City of Somerville

Greenhouse Gas Inventory Report

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SustainaVille
creating a resilient & carbon neutral somerville

Mayor Ballantyne Office of Sustainability and Environment

City of Somerville

Greenhouse Gas Inventory Report

Prepared by

AECOM

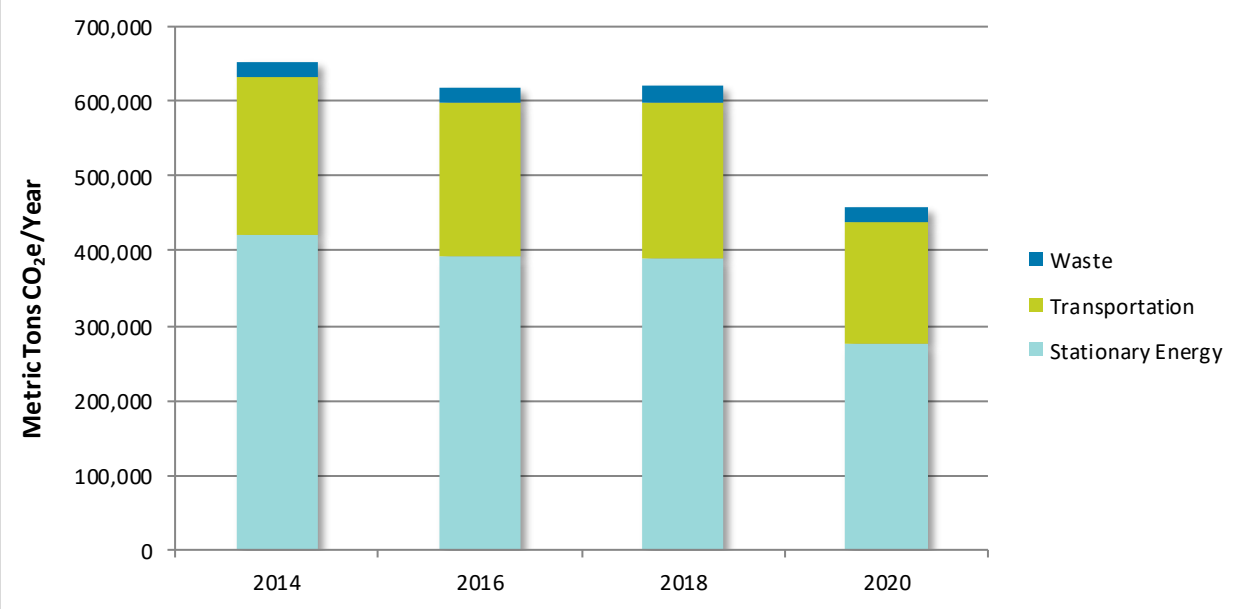
EcoDataLab

The City of Somerville developed its first greenhouse gas (GHG) emissions inventories to estimate emissions levels in 2014 resulting from community activities and from local government operations (LGO). The City prepared subsequent GHG inventories for 2016 and 2018 to monitor changes in emissions levels within each type of inventory and to track progress toward its GHG reduction targets evaluated in the Somerville Climate Forward plan. Continuing with this effort, this Greenhouse Gas Inventory Report presents the 2020 community and LGO inventory results with comparison to the prior inventories. Additionally, the City has broadened its lens of GHG emissions analysis to include evaluation of its first-ever consumption-based emissions inventory (CBEI). The CBEI considers emissions along the full supply chain from Somerville's household consumption within the categories of food, transportation, services, housing, and goods. This Greenhouse Gas Inventory Report provides a high-level summary of the CBEI analysis results. A companion CBEI Report is included as an appendix to provide additional detail on the CBEI results, forecasting and emissions reduction analysis, and inventory methodology.

2020 Community Greenhouse Gas Inventory

Somerville's community GHG emissions totaled approximately **459,707** metric tons of carbon dioxide equivalent (MT CO_2e) in 2020 (see Figure 1). This represents a **29% decrease** from the 2014 base year GHG inventory levels. It also represents a **33%** reduction in per capita emissions since 2014, demonstrating that the city has been able to grow its population and economy while reducing GHG emissions. In 2020, 60% of emissions came from the stationary energy sector, 35% from transportation, and 5% from waste.

Figure 1 – Community GHG Emissions Trends from 2014 to 2020



COVID-19 and Emissions Implications

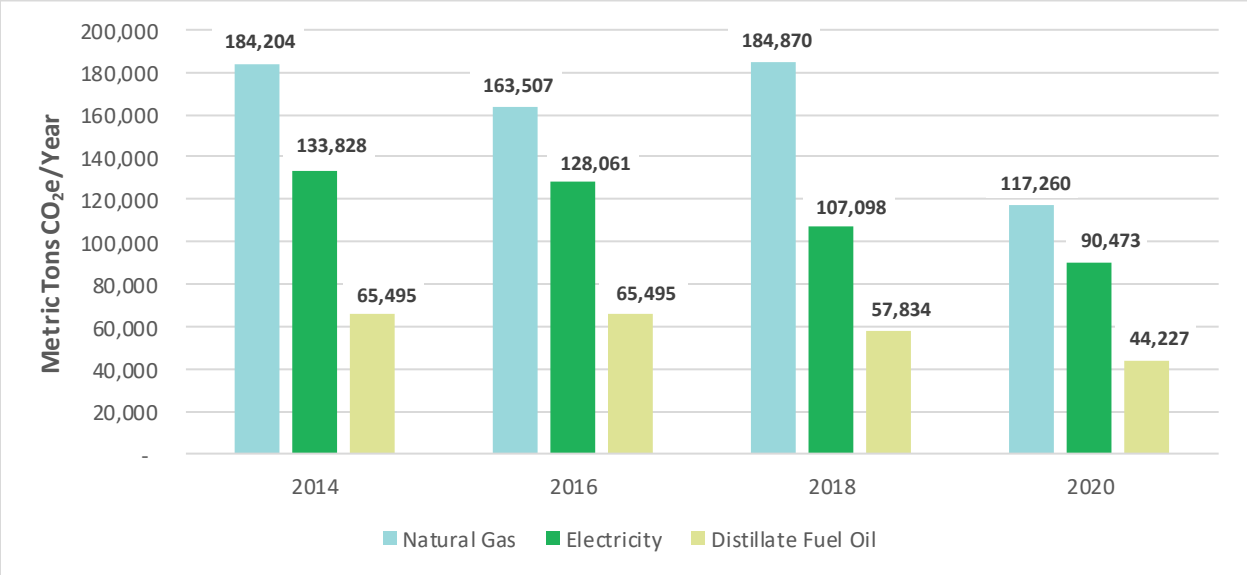
COVID-19 restrictions were first implemented in Massachusetts in March of 2020. The City declared a state of emergency on March 15. A local prohibition on non-essential retail, personal services, and construction went into effect March 22. A statewide stay-at-home advisory went into effect March 24. These actions impacted Somerville's GHG emissions, but the magnitude of that impact cannot be precisely measured. It is assumed that the COVID-19 pandemic contributed to the decrease in Somerville's on-road transportation emissions and stationary energy emissions due to decreased travel and services. Future GHG inventories will be helpful in better reflecting any long-term impacts of the pandemic on Somerville community and government operation emissions. A timeline of city and state related COVID-19 orders can be found at: www.somervillema.gov/covid19/orders.

Stationary Energy Sector

Total stationary energy sector emissions **decreased 35%** since 2014, primarily led by a **36% decrease** in natural gas emissions and a **32% decrease** in electricity emissions from residential and commercial/institutional consumers (see Figure 2). Fuel oil emissions also **decreased by 32%,** which was primarily due to an update in the inventory calculation methodology. The 2014 to 2020 electricity emission reductions were caused by a decrease in electricity use (11%) and an increase in carbon-free electricity provided to the regional electricity grid.

Many of Somerville's residents and businesses participate in the City's Community Choice Electricity (CCE) program with the intent to purchase additional zero-carbon electricity. In 2020, participation in the CCE program **decreased electricity emissions by 4%.** In 2020, CCE zero-carbon electricity represented 8% of total residential electricity use and 2% of total commercial electricity use while it was only 4% and 1% in 2018, respectively.

Figure 2 – Residential and Commercial / Institutional Energy Emission Trends by Fuel Type

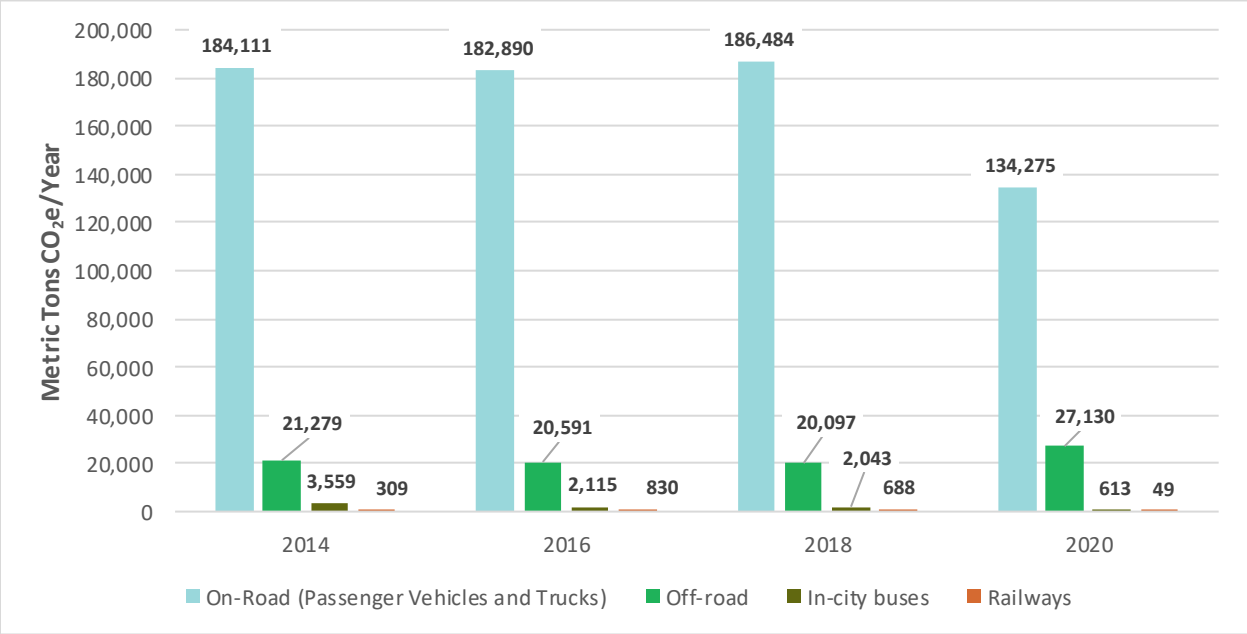


Transportation Sector

Overall transportation sector emissions **decreased by 23% since 2014**, which was almost entirely due to declines in on-road travel (see Figure 3). The transportation sector considers four main sources of emissions:

- on-road vehicles,
- off-road vehicles,
- buses, and
- railways.

Figure 3 – Transportation Emissions by Source



On-road Vehicles

Estimates of the on-road vehicle miles traveled (VMT) for non-transit vehicles were obtained from the Google Environmental Insights Explorer (EIE). This represents a change in the VMT data source from the prior community inventories and should allow the city to reflect its local on-road transportation activity more accurately in future inventories. The 2018 inventory was also updated with Google EIE VMT data, though information was not available to update the 2014 and 2016 inventories. This data showed a 36% decrease in on-road VMT from 2014 which resulted in an **emission decrease of 27%.** Notably, based on the 2021 Google EIE data, on-road VMT in Somerville almost fully returned to pre-COVID levels - therefore the city is unlikely to see a sustained reduction in on-road emissions in future GHG inventories.

Off-road Emission

Off-road emissions were estimated to have **increased by 27%** since 2014. Off-road emissions are calculated at the county-level using an Environmental Protection Agency (EPA) GHG model and are then scaled down to the city level; the off-road model does not reflect COVID impacts.

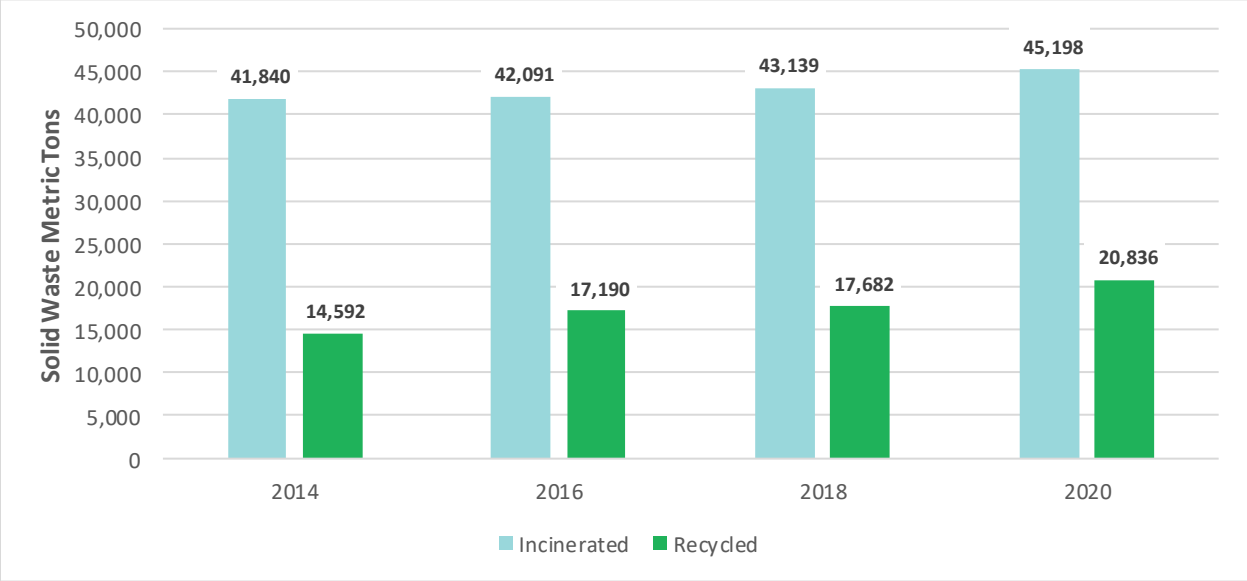
Public Transit – Buses and Railways

The COVID pandemic also impacted the community's use of public transit. In-city transit fuel use was estimated based on the decrease in Massachusetts Bay Transportation Authority (MBTA) ridership due to COVID and the city's 2018 transit levels; an MBTA study showed that bus and rail trips decreased during the height of the COVID pandemic by 70% and 93%, respectively.[1] Due to this drop in transit ridership, bus and rail transit emissions **were 83% lower** in 2020 than in 2014.

Waste Sector

Waste sector emissions increased by **15% since 2014.** This sector includes the treatment of solid waste and wastewater generated by the city. Solid waste disposal generates 95% of emissions in this sector. Total solid waste produced in the city was estimated using a waste generation per capita figure from the EPA, which has increased overtime (see Figure 4). Wastewater treatment emissions are relatively minor and have accounted for <1% of total community emissions since the 2014 inventory.

Figure 4 – Estimated Total Solid Waste Disposed by Treatment Method

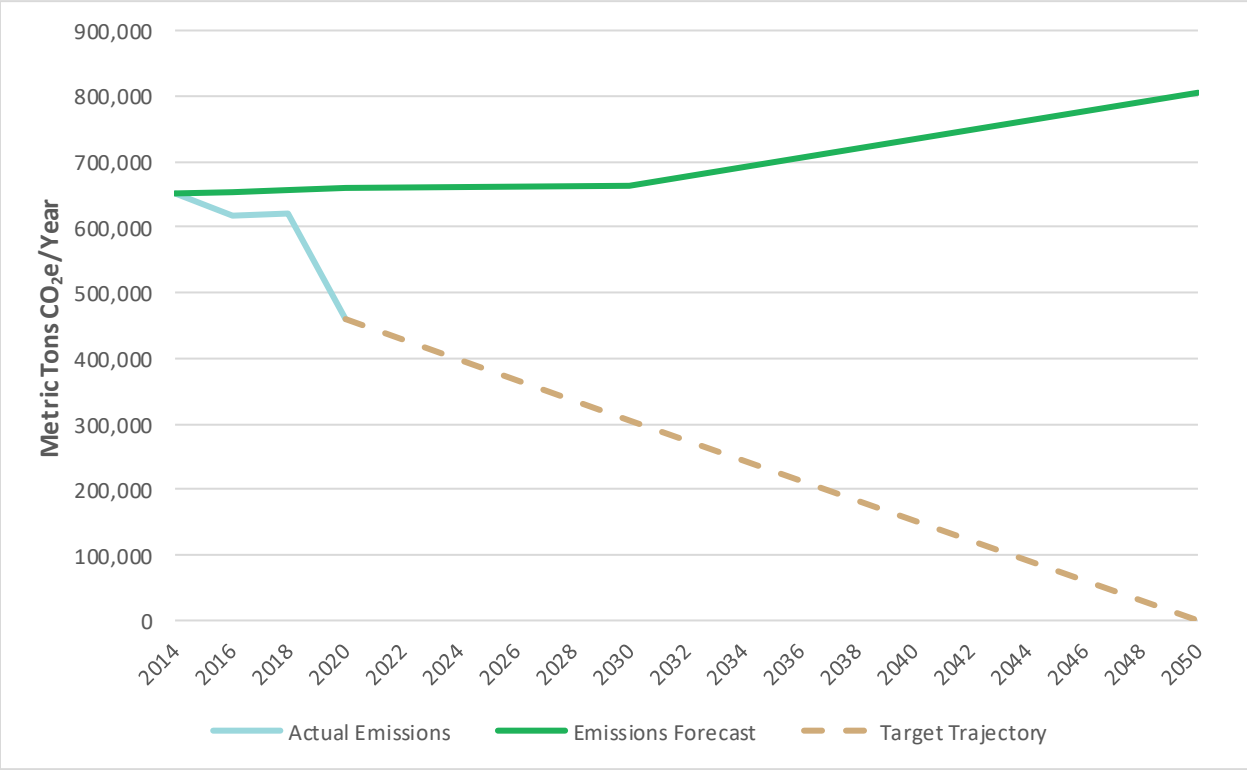


[1] *Bornstein, N. (2021, August 10). MBTA ridership trends compared to public transportation agencies nationwide: Blog Latest News. Pioneer Institute. Retrieved November 3, 2022, from https://pioneerinstitute.org/blog/mbta-ridership-trends-compared-to-public-transportation-agencies-nationwide/*

Community GHG Emissions Reduction Progress

Figure 5 compares Somerville's community emissions reduction progress to its emissions forecasts and 2050 net-zero carbon negative target (illustrated here as zero emissions). In 2016, Somerville forecast its community emissions to 2050 (green line in Figure 5) based on the assumption that community activities would follow a "business-as-usual" scenario in which no emission reduction activities would occur beyond those already in place in the 2014 base year. The forecasts were developed from population and employment growth estimates provided by the Boston Region Metropolitan Planning Organization (MPO). The blue line represents Somerville's actual emissions trend (a 29% decrease in 2020 compared to 2014 levels). The brown dotted line represents Somerville's GHG target trajectory, which shows that the city must continue to sharply decrease emissions to achieve its target.

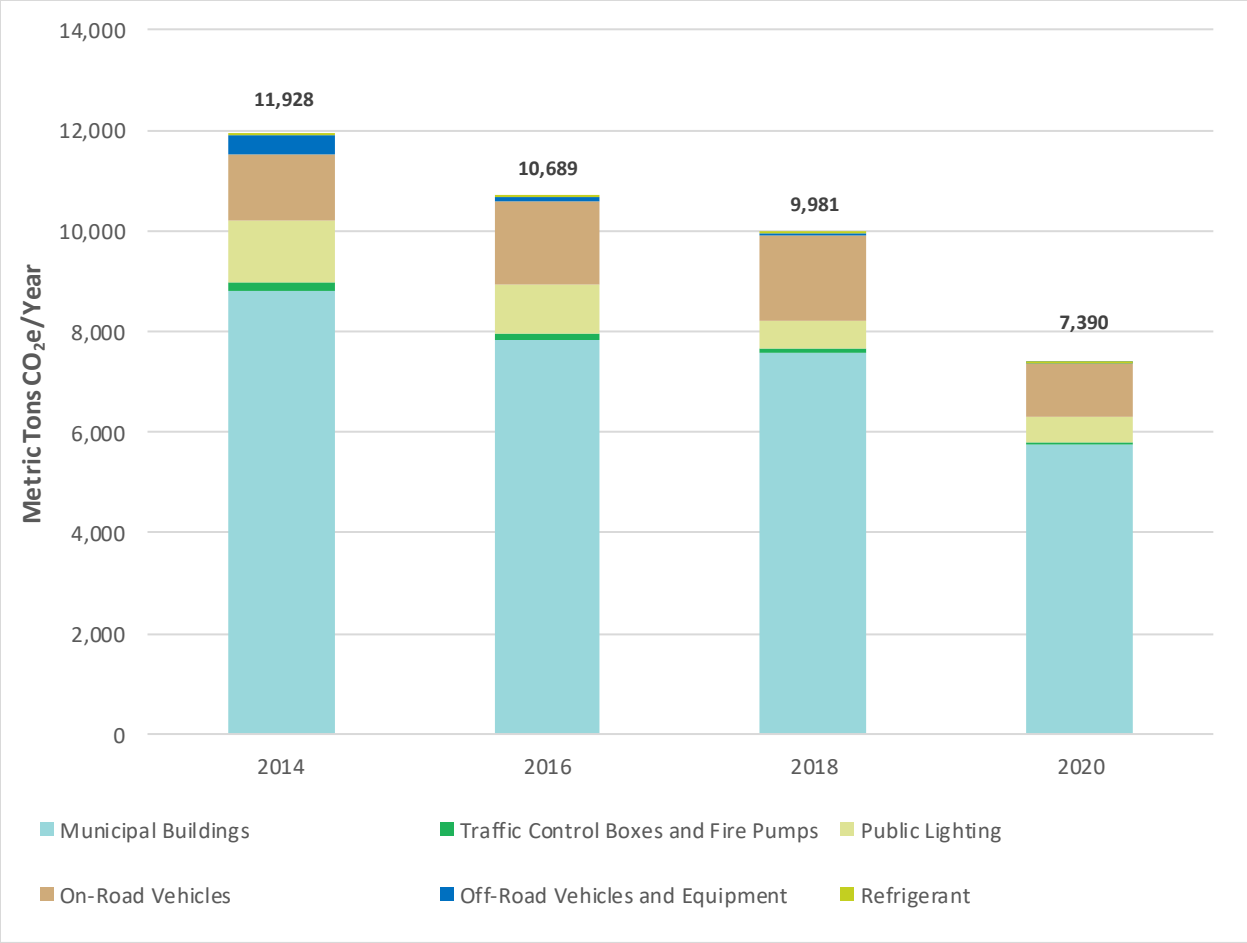
Figure 5 – Community Progress toward Target Achievement



2020 Local Government Operations Greenhouse Gas Inventory

The City of Somerville's LGO emissions totaled approximately **7,390 MT CO_2e** in 2020. This is a **38% decrease** from the 2014 base year (see Figure 6). In 2020, most emissions came from energy use in municipal buildings (78%) followed by on-road vehicles (14%) and public lighting (7%).

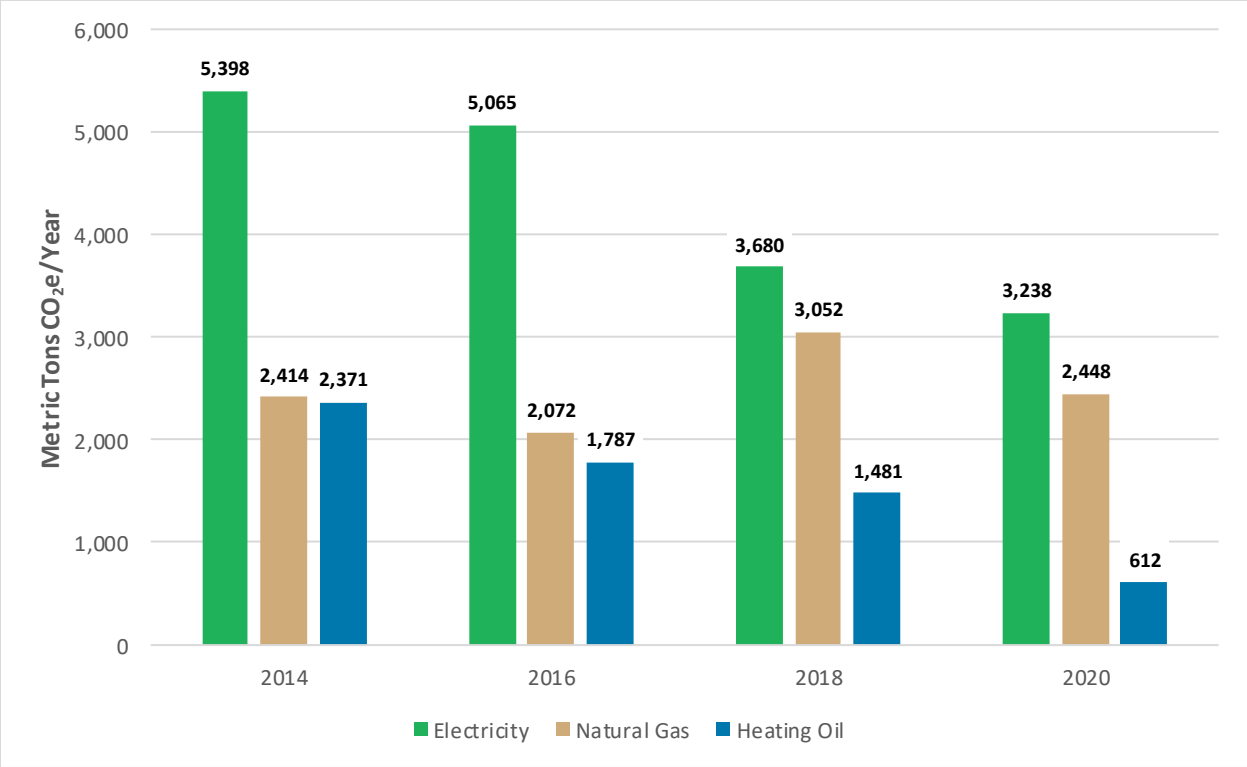
Figure 6 – Local Government Operations GHG Emissions Trends 2014 to 2020



Municipal Facilities

Most LGO emissions reductions since 2014 are from the municipal facilities sector, which includes municipal buildings, traffic control boxes and fire pumps, and public lighting. Emissions from these sources **decreased by 38% since 2014**, primarily due to the decrease in energy use in municipal buildings. During this time, electricity emissions decreased by 40% and heating oil emissions decreased by 74%, while natural gas emissions increased by 1% (see Figure 7). Electricity emissions decreased because the City used less electricity (28% less) and the amount of carbon-free electricity sources added to the electric grid increased across the region (due in part to implementation of the Massachusetts Renewable Energy Portfolio Standard).

Figure 7 – Municipal Facilities Emissions by Fuel Type



Vehicle Fleet

The City's vehicle fleet emissions **decreased by 38%** since 2014. On-road vehicle emissions decreased by 22%, while off-road emissions decreased by 96% from 2014 levels.

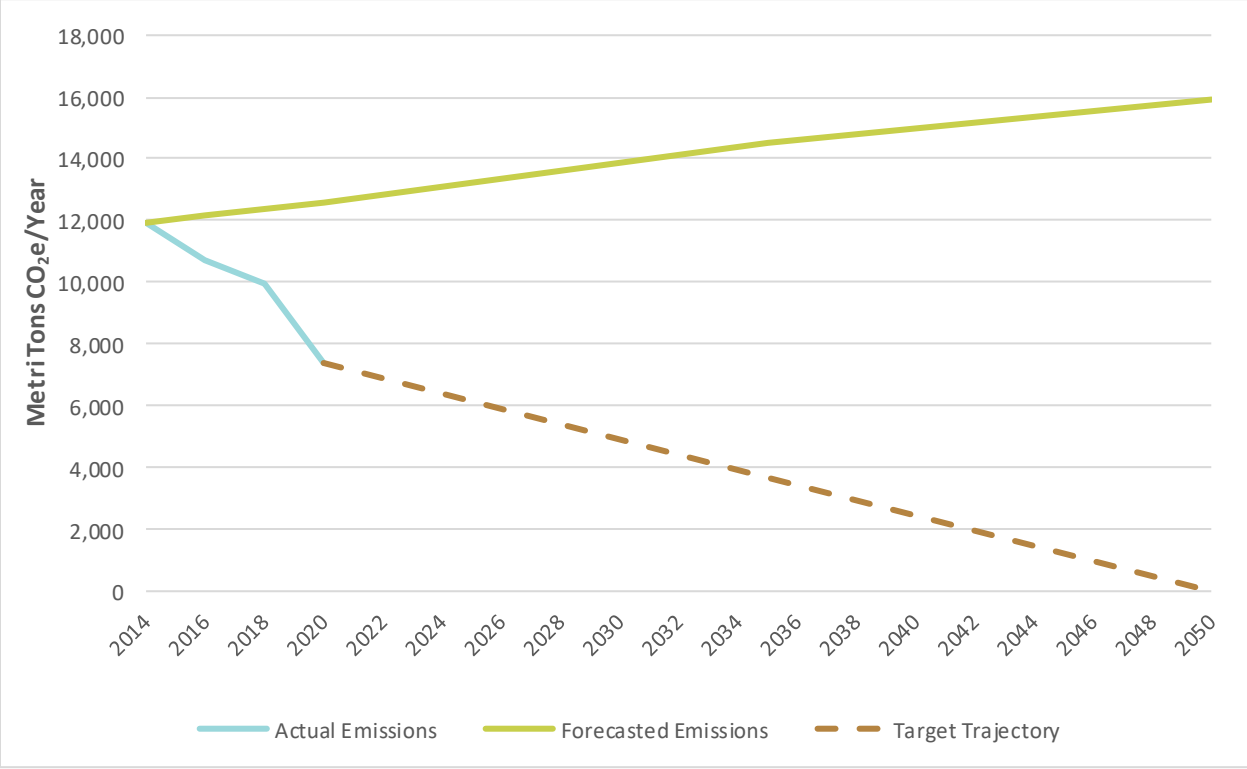
LGO GHG Emissions Reduction Progress

Figure 8 compares the City's LGO emissions reduction progress to its emissions forecasts and 2050 net-zero carbon negative target (illustrated here as zero emissions). In 2016, the City projected its LGO emissions to 2050 (green line in Figure 8) assuming activities would follow a "business-as-usual" scenario where no emissions-reduction actions will be undertaken beyond those already in place in the base year. The forecasts were based on varying growth factors for each emissions source, including:

- municipal budget and operating forecasts,
- community population growth,
- new city park development,
- new city library construction, and
- acreage of development envisioned in the SomerVision comprehensive plan.

The blue line represents the City's actual emissions trend (a 38% decrease below 2014 levels in 2020). The brown dotted line represents the City's GHG target trajectory, which shows that the City must continue to sharply decrease emissions to meet its target.

Figure 8 – LGO Progress toward Target Achievement

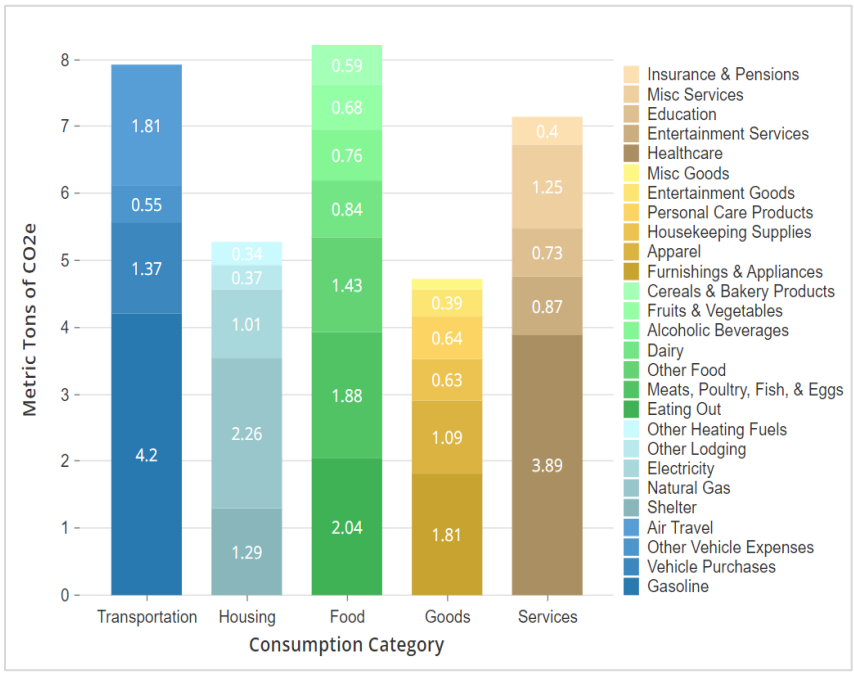


2019 Consumption Based Emissions Inventory

A consumption-based emissions inventory (or CBEI) is an estimate of the GHG emissions associated with the activity of all residents of a geographic area. It is equivalent to a personal household carbon footprint estimate, except calculated for all households in a jurisdiction. In traditional community inventories (like the one presented earlier in this report), a city would look at all emissions that occur within the city's borders. In contrast, CBEIs consider emissions that may occur anywhere in the world, if they are directly or indirectly a result of the city's residents' activities. As its first ever CBEI, the City developed a 2019 inventory to establish a baseline of consumption emissions using the most recent, pre-COVID pandemic data available. This inventory year differs slightly from the 2020 community and LGO inventories presented above, which already had established emissions baselines in 2014 as well as two subsequent pre-COVID inventories to illustrate three years of typical emissions levels in the community.

In Somerville in 2019, the **typical household was responsible for roughly 33 metric tons of carbon dioxide equivalent ($MTCO_2e$) annually**, or about **14 $MTCO_2e$ per person**. With 32,120 households in the city, this is a total of roughly 1 million $MTCO_2e$ in 2019 attributable to residents of Somerville. In contrast, the US average is about 41 $MTCO_2e$ per household. Figure 9 below provides an overview of the city's average per-household emissions in 2019. The actual emissions of any particular household in the city, however, could vary significantly from this average

Figure 9 – Somerville Consumption-based Inventory – 2019



Note: Emissions from the Misc Goods sub-category total 0.16 $MTCO_2e$

Food, transportation, and services are the largest overall emissions categories in Somerville, accounting for 25%, 24%, and 21% of emissions, respectively. Together, these account for approximately 70% of total emissions. Each of these categories also includes multiple sub-categories. Across all sub-categories, **gasoline, healthcare, and natural gas** are the top three emissions sources, accounting for 13%, 12%, and 7% of total emissions, respectively – a combined 31%.

Business-as-Usual Projections

Business-as-usual (BAU) is a common GHG emissions forecasting (or future projection) term that means continuing existing policies and behaviors under their current trends and projections, without additional intervention. Under a BAU approach, Somerville can expect to see average per-household consumption-based emissions **decline from the current levels of 33 $MTCO_2e$ per household to about 28 $MTCO_2e$ per household in 2030 and 21 $MTCO_2e$ per household by 2050** (see Table 1). The largest reductions occur in emissions from the transportation category, followed by the housing and services categories.

Table 1 – Consumption-based Emissions Business-as-Usual Projections

Category	2014	2019	2030	2050	Total Reduction (2014-2050)	% change (2014-2050)
Total	**30.4**	**33.3**	**27.7**	**21.1**	**-9.3**	**-31%**
Food	7.2	8.2	7.2	5.9	-1.3	-18%
Transportation	7.0	8.0	5.8	2.7	-4.3	-61%
Services	6.5	7.1	6.2	5.1	-1.4	-22%
Housing	5.8	5.3	4.3	4.0	-1.7	-30%
Goods	3.9	4.7	4.1	3.4	-0.6	-14%

Policy Scenarios Analysis

To reduce its consumption-based emissions further, the City evaluated a set of 15 policies across 3 different categories for their ability to potentially influence emissions directly or indirectly. The categories of analysis were building energy use, transportation and land use planning, and food policy. Based on the policies of interest, seven potential outcomes of these policies were analyzed for their effect on consumption-based emissions. Over the 25-year period 2025-2050, the seven modeled policy outcomes were found to have the total avoided emissions per household presented in Table 2.

Table 2 – Total Emission Reduction Potential by Policy Outcome

Policy Outcome	25-Year Total Emissions Avoided (Per Household)	Annualized Emission Reductions (average $MTCO_2e$/yr per household)
Reduce household natural gas and fuel oil use to 0 by 2050	29.9 $MTCO_2e$	1.2 $MTCO_2e$/yr
Increase housing construction to 1.15% per year – regionally / nationally avoided emissions	12.3 $MTCO_2e$	0.5 $MTCO_2e$/yr
Combined transportation policies – reduce vehicle ownership for new households, increase electric vehicle (EV) uptake, and increase housing construction	8.5 $MTCO_2e$	0.3 $MTCO_2e$/yr
Reduce meat and dairy consumption by 20% by 2050	5.7 $MTCO_2e$	0.2 $MTCO_2e$/yr
Increase housing construction to 1.15% per year – transportation impacts	5.5 $MTCO_2e$	0.2 $MTCO_2e$/yr
Reduce the building energy emissions from restaurants by 5% per year	3.3-4.5 $MTCO_2e$	0.1 – 0.2 $MTCO_2e$/yr
Reduce the building energy emissions from healthcare by 5% per year	2.5-3.1 $MTCO_2e$	0.1 $MTCO_2e$/yr
Increase EV uptake by 10% above state average	2.1 $MTCO_2e$	0.1 $MTCO_2e$/yr
Reduce vehicle ownership to 0.5 per household for new households	0.1 $MTCO_2e$	0 $MTCO_2e$/yr

Under a maximum reduction scenario, where all policies shown in Table 2 are deployed to their fullest extent, **Somerville could achieve another 3.8 $MTCO_2e$ in annual reductions**, bringing the average household's emissions down to **17.4 $MTCO_2e$ per household by 2050 – a 43% reduction from a 2014 baseline** (see Figure 10 and Table 3). This is primarily driven by reductions in emissions from buildings due to electrification policies in the maximum reduction scenario. The analysis also found strong emission reductions available through shifting to plant-based food alternatives and through increased housing development.

Figure 10. Total Emissions per Household - BAU and Maximum Reduction Scenario

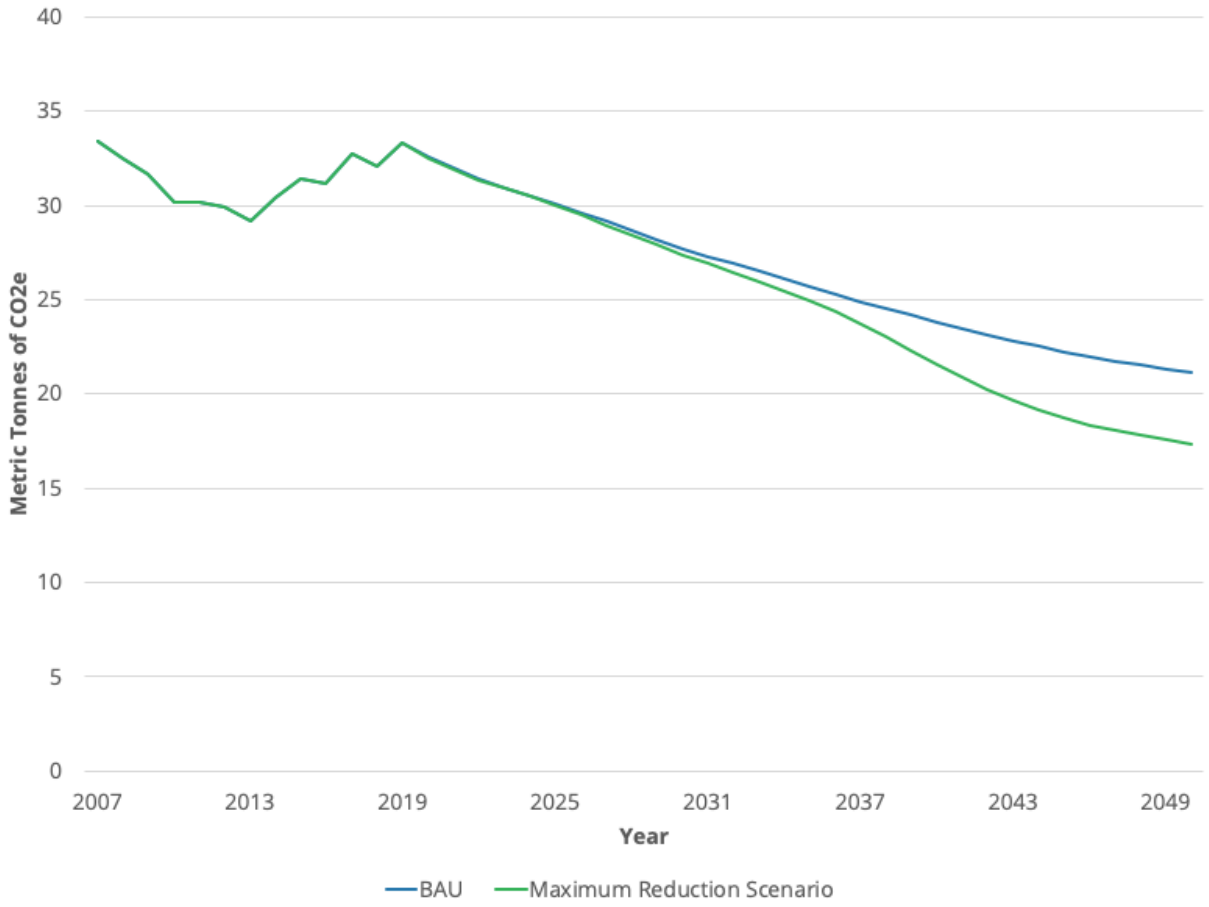


Table 3 – Maximum Achievable Reductions vs BAU Outcomes from Evaluated Policies

Category	**2014** Baseline year for community GHG inventory	**2019** Most recent CBEI analysis year	**2030** Interim target year	**2050** Target goal year	**BAU Reduction** (2014-2050)	**Maximum Reductions** (2014-2050)	**% change** (2014-2050)
Total	**30.4**	**33.3**	**27.4**	**17.4**	**-9.3**	**-13.1**	**-43%**
Food	7.2	8.2	7.1	5.2	-1.3	-2.0	-28%
Transportation	7.0	8.0	5.6	2.7	-4.3	-4.3	-61%
Services	6.5	7.1	6.2	4.8	-1.4	-1.7	-26%
Housing	5.8	5.3	4.3	1.2	-1.7	-4.6	-79%
Goods	3.9	4.7	4.1	3.4	-0.6	-0.6	-14%

CBEI Target Options

Under current modeling scenarios, Somerville's maximum potential CBEI reductions by 2050 are 43% of the 2014 baseline per-household emissions. Therefore, an achievable CBEI reduction target could be a **40% reduction by 2050 relative to 2014 levels** (just below the maximum reduction potential), with an interim target of **5% by 2030**. These targets should be potentially achievable under the scenarios explored in the CBEI policy analysis. However, these targets are not as well-aligned with existing City initiatives and commitments to net-zero carbon negative emissions for the geographic inventory and are less likely to drive policymaking much beyond the status quo.

Given the urgency of the climate crisis and Somerville's existing strong commitment to achieving net-zero carbon negative and a Green New Deal, the City could also consider adopting an **aspirational target of 50% reduction by 2050 relative to 2014 levels**, with an interim 2030 target of a 10% reduction. These ambitious targets are higher than the maximum emission reductions identified, but could be feasible with strong city commitment, early adoption of policies, and future unanticipated changes in technology, regulatory environments, industry commitments, etc. These target recommendations are summarized in Table 4 below.

Table 4 – Recommended CBEI Target Options

Feasible Targets (based on modeling)	Ambitious Targets
• 5% reduction by 2030 relative to 2014 levels • 40% reduction by 2050 relative to 2014 levels	• 10% reduction by 2030 relative to 2014 levels • 50% reduction by 2050 relative to 2014 levels