Town of Amherst
Greenhouse Gas Inventory Report

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Table of contents

I. INTRODUCTION: AMHERST AND CLIMATE ACTION

The Town of Amherst (Amherst) is located in eastern Hampshire County, in the Pioneer Valley region of the Commonwealth of Massachusetts (Massachusetts).

As of 2022, Amherst's population was estimated to be 40,059, the largest in the county. Periods of modest growth and modest decline are expected in the coming decades, with the population remaining between approximately 35,000 and 41,000 residents.

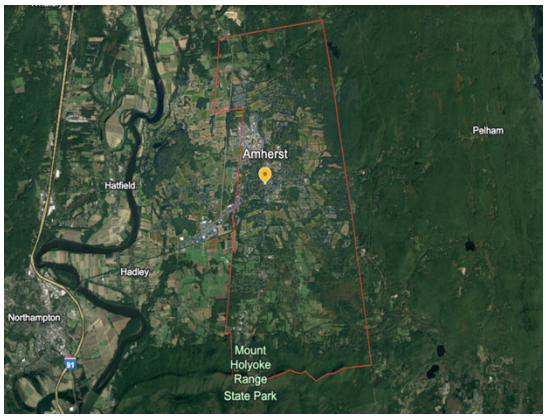


Image 1. Birdseye view of the Town of Amherst. Image credit: Google Earth.

Amherst has previously completed four greenhouse gas (GHG) inventories, using data from the fiscal years (FYs) (July 1 through June 30):

- 1997
- 2005
- **2011 and 2016 (included in the same inventory workbook and report)**

The FY 2011 and FY 2016 inventories established a baseline for emission reduction goals. Using the same scope as the FY 2011 and FY 2016 inventories, the FY 2022 inventory will help the Town understand where emission reductions have been made and what climate actions may have been impactful to date, as well as identify areas in which further efforts can be made. Overall, the FY 2022 inventory update takes stock of the community's emissions so that the Town of Amherst may:

- **assess progress** made toward emission target goals—in particular, the approaching 2025 emission reduction goal;
- **prioritize projects** based on potential emissions impact; and
- **support and incentivize community climate action**.

Goals

In 2019, the Town Council committed to ambitious communitywide emission reduction goals, recommended by the Town's Energy and Climate Action Committee (ECAC), and based on the GHG emissions from baseline year 2016.

- **By 2025: 25%** emission reduction from 2016 baseline
- **By 2030: 50%** emission reduction from 2016 baseline
- **By 2050: 100%** emission reduction from 2016 baseline (zero emissions)

Efforts to date

Since the last GHG inventory in 2017, the Town has taken action to become a more sustainable, equitable, and resilient community. Highlights include:

- The formation of the **Energy and Climate Action Committee (ECAC)**, a group to guide the climate adaptation, mitigation, and resilience work of the Town

What are process and fugitive emissions?

Process and fugitive emissions are emissions from losses that take place during the distribution and delivery of oil and gas, as well as leaks that take place during operation/use. Additionally, there are emissions associated with losses that take place during the transmission and distribution (T&D) of electricity.

- The development and publication of the **Climate Action, Adaption, and Resilience Plan (CAARP)**, a plan to drive the Town's near-, middle-, and long-term climate action work with a focus on equity, health, and resilience for Amherst's residents

- The development of a **Town-wide Solar Assessment Report** and **Solar Feasibility Mapping Tool**, together intended to serve as tools to serve the **Solar Bylaw Working Group** and to guide municipal and community development of solar energy in Amherst

- The implementation of a **Net Zero Energy Bylaw,** which requires that all new Town buildings and additions that cost more than $2,000,000 operate without fossil fuels

For recommendations on further efforts and opportunities for climate action, see the **Town of Amherst Climate Action, Adaptation, and Resilience Plan (CAARP)** recommendations.

II. INVENTORIES

Municipal Inventory

The Municipal Inventory accounts for the greenhouse gas (GHG) emissions associated with municipal operations, covering all facilities, vehicles, and amenities that the Town controls. This inventory quantifies the activities and emissions that the Town of Amherst can directly impact. With knowledge of the emissions generated by operations, Amherst will be able to target emitters and prioritize energy efficiency and clean energy projects to reduce carbon.

The Municipal Inventory also allows the Town to understand their contribution to the broader community's emissions. In relation to communitywide emissions, municipal emissions are a small slice of the Amherst emissions pie. For contextualization of municipal and communitywide emissions, see *Section IV. Community Emissions Summary—Community Emissions Overview*.

The greenhouse gases included in the inventory are:

- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxides (NO_x)

Emissions from methane and nitrous oxides are converted using their respective 100-year Global Warming Potentials (GWPs) and expressed in terms of carbon dioxide equivalent (CO_2e).

What is global warming potential?

Each greenhouse gas (GHG) has a global warming potential (GWP), which is an expression of the warming impact of that gas. While a certain concentration of GHGs in the atmosphere are essential to retaining a degree of warmth that makes life on earth possible, an excess of GHGs caused by human activity are present in the earth's atmosphere, allowing less and less heat to escape and causing the rapid heating of our planet and threatening its habitability.

Methodology. The Municipal Inventory was completed using guidance provided in the ***Local Government Operations Protocol*** **(LGOP)**, a protocol developed by ICLEI – Local Governments for Sustainability, the California Air Resources Board, the California Climate Action Registry, and The Climate Registry.

Activities and emissions are organized into six major categories:

- Municipal Buildings
- Other Municipal Facilities
- Public Lighting
- On-Road Vehicles
- Off-Road Vehicles and Equipment
- Other Process and Fugitive Emissions

Emissions are further categorized by Town department: Administration (sometimes referred to as General Government); Conservation; Fire; Information Technology (IT), which represents public Town wireless internet; Libraries; Parking; Parks & Commons; Police; Public Works, which includes Waste (emissions from operations related to waste and not from the waste itself); Recreation (formerly known as LSSE or Leisure Services); Schools; Traffic/Street Lights; Wastewater; and Water.

Assumptions and adjustments. Empirical data was available for some but not all activities. Detailed information concerning the character of data (empirical or modeled) can be found in the Municipal Inventory workbook. Assumptions and adjustments made for the Municipal Inventory beyond these data distinctions are noted below.

> *On-Road Vehicles.* Although the municipal vehicle fleet includes electric vehicles (EVs), electricity consumed by these vehicles is not specifically accounted for in the on-road vehicles section, since electricity consumption for charging is not tracked. Instead, because EVs are charged at municipal buildings, their electricity consumption is accounted for under Municipal Buildings electricity usage.
>
> *Other Process and Fugitive Emissions.* While municipal activities generate waste, it is not currently possible to distinguish the waste generated by municipal operations from other waste. Therefore, all solid waste activity data and emissions are included in the Community Inventory.

Community Inventory

The Community Inventory accounts for activities within the geographic boundaries of the Town of Amherst and the emissions they generate. This includes the municipal activities and operations calculated in the Municipal Inventory as well as activities and emissions from residences, commercial and industrial (C&I) properties and activities, higher education institutions, transportation, waste, agriculture, and land use.

Methodology. The Community Inventory was completed using guidance provided in the ***Global Protocol for Community-Scale Greenhouse Gas Emission Inventories* (GPC)**. The GPC BASIC+ Framework was used to determine which activities were included in the inventory. Emissions are categorized by sector:

- Stationary Energy
- Transportation
- Waste
- Agriculture, Forestry and Other Land Use (AFOLU)

Sectors are then organized into subsectors.

Where possible, community emissions are subset by contributor:

- Amherst College
- Hampshire College
- University of Massachusetts Amherst (UMass)
- Municipal
- Residential
- Community (remaining community emissions, including commercial and industrial (C&I), that cannot be attributed to any of the above)

Assumptions and adjustments. Empirical data was available for some but not all activity categories and sectors. Detailed information concerning the character of data (empirical or modeled) can be found in the Community Inventory workbook. Assumptions and adjustments made for the Community Inventory beyond these distinctions are noted below.

Stationary energy. Information from Amherst College was not available. In lieu of emissions calculations based on activity data provided by Amherst College, the Community Inventory uses numbers based on data from 2016 and from the adjusted business-as-usual (ABAU) forecast for 2025 prorated for 2022, assuming a constant rate of change from 2016 to 2025 year over year.

Transportation. Information from Amherst College was not available. Estimated ABAU numbers were calculated as described in *Stationary energy* above.
Waste. Information from Amherst College was not available. Estimated ABAU numbers were calculated as described in *Stationary energy* above.

Industrial Processes and Product Use (IPPU). Because no major industrial processes are located within the Town of Amherst, this sector is not included.

III. MUNICIPAL EMISSIONS SUMMARY

As discussed previously, since the last inventory was conducted in 2017, Amherst has undertaken a number of initiatives to reduce emissions and advance sustainability, equity, and resilience. In particular, the Town has worked to make its operations—all activity associated with municipal buildings, facilities, and transportation—less carbon-intensive.

2016	**4,389 $MTCO_2e$**	**-537 $MTCO_2e$**	**-12.24%**
2022	**3,852 $MTCO_2e$**		

Figure 1. Equivalency of municipal emission reductions in terms of emissions avoided by trash bags of waste recycled instead of landfilled and, alternatively, in terms of carbon sequestered by acres of forest. Credit: US EPA Greenhouse Gas Equivalencies Calculator.

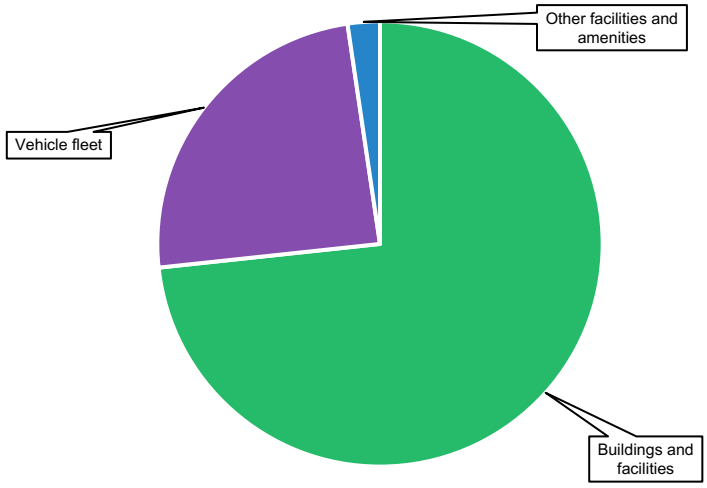


Figure 2. Municipal emissions by sector.

73.3% Buildings are the largest emitters in the Municipal Inventory. They consume heating fuels (methane gas and heating oil) as well as electricity.

24.4% Fleet vehicles are the next largest emitters. While the fleet contains several electric vehicles (EVs)—also known as zero-emission vehicles (ZEVs)—the majority of municipal vehicles consume gasoline and diesel.

2.3% Other buildings and facilities generate the least emissions.

The three facilities/amenities included in the **Other buildings and facilities** sector are:

- **Street and traffic lights**, which the Town has converted to LED lighting with support from the Commonwealth of Massachusetts Green Communities Program
  Note: The Town does not control all traffic and street lights within the geographic bounds of Amherst; they retrofitted all of the lights that they own and operate.
- **Parking**, which includes the kiosks used for parking payment
- **Downtown wireless,** which is a free public amenity provided downtown

All municipal operations account for **3,852 $MTCO_2e$**—or just **1.5%**— of communitywide emissions. While the Town contributes relatively little to Amherst's overall emissions, it still aims to transition away from toxic fossil fuels in all operations, leading by example so that residents, businesses, and institutions may follow.

Municipal Buildings

2016	**2,248 $MTCO_2e$**	**+576.9 $MTCO_2e$**	**+25.6%**
2022	**2,824.9 $MTCO_2e$**		

The Town has endeavored to improve energy efficiency, move away from fossil fuel-burning systems, and substitute less carbon-intensive for more carbon-intensive fuels in its buildings. However, overall building emissions in FY 2022 were greater than those in FY 2016, increasing from **2,248 $MTCO_2e$** to **2,824.9 $MTCO_2e$**.

Amherst Facilities Maintenance Manager Jeremiah LaPlante posits that this increase comes from the diminishing efficiency of the Town's existing fossil fuel-burning systems. Simply put, as systems age, they become less efficient. To mitigate the effects of decreased efficiency and to minimize the resultant emissions, existing systems should be maintained and routinely serviced, until they are replaced by fossil fuel-free systems.

Transitioning municipal buildings away from fossil fuels

In Summer 2023, Sustainability Fellow Miguel Gothers-Reyes created an inventory of all municipal buildings' and facilities' HVAC systems, as well as a rating method and a phased timeline for the replacement of municipal fossil fuel-burning HVAC systems with electric systems. For more information, see Miguel's report.

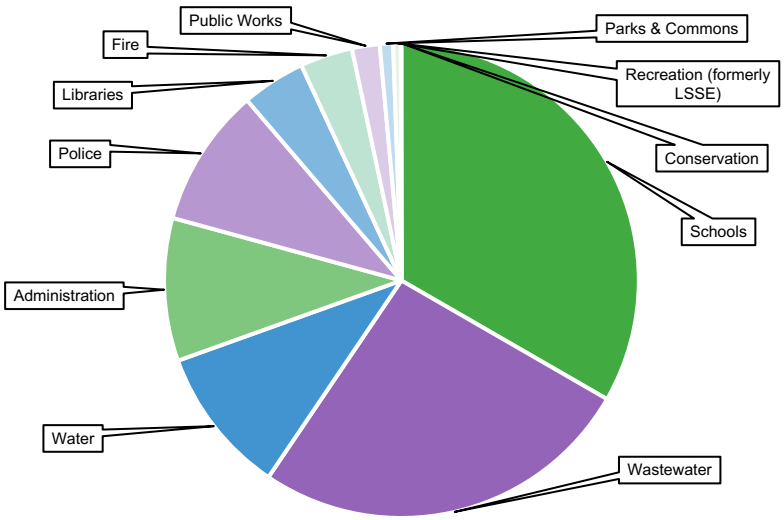


Figure 3. Municipal building emissions by department.

33.3% Schools are the largest emitters of the municipal buildings.

Note: Only Amherst elementary schools are accounted for in the municipal inventory, as the middle school and high school are regional.

26.1% Wastewater treatment operations make up the next largest bucket of emissions.

Note: This includes emissions only from the operations of the wastewater treatment plant, not from the wastewater itself.

10.1% Water treatment is the third greatest generator of emissions.

The fourth and fifth greatest departments closely follow the emissions of water treatment: **Administration**, which includes Town Hall and Bangs Senior Center operations and accounts for **9.7%** of municipal building emissions, and the **Police Department,** which accounts for **9.5%** of municipal building emissions.

The Town's building energy mix has seen several changes since FY 2016, while still using the same three main sources of energy: electricity, methane gas, and heating oil (distillate fuel oil no. 2).

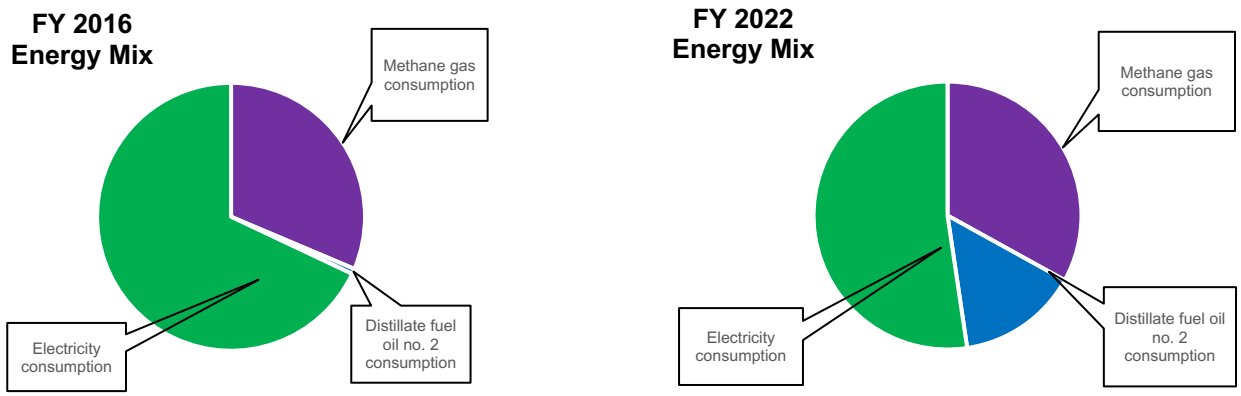


Figure 4. Municipal building energy consumption by fuel type for FY 2016 and FY 2022.

Electricity. Overall electricity consumption for municipal buildings and facilities decreased from **6,783,180 kWh** in FY 2016 to **5,956,451 kWh** in FY 2022. Emissions resulting from electricity use in municipal buildings and facilities also decreased from **1,773.68 $MTCO_2e$** in FY 2016 to **1,469.45 $MTCO_2e$** in FY 2022.

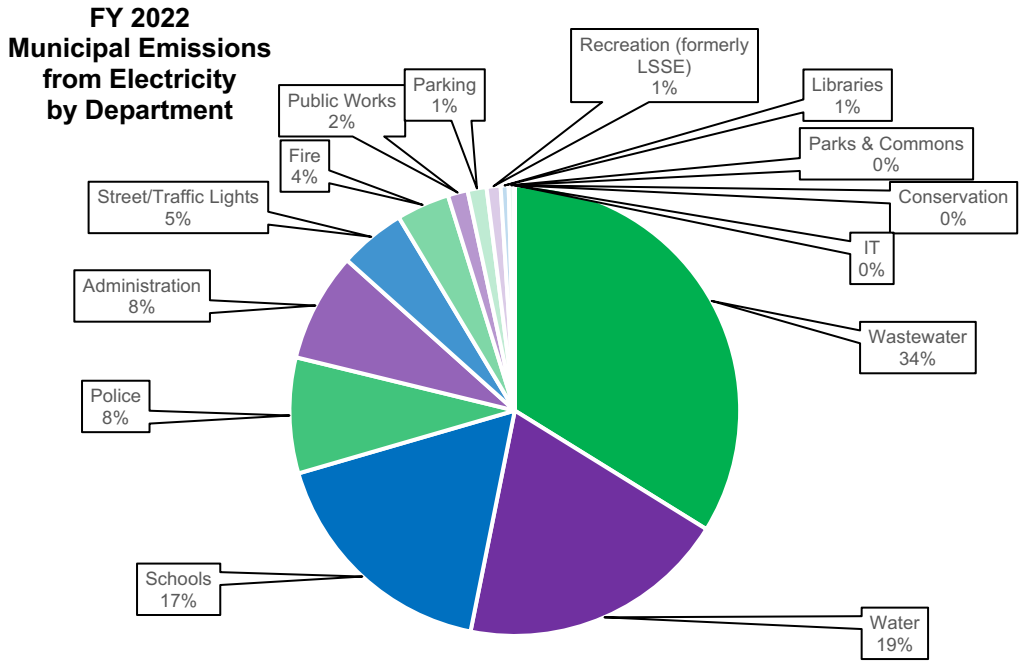


Figure 5. Municipal building emissions from electricity by department.

Methane gas. Overall methane gas consumption for municipal buildings and facilities increased from **106,696.7 therms** in FY 2016 to **120,262.0 therms** in FY 2022. Emissions resulting from methane g as consumption in municipal buildings and facilities also increased from **580.3 $MTCO_2e$** in FY 2016 to **1,050.6 $MTCO_2e$** in FY 2022. These totals include the modeled emissions associated with methane gas transmission and distribution (T&D) losses.

Why call natural gas "methane gas" instead?

In **HEATED**, Emily Atkin writes about a Yale Program of Climate Change study that found that the use of the word "natural" in describing methane gas gave the gas a positive connotation, whereas the use of "methane" gave it a negative connotation. Given that the use of "natural" serves to inaccurately label the gas as source of clean energy, and that "methane" accurately describes the contents of the gas and its impacts on the climate, HEATED has committed to using "methane gas" instead of "natural gas."

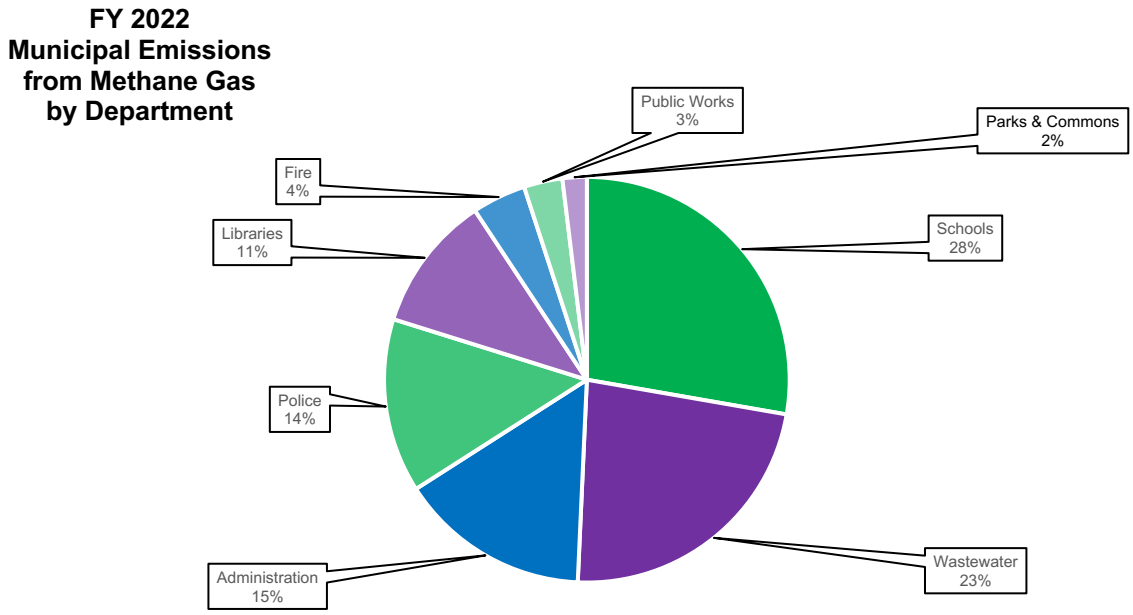


Figure 6. Municipal building emissions from methane gas by department.

Heating oil. Overall heating oil consumption for municipal buildings and facilities increased from **1,602 gallons** in FY 2016 to **38,569 gallons** in FY 2022. Emissions resulting from heating oil consumption in municipal buildings and facilities also increased from **16 $MTCO_2e$** in FY 2016 to **395 $MTCO_2e$** in FY 2022.

Schools were the only buildings consuming heating oil and generating heating oil-related emissions represented in the FY 2016 and FY 2022 inventories.

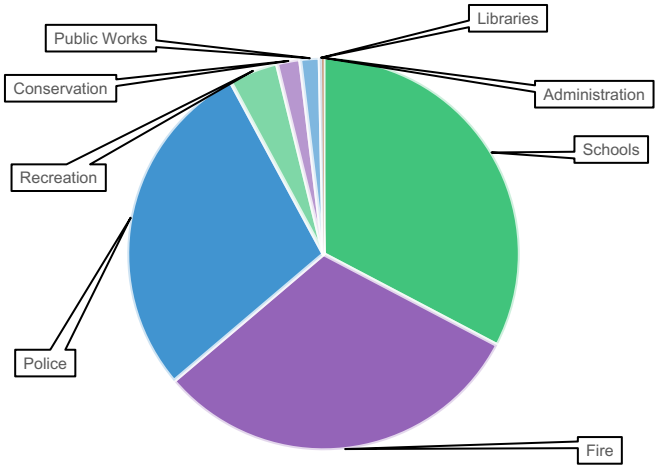
Municipal Fleet

2016	**2,017 $MTCO_2e$**	**-1,077.2 $MTCO_2e$**	**-53.4%**
2022	**939.8 $MTCO_2e$**		

The Town's fleet is made up primarily of fossil fuel-burning vehicles. However, since FY 2016, the Town has added several electric vehicles (EVs) to their fleet. Overall fleet emissions—including those from on-road gasoline vehicles, on-road diesel vehicles, and off-road liquefied petroleum gas (LPG)—decreased from **2,017.0 $MTCO_2e$** in FY 2016 to **939.8 $MTCO_2e$** in FY 2022.

Although Amherst has added EVs to its fleet, it has not yet electrified its fleet significantly. The reduction of emissions may be attributed to the replacement of older vehicles with new ones that have better fuel efficiency, or to reduced use and fuel consumption. The Town may better understand this reduction of emissions by referring to its fleet inventory and records.

Note: There are two municipal fueling stations: one at the Fire Department and one at the Public Works building. It was not always possible to accurately allocate gasoline and diesel consumption to a specific department. Thus, gasoline or diesel consumption is subset out by department only to the extent possible.



33% School vehicles and equipment are the largest emitters of the municipal fleet.

Note: Only Amherst elementary schools are accounted for in the municipal inventory.

31% Fire Department vehicles are the second largest emitters of the fleet.

28% Police vehicles are the third largest emitters of the fleet.

Figure 7. Municipal fleet emissions contributors by department.

The Town fleet fuel mix was made up of the same three fuels in FY 2016 and FY 2022: gasoline, diesel, and liquefied petroleum gas (LPG).

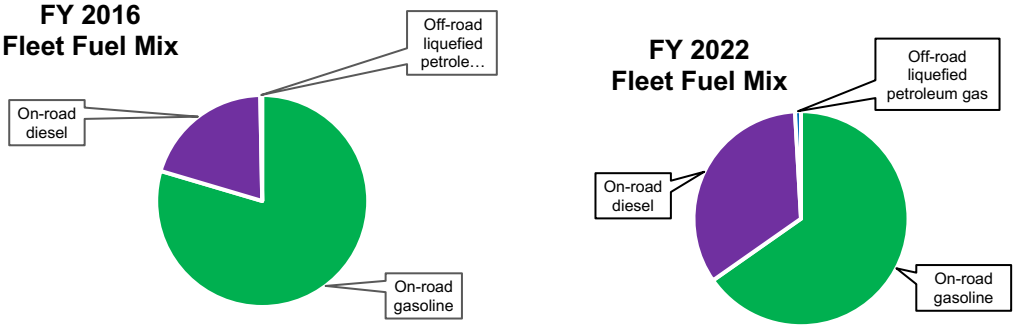


Figure 8. Municipal fleet consumption by fuel type for FY 2016 and FY 2022.

Gasoline. Overall gasoline consumption for municipal vehicles and equipment decreased from **80,116.0 gallons** in FY 2016 to **54,745.0 gallons** in FY 2022. Emissions from gasoline consumption also decreased from **706.0 $MTCO_2e$** in FY 2016 to **482.9 MTCO2e** in FY 2022.

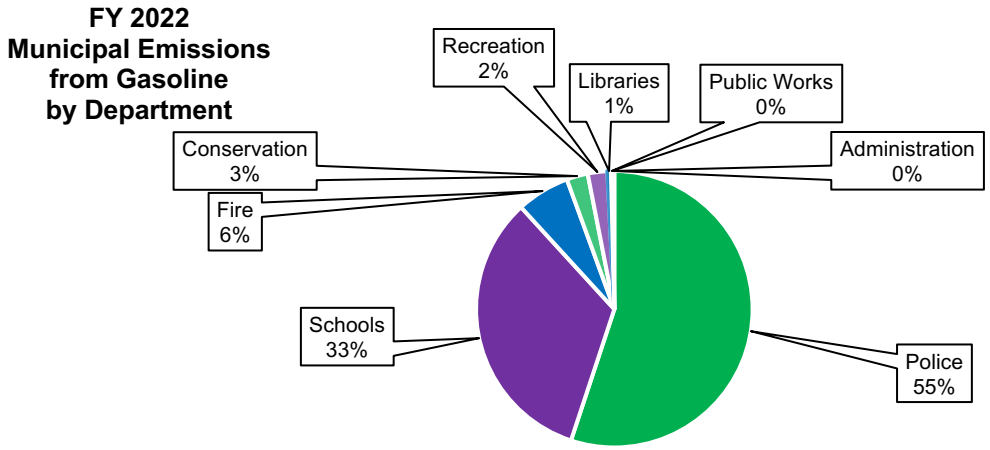


Figure 9. Municipal fleet emissions from gasoline by department.

Diesel. Overall diesel consumption for municipal vehicles and equipment decreased from **74,089.0 gallons** in FY 2016 to **25,594.0 gallons** in FY 2022. Emissions resulting from diesel consumption also decreased from **1,302.0 $MTCO_2e$** in FY 2016 to **450.0 $MTCO_2e$** in FY 2022.

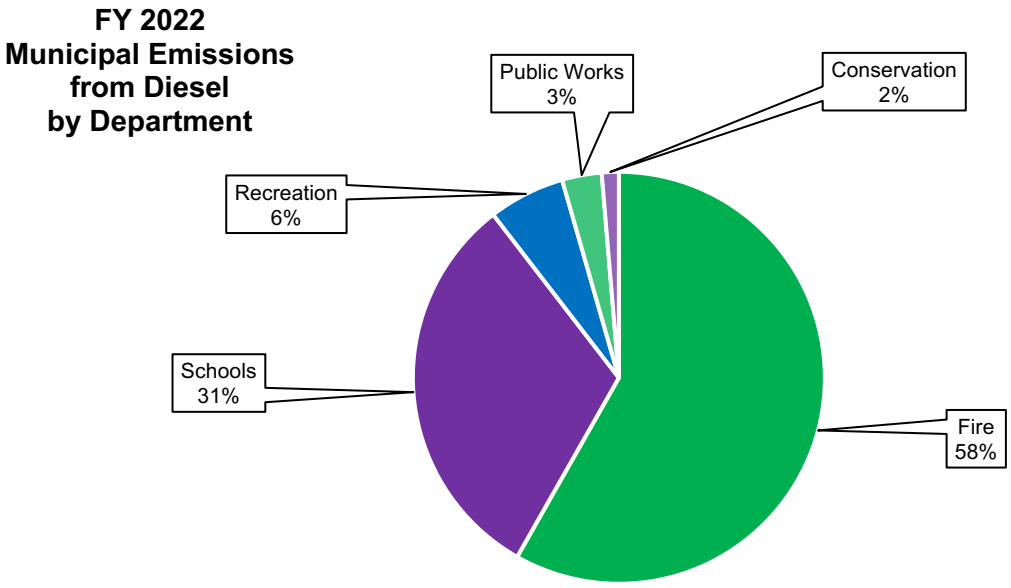


Figure 10. Breakdown of FY 2022 municipal fleet emissions from diesel by department.

Other transportation fuel sources. As mentioned above, some municipal vehicles and equipment consume fuels other than gasoline and diesel.

Electricity. The municipal fleet includes several EVs. The electricity these vehicles consume is accounted for under Municipal Buildings—Electricity, since these vehicles are charged at municipal buildings and their electricity consumption is not tracked separately.

What are off-road vehicles and equipment?

Off-road vehicles and equipment are those that do not operate on roads like cars, motorcycles, and trucks. They are organized and addressed by the United States Environmental Protection Agency (US EPA) in the following categories: **aircraft, heavy equipment, locomotives, marine vehicles and equipment, recreational vehicles,** and **small equipment and tools.**

Liquefied petroleum gas (LPG). LPG is consumed by off-road vehicles and equipment.

Other Municipal Facilities and Public Lighting

2016	**107.9 $MTCO_2e$**	**-17.8 $MTCO_2e$**	**-16.5%**
2022	**90.1 $MTCO_2e$**		

This sector includes the following public services and amenities:

Street and traffic lights, which the Town has converted to LED lighting with support from the Commonwealth of Massachusetts Green Communities Program;

Note: The Town does not control all traffic and street lights within the geographic bounds of Amherst; they retrofitted all of the lights that they own and operate.

Parking, which includes the kiosks used for parking payment; and

Downtown wireless, which is a free public amenity provided downtown.

Electricity. This sector consumes electricity only. Electricity consumption for this sector decreased from **413,744 kWh** in FY 2016 to **366,929 kWh** in FY 2022. Emissions resulting from electricity consumption by public lighting, wireless internet, and parking stations and kiosks also decreased, from **107.9 $MTCO_2e$** in FY 2016 to **90.1 $MTCO_2e$** in FY 2022.

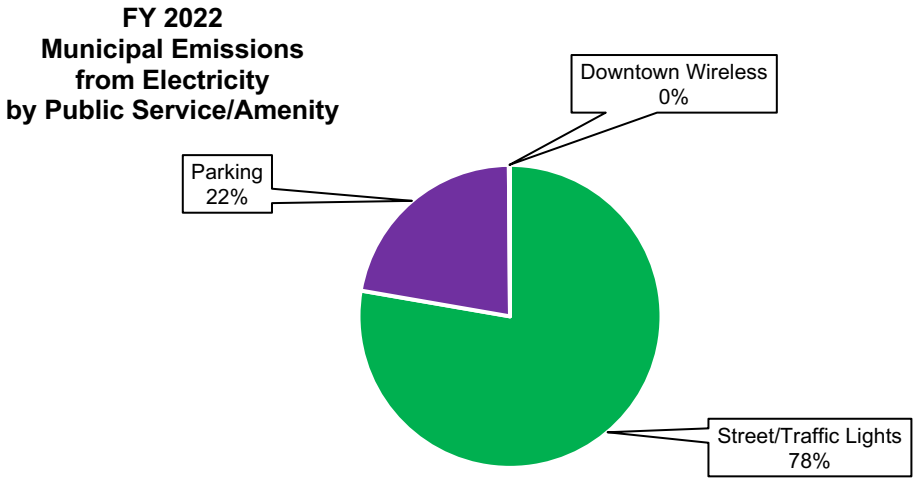


Figure 11. Other municipal facilities and public lighting emissions from electricity by public service/amenity.

Municipal Emissions Overview

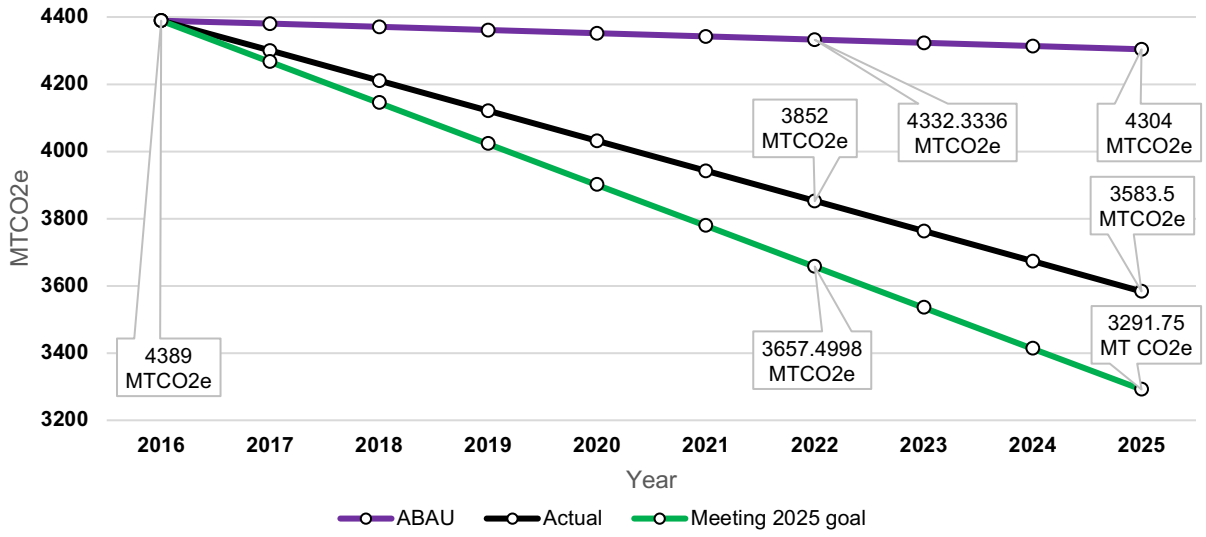


Figure 12. Comparison of total municipal emissions from FY 2016 to FY 2025 for three trajectories: adjusted business as usual (ABAU), actual (based on reduction rate from FY 2022 inventory), and goal (where the goal of reducing FY 2016 emissions 25% by 2025 is met).

The Town of Amherst has worked diligently to reduce the greenhouse gas (GHG) emissions generated by its operation of municipal buildings, vehicles, equipment, and infrastructure. The benefits of its efforts can be seen in Figure 11, which illustrates three different scenarios, assuming that the rate of emissions reductions for each remains constant year over year.

The adjusted business as usual (ABAU) scenario, represented by the purple line, shows a minimal reduction of **85 $MTCO_2e$**—or **2%**—between FY 2016 and FY 2025. The goal scenario, represented by the green line, shows a reduction of **1,097.25 $MTCO_2e$**, which equates to a **25%** reduction to meet Amherst's 2025 target. Between these two scenarios is the actual scenario, represented by the black line and based on the FY 2022 inventory findings. This scenario projects a reduction of **805.5 $MTCO_2e$**—or **18.35%**—by 2025.

Key takeaways

Amherst is on the right track. Figure 11 illustrates the progress Amherst has made toward its emission reduction goals through its past and existing initiatives. The Town's actual emissions are a significant improvement compared to the projected ABAU scenario, in which Amherst would presumably take no action.

Buildings account for the majority of emissions. This is true for many communities. While overall municipal emissions have been reduced since the FY 2016 GHG inventory was conducted, municipal building emissions have increased. Even if municipal building emissions had decreased, the building sector would almost certainly have been the primary generator of emissions and, so, the priority target for emissions reduction.

Why are buildings the biggest emitters?

According to BuildingGreen and their writing on a 2001 study conducted by the University of Maryland Survey Research Center and funded by the US EPA, typical Americans spend 87% of their time in buildings.

Amherst's buildings and climate action

Energy-efficient buildings. Energy efficiency for existing buildings is best achieved through the following steps:

Energy audit. Conducted by a certified energy auditor, an energy audit is a thorough assessment of how a building uses and loses energy. The purpose of an energy audit is to identify opportunities to increase energy efficiency, particularly as it pertains to the building envelope. These opportunities are translated into actions and ranked according to the cost and energy savings each can provide. These actions provide a roadmap for weatherization.

Weatherization. Weatherization typically includes upgrades to building envelope and the addition of insulation in order to enhance energy efficiency. Essentially, weatherization is meant to seal the interior of a building from the outdoor environment and minimize energy used for optimum heating or cooling impact.

Efficient building systems. As noted in relation to the increase of municipal building emissions from FY 2016 to FY 2022, maintaining heating, ventilation, and air conditioning (HVAC) systems that are already in use with regular service can help limit declines in energy efficiency that come with age. Regular maintenance will also keep building owners and operators up to date on the

condition of their systems, allowing them to plan replacement. In-kind replacement of fossil fuel-burning systems should be avoided.

Energy efficiency for new construction is best achieved through building code as well as measures like Amherst's recent Net Zero Energy Bylaw, which requires that all new Town buildings and additions that cost more than $2,000,000 must operate without fossil fuels. The Bylaw currently aims to target the Town's largest emitters. In the future, the Town may consider expanding the scope of the Bylaw to include less expensive projects as well as those not owned by the municipality.

Clean energy buildings.

Electrification. Fossil fuel-burning HVAC systems should be replaced with electric HVAC systems as their service life ends—or before, if possible. Recent advances in heat pump technology and studies on their efficiency in cold climates should encourage the Town of Amherst.

How do heat pumps work?

Heat pumps operate by drawing existing warmth from a source—most often air—and then circulating the warmth using refrigerant and delivering it through a forced air or a hydronic system.

On-site renewables. Where possible, electrification should be paired with on-site renewables to reduce additional load on the electric grid, build resilience, and mitigate or potentially eliminate electric utility costs.

Storage. In addition to exploring electrification and on-site renewables, the Town of Amherst may also explore on-site battery storage for municipal buildings, which would enhance energy resilience further.

Off-site renewables. As the Town works to make Valley Green Energy—an inter-municipality community power aggregator—a reality for the broader community of Amherst, it may also consider its own energy portfolio, including the strategy of purchasing Renewable Energy Certificates (RECs).

Amherst's vehicles and climate action

Energy efficient vehicles. Similar to the recommended approach to building systems, all fleet vehicles should be regularly serviced to maintain their efficiency.

Clean energy vehicles. Fossil fuel-burning vehicles should be ranked and prioritized for replacement with electric vehicles.

Charging infrastructure. To support the adoption of municipal fleet vehicles, the Town of Amherst may introduce more EV chargers at municipal buildings where charging of fleet vehicles would be appropriate.

Amherst's other facilities, public lighting, and climate action

Clean energy parking kiosks. Other facilities and lighting contribute relatively little to municipal emissions. However, the introduction of solar power for all kiosks may be considered if it has not been already.

IV. COMMUNITY EMISSIONS SUMMARY

Community emissions are those generated from all activities that take place within the geographic boundary of Amherst. The Community Inventory includes a variety of emissions sources that the Town cannot directly impact. However, with knowledge of major emitters, the Town may develop responsive policies and programs to further support emission reductions.

2016	**286,773 $MTCO_2e$**	**-28,605 $MTCO_2e$**	**-9.97%**
2022	**258,168 $MTCO_2e$**		

Figure 13. Equivalency of community emission reductions in terms of emissions avoided by trash bags of waste recycled instead of landfilled and, alternatively, in terms of carbon sequestered by acres of forest. Credit: US EPA Greenhouse Gas Equivalencies Calculator.

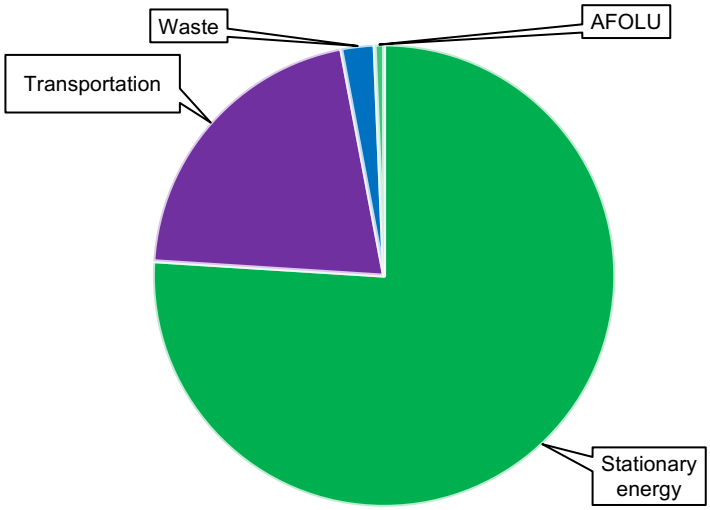


Figure 14. Community emissions by sector.

76% Stationary energy (building operations) generated the greatest volume of emissions.

21% Transportation generated the next greatest volume of emissions.

Waste and **agriculture, forestry, and other land use (AFOLU)** contribute just 2% and 1% of the community's emissions, respectively.

Note: While waste and AFOLU contribute relatively little to the community carbon footprint, this does not mean they are not important areas for climate action.

44% UMass contributed the largest volume of emissions within the community of Amherst.

32% Community (or **remaining community**) contributes the second greatest volume of emissions in the Town of Amherst.

Note: In cases where community emissions can be further subset, they are. For example, emissions from

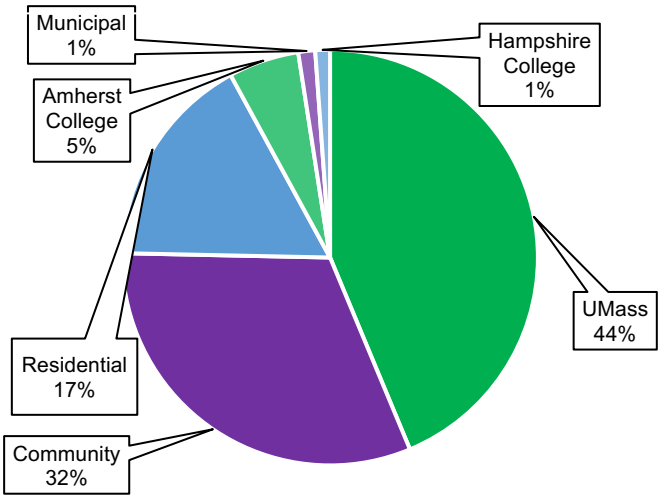


Figure 15. Community emissions by contributor.

electricity consumption are broken out into the following categories: municipal, residential, UMass, Amherst College, Hampshire College, and remaining community. In other cases, the data may not be subset. Please refer to the Community Inventory workbook to understand how each sector's emissions are broken down.

17% Residential building operations contribute the third greatest volume of emissions.

Remaining contributors to community emissions are **Amherst College**, **Hampshire College**, and **municipal** operations. Hampshire College and municipal operations represent just 1% of communitywide emissions each.

In fact, Hampshire College achieved its 2032 goal of carbon neutrality in FY 2022 by significantly lowering its emissions and purchasing renewable energy certificates (RECs) to make up the difference between its on-campus emissions reduction and its carbon neutrality goal. These purchased RECs are not reflected in the 2022 inventory.

Additionally, readers should note that FY 2022 data from Amherst College was not available; instead, FY 2022 numbers were extrapolated from FY 2016 data and FY 2025 adjusted business as usual (ABAU) forecast numbers. While there is some emission reduction projected in the ABAU scenario, the rate of reduction is relatively small. Amherst College—like the other higher education institutions in Amherst, and the Town itself—has intentionally acted to reduce emissions. It is likely that Amherst College's FY 2022 emissions—and, in turn, FY 2022 communitywide emissions—are lower than those reflected in the Community Inventory.

Stationary Energy

2016	**211,716 $MTCO_2e$**	**-15,512 $MTCO_2e$**	**-7.33%**
2022	**196,204 $MTCO_2e$**		

Stationary energy refers to the energy consumed by building operations, as well as energy lost in the process of distributing and supplying fuel and electricity to buildings. The largest source of Amherst's emissions, emissions from community stationary energy decreased from **211,716 $MTCO_2e$** in 2016 to **196,204 $MTCO_2e$** in FY 2022.

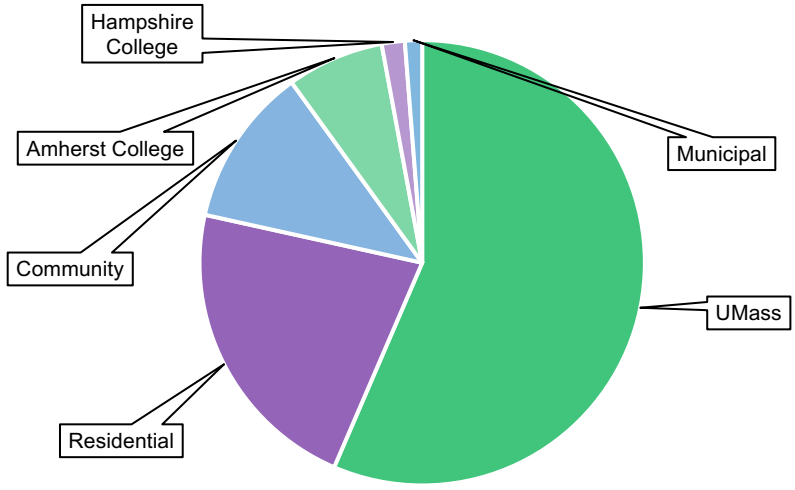


Figure 16. Breakdown of community stationary energy emissions by

56% The **University of Massachusetts Amherst (UMass)** contributes the greatest volume of emissions.

Note: With nearly 30,000 students, 1,400 faculty members, a 1,450-acre campus, and over 170 buildings and facilities, it is not surprising that UMass emissions make up a significant portion of the community's emissions.

22% Residential buildings contribute the second largest volume of emissions.

12% Remaining **community** activity is the third largest contributor to emissions.

The community stationary energy source mix has changed between FY 2016 and FY 2022.

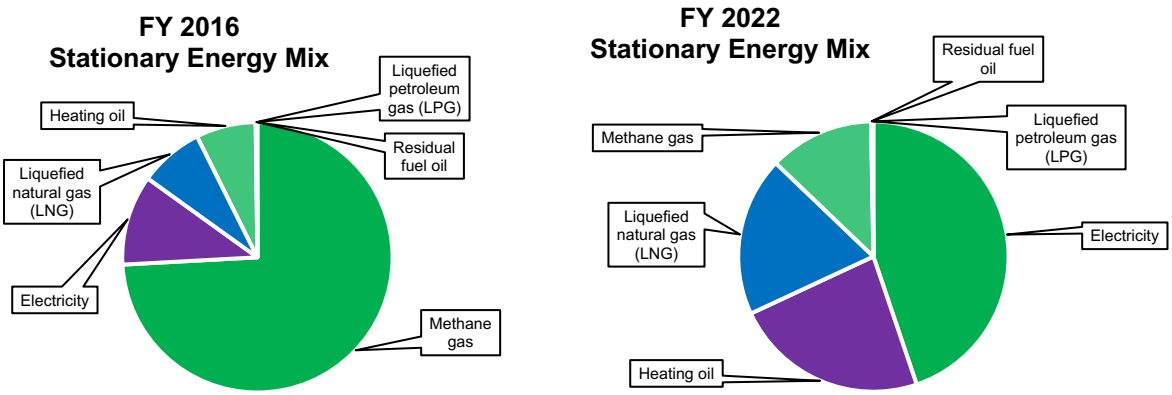


Figure 17. Breakdown of community stationary energy consumption by energy source for FY 2016 and FY 2022.

Electricity. Overall electricity consumption for buildings and facilities in the community decreased from **169,362 MWh** in FY 2016 to **163,083 MWh** in FY 2022. Emissions resulting from electricity also decreased from **44,323 MTCO$_2$e** in FY 2016 to **40,205 MTCO$_2$e** in FY 2022.

Note: These numbers include both electricity consumed directly by building operations, as well as the electricity lost during transmission and distribution (T&D) for consumption.

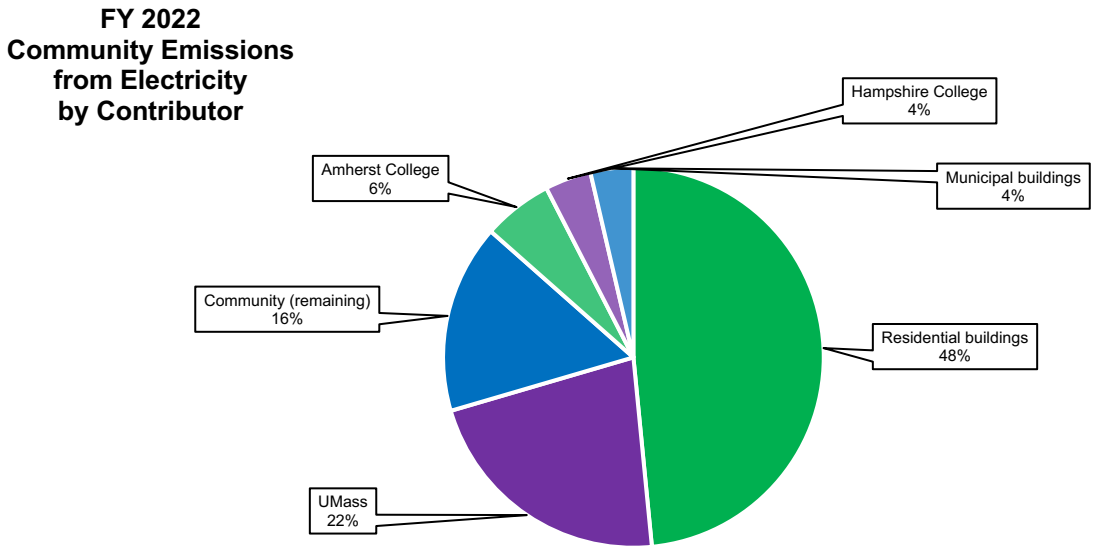


Figure 18. Community stationary energy emissions from electricity by contributor.

Methane gas. Overall methane gas consumption for buildings and facilities decreased from **24,170,815.0 therms** in FY 2016 to **22,761,263 therms** in FY 2022. Emissions resulting from methane gas also decreased from **131,512.0 $MTCO_2e$** in FY 2016 to **123,330.0 $MTCO_2e$** in FY 2022.

Other stationary energy sources.

Heating oil. Heating oil consumption for buildings and facilities in the community increased from **1,867,920.0 gallons** in FY 2016 to **2,294,631.0 gallons** in FY 2022. Emissions resulting from heating oil use in community buildings and facilities also increased from **19,132.0 $MTCO_2e$** in FY 2016 to **23,502.0 $MTCO_2e$** in FY 2022.

Liquefied natural gas (LNG). LNG consumption for buildings and facilities in the community decreased from **2,011,961.0 gallons** in FY 2016 to **1,882,000.0 gallons** in FY 2022. Emissions resulting from LNG use in community buildings and facilities also decreased from **8,973.0 $MTCO_2e$** in FY 2016 to **8,394.0 $MTCO_2e$** in FY 2022.

Liquefied petroleum gas (LPG). LPG consumption for buildings and facilities in the community increased from **35,841.0 gallons** in FY 2016 to **103,097.0 gallons** in FY 2022. Emissions resulting from LPG use in community buildings and facilities increased from **206.0 $MTCO_2e$** in FY 2016 to **592.0 $MTCO_2e$** in FY 2022.

Residual fuel oil. Residual fuel oil consumption for buildings and facilities in the community decreased from **18,060.0 gallons** in FY 2016 to **14,342.0 gallons** in FY 2022. Emissions resulting from residual fuel oil use in community buildings and facilities also decreased from **204.0 $MTCO_2e$** in FY 2016 to **162.0 $MTCO_2e$** in FY 2022.

Transportation

2016	**66,916 $MTCO_2e$**	**-12,638 $MTCO_2e$**	**-18.89%**
2022	**54,278 $MTCO_2e$**		

Transportation is the next largest source of Amherst's emissions, after stationary energy. Transportation emissions decreased from **66,916 $MTCO_2e$** in 2016 to **54,278 $MTCO_2e$** in 2022. Transportation activity is reported in two categories:

- **on-road transportation**, which refers to typical vehicular travel and makes up **63%** of transportation-related emissions in Amherst
- **off-road vehicles and equipment**, which make up **37%** of transportation emissions and include the following categories: construction, industrial, lawn and garden, agriculture, and commercial.

  Note: Air, boat, and train travel were excluded since these modes are not significantly active in the Town of Amherst.

On-road transportation. Emissions resulting from on-road transportation decreased from **59,504 $MTCO_2e$** in FY 2016 to **34,461 $MTCO_2e$** in FY 2022.

On-road transportation emissions consist of emissions from passenger, commercial vehicles, and city bus travel within the town. Municipal and higher education institution emissions are a

subset of these emissions. Like the Town, each higher education institution tracks its own fuel usage.

Note: Because total on-road transportation emissions are calculated using two different measures—empirical fuel consumption for municipal and higher education institution operations, and modeled vehicle miles traveled (VMT) for all other vehicles in the community—consumption by fuel type cannot be adequately represented and therefore only emissions are reported here.

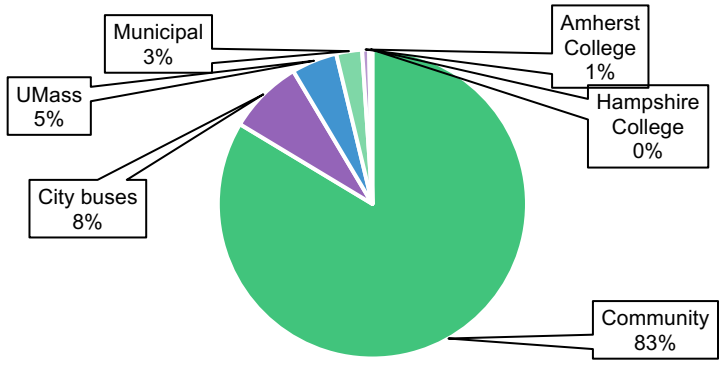


Figure 19. Community emissions from on-road transportation.

83% Community travel accounts for the majority of on-road transportation emissions in Amherst.

Electricity. Electricity consumption and related emissions are tracked for neither municipal nor other community vehicular activity. It should be assumed that activity data for all EVs is included in overall community electricity consumption.

Off-road vehicles and equipment. Off-road emissions increased from **7,412 $MTCO_2e$** in FY 2011 to **19,818 $MTCO_2e$** in FY 2022.

Electricity. Electricity consumption and related emissions are tracked for neither municipal nor other community vehicular activity. It should be assumed that activity data for all EVs and electric equipment in the Town of Amherst is included in overall community electricity consumption.

63% Industrial vehicles and equipment generated the greatest volume of emissions.

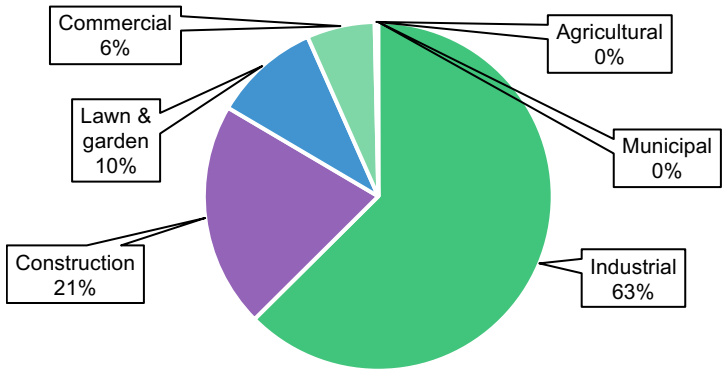


Figure 19. Community emissions from off-road

21% Construction vehicles and equipment generated the second greatest volume.

10% Lawn & garden vehicles and equipment generated the third greatest volume.

Remaining contributors to off-road emissions are **commercial** off-road vehicles and equipment, which represented 6% of emissions, and **agricultural and municipal** off-road vehicles and equipment, which each represent less than 1% of communitywide emissions.

Waste

2016	**7,270 $MTCO_2e$**	**-1,271 $MTCO_2e$**	**-17.5%**
2022	**5,999 $MTCO_2e$**		

Emissions generated from municipal solid waste (MSW) and wastewater treatment—waste, collectively—are the third largest group of Amherst's emissions. Emissions from waste decreased from **7,270 $MTCO_2e$** in FY 2016 to **5,999 $MTCO_2e$** in FY 2022.

Waste management methods represented by the FY 2022 emissions inventory include landfilling and biological treatment (composting) of municipal solid waste (MSW) as well as wastewater treatment.

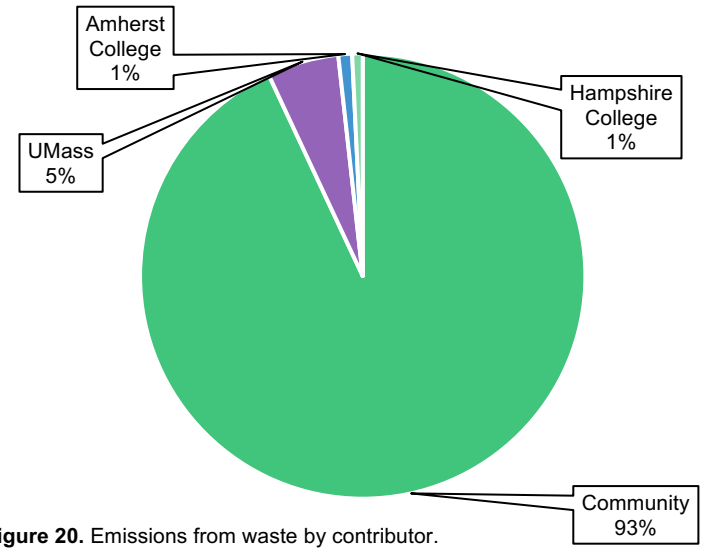


Figure 20. Emissions from waste by contributor.

93% Community emissions from solid waste and wastewater represent the greatest volume of emissions.

Note: Because solid waste and wastewater from municipal operations are not tracked separately, any waste-related emissions from municipal operations are included in the community category.

5% UMass was the second greatest contributor to waste-related emissions.

Both **Hampshire College** and **Amherst College** represented 1% of emissions.

Waste-related emissions came primarily from landfilled solid waste, based on modeling using statewide data. This reflects a change since FY 2016, when landfilled and incinerated solid waste together generated the majority of waste-related emissions. Relatively little solid waste was treated biologically. For the purposes of this inventory, recycling is not included, since it is assumed recycling does not generate GHG emissions. Wastewater treatment continued to be efficient, using an aerobic system—which means the digestion process includes oxygen—with enhanced nitrogen removal.

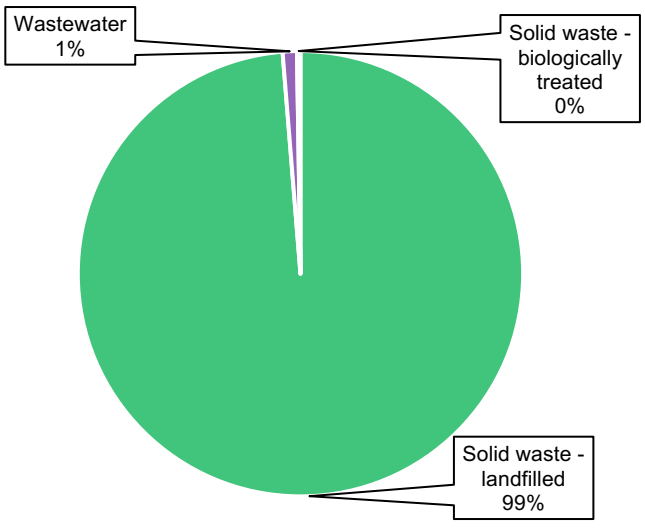
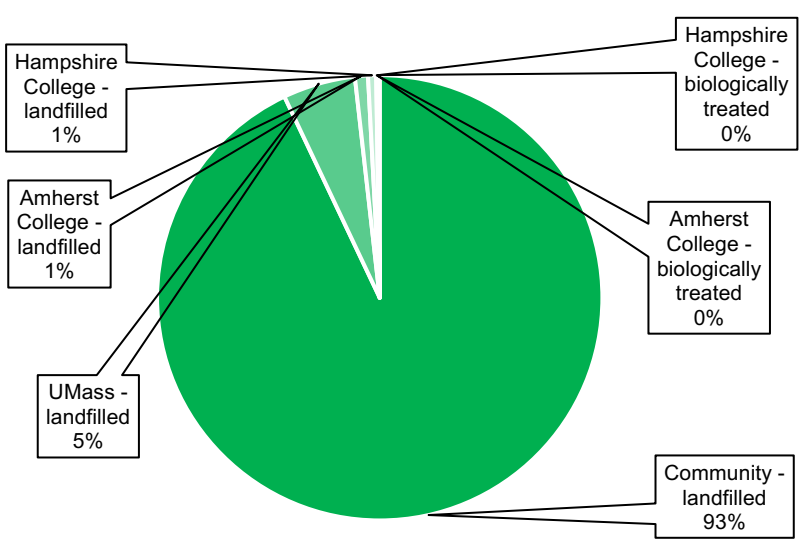


Figure 21. Emissions from waste by contributor.

Municipal solid waste. Municipal solid waste (MSW) refers to everyday trash. It excludes waste from construction and demolition (C&D) and industrial processes. The modeled volume of waste generated within Amherst increased from **36,484 tons** in FY 2016 to **36,749 tons** in FY 2022. Emissions decreased from **7,131 $MTCO_2e$** in FY 2016 to **5,922 $MTCO_2e$** in FY 2022.

Why did emissions decrease while MSW grew?

Tons of waste generated grew slightly between FY 2016 and FY 2022. According to the US Environmental Protection Agency (EPA), the amount of waste generated per person per day increased from 4.5 pounds in 2017 (the volume used for FY 2016) to 4.9 pounds in 2018 (the volume used for FY 2022). The EPA attributes this to the added consideration of certain food waste. Although the volume of waste generated grew, the elimination of incineration as a MSW treatment method led to reduced emissions.



93% Community waste that is **landfilled** accounts for the majority of Amherst's emissions from solid waste.

5% UMass waste that is **landfilled** accounts for the next largest volume of emissions from solid waste.

Amherst College and **Hampshire College** contribute relatively little to the community's waste-related emissions.

Figure 22. Emissions from MSW by contributor and treatment.

Wastewater. Wastewater refers to sewage and wastewater, which may be thought of as used water, for treatment. Emissions from wastewater treatment decreased from **139 $MTCO_2e$** in FY 2016 to **62 $MTCO_2e$** in FY 2022.

Agriculture, Forestry, and Other Land Use

2016	**842 $MTCO_2e$**	**+845 $MTCO_2e$**	**+100.35%**
2022	**1,687 $MTCO_2e$**		

Emissions generated from agriculture, forestry, and other land use (AFOLU) make up the smallest volume of Amherst's emissions. AFOLU emissions increased from **842 $MTCO_2e$** in FY 2016 to **1,687 $MTCO_2e$** in FY 2022. The agriculture subsector represents emissions related to livestock. Other land use represents emissions related to managed soils.

Agriculture. Emissions related to agriculture include direct emissions from livestock, which make up the majority of the emissions, as well as the management of manure from livestock. The modeled number of livestock head (number of animals kept as livestock) based on data from the US Department of Agriculture (USDA) National Agricultural Statistics Service,

Amherst's livestock population increased, nearly doubling, from **704 heads of livestock** in FY 2016 to **1,325 heads of livestock** in FY 2022. Total agriculture emissions increased from **539 $MTCO_2e$** in FY 2016 to **881 $MTCO_2e$** in FY 2022.

Other land use. In the case of the Town of Amherst, the other land use subsector emissions are described as emissions from aggregated sources and non-CO_2 emission sources on land. The total emission from other land use increased from **303 $MTCO_2e$** in FY 2016 to **806 $MTCO_2e$** in FY 2022. Land use change was excluded from this subsector due to difficulty understanding how Amherst's land use may have changed since FY 2016.

Community Emissions Overview

Not only has the Town of Amherst worked diligently to reduce the greenhouse gas (GHG) emissions generated by its municipal operations, but the community members of Amherst have also made efforts to reduce GHG emissions. In particular, the higher education institutions each have aggressive goals:

- **UMass:** Carbon zero before 2050
- **Amherst College:** Decarbonization by 2032
- **Hampshire College:** Carbon neutrality by 2022

The benefits of these efforts can be seen in Figure 23, which illustrates three different scenarios, assuming that the rate of emissions reductions for each remains constant year over year.

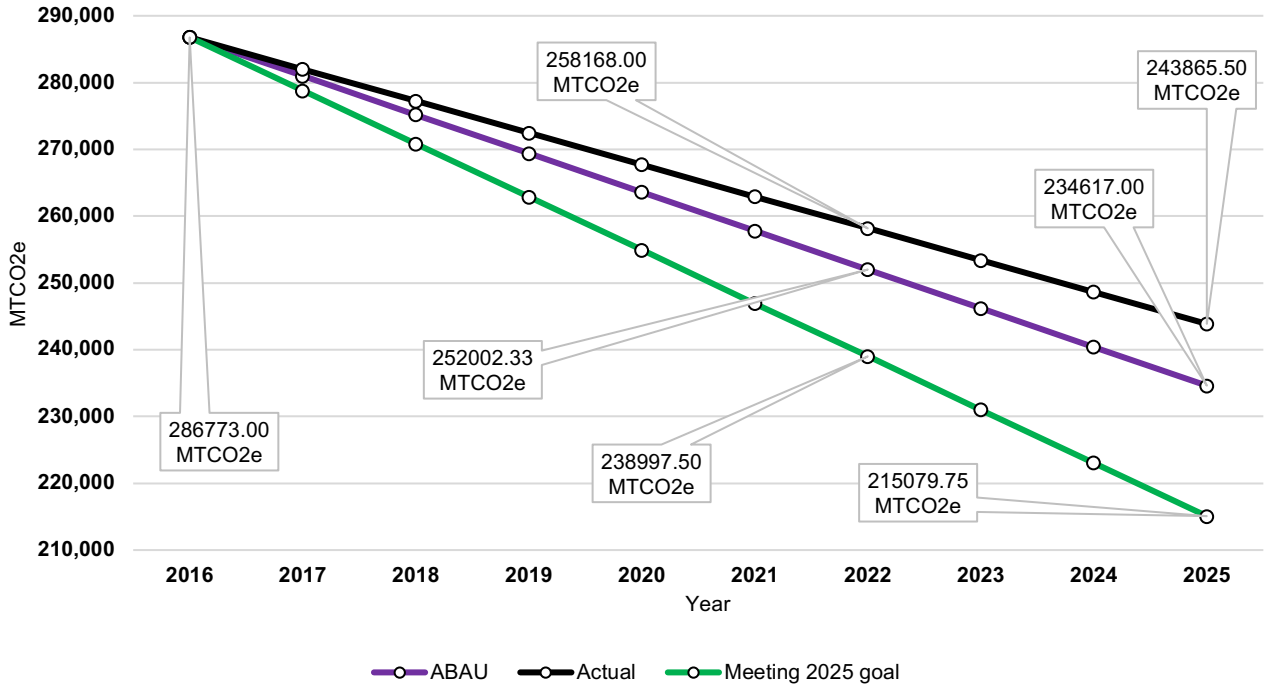


Figure 23. Comparison of total community emissions from FY 2016 to FY 2025 for three trajectories: adjusted business as usual (ABAU), actual (based on reduction rate from FY 2022 inventory), and goal (where the goal of reducing FY 2016 emissions 25% by 2025 is met).

The adjusted business as usual (ABAU) scenario, represented by the purple line, shows a reduction of **52,156 $MTCO_2e$**—or **18%**—between FY 2016 and FY 2025. The goal scenario, represented by the green line, shows a reduction of **71,693.25 $MTCO_2e$** between FY 2016 and FY 2025, which equates to a **25%** reduction to meet Amherst's 2025 target. The actual scenario is represented by the black line and based on the FY 2022 inventory findings. This scenario projects a reduction of **42,907.5 $MTCO_2e$**—or **15%**—by 2025.

Key takeaways

Amherst is on the right track. Figure 23 illustrates the success that the community has had in reducing its emissions through climate action since FY 2016. Currently, Amherst's actual emissions are tracking higher than those in the projected ABAU scenario and in the goal scenario. Still, emissions are decreasing, and this momentum and movement in the right direction can be harnessed and built upon.

In addition to recognizing and celebrating reductions to date, Amherst's undertaking of a communitywide inventory should itself be lauded. Many municipalities have limited their carbon accounting to the activities they directly control. Amherst's big-picture approach to carbon accounting demonstrates a commitment to partnerships and collective action in order to holistically and inclusively work toward climate goals.

A commitment to community decarbonization is also demonstrated by Amherst's higher education institutions. UMass, Amherst College, and Hampshire College should all be considered collaborators in climate action—whether formally or informally—as they pursue aggressive emission reductions and implement a variety of climate strategies. Together, the Town of Amherst, UMass, Amherst College, and Hampshire College may be considered co-learners and co-leaders.

Municipal emissions make up a relatively small portion of the Town's overall emissions. Municipal operations make up just 1.5% of total community emissions. This means the municipality has little direct control over the majority of emission sources, and will need to creatively and collaboratively work toward influencing other entities' emissions with policies and programs.

Buildings account for the majority of emissions. As with the Municipal Inventory, consumption of electricity and heating fuel for building operations generate the greatest volume of emissions. While community building emissions have decreased since FY 2016, there are still significant energy savings measures to be taken that can reduce this leading emissions sector.

The community's buildings and climate action

The building-related climate actions discussed for municipal buildings in ***Amherst's buildings and climate action*** are also applicable to buildings communitywide. Please refer to those actions, as well as the additional actions outlined below.

Energy efficient buildings. In addition to the measures for municipal buildings discussed previously, implementing the following measure for existing buildings will be important to understanding and mitigating the impacts of buildings in Amherst.

Building performance standards (BPS). Typically targeting the largest commercial, institutional, and multifamily housing buildings in a community, BPS can require building owners to report to their municipality on energy use, energy use intensity (EUI), and/or emissions, and their reduction. Most BPS establish emissions and/or energy use reduction targets, first requiring building owners to establish and report baselines—by measuring their business-as-usual energy use, EUI, and or emissions—then requiring building owners to meet interim and final reduction goals by increasing energy efficiency and/or clean energy use. BPS usually take a phased approach, applying to the largest buildings first, then expanding to include other size or types of buildings to ultimately cover all community buildings possible.

Clean energy buildings.

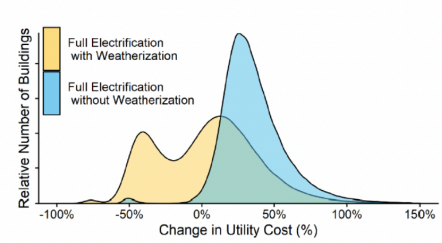
Community choice aggregation (CCA). The Town of Amherst—in partnership with the City of Northampton and the Town of Pelham—is currently establishing a CCA program, Valley Green Energy. CCA programs empower municipalities to enter longer-term contracts with utilities to provide pricing stability and access to cleaner energy options. The Valley Green Energy CCA plan has been submitted to the state for regulatory review and approval. Once the program launches, enrolled participants will get their energy from a mix that includes more renewable sources than they currently do as a standard utility customer today.

Renewable energy development. The Town of Amherst and its Solar Bylaw Working Group (SBWG) have laid the foundation for increasing renewable energy generation, commissioning a study to identify potential locations for solar and developing a policy and processes for solar siting, permitting, and construction. Like Valley Green Energy, this project is in progress; however, when solar development policies are in place, the SBWG's work will likely have an impact on increasing the availability and accessibility of clean energy in Amherst.

Whole-home repair, weatherization, and electrification. While energy audits, weatherization, and electrification have already been discussed in ***Amherst's buildings and climate action***, they are worth mentioning that single-family and small multifamily homes—particularly those of low- to moderate-income (LMI) residents—may need repairs before weatherization can take place. To further advance equity, anti-displacement, and climate justice, the Town may consider supporting repairs as well as weatherization and electrification for LMI households—especially considering federal funding made available for weatherization and rebates for home efficiency and energy upgrades that are coming on line.

Why weatherize before electrification?

Below, find an American Council for an Energy Efficient Economy (ACEEE) visualization of how utility costs are impacted by weatherization (or lack thereof) in combination with electrification.



Using weatherization to improve a building's energy efficiency before electrification both facilitates cost savings and lowers demand on the grid by reducing energy consumption.

As mentioned previously in ***Amherst's buildings and climate action,*** efficiency for new construction is best achieved through building code. Measures such as the Amherst Net Zero Energy Bylaw—which requires that all new Town buildings and additions that cost more than $2,000,000 must operate without fossil fuels—and the Massachusetts Stretch Code—which enables communities to opt in to a code that requires greater sustainability measures than the base building code. Amherst was an early adopter of the Stretch Code, and its existing commitment to the code, a new version of which took effect 2023, will ensure the resultant reduction of energy use and GHG emissions. Further, Amherst has adopted the next level of the Stretch Code—the Specialized Code—which champions Net Zero new construction, and will boost Amherst's efforts to move toward its interim and final emission reduction goals.

The community's vehicles and equipment and climate action

The transportation-related climate actions discussed for the municipal fleet in ***Amherst's vehicles and climate action*** are also applicable to vehicles communitywide. Please refer to those actions, as well as the additional actions outlined below.

Clean energy off-road vehicles and equipment. Amherst may consider restricting gas-powered lawn and garden equipment in order to reduce emissions and related climate impacts. There has been a recent movement among Massachusetts municipalities to ban gas-powered leaf blowers, in particular.

The community's waste and climate action

Although waste-related emissions in the community are relatively small, they may still be reduced. In fact, waste may be the most tangible way to engage the general community in climate action, since community members can see and touch the waste they generate. Additionally, the reduction of solid waste can offer climate and community benefits other than reduced emissions. Consumption reduction and food waste reduction campaigns, reuse and repair workshops, and a community composting program may be ways to reduce GHG emissions while encouraging community members to think about their individual carbon footprints.

The community's agriculture, forestry, land use, and climate action

Like waste-related emissions, emissions generated through agriculture, forestry, and other land use (AFOLU) are relatively small, compared to emissions from buildings and vehicles. Still, the Town may consider how the growth or decline of carbon-emitting and carbon-sequestering land use may ultimately impact its climate goals.

V. AMHERST'S CLIMATE FUTURE

Recommendations

The actions that the Town of Amherst and its community must undertake to meet their goal of reducing annual emissions from the FY 2016 by 25% by the year 2025 are already outlined in the Climate Action, Adaptation, and Resilience Plan (CAARP). Variations or components of these actions are discussed in the ***Key Takeaways*** sections of the ***Municipal Emissions Overview*** and the ***Community Emissions Overview.***

A number of these actions are already underway. Further, a number of the actions may be eligible for federal support from the Bipartisan Infrastructure Law (BIL) (also known as the Infrastructure Investment and Jobs Act (IIJA)) and the Inflation Reduction Act (IRA), as well as state-level support, made available through different channels.

Roadmap to 2025 Strategies

Climate Action	CO2e reduction from Non-C&U Emissions	% of Non-C&U Emissions
Total 2016 Emissions (baseline)	147908	100%
Affordable Housing Retrofit Program	102	0.07%
Multifamily Housing Retrofit Program	1818	1.23%
Single-Family Housing Retrofits	2899.6	1.96%
Energy Benchmarking and Disclosure Bylaw	3552	2.40%
Property-Assessed Clean Energy (PACE) Financing	9115	6.16%
Community Choice Aggregation 3.0	6562	4.44%
Business and Household Renewables Adoption	2315	1.57%
Transportation Mode-Shifting	3470	2.35%
ZEV Adoption and Charging Infrastructure	6361	4.30%
Individual, State, Federal, and Other Actions	783	0.53%
Total Reduction	36977.75	25.00%

Figure 24. Roadmap to 2025 Strategies. Credit: Town of Amherst Climate Action. Adaptation, and Resilience Plan (CAARP).

The Town may use its knowledge of funding and other financial incentive programs to execute its climate strategies. It may also leverage existing or other new sources of funding to maximize the impact of its climate action efforts.

In addition to exploring multi-source funding to achieve its climate goals, the Town may approach its climate action with an interdepartmental framework. This has the potential to maximize funds and optimize workflow. Examples of an interdepartmental approach to climate action could include: the Town's sustainable procurement statement; intentionally integrating climate action work into all departments; and expanding commission, committees, and working groups charges to incorporate climate considerations into their work –for example, aligning the duties of the Historical Commission and the Local Historic District Commission with climate action for existing buildings, or aligning criteria and allocating funds to climate action projects through the Community Development Block Grant (CDBG) Advisory Group or the Community Preservation Committee.

The Town's engagement and relationships with external (non-municipal) stakeholders will likely be critical to achieving its emission reduction goals. Opportunities to engage community members can be integrated into existing programs, events, and communication channels, or new ones can be created. In particular, reaching building owners—for buildings of all uses—to share programs and incentives that will reduce their emissions while offering them benefits may be prioritized, given the substantial contributions that community buildings make to Amherst's overall emissions. Providing technical assistance to support building owners in their pursuit of energy efficiency and clean energy upgrades may also be considered.

Finally, another critical piece to achieving Amherst's emission reduction goals will be a workforce that is prepared to execute energy efficiency and electrification projects at scale. While the Town may not be positioned to develop this workforce, they should be aware of the limitations or the opportunities presented by the number of energy efficiency and clean energy professionals specific to the Pioneer Valley.

Future Inventories

For future inventories, the Town should continue to seek new sources of empirical data specific to the Town of Amherst and its residences, buildings, and institutions where relevant, rather than using state- or country-level to estimate Amherst activity data. For example, between the FY 2016 and the FY 2022 inventories, the Massachusetts Vehicle Census became available, giving more detailed community-level transportation information for Amherst.

The Town may also consider expanding the scope of its inventory in the future to include additional Scope 3 emissions. Specifically, an important consideration is embodied carbon—or all of the emissions that are generated during the manufacturing, processing, transportation, and construction (where relevant) of a material, piece of equipment, or building before that material, piece of equipment, or building are actually used within Amherst. Minimizing and continuing to reduce operating emissions for all activities in Amherst is critical. However, accounting for the upfront (embodied) emissions generated—which cannot be reduced once they have been generated to produce a material or building—in order to reduce operational emissions will provide a more well-rounded picture of Amherst's climate impacts.

VI. CONCLUSION

The FY 2022 Municipal Inventory and Community Inventory findings indicate that Amherst is on the right track. Amherst's efforts to date should be recognized, and its municipal and communitywide reductions should be celebrated. While acknowledging the progress that has been made, Amherst should keep its sights set on its 2025 emission reduction targets and move forward on multiple fronts to aggressively reduce emissions further. Along the way, the community should continue to celebrate its "wins," and acknowledge that every climate action taken—whether small or large—adds up to reduce climate impacts.

In the time remaining between now and 2025, Amherst would benefit from prioritizing its climate action focus and targeting buildings—by far the biggest emitters on both the municipal and the communitywide levels—without neglecting other sectors.

Amherst should move forward with the understanding that its greatest climate action asset is its community. With engaged residents and an approaching emission reduction target—as well as the knowledge that Amherst is on the right track—there is momentum to be captured and motivation for community members to commit to and benefit from climate action. No single entity alone can ensure that Amherst's climate goals are met; Amherst requires community action to create Amherst's sustainable, resilient, and equitable future.

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