July, 2024

GEOGRAPHIC & CONSUMPTION-BASED GHG INVENTORY AND REDUCTION STRATEGY.

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Introduction

In 2022, The Town of Sudbury passed Article 58, declaring a climate emergency and setting the Town on a pathway to addressing the local causes and coming impacts of climate change. This included hiring a dedicated Sustainability Director and developing the 2023 Climate Mobilization Plan. This report represents the next step in the formalization of climate action in Sudbury by adding a quantitative assessment of how the community is contributing to climate change and the most effective ways to begin to reduce emissions. Greenhouse gas (GHG) emissions are viewed through two lenses here. First the geographic view of emissions accounts for those GHGs that are created as a result of direct combustion of fossil fuels or other sources within Sudbury as well as indirect emissions from the use of grid electricity or as a result of the disposal of solid waste.

Contrasted with Consumption-Based Emissions, which represents GHGs associated with all of the activities involved with supplying Sudbury residents with the goods and services they use every day. While there is some overlap between the two, each approach informs a different type of action. The geographic approach informs the prioritization of actions that Sudbury residents have the greatest direct control over and where local action is required to achieve reductions. The consumption-based approach recognizes the full scope of actions individuals can take to reduce GHGs throughout the economy through smarter purchasing. The 2023 Climate Mobilization Plan has a full suite of actions that aims to both protect the climate and enhance resilience in the community, all of which would yield positive outcomes for the climate. This report details areas where the greatest attention is required to meet the GHG reduction targets established in Article 58 to reduce GHGs by 50% below 1990 levels by 2030, 75% by 2040, and net zero by 2050

Geographic Community-Scale Emissions

Greenhouse gas emissions directly attributable to activities by the residents, businesses, and municipal operations in Sudbury for 2021 total 195,899 metric tons CO_2 equivalent ($MTCO_2e$). This is roughly equivalent to half of annual emissions from a typical fossil gas fired power plant.

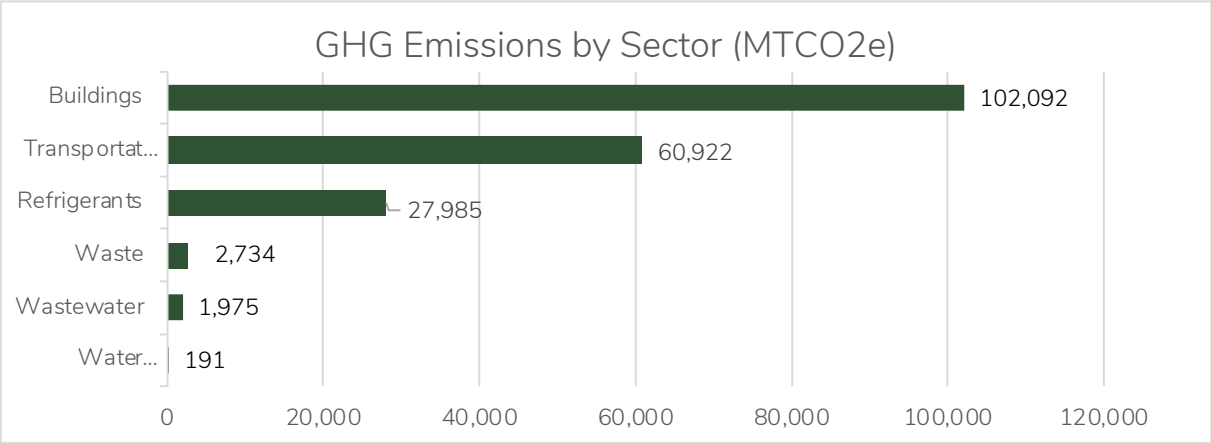

Figure 1. Sudbury 2021, GHGs by Sector

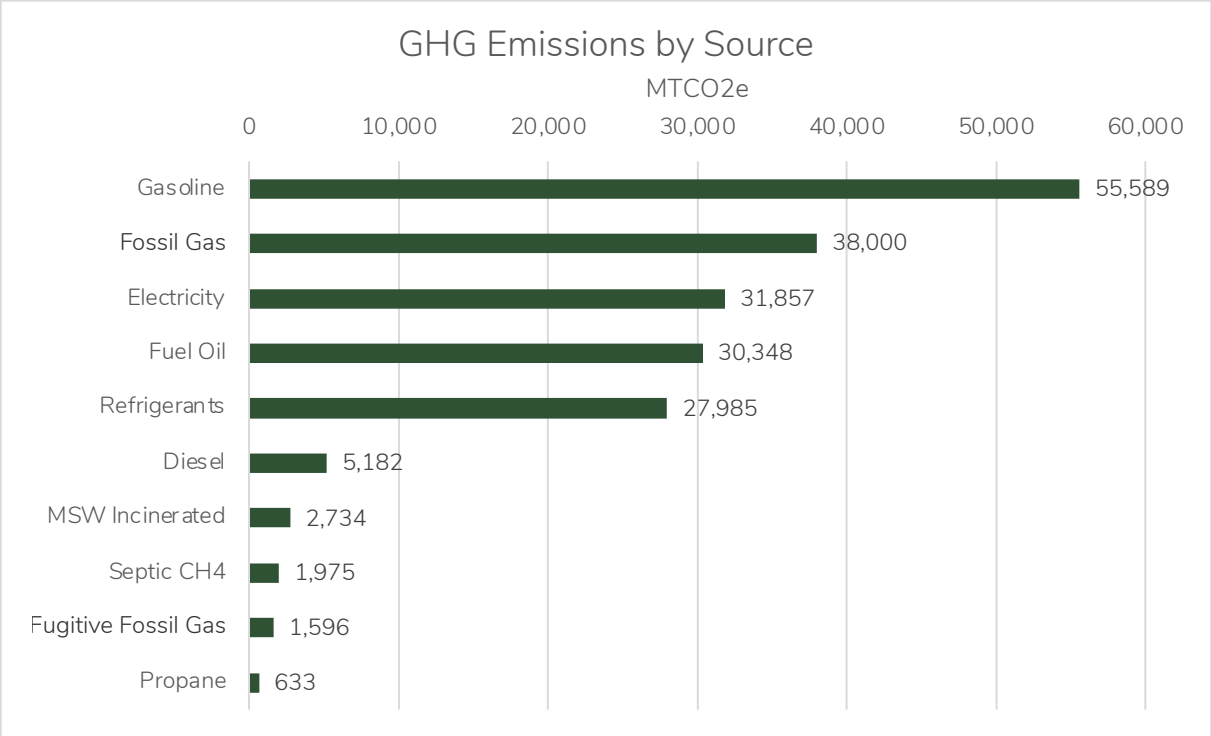

Figure 2. Sudbury 2021, GHGs by Source

Viewing the results by sector indicate that energy used in buildings is the highest contributor, which is a combination of GHGs resulting from electricity, fossil gas, and fuel oil. When viewed by source category a slightly different picture emerges with gasoline, primarily used in on-road passenger vehicles, is the largest single source of emissions.

Another significant source of GHGs today are refrigerants that leak from nearly every device that provides cooling of buildings or kitchen applications. While significant today, these gases are being phased out at the federal level. On the other hand, disposal of solid waste today is relatively small in the overall picture but poised to grow in the future as detailed in the business-as-usual forecast below.

Within the community-wide total, Sudbury Municipal Operations generated 5,304 $MTCO_2e$ from energy used in buildings and facilities as well as the town fleet. This is approximately 2.7% of the townwide total and typical of the local government contribution for many communities.

Business-as-Usual

Emissions from Sudbury are expected to decline slightly even without concerted action due to the federally mandated phase out of high global warming potential refrigerants and from the anticipated decline in grid electricity carbon intensity. In the absence of substantial growth in households and other development, these changes will dominate in the years ahead.

One source of GHGs that is expected to rise however, is emissions from solid waste disposal. This analysis assumes that by 2030, solid waste will be disposed via landfill rather than incineration as is widely practiced today. While the timing in uncertain, it is likely This change will increase the GHGs associated with solid waste by 2.5x what they are currently today for the same volume of waste.

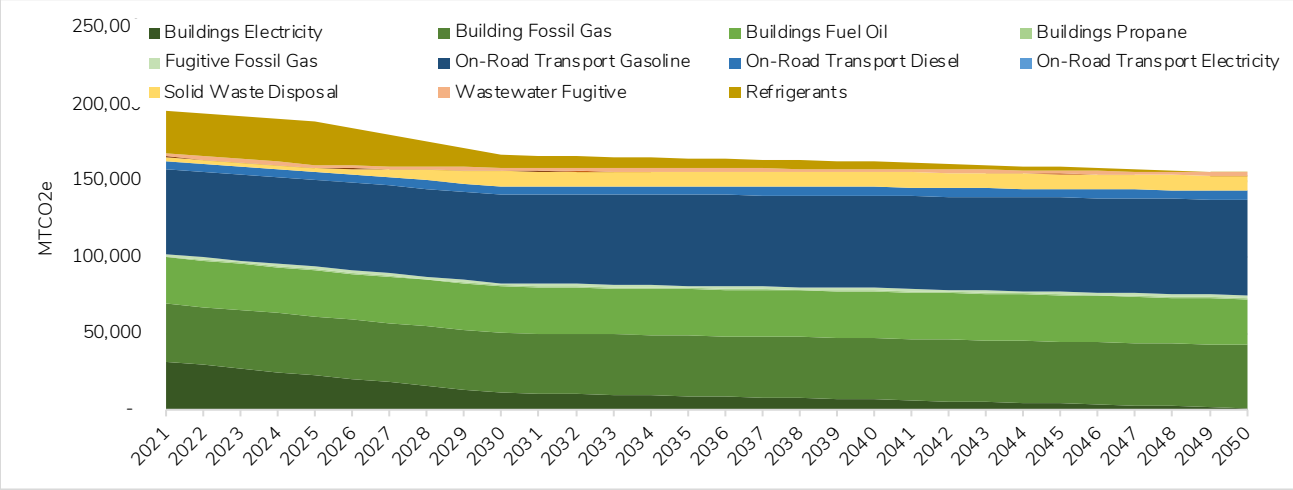

Figure 3. Sudbury Business as Usual GHG Forecast

Overall GHGs are expected to decline by 7.3% by 2050 from 2021 levels under a business-as-usual scenario. This illustrates that while there are some tailwinds helping Sudbury achieve its goals, substantial additional effort will be required accelerate reductions.

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Emissions Reductions

Article 58 set aggressive GHG reduction targets in line with the level of ambition expressed in the State of Massachusetts targets that aim for a 50% reduction from 1990 levels by 2030 on a pathway to net zero by 2050. While we cannot look back to 1990 as our starting point, The State of Massachusetts Decarbonization Roadmap and 2030 Climate and Energy Plan provide targets for transitioning the built environment, transportation, and waste systems that allow individual communities to align transition targets to meet the same outcomes. Meeting those benchmarks would lead to a 35% reduction from 2021 by 2030 and 77% by 2040. As illustrated in the following sections, these targets all require rapid acceleration in the short term to put us on a pathway to zero by 2050.

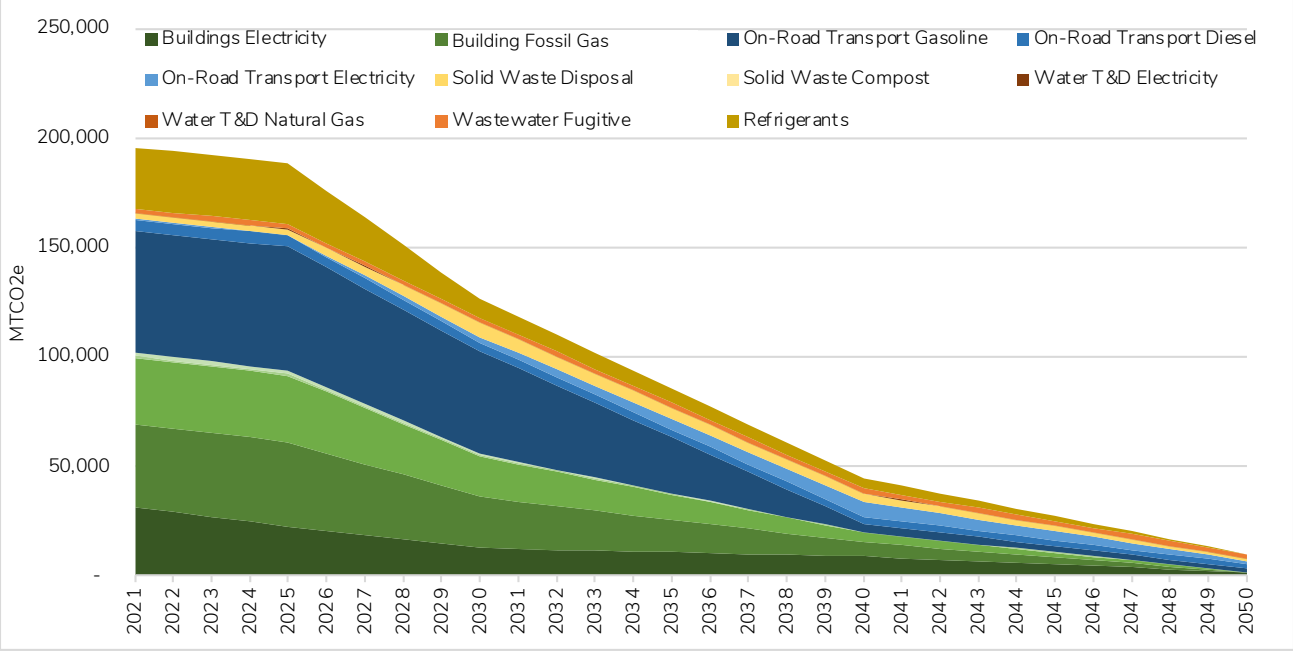

Figure 4. Sudbury GHG Reduction Pathways

Home Efficiency and Electrification:

Elimination of the direct use of fossil fuels in homes by electrification of space heating, water heating and cooking is the primary means of GHG reduction. The 2030 Clean Energy and Climate Plan targets 38% of homes by 2030, which defines the implementation schedule below.

	2030	2040	2050
Weatherization Only Target	597	1,194	-
Weatherization Homes / Year	119	60	-
Weatherization + Electrified Target	2,269	4,776	5,970
Weatherization + Electrified Homes / Year	454	251	119
Total Homes to retrofit	2,866	5,970	5,970
Total Homes / Year	573	310	119

Table 1. Sudbury Residential Retrofit Schedule

While any home that is a good candidate for electrification now should be prioritized for retrofits, there are a number of homes which could reduce energy use substantially just through weatherization.

Heat pump technology is evolving rapidly and there are new air-to-water systems designed to work with forced hot water heating systems common to many homes in Sudbury coming on the market now. However, many of the models available today work very well in homes with existing duct work and a hot air distribution system. According to the Sudbury Assessors Database, there are ample candidate homes with an easy pathway to electrification today with new options to make the transition easier for all existing systems widely available soon.

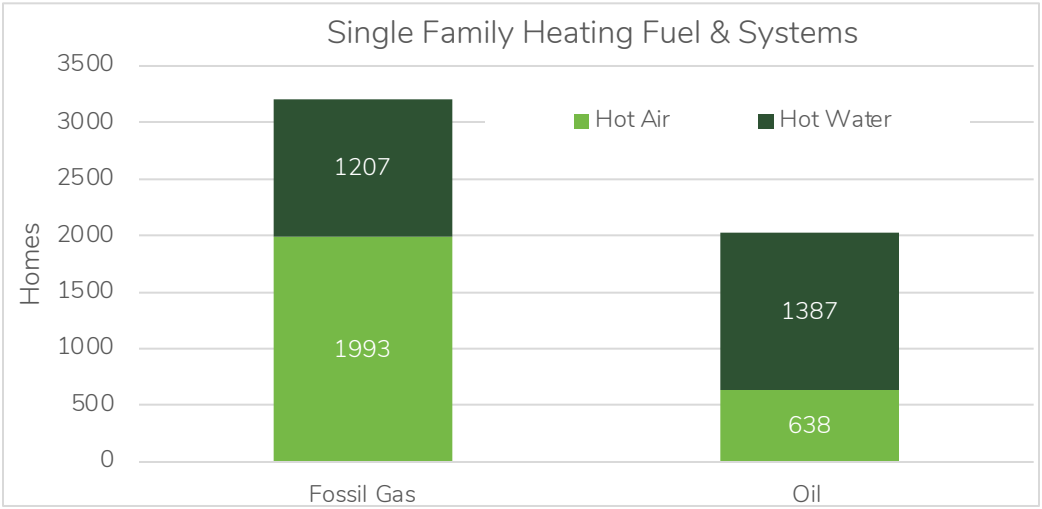

Figure 5. Sudbury Share of Residential Heating System Types

The addition of heat pumps for heating and air conditioning has the potential to increase the use of high-global-warming-potential refrigerants in new equipment. While many of the most climate-damaging chemicals are being phased out, homeowners should seek models that use low-global-warming-potential refrigerants where possible.

While there are far fewer commercial buildings in Sudbury, a similar rate of change will be needed among those buildings as well to complete the transition away from local use of fossil fuels. Sudbury municipal operations could provide demonstrations of those transitions by pursuing electrification projects through the Massachusetts Green Communities program and new Climate Leaders program, designed specifically to support the Town's internal decarbonization efforts.

Electric Vehicle Transition

The single most effective GHG reduction strategy is to avoid vehicle trips whenever possible. While Sudbury is fairly car-dependent, the trend towards work from home may allow more residents to forego multiple vehicles per household and adjust to take more active mode trips with bikes/e-bikes and other options. The direction of the Sudbury Comprehensive Plan towards more compact and complete community will make these options more feasible for residents over time.

To reach our GHG reduction targets, any trips that cannot be avoided must transition to zero emissions electric vehicles. The 2030 Clean Energy and Climate Plan sets a target of 19% of

passenger vehicles to be zero emissions technology by 2030. Applied to the number of vehicles registered in Sudbury, that would require roughly 450 vehicle purchases to be electric each year, or 57% of all new cars between now and 2030. While ambitious, this level is absolutely achievable for Sudbury, especially as the variety of models expands to meet nearly every class of passenger vehicle.

	2030	2040	2050
Percent of Vehicles Electrified	19%	80%	100%
Total Resident Vehicles Electrified	2,863	11,930	14,913
New EVs / Year	450	907	298

Table 2. Sudbury Vehicle Electrification Schedule

While this analysis does not explicitly call out full battery electric versus plug-in hybrid options; homeowners should consider where plug-in hybrids can meet most of their transportation needs while in electric mode.

New Construction and Rebuilds

The new Massachusetts Specialized Energy Code has many provisions and provides multiple compliance pathways that would all lead to reduced energy use and emissions for new buildings. While it is difficult to model all the hypothetical ways that could play out, we can illustrate the potential magnitude of the benefit of this action within Sudbury by illustrating the improvement that would occur under the all-electric option for a single-family home that is 4,500 square feet in living space; just above the threshold that would trigger a higher standard.

A mixed fuel home using fossil gas for space heating would generate approximately 234 $MTCO_2e$ from 2025 to 2050; whereas an all-electric home would generate just 100 $MTCO_2e$ over that same period.

Sudbury's Assessor Database indicates that roughly 5 households of this size are built annually in town. If the specialized code were enacted in 2025, the cumulative avoided GHGs between now and 2050 would be over 10,000 $MTCO_2e$. Not only would this avoid generating new GHGs but will also reduce the cost to ultimately transitioning all the housing stock to run on clean electricity. If new homes are developed to meet standards for zero net energy or even just have some degree of onsite solar, the impact would be even greater.

Maintenance of Tree Cover

One key topic related to development is the maintenance of tree cover. Stabilizing the climate within the lifetimes of most people alive today will require removal of as much CO_2 from the air as possible even after we have eliminated the sources of GHGs. Tree cover is an important way to do that. Sudbury is currently estimated to have over 572,000 $MTCO_2e$ stored within trees. Loss of tree cover would be an increase in the release of CO_2 from what is currently stored at a rate of 114 metric tons per acre. Moreover, that loss of trees would reduce the capacity to absorb CO_2 from the atmosphere by 4.5 metric tons per acre per year.

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Solid Waste Diversion

Currently household waste collected at either the transfer station or from a private hauler pickup is likely destined for incineration at one of several waste to energy facilities in Massachusetts. Under this disposal system, the primary source of greenhouse gases is from the combustion of plastics which are made of petrochemicals, just as any other fossil fuel. Currently the best strategy for GHG avoidance is from avoidance of disposable plastic.

It is likely that the incineration of solid waste in Massachusetts will no longer be a significant disposal method by the end of the decade as waste-to-energy facilities become increasingly difficult to operate due to tighter air quality regulations and anticipated closure of many onsite ash landfills. Anticipating this change, Sudbury should place attention on diversion of organic material from the waste stream as soon as possible. Public Schools and commercial food establishments provide an excellent starting point to capture enough volume of materials to support a significant composting operation. Regardless of the disposal option, the State of Massachusetts is targeting 90% reduction in waste disposed by 2050. Reaching this volume will take concerted effort and a unified approach to solid waste management in Sudbury to achieve.

Targeted Actions

Nearly all of the reductions that must happen to reduction targets will come from the action of residents and businesses. Mobilizing those actions requires concerted attention towards the elimination of fossil fuels and deployment of renewable energy throughout the community wherever possible. As of this writing in 2024, financial support to help with these actions is at a historic high with new programs to be released within the next year as a result of the Federal Inflation Reduction Act.

Many of these programs will flow through the MassSave program and it provides a good entryway for residents ready to make the move on their own. Sudbury can likely accelerate the transition by leveraging information in the Town Assessor Database and Massachusetts Vehicle Census to develop targeted outreach to homes ready to make the transition now as they invest in their homes and other property and avoid locking in another generation of fossil fuel powered appliances and equipment.

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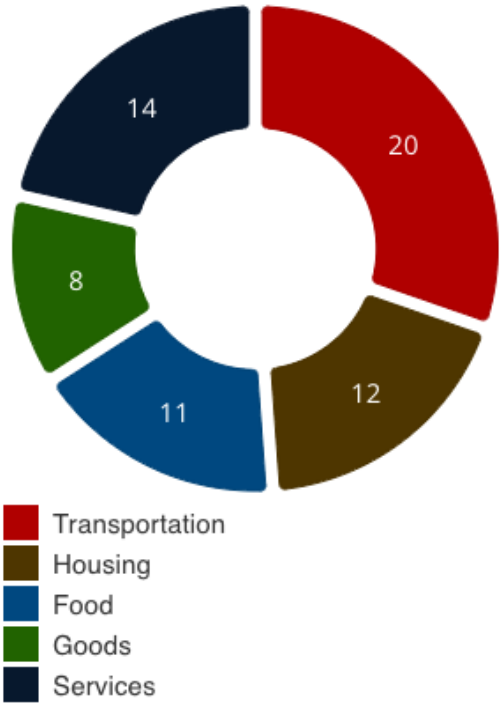
Sudbury Consumption-Based Emissions Summary Report

The Town of Sudbury completed a consumption-based emissions inventory ("CBEI"), estimating the greenhouse gas emissions associated with the household consumption of all residents. This inventory is equivalent to a personal household carbon footprint calculation, except calculated for the community as a whole rather than for an individual household.

Figure 6. Sudbury 2022 Community-Wide CBEI Summary



These emissions are broken out into five categories: transportation (including driving and air travel), housing (including home construction and household energy use – electricity and fossil gas), food (including meat, dairy, fruits & vegetables, cereals & bakery products, and other foods), services (including healthcare and education), and goods (including furnishings and appliance and other miscellaneous goods). Figure 6 shows the breakdown of Sudbury's emissions across these 5 categories.

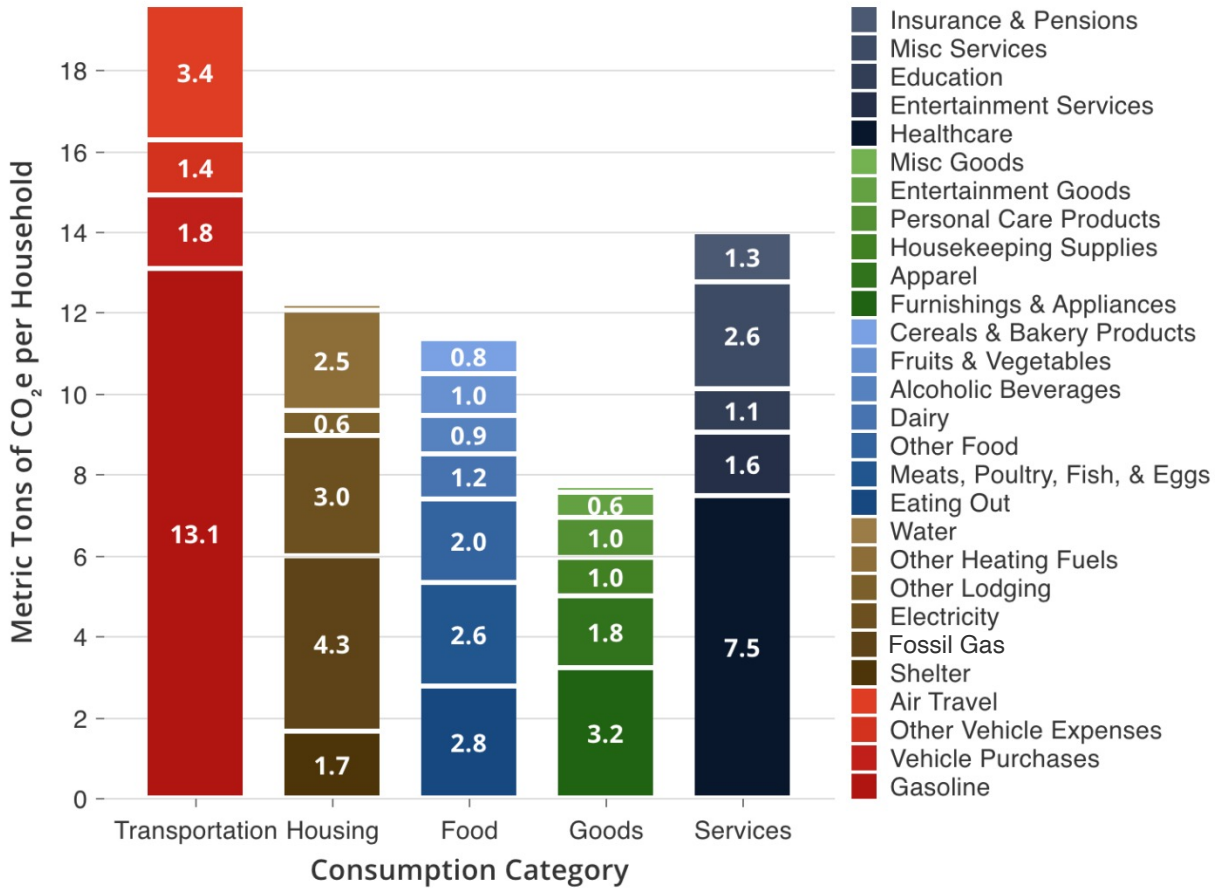
In Sudbury in 2022, the typical household was responsible for roughly 65 metric tons of CO_2e annually ($MTCO_2e$), or about 21 $MTCO_2e$ per person. With 6,046 households in the town, this is a total of roughly 393 thousand $MTCO_2e$ in 2022 attributable to residents of Sudbury. In contrast, the community-wide inventory totaled only 195,901 $MTCO_2e$. Sudbury's consumption-based emissions are nearly double its sector-based emissions.

Sudbury's household consumption-based emissions are modeled based upon local household characteristics. All of these characteristics are higher than the US average. The US average household emissions are roughly 43 $MTCO_2e$.

The largest sub-categories of consumption-based emissions in Sudbury are gasoline (13.1 $MTCO_2e$), healthcare (7.5 $MTCO_2e$), fossil gas (4.3 $MTCO_2e$), and air travel (3.4 $MTCO_2e$). Meat and dairy combined also comprise 3.8 $MTCO_2e$. Together, these sub-categories account for nearly 50% of emissions.

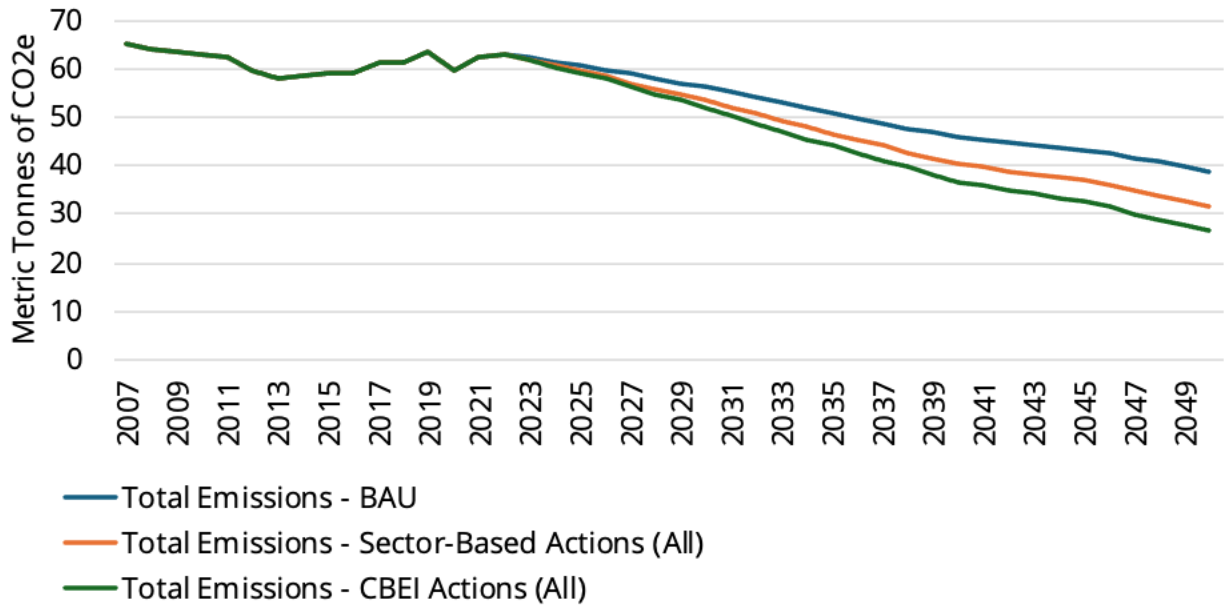
The largest sub-categories of consumption-based emissions in Sudbury are gasoline, healthcare, fossil gas, and air travel.

Figure 7. Sudbury 2022 Consumption-Based Emissions Inventory



Sudbury's emissions were projected into the future under three scenarios: a business-as-usual (BAU) scenario, assuming a complete transition to electric vehicles and 95% carbon-free electricity; a sector-based actions scenario, assuming a complete decarbonization of existing buildings and 100% carbon-free electricity; and a CBEI actions scenario, assuming 30-50% reductions in meat & dairy, food waste, air travel, and furnishings & apparel emissions. Under these scenarios, Sudbury's consumption-based emissions are expected to decline by about 38%, 50%, or 55% by 2050, respectively, as shown in Figure 8.

Figure 8. Sudbury CBEI Forecast 2007-2050



While no pathway to zero consumption-based emissions presently exists, Sudbury can still take meaningful actions to achieve significant reductions in emissions by 2050. These actions include:

- Prioritizing necessary actions to realize BAU and sector-based reductions through fully transition to electric vehicles and all-electric buildings
- Encouraging and educating residents on strategies to reduce food waste
- Promoting plant-based foods at home, in schools, and in restaurants
- Supporting repair, reuse, and durability of clothing, furniture, and appliances
- Encouraging local or train-based vacation travel, and supporting state and federal policies to increase the production of sustainable aviation fuel

Sudbury should prioritize these actions based upon feasibility, capacity, and the ability to collect data necessary for tracking progress and impact.

Closing

Sudbury like many communities across the Commonwealth has recognized the need for focused action to address Climate Change. The 2023 Climate Mobilization Plan and the coalition of engaged community partners from that process should continue to incorporate climate considerations into all the decisions that are made throughout Town government and beyond. However, there are relatively few sectors that hold the key to achieving deep measurable reductions in GHGs. Luckily these actions are those that are receiving significant support from all levels of government and they are ones for which the Town can track internally with permit records and property database and through resources such as MassSave Reports and the Massachusetts Vehicle Census.