To	Oliver Sellers-Garcia, Hannah Payne, City of Somerville
Subject	City of Somerville Climate Neutrality Pathway Assessment Whitepaper
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Carbon Neutrality Pathway Assessment Whitepaper

1. Introduction

In 2014, the City of Somerville set an ambitious goal to achieve carbon neutrality by 2050, and initiated a climate action planning process to define the pathway needed to achieve this goal. The City first developed community-wide and municipal operations greenhouse gas (GHG) emissions inventories that demonstrate the sources of emissions in the city today. Emissions forecasts were also developed to estimate how the City's emissions could grow through the year 2050 if no GHG reduction actions were put in place. The City then reviewed the GHG commitments of other leading local and international cities to define a climate neutrality goal in the context of its own communitywide GHG emissions. After evaluating the climate neutrality goal against the sources and magnitude of local GHG emissions, the City analyzed a preliminary list of GHG mitigation strategies and policy implementation mechanisms. This list was vetted through expert interviews with City staff and leading academics to identify potential implementation barriers and assess the likelihood and extent of long-term implementation as it relates to the City's climate neutrality goal. The GHG reduction benefits of the underlying technological changes driven by each strategy were quantified to define a pathway towards carbon neutrality in Somerville. This whitepaper summarizes the results of the City's previous work.

2. Summary of Somerville's GHG Inventory

Greenhouse gas inventories at the community scale are typically organized into categories or sectors that represent the commonly understood major sources of emissions. Somerville's community inventory, upon which the analysis in this whitepaper was based, includes emissions from the following sectors:

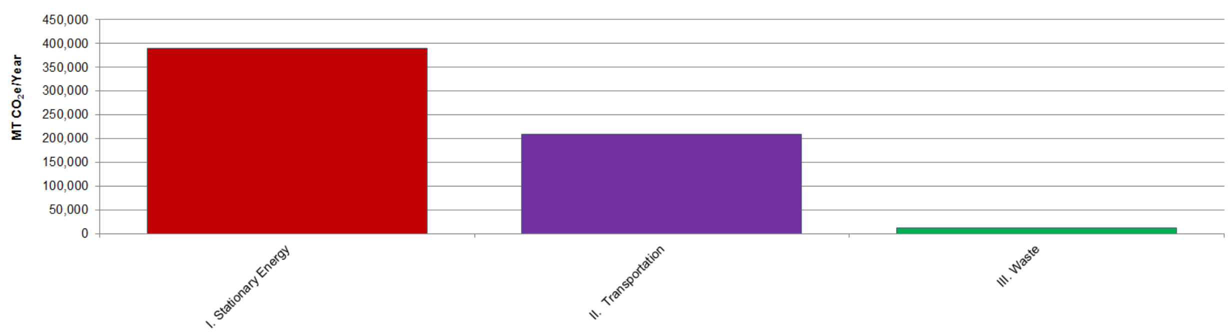
- Stationary or Building Energy (e.g., electricity, natural gas)
- Transportation
- Waste

The community inventory estimates the total emissions generated from activities within the City of Somerville boundary. The inventory represents emissions from residential, commercial, industrial, and public activities. The results of the inventory were used to inform the preliminary list of strategies for

GHG reduction in the community. This section gives a brief summary of the community inventory results. Further detail can be found in the City of Somerville Greenhouse Gas Inventory Report.

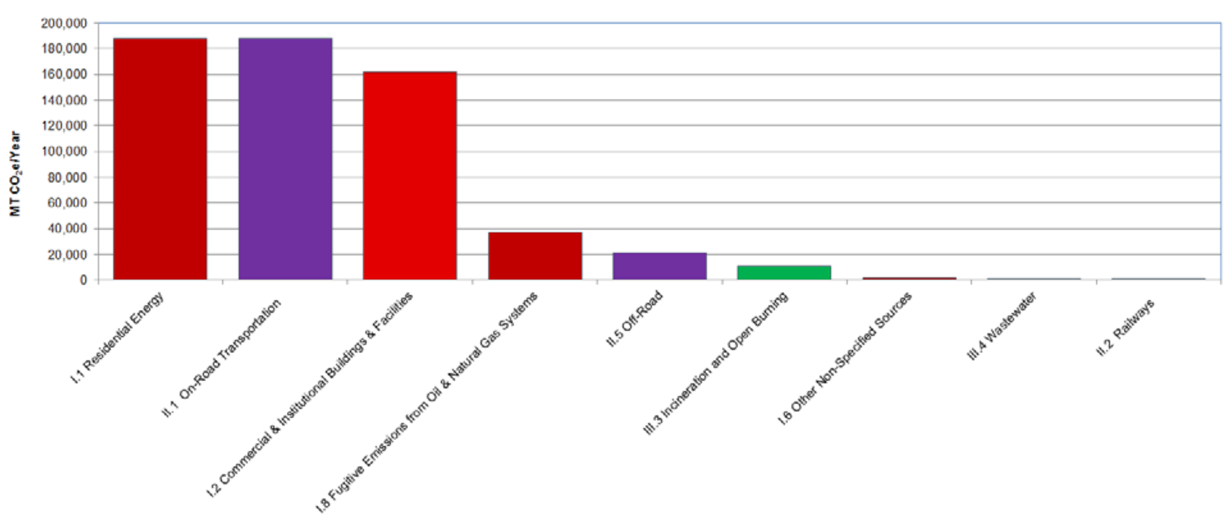
The majority of Somerville's emissions come from the building energy sector (64%), more than a third from the transportation sector (34%), and the remaining emissions from the waste sector (2%). Figure 1 below shows this breakdown.

Figure 1: Communitywide GHG Emissions by Sector



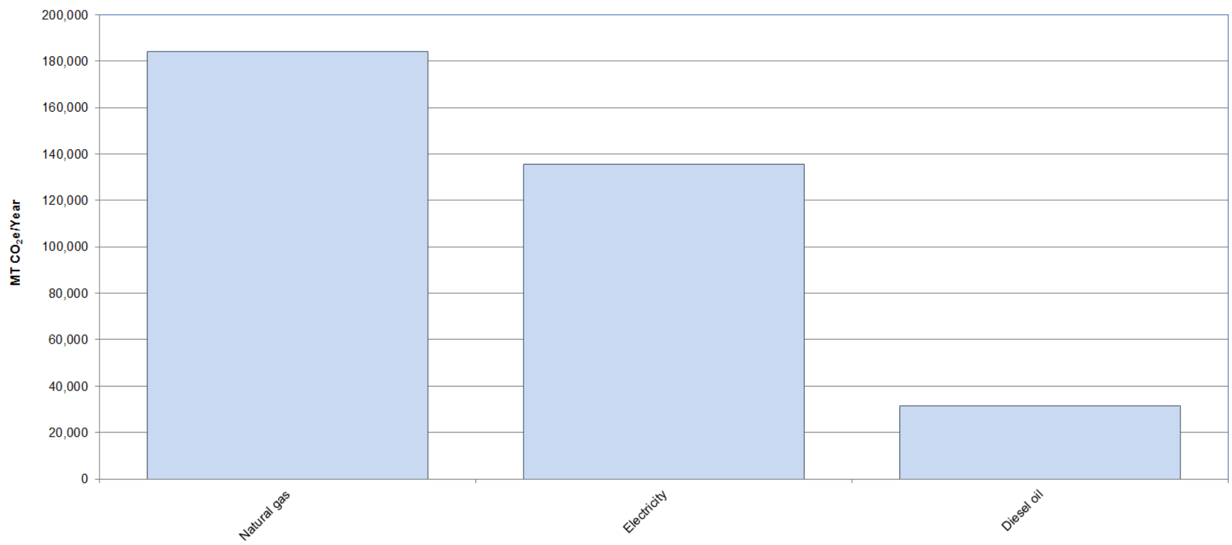
A closer analysis of the building energy and transportation sectors shows that residential buildings, on-road vehicles, and commercial buildings are the primary contributors to emissions (see Figure 2).

Figure 2: Communitywide Building Energy and Transportation Emissions by Sub-Sector



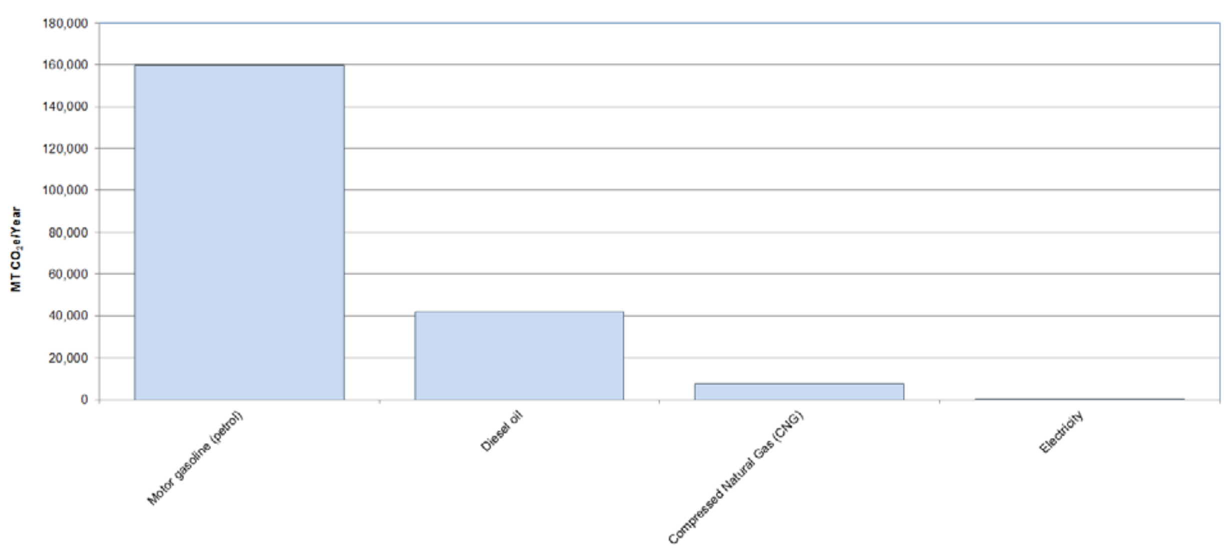
Within the building energy sector, natural gas combustion contributes to more than half of this sector's emissions. Electricity and heating oil contribute approximately 33% and 8%, respectively (see Figure 3). This suggests that actions to reduce emissions in the building energy sector will need to focus on deployment of clean electricity, increasing the thermal efficiency of buildings, and electrification of space and water heating.

Figure 3: Building Energy Sector Emissions by Fuel Type



Within the transportation sector, a large majority of emissions (98%) are from personal automobiles (particularly gasoline, as shown in Figure 4). Overlapping actions can help to reduce transportation emissions by increasing non-automotive circulation within the city (mode shift) and decreasing vehicle-related fuel emissions (fuel switching). The role of land use and transportation planning may also have a marginal influence on travel mode split within the city. However, as a largely built-out city that is already served by regional transit, the potential for dramatic land use-based change in Somerville is likely low.

Figure 4: Transportation Sector Emissions by Fuel Type



3. Carbon Neutrality Definition

Several factors were considered in the refinement of Somerville's carbon neutrality targets, such as the latest climate science, the state and national policy context, the city's baseline emissions and projected growth, and support from city leadership for climate protection. They are described below:

- **Science-based Targets**: GHG reduction targets are considered "science-based" if they are consistent with the magnitude of emission reductions required to limit the increase of global temperatures to 2°C above pre-industrial temperatures. This translates to the need to reduce global emissions by at least 80% below 1990 baseline levels by 2050.[1] Recent research suggests that limiting global temperature increase to 2°C may not be adequate, and that a 1.5°C limit may be needed to avoid the most adverse impacts of climate change. Therefore, targets that go beyond 80% reductions below baseline levels by 2050 may be a more appropriate choice for cities wanting to contribute to global climate protection efforts.
- **State and National Policy Context**: Somerville's target also needs to be framed within state and national climate mitigation efforts. Massachusetts has been among the leading states in the nation to adopt short-term and long-term GHG reduction targets. The Global Warming Solutions Act (GWSA), signed in 2008, requires the State to reduce emissions to 25% below 1990 levels by 2020 and to 80% by 2050. At the national level, the former Obama administration set a short-term target to reduce emissions to 26-28% below 2005 levels by 2025 in its declaration to the United Nations Framework Convention on Climate Change (UNFCCC). According to the U.S. Department of State, this target would put the nation on the pathway to achieve deep economy-wide reductions of 80% or more by 2050.
- **Somerville's Baseline and Projected Emissions:** An analysis of Somerville's baseline GHG inventory shows that while a majority of the emissions are from the building energy sector (64%) and are within the jurisdictional authority of the City, the transportation sector also makes up a sizeable portion of the inventory (34%) and is harder to address, as it is largely influenced by regional policy and planning. Furthermore, the waste sector (2%) includes some fugitive emissions that cannot be feasibly eliminated due to the bio-chemical nature of waste treatment processes.
- **City Leadership and Purpose**: Elected officials and City employees in Somerville recognize that cities can and should lead the way in addressing climate change, and that the actions necessary to do so must be bold. The City considers decarbonization as critical not only to safeguarding its future, but also an opportunity to innovate, improve the local quality of life, and expand the local economy.

[1] Fifth Assessment Report of the Intergovernmental Panel on Climate Change

Alternative Definitions of Carbon Neutrality

After taking the above factors into consideration, the City reviewed various definitions of the term 'carbon neutrality'. In the context of communitywide GHG emissions, carbon neutrality is often used interchangeably with 'zero carbon emissions', 'net zero carbon emissions', and 'deep carbon reductions (or deep decarbonization)'. It is important to distinguish between these terms.

- **Zero Carbon Emissions:** In its strictest sense, this term refers to a scenario under which a city completely eliminates all sources of direct GHG emissions associated with its activities. While theoretically possible, this type of target is very challenging to achieve due to the fact that some sources of GHG emissions are very difficult to eliminate.
- **Net Zero Carbon Emissions:** This term means that the *net* GHG emissions associated with a city are zero. Under this scenario, some residual emissions may be produced by a community each year, but they can be fully balanced by investing in offsetting activities such as generating additional renewable energy and providing it to consumers outside the community, biological carbon sequestration, green procurement strategies, or the purchase of carbon credits.
- **Deep GHG Reductions:** This term refers to the common long-term GHG reduction target set by cities, aiming to reduce emissions to approximately 80% below baseline levels by 2050 in order to limit the global temperature increase to 2°C compared to pre-industrial temperatures. Most cities leading the effort on GHG mitigation have set this long-term target.

While the above targets focus on GHG emissions as a metric for measurement of progress, leading cities are also adopting goals that focus specifically on the activities causing GHG emissions, such as energy consumption in the building and transportation sectors or solid waste generation. Cities have adopted these targets in addition to or in lieu of a higher-level carbon neutrality goal. Such activity-based targets can include:

- **Fossil-fuel Free or 100% Renewable Energy-based Targets:** This type of target focuses on the activity that generates the majority of overall GHG emissions – fossil fuel combustion for energy generation.
- **Efficiency-based GHG Targets:** In addition to measuring overall GHG emissions, many cities set goals for their per-capita emissions, as a way of making sure that population growth and economic activity are accounted for in targets. Efficiency targets can allow for population and economic growth to occur in a manner that generates increasingly fewer emissions per unit of growth. Efficiency target are often expressed as metric tons of carbon dioxide equivalent (MT CO_2e) per capita or MT CO_2e/Gross Domestic Product (GDP).

Somerville's Proposed GHG Target

After reviewing the definitions of carbon neutrality as well as the strengths and challenges associated with each definition, the City has proposed a **net zero GHG target by 2050**. This target goes beyond the deep carbon reduction targets that many other cities have adopted, but stops short of a pure zero carbon emissions target, which is currently infeasible to achieve.

The proposed target accounts for all types of GHG emissions from all activities included in the City's community and municipal GHG inventories; not just CO_2 emissions from fossil fuel combustion. At the same time, it accommodates the reality that some sources of GHG emissions cannot be feasibly eliminated, such as process emissions from wastewater generated by the community and sent to the Deer Island Waste Water Treatment Plant. With a net zero GHG target, the City could use a combination of biological carbon sequestration, exported green electricity, green procurement strategies, or carbon credit purchases to offset residual emissions from such sources. As the use of purchased credits to achieve a target does not directly induce global carbon reduction, the City currently prioritizes the other three offsetting strategies for policy and planning purposes. Furthermore, regional collaboration on offsetting emissions can also be maximized.

Limits on jurisdictional authority necessitate that the City rely on regional, state, and national policies and programs to drive emission reductions from specific sectors, like transportation or electricity generation. For example, the City's forecast of future GHG emissions assumes that the Massachusetts Low Emission Vehicle Program (LEV) will act to reduce future vehicle emissions by increasing vehicle efficiency requirements. Similarly, it assumes that the Massachusetts Renewable Energy Portfolio Standard (RPS) will result in lower electricity emissions by requiring 20% of electricity sold in Massachusetts to be generated from renewable sources by 2025.

The City's efforts to achieve its target will consider the future efficacy of these outside policies and programs so that strategies can be developed to address the emissions that will remain after their implementation. In this way, the City is not working alone to achieve its target, but is identifying complementary actions to build upon the efforts of other actors (e.g., regional, state, national efforts).

Interim Targets

In addition to an overarching net zero GHG reduction target by 2050, the City is also considering short- and medium-term targets, as they can help create a linear reduction trajectory toward the final target. Intermediate targets facilitate additional support and accountability, and help to ensure continued momentum around local climate protection efforts. The intermediate targets should be quantitative, such that progress towards the ultimate target can measured and monitored regularly. In addition, they should be flexible to account for fluctuations in performance, and adjusted based on the findings of periodic monitoring. For example, research indicates that to remain within a 1.5°C degree temperature rise, cities around the world need to limit emissions to approximately 2.9 MT CO2e/Capita by 2030. If Somerville follows a linear trajectory towards its long-term net zero target, the City would be on track to achieve an emissions level of 2.2 MT CO_2e/Capita by 2030 and therefore make its fair-share contribution to global climate mitigation efforts.

Parallel Targets

The overarching target using GHG emissions as a performance metric can also be complemented with targets that focus on the activities that contribute to emissions, such as energy consumption in the built environment and transportation sectors, and waste generation. The City may consider a target to procure 100% of its electricity from renewable energy sources by a target year (to be determined). Alternatively, the City may set a more ambitious target to become completely fossil-fuel free within the same timeframe. This type of target would also include natural gas, which represents a significant portion of overall energy consumption in the built environment in Somerville.

Further details on how the City determined its net zero GHG target are provided in the Carbon Neutrality Definition Memorandum.

4. Carbon Neutrality Pathway

In climate action planning, a GHG reduction pathway is a scenario that demonstrates the technological transformations necessary to achieve an emission reduction target, through the implementation of policies and programs. The City's Carbon Neutrality Pathway was developed with input from key experts, using the Compact of Mayors / C40 Cities Climate Action for Urban Sustainability (CURB) tool - a decision support tool which quantifies the GHG reduction potential and financial costs and benefits of strategies based on local context-specific information. Policy- and program-based mechanisms to implement the GHG reduction strategies were identified based on their applicability to Somerville, as well as their effectiveness in other cities.

Expert Interviews

As described earlier, buildings contribute to roughly two-thirds of GHG emissions in the city, followed by the transportation sector, which contributes approximately one third. Therefore, considerable emissions reductions must occur within these sectors for the City to achieve its long-term GHG reduction goal. Taking this into account, the City, with guidance from its consulting team (AECOM), developed a preliminary list of potential GHG reduction strategies and policy- or program-based implementation mechanisms to achieve Somerville's carbon neutrality goal.

In its approach to identify appropriate strategies and implementation mechanisms, the consulting team interviewed experts from academic institutions and local government in the areas of building energy, transportation, and solid waste. The interviewees provided insights on the political and technical feasibility of the strategies and mechanisms, the extent of City authority over the building, transportation, and waste sectors, potential barriers to implementation, as well as their long-term uptake potential.

The City conducted expert interviews to discuss the preliminary list of implementation mechanisms with the following individuals:

- Ellen Schneider Collins, City of Somerville, Inspectional Services Department
- Goran Smiljic, City of Somerville, Inspectional Services Department
- George Proakis, City of Somerville, Planning Division
- Vital Deshpande, City of Somerville, Environmental Coordinator
- Seth Federspiel City of Cambridge, Net Zero Energy Planner
- David Keith, Assistant Professor, MIT Sloan School of Management
- Don MacKenzie, Assistant Professor, University of Washington

A summary of comments and insights collected during these interviews is provided below.

Building Energy

- The City has limited jurisdiction over building code requirements, which are set at the State level.
- Incentive-based programs to encourage voluntary implementation could be more efficacious than changing requirements in the building code, such as the Solarize Somerville program to increase solar photovoltaic (PV) installations in the community.
- Somerville's existing building stock includes old structures (i.e., pre-1930) that could be challenging to bring up to current energy code standards; mandating building retrofits could present a substantial economic burden to some property owners.
- Implementing a broad fuel-switch effort away from fossil fuels (e.g., natural gas, heating fuel oil) and toward lower-carbon options (e.g., clean electricity, geothermal, electric heat pumps) could be challenging and would require extensive public outreach/education campaigns; it would also likely require extensive electric upgrades in buildings to support all-electric systems.
- The City of Cambridge is developing zero net energy building requirements that would supersede the Massachusetts building code, and has developed a coalition of support that includes building industry representatives to minimize opposition to the new requirements; there may be opportunities for cities to partner in lobbying efforts regarding building and energy code revisions.

Transportation

- Somerville is already relatively dense and walkable, so land use-based strategies to reduce transportation emissions will have marginal impact and will occur over a relatively slower time period than deployment of new technologies, but could play a contributing role in emissions reductions.

- The City has authority to complete Somerville's bike lane network, which would support multi-modal transportation and/or mode-shift away from personal vehicles and toward alternative transportation options.
- Currently, most electric vehicle charging is done at home, which presents a barrier for broad technology adoption in multi-family residential buildings unless reliable primary Electric Vehicle (EV) charging facilities can be provided elsewhere for EV owners (e.g., supplied at work, broadly throughout community with attention paid to parking limits).
- In addition to technological and economic barriers, the City needs to consider the social barriers to adoption of new technology (e.g., alternative fuel vehicles), including fear of the unknown; the City can play an advocacy/educational role by incorporating low- or zero-emissions vehicle options into the municipal fleet and showcasing the technology at community events, coordinating test-ride events with local auto dealers, and working with car-sharing providers (e.g., Zipcar, local taxi fleet, Lyft, Uber) to incorporate such options into their vehicles fleet to increase volume of exposure to the general public.
- A broad community shift toward alternative fuel vehicles will take decades to occur, but the City can take steps to incentivize use of hybrids and other high-efficiency vehicle options in the near-term.
- The impact of autonomous vehicles on community transportation emissions is currently unknown; it could lead to increased use of automobiles for everyday transactions through sharing economy models (e.g., laundry service, delivery of goods/food); if the autonomous vehicle fleet consists of low- or zero-emissions vehicles, there could be a net reduction in transportation emissions even if total vehicle miles traveled increase; early-applications of autonomous vehicles in highway use for long-haul trucking can improve fuel efficiency and reduce embedded emissions in goods bought/sold in the community, but these GHG reductions would largely not be reflected in the community emissions inventory or affect achievement of the City's carbon neutrality goal.
- Primary transportation sector GHG reduction opportunity may be through improved fuel efficiency standards, which are decided at the federal (and possibly state) level.

Waste

- The City's mandatory recycling program is not currently applied to large multi-unit buildings that are not served by City waste haulers; broadly increasing the level of recycling participation across the city would help remove some waste types from the waste incineration stream and reduce waste sector GHG emissions.
- There are economic challenges to implementation of a city-wide food scrap collection program that could be used for anaerobic digestion purposes; however, anaerobic digestion is an effective means of reducing GHG emissions from organic waste.

GHG Reduction Strategies

Following the experts' review of the preliminary list of GHG reduction strategies, these strategies were further refined and their GHG reduction potential was quantified in the CURB tool using city-specific data on Somerville's baseline and projected activities and emissions, emission factors, building stock typology and square footage, energy use intensities, transportation mode-share data, average vehicle fuel efficiencies, average trip lengths, waste characterization and management, etc. CURB quantifies the GHG reduction potential of strategies at the technology level by calculating the difference in the performance of baseline technologies versus improved, low-carbon alternatives in building energy, transportation, and waste sectors. The cumulative GHG reduction from the adoption of improved technologies was calculated by assuming specific deployment rates over the selected time horizons of the analysis across all sectors.

Figure 5 and Table 1 show the relative contributions of potential strategies being considered by the City in the building energy, transportation, and waste sectors towards the City's proposed net zero GHG neutrality target by 2050. From this analysis, it is clear that strategies focusing on low-carbon electricity, district-scale energy systems, energy efficiency improvements in existing buildings, and fuel switching in buildings and passenger vehicles are likely to yield the most significant GHG reduction benefits for Somerville. These are highlighted in blue in Table 1.

Figure 5: Relative Contributions of GHG Reduction Strategies to Net Zero GHG Neutrality

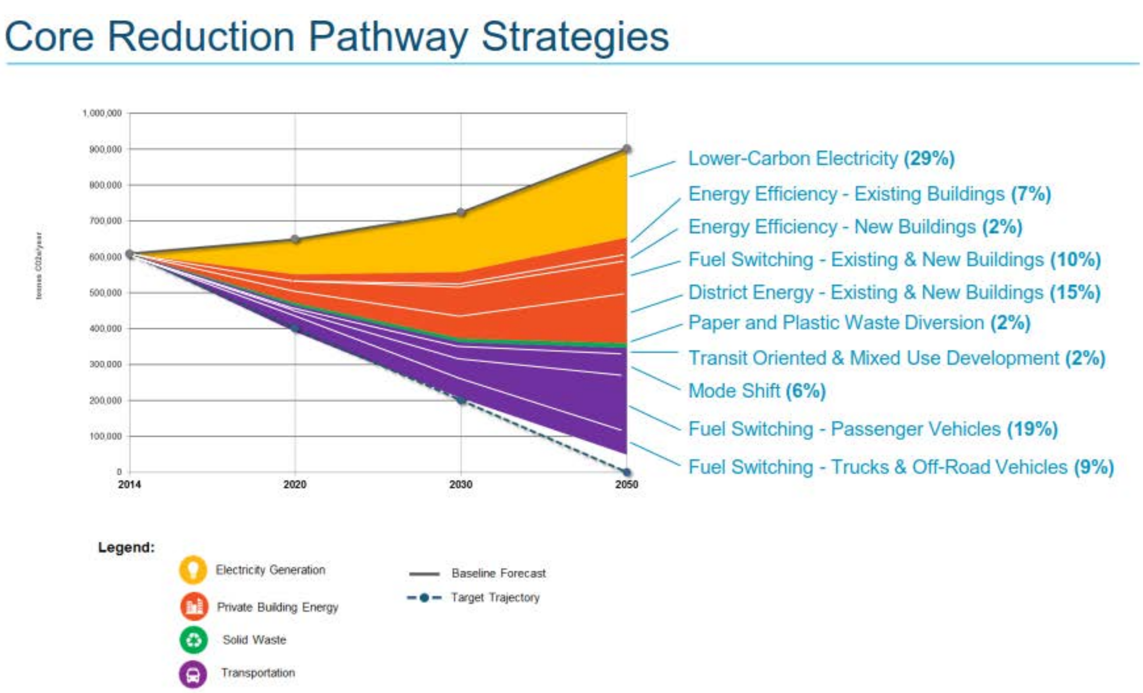


Table 1: Relative Contributions of GHG Reduction Strategies to Net Zero GHG Neutrality

Strategy	Emissions Reduction Potential (MT CO_2e/Year)			% of 2050 reductions
	2020	2030	2050	
Lower-Carbon Electricity (CCA & RPS)	98,000	167,000	248,000	**29%**
Building Energy Efficiency	23,000	49,000	77,000	**9%**
Building Energy Fuel Switching	31,000	81,000	88,400	**10%**
District Energy	26,000	55,000	131,000	**15%**
Paper and Plastic Waste Diversion	7,000	10,000	13,000	2%
Transit Oriented/Mixed Use Development	3,000	8,000	20,000	2%
Passenger Mode Shift (from SOV to transit and walk/bike)	8,000	42,000	54,000	6%
Vehicle Fuel Switching (passenger - fossil fuels to electric)	16,000	56,000	161,000	**19%**
Vehicle Fuel Switching (trucks - diesel to biodiesel)	30,000	34,000	42,000	5%
Vehicle Fuel Switching (off-road - diesel to biodiesel)	3,000	8,000	20,000	2%

Figures 6 to 10 show the **incremental** GHG reduction impacts of strategies in the building sector along with assumptions for specific low-carbon technological interventions and implementation rates for three proposed time horizons (2020, 2030, and 2050). **Note that the incremental GHG reductions from strategies in each succeeding figure are shown as building on the reductions from strategies in the preceding figure.**

Figure 6: GHG Reduction potential of Low-Carbon Electricity

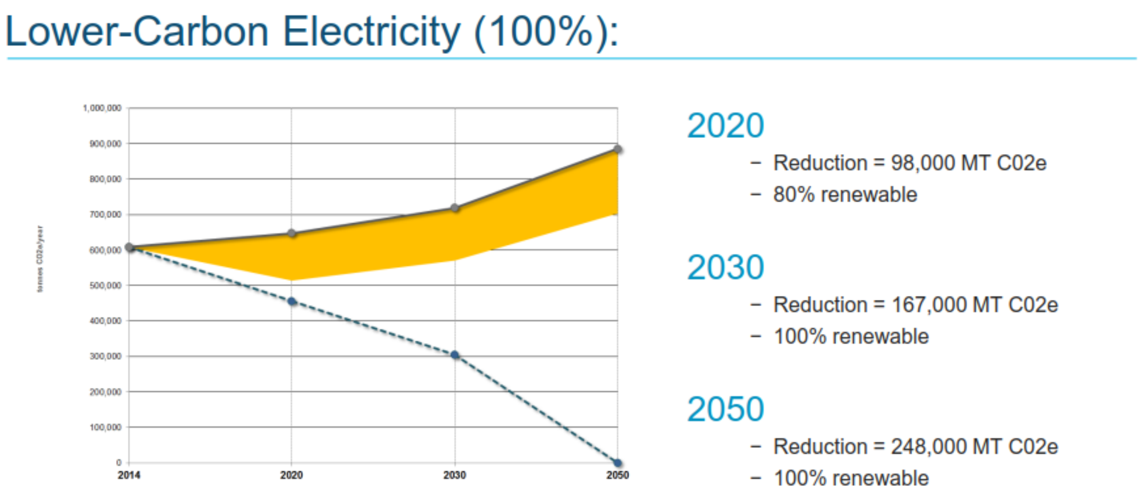


Figure 7: GHG Reduction Potential of Energy Efficiency in Existing Buildings

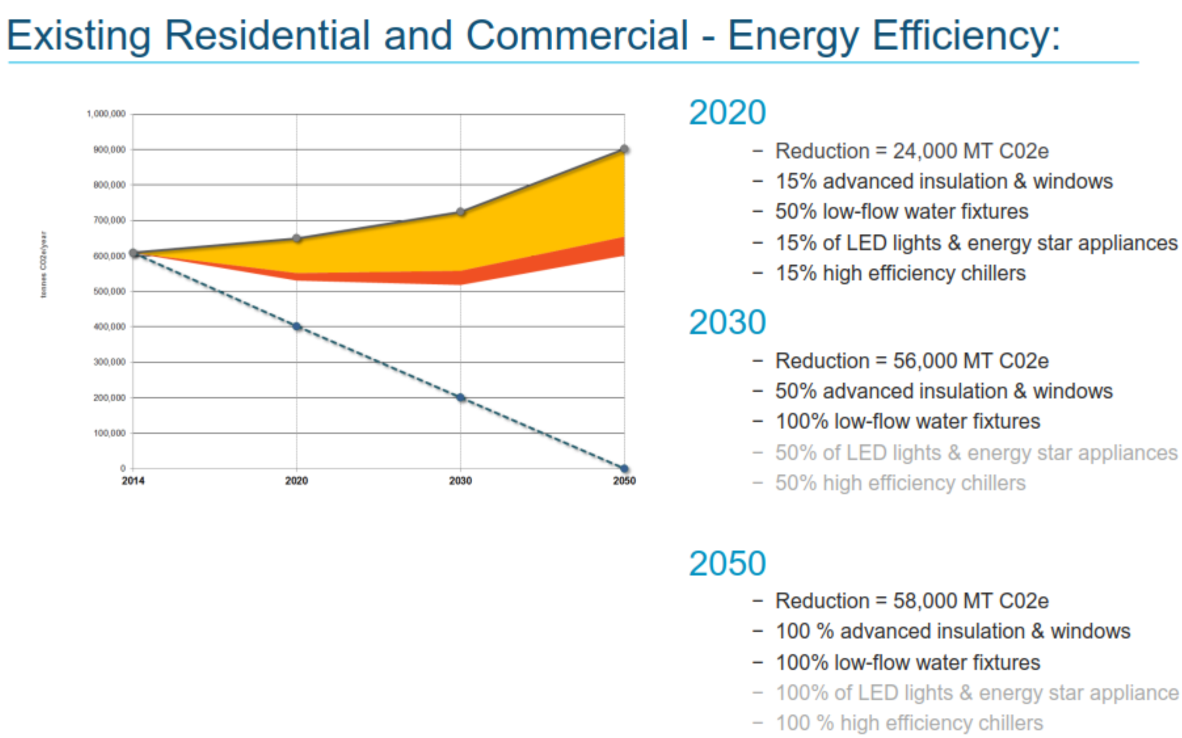


Figure 8: GHG Reduction Potential of Energy Efficiency in New Buildings

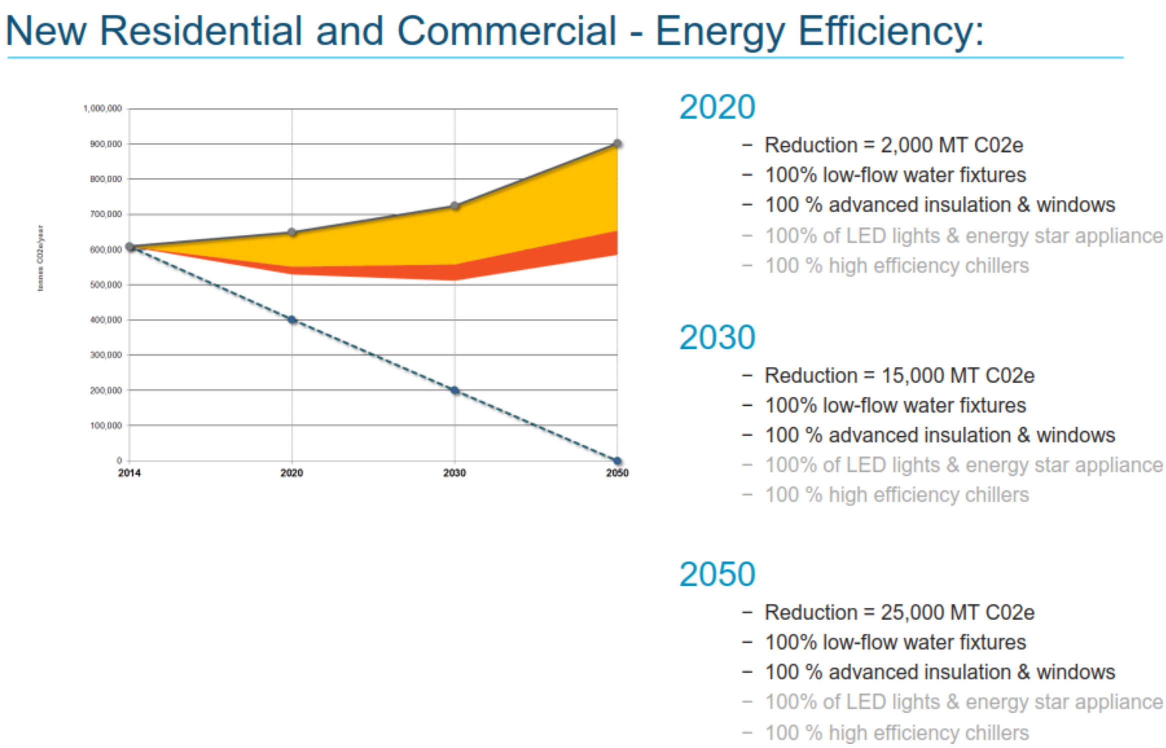


Figure 9: GHG Reduction Potential of Fuel Switching for End Uses in All Buildings

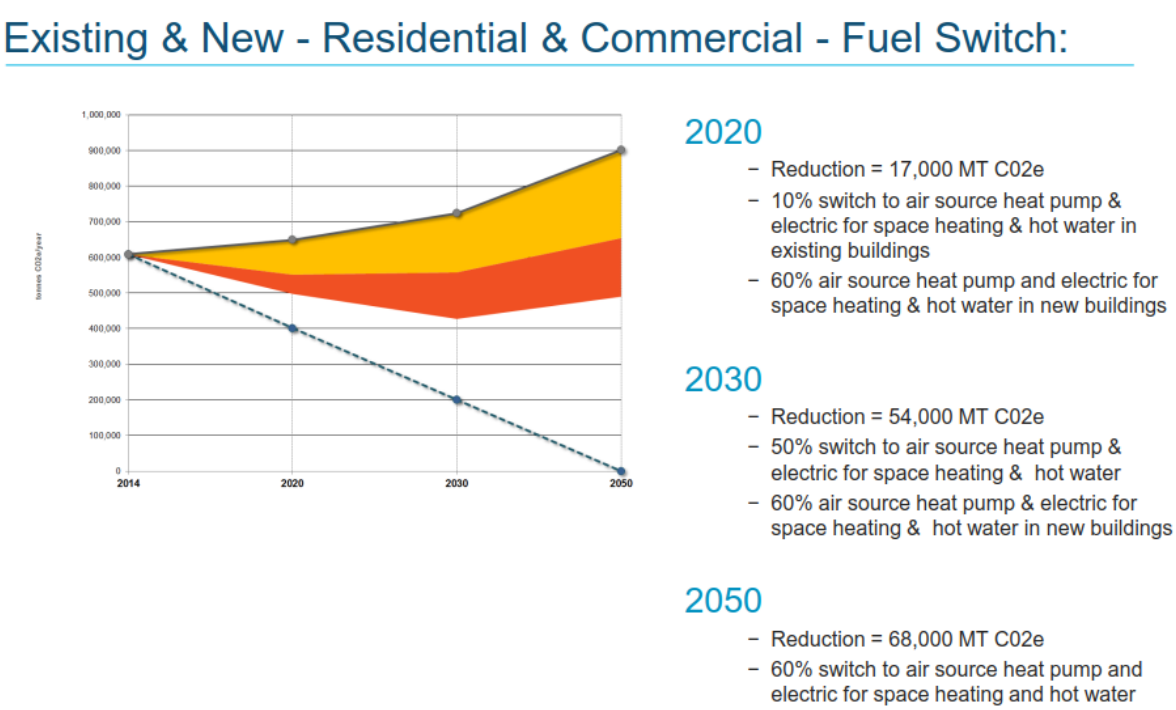


Figure 10: GHG Reduction Potential of District Energy Systems for All Buildings

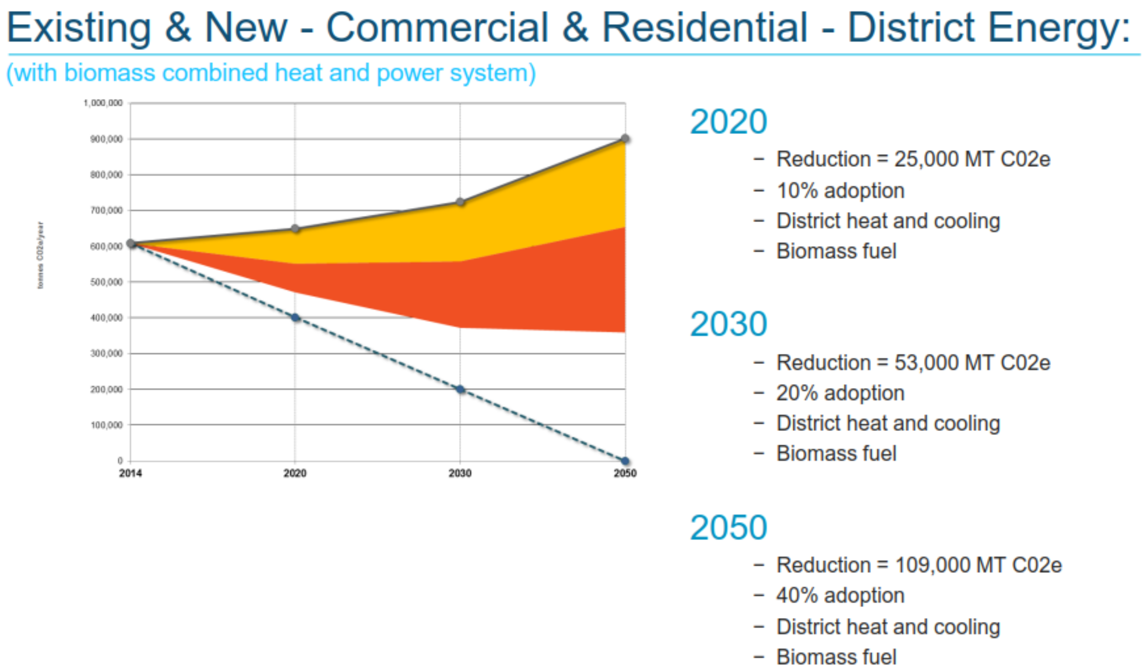
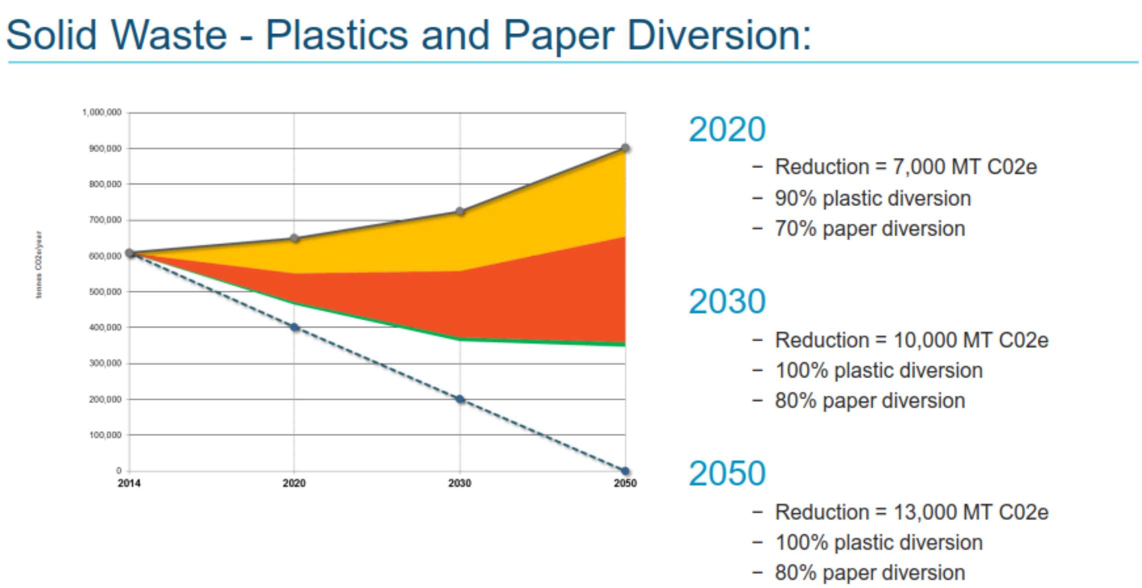


Figure 11 shows the **incremental** GHG reduction impacts of the diversion of plastic and paper waste along with assumptions for specific diversion rates for the same three time horizons as above. The incremental impacts of waste diversion can be seen in the green wedge.

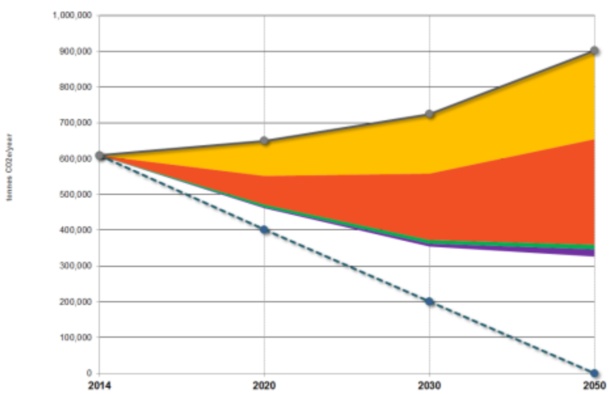
Figure 11: GHG Reduction Potential of Plastic and Paper Waste Diversion



Figures 12 to 15 show the **incremental** GHG reduction impacts of strategies in the transportation sector along with assumptions for specific low-carbon technological and planning-based interventions and implementation rates. **As previously stated, the incremental GHG reductions from strategies in each succeeding figure are shown as building on the reductions from strategies in the preceding figure.**

Figure 12: GHG Reduction Potential of Transit Oriented & Mixed Use Development

Transportation – Transit Oriented & Mixed Use Development:



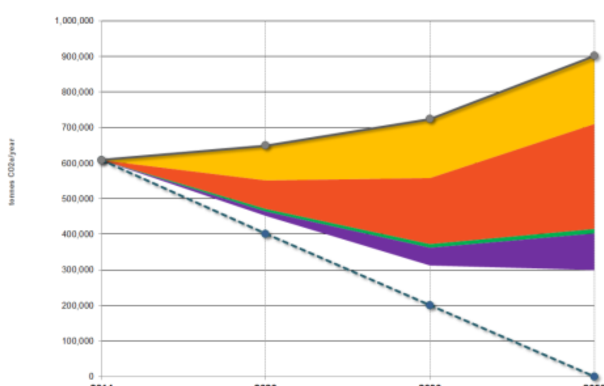
2020
- Reduction = 3,000 MT C02e
- 100% of new development in TOD
- 25% reduction of VMT generation in TODs

2030
- Reduction = 8,000 MT C02e
- 100% of new development in TOD
- 25% reduction of VMT generation in TODs

2050
- Reduction = 20,000 MT C02e
- 100% of new development in TOD
- 25% reduction of VMT generation in TODs

Figure 13: GHG Reduction Potential of Mode Shift

Transportation – Mode Shift:



2020
- Reduction = 8,000 MT C02e
- 5% shift from SOV to subway
- 1% shift from SOV to walk/bike

2030
- Reduction = 42,000 MT C02e
- 20% shift from SOV to subway
- 5% shift from SOV to walk/bike

2050
- Reduction = 54,000 MT C02e
- 30% shift from SOV to subway
- 8% shift from SOV to walk/bike

Figure 14: GHG Reduction Potential of Fuel Switching in Passenger Vehicles

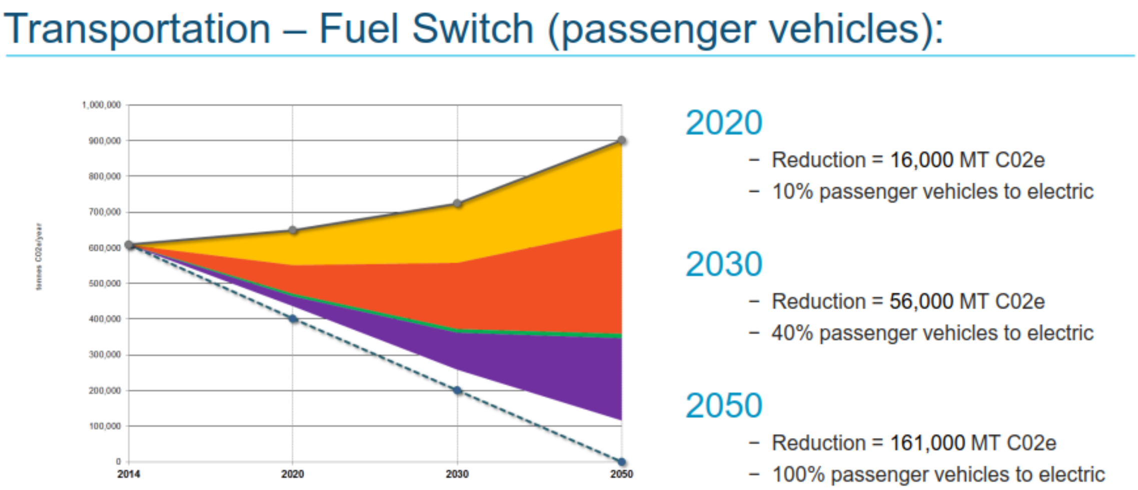


Figure 15: GHG Reduction Potential of Fuel Switching in Trucks and Off-road Vehicles

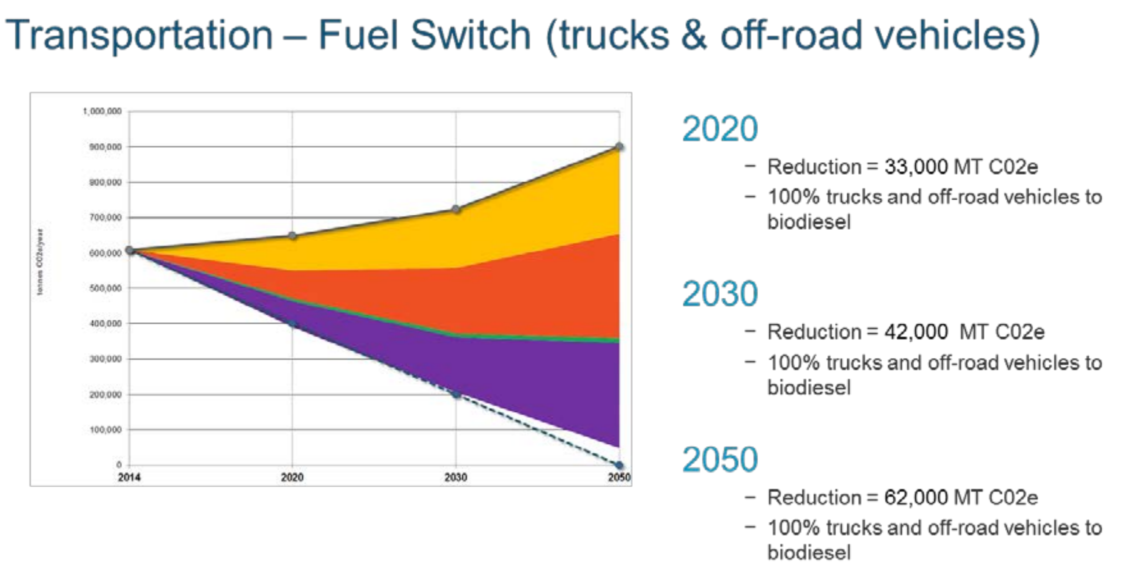
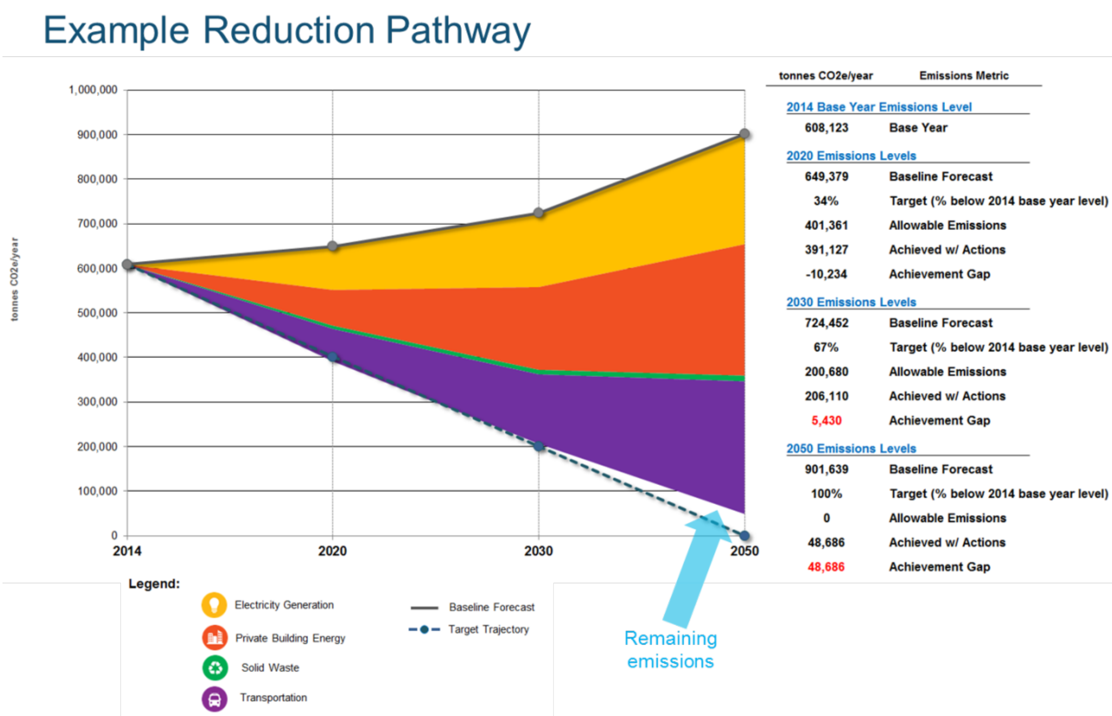


Figure 16 compiles the cumulative impacts of the GHG reduction strategies described above to illustrate a potential pathway that the City could adopt to achieve net zero GHG neutrality. This figure also shows the magnitude of emissions from natural gas leakage, off-road equipment, and waste-related biochemical processes that cannot be feasibly eliminated. The blue arrow on the figure points to the gap between net GHG neutrality by 2050 and the cumulative impact of the currently feasibly reduction strategies analyzed in this whitepaper. As described earlier, these residual emissions could be fully balanced through investments in offsetting activities (e.g., renewable energy generation, biological carbon sequestration) to achieve the City’s proposed net GHG neutrality goal.

Figure 16: Illustrative GHG Reduction Pathway for Somerville



5. Implementation Mechanisms for GHG Reduction Strategies

Based on the options for GHG reduction strategies identified by the City, and the feedback received during expert interviews, a memorandum on potential policy- or program-based strategy Implementation Mechanisms was developed, which includes descriptions of the mechanisms and case study examples of successful deployment in other cities. The memorandum contains mechanisms in the building energy, transportation, and solid waste sectors, which could form a roadmap enabling Somerville to achieve net zero GHG neutrality by 2050. Table 2 showcases a **subset** of implementation mechanisms for four core strategies that are likely to result in the most significant GHG reductions in Somerville – low-carbon electricity, district-scale energy systems, energy efficiency improvements in existing buildings, and fuel switching in buildings and passenger vehicles.[2] These mechanisms do not represent the only mechanisms available to implement the City's GHG mitigation strategies. They are highlighted as examples of policies/programs that Somerville can implement to advance its GHG reduction goals.

[2] A full list of implementation mechanisms for other strategies can be found in the memorandum.

Table 2: Sample Implementation Mechanisms for Core GHG Reduction Strategies

Strategy Type	Implementation Mechanism
Energy	
E.1 Lower-Carbon Electricity (beyond RPS)	E 1.1 Community Choice Aggregation Policy
E.2 District Energy	E 2.1 District Energy Systems Planning
E.4 Energy Efficiency – Existing Buildings	E 4.1 Point-Of-Sale Energy Efficiency Improvements
	E 4.2 Financial Rebates / Incentives
E.6 Fuel Switch – Heat & Hot Water to Electric/Ground Source Heat Pump	E 6.1 Mandatory Electric Heat Pump Policy
	E 6.2 Zero-Net Energy Building Requirements
	E 6.3 Point-Of-Sale Energy Efficiency Improvements
Transportation	
T.3 Fuel Switch	T 3.1 Publicly Accessible CNG Fueling Stations
	T 3.2 Public Electric Vehicle Charging Facilities
	T 3.3 Publicly Accessible Biofuel Stations

Note: The reference numbers for strategies and implementation mechanisms in this table correspond with those in the Implementation Mechanisms memorandum.

Each of the strategies and implementation mechanisms identified in Table 2 (and the Implementation Mechanisms memorandum) has a demonstrable track record of actual implementation and GHG emissions reduction potential in other cities. As stated before, the list was selected based on a review of the City's implementation authority in the building energy and transportation sectors and other input received during the expert interviews. In cases where the City's authority is limited (most notably in the building energy sector), challenges to implementation are also identified and preliminary steps to address these challenges are briefly discussed.

The following section presents a brief summary and case studies showing successful deployment of the implementation mechanisms identified in Table 2. Additional details can be found in the Implementation Mechanisms memorandum.

Building Energy

Of the three sectors, the buildings sector has the most strategies and mechanisms aimed at reducing GHG emissions. This is due to the fact that most of the strategies, if taken alone, have marginal effects on GHG reductions. It is only when multiple strategies are implemented together that greater GHG mitigation is achieved.

Strategy E.1 Lower Carbon Electricity (beyond RPS)

Mechanism E 1.1: Community Choice Aggregation

Community Choice Aggregation (CCA) districts provide communities with local energy choices. A CCA allows consumers within a specific community or city to combine their energy demand needs to negotiate preferred rates from renewable energy generators. Creation of a CCA would allow the community to purchase electric grid mixes that exceed the utility providers' mandated portfolio of carbon-free electricity, as specified in the RPS. The City is currently proposing the creation of a CCA (known as municipal aggregation in the city), which will employ a procurement process designed to maximize cost savings. The plan, currently undergoing review by the Massachusetts Department of Public Utilities, will provide a full set of consumer protections, including the right for any customer to opt out of the program at any time at no charge.

Precedents:

Lowell, MA: Lowell established a Community Choice Power Supply Program aligned with the Massachusetts Electric Utility Restructuring Act of 1997. Hampshire Power serves as the supplier for the program. Customers are charged a consistent rate lasting three years. One hundred percent of the program's power supply is offset with New England-based Renewable Energy Credits. The Aggregation Plan anticipates that 97% of eligible customers in the City will participate in the program. According to the Plan, the City seeks to take control of energy prices. Participation is voluntary for each eligible consumer.

Marin County, CA: The community of Marin County established Marin Clean Energy (MCE), California's first CCA program, providing customers the choice of 50% to 100% to their purchased power provided by renewables. The service is a partnership with Pacific Gas and Electric Company (PG&E) to provide billing and electric delivery services. The program was launched in May 2010 and serves approximately 125,000 customers (including some consumers in the City of Richmond).

Strategy E.2 District Energy

Mechanism E 1.2: District Energy Systems Planning

District energy systems produce local and distribute thermal energy. They are an efficient means of providing locally generated thermal energy for heating and cooling buildings. District energy systems typically consist of a central energy plant containing equipment that producing thermal energy in the form of steam or hot water for heating, or chilled water for cooling. The systems also include a network of insulated pipes to distribute the thermal energy from the central plant to buildings. The steam, hot water, and/or chilled water distributed through these systems can provide a range of services including space heating, domestic hot water services, and cooling.

Precedents:

Kendall Cogeneration Station, Boston and Cambridge, MA: This system, owned and operated by Veolia North America, generates 48 megawatts of combined heat and power (CHP) capacity and serves 250 customers in the central business district of Boston and Cambridge, including biotechnology and pharmaceutical companies in Cambridge, 70% of the high-rise office buildings in Boston, large healthcare facilities in Boston, as well as some Boston hotels and universities. By leveraging advanced CHP technology, the natural gas-powered station recaptures thermal energy previously lost to the environment.

Co-op City, NY: Co-op City in the borough of the Bronx, New York, is the largest single residential development in the United States. The 340-acre complex is home to about 60,000 residents who occupy over 15,000 units in 35 high-rise buildings and seven townhouse clusters. The reconstruction of its central district energy plant from 2004-2007 resulted in CHP facility that produces annual revenues of $15-25 million from the sale of excess electricity to the city's local utility, Con Edison.

St. Paul, MN: In direct response to skyrocketing oil prices in the late 1970s, downtown business owners collectively developed a plan to avoid fossil fuel dependence. St. Paul's district energy system was created in 1983 to provide heating to downtown commercial buildings. The system added cooling service in 1993, and in 2003, converted fuel sources to burn urban wood waste as the primary source of energy. The system serves nearly 200 buildings, totaling over 30 million square feet.

Strategy E.4 Energy Efficiency – Existing Buildings

Mechanism E 4.1: Point-of-Sale Building Energy Efficiency Improvements

Cities can enact local legislation that can have a measurable impact on building energy consumption through municipal ordinances. Residential Energy Conservation Ordinances (RECO) and Commercial Energy Conservation Ordinances (CECO) could require property owners to meet specific energy efficiency standards in line with local and/or state targets, and may be triggered by events such as a home or building sale or remodel. The ordinances accelerate implementation of energy efficiency improvements, resulting in direct GHG reductions and support lower homeowner/renter utility bills.

Note: Implementing policies that mandate energy efficiency improvements beyond the requirements of the Massachusetts Building Code may be met with regulatory challenges. In Massachusetts, the State has purview over the building code, and the ability of cities to pass ordinances requiring development to exceed the Massachusetts code is extremely limited. However, in recognition of the role that the built environment will play in reducing GHG emissions, the State is required to update its building code every three years to be consistent with the most recent version of the International Energy Conservation Code (IECC). Furthermore, the State allows municipalities to adopt a more stringent version of its base code, which is referred to as the "stretch code". Somerville currently complies with the State's stretch code, and it is recognized that applying more stringent efficiency requirements on development will be challenging in the near term. However, there are ongoing efforts to overcome regulatory barriers to the adoption of stronger efficiency standards. The City of Cambridge, which recently published its Net Zero Action Plan focusing on GHG reductions in its built environment, launched an extensive stakeholder engagement process to build community support for City-initiated polices that require development to exceed the State code. With the backing of the community, Cambridge has been engaged in an ongoing dialogue with the State to find ways to allow greater energy efficiency in its development while meeting State requirements, and minimizing liabilities associated with deviating from State requirements.

Therefore, this implementation mechanism is recommended while recognizing regulatory barriers to implementation, and with the assumption that these challenges can be addressed by building local support and collaborating with the State on solutions.

Precedents:

San Francisco, CA: Before selling their property, the City's RECO requires homeowners to obtain a valid inspection, install basic energy and water conservation devices or materials, and obtain a certificate of compliance. San Francisco, along with other cities in California, has been able to legally pass ordinances requiring improvements exceeding State building code requirements. Energy conservation devices and measures may include insulating attic space, weather stripping doors, insulating hot water heaters, caulking and sealing openings in building exteriors, and insulating accessible heating and cooling ducts.

Berkeley, CA: The City's CECO was passed in 1993 to increase the energy and water efficiency in Berkeley commercial buildings. It required commercial buildings to meet minimum energy efficiency measures when a building was sold or received major renovations. As of December 1, 2015, the CECO has been replaced a Building Energy Saving Ordinance (BESO). With the BESO, the CECO requirements of installing energy and water efficiency improvement measures are no longer mandatory. Instead, the BESO requires Berkeley building owners to complete energy assessments and publicly report the building's energy efficiency information with the goal of helping building owners to save energy and motivating them to participate in whole-building energy efficiency programs. BESO is required prior to sale of a house or whole building, except for large buildings over 25,000 square feet and on a phased-in schedule for all buildings, except houses.

Mechanism E 4.2: Financial Rebates / Incentives

Financial rebates and incentives can catalyze investments and adoption of alternative energy technologies. They may reduce initial investment costs, thus accelerating the payback period, or focus on defraying ongoing operation and maintenance costs. Incentives may include rebates, loans, grants, and tax exemptions or reductions.

Strategy E.6 Fuel Switch – Heat & Hot Water to Electric/Ground Source Heat Pump

Mechanism E 6.1: Mandatory Electric Heat Pump Policy

The benefits of electric heat pump systems are numerous and multiple approaches should be undertaken to ensure widespread and efficient adoption. Beyond incentive programs, Somerville could require the use of heat pump systems (for heating and water heating) for all new residential and commercial construction. Any mandate must consider multiple possibilities or be flexible enough to ensure that appropriate technologies are being used for the right situation. There are a number of potential approaches to ensure that a mandate meets the needs of the community, including exemptions for high thermal load commercial uses from the heat pump requirement.

Precedents:

No precedent for mandatory policies has yet been found. However, financial incentives exist. For example, Massachusetts offers rebates of up to $12,500 for the installation of high-efficiency ground-source heat pumps in residential buildings of one to four units. Retrofit installations are also eligible for a rebate in the amount of 20% of eligible project costs, capped at $6,250.

Mechanism E 6.2: Zero-Net Energy Building Requirements

In general, zero net energy (ZNE) buildings generate a greater amount of renewable energy on-site than is consumed annually. By generating sufficient renewable energy to meet their own annual energy consumption requirements, ZNE buildings reduce non-renewable energy use. Increases in building efficiency are best implemented at a rate that accommodates aggressive, yet realistic market transformation and allows additional construction costs to be minimized. Early input from building industry experts will be critical to establishing support for any additional building code requirements; the City of Cambridge performed extensive outreach with the construction/development community when drafting its Net Zero Action Plan. The timing of code implementation is also critical to achieving long-term energy GHG reduction. The earlier more stringent codes can be adopted the more efficient the City's building stock will be in 2050. New buildings constructed at a lower level of efficiency represent a lost reduction opportunity. It should be noted that electric heaters can be fueled by either air or ground sources. Today's heat pumps are two to four times as efficient as a conventional resistance heater.

Precedents:

Santa Monica, CA: Santa Monica recently introduced the first zero-net energy housing ordinance in the world. In October 2016 the City Council voted to require new single-family residential buildings to achieve zero-net energy performance starting in 2017. Net-zero energy buildings will help the City reach its goal of sequestering or offsetting all of its greenhouse gas emissions by 2050 to become carbon neutral. The City has a head start in what will soon become a state requirement. In 2008, the California Public Utilities Commission adopted a plan requiring all new residential construction to be zero-net energy by 2020. Commercial construction will be subject to the same requirement in 2030.

Ontario, Canada: Ontario has set dates to phase out natural gas. By 2030, the building code for residential and small buildings will eliminate combustion heating. By 2050, combustion heating will be outlawed in all buildings.

Mechanism E 6.3: Point-of-Sale Energy Efficiency Improvements

Please refer to Mechanism E 4.1 for a description of point-of-sale building energy efficiency improvements.

Transportation

In the transportation sector, the showcased core strategy focuses on the transition to alternative vehicle fuels (fuel switches) and the diversification of transportation modes. There will be interplay among implementation mechanisms, and action toward the adoption any one fuel type will influence the deployment and development of others. While adoption of alternative fuels should be encouraged by local institutions, some level of organic growth and market influence should occur to achieve an optimized distribution of alternative fuels.

Strategy T.3 Fuel Switch

Mechanism T 3.1: Publicly Accessible CNG Fueling Stations

The carbon intensity of transportation in the Boston region could be reduced if a considerable portion of the private sector adopts compressed natural gas (CNG) as a primary transportation fuel source. CNG and CNG vehicles are becoming increasingly available and cost-effective. However, achieving a large-scale transition will require an increase in CNG fueling stations. Municipal CNG fueling stations that are open to public use can serve as a catalyst for community CNG vehicle adoption.

Precedents:

Ontario, CA: The City of Ontario, California has expanded its CNG fueling facility and made considerable investments in CNG vehicles for the municipal fleet. The CNG station is also open for use by the public, seven days a week, twenty-four hours a day. A recent project includes the installation of new and replacement fuel dispensers and provision of additional CNG fuel storage capacity. The City was awarded a grant fund from the Mobile Source Air Pollution Reduction Review Committee (MSRC) Local Government Match Program.

Mechanism T 3.2: Public Electric Vehicle Charging Facilities

A comprehensive network of publicly accessible charging stations will be required to extend the travel range of EVs and assure users that they will not be left stranded without access to charging facilities. In the Boston region, public charging stations are primarily concentrated in the cities of Boston and Cambridge, with local chargers available at Somerville City Hall, Davis Square, and Union Square. The majority of EV charging happens at home followed by the work place. However, there is still a role for publicly-accessible EV charging facilities to play in broader adoption of this technology. Public charging facilities contribute to a growing regional refueling infrastructure, which can help to decrease range anxiety. It also increases visibility and awareness of the technology as a viable option. According to expert interviews conducted in support of this study, fear of the unknown still represents a significant barrier to adoption of alternative fuel technologies.

Precedents:

Chicago, IL: According to the PlugShare.com EV charging station map, there are hundreds of public charging stations in the Chicago metro area. Most of these stations are equipped with

Level 2 chargers, and some are equipped with direct-current (DC) fast chargers. A free, user-friendly, online and mobile map identifies the locations of charging stations across the country and displays in real-time whether they are in use. It also differentiates between regular and "high-power" stations that can charge your car faster.

Copenhagen, Denmark: The City Council has reserved 500 parking spaces for EV providers to set up and operate charging stations for a period of ten years. As of 2013, 106 charging points and 218 parking spaces, one fast charging point, and one hydrogen station have been established. As relevant standards and legislation are made ready, the City of Copenhagen will offer long-term concessions to ensure the full-scale roll-out of infrastructure on public roads. There is ongoing cooperation with car manufactures and service providers who can contribute to creating a public infrastructure.

Portland, OR: The City has developed a strategy to address the many issues around adoption of this new technology: "Electric Vehicles - the Portland Way" was adopted by the Portland City Council on July 20, 2010. One of the key areas in the document addresses streamlining the permitting process for charging stations. Portland also benefitted from The EV Project, a federally funded initiative to install over 2,000 charging stations in the Willamette Valley. Of these stations, approximately 1,000 will be accessible to the public, enabling EV users to charge at destinations throughout the region.

Westminster, London: In 2006, the Westminster City Council installed two on-street EV recharging stations as part of a pilot/demonstration project. The City established criteria for siting on-street chargers including: compliance with the Westminster Way Street design guidelines, suitability for disabled users, and compatibility with the majority of electric vehicles used in London. Following this successful pilot project, the City installed more than 40 on-street charging stations to date.

Mechanism T 3.3: Publicly Accessible Biofuel Stations

A comprehensive network of publicly accessible biofuel stations would need to be developed to serve medium and heavy-duty vehicles in the community. Due to limited adoption of this technology at present, there is also limited market opportunity for private companies to develop the appropriate infrastructure to support the technologic shift. In order to achieve this infrastructure, it will be necessary to encourage private sector development of alternative fueling stations (biofuels) through preferable zoning or environmental mitigation requirements.

Precedents:

Chicago, IL: Partnering with Gas Technology Institute (GTI), Chicago Area Clean Cities Coalition, the State of Illinois, municipalities, and private companies, the City of Chicago has developed multiple alternative fueling stations, including eight E-85 fueling stations that are open for public use.

6. Next Steps

As a next step, the City plans to use the results of its GHG inventory, carbon neutrality analysis, and preliminary GHG mitigation strategy identification efforts to inform its integrated Climate Change Action Plan. The Plan will formalize the City's vision and goals related to climate mitigation and adaptation, and further refine and prioritize the GHG mitigation strategies using a comprehensive evaluation framework and stakeholder engagement. The evaluation exercise may consider various criteria such as the GHG reduction potential of strategies, economic costs and cost savings from implementation, the implementation time-frame, the role of lead agencies, and co-benefits to the environment, economy, and society. Stakeholders may be engaged via the use of advisory groups and public workshops through which the community will have opportunities to actively inform the visioning, goal-setting, and GHG strategy selection stages of the Plan.