YARMOUTH CLIMATE ACTION

GPCOG
GREATER PORTLAND COUNCIL OF GOVERNMENTS

Solar array in Acton, ME, that produces solar for Municipal and School electricity use.

Yarmouth Greenhouse Gas Emissions Inventory

March 2024

YARMOUTH MAINE

Table of Contents

ACRONYMS

ACS	American Community Survey
CACP	Clean Air and Climate Protection
CBECS	Commercial Buildings Energy Consumption Survey
CEES	Committee for Energy Efficiency and Sustainability
CH4	Methane
CMP	Central Maine Power
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide equivalent
FLIGHT	Facility Level Information on Greenhouse gases Tool
GHG	Greenhouse Gas
GMRI	Gulf of Maine Research Institute
GOPIF	Governor's Office of Policy Innovation and the Future
GPCOG	Greater Portland Council of Governments
HFCs	Hydrofluorocarbons
MMBtu	Metric Million British thermal unit
MT	Metric Tons
N_20	Nitrous Oxide
ODS	Ozone-Depleting Substances
PBA	Primary Building Activity
PFCs	Perfluorocarbons
SF6	Sulfur Hexafluoride
SMPDC	Southern Maine Planning and Development Commission
T&D Loss	Transmission and Distribution Loss
YCAT	Yarmouth Climate Action Task Force
YCER	Yarmouth Climate Emergency Resolution

INTRODUCTION

By conducting an inventory of greenhouse gas (GHG) emissions, municipalities can better understand their contribution to global climate change and take meaningful steps toward mitigating their impact. As part of Yarmouth's climate action planning process, the Greater Portland Council of Governments (GPCOG) conducted an inventory of the town's municipal and community-wide greenhouse gas (GHG) emissions. This inventory provides Yarmouth with detailed emissions data, which can be used to:

- Identify opportunities for reducing emissions
- Create specific key performance indicator targets for strategy areas
- Develop a baseline to track progress toward meeting emissions reductions targets

This inventory was restricted to the Town of Yarmouth in Cumberland County, Maine. Yarmouth is located about 12 miles north of Portland and occupies an area of 22.94 square miles, with 13.35 square miles of land. In 2019, the population of Yarmouth was 8,529.

Due to major disruptions from Covid-19, this inventory uses data from the year 2019 to reflect pre-pandemic activity. Human activity significantly changed for an extended period of time, reducing daily GHG emissions up to -17%. Many communities conducting annual inventories noticed that the baseline years of 2020 and 2021 reflected the pandemic irregularities — which impacted the emissions data. Current best practices recommend using 2019 as a baseline year until 2022 data is available and complete, which it was not during development of this inventory.

Yarmouth's Committee for Energy Efficiency and Sustainability (CEES)—formerly known as the Renewable Energy & Sustainability Advisory Committee—was established in 2018 to advise the Town Council on issues of energy conservation, support implementation of sustainability projects, and provide a space for the Town and public to engage on climate issues. By forming this committee, the Council demonstrated dedication to stewarding the town, its resources, and residents in an environmentally sustainable manner. With support from the Yarmouth High School Environmental Action Club, the Yarmouth Town Council passed a Climate Emergency Resolution in February 2022, which specifies the formation of a Climate Action Task Force (YCAT), describes the scale, scope, and urgency of climate challenges, and outlines municipal and community-wide reduction targets. The Resolution created a target of achieving net-zero municipal greenhouse gas emissions and an 80% reduction in community-wide greenhouse gas emissions by 2030, with a net-zero community-wide emissions target by 2050. The successful passage of the Resolution and ongoing implementation work is a collaborative effort with Town committees, GPCOG, Yarmouth Town Council and staff, and community members.

KEY TERMS

Net zero describes when greenhouse gases going into the atmosphere are balanced by removal out of the atmosphere. Removal strategies are pursued only after all emissions reduction strategies are exhausted.

SIGNIFICANCE OF A GREENHOUSE GAS INVENTORY

Greenhouse gases (GHGs) are naturally occurring gases responsible for trapping heat inside the Earth's atmosphere — which helps regulate our planet's temperature. A range of human activities also generate these gases, such as the burning of fossil fuels for energy production and transportation.

A GHG inventory is a list of emission sources and an estimation of the quantity of associated emissions that occur within a community's geographic boundary. It can be a tool for communities to:

- determine a community's emissions footprint for informing climate action planning,
- set baseline emissions reduction targets and track greenhouse gas emissions performance over time,
- identify priority areas to reduce emissions, and
- demonstrate municipal accountability and leadership.

Emissions in this inventory are designated into two records (1) community-wide and (2) municipal and school.

The goals of a GHG inventory are to provide the Town with a comprehensive breakdown of the highest emitting sectors and to act as a comparison tool to measure progress in reducing greenhouse gas emissions. The 2019 inventory is a baseline for Yarmouth's emissions and a snapshot of the Town's emitting activities at that point in time. GPCOG recommends that the GHG inventory protocol is replicated every 3 years to measure how emissions are changing over time in order to evaluate the progress of emission reduction strategies.

METHODOLOGY AND DATA COLLECTION PROCESS

This inventory uses the methodology outlined in the SMPDC GHG Emissions Inventory Protocol, which provides a standardized system for the GHG emissions collection process for Southern Maine communities. The SMPDC protocol is informed by the U.S. Community Protocol for Reporting and Accounting for community greenhouse gas emissions, an internationally used best practice methodology.

This report presented emissions data resulting from:

1. A Community-wide inventory which accounts for GHG emissions produced by the activity within the boundary of the community from its residents, workforce, and visitors. This includes activities in the categories of stationary energy, transportation, and waste sectors.
2. A Municipal Operations Inventory produces a detailed account of the sources and amounts of GHG emissions within the jurisdictional boundaries of the town generated by municipal operations. Municipal GHG emissions are also included in the community-wide inventory.

Inventory Year: The Community-wide and Municipal Operations GHG emissions inventories were completed using a combination of data sources from 2019—the selected baseline year. The inventory year of 2019 was selected as the most recent and readily available data that accurately reflects non-pandemic era activity.

Inventory Boundary: The inventory boundary is the geographic extent of Yarmouth's administrative jurisdiction. All emissions that happen inside the administrative boundary are included. Emissions that happen outside the boundary but as a direct result of community activity within the boundary (i.e. electricity use, landfilling of waste) are also included. See "Emission Scopes" for more information.

Greenhouse Gases

This GHG inventory for Yarmouth includes three of the six internationally recognized greenhouse gases. The three gases included are carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). This inventory will not include the greenhouse gases categorized as ozone-depleting substances (ODS), such as hydrofluorocarbons or perfluorocarbons, because:

1. They primarily result from industrial, agriculture, forestry, and land use sectors; sectors which are not included in the scope for this inventory, and of which there is limited application in Yarmouth.
2. It is difficult to measure the warming effect of ODS: they deplete another greenhouse gas, stratospheric ozone.[1]
3. ODS resulting from human activity are being phased out by the Clean Air Act.

KEY TERMS

$MTCO_2e$
Metric tons of carbon dioxide equivalent. This is the standard unit used for GHG emissions. It is comprised of metric tons of carbon dioxide, but also includes other greenhouse gases. The tonnage of other greenhouse gases is adjusted to the equivalent tonnage of carbon dioxide necessary to produce the same warming effect. Example: If 1 metric ton of methane was emitted, it would be counted as 25 $MTCO_2e$, since methane has 25 times the warming effect of carbon dioxide.

Further information on the greenhouse gases included or excluded from the inventory are described in the SMPDC Greenhouse Gas Inventory Protocol. The table below describes the greenhouse gases that have the greatest effect on climate change.

All the greenhouse gases included in this inventory are converted and displayed as metric tons of carbon dioxide equivalent, or $MTCO_2e$. The greenhouse gases are measured in the equivalent amount of CO_2 that would result in similar levels of warming. CO_2e is used to help quantify the warming potential of each of the other included greenhouse gasses and allows them all to be categorized as the displayed $MTCO_2e$.

TABLE 1. Summary of Greenhouse Gases

Greenhouse Gas	Emitting Sources	Effect on Climate
CO_2 Carbon Dioxide	• Burning carbon- based resources (i.e. fossil fuels) • Decomposition of organics (e.g., food waste) • Respiration of plants and animals • Chemical reactions	• Contributes ~79% of global emissions • Increase in warming effect, 1990–2019: 161%
CH_4 Methane	• Agriculture (livestock and land) • Production and transport of fossil fuels • Landfill off-gassing	• Contributes ~11% of global emissions. • The warming impact is 25 times greater than that of CO_2 • Increase in warming effect, 1990–2019: 113%
N_2O Nitrous Oxide	• Agricultural soil management (fertilizers and manure) • Burning carbon-based resources • Industrial byproduct • Wastewater treatment	• Contributes ~7% of global emissions • The warming impact is 298 times greater than that of CO_2 • Increase in warming effect, 1990–2019: 154%
Fluorinated Gases (HFCs, PFCs, SF_6) (not included in inventory)	• Refrigerants, aerosols, solvents • Industrial byproduct • Electricity Distribution • No natural sources	• Contribute ~3% of global emissions • Last hundreds to thousands of years in the atmosphere • Have between 12,000 to 22,000 times the warming impact of CO_2. • Emissions of fluorinated gases increased 90% from 1990–2020

Sectors

There are three major sectors examined in this Community-wide and Municipal Operations GHG emissions inventory: stationary energy, transportation, and waste. These sectors are each broken down further into various subsectors and emission scopes.

- The **Stationary Energy Sector** refers to the energy consumed by buildings, facilities and other fixed structures that are connected to the electricity grid or burn on-site fossil fuels for power generation. This sector includes all energy used for lighting, heating, cooling, and other miscellaneous building services. Stationary energy also captures any industrial processes and equipment. Calculated as part of the stationary energy sector is Transmission and Distribution Loss (T&D Loss) and Fugitive Emissions from the power sector.
  - **Transmission and Distribution Loss (T&D Loss)** is an estimate of the energy lost in the process of supplying electricity to consumers. These losses mainly occur from energy dispersed in the conductors, transformers, and other equipment used for transmission, transformation, and distribution of grid-supplied electricity.
  - **Fugitive Emissions** account for the natural gas lost in the extraction and transportation across pipelines to utilities and establishments.
- The **Transportation Sector** measures the emissions from the combustion of fossil fuels from automobiles, public transportation, marine vehicles, and air transport occurring within Yarmouth's geographic boundary.
- The **Waste Sector** includes emissions produced during the management of waste and wastewater produced within town boundaries.

Emission Scopes

Greenhouse gas emissions may be either created directly, or indirectly. Direct emissions are generated and released within the boundaries of the town and include Scope 1 emissions (refer to Table 2). Indirect emissions (Scopes 2 and 3) are emitted outside of the town boundaries but are produced as a result of in-boundary activity. Examples of indirect emission sources include the consumption of energy from the electrical grid, or the incineration of Yarmouth's waste at the ecomaine facility. This Inventory does not include 'upstream' indirect emissions generated by creating or distributing goods, food, or services that Yarmouth residents purchase, with the exception of production and transportation of goods occurring in town boundaries. Generally, emissions that can be influenced by government coordination and/or community initiatives (I.e., under the control of residents, businesses, or the municipality) are included in this inventory.

The sources of greenhouse gas emissions are classified into three scopes. These scopes designate the community boundaries of the calculated emissions and allow for a comprehensive understanding of community emissions and provide a framework for developing strategies to reduce them.

TABLE 2. Summary of Emissions Scopes for Greenhouse Gas Inventory

Emission Scope	Source	Examples
Scope 1	Emissions produced directly from sources within the town boundary	Combustion of fuels within buildings in Yarmouth or vehicles driven in Yarmouth
Scope 2	Emissions resulting from consumption of energy supplied from outside town boundaries	Consumption of grid-supplied electricity
Scope 3	Emissions occurring outside town boundaries as a result of town activity	Transportation of goods or resident commute miles outside of town

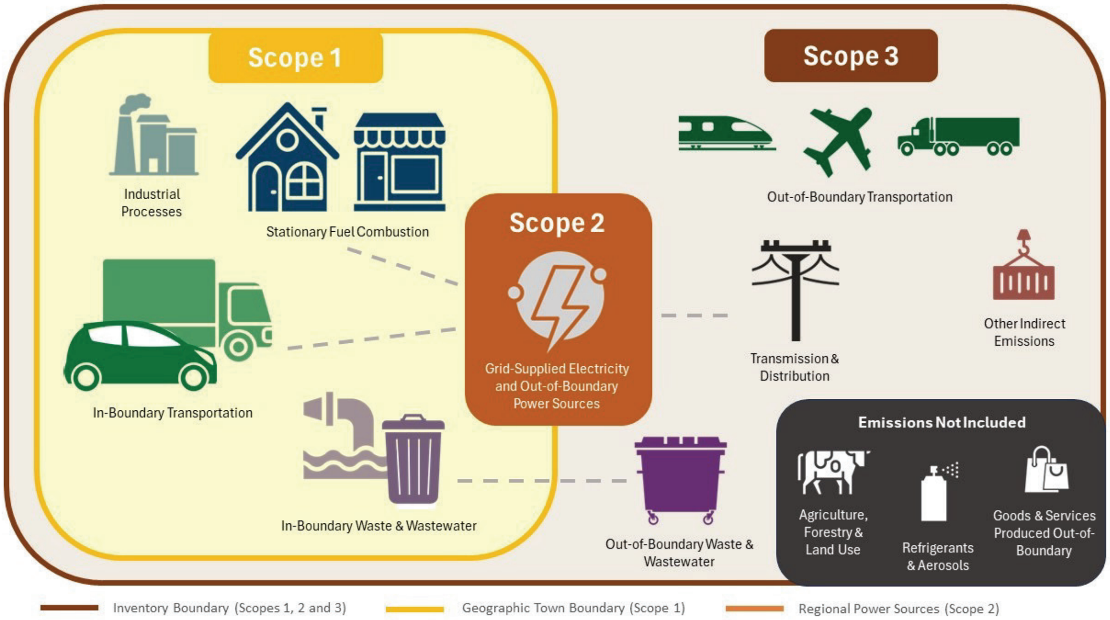


FIGURE 1. Emission Scopes from Global Protocol for Community-scale Greenhouse Gas Emission Inventories[2]

Tools and Resources

This GHG Inventory uses an emissions modeling software called ClearPath, developed by ICLEI – Local Governments for Sustainability. This software allows for GHG accounting of both community and municipal emissions and their related sectors. ClearPath utilizes the current methodologies and best practices outlined in the US Community Protocol and the Local Government Operations Protocol: a protocol developed by ICLEI.[3] SMPDC's protocol details how to use ICLEI's ClearPath tool to calculate community-wide greenhouse gas emissions and forecast future emissions for measuring the progress of strategies. Where data is unavailable, GPCOG uses best practices to model and estimate emissions. The inventories will be regularly revised and updated as new and better data become available, as models are improved, and as international standards and guidance evolve. The inventory is meant to identify ***medium to longer-term trends*** in changes in the amount of greenhouse gases emitted, rather than exact absolute numbers or year-to-year changes.

Challenges and Limitations

Greenhouse gas emissions modeling is not a perfect science. Conducting an emissions inventory uses the best available data, along with a variety of emissions modeling software, to estimate a town's total footprint within each sector. It is not an exact measurement of every ton of emissions. The reported greenhouse gas emissions should be used by the town as a guide for understanding sources and relative amounts. The quality of the collected data can vary depending on the source and sector. Some data sources, such as building electricity usage, are viewed as high quality and are tracked by the utility, but discrete fuel (i.e., home heating oil) usage data is not tracked at a community level and as a result, is modeled using the best available methodology and data.

The greenhouse gas emissions inventory for the Town of Yarmouth is not reflective of the actual carbon footprint for each resident. Community-wide GHG inventories are limited to the energy-related emissions produced within the three emission scopes described above. However, indirect emissions from purchasing goods and services (i.e., Scope 3), also contribute to climate pollution. While those emissions are not included in the emissions analysis of the Town, they should still be considered when evaluating an individual's or organization's environmental impact. One of the aims of this GHG inventory and resulting Climate Action Plan is to contribute to the global shift towards renewable energy and sustainable development and consumption, to reduce indirect resident emissions.

Data Collection

Data for this inventory was collected from the Town of Yarmouth, utility companies which provide electric and natural gas services within the town boundary, other utilities, and proprietary data from the transportation modeling software Streetlight. The tables below describe the emission and data sources included for each sector as part of the Community-wide and Municipal Operations inventories.

TABLE 3. Community Inventory Overview

Sector	Subsector	Emissions Sources	Energy Type	Data Source
Stationary Energy	Residential	Energy use in buildings as well as losses from distribution systems	Electricity	Consumption data from Central Maine Power (CMP)
			Natural Gas	Consumption data from Summit Natural Gas
		Energy use in buildings	Discrete Fuels	Fuel consumption data from 5-year ACS average
	Commercial	Energy used in commercial, government, and institutional buildings as well as losses from distribution systems	Electricity	Consumption data from Central Maine Power (CMP)
			Natural Gas	Consumption data from Summit Natural Gas
		Energy used in commercial, government, and institutional buildings	Discrete Fuels	Fuel consumption data modeled using commercial facility characteristics (size and fuel) data sets[4]
	Industrial	Energy used in manufacturing and industrial facilities as well as losses from distribution systems	Electricity	Consumption data from Central Maine Power (CMP)
			Natural Gas	Consumption data from Summit Natural Gas
		Energy used in manufacturing and industrial facilities	Discrete Fuels	Fuel consumption data modeled using industrial facility characteristics data sets[5]
Transportation	Passenger Vehicles	Fuel combusted from all passenger vehicle trips that are attributable to travel within the town boundaries	Gasoline, Diesel, Electricity	Modeled energy consumption/ activity data based on real activity data from Streetlight
	Commercial Vehicles	Fuel combusted from all commercial, municipal and school vehicle trips that are attributable to travel within the town boundaries	Gasoline, Diesel, Electricity	Modeled energy consumption/ activity data based on real activity data from Streetlight
	Public Transit	Fuel combusted from all passenger miles travelled on public transit within town boundaries	Gasoline, Diesel	Modeled energy consumption/ activity data based on real activity data from Streetlight
Waste	Solid Waste - Incineration	GHG emissions resulting from the incineration of all trash generated by residential, commercial, and municipal activity in the community that is sent to a Waste-to-Energy plant	Incineration Emissions	Ecomaine – Town curbside tonnage and emissions
	Wastewater	Process and fugitive emissions from treating wastewater from all residential and commercial activities	Electricity	Consumption data from Central Maine Power (CMP)
			Aerobic and Anaerobic Digestion	Processing of wastewater at the wastewater treatment facility
			Septic Systems	Modeled fugitive emissions from the number of septic tanks and average household size

TABLE 4. Municipal Operations Inventory Overview

Sector	Subsector	Emissions Sources	Energy Type / End Use	Data Source
Stationary Energy	Buildings and Facilities	Energy used within municipally owned buildings	Electricity	Consumption data from Central Maine Power
			Natural Gas	Consumption data from Summit Natural Gas
			Discrete Fuels	Consumption data from CN Brown Energy
	Streetlights and Traffic Signals	Electricity used in town streetlights and traffic signals	Electricity	Consumption data from Central Maine Power
Transportation	Fleet Vehicles	Fuel combustion of on and off-road municipal vehicles	Gasoline, Diesel	Consumption data from Yarmouth's Public Works Department
	Marine Vessels	Fuel combustion of municipally owned marine vessels	Gasoline	Consumption data from Yarmouth's Superintendent of Vehicle Maintenance
Waste	Wastewater Treatment	Emissions from wastewater treatment	Anaerobic Digestion	Number of wastewater connections and septic tanks provided by Yarmouth's Department of Public Works
		Grid electricity used in wastewater treatment	Grid Electricity	Consumption data from Central Maine Power

TABLE 5. School Operations Inventory Overview

Sector	Subsector	Emissions Sources	Energy Type / End Use	Data Source
Stationary Energy	Buildings and Facilities	Energy used for school buildings and facilities	Electricity	Consumption data from Central Maine Power
			Natural Gas	Consumption data from Summit Natural Gas
			Discrete Fuels	Consumption data from CN Brown Energy
Transportation	Fleet Vehicles	Fuel combustion of on-road school vehicles	Gasoline, Diesel	Consumption data from Yarmouth's Public Works Department

COMMUNITY-WIDE INVENTORY

The Community-wide Inventory for Yarmouth includes all emission sources and associated quantities of emissions for the stationary energy, transportation, and waste sectors. Differentiations are made between residential and commercial emissions. The Community-wide Inventory also includes emissions from municipal and school operations. This report breaks them out to better understand their impact.

The overall community greenhouse gas emissions for Yarmouth in 2019 are estimated at 99,828 $MTCO_2e$. Half of these emissions (50%) come from the stationary energy sector, primarily residential buildings. Transportation emissions were the second largest emitter at 43% while waste emissions only made up 7% of total community greenhouse gas emissions.

All emissions result from activity occurring within the community boundaries, even if some of the emissions themselves are generated beyond town lines. An example of this would be waste produced by Yarmouth residents that is exported to the ecomaine facility to be incinerated and converted into electricity.

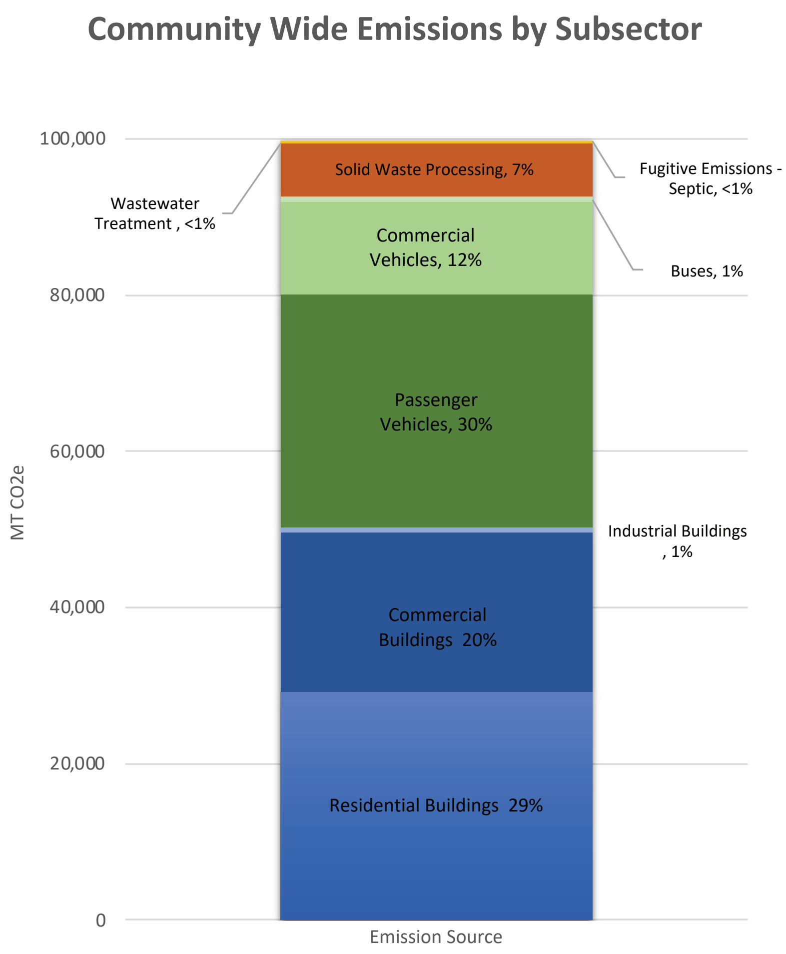
The following table provides the general breakdown by sector of community emissions for Yarmouth. Each sector is analyzed in detail below.

KEY TERMS

Process and fugitive emissions are emissions unintentionally released into the atmosphere as a by-product of equipment and infrastructure imperfections. For example, methane from a septic tank. Upstream impacts of activities refer to the emissions generated from production processes, such as the transmission and distribution (T&D) losses associated with electricity from the grid. Fugitive emissions and T&D Loss are accounted for in the buildings section.

TABLE 6. Community-Wide Emissions by Sector

Sector	Subsector	GHG Emissions ($MTCO_2e$)	% of Community Emissions
Stationary Energy (50%)	Residential Buildings	29,210	29%
	Commercial Buildings	20,433	20%
	Industrial Buildings	611	1%
Transportation (43%)	Passenger Vehicles	29,890	30%
	Commercial Vehicles	11,797	12%
	Buses	632	1%
Waste (7%)	Solid Waste Processing	6,859	7%
	Wastewater Treatment	<1	<1%
	Fugitive Emissions - Septic	395	<1%
	Total Community Emissions	**99,828**	**100%**



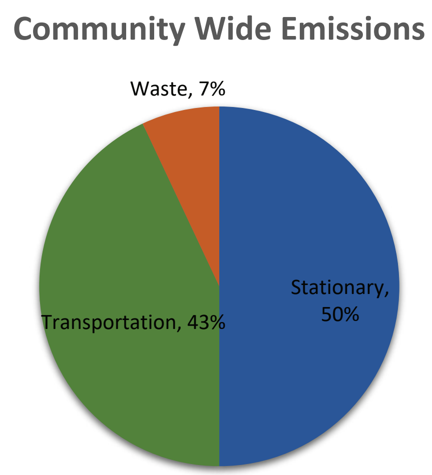


FIGURE 2. Community-Wide Emissions by Subsector

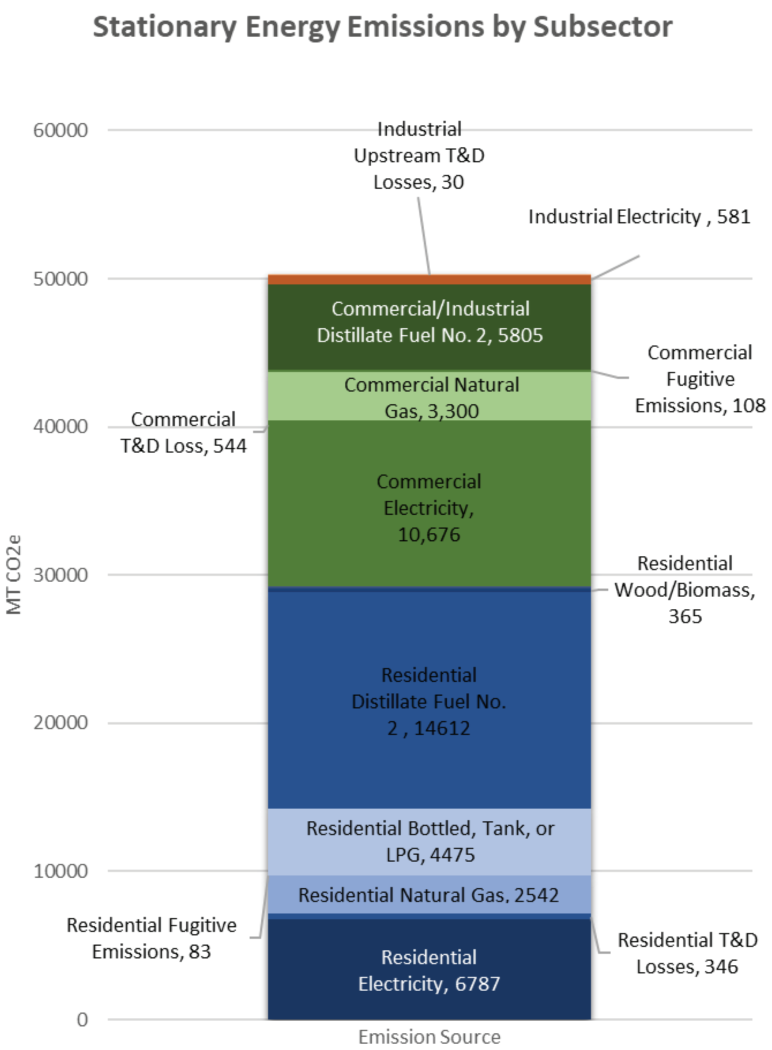
The community-wide greenhouse gas emissions correspond to approximately 11.7 $MTCO_2e$ per capita. However, this inventory provides an estimate for the emissions at the community-wide scale and is not a realistic picture of emissions per person. The emissions include electricity, fuel, and transportation use from seasonal residents and tourists, who are not counted as part of the population. As mentioned previously, the inventory does not account for the direct and indirect emissions of goods and services consumed by residents or visitors- such as air travel, clothing, or food.

Stationary Energy

Total stationary energy emissions were estimated at 50,254 $MTCO_2e$. In Yarmouth, residential energy use is the highest emitting subsector, producing nearly 59% of all stationary emissions.

TABLE 7. Stationary Emissions by Subsector

Sector	Emissions Source	GHG Emissions ($MTCO_2e$)	% of Stationary Energy Emissions	% of Community Emissions
Stationary Energy	**Total Residential Emissions**	**29,210**	**58%**	**29%**
	Residential Electricity	6,787	14%	7%
	Residential T&D Losses	346	1%	0.3%
	Residential Natural Gas	2,542	5%	3%
	Residential Fugitive Emissions	83	<1%	~0%
	Residential Bottled, Tank, or LPG	4,475	9%	5%
	Residential Distillate Fuel No. 2	14,612	29%	15%
	Residential Wood/Biomass	365	1%	0.4%
	Total Commercial Emissions	**20,433**	**41%**	**21%**
	Commercial Electricity	10,676	21%	11%
	Commercial T&D Loss	544	1%	0.5%
	Commercial Natural Gas	3,300	7%	3%
	Commercial Fugitive Emissions	108	<1%	~0%
	Commercial/Industrial Distillate Fuel No. 2	5,805	12%	6%
	Total Industrial Emissions	**611**	**1%**	**0.6%**
	Industrial Electricity	581	1%	0.6%
	Industrial Upstream T&D Losses	30	<1%	~0%
	Total Stationary Energy Emissions	**50,254**	**100%**	**50%**



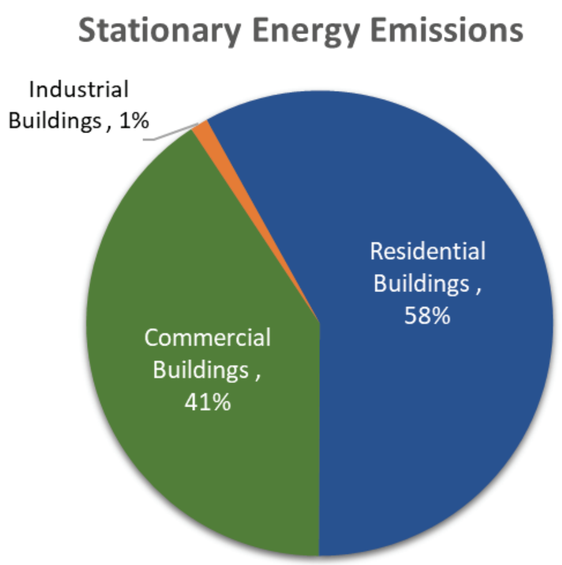


FIGURE 3. Community-Wide Stationary Energy Emissions and Subsector Emission Sources

RESIDENTIAL ENERGY USAGE

The subsector of Residential Energy Usage measures the emissions produced from residential consumption of grid-supplied electricity and the combustion of stationary fuels for home use. Residential emissions accounted for 29% of total emissions and were estimated at 29,210 $MTCO_2e$.

Residential energy usage emissions were calculated using 2019 town-wide electricity and natural gas consumption data. Discrete fuel consumption, which includes heating oil, was modeled using a combination of ACS data, community home heating characteristics, and Maine statewide home heating characteristics (as per the SMPDC protocol).

TABLE 8. Residential Energy Consumption of Grid-supplied Electricity and Stationary Fuel Combustion

Subsector	Emissions source	GHG Emissions ($MTCO_2e$)	% of Subsector Emissions
Residential Energy Usage	**Total Grid Electricity**	**7,133**	**24%**
	Electricity Consumption	6,787	23%
	Upstream T&D Loss	346	1%
	Total Natural Gas	**2,625**	**9%**
	Natural Gas Consumption	2,542	9%
	Fugitive Emissions	83	<1%
	Total Discrete Fuels	**19,452**	**67%**
	Bottled, Tank, or LPG	4,475	15%
	Distillate Fuel/Kerosene	14,612	50%
	Wood/Biomass	365	1%
	Total Residential Emissions	**29,210**	**100%**

COMMERCIAL ENERGY USAGE

The subsector of Commercial Energy Usage measures the emissions produced from commercial consumption of grid-supplied electricity and the combustion of stationary fuels. Emissions were calculated using annual 2019 town-wide electricity and natural gas consumption data. Discrete fuel consumption for the commercial sector, which includes heating oil, was modeled using a combination of Maine Industry Employment and Wages data, Commercial Buildings Energy Consumption Survey (CBECS) data, and Primary Building Activity (PBA) data. The modeling methodology used can be found in the discrete fuel use section of the Greenhouse Gas Inventory Protocol for Southern Maine Communities. Commercial emissions (20% of total community emissions) were estimated at 20,433 $MTCO_2e$.

Compared to residential stationary energy sources, commercial buildings use more energy from the grid and less from localized fossil fuel sources.

TABLE 9. Commercial Energy Consumption of Grid-supplied Electricity and Stationary Fuel Combustion

Subsector	Emissions Source	GHG Emissions ($MTCO_2e$)	% of Subsector Emissions
Commercial Energy	**Total Grid Electricity**	**11,220**	**55%**
	Consumption	10,676	52%
	Upstream T&D Loss	544	3%
	Total Natural Gas	**3,408**	**17%**
	Consumption	3,300	16%
	Fugitive Emissions	108	1%
	Total Discrete Fuels	**5,805**	**28%**
	Distillate Fuel No. 2	5,805	28%
	Total Emissions	**20,433**	**100%**

INDUSTRIAL ENERGY USAGE

Industrial energy usage emissions were calculated using 2019 town-wide electricity and natural gas consumption data provided by local utilities. Industrial energy usage in Yarmouth primarily uses grid-supplied energy. Industrial emissions (1% of total emissions) were estimated at 611 $MTCO_2e$.

TABLE 10. Industrial Energy Consumption

Subsector	Emissions Source	GHG Emissions ($MTCO_2e$)	% of Subsector Emissions
Industrial Energy	Industrial Electricity	581	95%
	Industrial Upstream T&D Losses	30	5%
	Total Stationary Emissions	**611**	**100%**

MAJOR EMITTING FACILITIES IN YARMOUTH

Wyman Power Station is a major emissions emitting facility located on Cousin's Island. This oil-fired facility has been in operation since 1978, but in recent years has drastically reduced its power production. The EPA's Greenhouse Gas Reporting Program collects data from large emitting facilities that result in greenhouse emissions when in operation. Those attributed emissions from Wyman Power Station activity can be found on the U.S. EPA Facility Level Information on Greenhouse gases Tool (FLIGHT).[6] According to FLIGHT, in 2019, this facility was responsible for emitting 24,544 $MTCO_2e$. Since this facility produces market electricity, emissions from this facility are excluded from the GHG inventory. Resulting emissions are instead captured through electricity usage within the community.

Transportation Energy and Mobile Sources

The transportation sector consists of all on-road transportation sources in Yarmouth. The community-wide transportation sector also encompasses the municipal fleet of on- and off-road vehicles and marine vessel fuel consumption.

Emissions were calculated from total community vehicle miles traveled (VMT) using proprietary data from the transportation modeling software Streetlight. The VMT is based on all trips that occur as a result of people travelling to, from, or within a community, but does not include those which pass through without stopping. This means that if a Yarmouth resident commutes from Yarmouth to Portland every day for work, only the portion driven within the geographic boundary of Yarmouth is included in the inventory. Transportation emissions are calculated using VMT, vehicle type, fuel type, and emissions factors for each greenhouse gas. The full details and methodology are outlined in the SMPDC Inventory Collections Protocol and adapted for Cumberland County from the Estimating On-Road Transportation Emissions in York County, Maine.

Emissions from freight rail, passenger rail, and aviation are not included as part of this inventory. These sectors were not included because data is either not available or not applicable to the town.

In 2019, the transportation emissions (42% of total) in Yarmouth were estimated to be 42,319 $MTCO_2e$. Emissions from passenger vehicles accounted for the most transportation emissions (71%), followed by commercial vehicles (28%). Gasoline and diesel fuel economies were weighted based on the statewide makeup of vehicle type.

TABLE 11. Community-Wide Transportation Emissions

Sector	Emission Source	GHG Emissions ($MTCO_2e$)	% of Transportation Emissions	% of Community Emissions
Transportation	**On-road Passenger Vehicles**	**29,890**	**71%**	**30%**
	Gasoline	29,379	70%	29%
	Diesel	511	1%	0.5%
	On-road Buses	**632**	**1%**	**<1%**
	Gasoline	78	<1%	0.1%
	Diesel	554	1%	0.6%
	On-road Commercial Vehicles	**11,797**	**28%**	**12%**
	Gasoline	1,284	3%	1%
	Diesel	10,513	25%	11%
	Total Transportation Emissions	**42,319**	**100%**	**43%**

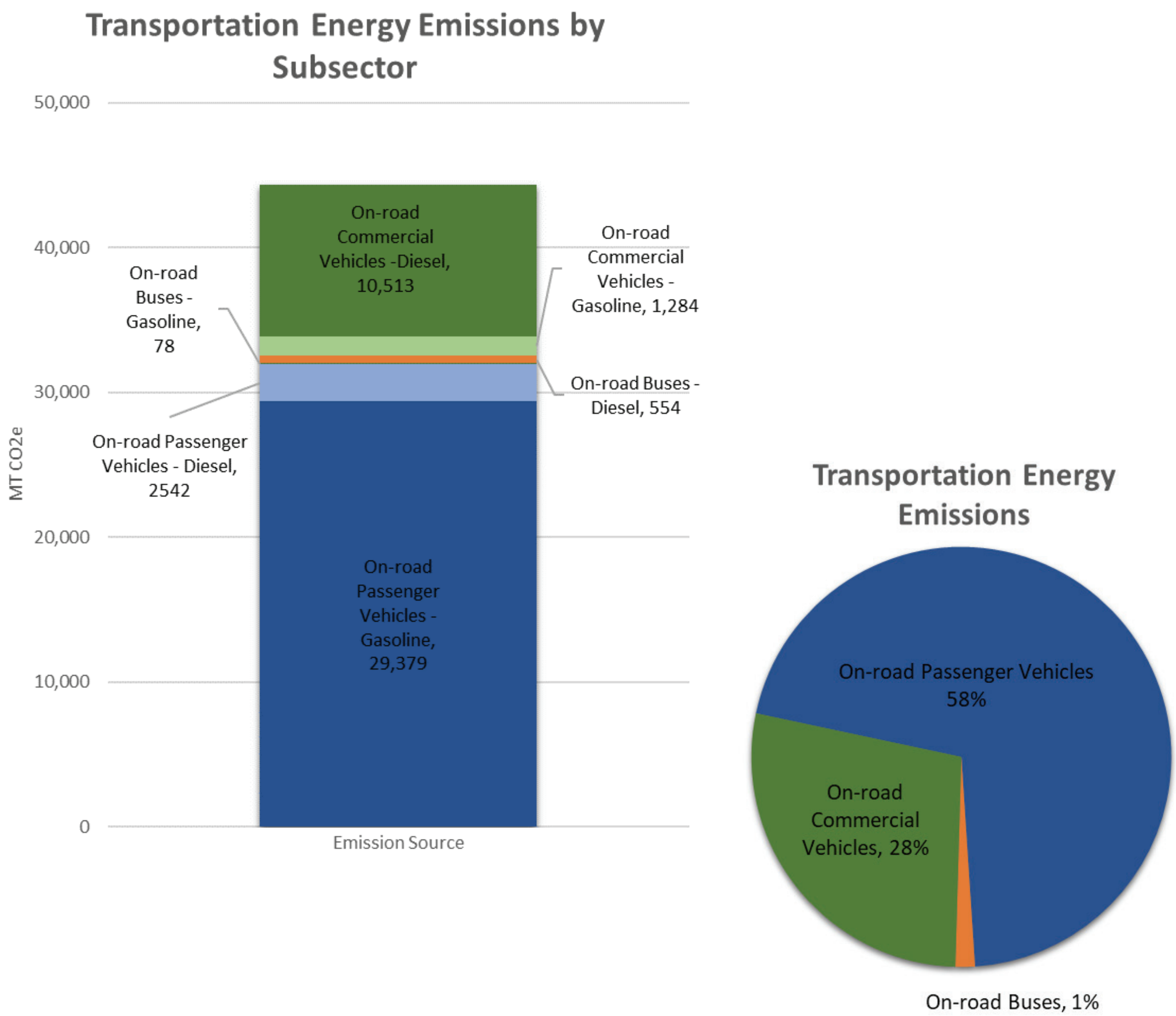


FIGURE 4. Community-Wide Transportation Emissions and Subsector Emission Sources

Waste

The emissions from this sector are based on the processing of the trash and recycling produced by the town. This sector also addresses greenhouse gas emissions produced by sewage management and septic tanks. Municipal solid waste disposal and wastewater treatment account for only 7% of Yarmouth's emissions. However, as noted earlier the upstream impacts of waste and consumption are not captured in this inventory. Reducing overall consumption, and thereby reducing waste, are important strategies for minimizing the lifecycle emissions from goods and services (scope three emissions).

TABLE 12. Community-Wide Waste Emissions

Sector	Subsector	GHG Emissions ($MTCO_2e$)	% of Waste Emissions	% of Community Emissions
Waste	Solid Waste Incineration	6,859	94%	7%
	Fugitive Emissions from Septic	395	5%	0.4%
	Wastewater Treatment (Anaerobic Digestion)	<1	<1%	~0%
	WWTP – Grid Electricity	87	1%	0.1%
	Total Waste Emissions	**7,255**	**100%**	**7%**

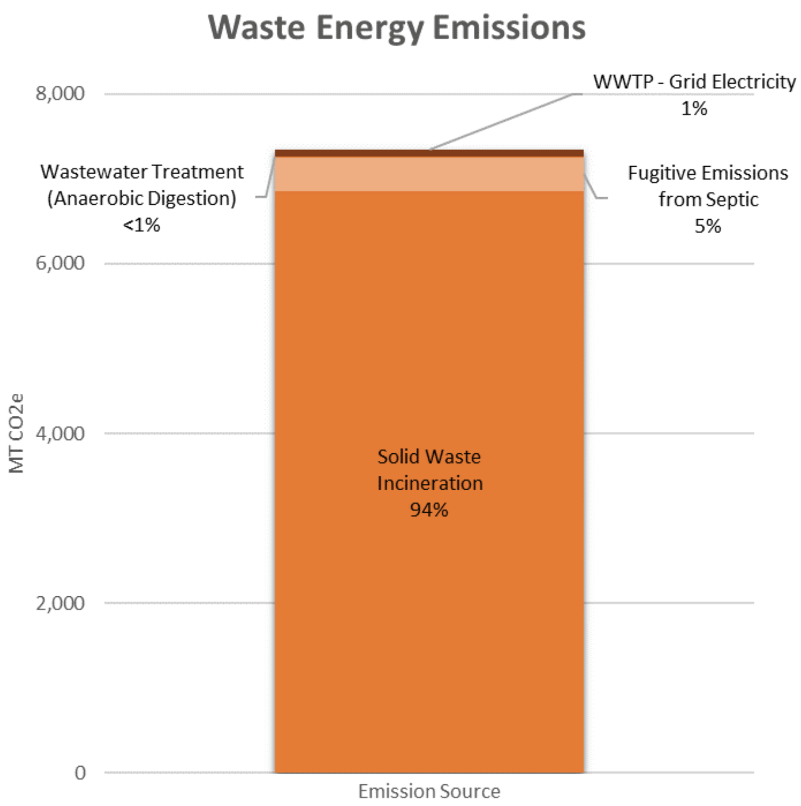


FIGURE 5.
Community-Wide Waste Emissions

SOLID WASTE

The solid waste sector of this GHG inventory includes the emissions from solid waste produced and sent to ecomaine for incineration. Yarmouth utilizes ecomaine's waste management and recycling services for municipal and town-wide waste. Yarmouth is an owner member of ecomaine, which means the Town collects the solid waste produced by community members at the town's transfer station and then the waste is sent to ecomaine's waste-to-energy plant. When necessary, ecomaine does landfill solid waste. Although none of Yarmouth's waste was landfilled during the inventoried year, it may be in future GHG inventories.

Solid waste (7%) emissions were estimated at 6,859 $MTCO_2e$ from incinerating 2,072 tons.

Yarmouth residents, businesses, and landlords may also hire a private hauler to pick up waste. There are two licensed waste haulers who service Yarmouth. This inventory only included waste and recycling collected at the Yarmouth Transfer & Recycling Center.

Recycling in Yarmouth

Emissions resulting from recycling and composting are not included in the scope of this inventory. Recycling waste products does have an emissions impact from collecting, transporting, and processing materials. However, recycling also significantly offsets emissions through three major channels:

1. Recycling offsets the emissions from obtaining, processing, and distributing virgin materials.
2. Paper and cardboard recycling increases the overall carbon storage capacity of forests.
3. Diverting materials from landfills and Waste-to-Energy facilities reduces the emissions produced from incineration and off-gassing.

The emissions savings from recycling were calculated for Yarmouth following ICLEI's Recycling and Composting Emissions Protocol [4]. While these figures do not affect the 2019 community-wide emissions, the emissions saved from recycling should be tracked as a metric for achieving emission reduction targets.

In 2019, Yarmouth avoided 1,726 $MTCO_2e$ of emissions by recycling. Yarmouth's recycling rate of 25.1% is slightly lower than Maine's statewide recycling rate of 33.9%.[5]

Material Type	Tonnage Produced	Emissions Savings ($MTCO_2e$)
Metals	43	-21
Glass	25	-14
Plastics	610	-57
Paper/Cardboard	20	-1,634
Total Emissions Avoided	**698**	**-1,726**

WASTEWATER

Fugitive and wastewater treatment emissions account for approximately 395 $MTCO_2e$. Wastewater treatment emissions are estimated using factors based on the specific treatment processes used by Yarmouth's Wastewater Treatment Plant to treat wastewater, and the total population served in Yarmouth. There were approximately 2,248 wastewater connections in 2019 and an estimated 1,384 septic tanks.

Fugitive emissions from septic tanks made up the majority of emissions for this sector. Septic releases carbon dioxide and methane as it decomposes, both significant greenhouse gases. Similarly, these gases are released during the treatment of sewage at the wastewater treatment plant. The grid electricity used to power the wastewater treatment plant and pump stations accounts for 0.1% of community-wide emissions annually.

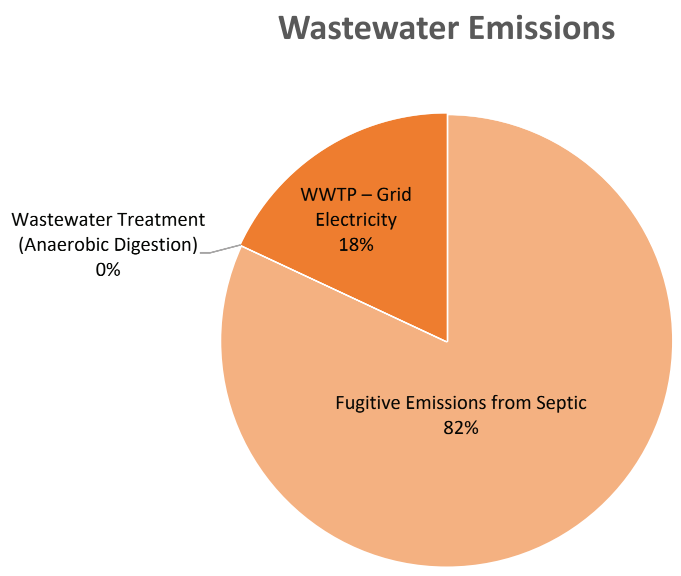


FIGURE 6. Community-Wide Wastewater Emissions

MUNICIPAL OPERATIONS INVENTORY

This section explains the greenhouse gas emissions resulting from Municipal Operations and the Yarmouth School District. As part of the Climate Emergency Resolution, the town set a target to reach net zero municipal and school emissions by 2030.

Total municipal operations emissions for 2019 were estimated to be 1,260 $MTCO_2e$ and total school emissions were estimated at 1,154 $MTCO_2e$. Municipal and School emissions account for 1% each of community-wide emissions (2% of the community total). The largest emissions sector for municipal operations was transportation (34% of combined municipal and school total) resulting primarily from fuel use in the municipal fleet. The largest emission sector for the school department was stationary energy (36% of combined municipal and school total).

TABLE 13. Municipal Emissions by Sector

Sector	Emission Source	GHG Emissions ($MTCO_2e$)	% of Total Combined Municipal and School GHG Emissions
Municipal Operations		**1,260**	**52%**
Stationary Energy (14%)	Buildings & Facilities	258	11%
	Streetlights & Traffic Signals	87	4%
Transportation (34%)	Municipal Fleet	825	34%
	Marine Vessels	3	<1%
Waste (4%)	WWTP	<1	<1%
	WWTP – Grid Electricity	87	4%
School Department		**1,154**	**48%**
Stationary Energy (36%)	Electricity	176	7%
	Natural Gas	686	28%
	Propane	13	1%
Transportation (12%)	Gasoline	42	2%
	Diesel	237	10%
Municipal + School Total		**2,414**	**100%**

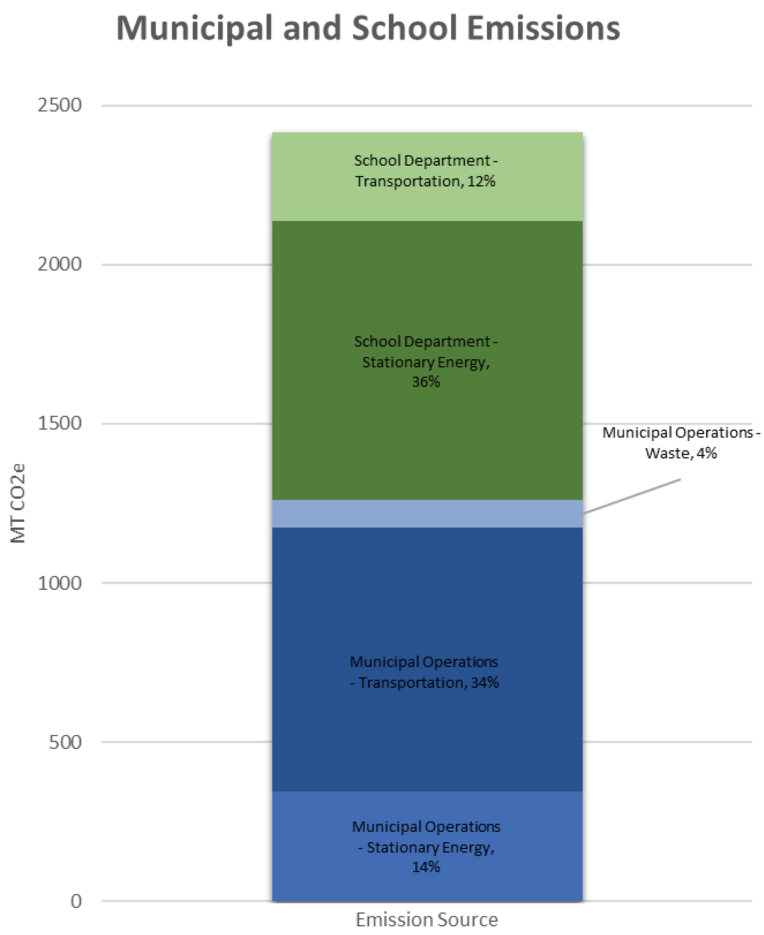


FIGURE 7.
Total Municipal and School Emissions by Subsector

Municipal Operations

STATIONARY ENERGY

Stationary Energy within Yarmouth's municipal operations accounted for 27% of total municipal operation emissions and was estimated at 345 $MTCO_2e$ in 2019. Within this sector, natural gas used for heating in municipal buildings was the most significant contributing energy source of emissions with 137 $MTCO_2e$.

TABLE 14. Municipal Operations Stationary Emissions

Sector	Energy Subsector	Energy (MMBtu)	GHG Emissions ($MTCO_2e$)	% of Municipal Stationary Emissions
Stationary Energy	Buildings & Facilities - Electricity	1843	121	35%
	Buildings & Facilities - Natural Gas	2492	137	40%
	Streetlights & Traffic Signals	1332	87	25%
	Total	**5,667**	**345**	**100%**

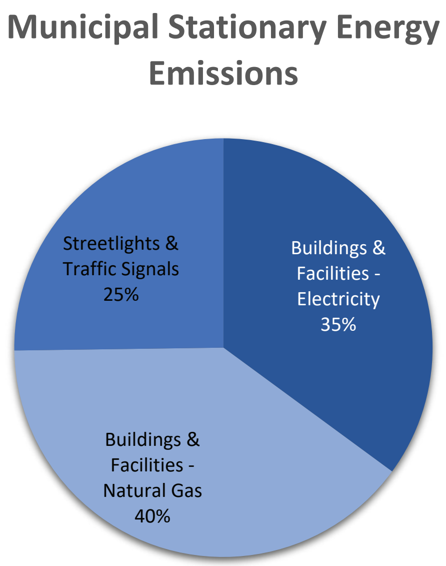


FIGURE 8.
Municipal Stationary Emissions

Since 2019, the municipal government has already taken steps to reduce operations emissions. Most significantly for buildings, the Town entered into a Power Purchase Agreement with ReVision Energy, which greatly offsets emissions from grid-supplied electricity.

TRANSPORTATION

The municipal fleet was responsible for approximately 828 $MTCO_2e$ with 35% coming from gasoline usage, 64% coming from diesel usage, and <1% coming from Yarmouth's marine vessels.

TABLE 15. Municipal Operations Transportation Emissions

Sector	Municipal Fleet	GHG Emissions ($MTCO_2e$)	% of Municipal Transportation Emissions
Transportation	Municipal Fleet – Gasoline	292	35%
	Municipal Fleet – Diesel	533	64%
	Marine Vessel –Gasoline	3	<1%
	Total	**828**	**100%**

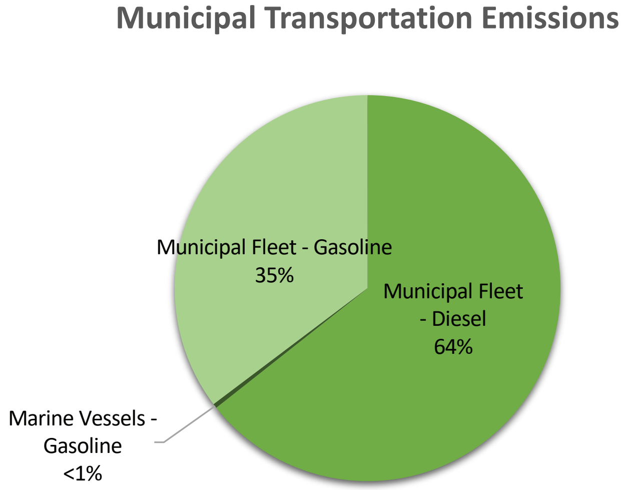


FIGURE 9.
Municipal Operations Transportation Emissions

Annual vehicle fuel data was provided by the Public Works department and marine vessel fuel data was provided by Yarmouth's Superintendent of Vehicle Maintenance. Fuel consumption data is not broken down by municipal department and instead is documented by all department fuel usage as a lump sum. The municipal transportation fuel usage consists of real consumption data provided by town records.

Data could be further improved by tracking fuel consumption by municipal department to better inform vehicle fuel efficiency investments. Additionally, Yarmouth could make the transportation emissions more accurate by calling out employee commuting emissions in the municipal inventory. Currently, those emissions are accounted for in community transportation.

KEY TERMS

MMBtu

Metric Million British thermal unit. This is the standard unit for measuring energy usage and consumption. One kilowatt hour is equivalent to approximately 0.0034 MMBtu.

WASTE

The emissions from this sector are based on the processing of the waste and recycling produced by the Town. This sector also addresses greenhouse gas emissions produced by sewage management and septic tanks. However, the Town does not currently track solid waste produced by its municipal operations, so emissions as a result of municipal waste disposal and incineration are instead captured within the scope of the community inventory.

WASTEWATER

Wastewater connections and septic tanks are contributors to overall greenhouse gases and are sources of methane (CH_4) and carbon dioxide (CO_2), two of the most important greenhouse gases.

Yarmouth's wastewater treatment plant uses anaerobic digestion to treat the sewage sludge generated during the treatment process. Anaerobic digestion involves the breakdown of organic matter in the absence of oxygen, which produces biogas that is composed mostly of CH_4 and CO_2. Biogas can be captured and used as a source of renewable energy or flared to prevent emissions of CH_4, a potent greenhouse gas. However, if the biogas is not captured or flared, it will be released into the atmosphere and contribute to GHG emissions. Currently, Yarmouth's wastewater treatment plant does not capture biogas.

Similarly, septic tanks, which are commonly used in areas that are not connected to a centralized wastewater treatment system, also produce CH_4 and CO_2 through the anaerobic decomposition of the sewage. The emissions from septic tanks may be less than those from a wastewater treatment plant, but they can still be significant, especially in areas with high septic tank densities. One major risk of depending primarily on septic tanks for managing wastewater is the potential for groundwater contamination. Septic systems are designed to treat and dispose of wastewater on-site, typically through a drain field where the effluent is released into the soil.

All municipal buildings in Yarmouth are connected to the Town's sewer system except the Community Building on Cousin's Island, which is serviced by a septic tank. Septic emissions are not included in Yarmouth's municipal inventory due to lack of data.

TABLE 16. Municipal Operations Waste Emissions

Sector	Subsector	GHG Emissions ($MTCO_2e$)	% of Waste Emissions
Waste	WWTP – Anaerobic Digestion	<1	<1%
	WWTP – Grid Electricity	87	99%
	Total	**87**	**100%**

School Department

The Yarmouth School Department includes William H. Rowe School, Yarmouth Elementary School, Harrison Middle School, and Yarmouth High School. Values used to calculate the school's emissions were provided by the school department staff and utility providers. As part of the Emergency Resolution, Yarmouth's School Department was included in the GHG emission reduction targets for the municipality — net zero emissions by 2030.

Emissions data for the schools is calculated using the data from the consumption of electricity, natural gas, propane, gasoline and diesel. Waste data was not readily available and thus excluded from the school department calculations. Data collection could be further improved by tracking the total tonnage of waste produced by the schools.

TABLE 17. School Emissions by Sector

Sector	Subsector	GHG Emissions ($MTCO_2e$)	% of Total School Emissions
Stationary Energy (75%)	Electricity	176	15%
	Natural Gas	686	59%
	Propane	13	1%
Transportation (25%)	Gasoline	42	4%
	Diesel	237	21%
School Department Total		**1,154**	**100%**

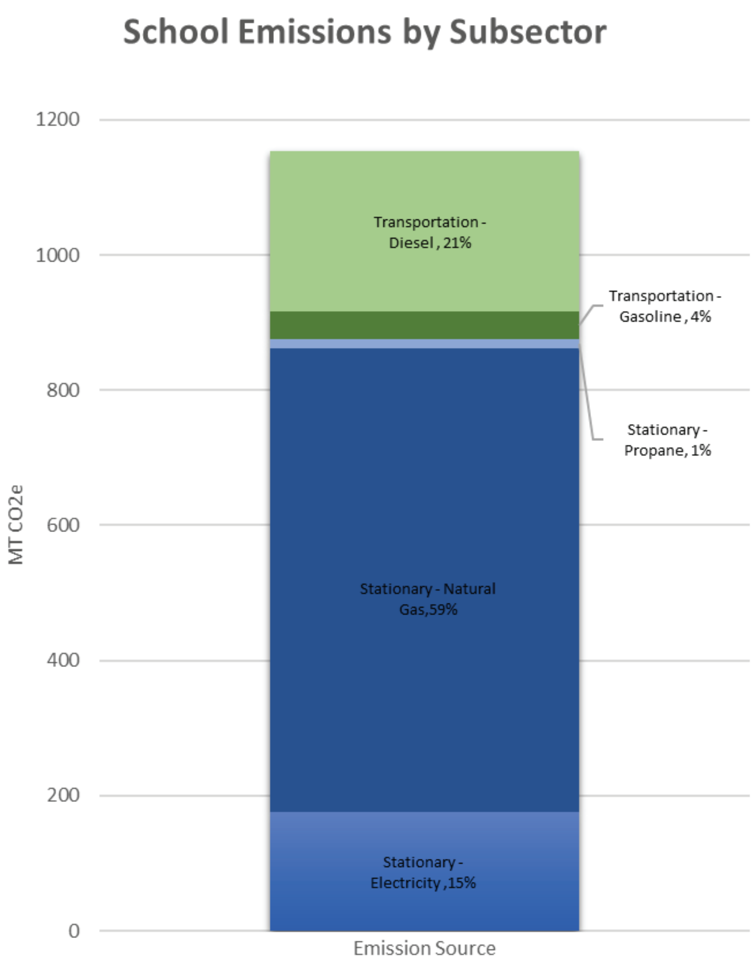


FIGURE 10. Yarmouth School Department Emissions

EMISSION REDUCTION TARGET

Setting emission reduction targets establishes clear, quantifiable goals for the town to measure. It can help align with state, federal and international goals, and ensures the town acts to reduce the future impacts of climate change. Reducing energy usage can also generate cost-savings for the municipality, businesses, and residents. The modeling software used for this inventory, ClearPath, can be used to establish emission reduction targets and detail the actions needed to achieve those targets. Yarmouth has already established emission reduction targets.

In 2022, Yarmouth passed a Climate Emergency Resolution which set a target of an 80% reduction in community-wide greenhouse gas emissions by 2030 and a net-zero target for community-wide emissions by 2050. It also established a net-zero emissions goal for municipal and school operations by 2030.

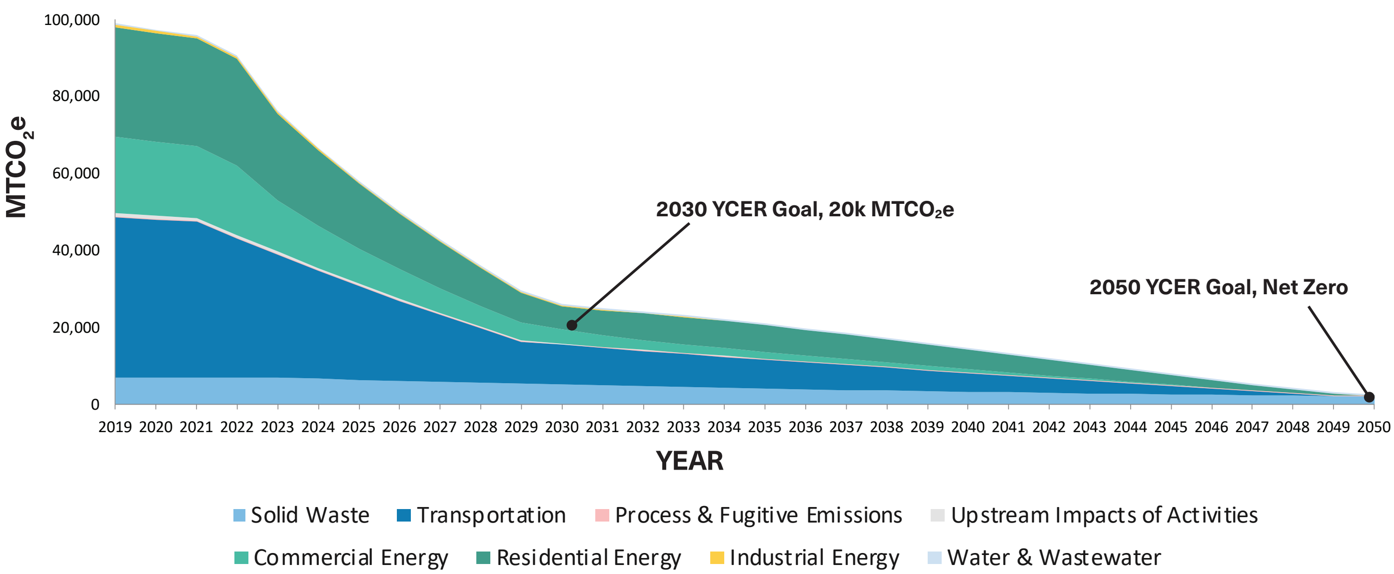
KEY TERMS

Net zero describes when greenhouse gases going into the atmosphere are balanced by removal out of the atmosphere. Removal strategies are pursued only after all emissions reduction strategies are exhausted.

ClearPath's emissions reduction utilizes the 2019 inventory as a baseline to provide a list of strategies to help reach reduction targets, such as residential electrification. These numbers are not a hard-set guide, but an attempt to illustrate possible pathways to achieving reduction targets. Electrification and efficiency strategies can be balanced against other sectors' strategies and should align with realistic expectations of progress in each sector. For example, if more residential buildings undergo weatherizations, then fewer commercial buildings will need to be weatherized to achieve the same community-wide emissions savings.

ClearPath modeling looks at stationary and transportation community-wide emissions with projected targets to model how much emissions need to decrease and generates potential strategies for how to meet those reductions goals.

FIGURE 11. Yarmouth Climate Emergency Resolution Emissions Forecast



Emission Reduction Strategies

In order for Yarmouth to achieve net zero emissions by 2050, the Town will employ actionable and measurable emission reduction strategies. Emission reduction strategies are those that specifically result in reduced community emissions. While some strategies focus on directly reducing the consumption of fossil fuels, others focus on increasing energy efficiency.

Stationary Energy Strategies

Installing Heat Pumps	Heat pumps are electric HVAC systems that can heat and cool buildings. Heat pumps displace the need for on-site fossil fuels, like propane or kerosene. Heat pumps vary considerably in the amount of area they can heat and the cost to install. For this report, a typical heating capacity of 2,000 square feet was used to determine the annual number of heat pump installations needed to reach emission reduction targets.
Weatherizing Buildings	Weatherization projects reduce the amount of heat lost from a building by updating the buildings infrastructure. By retaining heat inside the building longer, less energy is required to maintain the temperature, thereby reducing emissions. Updating or adding insulation is one method of improving the energy efficiency. Updating windows, or utilizing additional window insulation in the winter, can also improve energy efficiency. While weatherization projects have a smaller effect on reducing emissions than other strategies, they provide other benefits, such as long term energy cost savings and maintaining inside temperatures longer during power outages.
Producing Solar Energy	Switching to renewable energy sources is the most direct way to reduce emissions resulting from buildings. The modeling software used for this inventory only allows for solar energy to be accounted for in the emissions forecast scenario, but other types of renewable energy could be used to displace fossil fuels. Solar systems come in many kW capacities and sizes. ClearPath's modeling uses a 4 kW solar panel system as a standard size, since that size could be utilized as a rooftop panel or in a larger solar field. A 4 kW system, on average, is 269 square feet and can produce half the annual energy needs for a Yarmouth household.[7] The kW capacity added is a more flexible metric to track, as that can be related to any form of renewable energy, and directly correlates to fossil fuel energy displaced.

REDUCTION PATHWAY ASSUMPTIONS

To create emission reduction pathways and reduction strategies, additional parameters related to population and infrastructure changes were incorporated in the models. The assumptions, which apply to all emission forecasts, are described below:

Population Growth	Yarmouth's historical population data indicates an increasing trend. Data from the U.S. Census was used to calculate an annual growth rate of 0.46% for 2023-2050.[8]
Electricity Grid	In 2019, Maine established a new Renewable Portfolio Standard (RPS). The law requires that 80% of the state electricity grid is supplied from renewable energy sources by 2030, with an additional goal to increase the RPS to 100% by 2050.[9] These RPS values informed the carbon intensity coefficient for grid-supplied electricity in Yarmouth's models.
Weatherization Upgrades	Weatherization projects for buildings vary in type and scale, as described in the Stationary Energy Strategies table. Consequently, the impact on building energy efficiency can vary greatly. The ClearPath reduction strategies models a conservative savings of 271 kWh per household per year or 3% of the average household annual electricity usage. Commercial/industrial facilities' weatherization upgrades were modeled at 2% per building per year.
Passenger Vehicle CAFE Standards	Fuel efficiency is expected to improve over the next few decades due to federal regulation. Corporate Average Fuel Economy (CAFE) regulations were incorporated into the carbon intensity coefficient for passenger vehicles only.[10] ICLEI provides a standard set of factors to apply to forecasts, developed from an EPA fuel efficiency change model.[11]

2007 GREENHOUSE GAS INVENTORY

Yarmouth first conducted a Greenhouse Gas Inventory in 2007, which estimated that the town emitted 98,278 $MTCO_2e$. Residential energy was the biggest emitter making up 44% of total emissions.

TABLE 18. 2007 Community Greenhouse Gas Inventory by Sector

Sector	GHG Emissions ($MTCO_2e$)	% Of GHG Emissions
Residential Energy	40,654	44%
Commercial/Industrial	24,500	24%
Transportation	28,115	28%
Water Services	1,116	1%
Waste	885	<1%
Municipal	3,008	3%
Municipal Total	**98,278**	**100%**

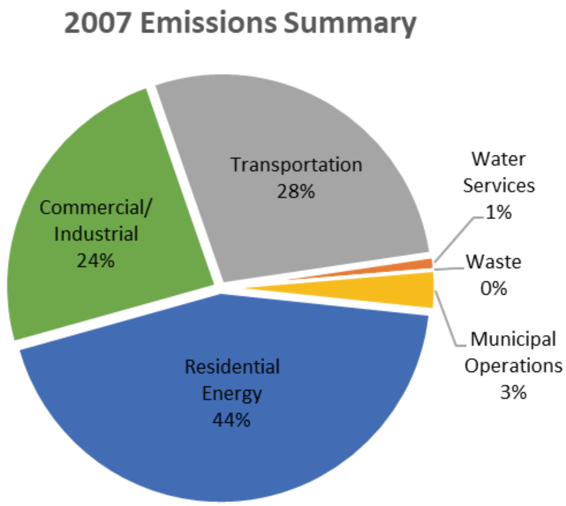


FIGURE 12.
2007 Community Greenhouse Gas Inventory by Sector

Results from the 2007 inventory are included here as a general comparison, however, the methods used for emissions data modelling, as well as the data collection software available, have changed significantly since the completion of Yarmouth's first inventory. Because the methods of collecting and calculating emissions data differ greatly from the methods used for this 2019 inventory, it is difficult to provide an accurate assessment of how community-wide emissions have changed since 2007. Below is a summary of differences between the two inventories.

Differences from 2007 Inventory

Yarmouth's first GHG Emissions Inventory used Clean Air and Climate Protection (CACP) software purchased from ICLEI.

Stationary Energy: While residential electricity consumption was also obtained from Central Maine Power, fuel consumption could only be estimated from data obtained from the Maine State Housing Authority for the year 2000 and Yarmouth Assessor's office looking at average fuel consumption per household. It was not able to separate out type of fuel. Also, the 2007 inventory could only estimate commercial and industrial fuel usage by using the average New England Commercial energy consumption per square foot of floor area by primary heating fuel type from the US Energy Information Administration. The report also does not indicate whether T&D Loss and Fugitive emissions are included.

Transportation: Total VMT estimates were obtained from the Maine Department of Transportation, which is not as accurate as current modeling and analysis software and unable to distinguish between type of vehicle (passenger, commercial, etc.), which impacts the emissions total. The inventory reflected only automotive transportation occurring entirely within the Town of Yarmouth and did not account for commuting residents, or those trips which started or ended in Yarmouth. The report indicates that transportation likely accounts for a larger portion of emissions than reflected in the inventory.

Waste: Unlike the 2019 inventory where ecomaine provided the annual tonnage of waste for Yarmouth, both incinerated and recycled, the 2007 inventory could only estimate their tonnage of solid waste through the Maine State Planning Office and did not include recycled materials. This results in an underestimation of total waste generated by both the municipality and residents.

TRACKING PROGRESS

Yarmouth is already taking steps to reduce greenhouse gas emissions and implement climate action strategies. However, an effective plan to reduce greenhouse emissions will require tracking and monitoring. To ensure that the town stays on track to meet its emissions reduction targets, Yarmouth will update the GHG Inventory every 3 years when possible, using the same ClearPath software for consistency. In addition to updating the inventory, there are additional metrics ('indicators') described below that the town can track on a yearly basis to assess progress between inventory assessments. Indicators detailed below relate to sectors most directly tied to emissions generation, but indicators in other strategy areas like natural resources and public health are also important for measuring progress towards Climate Action Plan goals. Further indicators and details on additional climate actions are included in the Climate Action Plan.

The models and assumptions used to create these indicators were based on the best-available data at the time this inventory was authored. However, it is crucial to keep in mind that both population trends and technological developments can experience drastic and unpredictable changes within the forecasted period. Cumberland County's population grew 2.1% between 2020 and 2021, more than double its average annual change for the preceding 5 years.[12] Maine experienced a population boom in 2020, largely due to an increase in the remote worker population due to the COVID-19 pandemic.[13] Similarly, Maine is likely to experience an influx in population of "climate migrants"- individuals from vulnerable areas seeking a more resilient community- as climate hazards intensify.[14] To incorporate flexibility into the planning process, it is better to focus on targets as an overall percentage of the target population when applicable. The Town of Yarmouth will reassess these indicators regularly as new population and technology information becomes available.

Key Performance Indicators (KPIs)

The following tables show the essential strategies needed to reach the net zero community target through residential and commercial stationary energy and transportation. The strategy areas, such as weatherization, have metric targets per year that show how progress can be made to meet the emissions reductions goals. These KPIs overlap with metrics of progress presented in the Climate Action Plan. The emissions presented here do not include upstream losses/fugitive emissions, which is why they differ slightly from values presented earlier in the report.

TABLE 19. Emission reductions by sector needed to reach targets

Sector	2019 GHG Emissions ($MTCO_2e$)	2030 GHG Emissions ($MTCO_2e$)	2050 GHG Emissions ($MTCO_2e$)
Residential Energy	28,781	5,903	0
Commercial	19,781	3,778	0
Transportation	42,319	10,942	16
% Reduction from 2019		**77%**[15]	**100%, Net Zero**

STATIONARY ENERGY

TABLE 20. Residential strategy areas to reach targets

Strategy	2024–2030	2031–2050	Total
Heat Pumps (Households Electrified)	1,055 151 per year	1,340 67 per year	2,399
Weatherization (Households)	525 75 per year	450 23 per year	975
Solar Energy (# of 4kW Solar Panel Systems Installed at homes)	15,750 2,250 per year	3,250 163 per year	19,000
Solar Energy (kW Capacity Added to households)	63,000 9,000 per year	13,000 650 per year	76,000

TABLE 21. Commercial strategy areas needed to reach targets

Strategy	2024–2030	2031–2050	Total
Heat Pumps (Installations)	1,750 250 per year	400 20 per year	2,150
Weatherization (Businesses)	244 35 per year	70 3.5 per year	314
Solar Energy (# of 4kW Solar Panels Installed at businesses)	2,800 400 per year	100 5 per year	2,900
Solar Energy (kW Capacity Added to Businesses)	11,200 1,600 per year	400 20 per year	11,600

Heat Pump Installations

Tracking heat pump installations can be an effective way to measure progress towards reducing overall greenhouse gas emissions. Heat pumps use electricity to move heat from one place to another rather than generating heat directly, typically between units inside and outside of a building, making them highly efficient and a low-emissions alternative to traditional heating and cooling systems.[16] Heat pump installations can help reduce the overall consumption of fossil fuels used for heating in the winter and electricity consumption for cooling in the summer.

The Town can get a sense of overall heat pump adoption within the community by tracking the total amount of Efficiency Maine rebates. Additionally, the municipality might consider tracking the energy savings achieved by heat pump installations within their own buildings to inform future policy decisions and local incentive programs for further adoption.

Weatherization Rebates
Similar to heat pump installation, tracking weatherization rebates can be an opportunity to show how many residents are taking advantage of Efficiency Maine programs, and working to reduce energy usage within homes.

In 2022, Yarmouth received 79 weatherization rebates from Efficiency Maine.

Household Energy Burden
Household energy burden is a term used to describe the percentage of a household's income that is spent on energy bills. It's a key indicator of energy affordability and is becoming increasingly important to consider as households struggle to afford necessities. A household's energy burden can be impacted by several factors such as a home's energy efficiency, the cost of electricity and heating fuel, and the household's income.

According to the US Department of Energy's Low Income Energy Affordability Data Tool, Yarmouth residents spend an average of 2% of household income on home energy bills compared to Maine's state average of 3% in 2020.[17] A high energy burden is considered to be anything above 6% and a severe energy burden above 10%. Yarmouth can use the site to monitor residents' energy burden over time.

TRANSPORTATION

In 2019 the Yarmouth municipal vehicle fleet was responsible for emitting 825 $MTCO_2e$ and community transportation emissions were responsible for 42,188 $MTCO_2e$. Measuring and tracking emissions from the transportation sector is important for developing effective strategies to reduce greenhouse gas emissions and mitigate the impacts of climate change.

Yarmouth can track its community's progress towards more sustainable transportation methods by collecting data on the total number of registered electric vehicles, the number of EV charging ports, and transit ridership frequency.

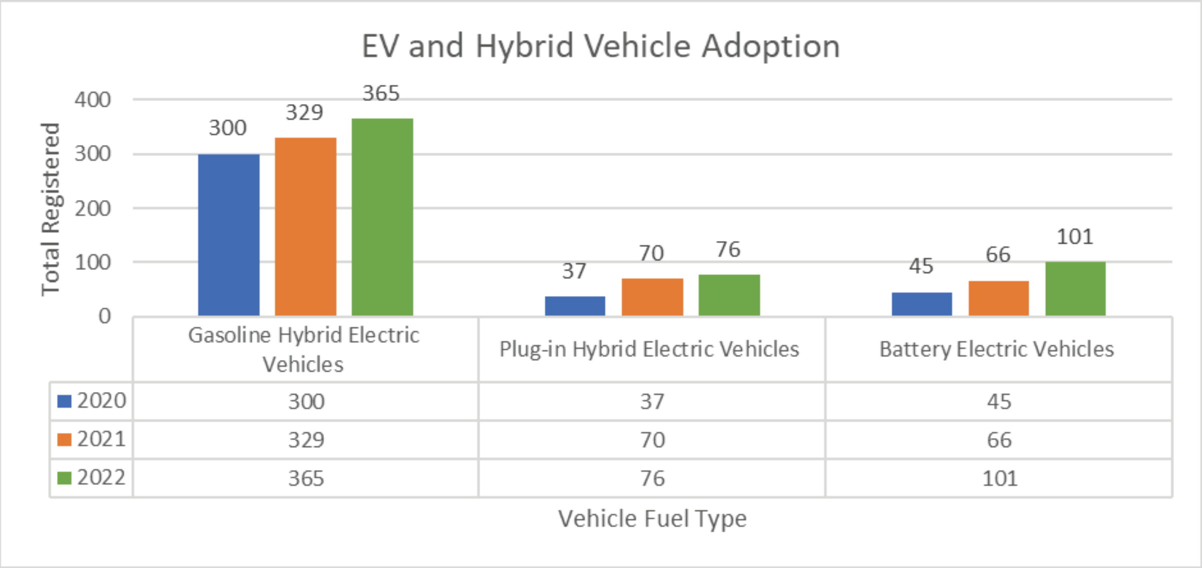
TABLE 22. Transportation strategy areas needed to reach targets

Strategy	2024–2030	2031–2050	Total
Electric Vehicle Transition	70% 10% per year	20% 1% per year	90% of community gasoline vehicles replaced with EVs[18]
Bus Conversion to Electric/Alternative Fuels[19]	100% of gasoline and diesel buses 3.7% per year		
Transit Expansion/ Vehicle Miles Traveled (VMT) Reduced	Decrease community VMT by 10%	Maintain 10% decrease in community VMT	

Number of Registered Electric Vehicles (EVs) and Hybrid-electric Vehicles

Battery electric vehicles produce zero tailpipe emissions, and plug-in hybrid electric vehicles emit significantly less emissions than traditional gasoline-powered cars. This means that as the total number of EVs on the road increases, there will be a corresponding reduction in transportation emissions. By tracking the total number of EVs on the road, it is possible to measure how much progress is being made in reducing transportation-related emissions. For the purpose of this inventory, an EV is classified as any vehicle which has the capability to plug into an EV charging station. This includes battery electric vehicles, and plug-in hybrid vehicles. Although gasoline hybrid vehicles still utilize an electric drivetrain and emit significantly fewer overall emissions than their traditional combustion engine counterparts, they are classified as hybrids, not electric vehicles.

In 2022, there were 7,862 vehicles registered in Yarmouth. Of vehicles registered, 4.6% are gasoline hybrid, 1% are plug-in hybrid, and 1.3% are battery electric.



	Gasoline Hybrid Electric Vehicles	Plug-in Hybrid Electric Vehicles	Battery Electric Vehicles
2020	300	37	45
2021	329	70	66
2022	365	76	101

FIGURE 13. Data from Maine Department of Environment Protection Vehicle Emissions and Greenhouse Gas Data[20]

Public EV Charging Stations

The availability of EV charging stations within a community can be an effective way to encourage more people to switch to electric vehicles, as it provides a convenient and reliable network to recharge their EVs. Although an affordable, accessible, and reliable charging network is essential for widespread EV adoption, according to a 2022 survey conducted by the Natural Resources Council of Maine, 90% of surveyed EV owners primarily charge at home.[21] Tracking the total number of public charging stations can still be a good indicator of EV adoption within the community, especially for renters.

Yarmouth has two charging stations: Town Hall with 3 ports and Casco Bay Ford with 1 port.[22] The Town won a grant in 2023 to add 4 additional ports on municipal property.

TABLE 23. Public EV charging stations in Yarmouth

EV Charging Types	Total Number of Charging Ports (2022)
Level 2 Charging	4
DC Fast Charging	0
Tesla Super Chargers	0

MUNICIPAL OPERATIONS

KPIs have also been developed to guide the Town of Yarmouth in achieving their municipal operations emissions goal of net zero by 2030. The following table outlines a possible approach the municipality could take to reduce greenhouse gas emissions from buildings and facilities, the municipal vehicle fleet, and waste from operations.

TABLE 24. Municipal strategy areas needed to reach targets

Sector	Strategy	2024–2030	Result
Buildings and Facilities	Electrify heating sources	• Prioritize buildings using propane and fuel oil. Transition the wastewater plant off fuel oil and school facilities off propane by 2025. • Transition 2 buildings every year from natural gas heating to electrified heat or other non-fossil heat starting in 2026.	100% electricity-based heating by 2030.
	Increase energy efficiency	• Perform energy efficiency upgrades (update insulation, install new windows, etc.) on 4 buildings every year. Prioritize municipal and school buildings by use, age and condition.	Reduced emissions and heating costs for all municipal and school buildings by 2030.
Fleet	Transition to electric/ alternative fuel vehicles	• Prioritize gasoline cars and light-duty trucks. Replace 3 of these vehicles every year. • Transition medium- and heavy-duty trucks. Displace/replace 2 vehicles every year. • Transition 3 vehicles/buses per year from the school fleet.	100% clean-fuel municipal and school on-road fleet by 2030.
Waste	Reduce waste volume	• Pursue recyclable and compostable materials for municipal and school operations. • Increase recycling and composting drop-off availability in public municipal-owned spaces.	Reduce solid waste from municipal and school operations.

CLIMATE ACTION PLAN

The Town of Yarmouth's Climate Action Plan used this inventory and modeling pathway as a guide to develop tailored strategies and actions the Town can take to reach its targets, as well as broader goals for community resilience to climate change. The Plan includes recommended metrics to track that indicate progress over time. This Inventory will serve as the foundation of data to update over time paired with a review and update of CAP actions.

ENDNOTES

1 https://www.epa.gov/sites/default/files/2015-07/documents/fugitiveemissions.pdf
2 https://ghgprotocol.org/sites/default/files/standards/GPC_Full_MASTER_RW_v7.pdf
3 https://icleiusa.org/ghg-protocols/
4 https://www.eia.gov/consumption/commercial/
5 https://www.maine.gov/labor/cwri/qcew1.html
6 https://ghgdata.epa.gov/ghgp/service/facilityDetail/2021?id=1001615&ds=E&et=&popup=true
7 https://pvwatts.nrel.gov/pvwatts.php
8 DP05: ACS DEMOGRAPHIC AND ... - Census Bureau Table
9 Renewable Portfolio Standards | Governor's Energy Office (maine.gov)
10 USDOT Proposes Updated Fuel Economy Standards to Strengthen Energy Security, Save Americans Hundreds of Dollars at the Gas Pump | NHTSA
11 Optimization Model for reducing Emissions of Greenhouse Gases from Automobiles (OMEGA) | US EPA
12 DP05: ACS DEMOGRAPHIC AND ... - Census Bureau Table
13 The pandemic gave Maine a population boom. Will climate change be next? (pressherald.com)
14 NOAA_NEST_REPORT_2023.pdf (d3esu6nj4wau0q.cloudfront.net)
15 The 2022 Yarmouth Climate Emergency Resolution set an intermediate goal of 80% emissions reduction by 2030.
16 https://www.efficiencymaine.com/heat-pumps/
17 https://www.energy.gov/scep/slsc/lead-tool
18 Up to 30% plug-in hybrid electric vehicles.
19 Includes both school and public transit buses. The Town of Yarmouth does not have direct control over regional public transit vehicles, but can advocate for alternative fuel public transit in the region. 20. https://www.maine.gov/dep/air/mobile/vehicle-data.html
21 https://www.nrcm.org/wp-content/uploads/2022/08/2022-NRCM-EV-survey-results.pdf
22 https://afdc.energy.gov/stations/#/analyze?region=US-ME&fuel=ELEC&ev_connectors=J1772&ev_connectors=J1772COMBO&ev_connectors=CHADEMO&show_map=true&location=Yamouth,%20Maine&radius=1F