central Connecticut. The New Haven area, situated in the south-central part of Connecticut, is the last but certainly not the least. This region includes the city of New Haven and surrounding areas, and the south of it is also positioned along the Long Island Sound. The New Haven area is known for its cultural and educational institutions, including Yale University, and it serves as an important economic and cultural hub in the state. The table below lists the total population, total housing units, and the average income of the three areas and Connecticut state.

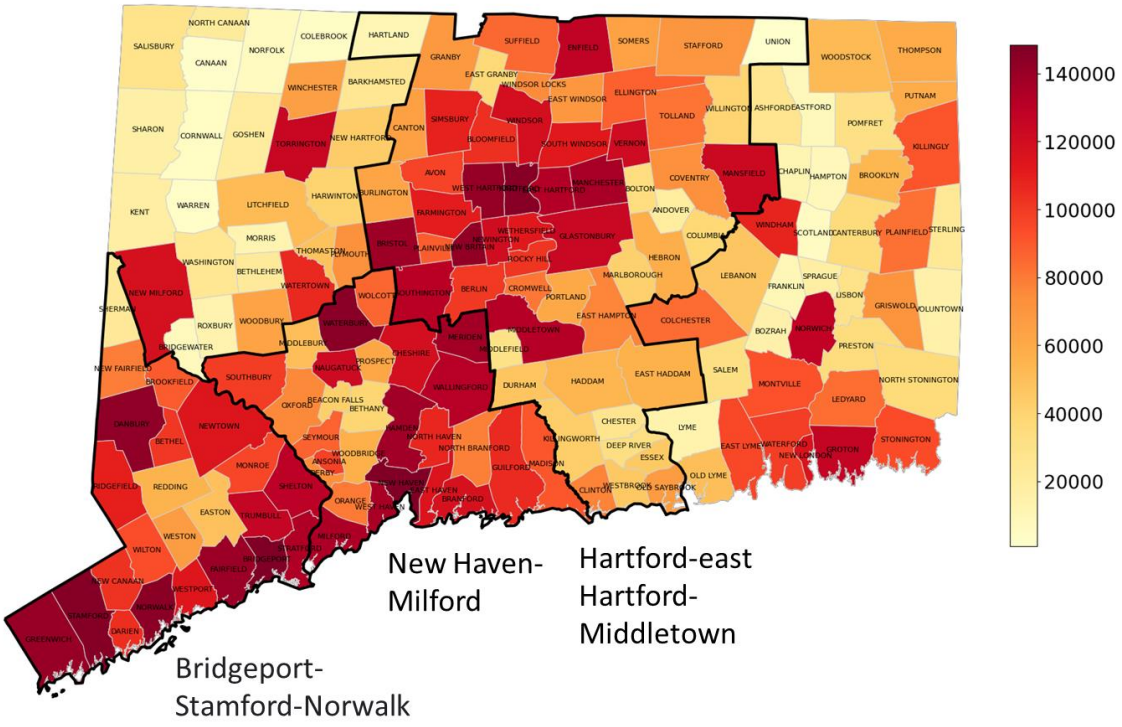


Figure 1. Connecticut town population heat map

Table 1. Comparison of the geographical information of the three MSAs in 2022.

MSA	Total population	Total housing units	Median household income (dollars)
Bridgeport Area	958,371	378,045	107,351
Hartford Area	1,215,703	521,773	89,371
New Haven Area	866,377	371,281	81,544
Statewide	3,611,317	1,531,332	90,213

1.3 Data collection

We have five tasks (covering 7 sectors) listed on the QAPP and table 2 shows all the activity data and data sources for GHG calculation in each sector.

Table 2. Emissions sectors and data sources

Sector	Activity data	Source
1. Mobile Combustion	Vehicle miles travelled	Requested from CTDOT
	Statewide vehicle type distribution	FHWA, DOT

	Vehicle fuel efficiency	LGGIT Mobile Combustion Section
2. Electric Power Consumption	Electricity consumption	Energize CT
3. Solid Waste (Landfills)	Landfill methane emissions	FLIGHT
	Fuel combustion	FLIGHT
4. Stationary combustion	Household heating fuels consumption	EIA
	Household heating fuels type	ACS
	OSMnx package for commercial building footprint	OSMnx
	Statewide commercial emissions	DEEP
	Large industrial facility emissions	FLIGHT
5. Agriculture & land management	Area of land using certain type of fertilizer	USDA
	Nitrogen content and lose in each type of fertilizer	LGGIT
	Statewide agricultural emissions data	DEEP
6. Wastewater treatment	Number of wastewater treatment facilities	Connecticut NPDES Permits
	Statewide wastewater emissions data	DEEP
7. Urban forestry	Forestry area	2015 Land Cover Number and Charts (University of Connecticu**t)**
	Carbon sequestration factor	LGGIT

1.4 Calculation methods

In this study, several different methods were adopted to estimate the emissions: some based on activity data and emissions factors while others scaled down the statewide emissions based on the proportion of some metrics (e.g. Fertilizer-treated land area, number of wastewater treatment facilities).

1.4.1 Task 1. Mobile combustion

Mobile combustion emissions were calculated by the activity data (VMT) of each vehicle type, the number of each vehicle type, and MPG of each vehicle type, and EFs. Table 3 shows the VMT data at each MSA and Table 4 shows the statewide vehicle (automobiles, trucks, buses, motorcycle) distribution. We computed the mobile combustion by the following assumptions:

1. All the automobiles are passenger cars, trucks are light trucks, buses are heavy duty.
2. Automobiles and motorcycles consume gasoline, trucks and buses consume diesel.

We used VMT and MPG to compute the fuel consumption and applied the fuel specific EFs to calculate the CO_2 emissions E_{CO_2} as follows:

$$E_{CO_2} = \frac{VMT}{MPG} \times \frac{f_{CO_2}}{1000}$$

where

- VMT: vehicle miles travelled, [Miles]
- f_{CO_2}:emissions factor for carbon dioxide, [kg CO_2/gallon]
- MPG :Miles per gallon

We computed the CH_4 and N_2O emissions by VMT and vehicle specific EFs from the following equations:

$$E_{CH_4} = VMT \times \frac{f_{CH_4}}{1\times10^6}$$

$$E_{N_2O} = VMT \times \frac{f_{N_2O}}{1\times10^6}$$

- f_{CH_4} and f_{N_2O}: EFs for CH_4 and N_2O, [g/mile]

After computing the emissions of each greenhouse gases, we converted the CH_4 and N_2O emissions into carbon dioxide equivalent according to the global warming potential (GWP) for CH_4, and N_2O[1], which were 25 and 298, respectively:

$$E_{total} = E_{CO_2} \times 1 + E_{CH_4} \times 25 + E_{N_2O} \times 298$$

Table 3. Vehicle miles travelled at each county and MSA.

MSA	County	VMT (billion miles)
Bridgeport area	Fairfield	7.1
Hartford area	Hartford	7.3
	Middlesex	1.8
	Tolland	1.3
New Haven area	New Haven	6.9

Table 4. Statewide vehicle type distribution.

Types	Vehicle Total	Proportion of total (%)
Automobiles	1,119,278	40.6
Trucks	1,543,765	56.0
Buses	10,222	0.4
Motorcycle	83,220	3.0

The fuel specific and vehicle specific EFs are obtained from the sheet "Factors – FormulaText" of the LGGIT.

1.4.2 Task 2. Electric power consumption

The GHG emissions from electric power consumption are calculated via the electricity consumption at residential and industrial/commercial sectors and regional EFs for CO_2, CH_4 and N_2O obtained from LGGIT. Table 5 shows the electricity consumption in residential and commercial/industrial obtained from Energize CT website. The following equation describes the calculation details:

$$E_g = \frac{e \times f_{e,g}}{2{,}204.62}$$

$$E_{total} = E_{CO_2} \times 1 + E_{CH_4} \times 25 + E_{N_2O} \times 298$$

- e: amount of electricity consumed, [MWh]
- $f_{e,g}$: emissions factors for the greenhouse gas in eGRID, [lbs /MWh]
- g $\in$ {CO2, CH4, N2O}

Table 5. Electricity consumption (TWh) in each subsector at each MSA.

Subsector	New Haven	Hartford	Bridgeport	Statewide
Residential	2.48	3.55	3.38	11.33
Commercial/Industrial	2.85	3.71	3.39	13.04
Total	5.33	7.26	6.78	24.37

1.4.3 Task 3. Solid waste (Landfills)

The GHG emissions in Landfills are obtained from FLIGHT website, which include the emissions from landfills methane release and fuel combustions. There are no active landfills that accept municipal solid waste; however, methane is emitted from the existing trash. There are two municipal waste landfills in this state reporting GHG emissions to GHGRP and both are in the Hartford area. No landfills report GHG emissions to the GHGRP in New Haven and Bridgeport area. One of them is Manchester landfill, whose emissions include stationary fuel combustion emissions and methane generation. Another one is Windsor Bloomfield landfill, whose emissions only include methane generation. Table 6 shows the total GHG emissions from the landfills in the Hartford area over the past seven years.

Table 6. Greenhouse gas emissions from landfills in Hartford area.

Year	GHG Emissions (MTCO2e)
2022	94,667
2021	88,101
2020	87,285

2019	108,171
2018	86,122
2017	91,993
2016	81,349

1.4.4 Task 4. Other sources

1.4.4.1 Stationary combustion

Stationary combustion includes emissions from equipment that provide heating and kinetic energy for residential, commercial, and industrial sectors through the combustion of fuels. In the residential sector, the detailed data collected mainly includes household fuel consumption distribution, the statewide fuel consumption, EFs for each fuel type (natural gas, propane, heating oil). To calculate the consumption of each heating fuel at each MSA, we employed the ratio of households utilizing a specific fuel type to the total number of households, and then applied this ratio to the statewide fuel consumption.

$$Q_{f,M} = \frac{H_{f,M}}{H_{f,S}} \times Q_{f,S}$$

- f: type of fuel consumed (natural gas, propane, heating oil)
- M: metropolitan statistical area
- S: statewide
- Q : amount of fuel consumed, [gallons]
- H : number of households using a certain type of fuels

Table 7 and table 8 show the number of households using a particular fuel and the amount of heating fuel consumed for residential heating at each MSA, respectively. After obtaining the fuel consumption at each MSA, we computed the emissions from EFs and the amount of fuel consumed, as detailed in the following equation:

$$E_g = \frac{Q_{fuel,MSA} \times f_{e,g}}{1000}$$

- $f_{e,g}$: emissions factors for the greenhouse gas of each heating fuel, [kg /gallons]
- g $\in$ {CO2, CH4, N2O}

The total emissions are summation of all the greenhouse gas:

$$E_{total} = E_{CO_2} \times 1 + E_{CH_4} \times 25 + E_{N_2O} \times 298$$

Table 7. Number of households using a particular fuel type at each MSA.

MSA	Natural gas	Propane	Fuel Oil
Bridgeport area	140,147	15,254	125,962

Hartford area	190,541	21,596	178,163
New Haven area	134,167	11,823	119,116
Statewide	495,646	64,356	551,817

Table 8. Total consumption of residential heating fuels at each MSA

MSA	Natural Gas (million cf)	Propane (million gal)	Fuel Oil (million gal)
Bridgeport area	10,434	13	79
Hartford area	14,185	18	112
New Haven area	9,989	10	75
Statewide	36,900	54.3	345.7

In the commercial sector, we computed the emissions by scaling down statewide commercial building emissions based on the proportion of the commercial building footprint at each MSA compared to the statewide total. We obtained the distribution of commercial building types at each MSA from a python package called OSMnx. The data is illustrated in Figure 2. The following equations show the detailed computation:

$$E = \frac{FP_M}{FP_S} \times E_s$$

- M: metropolitan statistical area
- S: statewide
- $E_{statewide}$: statewide greenhouse gas emissions, [MMTCO2e]
- FP: footprint of commercial building, [sq ft]

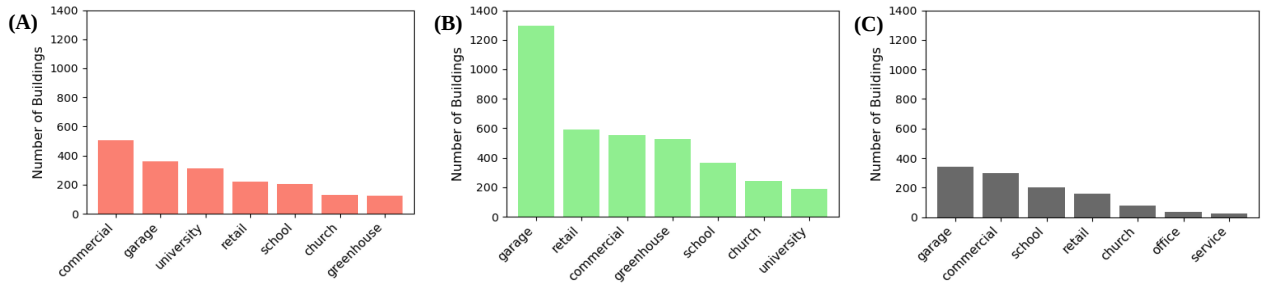


Figure 2. Distribution of commercial buildings at each MSA (top seven types).

In the industrial sector, we obtained the emissions directly from FLIGHT. Table 9 shows the emissions from large industrial facilities reported to GHGRP.

Table 9. Greenhouse gas emissions ($MMTCO_2e$) from large industrial facilities at each MSA

Subsector	Bridgeport Area	Hartford Area	New Haven Area
Petroleum & Natural Gas	0.05	0.16	0.14

Other	0.05	0.18	0.19
Pulp and Paper	0	0.02	0
Total emissions	0.1	0.36	0.33

1.4.4.2 Agricultural & land management

One of the main sources of NH_3 and N_2O emissions is the agricultural sector. We obtained the land area treated by different fertilizers (organic, manure, and synthetic), as illustrated in table 10, and the statewide agricultural emissions data and calculated the emissions based on the following assumptions:

1. The agricultural emissions at each MSA are directly correlated with the extent of land under fertilizer treatment.
2. Only fertilizer emissions are considered.

Firstly, we define the effectiveness (F_f) by the proportion of nitrogen loss in one type of fertilizer to the nitrogen loss in all types of fertilizer.

$$F_f = \frac{N_{c,f} \times N_{l,f}}{\sum_f N_{c,f} \times N_{l,f}}$$

- $N_{c,f}$: percent of Nitrogen in the fertilizer
- $N_{l,f}$: percent of nitrogen lost in due to volatilization in the fertilizer.
- f: {manure, organic, synthetic fertilizer}

Then, we computed the agricultural land emissions by downscaling the statewide emissions with percentage of effective land area (effectiveness times the land area) treated by fertilizer at each MSA.

$$E_M = \frac{\sum_f Q_{M,f} \times F_f}{\sum_f Q_{S,f} \times F_f} \times E_S$$

- M: metropolitan statistical area
- S: statewide
- Q : the area of land covered by a type of fertilizer, [acres]
- E_S: statewide agricultural land greenhouse gas emissions, [MMTCO2e]

Table 10. The area of land that is treated by different fertilizers at each MSA.

MSA	County	Manure fertilizer (acres)	Organic fertilizer (acres)	Synthetic fertilizer (acres)
Bridgeport Area	Fairfield	288	188	1,793
Hartford Area	Hartford	1,436	459	14,262
	Middlesex	949	79	2,314
	Tolland	5,882	54	4,921
New Haven Area	New Haven	1,125	173	3,764

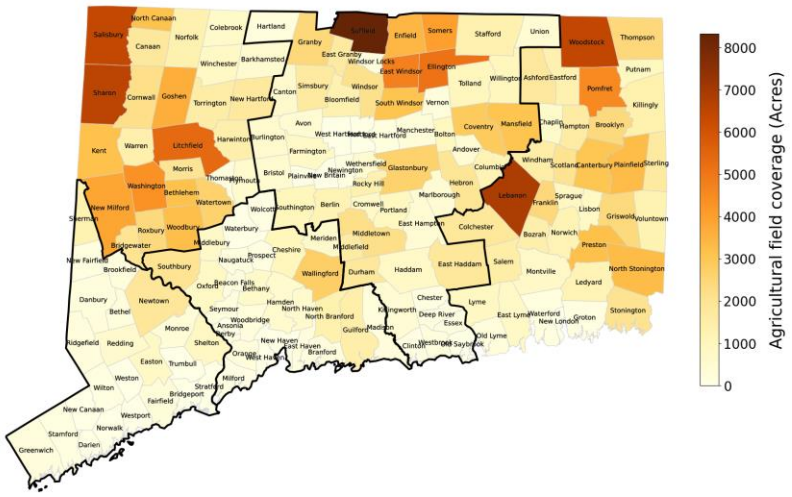


Figure 3. Agricultural land heat map.

1.4.4.3 Wastewater treatment

Wastewater treatment emissions are calculated by downscaling the statewide wastewater emissions with the proportion of facility at each MSA to the total state.

$$E_M = \frac{N_M}{N_S} \times E_S$$

- N: number of wastewater treatment facilities
- E_S: wastewater treatment GHG emissions, [MMTCO2e]
- M: metropolitan statistical area
- S: statewide

1.4.5 Task 5. Urban forestry

The Connecticut forests cover around 60% of the total land area and can sequester between 4-40 tons of carbon dioxide every year per hectare[2]. Figure 3 describes the forest land coverage at each MSA. Figure 4 depicts the heat map of forest land coverage in the entire Connecticut. The amount of carbon sequestrated is calculated by the following equation:

$$M_C = A_{forest,\,MSA} \times R_c \times C$$

- M_C : the amount of carbon dioxide sequestrated, [MTCO2]
- R_c: equals 2.23, carbon sequestration factor, [MTCO2 /hectare]
- $A_{forest,\,MSA}$: total area of the forest at each MSA, [hectare]
- C: equals 3.67, the ratio of carbon dioxide to carbon.

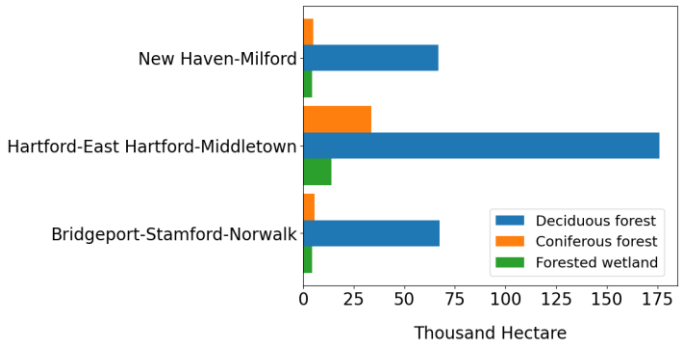


Figure 4. Forest land area/coverage at each MSA.

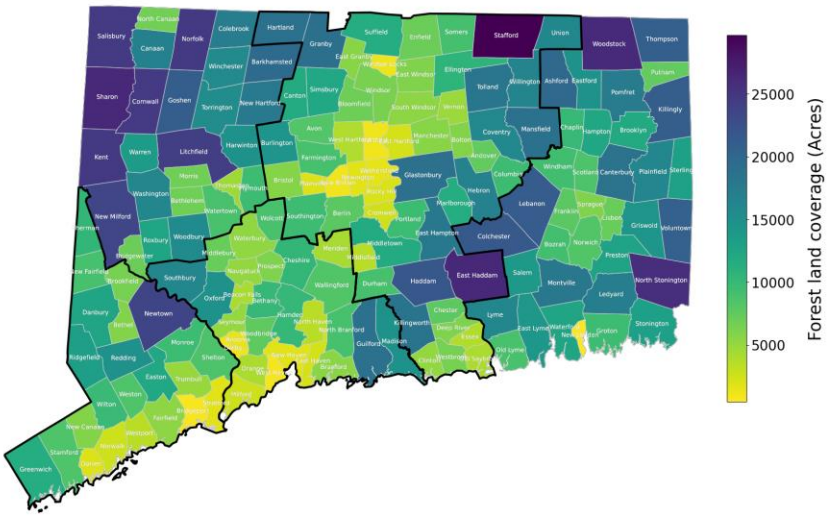


Figure 5. Forest land area/coverage statewide heat map.

Results and Discussion

Mobile emissions are highest in each MSA, constitute 52%, 47%, and 48% of total emissions in HEM, NHM, BSN, respectively, followed by stationary and electric power emissions. Emissions from solid waste, wastewater, and agricultural are nearly negligible.

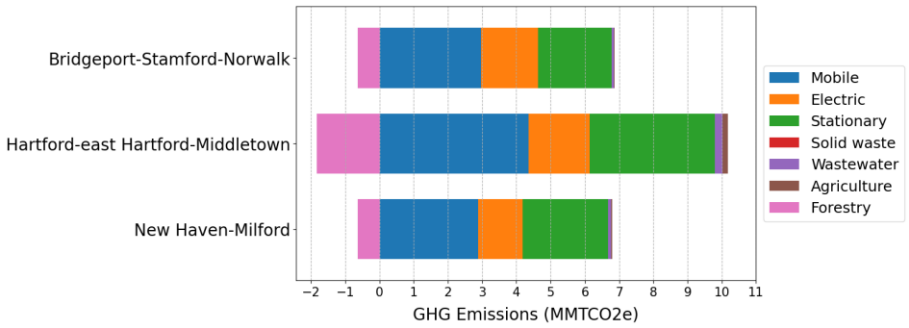


Figure 6. GHG emissions from each sector at each MSA.

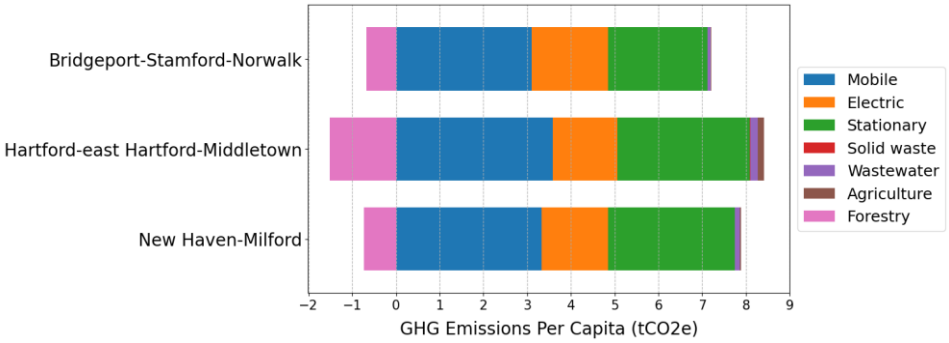


Figure 7. GHG emissions per capita from each sector at each MSA.

1.5 Mobile combustion emissions

Emissions from diesel vehicles are consistently greater than those from gasoline vehicles. According to Figure 6, diesel emissions are around 30% higher than gasoline emissions in all MSAs, which indicates that prioritizing electrification of diesel vehicles may yield greater emissions reductions. Figure 7 suggests that Emissions per capita are positively correlated with the VMT per capita.

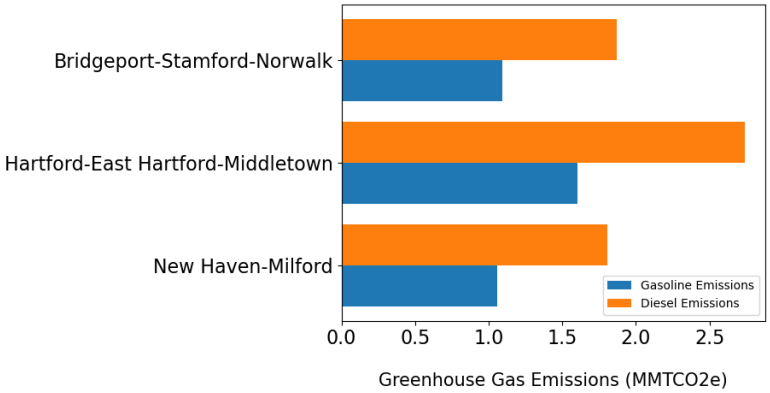


Figure 8. Emissions from diesel and gasoline-fueled vehicles.

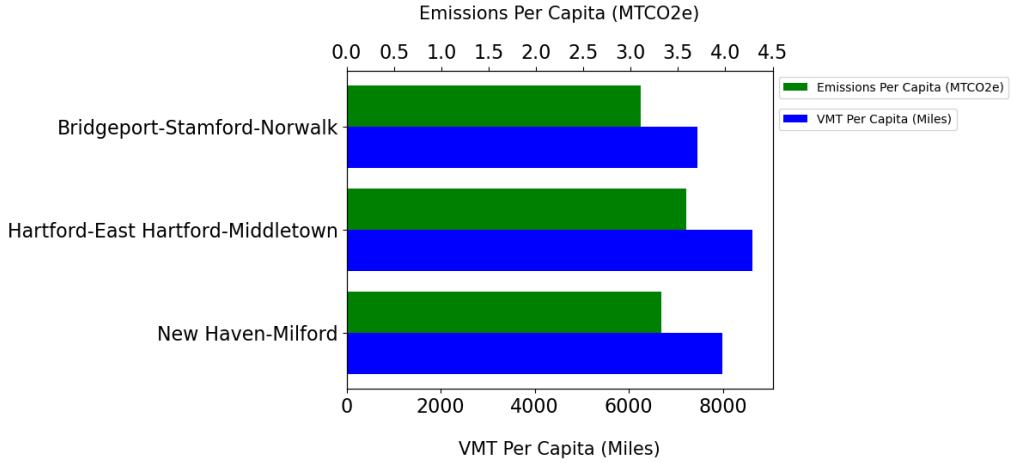


Figure 9. Emissions per capita and VMT per capita at each MSA.

1.6 Electric power consumption

Emissions from electricity consumption in the Hartford area is slightly higher than Bridgeport area and around 30% higher than New Haven area. Each MSA shares the same amount of emissions intensity. As for the emissions per capita, Bridgeport area BSN is the highest while New Haven and Hartford area are similar.

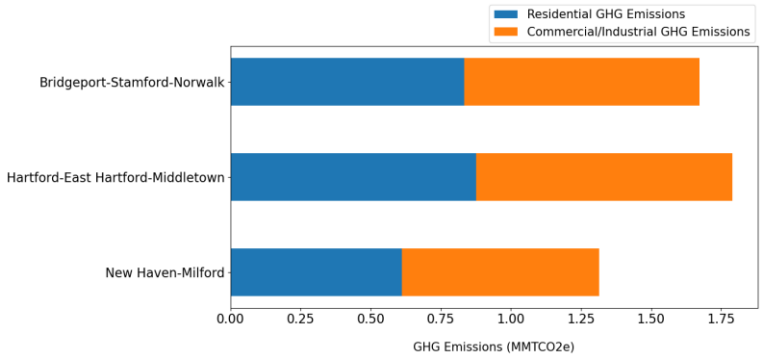


Figure 10. Electricity consumption emissions from different subsectors at each MSA

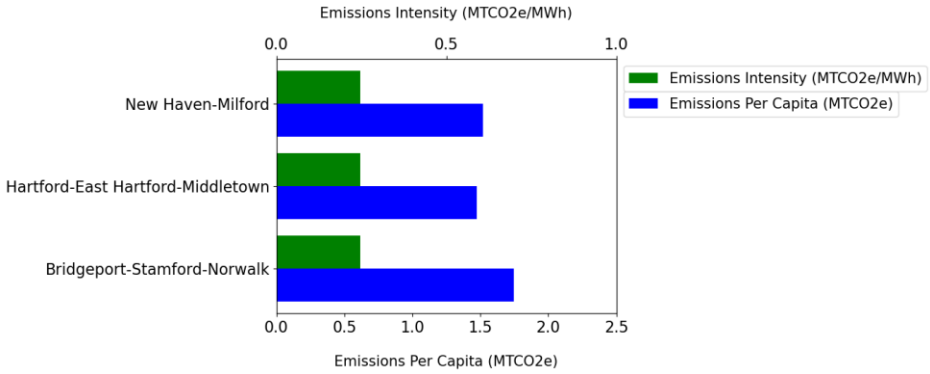


Figure 11. Emissions per capita and emissions intensity at each MSA.

1.7 Landfills and wastewater treatment

Landfills emissions data is provided in the Data and Methodology section. Figure 10 shows the wastewater emissions at each MSA, indicating emissions in Hartford area is 25% higher than the rest two MSAs combined.

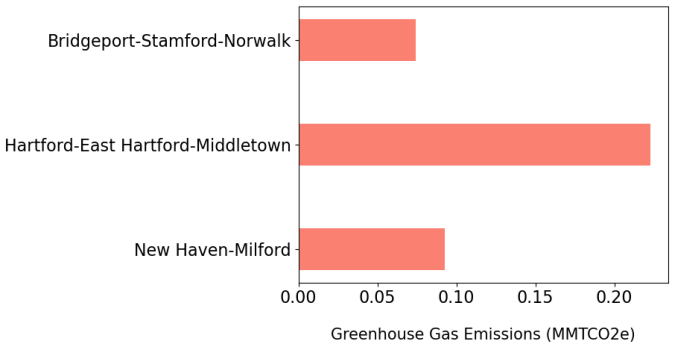


Figure 12. Emissions from wastewater treatment at each MSA.

1.8 Stationary combustion

1.8.1 Residential emissions

Among all the residential heating fuel sources, fuel oil is the largest emitter for residential heating, followed by natural gas and propane.

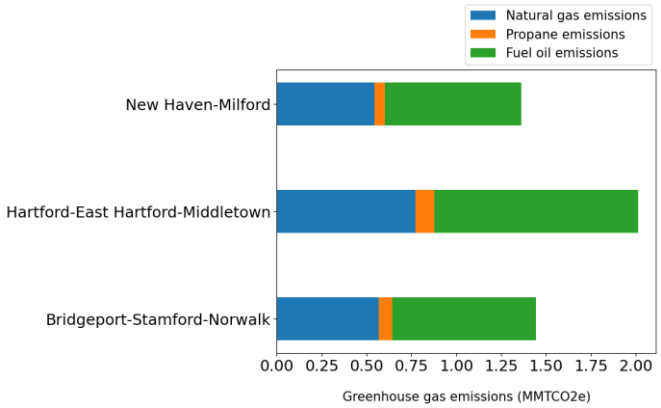


Figure 13. Emissions from residential heating fuel sources at each MSA.

1.8.2 Commercial emissions

Commercial building emissions in the Hartford area are twice as large as those in New Haven area.

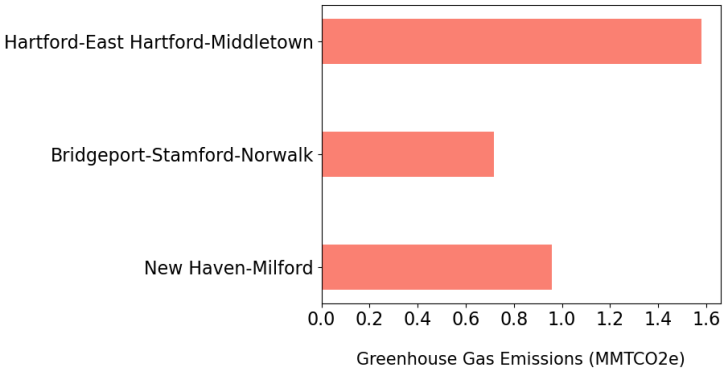


Figure 14. Emissions from commercial buildings at each MSA.

1.8.3 Industrial emissions

The New Haven area has similar industrial emissions to the Hartford area.

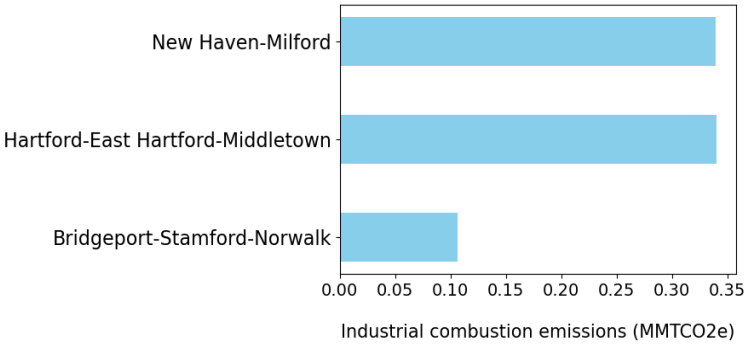


Figure 15. Emissions from commercial buildings at each MSA.

1.9 Agricultural and land management

Agricultural emissions in the Hartford area are 74% higher than the two MSAs combined. Emissions per acres are calculated by the total emissions divided by the fertilizer-zed land and figure 15 shows that the emissions per acre are almost the same at all the MSAs.

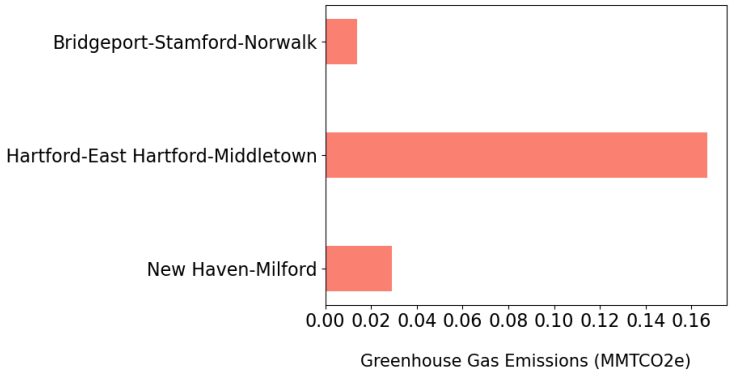


Figure 16. Emissions from commercial buildings at each MSA.

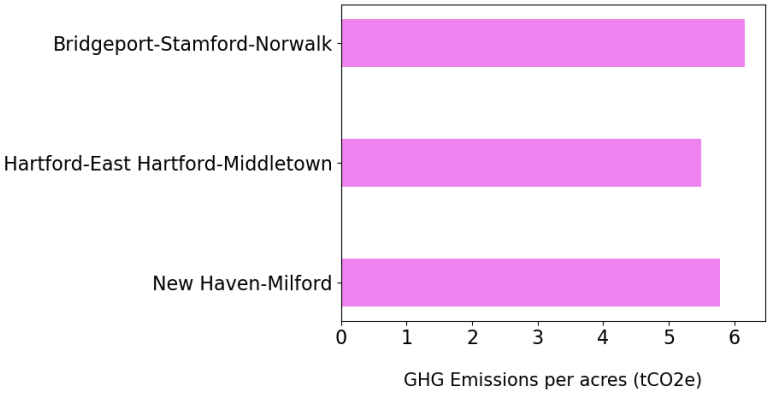


Figure 17. Emissions per acres.

1.10 Urban forestry

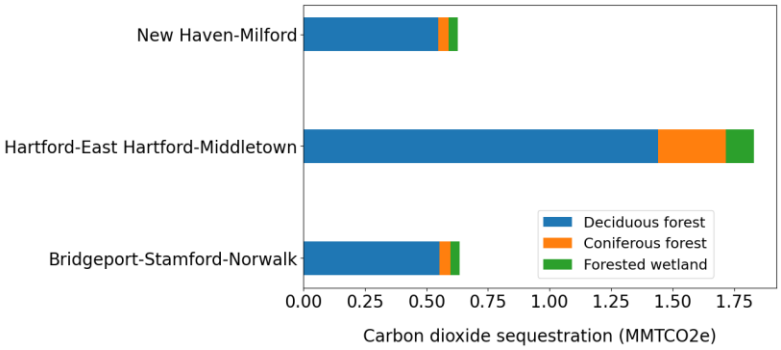


Figure 18. Carbo dioxide sequestrated by forest land at each MSA.

Conclusion

References

ACRONYMS AND ABBREVIATIONS

ACS	American Community Survey
CCAP	Comprehensive Climate Action Plan
CCM	CT Conference of Municipalities
CEEJAC	Connecticut Equity and Environmental Justice Advisory Council
CEJST	White House Council on Environmental Quality's Climate and Economic Justice Screening Tool
CGS	General Statutes of Connecticut
CH_4	methane
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
COG	Council of Governments
CPRG	Climate Pollution Reduction Grants
CRCOG	Capitol Region Council of Governments
CRERPA	CT River Estuary Regional Planning Agency
CT	Connecticut
CT CEQ	CT Council on Environmental Quality
CTCHRO	CT Commission on Human Rights and Opportunities
CT DAS	CT Department of Administrative Services
CT DECD	CT Department of Economic and Community Development
CT DEEP	CT Department of Energy and Environmental Protection
CT DESPP	CT Department of Emergency Services and Public Protection
CT DOT	CT Department of Transportation
CT DPH	CT Department of Public Health
CT GWC	CT Governor's Workforce Council
CT OHS	CT Office of Health Strategy
CT OPM	CT Office of Policy and Management
CTAC	Climate Technical Advisory Committee
EJScreen	EPA's Environmental Justice Screening and Mapping Tool
EPA	U.S. Environmental Protection Agency
ESRI	Environmental Systems Research Institute
EV	electric vehicle
GC3	Governor's Council on Climate Change
GHG	greenhouse gas
HAP	hazardous air pollutant
KCC	Kamora's Cultural Corner
kg	kilogram
LIDAC	low income and disadvantaged community
MetroCOG	Metropolitan COG
MT	metric ton

MOU	Memorandum of Understanding
MPO	Metropolitan Planning Organization
MSA	metropolitan statistical area
N_2O	Nitrous oxide
NECCOG	Northeastern COG
NHCOG	Northwest Hills COG
NPDES	National Pollutant Discharge Elimination System
NVCOG	Naugatuck Valley COG
PCAP	Priority Climate Action Plan
ppb	parts per billion
RGGI	Regional Greenhouse Gas Initiative
RiverCOG	Lower Connecticut River Valley Council of Governments
RPC	regional planning committee
RPO	regional planning organization
SCCOG	Southeastern COG
SCRCOG	South Central Region COG
UMass - Amherst	University of Massachusetts - Amherst
WestCOG	Western COG
ZEV MOU	Zero-Emission Vehicle Memorandum of Understanding

REFERENCES

1 Hartford Climate Action Plan. City of Hartford. September 2017. https://hartfordclimate.files.wordpress.com/2017/12/cap1.pdf

2 Connecticut: Our Changing Climate. CT DEEP, State Parks Division, Public Education and Outreach Office. August 2020. https://portal.ct.gov/-/media/DEEP/education/kellogg/CT-Changing-Climate-Booklet.pdf

3 "Climate Action Timeline for Connecticut." CT DEEP. February 2022. https://portal.ct.gov/DEEP/Climate-Change/Climate-Action-Timeline-for-Connecticut

4 "About Us." CRCOG. https://crcog.org/about/

5 CRCOG Capitol Region Natural Hazards Mitigation Plan Update. CIRCA. December 2019. https://circa.uconn.edu/crcog-natural-hazards/

6 2021 Lower Connecticut River Valley Hazard Mitigation Plan Update. RiverCOG. May 2021. https://www.rivercog.org/wp-content/uploads/2021/09/RiverCOG_2021_HMP_Final_FEMA-Approval-Letter-9.10.21-mb.pdf

7 "What will climate change cost you?" First Street Foundation. https://riskfactor.com/

8 Risk Factor: East Hartford. First Street Foundation. January 2024. https://riskfactor.com/city/east-hartford-ct/922700_fsid/flood

9 Hazard Mitigation Plan for the Former Central Connecticut Region - 2016-2021 Update: City of New Britain Annex. CRCOG and Milone & MacBroom. June 2016. https://crcog.org/wp-content/uploads/2016/06/NewBritainAnnexFinal.pdf

10 Middletown 2030: 2020-2030 Plan of Conservation & Development. City of Middletown. January 2021. https://russelllibrary.org/wp-content/uploads/2023/01/2020-2030-Middletown-POCD-Adopted-1.13.2021-FINAL.pdf

11 2019 - 2024 Capitol Region Natural Hazard Mitigation Plan Update: Municipal Annexes Document. CRCOG. April 2019. https://crcog.org/wp-content/uploads/2019/04/Annexes_APA_Flattened.pdf

12 Town of Vernon Plan of Conservation and Development. Planning and Zoning Commission. October 2021. https://www.vernon-ct.gov/departments-services/departments/planning-and-development/pocd

13 Natural Resources & Climate Change. Town of Enfield. April 2011. https://www.enfield-ct.gov/DocumentCenter/View/201/Natural-Resources-and-Climate-Change-PDF

14 Lawn Care Goes Electric. Environment America, U.S. PIRG Education Fund, Frontier Group. https://publicinterestnetwork.org/wp-content/uploads/2023/10/Lawn_Care_Goes_Electric_Oct23.pdf

15 "Gas-powered lead blowers will now be restricted in Westport." Kayla Mutchler, CT Insider. January 2023. https://www.ctinsider.com/westport/article/westport-adopts-leaf-blower-ordinance-17694379.php

16 "No complaints filed in first season of Westport's leafblower restriction ordinance, officials say." Kayla Mutchler, CT Insider. December 2023. https://www.ctinsider.com/westport/article/westport-norwalk-landscaper-gas-leaf-blower-18508898.php

17 Electric Vehicle Roadmap for Connecticut. CT DEEP. 2020. https://portal.ct.gov/-/media/DEEP/air/mobile/EVConnecticut/2020-04-22---EV-Roadmap-for-Connecticut---FINAL.pdf

18 "Roundabouts" Insurance Institute for Highway Safety. June 2023. https://www.iihs.org/topics/roundabouts

19 "CTDOT Announces New Complete Streets Design Criteria to Improve Roadway Safety and Enhance Mobility." CTDOT. August 2023. https://portal.ct.gov/DOT/CTDOT-Press-Releases/2023/CTDOT-Announces-New-Complete-Streets-Design-Criteria-to-Improve-Roadway-Safety-and-Enhance-Mobility

20 "DEEP to Allocate $2 Million to Address Tree Canopy Access in Connecticut." CT DEEP. January 2024. https://portal.ct.gov/DEEP/News-Releases/News-Releases---2024/DEEP-to-Allocate-2M-to-Address-Tree-Canopy-Access-in-Connecticut

21 1990-2021 Connecticut Greenhouse Gas Emissions Inventory. CT DEEP. April 2023. https://portal.ct.gov/-/media/DEEP/climatechange/1990-2021-GHG-Inventory/DEEP_GHG_Report_90-21_Final.pdf

22 Taking Action on Climate Change and Building a More Resilient Connecticut for All. Phase 1 Report: Near-term Actions. GC3. January 2021. https://portal.ct.gov/-/media/DEEP/climatechange/GC3/GC3_Phase1_Report_Jan2021.pdf