GREATER SUDBURY

COMMUNITY ENERGY AND EMISSIONS PLAN

POWER NOW
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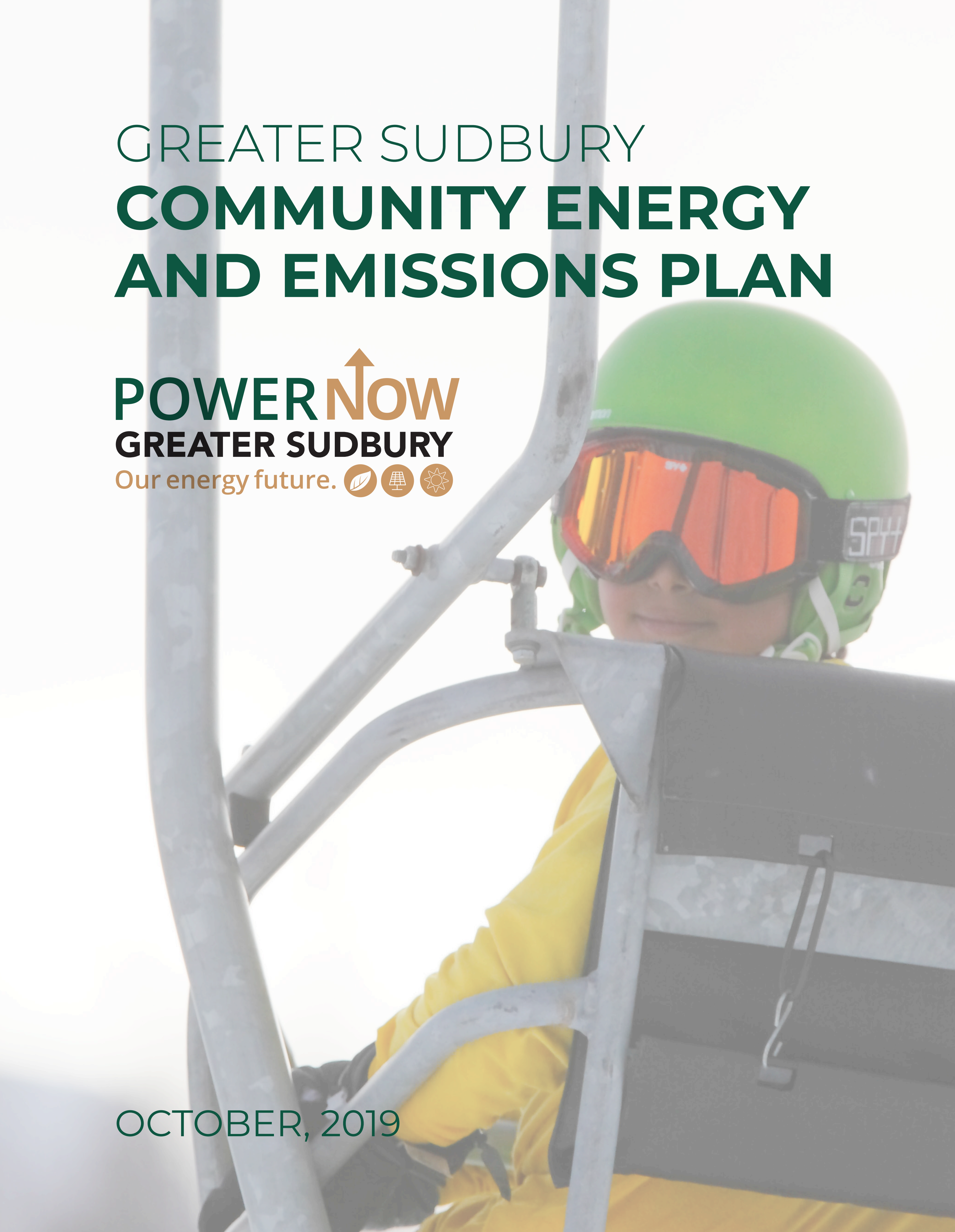
Our energy future.



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Acknowledgements

Greater Sudbury's Community Energy and Emissions Plan (CEEP) development took place over almost two years. We thankfully acknowledge the following individuals and organizations in the CEEP's preparation.

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Ontario Ministry of Natural Resources and Forestry
New Sudbury Centre
Electric Vehicle Society – Greater Sudbury
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CEEP Preparation

SSG SUSTAINABILITY SOLUTIONS GROUP

Greater Sudbury by the Numbers

		% change over 2016
Population, 2016 (Adjusted for student population)	176,435	
Population, 2050 (Adjusted for expected student population)	184,080	+4.3%
New dwellings, 2016-2050	5,153	+7.4%
New non-residential floor space, 2016-2050	379,118 m^2	+9.5%
2016 total GHG emissions	1,303,900 tCO_2e	
2050 total GHG emissions under current trajectory	1,163,000 tCO_2e	-11%
2050 total GHG emissions under CEEP implementation	0 tCO_2e	-100%
2016 per capita GHG emissions	7.4 tCO_2e	
2016 per capita net emissions under current trajectory	6.2 tCO_2e	-14%
2050 per capita net emissions under CEEP implementation	0 tCO_2e	-100%
2016 total energy consumption	26.9 million GJ	
2050 total energy consumption under current trajectory	24.6 million GJ	-9%
2050 total energy consumption under CEEP implementation	10.6 million GJ	-61%
2016 total energy costs	$776M	
2050 total energy costs under current trajectory	$901M	+17%
2050 total energy costs under CEEP implementation	$393M	-49%
Person years employment generated by the CEEP, 2020-2050	40,000	

Executive Summary

Greater Sudbury's Community Energy and Emissions Plan (CEEP) follows from decades of energy and emissions reduction initiatives in the community and responds to City Council's May 28, 2019 Climate Emergency declaration. A climate change mitigation plan, it parallels the City's climate change adaptation planning efforts. The CEEP uses energy, emissions, land-use, and financial modelling to determine the community-wide efforts required to meet a 2050 net-zero emissions target. The Plan also describes the efforts required to meet an 80% of 2016 emissions levels reduction target by 2050 for comparison.

The CEEP employs three key concepts in determining its recommended actions:

1. The Reduce-Improve-Switch paradigm (reduce energy use, improve efficiency, and switch to low-carbon energy sources);
2. Community energy planning prioritization; and
3. Infrastructure, mechanical, and energy systems turnover.

These concepts are applied to energy and emissions actions in 8 strategy sectors, in which there are 18 CEEP goals:

STRATEGY SECTOR		GOAL
1.	COMPACT, COMPLETE COMMUNITIES	**Goal 1:** Achieve energy efficiency and emissions reductions by creating compact, complete communities through infill developments, decreasing dwelling size through an increase in multi-family buildings, and increasing building type mix.
2.	EFFICIENT BUILDINGS	**Goal 2:** Periodically increase the energy efficiency of new buildings until all new buildings in 2030 onward are Passive House energy efficiency compliant. Goal 3: The existing building stock is retrofit for 50% increased energy efficiency by 2040 and large buildings are routinely recommissioned Goal 4: Achieve net-zero emissions in City buildings by 2040.

STRATEGY SECTOR		GOAL
3.	WATER, WASTEWATER, AND SOLID WASTE	Goal 5: Decrease energy use in the potable water treatment and distribution system by up to 60% by 2050. Goal 6: Achieve 90% solid waste diversion by 2050. An organics and biosolids anaerobic digestion facility is operational by 2030.
4.	LOW-CARBON TRANSPORTATION	Goal 7: Enhance transit service to increase transit mode share to 25% by 2050. Goal 8: Achieve 35% active mobility transportation mode share by 2050. Goal 9: Electrify 100% of transit and City fleet by 2035. Goal 10: 100% of new vehicle sales are electric by 2030.
5.	INDUSTRIAL EFFICIENCY	Goal 11: Increase industrial energy efficiency 35% by 2040.
6.	LOCAL CLEAN ENERGY GENERATION	Goal 12: Establish a renewable energy cooperative (REC) to advance solar energy systems and other renewable energy efforts of the CEEP. Goal 13: Install 10 MW of ground mount solar PV each year, starting in 2022. Goal 14: Install net metered solar photovoltaic (PV) systems on 90% of new buildings and 80% of existing buildings, supplying 50% of their electric load. Goal 15: Expand the downtown district energy system to 23 MW capacity. Goal 16: Install 50 MW of renewable energy storage.
7.	LOW-CARBON ENERGY PROCUREMENT	Goal 17: Procure 100% of community-wide grid electricity and 75% of natural gas demand from renewable sources by 2050.
8.	CARBON SEQUESTRATION	Goal 18: Increase the reforestation efforts of the Regreening Program.

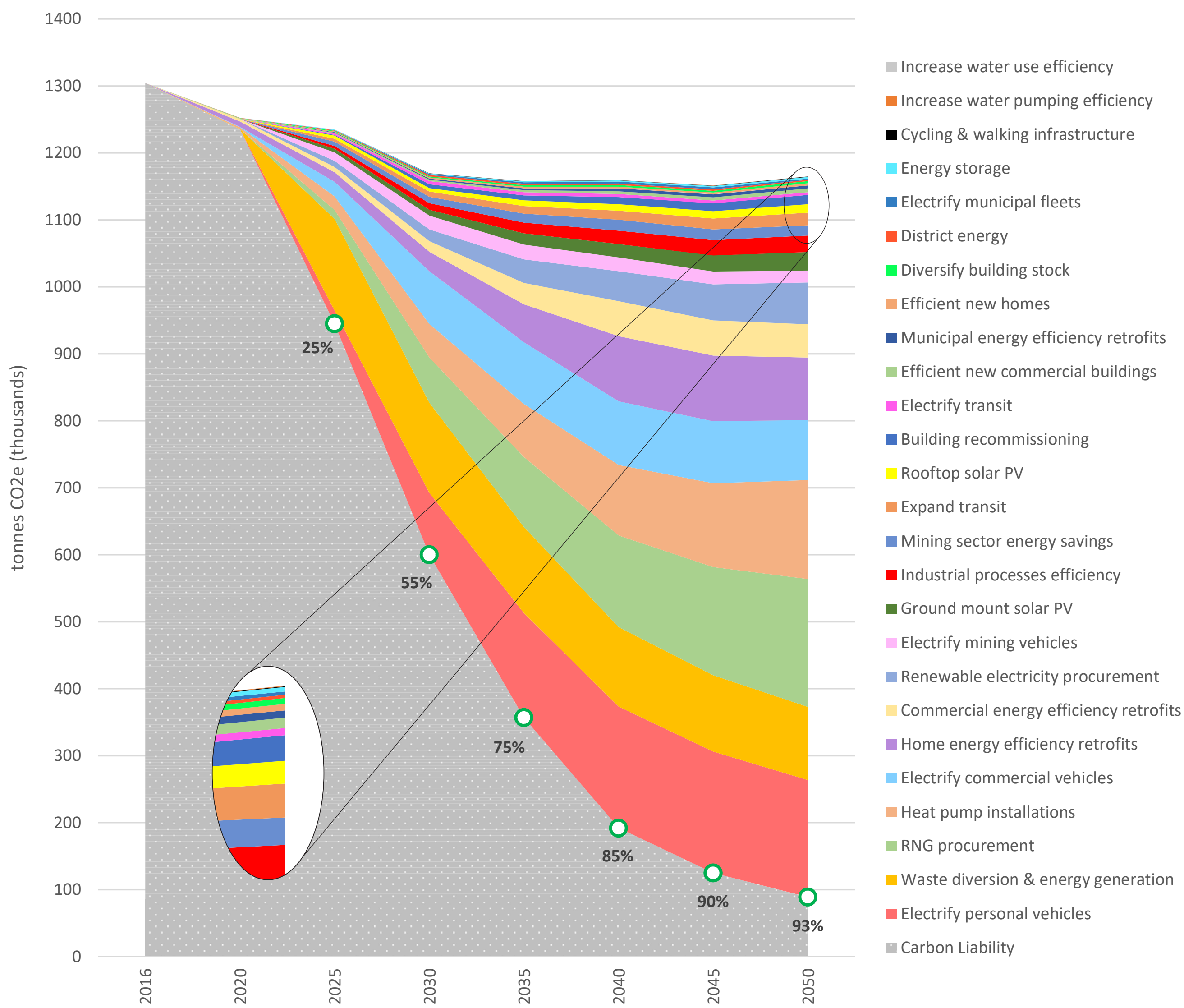


Figure 1. Wedge diagram showing the emissions reduction of each action in the CEEP Climate Emergency scenario, including emissions reduction percentage targets (of 2016 emissions levels). Note that although water use efficiency and water pumping efficiency actions save energy, their emissions saving is negligible and does not display on this graph.

Shows the emissions reductions effects of the best action options to achieve the 18 goals, and thus the 2050 net-zero emissions target. The top line of the graph indicates emissions under a business as usual scenario (i.e. accounting for current trends and plans). Energy efficiency, energy generation, and vehicle electrification actions will achieve the majority of emissions reductions. A variety of smaller actions are critical for achieving the remainder of reductions. These actions reduce 93% of 2016 emissions levels by 2050, leaving 100,000 tonnes of carbon dioxide equivalent (tCO_2e) present in that year.

The final 100,000 tCO_2e in 2050 could be completely reduced to meet the net-zero goal through some combination of approaches including:

- Increasing RNG use from the current goal of 75% natural gas replacement to 100% replacement, including in district energy systems;
- Operating all industrial activities on biofuels or renewable electricity;
- Expanding gas capture to all landfill operations; and
- Carbon sequestration.

Carbon sequestration is a promising option, as Greater Sudbury's Regreening Program has already proven to be a successful reforestation effort with sizeable sequestration results.

Financial modelling of CEEP actions determined their high-level costs and savings between 2020 and 2050 (Figure 2) as compared to expected costs and savings under a business as usual scenario. The costs and savings will be community-wide (i.e. not solely incurred by the City). Costs are incurred by energy generation infrastructure provision, transition to electric vehicles, building energy efficiency retrofits, etc. Savings are made through reduced vehicle and equipment operations and maintenance, avoided carbon tax payments, energy use cost savings, and revenues from local energy generation. By 2050 cumulative CEEP implementation costs total $6.5B with a present value of $4.3B (at a discount rate of 3%). Total net savings reach $14.6B. Financial modelling also estimates that 40,000 person years of employment will be generated by CEEP actions between 2020 and 2050.

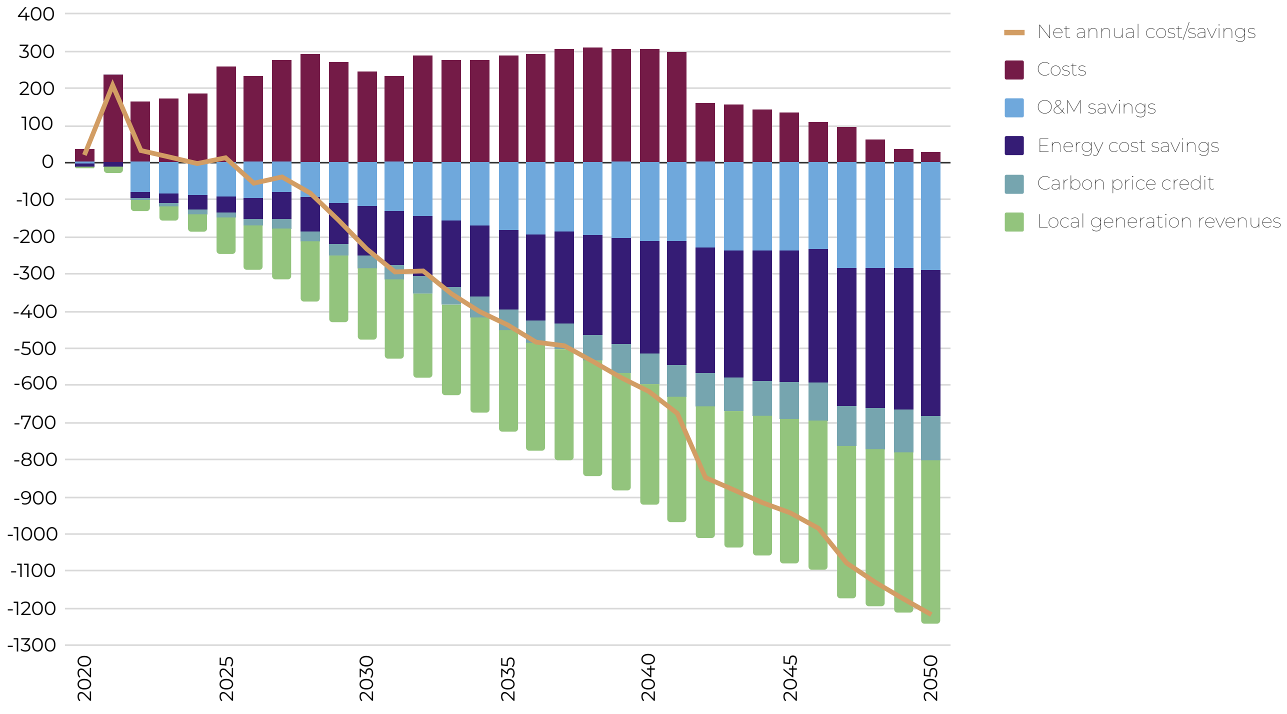
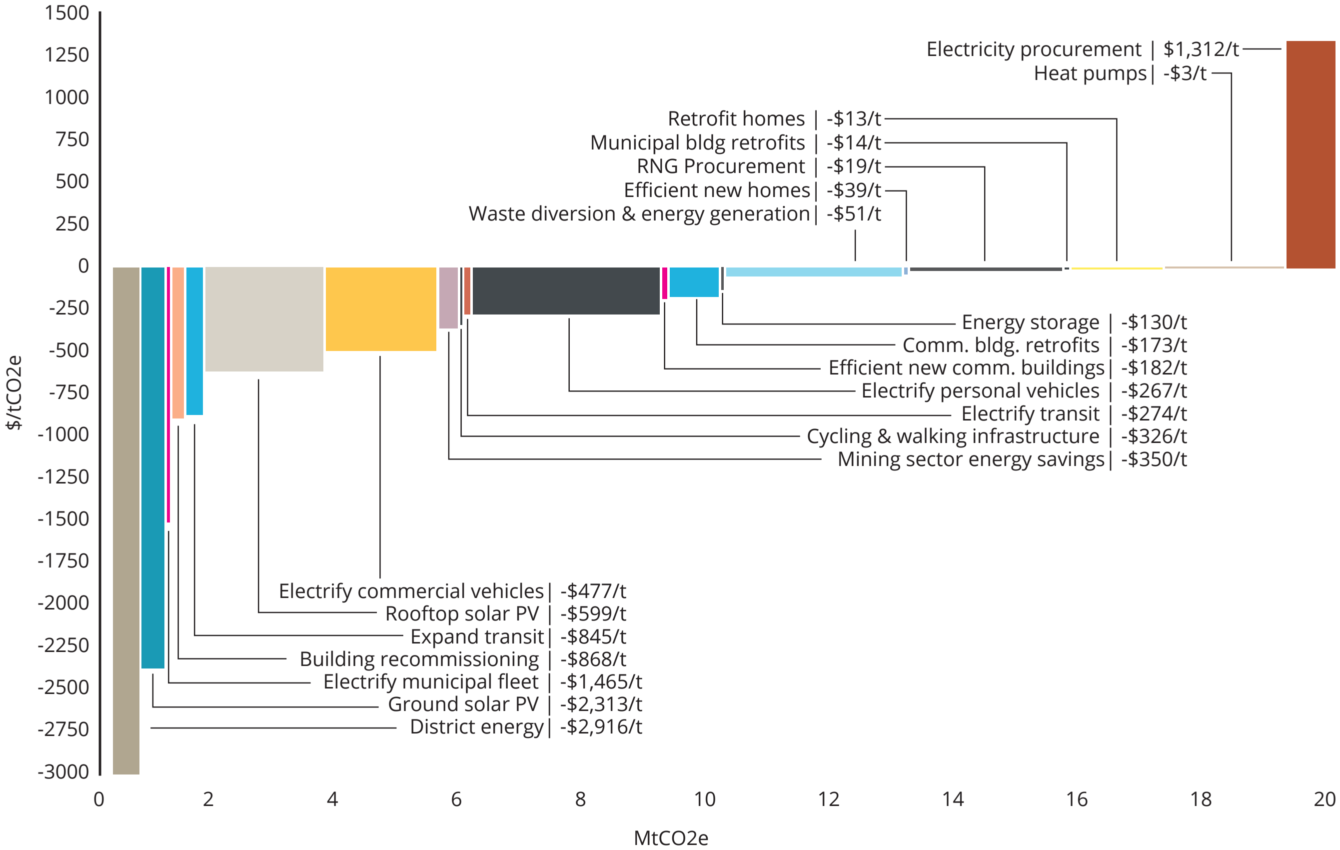


Figure 2. Summary of annual CEEP costs (above x-axis) and savings (below x-axis) relative to the BAU scenario.

Combining the energy and emissions actions analysis with the financial analysis yields the Marginal Abatement Cost (MAC) curve (Figure 3). The MAC curve provides an at-a-glance summary of the financial cost or savings per tonne of emissions reduced for each action. All CEEP actions except electricity procurement generate savings for every tonne of emissions reduced.



x-axis: tonnes CO2e reduced by the action (wider bars = greater reductions)
y-axis: net financial return or cost of the action (taller bars = greater return/cost)

Figure 3. CEEP marginal abatement cost (MAC) curve, showing the cost/savings per tonne of emissions reduced by action. Horizontal axis: megatonnes CO_2e reduced by the action (wider bars = greater reductions). Vertical axis: net financial cost/savings of the action (taller bars = greater cost/savings). Positive numbers are costs, negative numbers are savings.

The CEEP illustrates what is required to achieve a 2050 net-zero emissions target in Greater Sudbury. Although substantial effort is required to reduce energy use and transition from fossil fuel supplied energy, the environmental, financial, and community benefits indicate that the endeavour is worthwhile.

Part 1: Introduction

A Global and Local Imperative

The Community Energy and Emissions Plan is a proactive program that addresses energy use, emissions production, and climate change issues and opportunities in Greater Sudbury. It acknowledges the global scientific consensus that identifies present and increasing ecosystems and climate impacts caused by increased greenhouse gas (GHG) emissions from fossil fuel burning activities currently required to live our day-to-day lives.[1] Global climate functions are changing as a result, with large-scale changes to weather patterns, including increases in storms, droughts, extreme weather events, as well as an overall increase in the average global temperature.[2] These changes are impacting our infrastructure, buildings, crops, and ecosystems.

The Intergovernmental Panel on Climate Change (IPCC) estimates that human activities have caused approximately 1.0°C of global warming above pre-industrial levels, which is likely to reach 1.5°C sometime between 2030 and 2052. Limiting warming to 1.5°C requires reaching net zero carbon dioxide (CO_2) emissions globally around 2050, with concurrent deep reductions in emissions of non-CO_2 forcers, particularly methane (CH4).[3]

On May 28, 2019, the City of Greater Sudbury joined other Canadian and global municipalities in their declarations of a climate emergency. The Community Energy and Emissions Plan (CEEP), whose process began in summer 2017, was directed to respond to the climate emergency declaration by creating an action and policy pathway to achieve net-zero emissions community-wide by 2050.

Canada's International Commitments

Canada is a signatory to the Paris Agreement (2015), under which it has committed to achieving a 30% reduction in emissions below 2005 levels by 2030, and 80% below 2005 levels by 2050. The Paris Agreement aims to strengthen the global climate change response by keeping the global temperature rise this century well below 2.0°C relative to pre-industrial levels, and to pursue efforts to limit temperature increase even further to 1.5°C, to avoid the severe climate change impacts projected to occur if 1.5°C of warming is surpassed. Many Canadian local governments are using these directions for their own emissions reduction goals.

1 More details on the relationship between climate change and greenhouse gases at: www.ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5_Chapter01_FINAL.pdf

2 Ibid.

3 2018: Technical Summary. In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. https://www.ipcc.ch/sr15/technical-summary

The Pan-Canadian Framework (2016)[4] summarizes Canada's approach to GHG emissions reduction by 2030, providing climate action direction to provinces and cities. It is under this framework that carbon pricing is effected. Federal carbon pricing is currently at $20 per tonne of emissions, rising to $50 per tonne by 2022.

Cities' Efforts

Approximately 70% of global emissions are under the direct or indirect control or influence of municipal governments.[5] This points to municipalities as some of the world's strongest climate action champions. With bold vision and tenacity, cities are taking action and enacting policy to reduce greenhouse gas emissions within their borders, contributing to the worldwide action required to avoid climate catastrophe.

Many cities have already started to act. More than a dozen municipalities across Canada have adopted 100% renewable energy by 2050 targets, representing over 2.2 million Canadians. Dozens more have declared climate emergencies, identifying climate change impact mitigation as a critical, top priority issue.

A Brief History of Climate Planning in Greater Sudbury

The former Regional Municipality of Sudbury's Strategic Energy Plan (1995) initiated the region's energy and emissions planning, focusing on municipal building energy efficiency. The municipality joined the Cities for Climate Protection Program organized by the International Council for Local Environmental Initiatives (ICLEI) in 1997. The following year it joined the Partners for Climate Protection (PCP) program, a joint initiative of ICLEI and the Federation of Canadian Municipalities (FCM). ICLEI produced Sudbury's first GHG inventory, meeting PCP's first of five milestones.

EarthCare Sudbury (a municipal program) was established shortly after the region's 2000 amalgamation, in part to engage community partners (initially 38 businesses, institutions and non-government organizations) in setting emissions reduction targets and developing a Local Action Plan (PCP milestones 2 and 3).

The EarthCare Sudbury Local Action Plan was released in 2003 and received the FCM-CH2M Hill Sustainable Community Award. It was updated in 2010 with the support of what is now 150 partner organizations. EarthCare Sudbury's sustainability messaging continues to have broad community reach through its

4 Government of Canada. Pan-Canadian Framework on Clean Growth and Climate Change: http://publications.gc.ca/collections/collection_2017/eccc/En4-294-2016-eng.pdf

5 C40 website: https://www.c40.org/why_cities

partners' employee programs, its annual Green Living magazine (published in partnership with Northern Life), and its weekly 'EarthCare Minute' developed and televised in partnership with CTV. EarthCare Sudbury also delivers programming through its education-based partners: four local school boards, two colleges and one university.

Energy use reduction efforts too numerous to list have been proceeding in Greater Sudbury for decades. Notable instances include home insulation programs, "green" schools, and energy-related business process changes. Vale's $1 billion Clean AER (Atmospheric Emissions Reduction) project is anticipated to reduce smelter emissions by 40%. Other energy-related projects – large and small – will continue in many businesses, institutions, and organizations throughout Greater Sudbury and within the City's divisions.

Other notable climate efforts in Greater Sudbury include (chronological, incomplete list):

- 2000: a 5 MW district energy cogeneration system was installed, providing heating, cooling and electricity to some downtown buildings.
- 2000: Greater Sudbury Utilities (GSU) was incorporated, including four affiliate companies: Greater Sudbury Hydro Inc., @home Energy, Agilis Networks, and ConverGen (responsible for the Landfill Gas Generation Facility). Sudbury has always been an energy leader in Ontario. In January 1897, Sudbury became the first community in the province to own and operate an electricity generation facility. Greater Sudbury Hydro Inc. is the descendant of that first effort, and today distributes electricity to over 47,500 customers in Greater Sudbury and West Nipissing.
- 2002: The Ontario office of the Canadian Climate Impacts and Adaptation Research Network (C-CIARN) was formed, hosted at Laurentian University. It was funded by the Government of Canada through the Federal Impacts and Adaptation Research Program, and the Ontario Ministry of the Environment.
- 2006: Coalition for a Liveable Sudbury (CLS) is established and now grown to over 850 citizens and 34 community groups. CLS's actions help address various environmental and social issues including GHG reductions.
- 2006: EarthCare Sudbury launched the Efficient Sudbury campaign with dozens of local retail businesses and utilities to promote energy efficiency and conservation. The campaign received an ENERGY STAR® Market Transformation Award in 2007.
- 2006 and 2007: Greater Sudbury was a participant in a Laurentian University project funded by Natural Resources Canada (NRCAN): "*Promoting community sustainability through adaptive responses to socio-economic and risk assessments of the potential impact of climate change scenarios in a natural resource-based, mid-sized Canadian Shield Community: Greater Sudbury*."

- 2007: C-CIARN Ontario transitioned to the Ontario Centre for Climate Adaptation Resources (OCCIAR), now the Climate Risk Institute. The City and OCCIAR have worked collaboratively on a variety of climate projects.
- 2007 and 2008: Greater Sudbury was a key participant in an NRCAN and Engineers Canada study entitled "*Adapting to Climate Change – Canada's First National Engineering Vulnerability Assessment*" (2008). A City report outlined the application of the Public Infrastructure Engineering Vulnerability Committee (PIEVC) Engineering Protocol for Climate Change Infrastructure Assessment (Appendix B-4 in the NRCAN and Engineers Canada Final Report).
- 2007: reThink Green was established as a local not-for-profit organization administering energy and emissions reductions programs such as the annual low-carbon transportation Commuter Challenge program (formerly City-administered), the Earth Festival, and the Green Economy North program (2016-).
- 2007: Greater Sudbury Utilities' 1.5 MW Landfill Gas Generation System was completed. It converts landfill methane into electricity, powering the equivalent of over a thousand homes.
- 2008: The City participates in the Climate Adaptation Guidebook Pilot Project organized by ICLEI-Canada. Through NRCAN, this effort led to developing the '*Changing Climate, Changing Communities: guide and workbook for municipal climate adaptation*'.
- 2009: Through EarthCare Sudbury, the City was a key partner of the Greater Sudbury Climate Change Consortium, initiated by the Nickel District Conservation Authority, which delivered climate change public awareness and education campaigns.
- 2012: Greater Sudbury's Hot Weather Response Plan was a case study for "*Climate Change Planning: Case Studies from Canadian Communities*", a document developed by NRCan and the Canadian Institute of Planners.
- 2012: The City created a permanent position for a Certified Energy Manager, who rapidly implemented several energy efficiency retrofit projects, such as lighting, HVAC, heating and pumping, saving 7.7 million kilowatt hours of energy use to date.
- 2013-2014: GSU initiates and maintains planning sessions and discussions on the development of a community energy plan with a group of key stakeholders.
- 2014: A 10 MW solar PV array was installed in Capreol, feeding electricity into the grid managed by the Ontario Power Authority.
- 2015: The City prepared a Conservation and Demand Management Plan for its facilities.
- 2016: Two 245 kilowatt solar rooftop projects were installed on City buildings.

- 2016: The City initiated several subwatershed studies that will integrate climate change adaptation scenarios.
- 2016 and 2017: Through EarthCare Sudbury, the City was chosen to participate in the Great Lakes Climate Change Adaptation Project led by ICLEI-Canada and supported by the Ontario Ministry of Environment and Climate Change. The Train-the-Trainer initiative built municipal staff capacity to undertake adaptation planning.
- 2018: The City performed a climate change adaptation risk and vulnerability assessment with CGS divisional input and community engagement. The city was deemed either high risk or high vulnerability to several climate change impacts.
- 2019: Phase One of the City's Official Plan Review was approved by the Province. It now integrates many new plan policies linked directly to climate change mitigation and adaptation.

Greater Sudbury's Community Energy and Emissions Plan

Greater Sudbury Precedents

The CEEP follows from a collection of past City efforts and policy documents. Many of these documents inform the CEEP, establishing goals and objectives for Greater Sudbury's environmental and sustainability performance.

Strategic Documents	» 2019-2027 City of Greater Sudbury Strategic Plan » Official Plan » Community Economic Development Strategic Plan » Downtown Community Improvement Plan (2017)
Ecosystems and Sustainability Focus	» EarthCare Sudbury Local Action Plan (2010) » Greater Sudbury Biodiversity Action Plan (2009) » International Cities for Climate Protection Program (1997)
Transportation Focus	» Transportation Master Plan (2016) » Transportation Demand Management Plan (2018) » Complete Streets Policy (2018) » Transit Action Plan (2019)
Water, Wastewater, and Waste Focus	» Facilities Master Plan » Water and Wastewater Master Plan
Energy and Emissions Focus	» Strategic Energy Plan (1995) » Partners in Climate Protection Program (1995) » Efficient Sudbury campaign (2006) » Community energy plan discussions led by GSU (2013-2015)
Buildings Focus	» Building Bylaw » Ontario Building Code

Drawing from these precedents, Greater Sudbury's CEEP provides a realistic action plan that responds to the City's climate emergency declaration. It provides a path to a low-carbon future for the community with actions to reduce energy use and greenhouse gas (GHG) emissions over the next 30 years while developing a low-carbon economy that saves on energy costs and creates green jobs.

The CEEP will operate in coordination with existing City plans and strategies that govern land-use, transportation, housing, waste, and energy. Some of these plans are statutory documents while others provide policy and action guidance. The CEEP provides recommendations to address a variety of civic and community elements simultaneously, ensuring they are all working toward the same outcomes. The CEEP's major application will be to initiate new energy actions and policies, while informing and fortifying existing City policies.

There are even more CEEP-related areas in which action can be taken that aren't addressed in the current CEEP. Two topics that may play important roles within the community may be green asset management and sustainable local agriculture and food choices. With the release of the EAT-Lancet report[6] and with more funding and opportunities for green asset management training within Canada, these two topics may be further examined in other plans and projects.

6 https://eatforum.org/eat-lancet-commission/eat-lancet-commission-summary-report

An Engagement-fortified Plan

A plan for the whole community of Greater Sudbury, the CEEP is strengthened by public and stakeholder inputs through the PowerNow! Engagement program. The program had four streams:

1. In-person public events;
2. Online public engagement;
3. Stakeholder Working Group (SWG) meetings; and
4. Interviews and meetings with City Directors.

Two public sessions with over 40 people each contributed to the actions considered in the CEEP and the emissions reduction target level of ambition. Online contributions indicated priority issues and actions for the public. Members of the Stakeholder Working Group (listed in the Acknowledgements section) contributed valuable inputs on potential energy and emissions actions details and their application, ensuring the CEEP's realistic implementation.
City Directors contributed valuable background information and provided direction on realistic considerations for the CEEP's actions and their implementation.

The PowerNow! program was successful in engaging interested and concerned parties in the CEEP's development, setting its direction and content. The CEEP's successful implementation will depend on continued strong support and participation from the City, its stakeholders, and the public. A summary of public engagement efforts for this project can be found in the Appendices.

POWERNOW
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Our energy future.

Trends Overview

Climate leadership, energy systems, and energy technologies are changing rapidly, creating opportunities and challenges for municipalities. Examples of key trends include:

- **Governments increasingly support low or zero carbon energy options**: Federal and provincial policies are increasingly adopting low or zero carbon energy system approaches. This results in a shift from fossil fuel industry subsidy and investment to support for renewable energy and conservation.
- **Costing carbon creates new opportunities**: There is a growing market for carbon reductions, with economic opportunities provided by carbon pricing.
- **Renewable energy is more accessible than ever**: It is becoming easier for cities, households, and businesses to generate their own energy. Net-metering arrangements with power providers and the declining costs of renewable energy systems are creating opportunities for small to large-scale renewable energy projects.
- **Energy storage technologies are changing the grid**: Technologies like large lithium-ion batteries are already available for houses and businesses. Installations will increase rapidly as their costs continue to decline.
- **New models of electric vehicles are available every day**: Electric vehicle sales are increasing quickly across the country. EV ranges are increasing and charging options are more common, creating consumer security. As EV prices continue to decline and more models become available, EVs will increasingly displace internal combustion engine vehicles.
- **Heating systems remain a challenge, but new options are coming online**: Heat pumps continue to improve in efficiency and more models than ever are available. District energy is gaining traction as an efficient system for providing heating and cooling to communities, with the flexibility to add or subtract energy sources as required.
- **New financing strategies are increasing participation**: Municipalities and financial institutions are offering mechanisms to reduce financial barriers to energy retrofits and renewable technologies. Property-assessed Clean Energy (PACE) programs are a good example. Municipalities around the world are creating innovative policies and strategies to support or engage with these trends while advancing local priorities such as reducing air pollution, stimulating economic development and new employment opportunities, increasing the livability of the community, and improving affordability.

The CEEP applies these trends in its actions and their proposed implementation.

Creating the CEEP

Tracking Emissions

The CEEP follows the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC Protocol), a global framework describing how municipalities can estimate and report local GHG emissions, enabling them to benchmark emissions trends and reduction progress against their peers. Consistently applied, the framework also allows the aggregation of municipal emissions inventories for provincial emissions totals, and provincial aggregations for national-level emissions totals (which federal governments use to report to the UNFCCC). The GPC defines three 'scopes' of emissions, as illustrated in Figure 4.

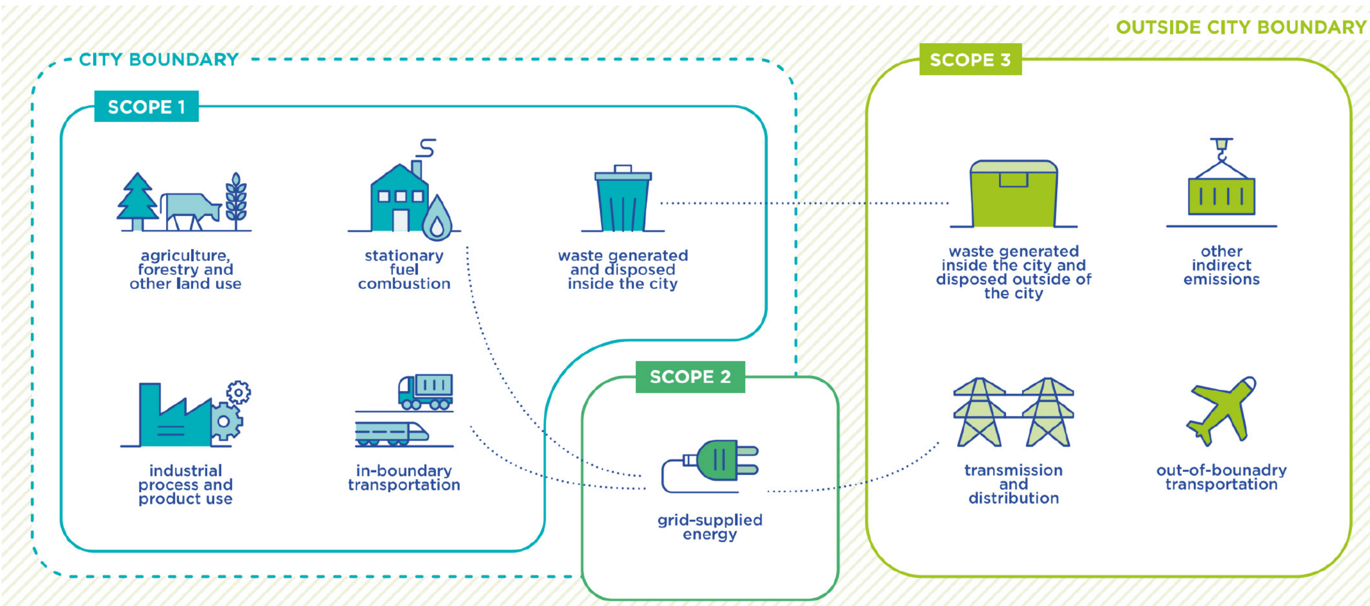


Figure 4. Emissions scopes as they relate to geographic and inventory boundaries.[7]

Charting a Low-carbon Future

The creation of Greater Sudbury's CEEP followed four central steps.

1. Current and Expected Energy and Emissions

The CEEP begins in the baseline year 2016 – a federal census year for which there is accurate demographic, energy, and emissions data. Quantitative modelling analysis details what is likely to happen with Greater Sudbury's energy use and GHG emissions production if no additional policies are introduced between now and the target year 2050. This is the business as usual scenario (BAU).

7 Image source: Consumption-Based Inventories of C40 Cities. https://www.c40.org/researches/consumption-based-emissions

Modelling for the 2016 baseline year and 2050 BAU scenario was completed using CityInSight, a comprehensive energy, GHG emissions, land-use, and finances model developed by SSG and whatIf? Technologies Inc. that uses the GPC Protocol Framework. This report uses a GPC BASIC inventory approach, which includes GHG inventories and modelling of the following elements:

- Residential buildings;
- Commercial, municipal, and institutional buildings and infrastructure;
- Fugitive emissions from upstream oil and natural gas systems;
- On-road resident and visitor transportation;
- Solid waste disposal; and
- Wastewater treatment.

2. Actions Development

Dozens of energy and emissions actions in the energy efficiency, energy generation, transportation, and buildings sectors were considered for the CEEP. Public and stakeholder engagement events were held to discuss actions and the appetite for levels of ambition for their implementation. Study, assessment and vetting by City staff, stakeholders, and the consulting team determined a final slate of actions to consider for modelling in low-carbon scenarios.

3. Scenario Exploration

After presenting the results of a 65% emissions reduction scenario to the public and City Directors, two energy and emissions scenarios were refined in which the determined actions were tested to varying extents: an 80% emissions reduction from 2016 levels by 2050 and a climate emergency 100% emissions reduction. The energy and emissions impacts of each action were modelled from the baseline year to the target year (2016-2050) using CityInSight.

4. Recommendations and Implementation Framework Development

Based on the scenario modelling, final actions were refined by City staff, stakeholders, and the consulting team. An implementation framework provides guidance on how each action can be implemented.

Greater Sudbury's Energy and Emissions Future

The city's baseline energy and emissions information describes where energy is currently sourced and how it is used, as well as the GHG emissions associated with its use. The BAU forecast uses sound assumptions about future buildings, transportation, waste, and energy generation and use circumstances to forecast the city's expected energy and GHG emissions profile in 2050.

Although Greater Sudbury's population is expected to increase slightly, overall energy use and GHG emissions are expected to decrease in the BAU scenario. The decreases are a long way from achieving national and international GHG emissions reduction targets, but it is at least a positive trend. The following sections explore where Greater Sudbury's energy and emissions trends are currently headed.

Governmental greenhouse gas inventories typically track carbon dioxide (CO_2), nitrous oxide (N_2O), and methane (CH_4) emissions—the three main types of greenhouse gases that governments can most control. Gases are measured in tonnes released into the atmosphere and are converted into tonnes of carbon dioxide equivalents (tCO_2e). This conversion allows comparison of each gas' greenhouse effect (global warming potential, GWP) relative to one unit of CO_2. It is calculated by multiplying the greenhouse gas' emissions by its 100-year global warming potential.

GREENHOUSE GAS	LIFETIME IN ATMOSPHERE (YEARS)	GWP VALUE	
		OVER 20 YEARS	OVER 100 YEARS
CARBON DIOXIDE (CO_2)	30-95	1	1
METHANE (CH_4)	12.4	86	34
NITROUS OXIDE (N_2O)	121.0	268	298

For more information on GHGs and FCM's Partners for Climate Protection GHG inventories, refer to www.fcm.ca/Documents/reports/PCP/Developing_Inventories_for_Greenhouse_Gas_Emissions_and_Energy_Consumption_EN.pdf

Climate Considerations

Climate analysis by Laurentian University shows that the average annual temperature has increased by 1.6°C, and average annual precipitation has increased by 10% between 1955 and 2010.* Spring precipitation has increased by 25%. These trends increase the risk of flooding, greater periods of freezing rain in winter, more dry summers with increased chance of forest fires, and periods of extreme heat. Greater Sudbury's building heating and cooling energy demand depends on outside temperatures.

Between 2000 and 2018, the average yearly cooling degree days (CDD, number of degrees that a day's average temperature is above 18°C, requiring building cooling) was 163, while the average heating degree days (HDD, number of degrees that a day's average temperature is below 18°C, requiring heating) was 4,868. The Climate Atlas of Canada anticipates that these values will increase to 384 CDD and decrease to 4,189 HDD due to a warming climate (Figure 5). Lower HDD reduces building heating requirements and thus natural gas use. Increasing CDD increases air conditioning, creating higher electricity loads in the summer. Forecasted degree day changes are considered in the CEEP scenario modelling.

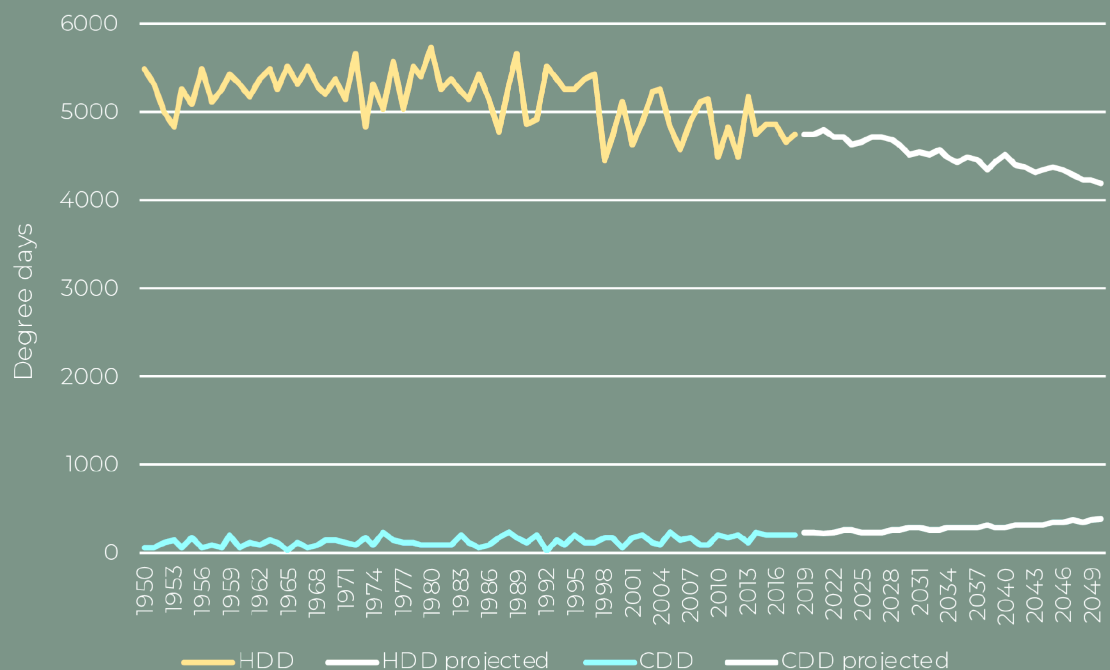


Figure 5. Historical and forecasted heating and cooling degree days in Greater Sudbury, 1950-2050.

* Climate Change and the Official Plan. Presentation to Planning Committee, Manager's Report. City of Greater Sudbury. Feb. 25, 2013.

Energy and Emissions Baseline and Forecast

Demographic Changes

It is estimated that there will be some increase in population, employment, housing, and vehicle ownership over the next 30 years. 2016 National Census (performed every 5 years) data provides population, employment, and housing baseline information and projections. Population numbers used here are adjusted for current and expected student populations. Greater Sudbury's population is projected to increase by 7,650 people by 2051, with 10,370 additional jobs, and 5,150 more homes (Figure 6). This demographic information helps establish the community's energy and GHG emissions baseline and trends.

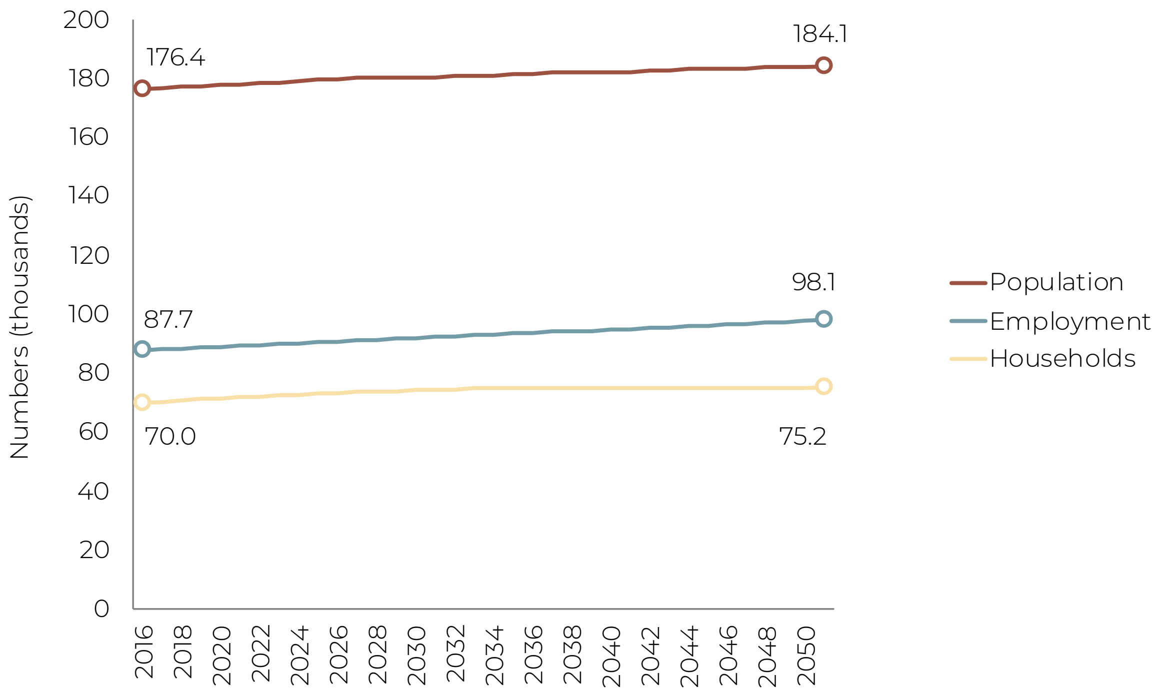


Figure 6. Forecasted population, employment and dwelling units, 2016-2050.

Greater Sudbury's Present and Projected Total Energy Use

Total Energy Demand

Total community energy use includes all energy used by buildings, transportation, and infrastructure. Under the BAU scenario (in which no major energy and emissions interventions are made), energy use is expected to decline 9% by 2050 (Figure 7). Although total energy use generally scales with increased population, there are some expected energy efficiency advances in buildings, fuel efficiencies, electrification of vehicles (electricity is more efficient than gasoline), and reduced building heating demand due to decreased heating degree days.

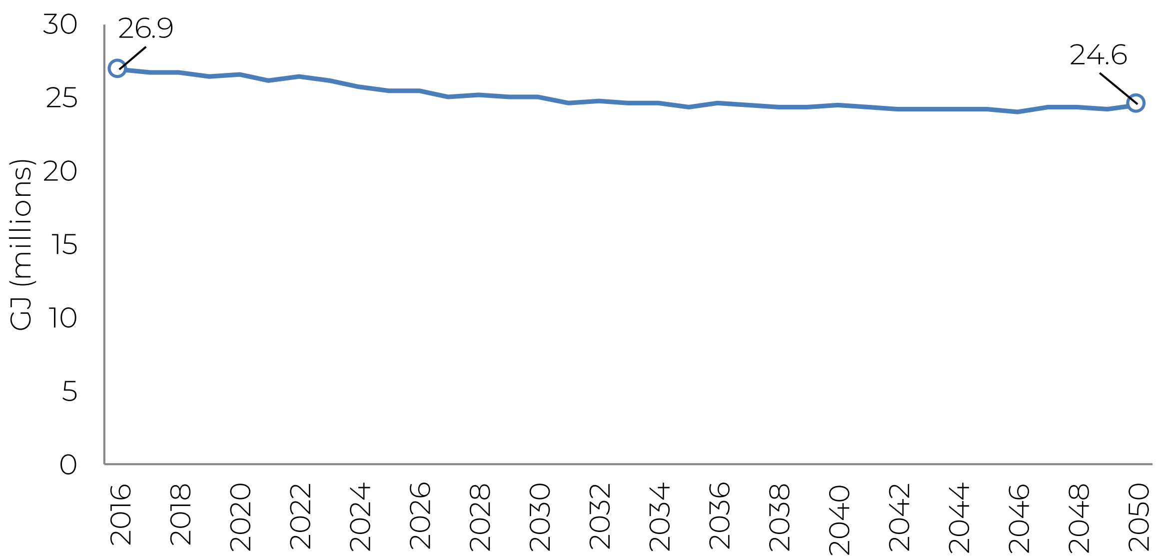


Figure 7. Forecasted total community energy use, 2016-2050.

Where Energy Comes From

Gasoline (vehicles), natural gas (space and water heating), and electricity provide most of Greater Sudbury's energy (Figure 8). Gasoline use declines by 2050 as vehicles become more fuel efficient and electrify. Natural gas is also projected to decrease slightly as heating demand decreases. Gasoline, natural gas, and electricity remain areas of focus for efficiency and shifting to clean electricity sources in 2050.

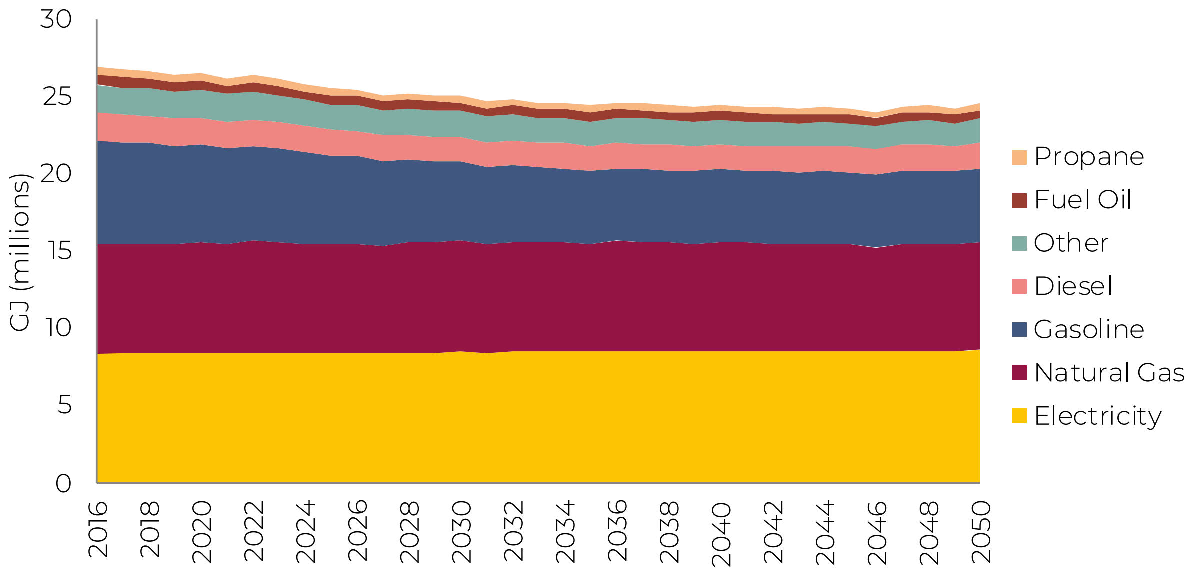


Figure 8. Forecasted community energy use by energy source, 2016-2050.

Where Energy is Used

Now and in 2050, the majority of energy is used in the transportation and residential sectors (Figure 9). While the transportation sector is expected to see some decline in energy use over the time period, the buildings sectors remain relatively consistent. In the BAU scenario, energy used in the commercial sector is expected to decline slightly (-4%) while energy used in the residential sector increases slightly (+3%) between 2016 and 2050. There is potential for energy efficiency improvements in all sectors; the largest opportunity being with residential buildings.

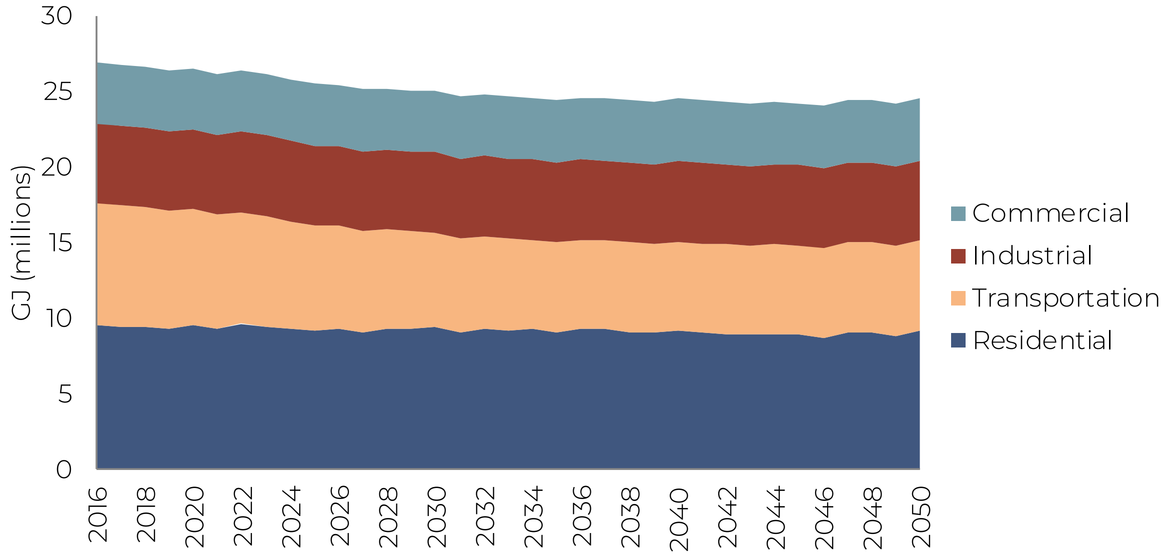


Figure 9. Forecasted community energy use by sector, 2016-2050.

How Energy is Used

Figure 10 shows energy use by end use. Transportation and space heating account for the majority of energy use in 2016 through 2050. Space heating demands decrease by 7% over the time period. Population increases drive increased energy use in water heating, major appliances, and plug loads. Transportation energy consumption decreases over the time period due to improved fuel efficiency standards in vehicles and an incremental uptake of electric vehicles (which contributes to increased electricity consumption).

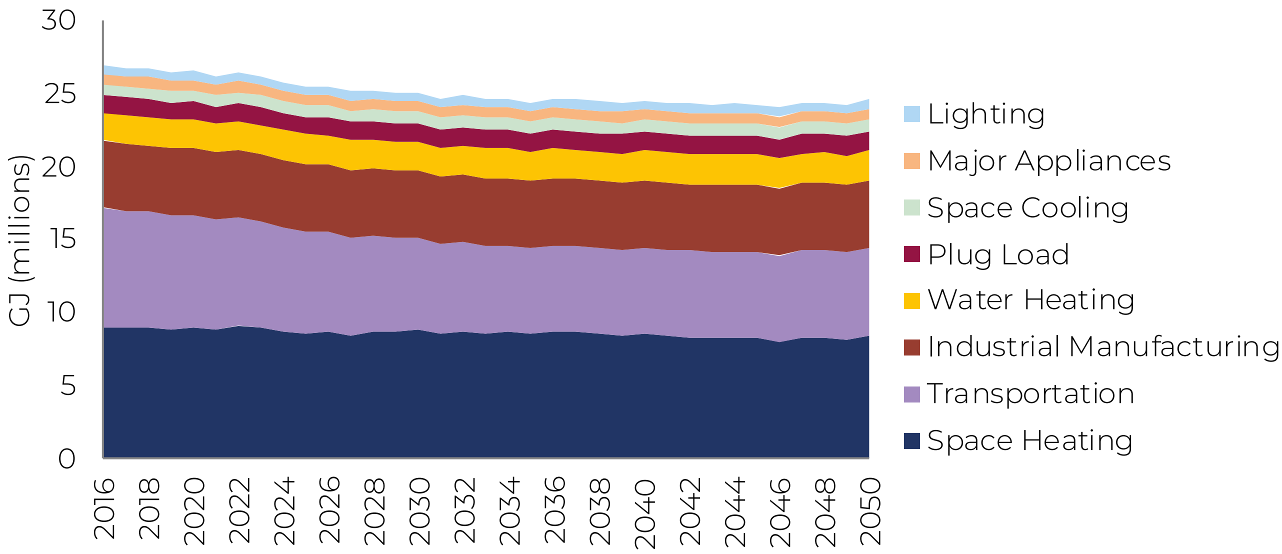


Figure 10. Forecasted community energy use by end use, 2016-2050.

Energy Flows

The Sankey diagram below depicts the flow of all energy across the entire city, from its source (left) to its end use sector (middle). Sums of total energy used and lost are on the right. The height of each bar indicates how much energy is supplied, used, or lost.

The diagram demonstrates that burning gasoline and diesel in vehicles is not very efficient – much of the fuel is wasted. Natural gas use in buildings is more efficient, although a substantial portion of it is also lost. The ratio of useful energy to conversion losses in 2016 is 1:1.53 (i.e. for every gigajoule of energy used, 1.53 gigajoules are lost).

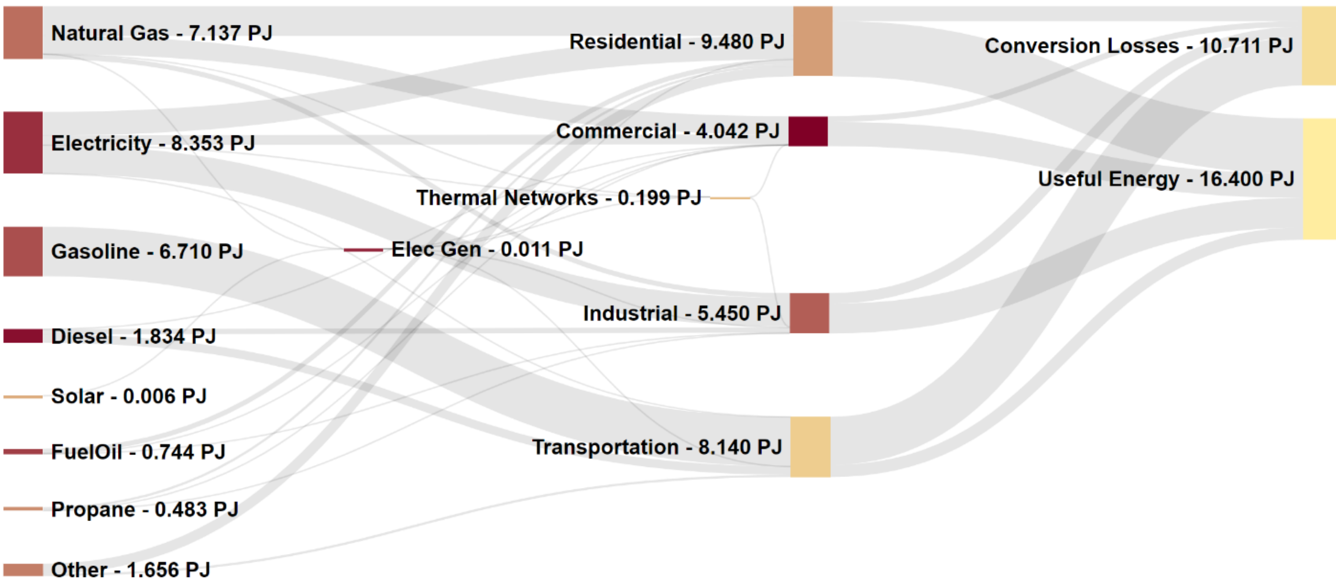


Figure 11. BAU Sankey diagram of energy sources, uses, and use/losses, 2050.

Present and Projected Total GHG Emissions

Total GHG Emissions

In 2016, Greater Sudbury's energy use in buildings, transportation, and infrastructure resulted in 1.3 million tonnes of carbon dioxide equivalent ($MtCO_2e$) emissions. In the BAU scenario, total projected GHG emissions decrease by 11% from 425 to 292 $ktCO_2e$ by 2050 (Figure 12). This is consistent with the forecasted reduction in energy use, with savings in natural gas and gasoline being the primary drivers of emissions reductions in the BAU scenario.

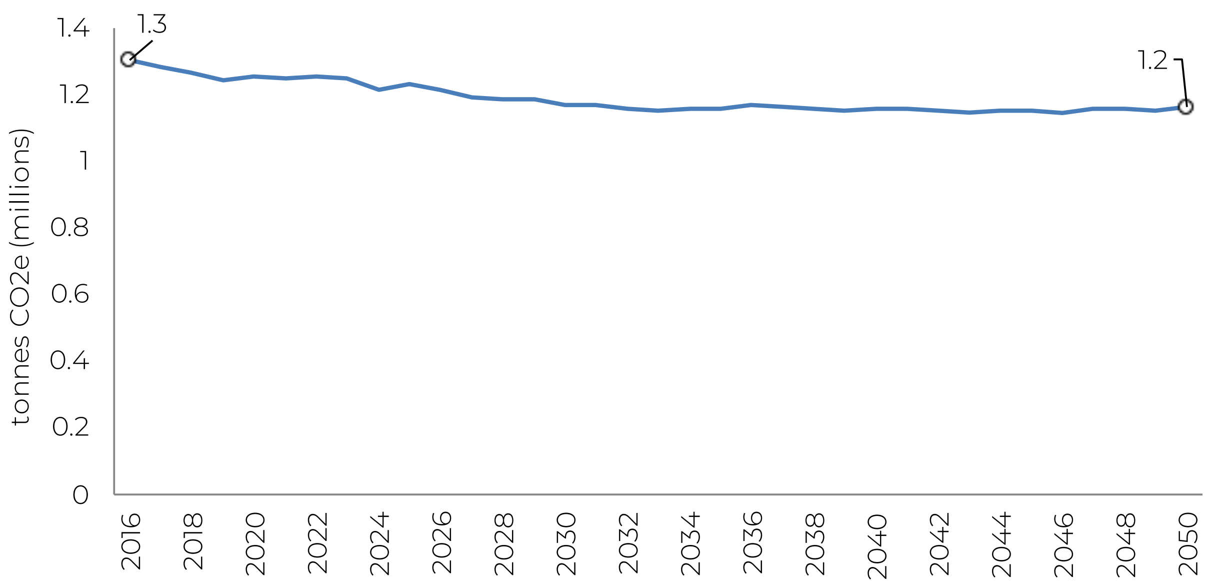


Figure 12. Forecasted total community emissions, 2016-2050.

Emissions from Energy Sources

In 2016, the highest emitting energy source was gasoline, with 37% of total emissions (Figure 13). Diesel use was responsible for 10% of emissions. Natural gas use was responsible for 27% while waste constituted another 10%.

By 2050, gasoline and diesel emissions are forecasted to decrease by 29% and 11%, respectively, due to improved fuel emissions standards, vehicle fuel efficiency, and EV uptake. Fuel oil emissions are expected to decline as its use decreases. Natural gas emissions remain roughly the same. Waste emissions scale with the expected additional population, increasing by 6%. Electricity related emissions are expected to increase 33% by 2050 as more natural gas electricity production facilities are added to the grid to meet increasing province-wide demand.

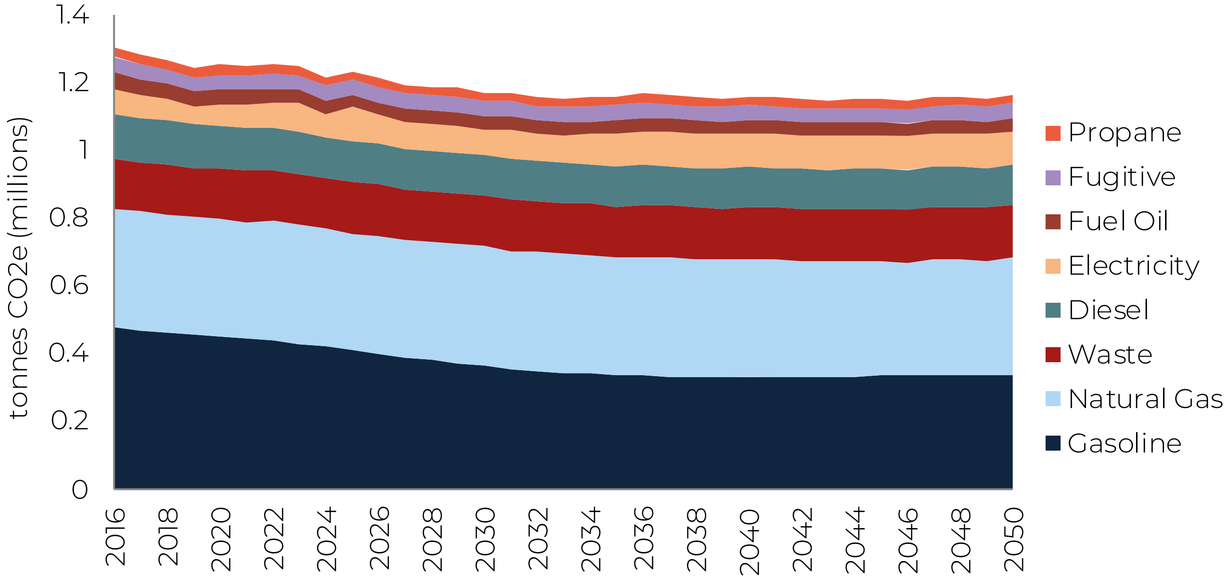


Figure 13. Forecasted GHG emissions by energy source, 2016-2050. Fugitive emissions are those attributable to losses in energy transmission (e.g. natural gas escape).

Where Emissions are Produced

As the largest users of fossil fuels, it is no surprise that transportation and residences are responsible for the majority of Greater Sudbury's emissions, with 43% and 22% of total 2016 GHG emissions, respectively (Figure 14). Emissions decreases are forecasted in these sectors by 2050 as fossil fuel use decreases.

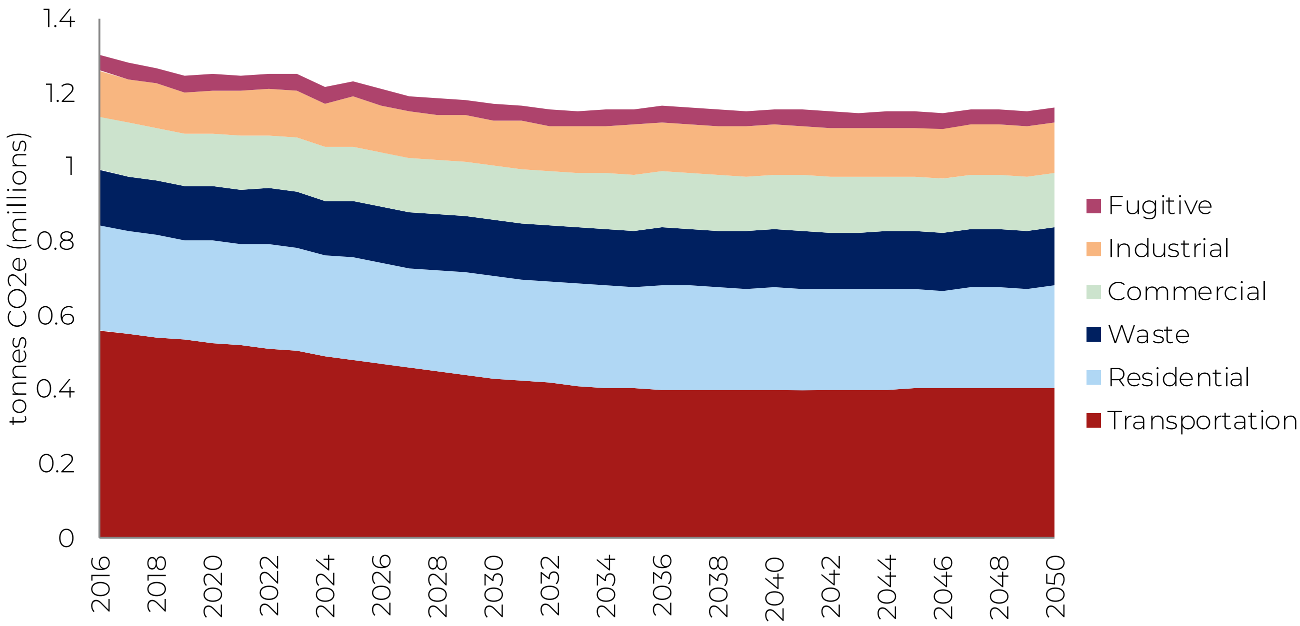


Figure 14. Forecasted GHG emissions by sector use, 2016-2050.

Transportation Fuel Emissions

Greater Sudbury's light trucks (pickup trucks, vans, and SUVs) are responsible for the majority of vehicle emissions, now and in 2050. Although EVs and fuel emissions standards reduce transportation emissions substantially by 2050 (mostly in cars), expected increases in car ownership (light trucks especially) and number of trips result in the levelling off and slight increase in emissions after 2035.

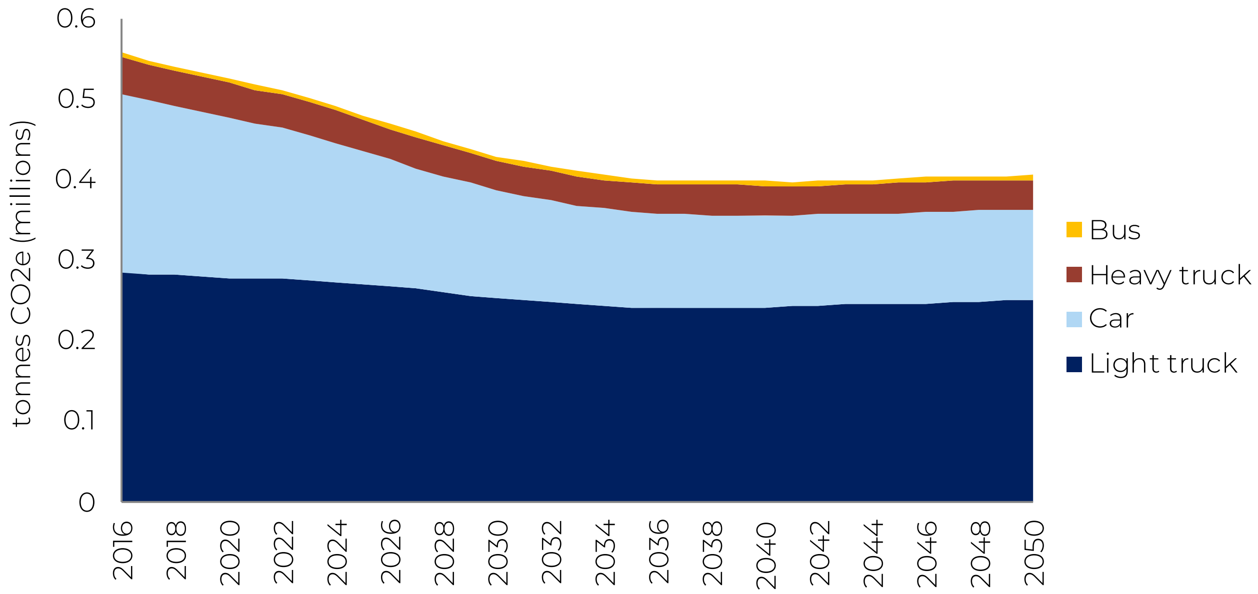


Figure 15. Forecasted transportation sector emissions by vehicle type, 2016-2050.

Buildings Emissions Sources

Space and water heating (largely with natural gas) account for 65% of buildings emissions in 2016. Space heating emissions are expected to decline 7.5% as fewer heating degree days reduce heating demand. Space cooling related emissions are expected to increase as cooling degree days rise. Water heating emissions are expected to increase 12.5% as the population increases. Lighting, appliance, and plug load demands all increase with population as well, with their associated emissions following suit. These expected changes in emissions by building end use result in very little difference in total annual building sector emissions between 2016 and 2050.

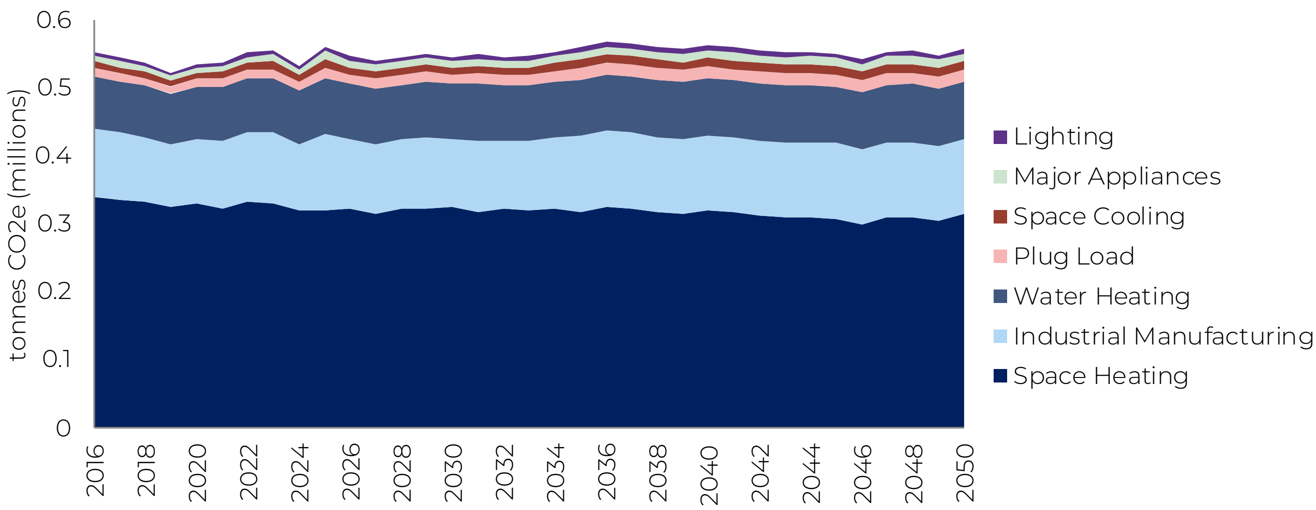


Figure 16. Forecasted building sector emissions by end use, 2016-2050.

Current Energy and Emissions Outlook

Mostly thanks to current Federal transportation direction on vehicle fuel efficiency, fuel emissions factors, and EV incentives, Greater Sudbury's energy and emissions future is expected to improve slightly over today's conditions. Total energy use and emissions are expected to decrease only slightly over the 2016-2050 time period. Sudbury's 2016 (baseline year) emissions levels were 1.3 $MtCO_2e$. Reducing Greater Sudbury's annual emissions by 80% of 2016 levels by 2050 means bringing emissions down to 260,000 tCO_2e in that year. This translates to avoiding over 1 $MtCO_2e$ in that year – a very large decrease.

Total GHG emissions in the BAU scenario are forecasted to be 1.1 million tonnes of CO_2e, leaving a gap of 900,000 tonnes of CO_2e reductions to bridge in order to meet an 80% emissions reduction target.

In the climate emergency scenario in which global average warming is limited to +1.5°C, global emissions must be net-zero by 2050. For Greater Sudbury to achieve this target, all 1.1 $MtCO_2e$ of emissions in 2050 would have to be eliminated through reduction efforts and, likely, offsetting through renewable energy production and carbon sequestration (e.g. afforestation).

Part 2: Charting a Path for the CEEP

Transitioning a community to clean, low-carbon energy sources requires minimizing energy use and shifting from decades-entrenched fossil fuel-based energy use to renewable energy sources. Shifting from fossil fuel power to electricity—electrification—provides flexibility in how power is generated, delivered, and used. Electrification can easily reduce community emissions in places where the electric grid is powered by renewable energy – Ontario's grid has relatively low emissions factors compared to other provinces that rely more on coal and natural gas generation.

Three key concepts are used in the CEEP to help navigate low-carbon community planning:

- The Reduce-Improve-Switch paradigm;
- Community energy planning prioritization; and
- Infrastructure, mechanical, and energy systems turnover.

The Reduce-Improve-Switch Paradigm

Low-carbon community planning considers a wide variety of actions in the transportation, buildings, industrial activity, energy use and generation, waste, and land-use sectors. The actions can be classified under one or more categories of Reduce, Improve, and Switch: reducing energy consumption, improving the efficiency of the energy system (supply and demand), and fuel switching to low-carbon renewable sources.

The most effective approach in transitioning to a low-carbon community is to first reduce the amount of energy needed as much as possible through energy efficiency and conservation, and then to switch to low carbon fuel sources to supply the remaining demand. The sequence of the approach is important: by avoiding energy consumption (Reduce), retrofit requirements (Improve) and the need to generate renewable energy (Switch) are both reduced.

Table 1. Sample Reduce-Improve-Switch actions.

	BUILDINGS	TRANSPORTATION	WASTE
REDUCE Reduce energy consumption and optimize energy demand.	Build efficient and low-carbon new buildings.	Build compact, complete communities and transit-oriented development.	Implement strategies to prevent the creation of waste.
IMPROVE Increase energy use efficiency.	Upgrade to energy efficient lighting systems. Perform energy retrofits for existing buildings.	Improve vehicle fuel efficiency.	Improve the efficiency of waste collection practices.
SWITCH Shift to low carbon energy sources.	Source energy from renewable sources.	Switch to electric vehicles that use renewable energy sources.	Collect landfill fugitive emissions for use as renewable natural gas.

Community Energy Planning Prioritization

The actions can also be categorized broadly as applying to new infrastructure or existing infrastructure. Infrastructure is the first priority in community energy planning as it locks communities into its use for decades. The second planning priority is to address major production processes, transportation modes, and building design. The final priority is making energy-using equipment efficient. This prioritization hierarchy concentrates actions where the options to intervene in the future will be fewest.

Infrastructure, Mechanical, and Energy Systems Turnover

There are cyclical opportunities to address existing infrastructure, such as the natural transition at the end of serviceable life, between now and 2050. Different types of infrastructure have different degrees of longevity, for example building HVAC systems (moderate longevity) versus their envelopes (high longevity). Increased energy efficiency can be realized by investing in appropriate upgrades during cycles of infrastructure maintenance and renewal.

CEEP Scenarios

Through technical analysis, research, and public, stakeholder, and City staff input, dozens of energy and emissions actions were vetted. The actions were modelled in CityInSight and two final suites of actions were determined for modelling in scenarios. The actions are grouped into eight general strategy sectors:

1. **Compact, complete communities.** Historical neighbourhood and city design and development has led to high energy use and high emissions lifestyles. Energy efficient land-use approaches achieve great emissions reductions along with a variety of socio-economic co-benefits.
2. **Efficient buildings.** This strategy involves making deep energy efficiency retrofits to all buildings in the community and ensuring that new buildings are built to superior energy standards.
3. **Water, Wastewater, and Solid Waste.** Education, awareness and incentive programs coupled with upgrades to the water distribution, wastewater treatment, and solid waste diversion systems aim to achieve energy efficiencies and emissions reductions in these sectors.
4. **Low-carbon transportation.** This strategy focuses on vehicle electrification, increasing and improving public transit services, and making more trips by walking, cycling and other means of active transportation.
5. **Industrial efficiency.** Local natural resource industries are already researching options for increasing energy efficiency and decreasing energy use costs. Vehicle electrification and increasing the efficiency of industrial processes will achieve emissions reductions while benefitting the industrial bottom line.
6. **Local clean energy generation.** Energy for buildings and vehicles can be produced locally. Solar photovoltaic systems are a central approach to achieve this, renewable natural gas from waste is another. This strategy includes actions to divert waste from landfills, generate energy from landfill gas, and minimize fugitive emissions.
7. **Low-carbon energy procurement.** It is challenging to provide all Greater Sudbury's energy needs locally. The energy demand that remains after energy efficiencies are maximized may not be met by local generation alone. Procuring low-carbon energy from outside the city's boundaries bridges the renewable energy and emissions reduction gap.
8. **Carbon sequestration.** Afforestation efforts can provide trees to sequester enough carbon to bridge the emissions gap remaining after Reduce-Improve-Switch actions have been taken.

Scenario Assumptions

The BAU, 80% Reduction, and Climate Emergency scenarios were modelled using CityInSight with varying actions assumptions, summarized in the following table. Unless otherwise noted, all actions are taken by and/or scaled up to the year 2050. The suite of CEEP actions under the 80% Reduction and the Climate Emergency scenario changes Greater Sudbury's 2050 energy and emissions outlook as compared to the BAU scenario. The actions under the 80% Reduction scenario are ambitious, while those under the Climate Emergency scenario are very ambitious. All actions are considered to an extent determined to be attainable by the City, community, business, and industry, albeit with substantial effort in some cases.

Table 2. Scenario assumptions.

	BASELINE/BAU	80% REDUCTION	CLIMATE EMERGENCY
DEMOGRAPHICS			
Population (people)	176,435 (2016) – 184,000 (2050)	Projections held constant	
Employment (jobs)	87,714 (2016) – 98,080 (2050)	Projections held constant	
COMPACT, COMPLETE COMMUNITIES			
Spatial distribution	Continue current development patterns.	80% of new development is in urban centres or adjacent to existing or new transit services, starting in 2025.	
Dwelling size	Same as baseline sizes.	Average home size decreases 20% due to more multi-family buildings.	
Building type mix	Same as baseline building mixes.	The share of new homes that is single-family decreases to 10%.	
EFFICIENT BUILDINGS			
Efficient new homes	New homes are 5% more efficient every 5 years.	+15% more efficient every 5 years starting in 2020.	Passive House Standard efficient starting in 2030.
Efficient new commercial buildings	New construction is 5% more efficient every 5 years.	+15% more efficient every 5 years starting in 2020.	Passive House Standard efficient starting in 2030.

	BASELINE/BAU	80% REDUCTION	CLIMATE EMERGENCY
Retrofit homes	Minimal retrofit instances.	Achieve 50% thermal savings and 30% electrical savings in 80% of existing dwellings by 2050 starting in 2020.	Achieve 50% thermal savings and 50% electrical savings in 100% of existing dwellings by 2040 starting in 2020.
Retrofits commercial buildings	Minimal retrofit instances.	50% thermal savings and 30% electrical savings in 80% of existing buildings by 2050.	50% thermal savings and 50% electrical savings in 100% of existing buildings by 2040.
Recommissioning	Standard recommissioning instances.	Recommission all buildings over 200,000 ft^2 and 40% of buildings over 25,000 ft^2 every 10 years for 10% energy savings.	
City retrofits	Same as current efficiencies.	100% of City buildings are retrofit to net zero emissions by 2040.	
Heat pump installations	Current instances of heat pump use are extrapolated.	40% and 30% of homes have air source and geothermal heat pumps, respectively. 75% of space heating and 100% of space cooling is electric in commercial buildings.	70% and 30% of homes have air source and geothermal heat pumps, respectively. 75% of space heating and 100% of space cooling is electric in commercial buildings.
WATER, WASTEWATER, AND SOLID WASTE			
Water pumping efficiency	Current efficiency held constant.	Decrease energy used in pumping by 2%/year.	
Water use efficiency	Current efficiency held constant.	Decrease water volume use by 2%/year.	
Solid waste diversion and wastewater treatment	Baseline generation and diversion rates extrapolated from current.	90% of residential and industrial, commercial, institutional (ICI) waste diverted by 2050. Installation of anaerobic digestion facility for wastewater and organics treatment with biogas capture for use as RNG.	

	BASELINE/BAU	80% REDUCTION	CLIMATE EMERGENCY
LOW-CARBON TRANSPORTATION			
Expand transit	Follows the Transit Action Plan.	10-minute frequency on high-demand routes, 20-minute frequency on medium demand routes, 7 days/week service. Transit mode share increases to 25%.	
Electrify transit	Current fuel mix held constant.	100% new vehicles electric and right-sized fleet by 2040.	100% new vehicles electric and right-sized fleet by 2035.
Cycling & walking infrastructure	Current mode shares held constant.	20% of trips are walking (<2km) and cycling (<5km).	35% of trips are walking (<2km) and cycling (<5km).
Electrify city fleets	None.	100% electric by 2035.	100% electric by 2035.
Electrify personal vehicles	3% of personal vehicles are EVs by 2040.	100% of all new sales are EVs by 2035.	100% of all new sales are EVs by 2030.
Electrify commercial vehicles	Current mix held constant.	Scales up to 100% electric of all new sales by 2030.	Scales up to 100% electric of all new sales by 2030.
INDUSTRIAL EFFICIENCY			
Electrify mining vehicles	Scales up to 100% electric of all new sales by 2040.	Scales up to 100% electric of all new sales by 2030.	Scales up to 100% electric of all new sales by 2030.
Industry efficiency	No change.	Increase process motors and energy efficiency by 50%.	
Mining industry	Continue current energy and emissions trajectories.	Include suggested initiatives (e.g. superstack replacement) and reduce overall energy use 25% by 2050.	Include suggested initiatives (e.g. superstack replacement) and reduce overall energy use 35% by 2040.

	BASELINE/BAU	80% REDUCTION	CLIMATE EMERGENCY
LOCAL CLEAN ENERGY GENERATION			
Ground mount solar	Current instances held constant.	+10 MW per year.	+20 MW per year.
Solar PV - net metering	Current instances of solar PV use held constant.	90% of new buildings and 50% of existing buildings have solar PV installed, supplying 50% of their electric load.	90% of new buildings and 80% of existing buildings have solar PV installed, supplying 50% of their electric load.
District energy	Current systems held constant.	Expand DE systems in the downtown core where building density thresholds are met to a 23MW capacity.	
Energy storage	None	Scale up to 50 MW by 2050 in decentralized storage.	
LOW-CARBON ENERGY PROCUREMENT			
RNG Procurement	None.	None.	Replace 75% of the remaining natural gas with RNG.
Electricity Procurement	None.	None.	Replace 100% of the remaining grid electricity with green electricity.
CARBON SEQUESTRATION			
Increase forest cover	Consistent with current reforestation efforts.	Consistent with current reforestation efforts.	Increase reforestation and afforestation efforts to quadruple carbon sequestration rates by 2050.

Actions Discussion

Complete, Compact Communities

As cities expand outward, they convert agricultural and vacant land to suburban uses. Costs increase for the municipality to provide and maintain infrastructure such as roads, pipes, and emergency services. Residents are more likely to be dependant on cars, driving longer distances, adding stress and time to commutes. Once neighbourhoods are built, it is difficult to alter the development pattern, thus locking in transportation patterns, building design, infrastructure, and energy supply for decades to come.

Land-use policy is also some of the most cost-efficient energy and emissions actions a municipality can take. Unlike retrofitting buildings or creating new energy systems, directing new development to create complete, compact neighbourhoods is very low cost.

Well-considered land-use policy also achieves many objectives simultaneously. Infill and compact, complete developments provide greater support for transit services. They also allow more trips to be made through active transportation, as places of work, play, schools, and services are close by. Smaller homes and homes that share walls are much more energy efficient, which reduces energy bills.

All these elements have impacts on energy use and emissions production. It makes sense to upgrade existing communities where possible and ensure new communities are complete. Land-use is a critical area of focus for energy efficiency and emissions reduction. It is a low-cost effort to ensure decades of low-carbon infrastructure is in place.

Through CEEP implementation, it is expected that residential development would focus on multi-family and mixed-use buildings. Apartment and condominium buildings are typically more energy efficient than single family homes. This is in part due to smaller dwelling sizes. Under CEEP implementation, it is expected that new homes would be 25% smaller than existing homes, on average. The focus on multi-family and mixed-use housing would also result in fewer new single-family homes. By 2050, the share of new single-family homes being built would decrease to 10% of total housing starts.

Efficient Buildings

New Buildings

Compared to many emissions-saving actions, energy efficient new buildings are easy to achieve. Energy use intensity targets (i.e. kw/m^2/year) can be established and met through efficient heating, ventilation and air conditioning systems, other mechanical systems, and building envelopes (walls, ceilings, and windows). Passive House buildings consume up to 90 percent less heating and cooling energy than conventional buildings. It is applicable to almost any building type. Buildings built to the standard provide fine-tuned control over indoor air quality and temperature with simple and durable systems. The operating costs of Passive House buildings is very low.

Existing Buildings

The existing building stocks present a greater challenge than new buildings – their energy inefficiencies have already been locked in. They also represent a great energy efficiency and emissions reduction opportunity. Although most buildings will require similar types of retrofits, some tailoring of the approach will be required. Building energy assessments are a good way to determine the most effective retrofit approach. Many homes in Sudbury could benefit from upgrading their envelopes and updating their heating systems.

Water, Wastewater, and Solid Waste

Potable Water

Greater Sudbury's potable water distribution system pumps water throughout the nearly 4,000 square kilometre community. Two major efforts can reduce the energy (electricity) used in the system: reducing end water use volumes and increasing the efficiency of the mechanical systems used in treatment and distribution. Education and incentive programs are required for the former while pumping station upgrades are required for the latter. The water distribution system is already undergoing diagnosis for pump upgrades that will greatly reduce energy use, following on a pilot project that achieves 50-60% greater energy efficiency. Automated water metering systems are planned as well, which will encourage water savings. Wastewater anaerobic treatment plants have been explored and are an option for facility upgrades that would produce renewable natural gas.

Solid Waste and Wastewater

Greater Sudbury's solid waste and wastewater activities have some of the richest metrics and plans in the city, allowing precise tracking of actions targeting emissions reductions in these sectors. A gas capture system is already in place at the Sudbury landfill. As the landfill volume grows, so too can the system's renewable natural gas generation capacity. Decreased weekly garbage volume limits, improved organics collection, increased diversion, and changes to disposal fee structures are some of the approaches that have been considered by the City that could decrease waste-generated emissions. Reducing wastewater through education programs and water saving fixture incentive programs will reduce emissions from treatment plants, as will improving end treatment to higher standards.

Low-carbon Transportation

Transit

Transit service enhancements are already being made in Greater Sudbury with the updated Transit Action Plan and the new GOVA family of transit services. As new building and land-use actions are coordinated, enhanced transit services will become increasingly viable. Increasing transit frequency, right-sizing the fleet for different routes and schedules, and offering integrated transit service with GOVA Plus, GOVA Zone, park-and-rides, and cycling infrastructure are some of the actions that will increase ridership.

As transportation is responsible for the most emissions of all sectors in Greater Sudbury, replacing trips made by car with transit trips is an important emissions reductions action.

Vehicles

The two major approaches to reducing vehicle emissions are to reduce trips and to make vehicles more fuel efficient. Creating complete, compact communities and enhancing transit services helps to reduce vehicle trips. The fuel efficiency of the internal combustion engine vehicle has improved only marginally over the last century. The emerging shift to electric vehicles is a leap in energy efficiency. Electrifying City fleets, commercial vehicles, business fleets, and personal vehicles will result in great emissions reductions.

With EV prices dropping and more models becoming available every year, fleet and personal vehicle electrification is becoming easier. The growing EV market will shift some new car purchases to electric versions, but several coordinated actions are required to accelerate the EV transition in Greater Sudbury, including education and awareness programs, coordinating a bulk buy program, and partnering with local car dealerships to increase model variety and support promotion.

Supplying EV charging infrastructure is a key consideration in the shift to EVs. EV ranges are getting longer, but ‘range anxiety’ still exists for prospective owners. Approaches to public, business, and private EV charging infrastructure are presented in the Greater Sudbury EV Study (Appendices).

Active Transportation

Few trips are currently made by walking, cycling, or other mode of active transportation in Greater Sudbury. The amalgamation of former towns is spread out, making many trips too far for comfortable active transportation. As proven in various cities around the world, balancing the provision of infrastructure, application of appropriate land-use policy, and use of market forces is the most effective way to achieve transportation mode shift away from personal vehicles to transit, walking, and biking. Focusing on one of these elements without attention to the others results in poor services, low uptake, and negative stigmatization of the so-called alternative modes of transportation. By aptly considering all three in any transit or active transportation efforts made, the City may achieve success in progressing towards its mobility goals. Transit and active transportation are also key options for reducing household transportation expenditures.

Industrial Efficiency

Greater Sudbury's industrial sector is already indicating shifts toward electric vehicles, more efficient processes and motors, and lower carbon activities. The CEEP encourages timelines for process and motor efficiency improvements and emissions reduction targets for their operations. Greater Sudbury mining companies are increasingly tracking energy and emissions metrics, which will help set and achieve CEEP-related targets in the industrial sector.

Local Clean Energy Generation

District Energy

Expansion of Greater Sudbury's central district energy systems will make heating energy delivery more efficient. Infill development will provide greater building density, making the systems more effective. Although these systems currently operate on natural gas, the facilities could be retrofit to use one or a combination of renewable energy sources like geothermal exchange heat pumps, air source heat pumps, solar PV or thermal, or renewable natural gas.

Solar PV

Solar PV systems are a local energy generation approach that reduces the need for grid electricity, which is likely to be supplied at least in part by natural gas generation for the foreseeable future. Greater Sudbury could replicate the success of the Capreol 10 MW solar PV system in various locations throughout the community. Solar PV incentive programs for existing buildings and requirements for new buildings could quickly expand the local electricity generation capacity of the community.

Energy Storage

Renewable energy can be stored for use when needed, in battery electric storage or pumped hydro storage, for example. Stored renewable energy can be deployed when needed, bridging the temporal gap between when energy is produced and when it is needed, for example at night and during peak demand periods. Releasing stored energy decreases reliance on fossil fuel-based peaking plants that operate during peak demand hours (e.g. mornings and evenings). The current cost of battery electric storage is high, but prices are decreasing quickly as battery technologies become increasingly inexpensive to produce.

Fuel Switching

Air and ground source heat pumps are typically 300% more efficient than electric resistance heating and current models operate in remarkably low-temperature conditions. These systems extract thermal energy from the air and ground (much like a refrigerator extracts heat from the air inside it) for use in buildings. Different heat pump configurations are available to retrofit various building heating systems.

Low-carbon Energy Procurement

It is challenging to reduce all energy demands and supply 100% of the remainder with renewable energy. Procurement of renewable electricity and renewable natural gas from outside the city is a simple and convenient approach to reducing emissions from the grid and in applications that use natural gas. It is a scalable option. An energy procurement study is needed to determine the best options for Greater Sudbury.

Carbon Sequestration

For over 40 years, tree planting has been the central element in the regreening of the industrially impacted Sudbury barrens. The program has been an important part of the social, economic and environmental renewal of Greater Sudbury, with 9.8 million trees planted on 24,811 hectares (average density of 395 tree seedlings per hectare) to date.[8]

There are large tree density variations from one plot to the next, but replanting increases sequestration on the remediated sites by an average of 1.1 tonnes of CO_2 per hectare per year.[9] This implies a current rate of sequestration of roughly 25,000 tonnes of CO_2 per year. Annual tree planting programs continue,[10] and the rate of sequestration should continue to increase.

It is important to note that efforts must be maintained to refresh the existing tree stock to keep its carbon sequestration rate consistent. The numbers noted above are based on average tree age and sequestration rates. Newly planted areas may not achieve these rates until their trees reach the average age. In planning to achieve target sequestration rates, it is best to overestimate the area and tree stocks required for these reasons.

8 Krista McCracken, "The Journey from Moonscape to Sustainably Green", Active History, June 2013. Accessed at: http://activehistory.ca/2013/06/11360 and personal communication, L-CARE (Landscape Carbon Accumulation through Reduction in Emissions) project researcher, Laurentian University.

9 Michael Preston, "Carbon sequestration following re-greening of a barren landscape: a chronosequence study", presentation to Mining and Environment International Conference VII, Laurentian University, Sudbury, June 26, 2019.

10 VETAC, "Regreening Greater Sudbury, Five Year Plan, 2016-2020", March 2016. Accessed at https://www.greatersudbury.ca/live/environment-and-sustainability1/regreening-program

Part 3: CEEP Energy and Emissions Outlook

Scenarios Energy Use Comparison

Total Energy Demand

Greater Sudbury's total energy use is 12.3 petajoules in the 80% Reduction scenario and 10.6 petajoules in the Climate Emergency scenario in 2050 (Figure 17). These amounts are 54% and 61% below 2016 energy use values, respectively. They are 50% and 57% less energy use than in the BAU scenario.

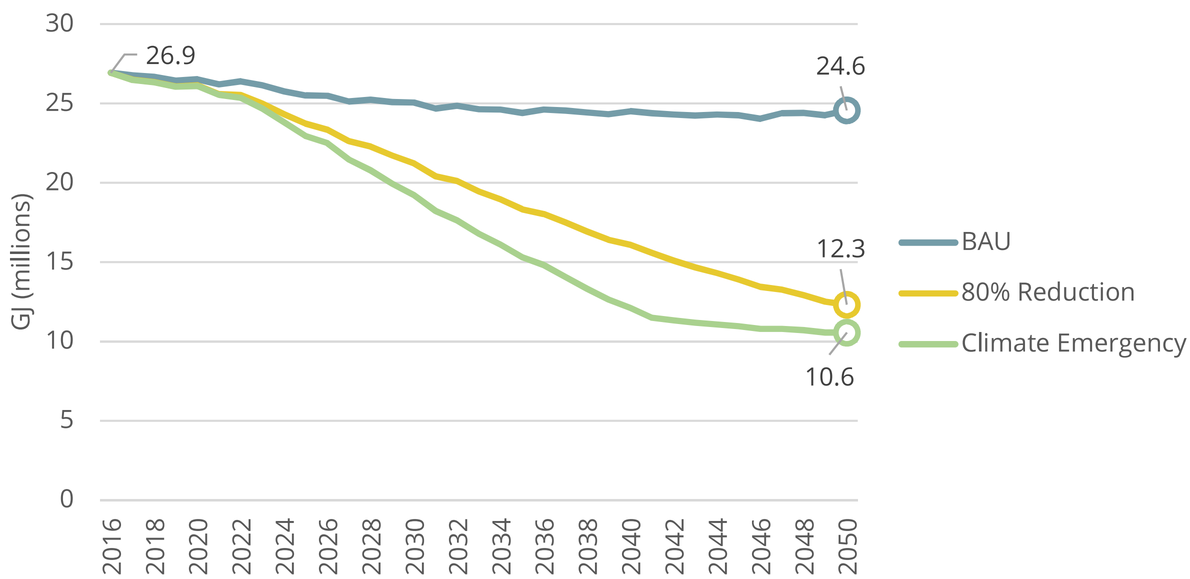


Figure 17. Scenarios total energy use comparison, 2016-2050.

Where Energy Comes From

The CEEP's energy efficient buildings and low-carbon transportation actions reduce natural gas and gasoline use dramatically. In both scenarios fossil fuel used is greatly diminished, with it being all but phased out in the Climate Emergency scenario with greater instances of heat pump and solar PV installations. The effects of greater building electricity efficiency measures coming into effect in the 2040s is evident in the Climate Emergency scenario.

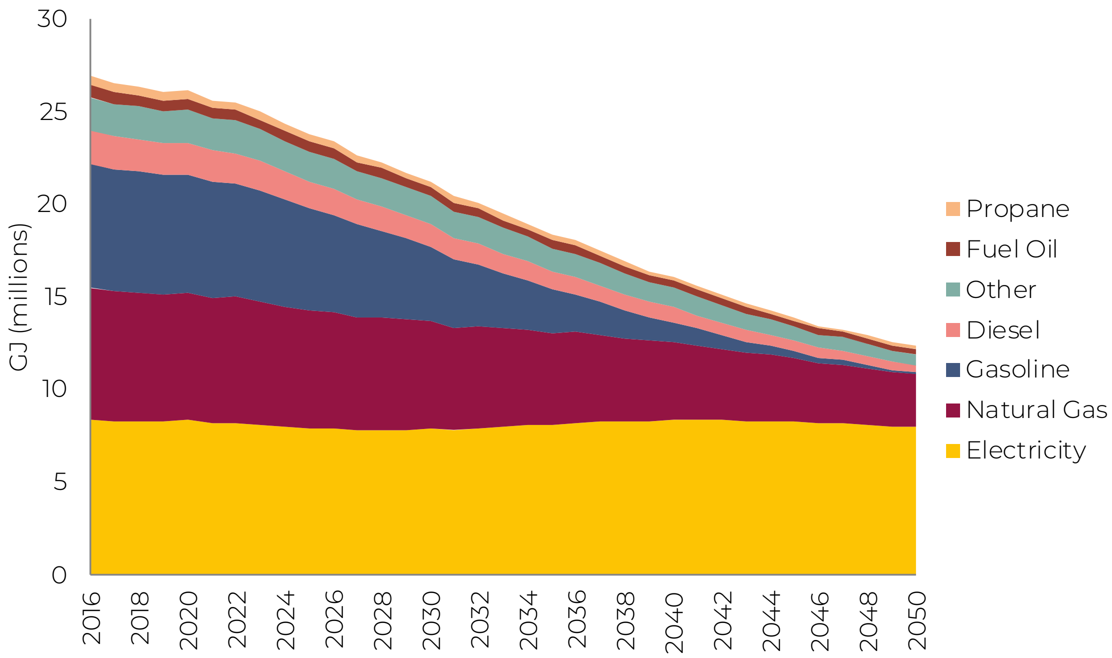


Figure 18. 80% Reduction scenario community energy use by energy source, 2016-2050.

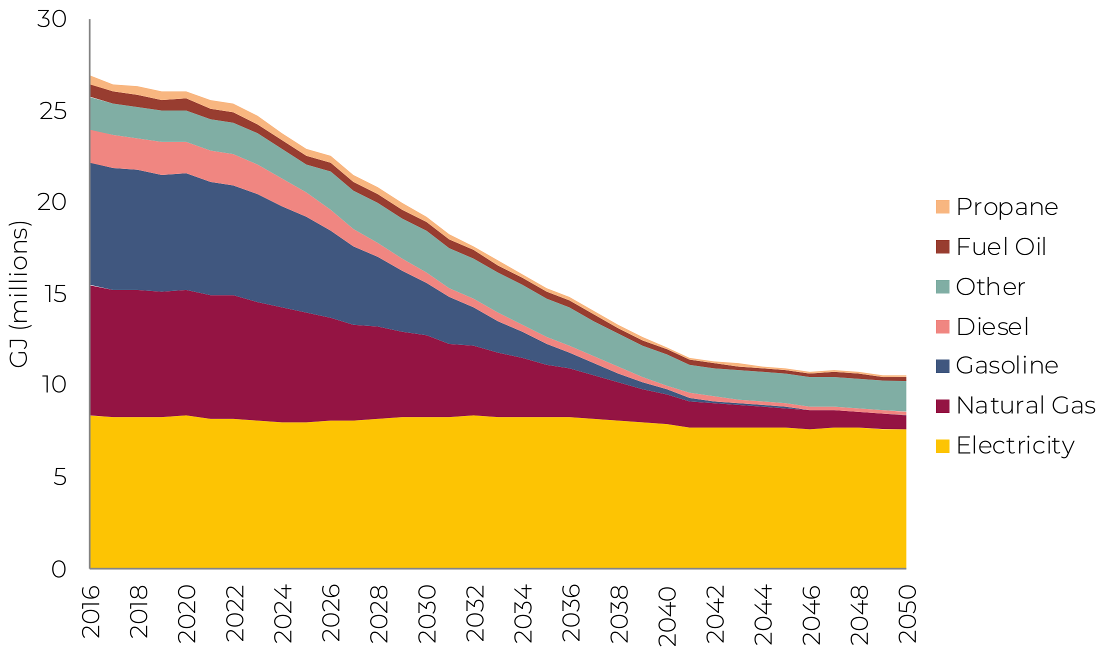


Figure 19. Climate Emergency scenario energy use by energy source, 2016-2050.

Where Energy is Used

The Climate Emergency scenario achieves energy reductions sooner than the 80% Reduction scenario (Figures 20 and 21). The biggest differences in energy use between the two scenarios is in the residential sector, where heat pump installations and building retrofits are more aggressive.

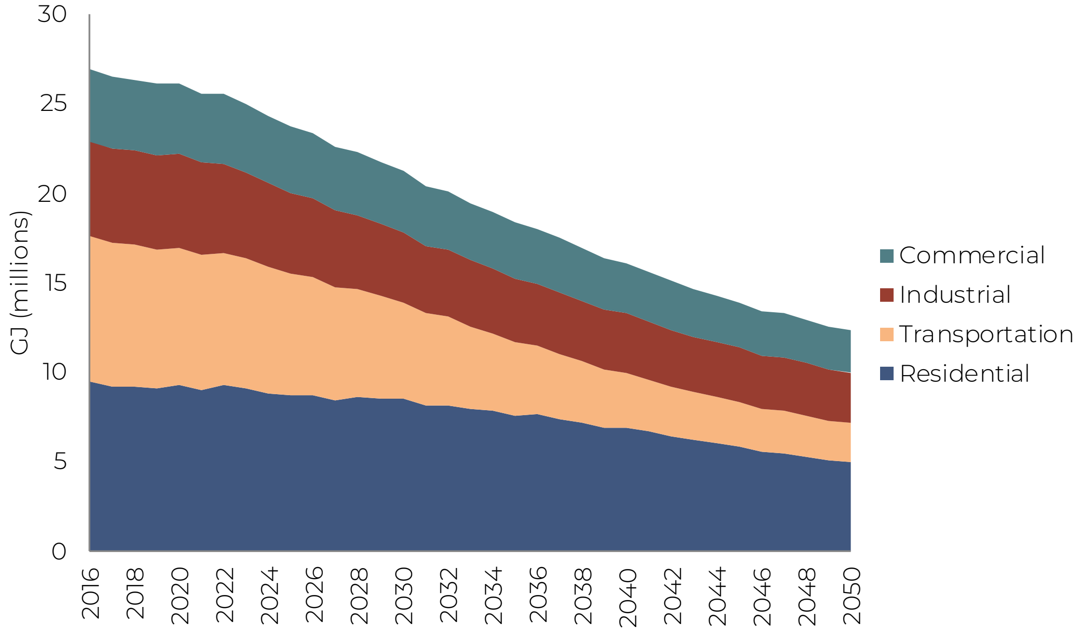


Figure 20. 80% Reduction scenario community energy use by sector, 2016-2050.

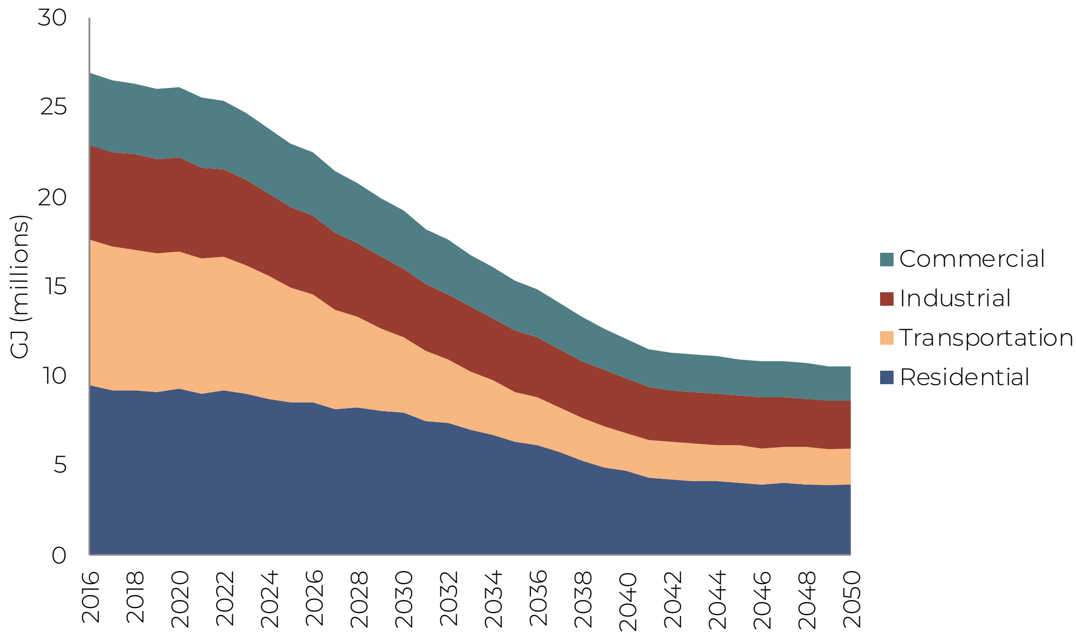


Figure 21. Climate Emergency scenario community energy use by sector, 2016-2050.

How Energy is Used

The effects of more aggressive heat pump installations and building retrofits in the Climate Emergency scenario can be seen in the space heating areas of Figures 22 and 23. Transportation energy also decreases further and faster in this scenario, as EV uptake is increased. Although less discernible, the Climate Emergency scenario also achieves greater energy efficiency in all other end uses than in the 80% Reduction scenario.

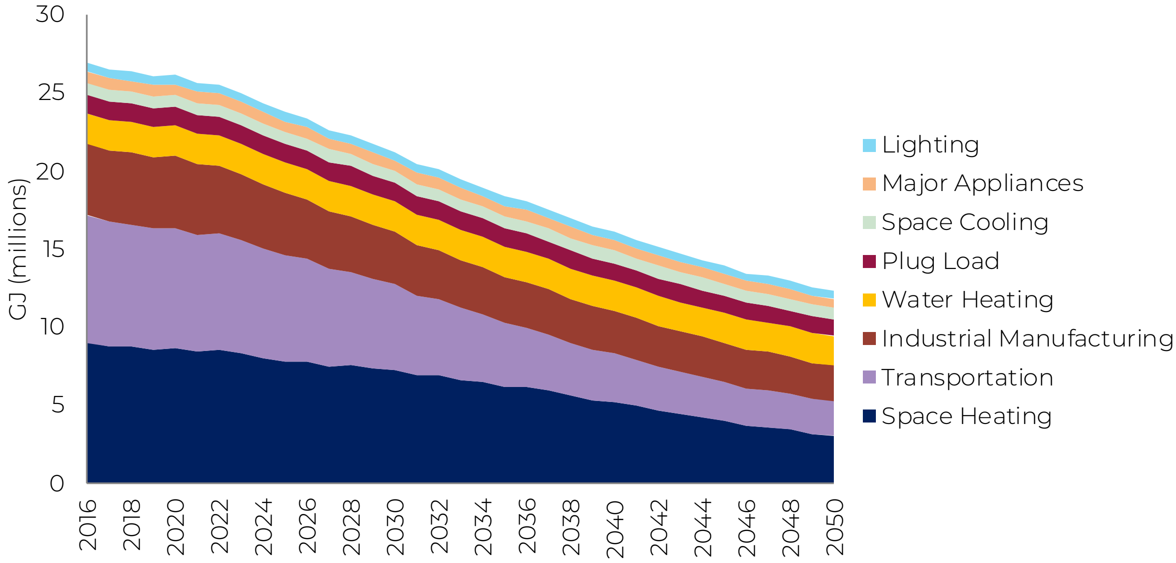


Figure 22. 80% Reduction scenario community energy use by end use, 2016-2050.

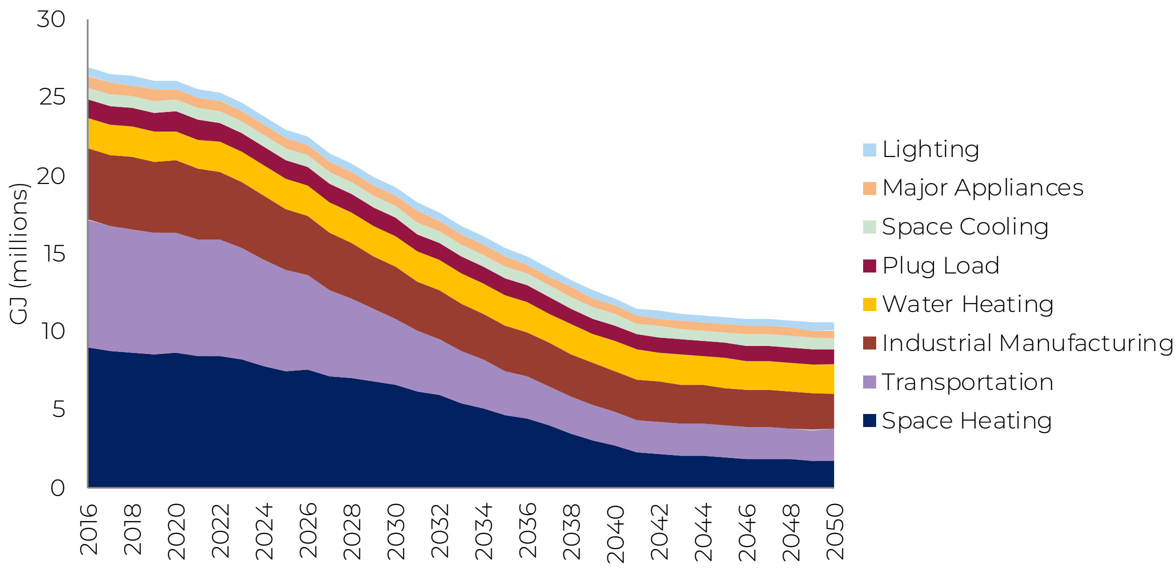


Figure 23. Climate Emergency scenario community energy use by end use, 2016-2050.

Low-carbon Energy Flows

Figure 24 shows Greater Sudbury's energy flows under the Climate Emergency scenario. Compared to the BAU Sankey diagram, solar PV, thermal networks (district energy), and electricity supply are greatly increased. Gasoline and natural gas energy sources are greatly diminished. Total energy used is much less than in the BAU, and conversion losses dwindle as inefficient fossil fuels are replaced with more efficient renewable and electric energy sources. The ratio of useful energy to conversion losses in much improved over the BAU scenario, at 1:0.44 (i.e. for every 1 gigajoule of energy used, 0.44 is lost).

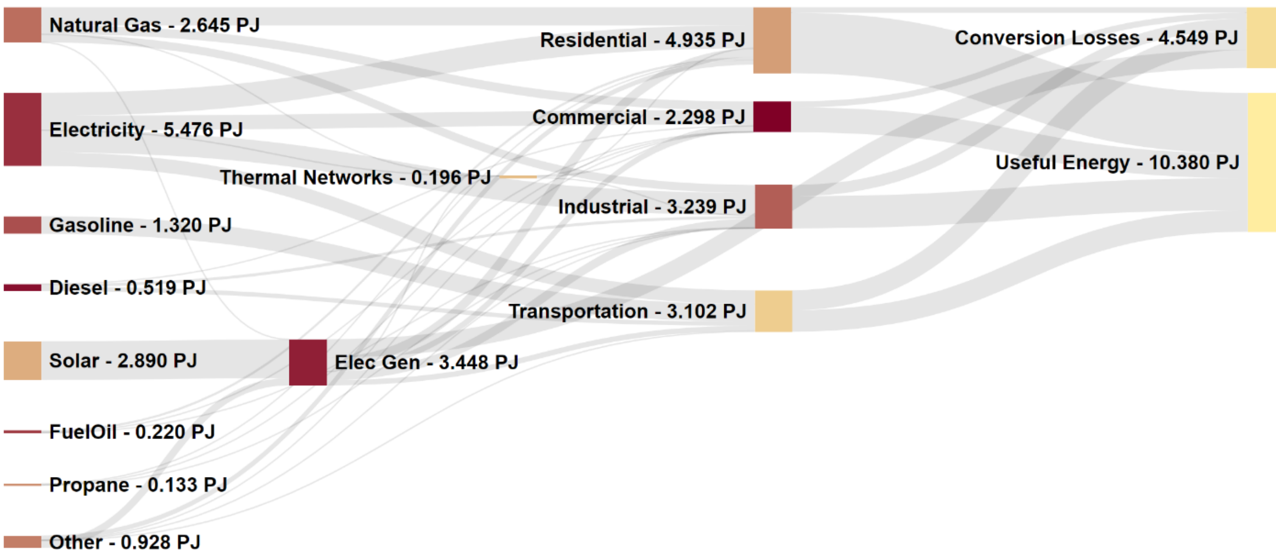


Figure 24. Sankey diagram of the Climate Emergency scenario.

Scenarios Emissions Comparison

Total Emissions

As energy demand is decreased under CEEP implementation, so too are GHG emissions. The 80% Reduction scenario achieves 80% emissions reductions from 2016 levels and 75% emissions reductions from BAU levels in 2050. The Climate Emergency scenario achieves 93% emissions reductions from 2016 levels and 92% emissions reductions from BAU levels in 2050. 300,000 tCO_2e of annual emissions remain in 2050 under the 80% Reduction scenario while 100,000 tCO_2e of annual emissions remain in the 2050 under the Climate Emergency scenario.

As modelled, the Climate Emergency scenario does not quite achieve the net emissions by 2050 target. It is still possible to bridge the final 100,000 tCO_2e of annual emissions in 2050 through increased renewable energy production and/or procurement and/or carbon sequestration actions (e.g. afforestation). These actions are discussed later in the report.

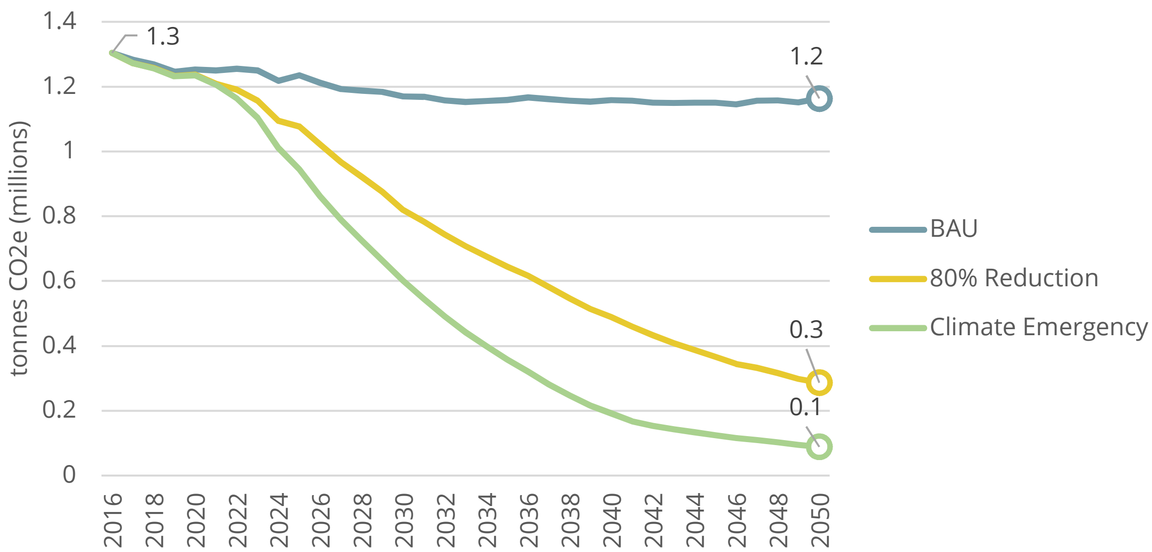


Figure 25. Scenarios total community emissions, 2016-2050.

Emissions from Energy Sources

Comparison of emissions by energy source in the two scenarios reveals the extra ambition in the Climate Emergency scenario to phase out gasoline and diesel use early on and to a greater extent through EV introduction. The effects of more aggressive buildings actions are also apparent in the greatly reduced natural gas and electricity emissions.

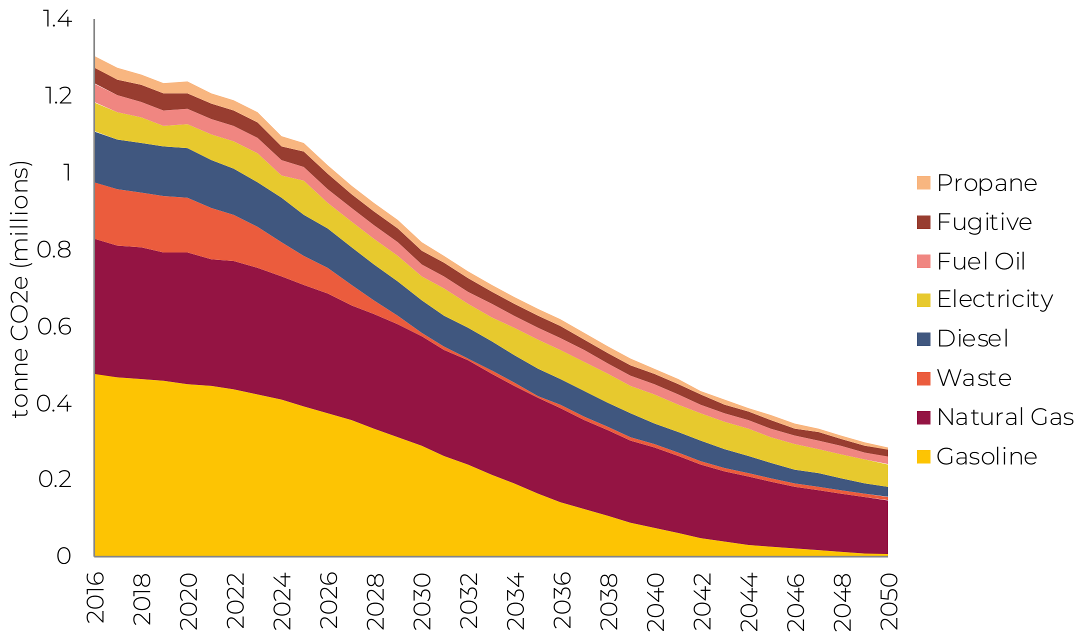


Figure 26. 80% Reduction scenario emissions by energy source, 2016-2050.

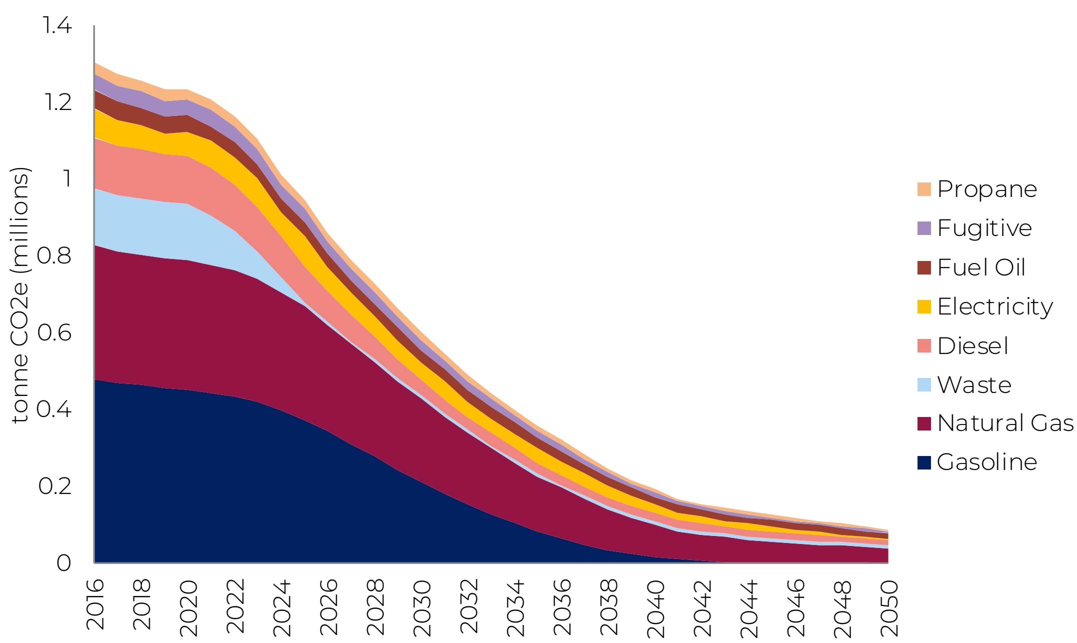


Figure 27. Climate Emergency scenario emissions by energy source, 2016-2050.

Where Emissions are Produced

Comparison of the emissions by sector between the two scenarios shows the extent to which actions in all sectors contribute to substantially more reductions in the Climate Emergency scenario. Transportation emissions are all but phased out by 2050, while buildings and waste emissions are reduced to very little. The residential sector remains the largest emitter in 2050 as there is still some natural gas heating assumed, as well as some emissions from grid electricity use.

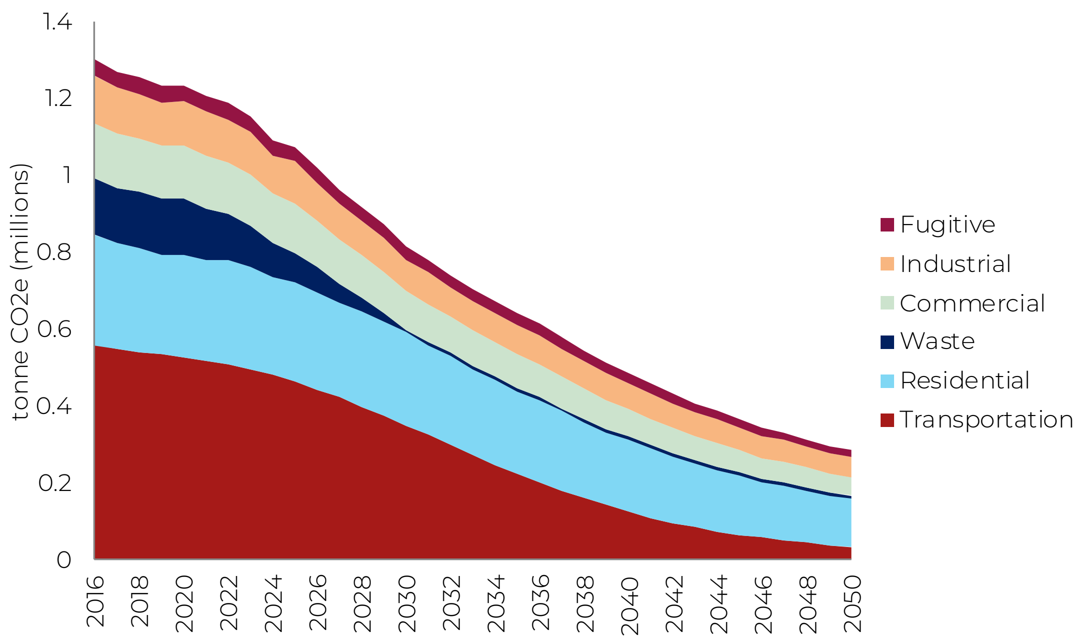


Figure 28. 80% Reduction scenario emissions by sector, 2016-2050.

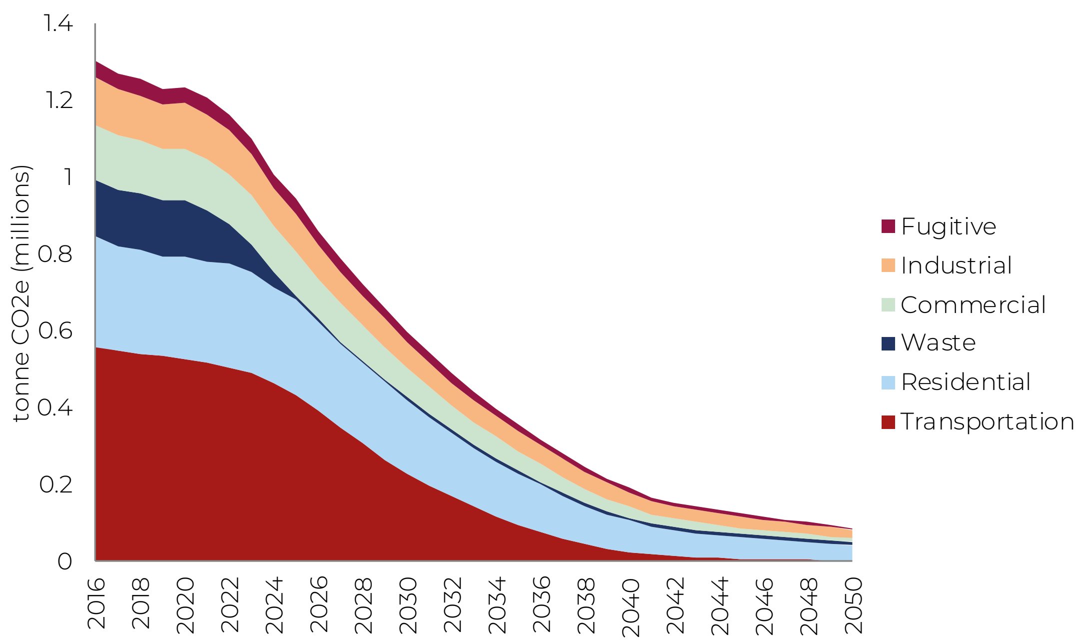


Figure 29. Climate Emergency scenario emissions by sector, 2016-2050.

Scenarios Energy and Emissions Outlook

Actions in both scenarios will substantially reduce energy use and emissions production in Greater Sudbury. Land-use theme actions are consistent in the two scenarios. The extra ambition in the other action themes in the Climate Emergency scenario is substantial, achieving another 200,000 tonnes of emissions reduction in 2050 compared to the 80% Reduction scenario. Figure 30 Summarizes the collective GHG emissions reductions of all the actions in the Climate Emergency scenario.

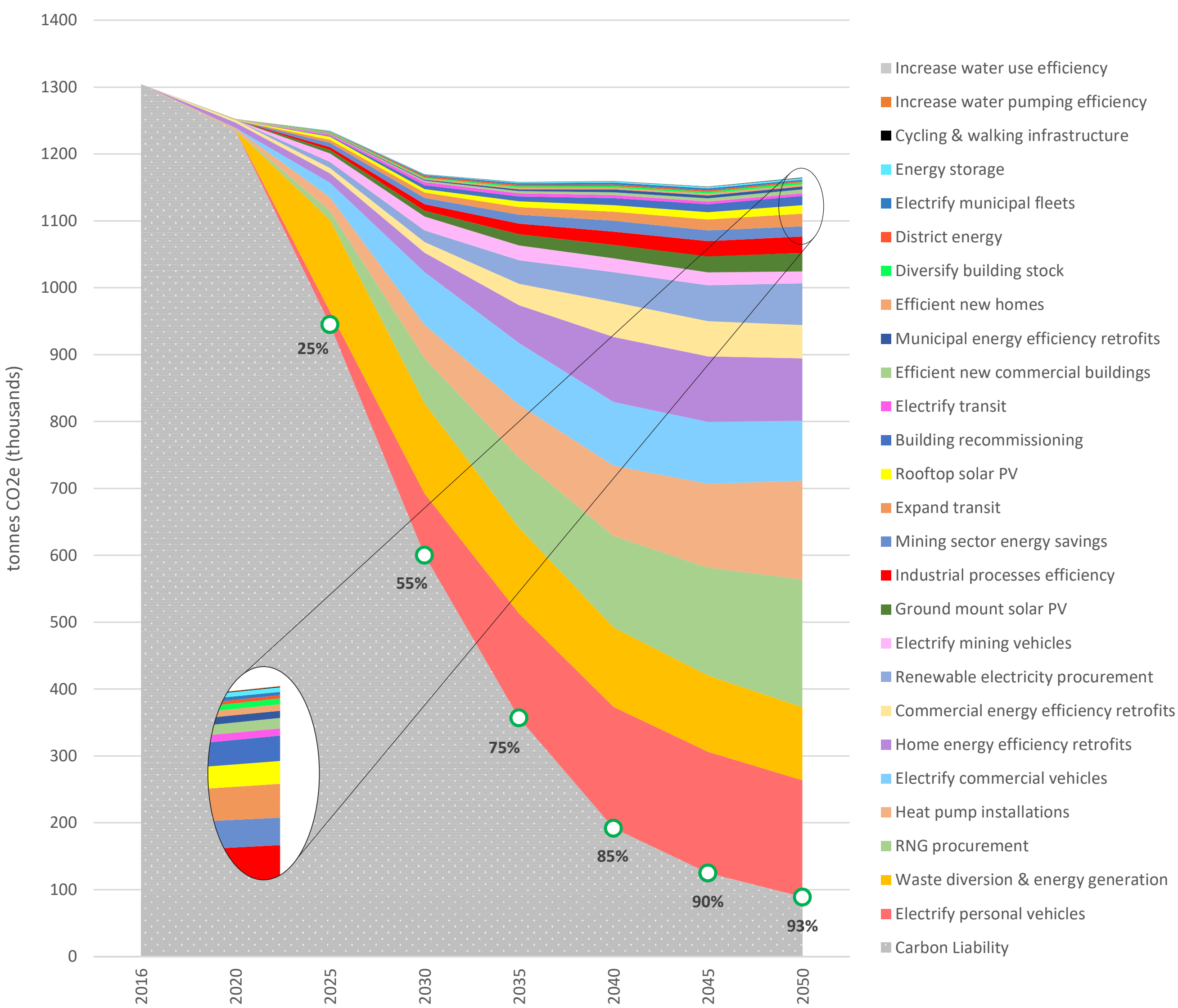


Figure 30. Wedge diagram showing the emissions reduction of each action in the CEEP Climate Emergency scenario, including emissions reduction percentage targets (of 2016 emissions levels). Note that although water use efficiency and water pumping efficiency actions save energy, their emissions saving is negligible and does not display on this graph.

Part 4: An Investment in Greater Sudbury

High-level financial analysis was undertaken to identify the required expenditures, savings, net present value, marginal abatement costs, and employment impacts of all Climate Emergency scenario actions in the CEEP. In both the BAU scenario and Climate Emergency scenario, buildings, transportation, and energy expenditures are made and savings occur. Financial information here is presented as the incremental additional expenditures required and costs and savings resultant from implementing the Climate Emergency scenario actions over those that are expected to be incurred in the BAU scenario.

Costs and Savings Summary

Costs and savings modelling considers upfront capital expenditures, operating and maintenance costs (including fuel and electricity), and carbon pricing. Table 3 summarizes expenditure types that were evaluated for the CEEP.

Table 3. Categories of expenditures evaluated.

CATEGORY	DESCRIPTION
Residential buildings	Cost of dwelling construction and retrofitting; operating and maintenance costs (non-fuel).
Residential equipment	Cost of appliances and lighting, heating and cooling equipment.
Residential fuel	Energy costs for dwellings and residential transportation.
Residential emissions	Costs resulting from a carbon price on GHG emissions from dwellings and transportation.
Commercial buildings	Cost of building construction and retrofitting; operating and maintenance costs (non-fuel).
Commercial equipment	Cost of lighting, heating and cooling equipment.
Commercial vehicles	Cost of vehicle purchase; operating and maintenance costs (non-fuel).
Non-residential fuel	Energy costs for commercial buildings, industry and transport.
Non-residential emissions	Costs resulting from a carbon price on GHG emissions from commercial buildings, production and transportation.
Energy production emissions	Costs resulting from a carbon price on GHG emissions for fuel used in the generation of electricity and heating.
Energy production fuel	Cost of purchasing fuel for generating local electricity, heating or cooling.

CATEGORY	DESCRIPTION
Energy production equipment	Cost of the equipment for generating local electricity, heating or cooling.
Municipal capital	Cost of the transit system additions (no other forms of municipal capital assessed).
Municipal fuel	Cost of fuel associated with the transit system.
Municipal emissions	Costs resulting from a carbon price on GHG emissions from the transit system.
Energy production revenue	Revenue derived from the sale of locally generated electricity or heat.
Personal use vehicles	Cost of vehicle purchase; operating and maintenance costs (non-fuel).
Transit fleet	Costs of transit vehicle purchase.
Active transportation infrastructure	Costs of bike lane and sidewalk construction.

Figure 31 summarizes modelled annual CEEP costs and savings over those in the BAU scenario. Costs vary year-over-year as investments in transit vehicles, active transportation infrastructure, City fleet, solar PV installations, building retrofits, and other elements are made. Costs wane after 2040 as retrofit and energy system installation efforts conclude.

Building mechanical systems and electric vehicles operations and maintenance (O&M) savings grow over the next thirty years as systems become more efficient and electricity powered, requiring less servicing and replacement. Energy cost savings grow substantially as energy savings are realized from more efficient buildings and vehicles, as well as increased transit use and active transportation (more affordable trips than those made by car).

Carbon pricing in the CEEP increases the value of fuel and electricity savings, modestly in the first half of the time period but more significantly in later years as the price increases. Federal carbon pricing is currently valued at $20 per tonne of emissions and is scheduled to increase to $50/tonne by 2022. Commitments beyond 2022 have not yet been made, but it is estimated that carbon pricing will be over $100/tonne by 2050.

The rooftop and ground mount solar PV systems and the district energy systems generate substantial revenues for their operators. As more systems are implemented over the time period, the total annual revenues of these systems increase.

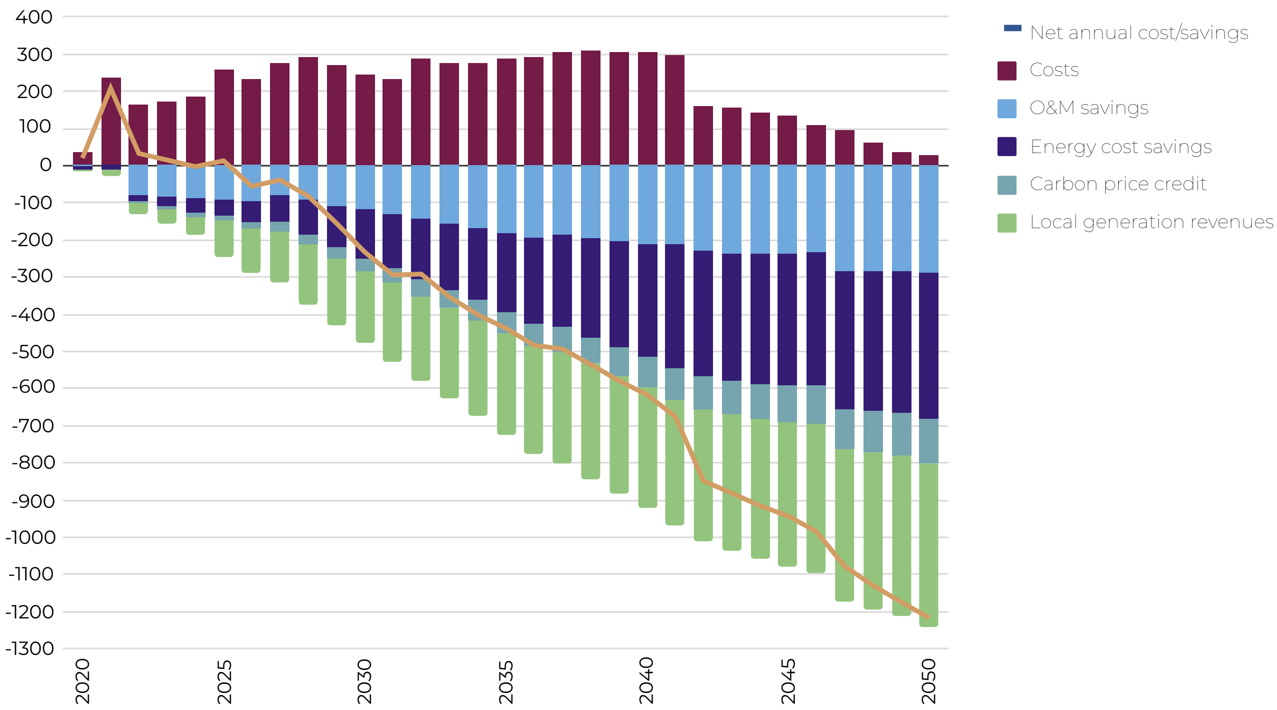


Figure 31. Summary of annual CEEP costs (above x-axis) and savings (below x-axis) relative to the BAU scenario.

Table 4 and Figure 32 summarize the cumulative costs and savings of CEEP implementation for the Climate Emergency scenario, with those of the 80% Reduction scenario for comparison. By 2050 cumulative CEEP implementation costs total $6.5B with a present value of $4.3B (at a discount rate of 3%). Total net savings reach $14.6B.

Table 4. Summary CEEP financial metrics (2016 $).

	CUMULATIVE COSTS AND SAVINGS TO 2050 (UNDISCOUNTED)		NET PRESENT VALUE (DISCOUNT RATE OF 3%)	
	80% REDUCTION SCENARIO	CLIMATE EMERGENCY SCENARIO	80% REDUCTION SCENARIO	CLIMATE EMERGENCY SCENARIO
Costs	$ 4.84B	$ 6.46B	$ 3.05B	$ 4.29B
O&M savings	(4.79B)	(5.15B)	(2.69B)	(2.91B)
Energy cost savings	(5.70B)	(6.44B)	(3.01B)	(3.47B)
Carbon price credit	(1.29B)	(1.78B)	(0.68B)	(0.96B)
Local generation revenues	(3.01B)	(7.72B)	(1.68B)	(4.28B)
Net annual cost / (saving)	**$ (9.95B)**	**$ (14.63B)**	**$ (5.01B)**	**$ (7.33B)**

The net present value of CEEP costs are $1.24B more in the Climate Emergency Scenario. The net annual savings are $2.32B greater.

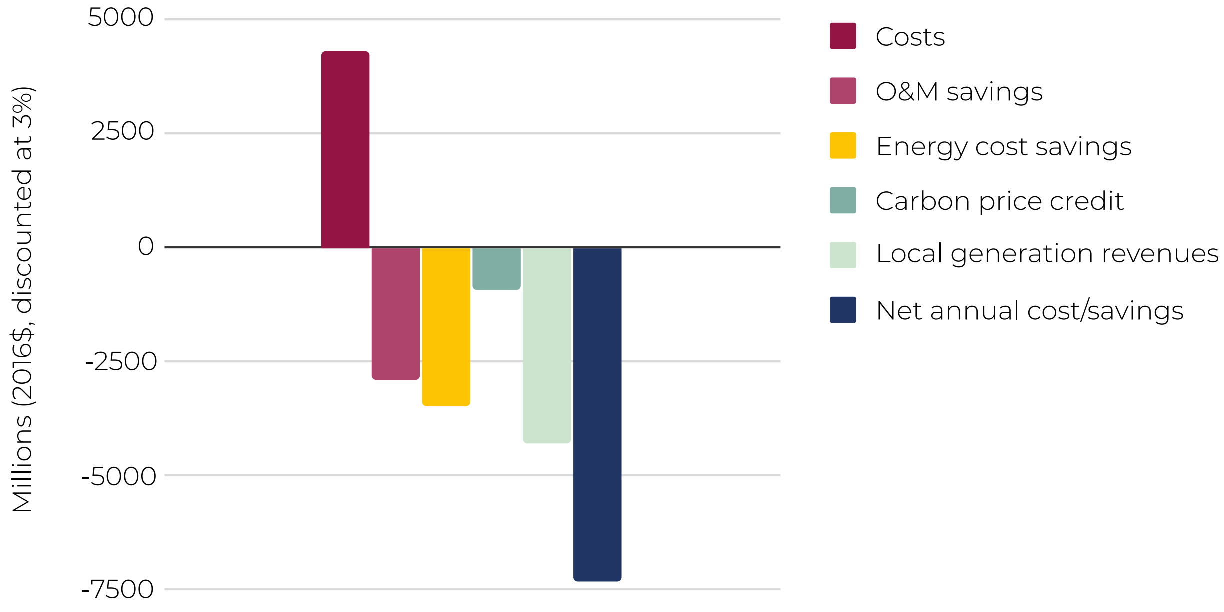


Figure 32. CEEP present value of costs (negative) and savings (positive) of the Climate Emergency scenario over the BAU scenario.

Capital Costs Summary

CEEP Climate Emergency scenario capital annual costs are summarized in Figure 33.

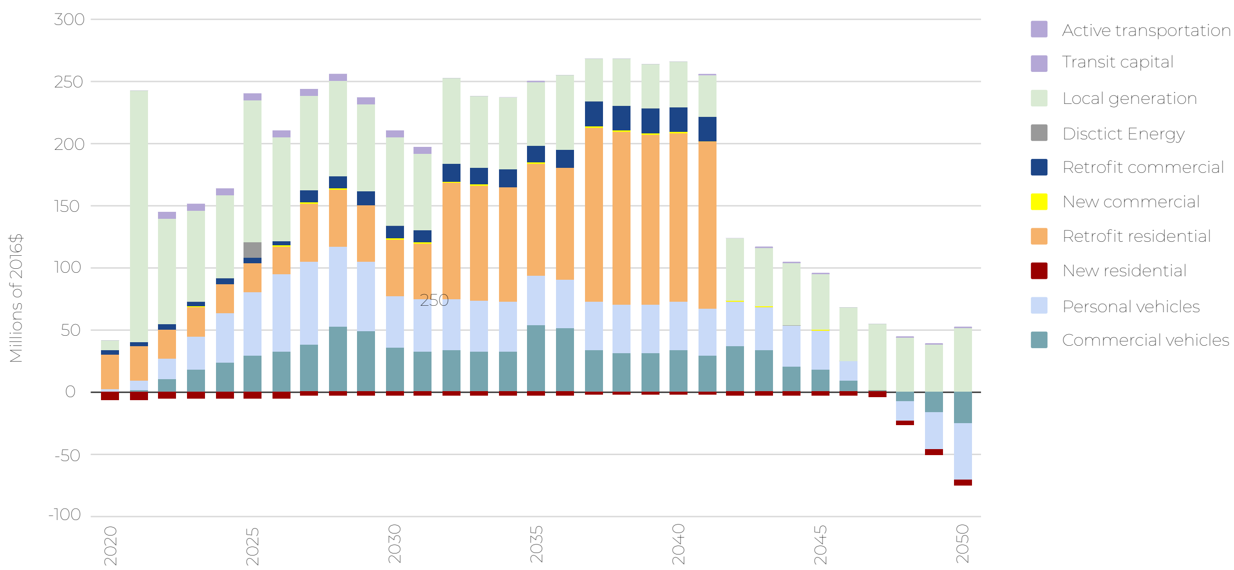


Figure 33. Annual incremental CEEP Climate Emergency scenario capital costs over BAU capital costs.

After peaking in the late 2020s, personal vehicle costs steadily decrease as EV ownership grows, until a crossover point in 2048 when net savings begin. The analysis assumes that the cost of electric vehicles will be lower than internal combustion engines by the middle of 2040, a conservative projection.

Residential and commercial retrofit costs increase over the time period, as more and more buildings are retrofit for energy efficiency. Building retrofits are completed in 2041.

Local solar PV generation investments are strong over the first 10 years of implementation, then steady for the last 20 years as ground mount and rooftop solar PV systems are consistently installed. District energy system expansion occurs in 2025.

Transit electrification costs occur between 2022 and 2032 and active transportation costs (sidewalks, bike lanes, etc.) occur over the whole 30-year period.

Energy Costs

Figure 34 depicts the expected total resident and visitor energy (fuel and electricity) costs for CEEP Climate Emergency scenario implementation versus the BAU scenario.

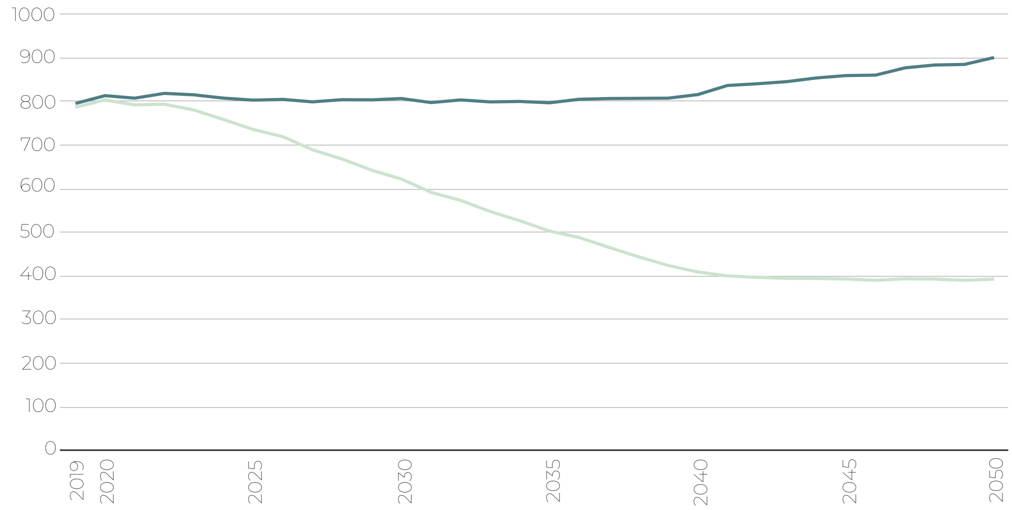


Figure 34. Estimated total annual energy costs for the BAU scenario (blue) and CEEP Climate Emergency scenario (green). CEEP energy costs decrease as solar PV and district energy expansion come online in the 2020s, levelling off in the 2040s when most energy efficiency efforts have been achieved.

In 2016, total energy costs paid by households, businesses, and other organizations totalled $776M. Energy prices are projected to increase to over $900M/year by 2050 in the BAU scenario. Under CEEP implementation, energy costs are reduced to $393M (-49% of 2016 costs).

In the BAU scenario, costs are expected to increase for all types of energy (Figure 35).

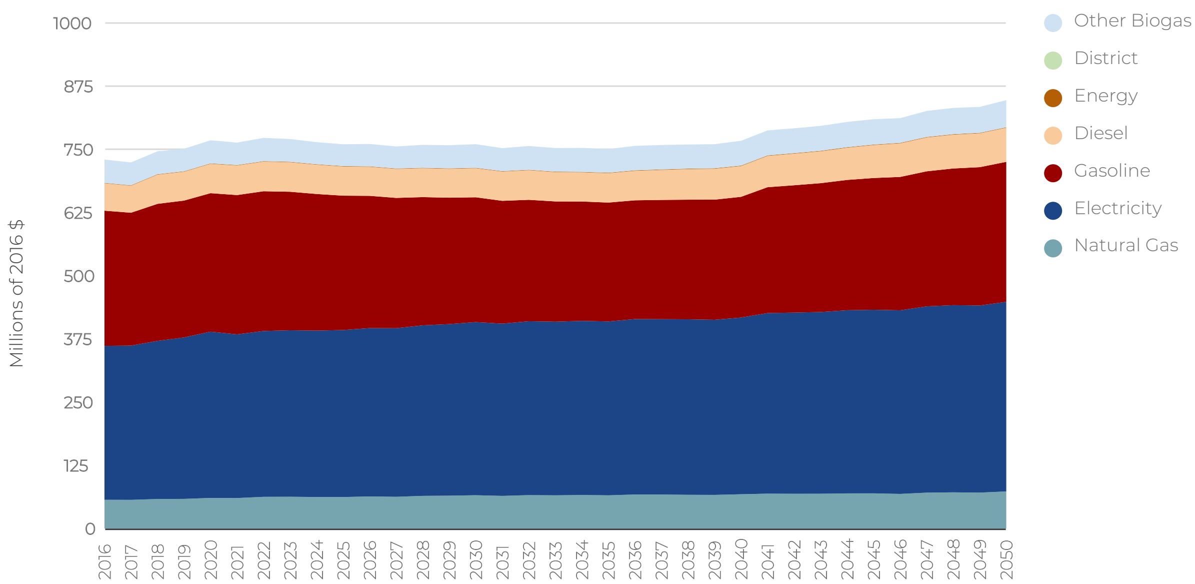


Figure 35. Total BAU annual energy costs by energy source.

Under CEEP implementation, total energy costs are lower than under the BAU scenario and electricity comes to dominate total energy spending as vehicles and building HVAC loads are electrified (Figure 36). Gasoline and diesel spending are all but phased out by the early 2040s. Biogas (renewable natural gas) costs begin in the mid 2020s, increasing to 2050 as RNG procurement increases.

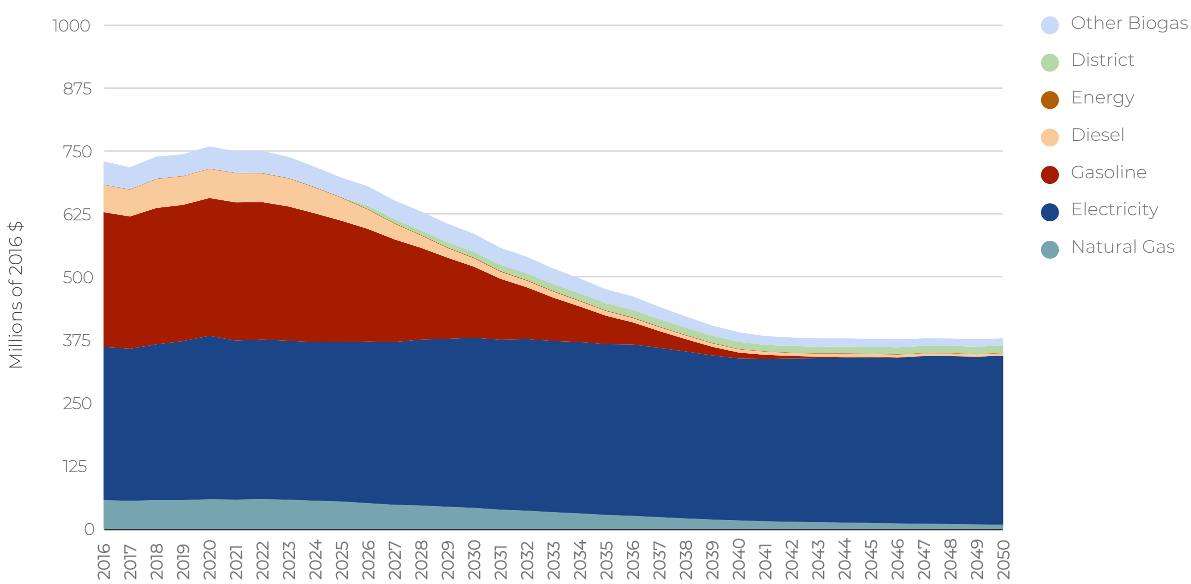
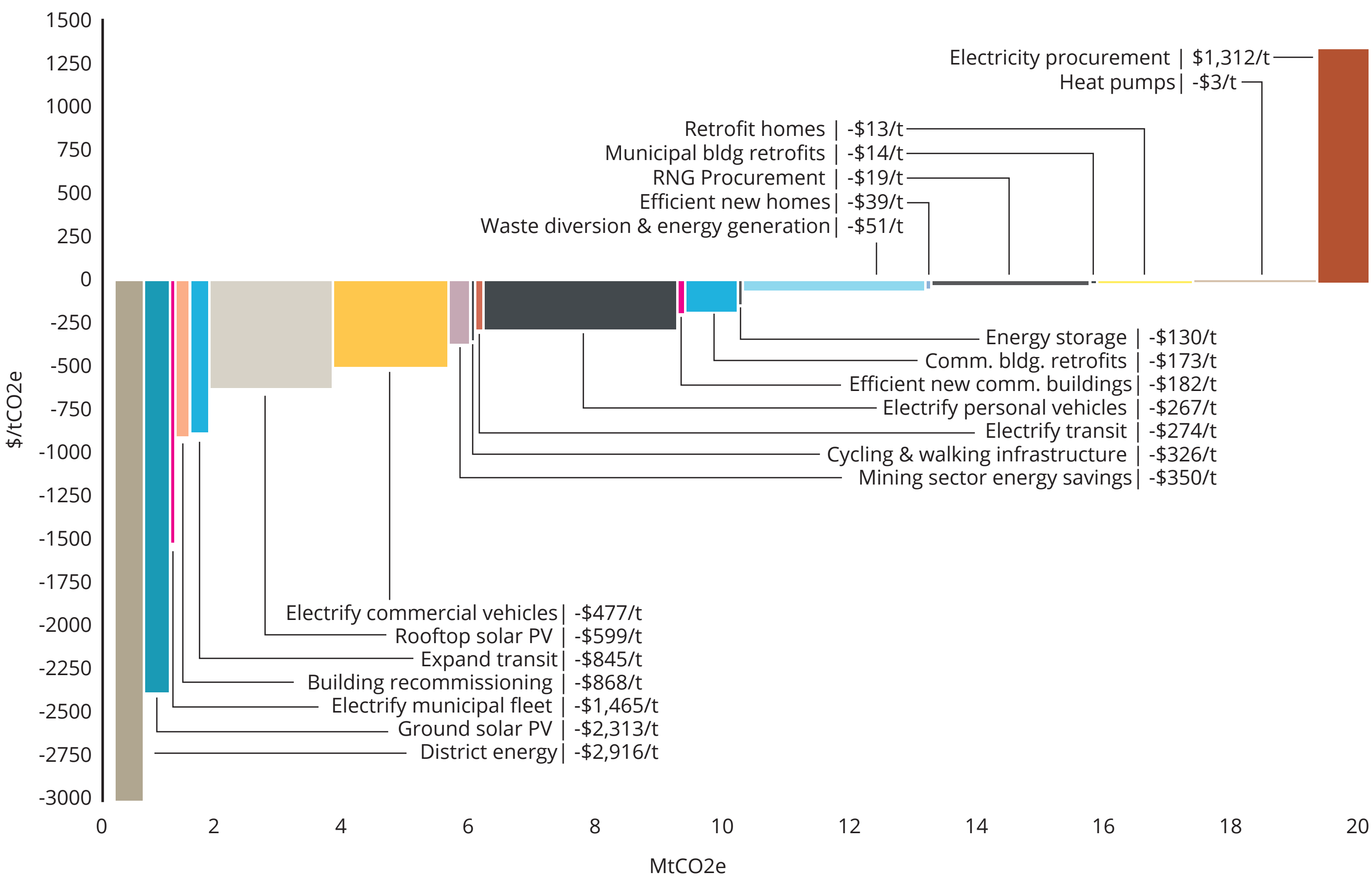


Figure 36. Total CEEP annual energy costs by energy source.

Marginal Abatement Costs

The marginal abatement cost (MAC) graph (Figure 37) provides at-a-glance emissions reductions versus costs/savings for each CEEP action. It is a measure of the cumulative cost or savings of reducing emissions for a particular action over the 2020-2050 time period. The MAC divides the total costs or savings of an action, as represented by the net present value (NPV), by the total emissions reductions associated with that action over its lifetime. The result is a cost or savings per tonne of emissions reduced for each action. An action costs money overall if its cost per tonne of emissions saved is positive. An action saves money if its cost per tonne of emissions saved is negative.



x-axis: tonnes CO2e reduced by the action (wider bars = greater reductions)
y-axis: net financial return or cost of the action (taller bars = greater return/cost)

Figure 37. CEEP marginal abatement cost (MAC) curve, showing the cost/savings per tonne of emissions reduced by action. Horizontal axis: megatonnes CO_2e reduced by the action (wider bars = greater reductions). Vertical axis: net financial cost/savings of the action (taller bars = greater cost/savings). Positive numbers are costs, negative numbers are savings.

The MAC graph shows that Greater Sudbury's CEEP actions all generate savings on the emissions they reduce except for renewable electricity procurement. Some actions have a large negative marginal abatement cost, but their emissions reductions are small relative to other actions, as summarized in Table 5. Other actions have less savings but achieve great emissions reductions, as summarized in Table 6. It is important to remember that the MAC graph presents cost/savings and emissions savings relative to each action. All actions are worth considering as they all reduce emissions.

Table 5. MACs of sample actions with small emissions reductions relative to other actions.

ACTION	MARGINAL ABATEMENT COST	EXPLANATION
Electrify municipal fleet	-$1,465	The total emissions saved by electrifying the municipal fleet is small as the municipal fleet itself is small and does not produce many emissions. The cost of reducing fleet emissions by replacing vehicles with electric versions is low, whereas the fuel cost and operations and maintenance savings are high, yielding a large negative MAC. There is a large savings for every tonne of emissions reduced from municipal fleet operations.
Cycling and walking infrastructure	-$326	The travel mode shift from personal vehicle trips to cycling and walking trips does not result in large emissions reductions compared to some other actions. However, providing walking and cycling infrastructure saves $326 per tonne of transportation-related emissions reduced through avoided fuel and vehicle costs.
Electrifying transit	-$274	Electrifying the bus fleet saves relatively few emissions as the fleet is small and doesn't contribute much to the community's overall emissions. $274 is saved per tonne of emissions reduced as electric buses use less energy (i.e. reduced fuel costs) and require less operation and maintenance costs than fossil fuel powered buses.

ACTION	MARGINAL ABATEMENT COST	EXPLANATION
Efficient new commercial buildings	-$182	As new commercial building floorspace is small over the next 30 years, efficient new commercial buildings have a small emissions reduction impact compared to other actions. The $182 saved per tonne of emissions reduced in commercial buildings is a result of energy cost savings.
Efficient new homes	-$39	The small anticipated population growth over the next 30 years is accompanied by limited housing growth. Thus, efficient new homes have a small emissions reduction impact compared to other actions. $39 is saved for every tonne of emissions reduced by energy efficient new homes due to lower energy costs.

Some of these actions represent low cost quick wins. Electrifying the municipal fleet and transit can be done quickly at relatively low cost, with few barriers in doing so. Ensuring new buildings are energy efficient requires the implementation of low-cost policy tools.

Table 6. MACs of sample actions with large emissions reductions relative to other actions.

ACTION	MARGINAL ABATEMENT COST	EXPLANATION
Electrify commercial vehicles	-$477	Commercial vehicles account for large emissions production in Greater Sudbury. Electrifying them results in greatly reduced fuel and operation and maintenance costs, resulting in large emissions reductions and a large negative MAC. $477 is saved in fuel and operations and maintenance costs for every tonne of commercial vehicle emissions reduced.

ACTION	MARGINAL ABATEMENT COST	EXPLANATION
Electrify personal vehicles	-$267	Personal vehicles are responsible for a large portion of emissions production. Personal vehicle electrification saves the most emissions of any action while saving on fuel and operation and maintenance costs, saving $267 for every tonne of emissions reduced.
Waste diversion & energy generation	-$51	Sending less waste to landfills and expanding the capture of methane from landfills for use as renewable natural gas (RNG) reduces emissions substantially. The RNG displaces natural gas use, saving $51 per tonne of emissions reduced.
RNG procurement	-$19	Replacing natural gas use with RNG has a large emissions reduction. Although there is a premium assumed on the cost of RNG versus natural gas, the MAC is negative due to considerations like production costs and social cost of carbon.
Retrofit homes	-$13	Retrofitting the existing housing stock for improved energy efficiency achieves large emissions reductions. Reduced energy costs contribute to achieving a negative MAC despite retrofit costs.

The sample actions in Table 6 are all relatively high cost and have high emissions reduction potential. They are typically implemented over the long term (except for RNG procurement) and they all result in savings per tonne of emissions reduced. By providing the cost/savings per tonne of emissions reduced for each CEEP action, the MAC analysis provides another tool in CEEP action decision-making.

CEEP Employment

CEEP capital expenditures result in increased employment. Employment factors for each sector were used to translate each million dollars of activity resultant from CEEP actions into full-time equivalent jobs (Figure 38). The CEEP is estimated to generate 40,000 person years of employment between 2020 and 2050 – an average of 1300 annually – compared to the BAU scenario. Many jobs are in the energy sector, with solar PV, DE systems, and heat pumps to install. Many others are related to building retrofits, lasting two decades until the vast majority of the building stock is retrofit by 2042. Some automotive repair jobs are lost (2048-2050) as the requirement for maintenance of vehicles is expected to decline. Residential building jobs are slightly fewer under CEEP implementation than in the BAU as fewer single-family homes will be built and dwellings will be smaller on average. These construction jobs are picked up by the renewable energy sector, as new and existing buildings have solar PV systems installed.

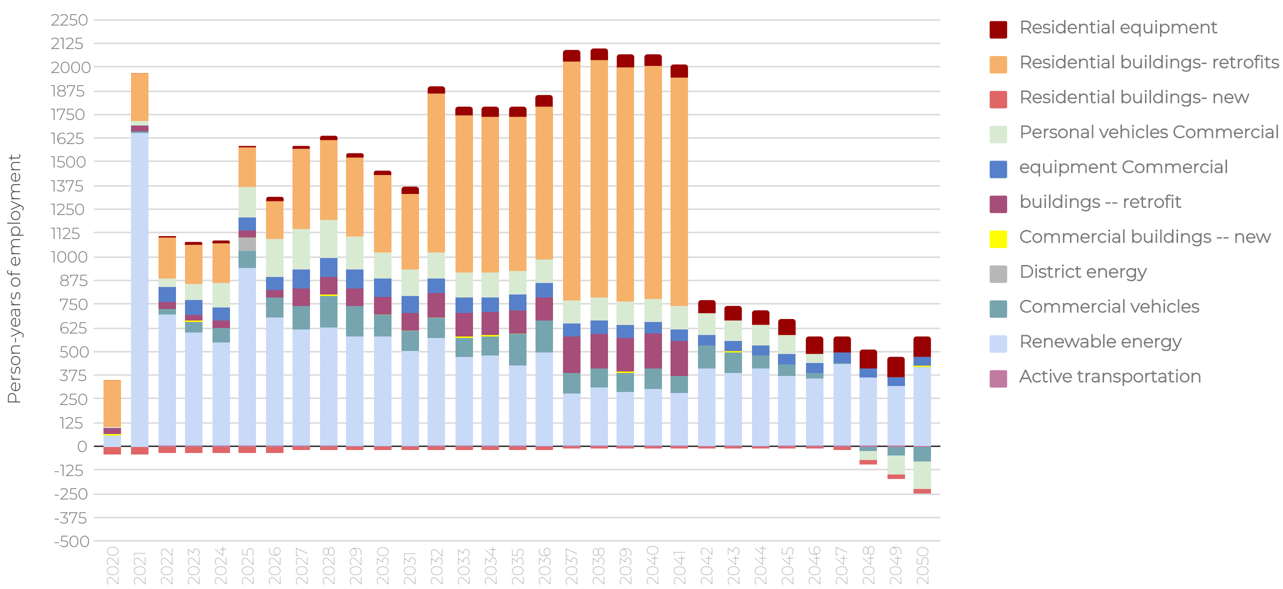


Figure 38. Employment generated by CEEP implementation.

Financial Analysis Summary

The high-level financial analysis reveals that CEEP implementation requires major upfront investments by the City, public and non-profit institutions, residents, and the private sector. However, energy savings, operations and maintenance savings, and avoided carbon taxes far outweigh the costs, and will therefore create significant economic value for the community over the long-term. Costs incurred on high emitting fuels and activities decline as the CEEP actions are implemented. Energy costs decrease overall and go increasingly toward clean, renewable energy sources. Almost all CEEP actions save money while reducing emissions and create substantial new employment opportunities.

Part 5: Recommendations and Next Steps

The energy and emissions analysis presented in the CEEP demonstrates what is needed to achieve a net-zero emissions target by 2050. The recommendations presented here reflect this. Through strong policy and action, Greater Sudbury can reduce its energy use and emissions production substantially over the next 30 years, responding to the direction set by the climate emergency declaration. The analysis shows that there are major areas of focus to achieve the bulk of the energy and emissions reductions, but also that many efforts must be made across all sectors to achieve a net-zero emissions target by 2050.

The CEEP's major action recommendations are grouped into their strategy sectors below. Goals, primary actions, and brief discussion on action implementation are indicated for each strategy sector. The implementation timing is also noted for each action:

- Near-term: implementation complete in fewer than 5 years;
- Medium-term: implementation complete in 5 to 10 years; and
- Long-term: implementation complete in 10-15 years or ongoing.

More action considerations are detailed in the CEEP Implementation Framework (Appendices). For each action sector the Framework considers:

- Base assumptions
- Implementation schedule
- Target audience(s)
- Existing policy/strategy/workplan considerations
- Potential partners
- Estimated human resources (not necessarily limited to City staff) and other resources required (besides funding)
- Estimated implementation budget (not limited to City funding)
- Potential implementation challenges
- Next steps
- Key performance indicators (KPIs) and reporting frequency

Recognizing that a City and its divisions are an intricate arrangement of policy and strategy application, the Implementation Framework provides some initial direction for CEEP implementation, which can be supplemented with additional and more precise information from each division. Its elements can be integrated into other plans and strategic documents as needed. They can also be updated, indicating the next steps in each policy's and action's trajectory as CEEP implementation proceeds.

Compact, Complete Communities Actions

Goal 1: Achieve energy efficiency and emissions reductions by creating compact, complete communities through infill developments, decreasing dwelling size through an increase in multi-family buildings, and increasing building type mix.

Primary Action: Coordinate land-use development through the Executive Leadership Team, Growth and Infrastructure Department, and Transit Services Division to direct land-use development in achieving compact, complete communities.

The direction given in the current Official Plan (OP) is strong in its support of infill development and compact land-use planning. Following this direction and strengthening it with energy, emissions, and climate goals will achieve energy and emissions reductions at very low cost. City land-use, development, and transportation plans and strategies that work with or in parallel to the OP should be updated as well to reflect the importance of the climate emergency declaration, ensuring that all City planning efforts are coordinated to foster low-carbon land-uses resulting in compact, complete communities. These efforts should include:

- A focus on infill development in core areas and scaling back urban settlement area development;
- Increasing minimum housing densities;
- Transportation oriented development approaches to coordinate transit and active transportation options with development densities;
- A focus on mixed-use and multi-family buildings to increase building energy efficiency and provide population density to support neighbourhood services and amenities;
- Green space and urban forestry requirements for community spaces that have carbon sequestration capacity.

The Official Plan includes energy and emissions considerations in its Transportation, Utilities, and Energy Efficiency sections, but energy, emissions and climate considerations are not central to its content. Amendments to the OP and related land-use plans could be quick wins in the near-term.

Efficient Buildings Actions

Goal 2: Periodically increase the energy efficiency of new buildings until all new buildings in 2030 onward are Passive House energy efficiency compliant.

Primary Action: Develop a Greater Sudbury Green Standard and rezoning energy efficiency requirements.

The Green Standard would be a tiered set of performance measures implemented through the development approval process. This standard can be based on the Toronto Green Standard or the BC Step Code. The Standard would outline incremental energy efficiency performance between the current provincial Building Code and Passive House energy performance standards.

Rezoning requirements can be invoked under the Provincial Planning Act through bylaw. Rezoning applications would trigger energy efficiency requirements determined by the City for proposed buildings. The efficiency requirements could be aligned with the Green Standard.

Although municipalities do not have specific powers under the Provincial Building Code to require higher energy efficiency in new buildings not requesting land-use rezoning, the Green Standard can be implemented as a voluntary option that would encourage developers and builders to build to improved energy standards. This could involve development processing incentives that encourage demonstration of improved energy performance of proposed developments. The Standard could be coupled with a local improvement charge (LIC) program designed with local utilities to provide additional upfront capital for improved building energy performance construction and energy generation systems. Under the LIC, energy related building costs could be paid back over a 10–20-year period at a rate aligned with avoided energy costs.

Using templates from other jurisdictions, the Greater Sudbury Green Standard and rezoning bylaws updates should be a near-term action to implement.

Goal 3: The existing building stock is retrofit for 50% increased energy efficiency by 2040 and large buildings are routinely recommissioned.

Primary Action: Develop a deep energy efficiency retrofits program.

A strong program focused on energy efficiency retrofits could involve partnerships with Provincial and Federal governments, utilities, industry, and higher education, with the City as the lead program manager and deliverer. The program would be accessible to anyone wanting to upgrade the energy efficiency of their building, and would also actively target groups of buildings, such as neighbourhoods and specific sectors (e.g. restaurants, grocery stores, offices, etc.). Renewable energy system installations (e.g. solar, district energy, heat pumps, etc.) would be included in the program. Retrofit funding could be offered through local improvement charges (LICs) and property-assessed clean energy (PACE) programs. The retrofit program would include incentives to building owners and minimum requirements for building energy efficiency performance. A promotional and educational campaign would accompany the program. The City already has a good track record of housing retrofits through the Social Housing Energy Retrofits and Social Housing Apartment Improvement programs that have been performed over the years. These programs should be continued and supplemented.

The retrofit program is a medium-term action that starts in the near-term.

Goal 4: Achieve net-zero emissions in City buildings by 2040.

Primary Action: Develop a prioritized list of City buildings to retrofit and perform energy audits, payback analyzes, and retrofits starting with the highest priority buildings.

Through retrofitting its own building stock for enhanced energy efficiency, the City will show leadership to homeowners and ICI building owners and operators. The lessons learned through City building retrofit processes will be transferable to retrofit efforts in other sectors.

Municipal building retrofits can start in the near-term and will be a medium-term endeavour.

Water, Wastewater, and Solid Waste Actions

Goal 5: Decrease energy use in the potable water treatment and distribution system by up to 60% by 2050.

Primary Actions:

- Continue with water treatment and distribution system upgrades through pump replacements with more energy efficient models.
- Decrease potable water use by 45% community-wide by 2050 through incentive and education programs.

The Water/Wastewater Services Division has pilot pump replacement projects underway and are monitoring the performance of new, more energy efficient pumps. A pump replacement plan is under development and Advanced Metering Infrastructure is being installed.

Water conservation education and awareness programming is already present in Greater Sudbury through municipal programs. Expanding these programs and offering a water efficient fixtures replacement incentive program would encourage homeowners and businesses to conserve water. These actions are being implemented over the long-term.

Goal 6: Achieve 90% solid waste diversion by 2050. An organics and biosolids anaerobic digestion facility is operational by 2030.

Primary Actions:

- Continue to implement and update the services and direction of the Waste Diversion Plan to incrementally improve solid waste diversion each year until the 90% target is reached or exceeded.
- Work with community partners to deliver consumption, conservation, and waste reduction education and awareness programs.
- Perform an updated anaerobic digestion facility study including options for producing electricity and RNG from its outputs.

Solid waste collection and treatment is a multi-faceted sector with overlapping governmental jurisdictions and service considerations. Direction from the Province governs some of what can be achieved with solid waste diversion. The City can choose to exceed direction from the Province for certain elements of its solid waste programming to increase solid waste diversion. Education and awareness programs employing demonstration projects and social media have proven effective in other jurisdictions; similar programs could be employed in Greater Sudbury. These actions can be implemented in the near-term and will endure over the long-term.

Although anaerobic digesters may not currently be feasible for Greater Sudbury, the technology is developing rapidly and costs will continue to decrease. Anaerobic digesters could be installed at wastewater treatment plants where organic waste delivery could be mixed with biosolids for treatment. The gas captured from the facility could be used to create electricity (similar to the existing landfill electricity generation facility) or as RNG in natural gas lines. This is a near to medium-term action.

Low-carbon Transportation Actions

Goal 7: Enhance transit service to increase transit mode share to 25% by 2050.

Primary Actions:

- Update the Transit Action Plan and Transportation Master Plan periodically with increasingly ambitious transit mode share targets.
- Enhance transit service through expanded routes and frequency, as possible.
- Right-size the transit fleet with smaller vehicles serving short and/or low passenger count routes.
- Develop an employer and institution transit incentive program that can be offered to employees and students to encourage transit use.

The recent Transit Master Plan update makes service and route improvements and some institutional bus pass programs are in effect during the school year. Enhancing these elements and supplementing them with other efforts will be critical to increasing ridership in years to come. Transit and transportation have many facets to consider. Coordinated efforts across City sectors are required to connect transportation, land-use, housing, and other city planning efforts to improve ridership.

Transit services are continuously being refined. These actions can be implemented in the near-term and refined over the long-term.

Goal 8: Achieve 35% active mobility transportation mode share by 2050.

Primary Actions:

- Continue to implement the Cycling and Pedestrian Master Plan (part of the Transportation Master Plan), developing the recommended cycling and walking infrastructure and networks.
- Dedicate and deploy annual capital budget to new active transportation infrastructure that makes significant progress toward implementing the full Cycling and Pedestrian Master Plan.
- Coordinate with community partners to deliver education and awareness programs about the economic and health benefits of active transportation.

Implementation of the City's Cycling and Pedestrian Master Plan is a critical component of increasing city-wide active transportation. Annual investments in, and realization of, new infrastructure are good metrics of plan implementation progress. Delivering education and awareness programs with community partners is an important component of creating the behaviour shift to choose making trips by active transportation, especially in winter months.
Active transportation improvements should be made each year. These actions are near-term with continued implementation over the long-term.

Goal 9: Electrify 100% of transit and City fleet by 2035.

Primary Action: Replace transit and city fleet vehicles with electric versions.
The rapid increase in electric vehicle model availability and continuing decrease in pricing greatly facilitates City fleet and transit vehicle replacement. Fleet replacement can occur through the dedication of annual capital budget. The City can also require its contractors to use electric vehicles through the contracting process and agreements. This action can be a near-term quick win for the City.

Goal 10: 100% of new vehicle sales are electric by 2030.

Primary Actions:

- Implement the recommendations of the Electric Vehicle Study, including:
- Updating building development applications, building permits, rezoning and retrofitting policies;
- Including EV infrastructure data in building records;
- Updating relevant city plans;
- Updating the licensing, regulating and governing of vehicles for hire;
- Coordinating and promoting EV subsidies, purchase incentives, and bulk purchases;
- Coordinating and delivering various sector-specific education and awareness campaigns; and
- Installing charging infrastructure.

The electric vehicle market is evolving quickly. However, EV sales remain only a small fraction of overall car sales. Accelerating EV uptake through the recommendations of the Electric Vehicle Study will help address the high energy use and emissions output of Greater Sudbury's transportation sector over a shortened timespan. Most actions in the Electric Vehicle Study can be started in the near-term and continued over the long-term.

Industrial Efficiency Actions

Goal 11: Increase industrial energy efficiency by 35% by 2040.

Primary Action: Create an industry energy efficiency working group composed of industry stakeholders that meets quarterly to discuss energy efficiency progress. Vehicle electrification and process equipment upgrades are saving money in industrial applications. Many industrial outfits in Greater Sudbury are already refining their activities with lower emissions vehicles and equipment. The working group would serve to disseminate knowledge of the latest technologies and industrial energy efficiency improvement approaches and discuss plans, action implementation, lessons learned, and timelines. This group can be formed in the near-term.

Local Clean Energy Generation Actions

Goal 12: Establish a renewable energy cooperative (REC) to advance solar energy systems and other renewable energy efforts of the CEEP.

Developing Greater Sudbury's new energy infrastructure and programs is a substantial amount of work. A renewable energy cooperative (or similar organization) will be essential to providing the capacity to do so. Its members can include staff, the City, utilities, businesses, institutions, and citizens. The REC's initial staff can consist of local experts and/or be formed from a community group already knowledgeable in the renewable energy field.

This is an organization effort that can be implemented in the near-term.

Goal 13: Install 10 MW of ground mount solar PV each year, starting in 2022.

Primary Actions:

- Assess land availability for solar farms and prioritize properties on which to install solar energy systems with input from stakeholders and the public. Use the Capreol solar array as a template for installation.
- Secure contracts with solar PV providers to achieve bulk purchase discounts on solar PV arrays.

The Capreol solar array is a precedent worth repeating in Greater Sudbury. With lessons learned from this project, future projects should be more efficient to realize. The renewable energy cooperative is a new entity whose mandate can include:

- Provision of renewable energy projects;

- Coordination of community investment opportunities in renewable energy projects;
- Developing local renewable energy expertise;
- Stimulating the local economy;
- Providing energy security and resilience; and
- Delivering education and awareness programs.

To be on target for the first 10 MW solar energy installation in 2022, these actions start in the near-term and be sustained over the long-term.

Goal 14: Install net metered solar photovoltaic (PV) systems on 90% of new buildings and 80% of existing buildings, supplying 50% of their electric load.

Primary Actions:

- Include this action as part of the approach of Goal 2;
- Deliver developer and builder information and training sessions through the REC;
- Coordinate homeowner outreach and incentive programs through the REC;
- Coordinate ICI outreach and incentive programs through the REC;
- Arrange bulk solar PV system purchasing; and
- Coordinate with electrical utilities on new metering programming.

New building solar PV systems can be mandatory under the new Green Standard and rezoning practices. The REC can help train developers and builders in the installation of solar PV systems while coordinating outreach and incentive programs to expedite the installation of systems on existing buildings. Installations on existing buildings will constitute a substantial effort but can be coordinated with the deep energy efficiency retrofits goal (Goal 3). New building solar PV installations can start in the near-term. Retrofitting buildings with solar PV systems can start in the near-term and will occur over the long-term.

Goal 15: Expand the downtown district energy system to 23 MW capacity.

Primary Action: Conduct a system expansion feasibility study that identifies priority buildings to connect to the system, determines system requirements, and demonstrates the business case.

The current downtown district energy system can be expanded to provide energy efficient heat to additional buildings. Discussions with current owners/operators and a feasibility study will determine the viability, timeline, and cost/payback of expansion. The expansion feasibility study can be performed in the near-term. The expansion itself will likely occur in the medium-term.

Goal 16: Install 50 MW of renewable energy storage.

Primary Actions

- Engage local utilities in exercises to determine the best approach to energy storage provision and ownership;
- If deemed necessary, perform a feasibility study on energy storage options; and
- Incrementally install renewable energy storage in concert with new renewable energy systems.

Mornings and evenings are when electricity grid demand peaks. Energy storage (likely in the form of batteries) could store energy from Greater Sudbury's new renewable energy installations for release during these peak times. This decreases demand from other grid generation sources, using renewable energy instead. Discussions and studies can begin in the near-term. The first storage projects can accompany renewable energy installations and will endure over the long-term.

Low-carbon Energy Procurement Actions

Goal 17: Procure 100% of community-wide grid electricity and 75% of natural gas demand from renewable sources by 2050.

Primary Actions:

- Engage subject matter experts to complete a preliminary study evaluating procurement options, including:
- Public-private partnerships (City, major property owners, large institutions) that sign long-term power purchase agreements with renewable energy developers; and
- Establishing a local (municipal) electricity retailer, allowing the City to purchase renewable electricity for all local customers that sign on.
- Following initial study, establish a stakeholder working group to identify/evaluate procurement options, opportunities, and obstacles.

Community Choice Aggregation is a community energy purchasing framework used in several jurisdictions in the United States. It allows municipalities to aggregate the buying power of customers to procure large amounts of renewable energy through contracts with suppliers. The municipality can choose the energy generation source and may be able to offer rates lower than those available to individual customers. In some jurisdictions in the United States, this arrangement employs an opt-out model wherein all customers are part of the aggregated energy purchasing system by default but can opt out if desired.

75% RNG procurement is an ambitious goal and will rely on availability, which will likely increase over the next 30 years. This action is scalable, as discussed in Part 6. Studies can occur in the near-term while setting up the procurement system would likely take place in the medium-term.

Carbon Sequestration Actions

Goal 18: Increase the reforestation effort of the Regreening Program.

Primary Action: Increase the resources available to the Regreening Program for its reforestation efforts through capital budget assignment and coordination with businesses, institutions, and community groups.

Greater Sudbury's Regreening Program is a renowned success. Increasing its capacity will help sequester more carbon and engage the community in environmental protection and restoration efforts. This action is scalable, as discussed in Part 6.

This action can be scaled up in the near-term through the Regreening program.

Part 6: Discussion

The CEEP's 18 goals and their associated actions form a low-carbon pathway to achieving net-zero community-wide emissions by 2050. Major energy efficiency, energy generation, and vehicle electrification actions will achieve the majority of emissions reductions. A variety of smaller actions will be critical for achieving the net-zero emissions target.

The actions reduce 93% of 2016 emissions levels by 2050 – 100,000 tCO_2e of annual emissions is projected to remain in that year. This is equivalent to the annual emissions of about 3,100 cars or the energy use of about 2,400 Canadian homes.[11] Figure 14 in Part 3 of this report identifies the residential and industrial sectors as responsible for 70% of the remaining emissions. The natural gas, fuel oil, propane, and diesel remaining in use in these sectors in 2050 are responsible for 82% of the remaining emissions. Waste is responsible for 10%. Fugitive emissions are responsible for the remaining 8%.

Eliminating the remaining 100,000 tCO_2e of annual emissions in 2050 would require completely phasing out fossil fuels and capturing all landfill emissions. This would involve a combination of the following approaches:

- Increasing RNG use from the current goal of 75% natural gas replacement to 100% replacement, including in district energy systems;
- Operating all industrial activities on biofuels or renewable electricity;
- Expanding gas capture to all landfill operations; and
- Carbon sequestration.

The 24,811 hectares of replanted area through the Regreening program provides 25,000 tCO_2e of sequestration per year. Quadrupling this amount would achieve an additional 75,000 tCO_2e of annual emissions reductions (100,000 tCO_2e total). This would require reforesting an additional ~75,000 hectares, an area equivalent to almost one quarter the land area of Greater Sudbury. Thus, it is unlikely the entirety of a tree planting effort like this could occur within the City boundary, especially with some land-use competition from new renewable energy projects. If this action were pursued, land outside the City could be considered for afforestation, in agreement with neighbouring jurisdictions, and perhaps on Crown lands. While new forests are planted, existing forests would also have to be maintained, replacing dying trees to maintain the forests' carbon sequestration capacity.

11 As calculated by NRCAN's Greenhouse Gas Equivalency Calculator: http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/calculator/ghg-calculator.cfm

Conclusions

Greater Sudbury's climate emergency declaration sets a strong direction for the City and community to mitigate GHG emissions. Its actions are supported by energy and emissions modelling indicating that their implementation will successfully reduce emissions by 93% of 2016 levels by 2050. By scaling up renewable energy procurement, energy generation actions, and/or afforestation efforts to achieve increased carbon sequestration, the climate emergency declaration goal of net-zero emissions by 2050 can be met.

Financial analysis of CEEP strategies presents a compelling case for action, with $7.33B in net present value cost savings over the next 30 years. CEEP implementation will require sustained leadership and investment, with $4.29B (net present value) required over the next 30 years from the City, businesses, institutions, and homeowners. The investment will foster a new local economy of renewable energy and construction goods and jobs, with 40,000 person years of employment added to the community.

The CEEP's implementation will rely on City political and staff leadership. It will also rely on industry stakeholders participating in working groups, educational institutions contributing research and development efforts, community groups contributing expertise and passion, and partnerships with First Nations. The new Renewable Energy Cooperative is an exciting mechanism for professional training, public education, and implementation of renewable energy projects. As the City's climate change adaptation efforts progress, mitigation and adaptation efforts can be integrated to holistically address climate impacts across the region.

The CEEP is a pathway to a low-carbon future for Greater Sudbury following the paradigm of Reduce-Improve-Switch. The 2050 net-zero emissions target is ambitious but achievable under this paradigm. The leadership of City council in declaring a climate emergency in response to the climate change concerns expressed by citizens is consistent with the shift among municipalities worldwide to take bold action to reduce emissions while creating resilient, high quality of life, and prosperous communities. The Community Energy and Emissions Plan aligns Greater Sudbury's efforts with those of hundreds of other municipalities across the globe taking action for a better future.

Appendices

1. Implementation Framework
2. Electric Vehicle Study
3. Public Engagement Summary

Appendix 1
Greater Sudbury
CEEP Implementation Framework

Summary and Overview

The Implementation Framework is the starting point for CEEP actions. It is designed to generate momentum on each action, providing reference checklists for starting implementation processes. As circumstances evolve (e.g. community champions are identified, funding becomes available, technologies change) the Implementation Framework can be updated to reflect new direction and opportunity. The Framework is presented in summary table form. It follows the template below.

Consideration	Notes
Assumptions	The circumstances and assumptions forming the basis of the action.
Schedule	The timing of action implementation.
Audience(s)	The direct and indirect audiences the action affects or engages.
Reporting Medium	The means by which progress and evaluation of the action are reported.
In which existing policies/ strategies/workplans can this action be embedded?	The City policies and administrative practices and processes to which the action is related and/or governed.
Partners	The entities with which to partner in this process and the approvals required prior to implementing and reporting.
Resources required (besides funding)	The technical and human resources (not necessarily City staff) required to support the action.
Budget	The estimated funding required to undertake the action, which can be provided by a variety of sources (i.e. all costs are not borne by the City). ***This is a high-level estimate that may change with further study and action refinement.***
Challenges	The key challenges that need to be overcome for the action to be successful.
Next steps	The practical steps needed to implement the action.
Key Performance Indicators (KPIs) Reporting frequency:	The metrics to be tracked and reported in order to determine the success of the action. The reporting frequency is annual unless otherwise stated.

Compact, Complete Communities Actions

Goal 1: Achieve energy efficiency and emissions reductions by creating compact, complete communities through infill developments, decreasing dwelling size through an increase in multi-family buildings, and increasing building type mix.

Timing: Near-term.

Consideration	Notes
Assumptions	- The City can use land-use by-laws and development permitting (Community Planning Permits) to create complete, compact communities that are energy efficient, require shorter trips that can be made by active transportation and transit, and create positive health and community outcomes
Schedule	- Ongoing
Audience(s)	- Residents - Businesses - Development community
In which existing policies/ strategies/workplans can this action be embedded?	- Official Plan - Transportation Action Plan - Transit Action Plan - Zoning by-laws - Development permitting processes
Partners	- Development community - Real estate community - Resident and business organizations
Resources required (besides funding)	- Staff time to coordinate with partners - Staff time to perform public engagement during planning and development processes - Staff time to update policies and regulatory frameworks
Budget	- $150,000/year. Budget needed for new planning tools and processes design, and to update existing planning tools and processes.
Challenges	- Implementing design guidelines to ensure multi-family and mixed-use buildings are designed to human scale and have community benefits. - Updating by-laws to enforce development area restrictions. - Changing public preferences for single family housing. - Current expansive, low density layout of the city. - Large supply of developable land. - Lack of minimum housing and population densities.
Next steps	- Review Official Plan and land-use by-laws to determine if updates are needed to focus development in infill and transit-served areas. - Scale back urban settlement area development. - Increase minimum housing densities. - Establish priority development areas and development-restricted areas. Update zoning to allow for appropriate residential densities. - Continue to align transportation policy, the Official Plan, and land-use by-laws.

	- Establish partnerships with development and real estate community to discuss direction of future growth. - Apply energy efficiency and climate change criteria to new development considerations.
KPIs Reporting frequency: annual	- Housing starts - Dwellings per hectare - Floor space ratio - New building type ratios - Percent of agricultural land preserved - Amount of growth occurring in settlement areas - Amount of growth occurring in built boundary

Efficient Buildings Actions

Goal 2: Periodically increase the energy efficiency of new buildings until all new buildings in 2030 onward are Passive House energy efficiency compliant.

Timing: Near-term.

Consideration	Notes
Assumptions	- The City can update its development processes to achieve high energy efficiency in new buildings.
Schedule	- All new buildings are Passive House compliant starting in 2030.
Audience(s)	- Entire community - Homeowners - Commercial property owners and developers - Real estate community
In which existing policies/ strategies/workplans can this action be embedded?	- Development application processes - Zoning by-laws
Partners	- Development community - Trades - Construction training program providers - Cities that have similar goals and have taken preliminary steps - Passive House Institute Canada
Resources required (besides funding)	- Staff time to update by-laws and development processes - Staff time to coordinate with partners - Communications staff time to promote program
Estimated Budget	- $150,000/year. Budget will be needed for additional building inspection requirements.
Challenges	- Facilitating uptake of a step code with the development community. - Enforcement policies. - Lack of ability to supplement the provincial Building Code. - Resistance from new building owners based on lack of knowledge of building construction approaches, energy efficiency, and upfront capital costs versus paybacks. - The short timeline during which to implement the changes.
Next steps	- Consult with cities that have implemented building energy efficiency step codes and green standards to see if their template can be applied in Sudbury. The step code or standard would increase new building energy efficiency every two-three years over the next decade until Passive House level energy efficiencies are attained. - Update development planning policies with a new Greater Sudbury Green Standard (step code and Passive House energy efficiency requirements). - Develop an engagement program for discussion with and education of the local construction and development community. Work with the community to facilitate a smooth transition to new building standards and practices.

	- Update engineering staff and building inspector skillsets with step code and Passive House knowledge through programs offered by the building organizations and networks, and Passive House Canada. - Join intermunicipal lobbying efforts to improve energy efficiency requirements in the provincial Building Code.
KPIs Reporting frequency: annual	- Building starts - Building energy performance - Instances of building standard certification (e.g. Passive House)

Goal 3: The existing building stock is retrofit for 50% increased energy efficiency by 2040 and large buildings are routinely recommissioned.

Timing: Near-term.

Consideration	Notes
Assumptions	- 50% thermal savings and 50% electrical savings can be achieved in 100% of existing buildings - All buildings over 200,000 ft^2 and 40% of buildings over 25,000 ft^2 are recommissioned every 10 years for 10% energy savings - Heat pumps are typically >300% more efficient than electric baseboard heating and their installation is straigtforward. - 100% of homes and 75% of commercial buildings can be retrofit with heat pumps to increase heating energy efficiency in buildings - 70% and 30% of homes have air source and geothermal heat pumps installed, respectively. 75% of space heating and 100% of space cooling is electric in commercial buildings.
Schedule	- Retrofitting program starts as soon as possible, and all building stock is retrofit by 2040 - All heat pump installations are complete by 2050
Audience(s)	- Homeowners - Commercial property owners - Landlords
In which existing policies/ strategies/workplans can this action be embedded?	- Strategic Plans - Land use by-law - Design guidelines
Partners	- Homeowners - Developers & industry associations - Small contractors and tradespeople - Real Estate Board - Provincial and federal government departments - Local colleges - Green building organizations like Passive House Institute Canada - Hydro One First Nations Conservation Program and Home Assistance Program - GreenSaver - City of Sudbury's Social Housing Energy Retrofits and Social Housing Apartment Improvement programs
Resources required (besides funding)	- Staff time for policy research and development, public/stakeholder consultations - Staff to prepare and oversee municipal programs and permitting - External subject matter experts
Budget	- Estimated >$1B costs
Challenges	- Developing financing programs, incentives, and other mechanisms to support retrofits - Overcoming upfront costs and encouraging a life cycle cost approach to building renewal - Overcoming inertia from building owners

	- Achieving heat pump life cycle cost parity with natural gas heating - Addressing potential heat pump noise concerns - Addressing supplementary heat requirement during extreme cold (i.e. heat pumps cease heat extraction from air below ~-20°C)
Next steps	- Develop partnerships with relevant provincial and federal government agencies, utilities, and local college departments - Research property-assessed clean energy (PACE) programs in other municipalities for best practices transfer - Develop education program to promote home retrofits - Develop sector-specific programs that support retrofits - Explore options for connecting property owners with private energy efficiency investment capital - Partner with relevant home improvement organizations and retailers to help develop green retrofit programs - Identify priority neighbourhoods and buildings for retrofitting and reach out to owners to help remove retrofit obstacles - Create recommissioning information materials for distribution to building owners and operators - Host information and engagement meetings with building owners - Establish partnerships with commissioning agents and authorities - Work with local HVAC contractors to document available heat pump technologies, market opportunities/challenges, best practices - Complete pilot/demonstration projects, e.g. on a municipally owned building - Research options for a heat pump incentive program - Consider implementing a bulk heat pump purchasing program in which residents and businesses can participate
KPIs & reporting frequency	- Greenhouse gas emissions (tonnes/year) - Total residential buildings energy consumption (MWh/year) - Green retrofit program participation rate

Goal 4: Achieve net-zero emissions in City buildings.

Timing: Medium-term.

Consideration	Notes
Assumptions	- The City has a financial impetus and a leadership imperative to upgrade the energy efficiency of its building - 100% of City buildings can be retrofit to net zero emissions
Schedule	- Retrofits begin as soon as possible and are complete by 2040
Audience(s)	- Council - Administration - Facility tenants
In which existing policies/ strategies/workplans can this action be embedded?	- Strategic Plan - Facilities Master Plan and management policies
Partners	- Council - Standards development & building permitting departments - Contractors - Green building organizations like Passive House Institute
Resources required (besides funding)	- Staff time for project management of energy audits, upgrades/retrofits, and energy performance monitoring
Budget	- $400M, depending on how net-zero is achieved.
Challenges	- Ensuring long-term commitment to retrofit investments - Managing potential disruptions to municipal operations
Next steps	- Identify priority buildings for retrofits, and schedule work - Complete energy audits - Monitor external funding opportunities
KPIs & reporting frequency	- Greenhouse gas emissions (tonnes/year) - Natural gas consumption (GJ/year) - Electricity consumption (MWh/year) - Annual energy costs ($/year)

Water, Wastewater, and Solid Waste Actions

Goal 5: Decrease energy use in the potable water treatment and distribution system by 60% by 2050.

Timing: Long-term.

Water pumping system upgrades.

Consideration	Notes
Assumptions	- The energy efficiency of the expansive potable water and wastewater networks can be improved through investment in modern pumping technologies. - Total system energy used in pumping can be decreased by 2%/year.
Schedule	- Starting as soon as possible, target of up to 60% increased efficiency is reached by 2050.
Audience(s)	- Public
In which existing policies/ strategies/workplans can this action be embedded?	- Strategic Plan - Water and Wastewater Master Plan
Partners	- N/A
Resources required (besides funding)	- Staff time to research pumping technologies - Staff time to oversee system upgrades
Budget	- $2M
Challenges	- Maintaining system performance during upgrades
Next steps	- Survey the water/wastewater network for priority system upgrade projects - Tender replacement pumps - Implement replacement scheduling - Develop a public information program if service outages are expected - Update Facilities and Wastewater Master Plans as required
KPIs & reporting frequency	- Pumps replaced - Water savings (l/year) - System efficiency improvements (kWh/year) - Emissions (tonnes/year)

Water network leak detection upgrades and incentive and education programs.

Consideration	Notes
Assumptions	- Energy use in potable water treatment and distribution can be decreased through water efficiency and leak detection/repair. - Water volume use can be decreased by 1.5%/year.
Schedule	- Starting as soon as possible. 45% community-wide water use reduction by 2050.
Audience(s)	- Public
In which existing policies/ strategies/workplans can this action be embedded?	- Strategic Plan - Water and Wastewater Master Plan

Partners	- Local sustainability and environment-focused not for profit groups - Educational institutions - Businesses (e.g. restaurants, other high-volume water users) - Residents (using new Advanced Metering Infrastructure)
Resources required (besides funding)	- Staff time to coordinate with partners - Staff time to produce incentive programs and educational and promotional programs - Staff time to detect and repair system leaks - Staff time to prepare and install Advanced Metering Infrastructure - Staff time to implement district metering
Budget	- $36M (assume average of $500 per household)
Challenges	- Changing public water use behaviour - Delivering education programs effectively
Next steps	- Continue the potable water network leak detection upgrades - Update Water and Wastewater Master Plan as required - Coordinate with partners on behaviour change education program deliver - Develop incentive program for efficient water using appliance upgrades and fixtures
KPIs & reporting frequency	- Incentive program participation - Water savings (l/year) - Energy savings (kWh/year) - Emissions (tonnes/year)

Goal 6: Achieve 90% solid waste diversion by 2050. An anaerobic digestion facility is operational by 2030.

Timing: Medium-term.

Consideration	Notes
Assumptions	- Increased waste diversion avoids emissions associated with anaerobic decomposition in landfills. - 90% of residential and ICI waste can be diverted. - An anaerobic digestion facility can be installed for organic waste and wastewater treatment with biogas capture for use as RNG.
Schedule	- Waste diversion targets is achieved by 2050. - Anaerobic digestion facility is installed by 2025.
Audience(s)	- Public - Employers - Institutions
In which existing policies/ strategies/workplans can this action be embedded?	- Facilities Master Plan - Waste Diversion Plan - Solid Waste Management Plan
Partners	- Waste haulers - Local waste-focused not for profit groups - Businesses - Building owners - Industry/Commercial/Institution sector - Subject matter experts
Resources required (besides funding)	- Staff time to research anaerobic digester options and oversee project implementation - Staff time to coordinate public waste diversion campaign - Staff time to coordinate City waste diversion approaches
Budget	- $150,000/year for staff. $1.5M for an anaerobic digester.
Challenges	- Changing public behaviour on consumption and waste disposal - Investment required for small increment in system performance improvement - Waste policy is a Provincial Government jurisdiction, making local waste programming and responsibility determination complicated
Next steps	- Engage subject matter experts to conduct a study to determine the best options for the anaerobic digestion facility, updating the knowledge gained from the previous study using best current practices and technologies. Determine implementation budget and schedule. - Consult with other cities to determine best practices. - Update Master Plans as required. - Coordinate with partners on waste disposal programming and education program delivery. - Set annual waste reduction and diversion targets. - Report publicly on waste diversion target progress.
KPIs & reporting frequency	- Waste diversion (tonnage/year) - Emissions (tonnes/year)

Low-carbon Transportation Actions

Goal 7: Enhance transit service to increase transit mode share to 25% by 2050.

Timing: Being implemented in the near-term and refined over the long-term.

Consideration	Notes
Assumptions	- With comfortable, frequent, and convenient transit service, fewer trips will be made by personal vehicle, thus reducing transportation emissions. - Transit service is increased to 10-minute frequency on high-demand routes, 20-minute frequency on medium demand routes, 7 days/week service. - Transit mode share increases to 25%.
Schedule	- Expanded transit actions are completed by 2050
Audience(s)	- Public - Employers - Institutions
In which existing policies/ strategies/workplans can this action be embedded?	- Strategic Plan - Transportation Action Plan - Transit Master Plan
Partners	- Employers (incentive programs) - Institutions (incentive programs) - Local transportation-focused not for profit groups
Resources required (besides funding)	- Staff time to research and coordinate transit service upgrades - Staff time to coordinate communications with residents and develop partnerships with employers and institutions - New fleet vehicles to right-size the fleet - Periodic additional human resources to update plans
Budget	- $3M for buses and maintenance.
Challenges	- Promoting a mode shift to transit among general public - Dispelling negative perceptions of public transit - Integration of transit with cycling, TransCab, park and ride, and Handi-Transit services in order to support mode-shift - Ensuring high ridership in winter months
Next steps	- Continue to implement and update the Transit Master Plan - Update the Transportation Action Plan as needed - Plan for increased service in fleet growth plans - Research and implement integrated mobility solutions between GOVA, GOVA Plus, GOVA Zone, and active transportation - Coordinate with other planning efforts, such as Official Plan updates - Perform surveys of transit infrastructure needs and prioritize new and upgraded infrastructure projects - Enhance promotion and awareness of transit services and benefits of using transit through education and awareness campaigns - Develop an employer and institution transit incentive program
KPIs & reporting frequency	- Ridership - Vehicle kilometres travelled (VKT, km/year) - Transit mode share

Goal 8: Achieve 35% active mobility transportation mode share by 2050.

Timing: Near-term with continued implementation over the long-term.

Consideration	Notes
Assumptions	- Improved cycling and walking infrastructure encourages active mobility transportation modes for trips less than 5km. - 35% of trips can be made by active mobility.
Schedule	- Ongoing infrastructure improvements to achieve the target mode shift by 2050.
Audience(s)	- Public - Employers - Institutions
In which existing policies/ strategies/workplans can this action be embedded?	- Strategic Plan - Transportation Master Plan and Cycling and Pedestrian Master Plan - Complete Streets Policy - Transportation Demand Management Plan - Transit Action Plan - Development plans - Official Plan
Partners	- Employers (incentive programs) - Institutions (incentive programs) - Local transportation-focused not for profit groups - Health organizations (promotion)
Resources required (besides funding)	- Staff time to coordinate and manage infrastructure upgrades and to update related policies - Staff time to engage public
Budget	- $5000 - $100,000/km depending on bike lane and sidewalk infrastructure approach.
Challenges	- Selecting and designing bike lane infrastructure - Determining the best mix of various cycling and walking programs and promotions to achieve the target mode shares - Minimizing any perceived or real impacts on local businesses - Maintaining active transportation mode share in the winter
Next steps	- Continue to implement the Cycling and Pedestrian Master Plan (part of the Transportation Master Plan) - Assess streetscapes for potential cycling and walking infrastructure upgrades (sidewalks, separated and/or identifiable bike lanes, bike parking, complete streets, active transportation priority intersections, etc) - Work to minimize interference between cycling and vehicle/pedestrian rights-of-way - Identify preferred route alternatives and program designs - Prepare public consultation program - Determine integration with transit services - Research funding opportunities for active transportation infrastructure upgrades

	- Coordinate with partners in delivering education and promotion programming
KPIs & reporting frequency	- Walk and bike mode shares - Traffic counter data (vehicle counts, and vehicle kilometers traveled) in key areas - User experience (surveys, interviews)

Goal 9: Electrify 100% of transit and city fleet by 2035.

Timing: Near-term.

Consideration	Notes
Assumptions	- Electric transit and City fleet vehicles are more efficient, have lower emissions, require less maintenance, and are cheaper to operate than internal combustion engine vehicles. - 100% of transit and City fleets can be electrified. - Fleet charging infrastructure can be spatially accommodated. - Vehicles' additional energy needs for field operations can be met by high capacity battery vehicles and/or solar PV charging panels.
Schedule	- All vehicles (City and contractor) are electric by 2035
Audience(s)	- City fleet operators and users
In which existing policies/ strategies/workplans can this action be embedded?	- Strategic Plan - Transportation Action Plan - Transit Master Plan - Solid Waste Management Plan
Partners	- Vehicle suppliers
Resources required (besides funding)	- Staff time to determine costs and vehicle replacement schedule - Staff time to coordinate with departments and fleet users on fleet needs and replacement scheduling
Budget	- $35M
Challenges	- Weighing higher capital costs versus lower operational costs - Managing cold weather operations - Accommodating charging requirements - Ensuring adequate vehicle range - Ensuring no reduction in quality of service - Dispelling negative perceptions about EVs
Next steps	- Support Greater Sudbury Transit in researching suitable EV bus models - Establish fleet replacement schedule - Determine needs to accommodate charging infrastructure - Provide support for maintenance/operations staff retraining
KPIs & reporting frequency	- Greenhouse gas emissions (tonnes/year) - Average fleet kilometrage (km/l equivalent) - Annual operating costs ($/km)

Goal 10: 100% of new vehicle sales are electric by 2030.

Timing: Started in the near-term and continued over the long-term

Consideration	Notes
Assumptions	- Electric vehicles are low-emission and inexpensive to operate and maintain. - Charging infrastructure is installed and maintained by public, private, and institutional entities.
Schedule	- 100% of all new vehicle sales are electric by 2030.
Audience(s)	- Public - Employers - Institutions - Auto dealerships and rental agencies
In which existing policies/ strategies/workplans can this action be embedded?	- Strategic Plan - Transportation Action Plan - Transit Master Plan - Official Plan
Partners	- Provincial and Federal Governments - Businesses - Institutions - Auto dealerships and rental agencies - Local transportation-focused not for profit groups
Resources required (besides funding)	- Staff time to research and implement incentive and charging infrastructure installation programs - Staff time to coordinate with partners on incentives, increasing local availability of EV models, and education and promotion programs
Budget	- $150,000/year for staff.
Challenges	- Municipality has little influence over private and commercial vehicle purchases - Municipality has little influence over EV technology development and market maturation - Charging infrastructure installation, especially in less dense residential areas and multifamily/mixed-use buildings
Next steps	- Prioritize and implement the recommendations of the Electric Vehicle Study (2019)
KPIs & reporting frequency	- EV market penetration - Available charging infrastructure - EV vehicle user experiences/recommendations

Industrial Efficiency Actions

Goal 11: Increase industrial energy efficiency by 35% by 2040.

Timing: Near-term.

Consideration	Notes
Assumptions	- Mining and other industrial businesses are self-incentivized to generate cost savings through energy efficiency measures. - Electrification of vehicles will result in emissions reductions and cost savings. - Energy use is reduced 35%.
Schedule	- Efficiency measures are already in progress and/or implemented as soon as possible and are complete by 2040.
Audience(s)	- Industrial businesses.
In which existing policies/ strategies/workplans can this action be embedded?	- Community Economic Development Strategic Plan
Partners	- Mining companies - Mining company equipment suppliers - Utilities - Business associations
Resources required (besides funding)	- Staff time to coordinate with partners
Budget	- To be determined by industrial businesses
Challenges	- Overcoming potential inertia of the sector - Availability of replacement technologies - Balancing lifecycle costs of new equipment versus sunk investments in existing equipment
Next steps	- Continue to coordinate with industrial businesses to determine their timelines for energy efficiency measures. - Relay public input on renewable energy and climate emergency concerns to the industrial sector, citing the impetus for action. - Create an industry energy efficiency working group composed of industry stakeholders that meets quarterly to discuss energy efficiency progress.
KPIs & reporting frequency	- Industrial fleet stocks - Energy use (GJ/year) - Emissions (tCO_2e/year)

Local Clean Energy Generation Actions

Goal 12: Establish a renewable energy cooperative (REC) to advance solar energy systems and other renewable energy efforts of the CEEP.

Timing: Near-term.

Consideration	Notes
Assumptions	- An increase in energy system deployment and electrification will require expertise, education and awareness campaign coordination, and championship. - Existing local community groups, utilities, and businesses are interested in leading and supporting energy system deployment and electrification efforts.
Schedule	- Operational in 2020
Audience(s)	- Public - Utilities - Businesses
In which existing policies/ strategies/workplans can this action be embedded?	- Strategic Plan
Partners	- Utilities - Local renewable energy generation businesses and suppliers - Energy-focused local not for profit groups - Provincial, regional, national and international energy organizations - Local First Nations
Resources required (besides funding)	- Staff time to sit on the board of the organization - Staff time to participate in the organization's activities - Partner organization time to establish and operate the organization
Budget	- Estimated $250,000/year for staff and overhead costs
Challenges	- Coordination of existing organizations and efforts in the energy and electrification areas - Establishing start up funding - Prioritization of a variety of energy system and electrification projects, campaigns, and outreach
Next steps	- Convene the stakeholders in the related energy, electrification, and education fields to determine whether a new organization is needed or if an existing organization can take on increased mandate and responsibilities. - If a new organization is needed, determine the co-op (or other) structure, membership, vision and goals - Incorporate the new organization - Secure start up funding, establish the board of directors, and hire staff - Prioritize the organization's activities - Create workplans for the first energy and electrification projects
KPIs & reporting frequency	- Annual membership - Annual projects initiated and completed

Goal 13: Install 10 MW of ground mount solar PV each year, starting in 2022.

Timing: Start in the near-term and be sustained over the long-term

Consideration	Notes
Assumptions	- The electricity grid will be partially dependent on fossil fuel generation for the next thirty years. - The 10 MW Capreol solar PV plant is a successful model to replicate. - Solar PV panels are increasing in efficiency and decreasing in price per kW installed capacity. - There is enough unused open space (e.g. fields, lakes for solar PV rafts, roadside, etc.) in Greater Sudbury to accommodate 560 MW of installed solar PV capacity.
Schedule	- The first new plant is operational in 2022. - An average of 20 MW of solar PV is installed each year until 2050.
Audience(s)	- Public
In which existing policies/ strategies/workplans can this action be embedded?	- Strategic Plan
Partners	- Farmland owners - Utilities - Local renewable energy generation businesses and suppliers - Energy-focused local not for profit groups - Local First Nations
Resources required (besides funding)	- Staff time to site locations, issue tenders, liaise with utilities, host public engagement, and coordinate with partners - Consultants to perform feasibility studies where needed
Budget	- Estimated $700M based on average assumption of $1M per megawatt capacity, plus installation costs
Challenges	- Land availability - Short timeframe for delivery of large solar PV projects - Securing long-term capital investment for repeated annual investments - Public perceptions of using land for solar PV electricity generation
Next steps	- Establish a renewable energy cooperative (REC) to coordinate energy projects. - Revisit the Capreol project lessons learned to help chart a development plan for the solar farms. - Assess land availability and identify all potential solar sites. Prioritize their development with input from stakeholders and the public. - Get solar capacity and installation quotes from providers. - Secure contracts with solar PV providers to achieve bulk purchase discounts on solar PV arrays. - Develop detailed short and long-term budgets for the installations, accounting for increased solar PV efficiency and decreased costs projections.
KPIs & reporting frequency	- Grid emissions avoided (tCO_2e/year) - Installed solar PV capacity (MW/year) - Annual maintenance cost ($/year)

Goal 14: Install net metered solar PV systems on 90% of new buildings and 80% of existing buildings, supplying 50% of their electric load.

Timing: New building solar PV installations can start in the near-term. Retrofitting buildings with solar PV systems can start in the near-term and will occur over the long-term.

Consideration	Notes
Assumptions	- Renewable energy generation and use helps avoid use of grid electricity which is produced in part by fossil fuels - 90% of new buildings and 80% of existing buildings have solar PV installed, supplying 50% of their electric load
Schedule	- Systems are installed starting as soon as possible and all systems are operational by 2050
Audience(s)	- Homeowners and residential property owners - Commercial property owners & public institutions
In which existing policies/ strategies/workplans can this action be embedded?	- Strategic Plan
Partners	- Utilities - Building owners - Local renewable energy system providers and installers - Local not-for-profit organizations - Institutions
Resources required (besides funding)	- A staff member dedicated to sustained management of incentives, policies, reporting, communications, etc.
Budget	- $350-750M. Budget needed for permitting, roof load assessments, engineering assessments, energy system purchase and installation, etc.
Challenges	- Education and communication about benefits of solar PV (e.g. simplicity of participating in incentive programs, installation, low maintenance, prolonged roof life, etc.) - Overcoming property owner perceptions (e.g. value, cost, aesthetics, effectiveness, effect on property value)
Next steps	- Include this action as part of the approach of Goal 2 - Deliver developer and builder information and training sessions through the REC - Coordinate homeowner outreach and incentive programs through the REC; - Coordinate ICI outreach and incentive programs through the REC - Arrange bulk solar PV system purchasing - Coordinate with electrical utilities on new metering programming - Develop partnerships with local renewable energy system providers and installers and coordinate pricing - Establish installed capacity milestone targets (kW/year)
KPIs & reporting frequency	- Greenhouse gas emissions (tonnes/year) - Total solar installed (kW) - Total annual output (MWh) - Program participation over time (kW/year) - Average install cost ($/W)

Goal 15: Expand the downtown district energy system to 23 MW capacity.

Timing: The expansion feasibility study can be performed in the near-term. The expansion itself will likely occur in the medium-term.

Consideration	Notes
Assumptions	- District energy systems supplying multiple buildings with heat are more energy efficient than individual buildings heating systems. - Existing district energy systems are expandable to more buildings and can be upgraded to higher generation capacity. - Additional combined heat and power generation can be accommodated by the electrical grid. - Existing downtown and hospital district energy systems are successful projects for replication.
Schedule	- System expansion starts as soon as possible & is complete by 2025.
Audience(s)	- Building owners and operators in the downtown area.
In which existing policies/ strategies/workplans can this action be embedded?	- Strategic Plan - Official Plan - Community Economic Development Strategic Plan - Downtown Community Improvement Plan
Partners	- Toromont Power Systems/Sudbury District Energy Corporation - Utilities - Sudbury Regional Hospital - Energy-focused local not for profit groups
Resources required (besides funding)	- Staff time for project management - Leadership and support from administration, Council - External subject matter experts
Budget	- $5-10M.
Challenges	- Technical feasibility must be established early on - Large projects require long-term staff capacity/capability - Development permits and environmental review may be required - Delivering energy at a cost comparable to, or lower than standard retail costs for electricity and gas. - Requires a strong economic case/return on investment - Stakeholder consultation, communications, and knowledge sharing required
Next steps	- Discuss expansion opportunities with current system operators - Identify priority buildings to connect to an expanded system - Conduct feasibility studies - Consult with electrical utilities on adding capacity to the grid - Secure funding - Determine whether to expand public-private partnership or if other entities should fund, own, and operate the system
KPIs & reporting frequency	- Greenhouse gas emissions (tonnes/year) - Natural gas consumption (GJ/ year) - Electricity consumption (MWh/ year) - Annual operating cost ($/year) - Annual maintenance cost ($/year)

Goal 16: Install 50 MW of renewable energy storage.

Timing: Discussions and studies can begin in the near-term. The first storage projects can accompany renewable energy installations and will endure over the long-term.

Consideration	Notes
Assumptions	- Renewable energy can be stored for use during peak electricity grid demand periods, reducing the amount of grid electricity (i.e. partially fossil fuel generated) required. - 50 MW total storage can be installed.
Schedule	- Storage is added with new solar PV and district energy generation systems starting in 2022, completed by 2050.
Audience(s)	- Generation and transmission utilities
In which existing policies/ strategies/workplans can this action be embedded?	- Strategic Plan
Partners	- Utilities - Renewable energy system owners and operators - Energy-focused local not for profit groups - Local First Nations
Resources required (besides funding)	- Staff time for engagement with partners - Staff time for systems siting and installation - External subject matter experts
Budget	- Estimated at ~$85M at current battery electric storage prices
Challenges	- Determining the optimal energy storage solutions to interface between the installed renewable energy capacity, end electricity uses, and the electricity grid - Financing installations - Availability of optimal storage technologies - Determining which systems the storage will be part of and who the owners/operators are
Next steps	- Consult with other cities on their energy storage approaches (e.g. Toronto, Sault St. Marie) - Engage a consultant to perform a feasibility study and determine the best energy storage options - Coordinate with partners on developing an energy storage installation schedule - Install energy storage in concert with new renewable energy systems
KPIs & reporting frequency	- Greenhouse gas emissions (tonnes/year) - Energy storage capacity installed (MW and MWh)

Low-carbon Energy Procurement Actions

Goal 17: Procure 100% of community-wide grid electricity and 75% of natural gas demand from renewable sources by 2050.

Timing: Studies can occur in the near-term while setting up the procurement system would likely take place in the medium-term.

Consideration	Notes
Assumptions	- Procurement of renewable electricity and RNG decreases emissions associated with grid electricity and natural gas use. - 75% of remaining natural gas use after energy efficiency and local biogas capture actions have been completed will be supplied by renewable natural gas procurement. - 100% of remaining electricity use after energy efficiency and local generation actions have been completed will be supplied by renewable electricity procurement.
Schedule	- Targets are met by 2050.
Audience(s)	- Energy consumers
In which existing policies/ strategies/workplans can this action be embedded?	- Strategic Plan
Partners	- Utilities - Transmission and distribution companies - Renewable energy suppliers - Subject matter experts
Resources required (besides funding)	- Staff time to coordinate with renewable energy suppliers
Budget	- +$0.01 to $0.03 per kWh
Challenges	- Sourcing credible renewable energy credits - Availability of sufficient RNG volumes - Legal/regulatory hurdles - Building local stakeholder support for program - Achieving cost parity with status quo

Next steps	- Engage subject matter experts to complete a preliminary study evaluating procurement options, including:
	    - Public-private partnerships (City, major property owners, large institutions) that sign long-term power purchase agreements with renewable energy developers
	    - Establishing a local (municipal) electricity retailer, allowing the City to purchase renewable electricity for all local customers that sign on
	- Following initial study, establish a stakeholder working group to identify/evaluate options, opportunities, and obstacles
	- Begin discussions with natural gas retailers and distributors about potential options for procuring RNG at scale

KPIs & reporting frequency	- Greenhouse gas emissions (tonnes/a) - Scale of community participation (MWh, as a percentage of total community electricity demand)

Carbon Sequestration Actions

Goal 18: Increase the reforestation effort of the Regreening Program.

Timing: This action is already being implemented through the Regreening program. It can be scaled up in the near-term.

Consideration	Notes
Assumptions	- Greater Sudbury's current afforestation efforts can be enhanced. - Local forestry knowledge can provide accurate estimates for local tree species carbon sequestration rates.
Schedule	- The current rate of carbon sequestration achieved by the Regreening program is substantially increased by 2050.
Audience(s)	- Public - Greater Sudbury Regreening Program
In which existing policies/ strategies/workplans can this action be embedded?	- Strategic Plan - Environmental Services Initiatives Workplan
Partners	- Landowners and farmers - National ecosystem and habitat not-for-profits (e.g. Scouts Canada, Ducks Unlimited, World Wildlife Federation, Sierra Club) - Community groups - Local First Nations
Resources required (besides funding)	- Staff time to consult on how to enhance afforestation programs - Staff time to coordinate with national and local not-for-profit groups - Staff time to plant trees
Budget	- TDB based on amount of saplings/year planted
Challenges	- Identifying and securing land and land agreements for planting - Cost of tree supply and planting workforce - Coordinating funding and volunteer efforts of not-for-profits - Monitoring tree growth - Managing competing land-use interests
Next steps	- Continue to consult with Laurentian College experts in determining land, tree species and number, and planting timeline requirements for the afforestation effort - Consult with Greater Sudbury Regreening Program staff to determine effort required to modify tree planting efforts in accordance with Laurentian College recommendations - If necessary, seek partnership and funding from national and local not-for-profit groups - Coordinate annual community tree planting events
KPIs & reporting frequency	- Annual number of trees planted - Greenhouse gas emissions sequestered (tonnes/a)

Appendix 2
Greater Sudbury
Electric Vehicle Study

Prepared by SSG

January 2018

Electric Vehicle Terms

Battery Electric/Plug-in Electric (BEV/PEV) Vehicles: Vehicles that rely solely on batteries and electricity and require electrical charging to refuel.

Plug-in Hybrid Electric Vehicles (PHEV): Vehicles that require plug charging and rely on internal combustion engines should their battery be insufficient.

Fuel Cell Electric Vehicles: Vehicles that convert on-board hydrogen to electricity for use in electric engines similar to that of BEVs. There are no tailpipe emissions and the byproduct is water.

Internal Combustion Engine (ICE) Vehicles: Vehicles whose engines are powered by gasoline, natural gas, or diesel.

Zero-Emissions Vehicle (ZEV): A synonym for battery or plug-in electric vehicle.

Contents

Executive Summary

Municipalities across Canada are increasingly looking to transform transportation in their jurisdiction to support their local economy, encourage diverse travel modes, and reduce emissions resulting from the sector. Electric vehicles (EVs) present an opportunity to reduce emissions, pollutants, and noise from urban environments and have therefore spurred new policies and incentives to encourage their uptake. In the context of policy making and incentives it is widely accepted that a multi-stakeholder approach is necessary for rapid uptake of EVs, including all levels of government and the private sector. Ontario has a proven track record in rapidly increasing EV uptake through provincial programs such as the "Electric and Hydrogen Vehicle and Charging Incentive Programs" where Ontario EV sales led the country, exceeding 4,500 vehicles annually. Municipalities across Ontario and Canada are applying different levels of effort to ensure EVs are well integrated into their community and can help meet climate goals.

Transportation is responsible for almost 40% of Greater Sudbury's greenhouse gas emissions and 30% of the city's energy use.[1] The dispersed nature of the city's homes and places of work, learning and recreation encourage driving to most destinations. One important strategy to reduce emissions in the transportation sector is to transition from internal combustion engine (ICE) vehicles to electric vehicles (EVs).

This report explores the potential energy and emissions reduction results of two scenarios in which the electric vehicle uptake rate is accelerated compared to the currently estimated market rate from now until 2050. Scenario modelling of electrification of transit, City fleets, personal vehicles, and industrial vehicles found the following:

Moderate Effort Scenario (by 2050)

- Transitions more than 16,000 ICE vehicles to EVs over the business as usual case;
- Reduces emissions by 1923.8 ktCO2e; and
- Reduces energy use by 29.6 million GJ.

Aggressive Scenario (by 2050)

- Transitions more than 82,000 ICE vehicles to EVs over the business as usual case;
- Reduces emissions by 2983.3 ktCO2e; and
- Reduces energy use by 42.4 million GJ.

Various EV uptake encouragement strategies available to a municipality that could be employed in either of the scenarios are detailed in the report. The areas of strategy concentration and their action recommendations are:

Municipal Policy Recommendations

- Update Building Development Applications, Building Permits, Rezoning and Retrofitting Policies
- Include EV Infrastructure Data in Building Records
- Update Relevant City Plans
- Update the Licensing, Regulating and Governing of Vehicles for Hire

Subsidies and Incentives

[1] From the energy and emissions inventory developed as part of the Greater Sudbury Community Energy and Emissions Plan (2019).

- Provide Business Licensing Subsidies
- Provide Property Tax Incentives
- Provide EV Purchase Subsidies
- Coordinate EV Bulk Buying
- Provide ICE Vehicle Retirement Incentives

Education and Marketing

- Develop an Overarching EV Campaign Branding Strategy
- Deliver a Public EV Awareness Campaign
- Deliver a Car Dealership Campaign
- Deliver a Workplace EV Promotion Campaign
- Deliver an Industry and Institutions Campaign
- Establish Partnerships

Charging Infrastructure Provision

- Deliver charging infrastructure in two phases: the first to create visibility and generate demand, and the second to create a connected city.
- Prioritize DC Fast Charging station installation over Level 2 and Level 1 chargers.
- Perform ongoing financial analysis to ensure capital costs, return on investments, and charging fees are up to date and appropriate as charging infrastructure costs change
- Engage with Hydro Sudbury for optimal charging station locations, and potentially cluster charging stations near Science North to capitalize on the Smart Micro Grid.
- Continuously monitor EV uptake and charging station use to enable proactive municipal programming that increases EV uptake

Governance and Leadership

- Update City Fleet Purchasing and Replacement Policies
- Showcase City Fleet EVs and Charging Stations
- Update City Purchasing Policies
- Hire an EV Strategy Manager in the Planning Services Division

1. Introduction

EVs and Sudbury's Low Carbon Future

Greater Sudbury's regional geography and urban development patterns result in reliance on private automobiles as the primary transportation mode (first as drivers and second as passengers). The transportation sector used 7.7 million GJ in 2016, representing 29.6% of total energy use. This yielded 539,385 tonnes carbon dioxide equivalent (tC02e), making the transportation sector responsible for a large portion of Greater Sudbury's total greenhouse gas (GHG) emissions (39.9%). Rural areas and places of employment are difficult to access without a personal vehicle due to long distances and lack of frequent transit. Public transit and walking have similar modal shares, with slightly less than 5% of trips each.

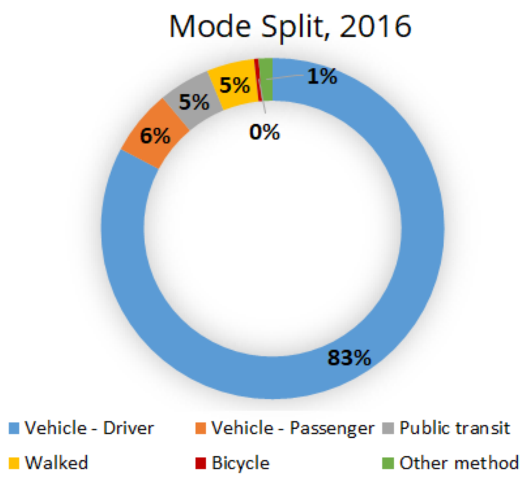


Figure 1: Transportation mode split, 2016.[2]

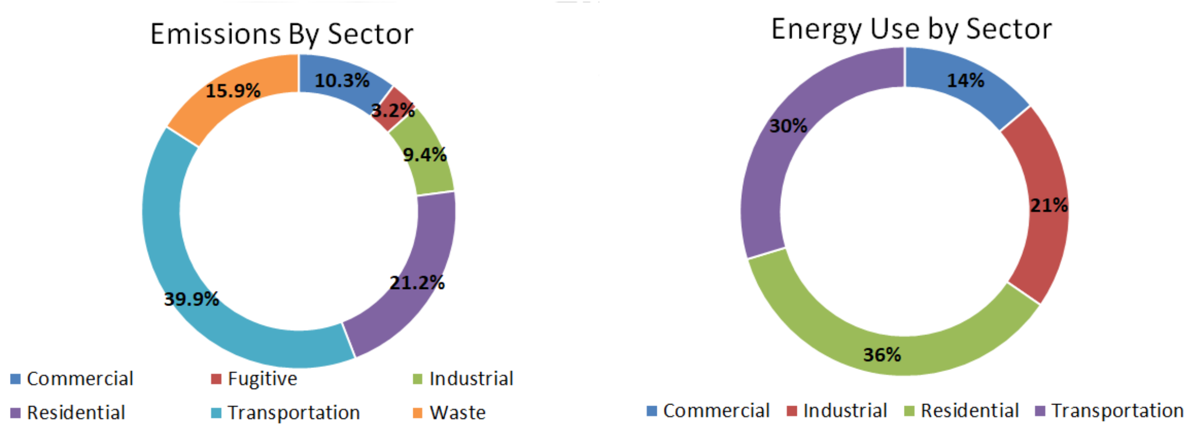


Figure 2. Emissions and energy in Greater Sudbury, 2016.

Light trucks consume most of the energy in 2016 (51%), followed by cars (42%) and heavy trucks (9%). Under a Business-as-usual approach energy consumption in cars declines by 51% in 2050 from 2016, as a result of fuel efficiency standards, saving nearly 2 million GJ. Heavy trucks show a slight decrease in energy consumption from 2016 to 2050 as a result of increased fuel efficiency.

Vehicle kilometres travelled (VKT) are estimated to increase in coming years, as a slight population increase results in greater vehicle ownership. Light truck ownership is projected to increase while car ownership decreases. This results in a decrease in average fuel efficiency across privately owned vehicles. Total VKT is projected to increase by 210,000,000 in the year 2051 compared to 2016.

[2] Census 2016, Greater Sudbury. Census Profile, Mobility and Transportation

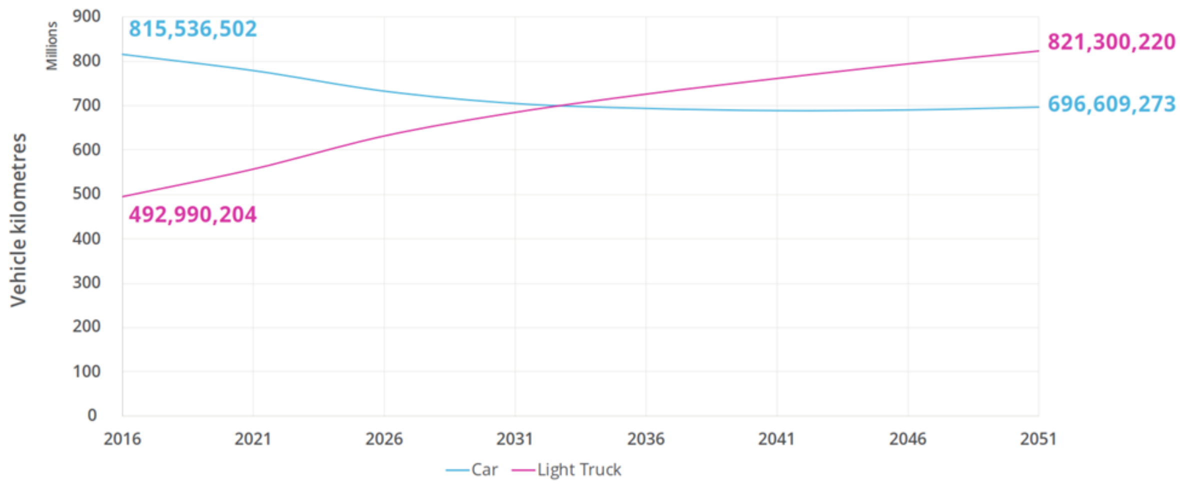


Figure 3: Personal vehicle ownership and vehicle kilometres travelled, 2016-2051.

Transportation will remain the largest emitting sector in Sudbury moving toward 2050, despite an anticipated reduction between 2016 and approximately 2032 owing to improved vehicle fuel efficiency standards, lower carbon fuels, and a small uptake of electric vehicles.

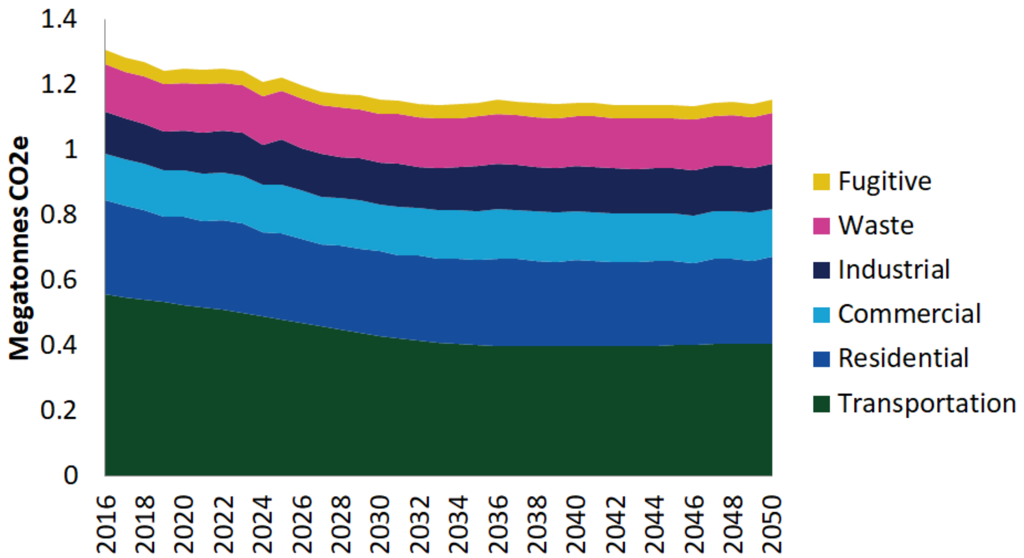


FIgure 4. Business as usual emissions projection, 2016-2050.

2. Background

Ontario Electric Vehicle Sales

The 2017 Long-term Energy Plan (LTEP) prioritized switching to electric vehicles and began a rebate program—awarding approximately $10,000 per vehicle—to equalize the cost of EVs with non-electric vehicles.[3] This program is on hold by the current government, but has a proven track record of success with electric vehicle ownership increasing incrementally year-over-year in Ontario, reaching 120% growth from 2016 to 2017.[4] The LTEP targeted 5% of new vehicle sales by 2020.[5] Despite this target and strong sales growth, EVs represented less than 1% of total vehicles sold in 2017.[6] It is unlikely that LTEP targets will be met in the current context, where EV rebates are no longer available. However, transitioning from combustion engine vehicles to EVs significantly reduces GHG emissions and remains a worthwhile strategy to pursue.

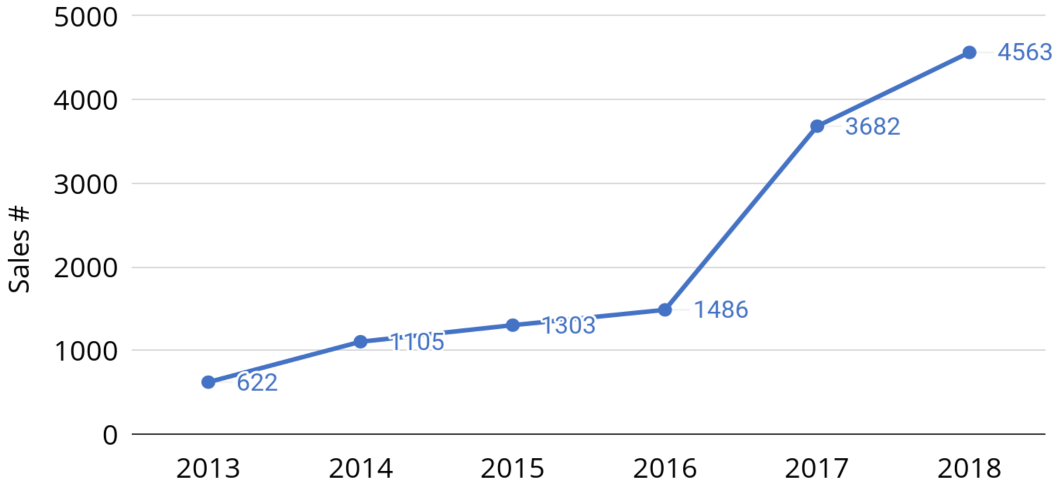


Figure 5. BEV sales in Ontario, 2013-2018.[7]

Electrical Capacity for Increased Electrical Vehicle Demand

Many municipalities and utility companies in Ontario have been considering electric load capacity should a dramatic increase in EVs occur. The IESO estimates that they are able to meet demand for the growing uptake for EVs in the near future, but this will need to be supplemented by increased low carbon energy or natural gas in the medium-term.[8] Demand for electricity creates a challenge but also an opportunity where municipalities can lead in creating local renewable energy under their own utilities to supplement grid electricity for EV use. More information on this topic is provided in the "Barriers" section.

[3] Ontario News Bulletin (2009) https://news.ontario.ca/mto/en/2009/07/a-plan-for-ontario-1-in-20-by-2020.html

[4] Sales Data provided by Fleetcarma. https://www.fleetcarma.com/electric-vehicles-sales-update-q1-2018-canada/ There is some agreement that sales were boosted before the termination of the EV granting program.

[5] Ontario News Bulletin (2009)

[6] New Motor Vehicle Sales: Ontario 2013-2018 https://www150.statcan.gc.ca/t1/tbl1/en/cv.action?pid=2010000101

[7] Sales Data provided by Fleetcarma. https://www.fleetcarma.com/electric-vehicles-sales-update-q1-2018-canada/

[8] "Preliminary Outlook and Discussion: Ontario Supply/Demand Balance to 2035." 2016. IESO, March 23. http://www.ieso.ca/-/media/Files/IESO/Document-Library/sac/2016/SAC-20160323-Ontario-Planning-Outlook.pdf?la=en.

Grid Emissions

The high GHG intensity of using fossil fuels to power vehicles means that EVs present a strong opportunity to reduce emissions in Ontario communities. The province's electricity grid offers a much lower GHG intensity factor (Figure 6).

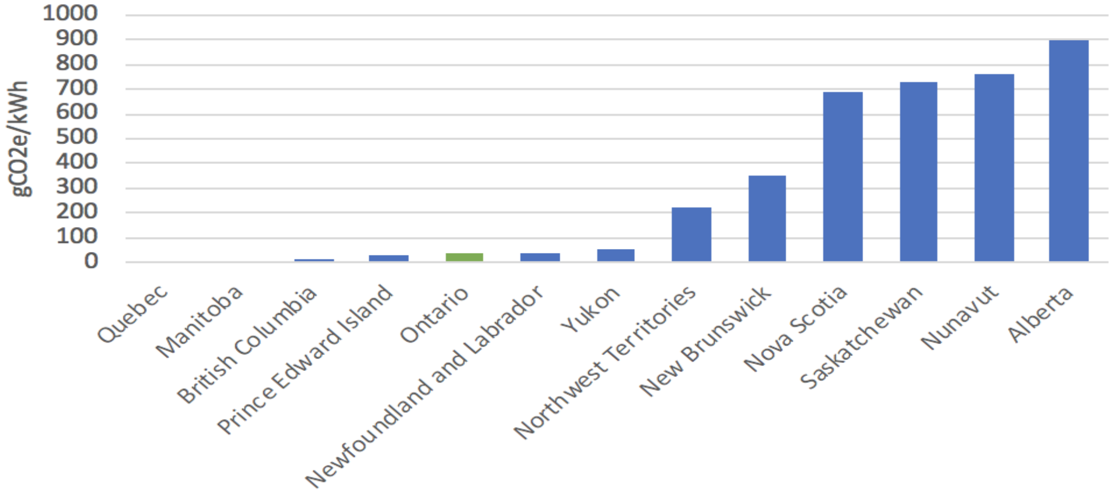


Figure 6. Electricity grid emissions by province.[9]

Ontario's electricity grid will continue to have a low emissions intensity, as Ontario's LTEP plans to meet new electrical capacity requirements with renewable capacity.[10] Currently, 58% of electricity is provided by nuclear energy, but the LTEP anticipates growth in wind energy. The relatively clean electricity means that electrification is a key strategy for GHG reductions for transportation sectors.

[9] Environment Canada (2018). National and Provincial/Territorial Greenhouse Gas Emission Tables. Retrieved from: http://data.ec.gc.ca/data/substances/monitor/national-and-provincial-territorial-greenhouse-gas-emission-tables

[10] Ontario Long-Term Energy Plan (2017) p. 43.

Electric Vehicles in Greater Sudbury

Registered Electric Vehicles

Data compiled by the Ontario Ministry of Transportation in 2018 gives an estimate of 125 registered EVs in Sudbury. This group includes both Plug-in Hybrid Electric (PHEV) and Battery-Electric (BEV).

Charging Stations

There are currently 11 charging stations in Greater Sudbury. These have been implemented largely under private initiative and the majority are located at car dealerships. Table 1 summarizes the location and charging type of Greater Sudbury's current charging stations.

Charger Type Definitions

Level 1	First generation technology. Uses 120V plug capacity and is capable of providing 65km driving distance in an 8 hour period and has been generally used for homes.
Level 2	Faster charging and increasingly common for homes and public charging stations. Uses a 240V plug capacity (washer and dryer outlets) and can charge up to 290km driving distance in 8 hours.
DC Fast Charger	Fastest charging method and public chargers increasingly use this infrastructure. Capable of charging up to 128-145km driving distance in 30 minutes.
Tesla Supercharger	Up to 275km driving distance in 30 minutes, but are only compatible with Tesla vehicles.

Table 1. Public charging stations in Greater Sudbury.[11]

Location	Charger Type
Ford Lincoln - Belanger Dealership, 204 Michael Street, Chelmsford	Level 2 Charger
Tim Horton's, 514 Notre Dame St E, Azilda	DC Fast Charger
Ionic Engineering, 95 Mumford Rd, Lively ON	Level 2 Charger
2404 Long Lake Road, Sudbury	Tesla Supercharger
Southside Chevrolet, 2601 Regent Street, Sudbury	Level 2 Charger
Science North, 100 Ramsey Lake Road, Sudbury	Level 2 Charger
Quality Inn Conference Centre, 290 Elgin Street South, Sudbury	Level 2 Charger
Sudbury Hyundai, 1120 Kingsway, Sudbury	Level 2 Charger
Audi Dealership, 1593 Lasalle Boulevard, Sudbury	Level 2 Charger
Nickel Centre International Truck Centre, 1035 Falconbridge Rd, Sudbury	Level 2 Charger
Mid North Mitsubishi Chargepoint, 2100 Kingsway, Sudbury	Level 2 Charger

[11] Chargehub: Sudbury. https://chargehub.com/en/charging-stations-map.html?lat=46.56832006126451&lon=-81.1897653915405&locId=65301

Industry Trends

Cost of Batteries and Energy Density

As EV technology progresses, the cost to manufacture lithium-ion batteries decreases, resulting in lower vehicle purchase prices. From 2009 to 2015, battery manufacture costs decreased 73%. The cost is anticipated to continue decreasing by 53% toward 2023.[12] Bloomberg Energy reports that the cost to produce a battery pack in 2010 was $1000/kWh, dropping to $209/kWh in 2017.[13] The United States Department of Energy conservatively estimates that the cost will be $125/kWh by 2022.[14] Decreasing production costs has been accompanied by higher battery energy density enabling longer driving ranges, up to 200km.[15] Figure 7 illustrates the decreased cost of battery packs compared to the increase of energy density over time.

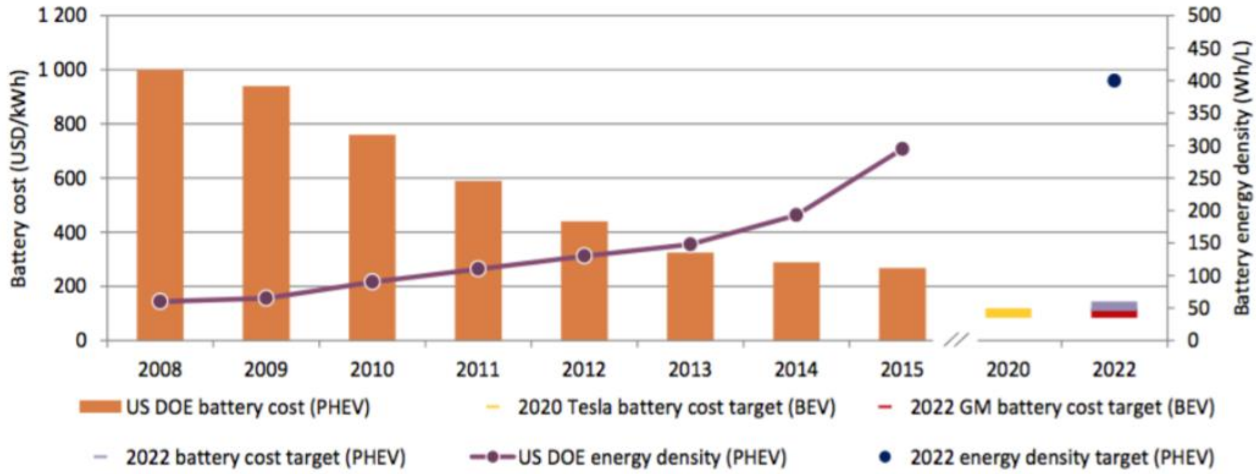


Figure 7. Battery production cost per kWh and energy density over time.[16]

There is some concern over the sustainability of lithium and cobalt supplies – key components of lithium ion batteries. The EV market and other lithium-ion battery markets are elevating the demand for these materials at increasing rates.[17] In the near-term, limits to supply of these metals could create material bottlenecks, increasing the cost of, and/or limit the supply of, EV batteries before battery technologies evolve to use other materials.[18]

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[12] An Analysis of Electric Vehicle Trends in Developed Nations: A Sustainable Solution for India. Farhan Faisal University of Illinois at Chicago, Chicago, IL.
[13] "Electric Vehicle Outlook." 2018. United States: Bloomberg New Energy Finance. https://about.bnef.com/electric-vehicle-outlook/.
[14] An Analysis of Electric Vehicle Trends in Developed Nations: A Sustainable Solution for India. Farhan Faisal University of Illinois at Chicago, Chicago, IL.
[15] Ibid
[16] Ibid.
[17] Lithium and Cobalt: A Tale of Two Commodities. McKinsey & Company, 2018. https://www.mckinsey.com/industries/metals-and-mining/our-insights/lithium-and-cobalt-a-tale-of-two-commodities
[18] Olivetti, Elsa & Ceder, Gerbrand & Gaustad, Gabrielle & Fu, Xinkai. (2017). Lithium-Ion Battery Supply Chain Considerations: Analysis of Potential Bottlenecks in Critical Metals. Joule. 1. 229-243. 10.1016/j.joule.2017.08.019. https://doi.org/10.1016/j.joule.2017.08.019

Charging Behaviour

Cities and provinces are increasing the number of public charging stations available. This has several benefits including creating awareness of the technology, adding assurance that drivers can charge while taking a variety of trips, and allowing residents who do not have off-street parking to charge their vehicles.

80-90% of charging currently happens at home, likely during evening hours.[19] Level 2 Chargers provide a full charge over an 8-hour period and are amenable to in-home installation, as the charger fits contemporary laundry machine or deep freeze plugs. Outdoor charger installation may require an electrician, but it is a minor procedure. Home charging does not currently present any issues with grid electricity supply, but increased EV uptake may require policy intervention and/or infrastructure upgrades.

EV users increasingly prefer to charge their vehicles at work. A study on consumer preference reported that purchasers would be 20% more likely to choose an EV if there were chargers at their workplace.[20] Greater charging infrastructure at work has several benefits, including reduced need for public chargers, and the potential to use solar PV generated electricity for charging.

EV Model Diversity

Lack of variety in the early stages of EV production presented a sales barrier. Also, to some the EV aesthetic was unattractive and deterred their purchase.[21] An increasing number of vehicle manufacturers now produce different EV models, as shown in Figure 8.

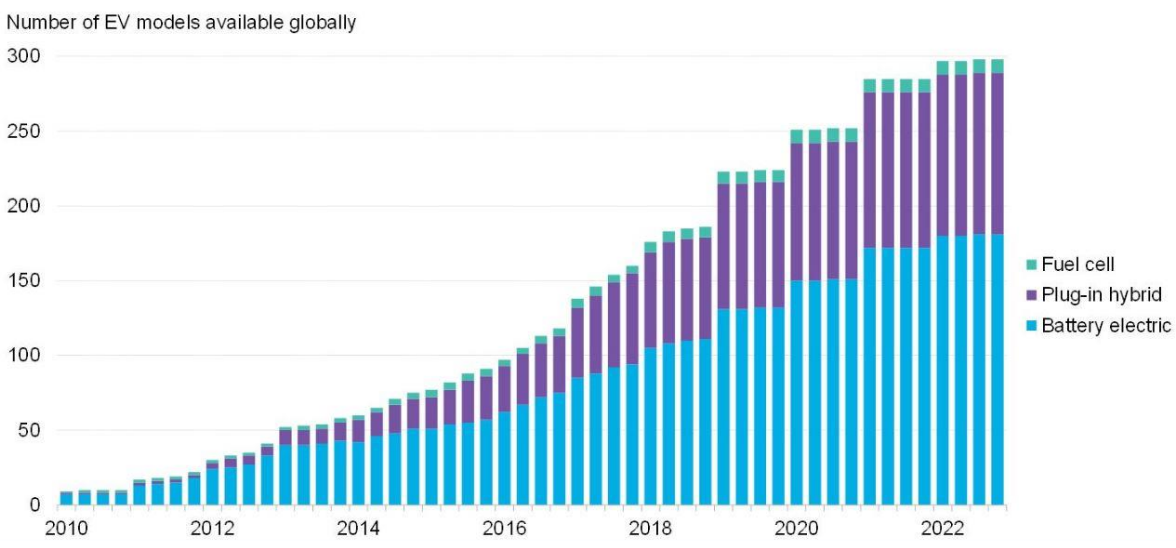

Figure 8. EV model diversity over time.[22]

[19] Plugn'Drive Canada: https://www.plugndrive.ca/wp-content/uploads/2017/07/160159_ElectricVehicleReport_R001.pdf
[20] Hall, Dale, and Nic Lutsey. 2017. "Emerging Best Practices for Electric Vehicle Charging Infrastructure." White Paper. USA: International Council on Clean Transportation. https://www.theicct.org/sites/default/files/publications/EV-charging-best-practices_ICCT-white-paper_04102017_vF.pdf
[21] Plugn'drive Canada: Market Report.
[22] Bloomberg New Energy Finance, Marklines. 2018. Retrieved from: https://twitter.com/colinmckerrache

Heavy Duty Vehicles and Transit Fleets

Electrifying commercial, industrial, and transit vehicles presents a larger challenge than personal vehicles due to the greater size and weight of vehicles, the distance of daily travel for shipping, and the absence of widely-distributed vehicle charging stations. Commercial vehicles that operate solely within urban areas or industrial face lower barriers due to shorter trips and greater charging stations availability. There is promise of new technologies as major companies such as Daimler and Tesla have announced the launch of electric semis able to operate for similar distances as most long distance freight trucks operating today.[23] Many different transit authorities across Canada have tested electric buses and have begun to make commitments to electrify their fleets.

[23] Lambert, Fred. "Daimler Unveils Electric E-Cascadia Semi Truck to Compete with Tesla Semi, Launches Electric Truck Group." Electrick, June 9, 2018. https://electrek.co/2018/06/07/daimler-electric-semi-truck-ecascadia-tesla-semi/

Discussion: Electric Vehicle Uptake Without Intervention

The trends presented above indicate continued increases in EV ownership in Ontario and Sudbury. With falling material prices, EVs are expected to be price competitive with internal combustion engine vehicles by 2024 or sooner, depending on battery price.[24] The Bloomberg report refers to two potential barriers to greater uptake: the availability of cobalt to produce batteries, and the availability of charging facilities for users.[25]

There are 3 types of EV consumers: pioneers, potential early mainstream PEV buyers, and potential later mainstream PEV buyers. Characteristics of the group are summarized in Table 2.

Table 2. Consumer groups and electric vehicles.[26]

Consumer Group	Characteristics
EV Pioneers	This group represents the very first group of buyers, who are generally enthusiasts of the technology, but represent a small market share. Pioneers are likely to have higher income and education levels. This group generally has pro-technology and pro-environmental values.
Potential early mainstream EV buyers	This group represents a larger proportion of consumers. Early mainstream EV buyers will wait until the technology is widely proven and accepted.
Potential later mainstream EV buyers	This group also represents a large market segment. They may become buyers at a future date, but changes in policy, costs, technology, or cultural norms are required.

Consumer surveys and interviews suggest that all three groups would prefer or need some form of incentive in order to purchase an EV (inclusive of the pioneers group).[27] There is some likelihood that the industry trends covered in the previous section will meet the needs of the pioneer group and a proportion of the potential early mainstream EV buyers group.

Significant incentives are needed to meet the greater needs of the early mainstream EV buyers, and even more for the potential later mainstream EV buyers. This may include increased visibility and availability of charging stations, increased knowledge of the technology, and price incentives for vehicles and home chargers. For the later mainstream group who has no current interest in purchasing an EV, policies that would push them towards EVs may include carbon pricing, vehicle taxes, or road pricing that targets internal combustion engine (ICE) vehicles. When surveyed, the potential early and later mainstream EV buyers often referred to price incentives as the major

[24] Electric Vehicle Outlook, 2018. Bloomberg.
[25] Ibid.
[26] Axsen, John, Suzanne Goldberg, and Joseph Bailey. 2015. "Electrifying Vehicles: Insights from the Canadian Plug-in Electric Vehicle Study." Simon Fraser University: Sustainable Transportation Research Team. http://rem-main.rem.sfu.ca/papers/jaxsen/Electrifying_Vehicle_(Early_Release)-The_2015_Canadian_Plug-in_Electric_Vehicle_Study.pdf.
[27] Ibid.

incentive that would convince them to purchase an EV, but greater stability in the technology will also be required to ensure EVs meet their needs.[28]

Intervention from different groups is also needed to promote knowledge about EVs and about incentives when they become available. Plug'n Drive Ontario released a consumer survey that found that potential car consumers were unaware of any vehicle incentives, reduced costs over time from driving an EV, and unaware of GHG emissions resulting from ICE vehicles.[29] Specific to driving and charging, other surveys found that a large proportion of vehicle consumers were unaware of nearby charging stations, the distance that an electric vehicle could travel on a charge, or how to charge an EV.[30] Relaying information about the cost savings of owning and operating EVs versus ICE vehicles to the public is a simple step EV proponents can take (Figure 9).

Industry trends suggest that EVs will become cheaper and reduce the price gap with ICE vehicles, but more incentives, awareness campaigns, and policies will be required to increase EV uptake. These actions are especially necessary to meet 2050 emissions targets.

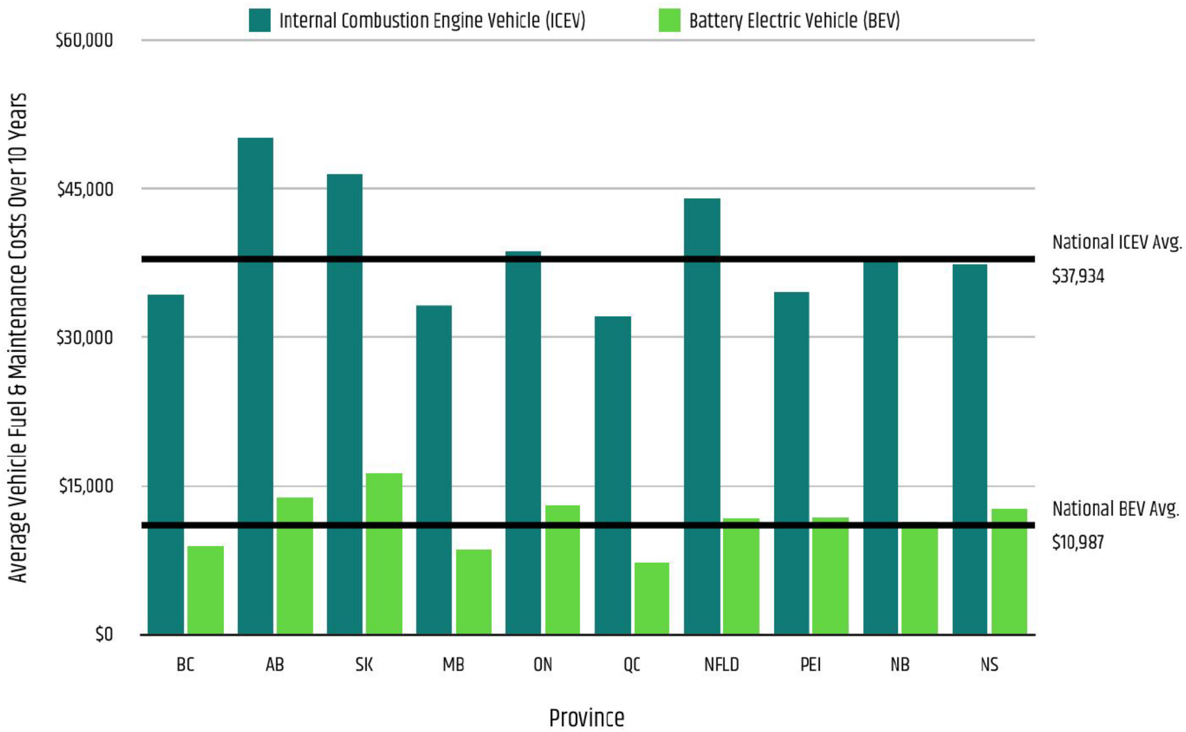

Figure 9: Average 10-year fuel and maintenance costs of ICE vehicles and BEV per household.[31]

[28] Ibid.
[29] Driving EV Uptake in the Greater Toronto and Hamilton Area. Plug'nDrive. May 2017. http://www.plugndrive.ca/wp-content/uploads/2017/07/EV-Survey-Report.pdf
[30] Electrifying Vehicles: Insights from the Canadian Plug-in Electric Vehicle Study.
[31] 2° Institute, 2018. *Comparing Fuel and Maintenance Costs of Electric and Gas Powered Vehicles in Canada*. https://www.2degreesinstitute.org/reports/comparing_fuel_and_maintenance_costs_of_electric_and_gas_powered_vehicles_in_canada.pdf

3. Policies and Programs to Promote EV Uptake

There are two main approaches to encourage potential buyers to choose EVs: through "push factors", which may add fees or "penalize" someone from choosing to drive a gas or diesel powered vehicle, and "pull factors" which encourage or make it more convenient and accessible to use electric vehicles. Push factors such as road pricing, carbon pricing, and vehicle taxes require participation and approval from senior levels of government and other stakeholders, but several other policy measures are available to municipalities. A summary of push and pull factors is provided in Figure 10.

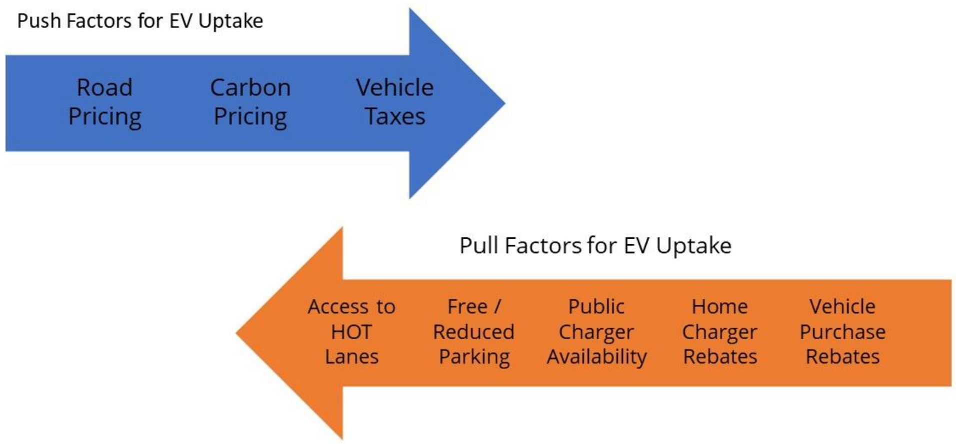

Figure 10. Push and pull factors for EV uptake.

Provincial and Federal Policies and Funding Programs

Funding, awareness, and incentive programs stemming from the Federal and Provincial government will continue to be the strongest levers in an EV strategy. These programs may periodically be put on hold or be given increased funding depending on priorities. Both the Federal and Provincial Governments are capable of providing large financial incentives to consumers and reducing the current price gap between EVs and ICE vehicles.

Federal Policies and Funding

The Energy Innovation Program (EIP) 2016[32]

Commencing in 2016, Natural Resources Canada (NRCan) received $49 million over 3 years to support clean energy initiatives. This program is supported by the Federal Government with the intention of transitioning to a low-carbon economy. Priority areas of the program are:

- Renewable, smart grid and storage systems;
- Reduced diesel use by industrial operations in northern and remote communities;
- Methane and VOC emission reduction;
- Reduced GHG emissions in the building sector;
- Carbon capture, use and storage; and
- Improved industrial efficiency.

[32] Energy Innovation Program (EIP), information retrieved from: https://www.nrcan.gc.ca/energy/funding/icg/18876

This program has funded multiple zero emission vehicle programs across the country including projects such as: EV charging stations across the Trans-Canada Highway, developing electrical safety standards for EVs in Canada, the Electric Mobility Adoption and Prediction Tool, and battery density studies for EVs.

Federation of Canadian Municipalities (FCM) Green Municipal Fund[33]

The FCM provides funding and knowledge services to support sustainable and low-carbon actions in cities. The Green Municipal fund provides funding for plans, feasibility studies, pilot projects, and capital projects. One strategy area is under "Transportation and fuel efficiency" where municipalities have applied to fund initiatives to green their fleets, developing city-wide EV strategies, and start-up the process to install EV charging stations across a city. For example, FCM helped the City of Vancouver launch their EV strategy commencing in 2005. It includes a network of public charging sites across the city, updating building code requirements to be EV-ready, updating the municipal fleet, and having a fast charging demonstration project.[34]

Pan-Canadian Framework[35]

In December 2016, the Government of Canada adopted the Pan Canadian Framework on Clean Growth and Climate Change with the goal to reduce GHG emissions and build resilience to adapt to a changing climate. The framework had a 2016 budget proposal to invest in strategies to reduce GHG emissions from transportation and fuel emissions among a diversity of other sectors. This investment includes $3.25 million in funding for electric and alternative fuel vehicle information technology development; an additional $62.5 million to fund charging infrastructure and research for the next generation of recharging technologies.

Provincial Policies and Funding

The Province of Ontario has a proven track record through previous incentive programs to aggressively increase EV uptake within the province. Recent initiatives such as the Electric Vehicle and Charging Incentive Program, The Cap and Trade program for emissions, and the Green Climate Fund were all proven to move the province away from ICE vehicles and their related emissions. Should policies around these areas return in the future, there is an increased likelihood of meeting aggressive goals for EV uptake.

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[33] Green Municipal Fund, retrieved from: https://fcm.ca/home/programs/green-municipal-fund/what-we-fund/eligibility/transportation-funding.htm
[34] Vancouver EV strategy 2011-2016, Green Municipal Fund. Retrieved from: https://fcm.ca/home/awards/sustainable-communities-awards/past-winners/2014-winners/2014-transportation.htm
[35] Government of Canada. Pan-Canadian Framework on Clean Growth and Climate Change: http://publications.gc.ca/collections/collection_2017/eccc/En4-294-2016-eng.pdf

Municipal Policies for Electric Vehicles

Municipal policies and incentives are strongest when paired with those of senior levels of government. If senior support is lacking, municipal efforts can still spearhead policy to promote awareness and provide strategic infrastructure for EVs and to encourage uptake.

Table 3. Sample municipal policy initiatives for EV adoption.

Policy	Description
Gas station retrofits and new development	As gas stations renew or are developed,[36] a bylaw that mandates EV charging infrastructure be placed on-site can increase EV charging spots within the city.
Update Zoning and Building bylaws for residential and commercial buildings	For new multi-family, commercial, or mixed-use developments within Greater Sudbury, EV chargers installation can be mandated. Alternatively, new developments can also be "EV ready" by providing plug capacity for level 2 chargers (240 V).
EV charging stations on municipal land	Greater Sudbury can make use of municipal lands to begin providing greater public EV charge points for drivers in the community. Recreation, cultural centres, government buildings, or utility buildings can help a municipality to begin developing a network of charge points.
Municipal bulk EV purchases	A municipality can partner with large employers (hospitals, universities, school boards, taxi companies, and industrial employers) to purchase EVs in bulk. This approach has been pioneered by the US Coalition of Mayors who issued a Request for Proposals to purchase more than 100,000 EVs.[37]
City fleet renewals	The city vehicle fleet can renew every 30 years or less, and policy to renew the fleet to be electric will allow the municipality to lead the community to a low-carbon future. Renewal can also be accelerated with a cost analysis of EV versus ICE purchase and operating costs that shows the ideal transition time for vehicle replacement with EVs. This policy can work in tandem with the bulk purchases policy above.
Taxi bylaw	A proposed bylaw change requiring that all new taxis transition to low-carbon sources at time of renewal, a 10-year period under Greater Sudbury's current bylaw.
Transit fleet renewal	The Greater Sudbury Transit provider has 58 buses running primarily on diesel fuel or as hybrid-diesel. Transit electrification can have large emission reductions while encouraging EV uptake in the community.
Residential subsidies for home chargers	A subsidy or rebate program for residences to purchase home chargers can help new vehicle buyers choose EVs and provide security in always having an available charge point.
Workplace subsidies	Subsidies for workplaces to install chargers for EV drivers to charge while at work can provide confidence that commuters can get home and to work.
Prioritized parking	Greater Sudbury can allow priority parking for EVs.

[36] e.g.: Petro Canada stations charging initiative: https://www.petro-canada.ca/en/personal/fuel/alternative-fuels/ev-fast-charge-network

[37] Lambert, Fred. 2017. "U.S. Cities' Massive Electric Vehicle Order Increases to 114,000 Vehicles, ~40 Companies Competing." *Electrek*, March 15, 2017. https://electrek.co/2017/03/15/electric-vehicle-order-114000-vehicles-40-companies-competing/

Supporting Industrial Fleet EV Transition

Electrification can be a benefit to industry in two major ways: reducing expenses related to fuel, and reducing air pollutants from diesel vehicles associated with industrial activity. Heavy duty vehicles rely more on diesel fuel for energy, which has lower costs but produces more particulate matter, and can be dangerous to human health in confined areas such as Greater Sudbury's mines.

Municipal authorities' influence in transitioning industrial and commercial fleets towards electrification is limited. Commercial and industrial businesses in Sudbury have an interest in reducing their costs through reduced fuel use and vehicle maintenance costs and should be motivated to make the transition to electricity where feasible. However, if there is no financial benefit to transition, there is less incentive to make the switch. Policies such as carbon pricing can be effective in encouraging industries to use more efficient and low carbon vehicles, but intervention from senior levels of government are typically required to implement such tools.

A non-traditional method that cities can use to partner with large institutions or industry is to create bulk purchase agreements. The region can create an RFP to order new vehicles fleets for itself and other organizations to reduce the overall purchase costs due to a large and consistent order. As mentioned in the table above, US Cities including Los Angeles, San Francisco, Portland, and Seattle put a group order exceeding 100,000 electric vehicles to renew their fleets.

Other methods for encouraging electric vehicles in industrial fleets include using information such as reduced energy costs, reduced time and cost on maintenance of vehicles (Figure 10), reduced particulate matter, exhaust, and pollution in closed environments (mines) that accompany heavy-duty diesel vehicles, and lower carbon mining processes.

4. EV Policy Benchmarking, Successes and Challenges

Many municipalities have begun to set electric vehicle targets and initiatives. Table 4 summarizes a varying degree of resources dedicated towards increasing EV adoption depending on community size and ambition. Larger cities featured in the table below have seen higher rates of EV uptake than smaller to this point, and have increased infrastructure available. Other cities are considering strategies for more home charing. Most cities have set a goal to convert their municipal fleet to electric.

Table 4. Electric vehicle benchmarks in other jurisdictions.

City/Region	Public EV target or / EV policy	Existing Stations [38]	Transportation Emissions	Emissions Target
Kingston[39]	• Increase charge points from 8 to 50, with 2 DC fast chargers • Add 62 Charging Stations in partnership with Tesla at Kingston University	40-50	422,000 tCO2e, representing 30% of Kingston's total emissions	Reduce emissions by 15% by 2020, and 30% by 2030
Toronto[40,41]	• Install 14 curb-side charging stations using existing telephone poles, in addition to 5 existing stations • Scale up charging stations depending on demand	80-100	6 million tCO2e, (31% of community emissions)	Reduce community emissions 80% by 2050
Guelph[42,43]	• Consider adding Home-charging stations as part of residential retrofit program • Make transit 100% electric • Incrementally green the municipal fleet	12-15	347,000 tCO2e, (32.4% of community emissions)	Net Zero Carbon by 2050
Ottawa[44,45]	• Incrementally increase the municipal fleet to 100% electric • Partner with Hydro-Ottawa to	60-70	2.1 million tCO2e (42% of community emissions)	Reduce emissions by 80% by 2050 from 2012 levels

[38] Approximate counts based on Chargehub mapping, stations can have multiple ports. "Charging Stations Map." n.d. Chargehub. https://chargehub.com/en/charging-stations-map.html.
[39] Kingston EV Strategy (2017): www.cityofkingston.ca/residents/environment-sustainability/climate-change-energy/electric-vehicle-charging-stations
[40] Transform TO Baseline Report (2016). Prepared by SSG.
[41] "Preparing Toronto for Electric Vehicles." 2017. Report to Committee. City of Toronto. https://www.toronto.ca/legdocs/mmis/2017/pw/bgrd/backgroundfile-107507.pdf.
[42] Guelph Baseline Emissions Analysis, 2016. Prepared by SSG.
[43] "Guelph Community Energy Initiative." 2018. Report to Council. Our Energy Guelph. Guelph, Ontario: City of Guelph. https://guelph.ca/wp-content/uploads/cow_agenda_050718.pdf#page=53.
[44] City of Ottawa Baseline Emissions (2016). Prepared by SSG.
[45] "Ottawa's Community Energy Transition Strategy - Phase 1." 2017. Energy Evolution. Ottawa: Planning, Infrastructure and Economic Development. https://documents.ottawa.ca/sites/default/files/energy_evol_phase1_en.pdf.

	keep pace with demand for charging stations			
Ontario[46]	• 5% of new vehicles sold are electric by 2020 • Install 500 public charging stations across the province	1400+	58.7 MtCO2e, representing 34% of provincial emissions	GHG Goal: *Currently Under Review*
Vancouver[47, 48]	• 22% of Vehicles are electric by 2050 • Install 20 curbside chargers as a pilot, 20 charging stations at community centres, and 8-10 additional stations across the city • Incrementally increase municipal vehicle fleet to 100% electric	80-100	815,000 tCO2e, representing 30% of community-wide emissions	Reduce community-wide emissions by 80% by 2050 from 2005 levels
Montreal[49]	• Install 1,000 charging stations by 2020 • 100% of new bus orders are electric by 2025[50] • Incrementally increase municipal vehicle fleet to 100% electric	400+	4.6 million tCO2e (40% of total emissions)	Reduce city GHG emissions by 30% by 2020 from 1990 levels, and 80% by 2050

EV Strategy Successes to Date

Many cities are seeing an uptake of electric vehicles and see this as an opportunity to move towards a low-carbon economy. Vancouver has seen a 70% growth in EV ownership from 2011 to 2018.[51] As a response, the city created their goals for an EV "Ecosystem" to push this trend forwards. Quebec has been consistent and aggressive with their EV policies and has led the country in EV sales other than 2017 where Ontario surpassed them.[52] Through the Electric-Circuit Initiative, Quebec has established a goal of creating charging stations throughout the province to provide options for residents to travel province-wide without risk of losing their charge. The province currently has 130 DC fast chargers and targets an additional 1,600 in 10 years.[53] The City of Montreal has targeted electric vehicles as a significant pathway to meet their climate goals, and has successively installed 200 charging stations annually, alongside being a

[46]"Ontario Long-Term Energy Plan 2017." 2017. Delivering Fairness and Choice. Ontario: Ministry of Energy. https://files.ontario.ca/books/ltep2017_0.pdf.
[47] City of Vancouver. 2015. "Renewable City Strategy- 2015-2050." http://vancouver.ca/files/cov/renewable-city-strategy-booklet-2015.pdf.
[48] "Vancouver's EV Ecosystem Strategy." 2016. Renewable Energy Strategy. City of Vancouver: Engineering and Sustainability. https://vancouver.ca/files/cov/EV-Ecosystem-Strategy.pdf.
[49] "SUSTAINABLE MONTRÉAL 2016-2020." 2016. Ville De Montreal. http://ville.montreal.qc.ca/pls/portal/docs/page/d_durable_en/media/documents/plan_de_dd_en_lr.pdf.
[50] "Electric Bus: 365 Days and 8,781 Charges Later." n.d. Transit. Société de Transport de Montréal. http://www.stm.info/en/about/major_projects/bus-network-electrification/electric-bus.
[51] Vancouver EV ecosystem strategy.
[52] Fleet Carma Outlook.
[53] "Québec Introduces Bill to Promote the Establishment of a Public Fast-Charging Service for Electric Vehicles." 2018. Government. The Electric Circuit. May 15, 2018. http://news.hydroquebec.com/en/press-releases/1356/quebec-introduces-bill-to-promote-the-establishment-of-a-public-fast-charging-service-for-electric-vehicles/.

pioneer for electric buses. Laval, QC is the first Canadian city to offer a rebate program for electric vehicles for $2,000 to enhance the provincial rebate program, and has extended the program due to its popularity.[54] More case study success stories can be found in Appendix 2.

Public Charging Stations Background

Research suggests there is a relationship between the availability of public charging infrastructure and greater uptake of EVs. Best practices from European cities show that availability of public chargers can influence buyer behaviour, especially when paired with other incentives. The figure below illustrates public charge points in various cities compared to the number of EVs and the respective population. Many European cities with older building stock do not have off-street parking for cars, thus increasing the importance of public charging infrastructure. North American cities such as San Francisco, Los Angeles, and San Jose have a newer building stock built with requirements for off-street parking, making home charging more viable.

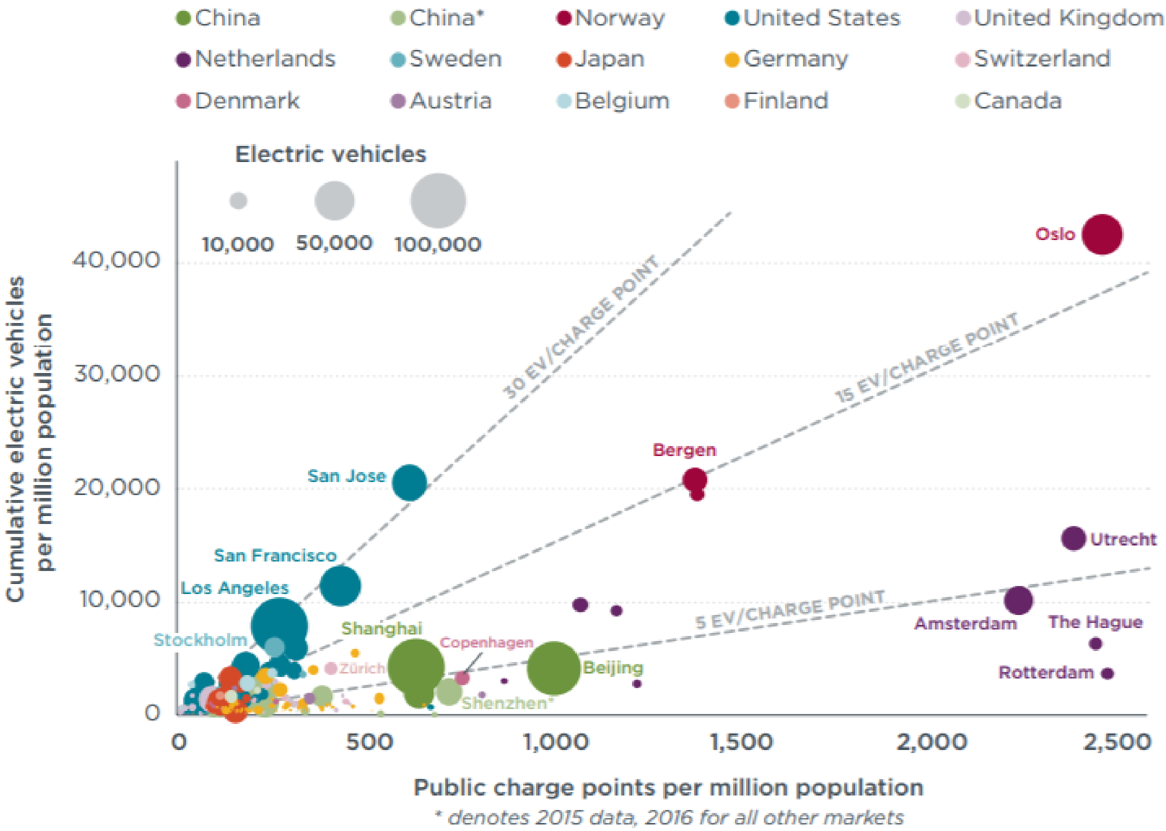

Figure 11. Charge points compared to EV cars in use.[55]

Sudbury's housing stock has a large share of single-detached housing (62.1%) enabling the City to consider initiatives such as incentivizing home charging or workplace charging in addition to public charging stations. Consultation with residents to understand the demand for EVs and how they intend to use and charge vehicles will be critical to develop a strong charging network for the city.

[54] CBC. 2018. "Laval Extends Electric-Vehicle Subsidy in Response to High Demand," October 15, 2018. https://www.cbc.ca/news/canada/montreal/laval-electric-vehicle-subsidy-demand-1.4864028.
[55]ibid.

Barriers to EV Ownership and Charging

Consumer Barriers

There are four major consumer barriers that prevent faster uptake of electric vehicles[56]:

1. **Low model diversity:** EV models are limited. Many drivers prefer light trucks, sport utility vehicles, or family-sized vehicles, which are not widely available as EVs. This barrier has decreased—and will continue to decrease—over time as vehicle manufacturers join the EV marketplace and offer additional models.

2. **Up-front cost:** EVs are more expensive to purchase than their ICE counterparts. For example, a 2017 Nissan Leaf will be priced at $36,000 CAD compared to a 2017 Honda Civic at $23,000 CAD.[57] In the absence of subsidies, this discourages EV purchases. However, providing operating cost information to drivers can help overcome this barrier.

3. **Range-Anxiety:** A fear of battery depletion before a trip or several trips are concluded may prevent consumers from choosing EVs, despite the vast majority of trips being short and the average driving distance of EVs greatly exceeding typical total daily driving distance. Furthermore, when people consider the option to purchase a new vehicle there is a tendency to think of long-distance trips (vacations, road trips) and believe that EVs are not be capable of travelling that distance.

4. **Lack of Convenient Public Charging:** Many cities are in their infancy for publicly available charging stations. As stations are not yet ubiquitous in cities, there is less signalling for drivers that they can take a number of trips in different areas of a city and be assured that they will be able to return home.

"Lock-in" Effect of Technology

In addition to these consumer barriers, there is also a charging infrastructure barrier with building owner/operators who may be resistant to upgrading buildings' charging technology (i.e. Level 1 to Level 2, Level 2 to DC Fast). This barrier may be due to a lack of willingness to pay the capital costs of the upgrades and/or the perception that charging infrastructure is bound to change in the short term and they should wait and see.

Electric Grid Capacity and Safety

EV charging has the potential to use vast amounts of power, and although it currently does not pose any substantial risk to the grid according to the IESO, this is an issue to consider by authorities as the market grows. The increasing number of DC Fast Chargers presents an upcoming challenge due to the high amounts of energy required over a short period of time (1 hour or less). This challenge can grow with greater EV uptake and if consumer demand pushes for even faster charging.

Research completed by the City of Toronto, under the TransformTO program has shown that early EV adopters tend to cluster in specific neighborhoods and share similar charging patterns,

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[56] "Accelerating the Deployment of Plug-In Electric Vehicles in Canada and Ontario." 2017. Plug'ndrive Canada. http://www.plugndrive.ca/wp-content/uploads/2017/07/160159_ElectricVehicleReport_R001.pdf.
[57] "New vehicle estimates: Honda Civic, Nissan Leaf." Carcost Canada. https://carcostcanada.com/

for instance between 7pm and 9pm.[58] As a peak demand issue, multiple vehicles charging on the same street simultaneously could potentially lead to localized electrical service disruption, particularly as the number of EV owner households increase.

Toronto Hydro, as a local energy provider, is actively working on this issue and in 2016 completed the Charge TO project with its industry partners to manage local electrical impacts. Toronto Hydro has also created web-based educational material and various social media material towards encouraging EV charging to avoid local impacts. A best practice at this time is to ensure that charging stations are placed near high-capacity electrical infrastructure.

Municipal Authority and Jurisdiction
Provincial subsidies offsetting EV prices were effective in increasing uptake, however funding for these initiatives has waned. As financial incentives are considered one of the major incentives to encourage EV uptake, municipalities will find it difficult to fill this incentive gap. Although municipal subsidies could be provided, they may detract from other competing City interests such as public amenities or affordable housing.

Policies such as carbon pricing can also discourage vehicle trips, or encourage EV ownership by increasing costs related to fossil fuels and thereby tipping the scale to choose alternative modes of travel. These "push" policies are generally under the jurisdiction of the Provincial or Federal government, however.

Legal Considerations
With expanded workplace charging or privately owned curbside charging, Greater Sudbury may be required to work with the IESO and/or local utilities to ensure that businesses or individuals can (re)sell electricity on fee-based charging systems.

[58] "Preparing Toronto for Electric Vehicles." 2017. Report to Committee. City of Toronto. https://www.toronto.ca/legdocs/mmis/2017/pw/bgrd/backgroundfile-107507.pdf.

5. Analysis

EV Stock and Emission Scenarios

Three scenarios were modelled to explore energy and emissions effects of different EV uptake scenarios: Business as Usual (BAU), Moderate, and Aggressive, as detailed in Table 5.

Table 5. EV uptake scenarios and assumptions.

Vehicle Type	BAU (no extra efforts or actions)	Moderate (concerted municipal effort to increase EVs)	Aggressive (every possible municipal effort is made to increase EVs)
Passenger	Based on current market trends, EV sales constitute 3% of all new personal vehicles by 2040.	Based on 30@30 Scenario by the International Energy Agency:[59] • 30% of Vehicle sales are electric by 2030 • 40% by 2040 • 50% by 2050	A scaled up approach to the IEA projections • 50% of vehicle sales are electric by 2030 • 100% by 2050
Municipal fleet, commercial/ industrial fleets	No change	100% of municipal and industrial fleets are electric 2040	100% of municipal and industrial fleets are electric by 2030
Public transit fleet	No change	100% of transit fleet is electric by 2040	100% of transit fleet is electric by 2030

Table 6. Modelled Greater Sudbury EV stocks by scenario, 2035 and 2050.

	BAU	Moderate	Aggressive
Total 2035 modelled EV stock	2,455	16,528 (over 14,000 more than BAU)	18,936 (over 16,000 more than BAU)
Total 2050 modelled EV stock	4,612	38,012 (over 33,000 more than BAU)	82,474 (almost 78,000 more than BAU)

Both the Moderate and Aggressive Scenarios represent a vast increase in EV uptake over the BAU Scenario. A variety of EV purchasing incentives and programs, charging station implementation strategies, and promotional strategies would be required to achieve such accelerated uptakes.

[59] "Global EV Outlook." International Energy Agency, 2018. https://webstore.iea.org/download/direct/1045?fileName=Global_EV_Outlook_2018.pdf.

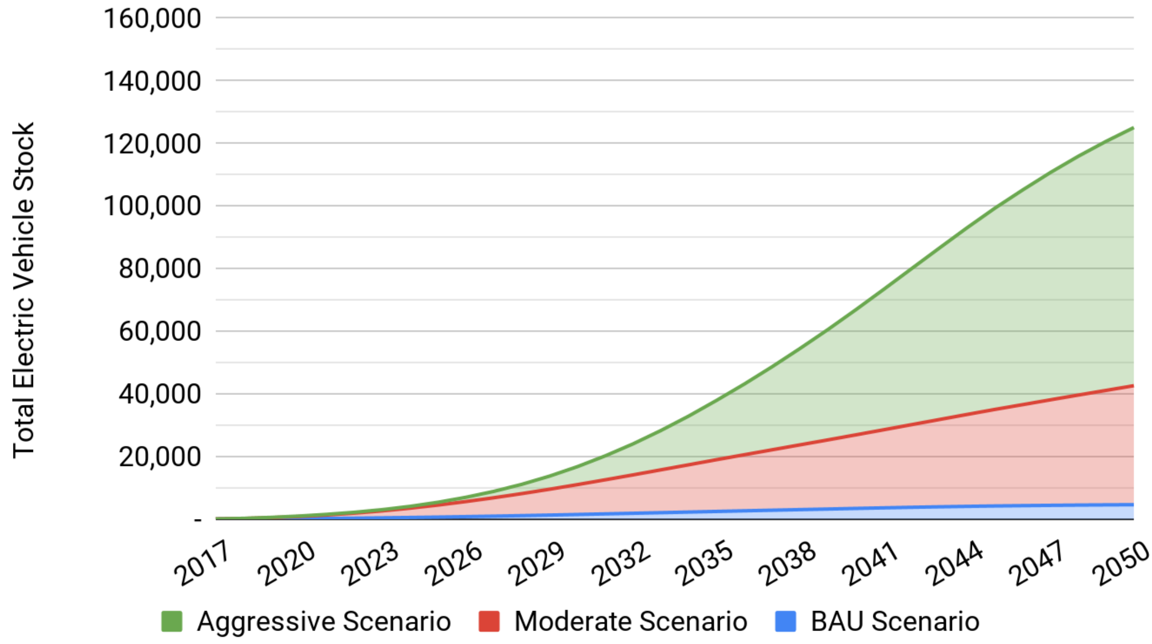

Figure 12. EV Uptake projections for the BAU, Moderate, and Aggressive Scenarios.

Under the Aggressive Scenario, a small proportion of vehicles remain as gas powered internal combustion engine by 2050, and the majority (90%) becomes electric. The figure shows the growth from 22 battery electric vehicles in 2016 to over 82,000 in 2050. In 2050, approximately 12,500 Gas powered (ICE) vehicles remain on the road.

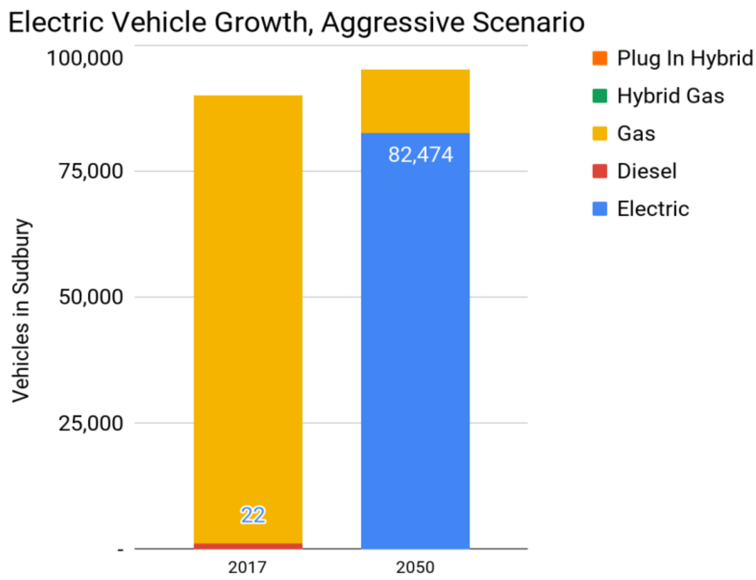

Figure 13. Modelled EV stock growth.

Energy Use and Emissions Scenarios

Energy Use

In the BAU Scenario, transportation sector energy consumption is projected to decrease by 26%, from 8.1 million GJ in 2016 to 6 million GJ in 2050. The decrease is largely due to vehicles becoming more fuel efficient and gasoline becoming less carbon-intensive under federal regulations. The BAU also includes a conservative estimate for EV update. The Moderate Scenario results in an energy use decline of 39% by 2050 to 4.9 million GJ, and the Aggressive Scenario results in a decline of 53% by 2050 to 3.8 million GJ. In the Moderate and Aggressive uptake scenarios, energy use overall declines due to the improved efficiency of electric engines over internal combustion engines. The Moderate and Aggressive Scenarios diverge in 2035 where the amount of electric cars on the road in the Aggressive Scenario double that in the Moderate Scenario.

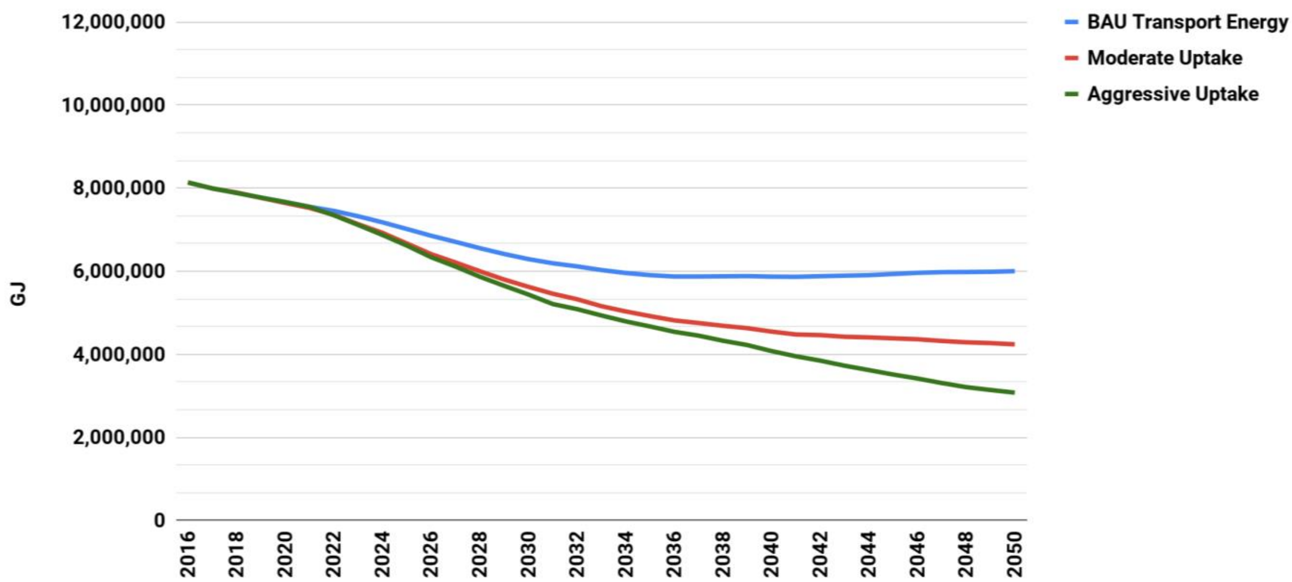

Figure 14. Modelled energy use considering EV uptake rate scenarios.

Gasoline use decreases by 50% from 2016 to 2050 in the Moderate Scenario, and 75% in the Aggressive Scenario. During this period, electricity use increases from 115 GJ to 640,000 GJ in the Moderate Scenario, and to 1.3 million GJ in the Aggressive Scenario (Figure 14).

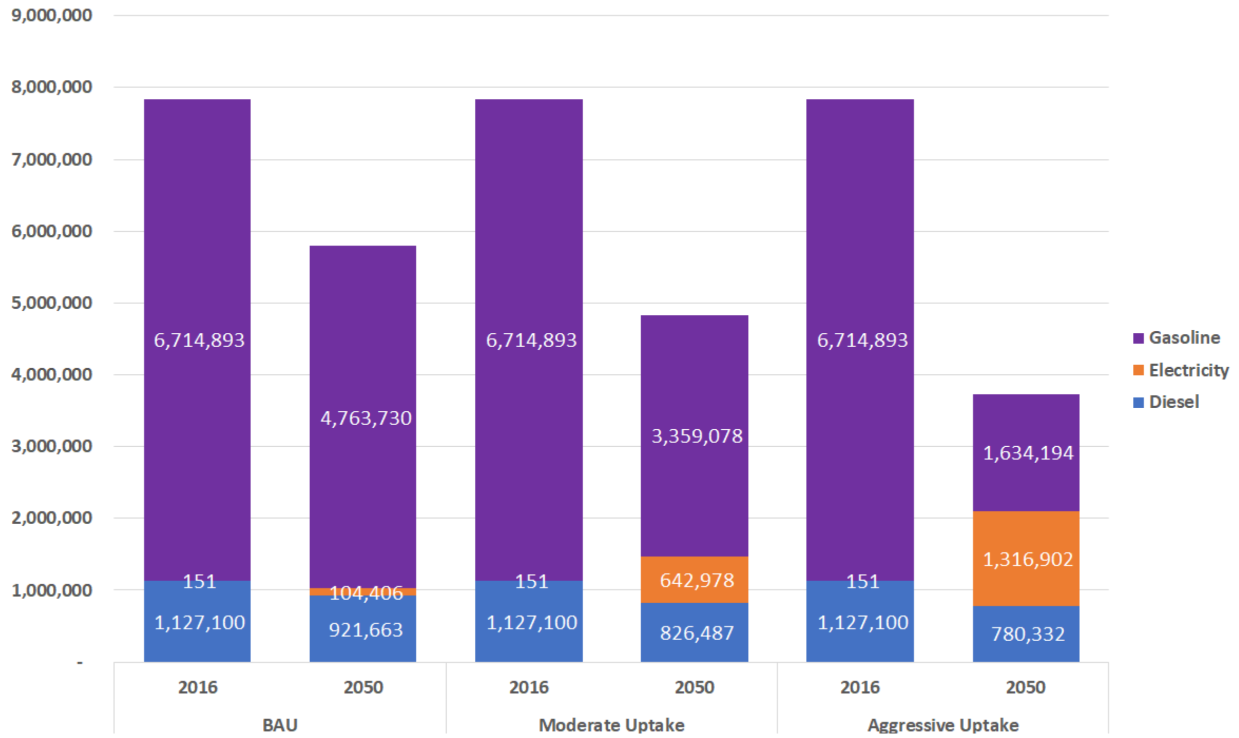

Figure 15. Energy by fuel type, 2016 and 2050.

Emissions

Transportation emissions drop by 50% compared to 2016 in the Moderate Scenario and by 72% in the Aggressive Scenario due to decreased gasoline and diesel use. Some emissions are decreased as electricity sourced from the grid starts to be generated by more renewables, decreasing the grid's emissions intensity factor. As with the energy use results, the Moderate and Aggressive Scenarios diverge in 2035 where EVs are doubled.

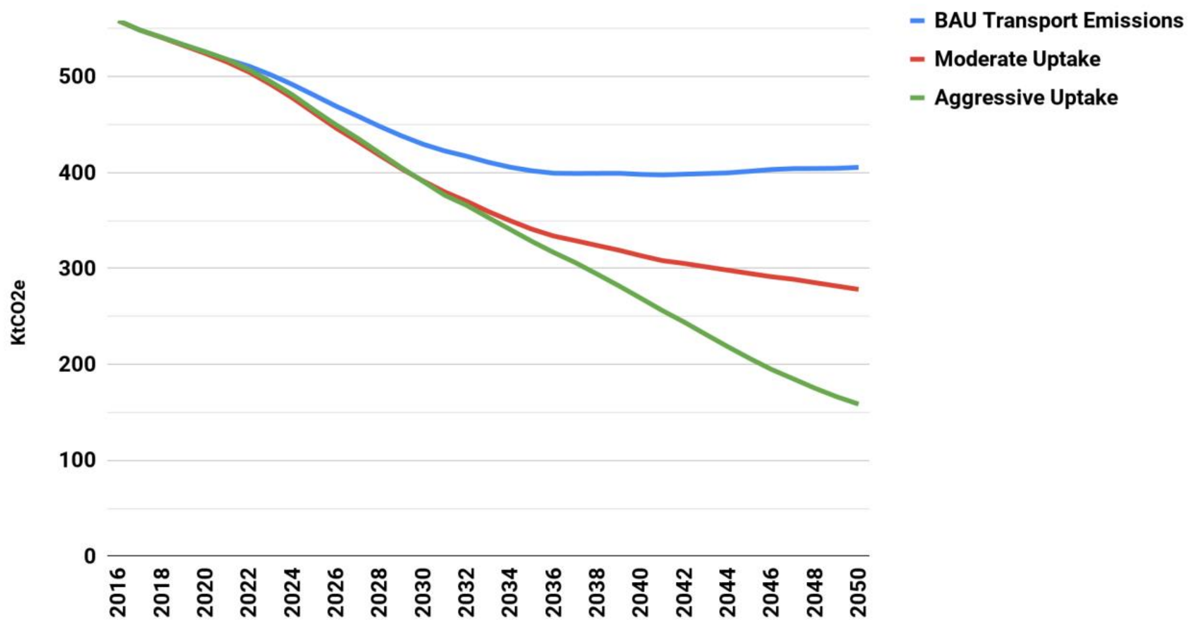

Figure 16. Emission scenarios for EV uptake.

Modelling Summary

The tables below detail the energy and emissions outcomes for each scenario. The biggest impact results from transitioning personal vehicles from internal combustion engine powered to electric. Transforming the industrial fleet has the second largest impact, followed by transit and finally the municipal fleet. The Aggressive Scenario would achieve a 72% reduction in transportation emissions under 2016 levels by 2050, with nearly 3,000 ktCO2e cumulatively mitigated by 2050. This scenario would also reduce 42.4 million GJ of energy in the transportation sector in this period—a 63% reduction.

Table 7. Moderate Scenario actions.

Action	Cumulative emissions reductions 2016-2050 (kt CO2eq)	Emissions reductions 2050 (kt CO2eq)	Cumulative energy reductions 2016-2050 (GJ Millions)	Energy reductions 2050 (GJ)
Electrify 100% of transit fleets by 2040	84.5	5.6	1.20	82,000
Electrify 100% of city fleets by 2040	46.2	2.5	0.44	20,000
• 30% of vehicle sales are electric by 2030 • Scale to 40% by 2040 • Scale to 50% by 2050	1,251.4	93.5	12.2	914,992
Electrify 100% of industrial fleets by 2040	541.6	25.6	15.8	744,000
Total	**1923.8**	**127.2**	**29.6**	**1,760,992**

Table 8. Aggressive Scenario actions.

Description	Cumulative emissions reductions 2016-2050 (kt CO2eq)	Emissions reductions 2050 (kt CO2eq)	Cumulative energy reductions 2016-2050 (GJ Millions)	Energy reductions 2050 (GJ)
Electrify 100% of transit fleets by 2040	142.7	5.8	2.10	83,966
Electrify 100% of municipal fleets by 2040	63.0	2.5	0.60	24,096
• 30% of vehicle sales are electric by 2030 • Scale to 40% by 2040 • Scale to 50% by 2050	2,147.7	212.9	21.0	2,076,300
Electrify 100% of industrial fleets by 2040	635.8	25.6	18.7	744,000
Total	**2,983.3**	**246.9**	**42.4**	**2,924,300**

6. Recommendations and Summary

Municipal EV actions can be grouped into five major themes:

- Municipal policy changes;
- Subsidies and incentives;
- Education and marketing;
- Charging infrastructure provision; and
- Governance and leadership.

A variety of actions in each area can be taken by the City of Greater Sudbury and its partners to accelerate EV uptake and reduce the city's transportation emissions.

Municipal Policy Recommendations

There are several policy-related actions that the City should consider to encourage EV uptake, including the following.

Update Building Development Applications, Building Permits, Rezoning and Retrofitting Policies

The City should create several policies to require and encourage EV charging infrastructure in new and existing buildings.

1. **New multi-family buildings**: create Zoning Bylaw and Building Code requirements for at minimum Level 2 Charger outlet provision for 50% of parking spaces in all new multi-family buildings, with minimum Level 2 Charger ready wiring installed for the remaining spaces.
2. **Existing multi-family buildings**: Provide funding through incentives or rebates to building owners and operators to encourage retrofitting 10% of buildings' parking spaces with at minimum Level 2 Chargers.
3. **New non-multi-family residential buildings**: create Zoning Bylaw and Building Code requirements for all new single family homes, duplexes, row houses, etc. to include electrical infrastructure making them at minimum Level 2 Charger ready.
4. **Existing non-multi-family residential buildings**: Provide funding through incentives or rebates to homeowners to encourage retrofitting with Level 2 Chargers at minimum.
5. **New commercial buildings**: create Zoning Bylaw and Building Code requirements for at minimum Level 2 Charger outlet provision for 25% of parking spaces, placed in preferred parking areas.
6. **Existing commercial buildings**: Provide funding through incentives or rebates to building owners and operators to encourage retrofitting 10% of buildings' parking spaces with Level 2 Chargers at minimum, placed in preferred parking areas.

Retrofitting multi-family buildings can be especially challenging, as the electrical infrastructure may not be present to support EV charging stations. One source of inspiration in this area is Metro Vancouver's Electric Vehicle Charging in Condos, Apartments and Townhomes program.[60]

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[60] http://www.metrovancouver.org/services/air-quality/climate-action/transportation-programs/ev-strata-condo/Pages/default.aspx

Include EV Infrastructure Data in Building Records

If it hasn't already, the City should add EV charger record keeping policies in its development application and renovation records keeping to have a city-wide database of buildings that have installed EV charging equipment and are EV charger ready. This will provide a map of EV charging infrastructure across the City, indicating where significant gaps exist while tracking the age of the infrastructure, which will help infrastructure renewal planning.

Update Relevant City Plans

Several City bylaws and planning documents should be updated to include special provisions for EV charging infrastructure (and fees) and assignment of preferred EV parking spaces, including:

- Greater Sudbury's Official Plan's Transportation section;
- The Zoning Bylaw;
- Traffic and Parking Bylaw;
- Licensing, Regulating and Governing of Taxi, Limousine, and Shuttle Transportation Bylaw;
- The Downtown Community Improvement Plan;
- The Downtown Sudbury Master Plan; and
- Other Community Improvement and Incentive Programs.

The City can coordinate plan updates with a goal of providing a target percentage of all public parking with EV charging infrastructure by 2025 (see Charging Infrastructure section below).

Update the Licensing, Regulating and Governing of Vehicles for Hire

The City should encourage the use of electric vehicles for hire through reduced business license fees or via a new/replacement vehicle incentive program, in the short term. The City can work with vehicle for hire service providers to assess the financial implications of transitioning their fleets to EVs. The Licensing, Regulating and Governing of Taxi, Limousine, and Shuttle Transportation bylaw could also be updated to require vehicle for hire service providers to purchase EVs when updating their fleets.

Subsidies and Incentives

A variety of subsidy and incentive approaches exist to encourage EV uptake. The City can consider the following options and implement those it feels are most mutually supportive and likely to succeed.

Provide Business Licensing Subsidies

The City could offer a business license discount or similar incentive to those businesses who install charging stations (at minimum Level 2, from a selection of charger types specified by the City) in preferred parking spaces. This promotion can also be extended to other licensed entities, like campgrounds. The discount could scale by ratio of available parking spaces to charging spaces—the smaller the ratio the greater the discount. The discount could reduce or waive business license fees for a a single year or for multiple years, depending on what is considered an effective incentive.

Provide Property Tax Incentives

The City could offer a one-time annual property tax decrease incentive for property-owners, businesses and institutions if they install at minimum Level 2 Chargers for private or public use on their premises.

Provide EV Purchase Subsidies

The City should perform an accounting exercise to determine the viability of dedicating annual budget to providing EV purchase subsidies in the range of $500-$2500 per vehicle. A social cost of carbon exercise should be a part of this exploration, to compare the cost differences between action (reducing emissions) and inaction (emissions increase). If viable, a subsidy program could be developed to encourage car buyers to purchase EVs. The funding project could run as a pilot for 1-2 years, and for subsequent years, depending on the program's success. Such subsidy programs are usually offered through provincial governments, however there are municipal precedents (e.g. Laval[61]).

Coordinate EV Bulk Buying

With its business and community partners, the City should coordinate an EV bulk buying program to purchase many EVs at reduced prices for businesses and the public. Working with local car dealerships or directly with car manufacturers, the City could negotiate bulk buy discounts on select EV makes and models, as well as their associated charging infrastructure. Offering once a year opportunities to participate in a bulk buying program with limited duration encourages engagement in the program. Programs in the US have been able to discount EV purchases between $2000 and $8500 USD per vehicle. Southwest Energy Efficiency Project's The Electric Vehicle and Photovoltaic Power Purchase Handbook[62] is a good resource for establishing a bulk buying program.

Provide ICE Vehicle Retirement Incentives

The City and its community partners could offer cash refund incentives or EV purchase rebates upon the retirement of an ICE vehicle. The incentive could be applied to certain makes and models of cars, recognizing that luxury EVs need not be subsidized. This incentive program could be modelled on British Columbia's ScrapIt program, which offers $6000 for a new EV and $3000 for a used EV when ICE vehicles are retired.[63]

Education and Marketing

There is a variety of EV promotional and awareness campaigns that can be undertaken by Greater Sudbury with its community, business and industry partners. Each of the following options are important components of an overarching education and marketing strategy. Generally, campaigns targeting the public will require the most resources and realize the slowest EV uptake returns, while campaigns targeting businesses and industry require fewer resources and have the potential for quicker returns, if at a typically smaller scale. The City can establish

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[61] The City of Laval offers a $2000 EV subsidy for new EV purchases: https://www.laval.ca/Pages/Fr/Citoyens/vehicule-electrique.aspx

[62] http://www.swenergy.org/data/sites/1/media/documents/publications/documents/Power_Purchase_Handbook.pdf

[63] https://scrapit.ca

and implement as many components of the overarching strategy as resources allow, prioritizing the elements felt to be the most important and opportune. Since transportation accounts for a significant amount of emissions production in Greater Sudbury, education and marketing campaigns are a crucial approach to achieving emissions reductions targets.

Develop an Overarching EV Campaign Branding Strategy

A simple branding strategy should be developed for application to all the City's EV promotional undertakings. A recognizable brand will ensure that all campaigns and promotions are readily associated with City efforts in the EV realm. The branding strategy could include:

- A logo and/or wordmark;
- Branding materials colour palette;
- Descriptive tagline; and
- Usage guidelines.

Deliver a Public EV Awareness Campaign

Deliver an EV public education and marketing campaign through EarthCare Sudbury and its partners to make the public more knowledgeable about EVs. There are many EV information campaigns from which to draw inspiration, including Plug 'n Drive in Ontario,[64] PlugIn BC's Emotive program,[65] Time to Electrify Canada,[66] Clean Technica's EV information,[67] and Electrify America.[68]

Greater Sudbury can offer general and Greater Sudbury-specific EV information via a website and through printed marketing materials at its civic institutions. Social media presence can promote the website and publish EV news stories and information resources to promote EV awareness. These communications channels can convey market research information, EV reviews, local maps indicating the dealerships selling EVs, local maps indicating EV charger locations, any City EV programs, re-posts from other EV programs (such as those mentioned above), etc.

Deliver a Car Dealership Campaign

The City should work with local dealerships to encourage them to stock EVs and be aware of any incentives, discounts and programs available that can be passed on and promoted to their customers. It is important that dealers carry a variety of EV makes and models, as well as their supporting equipment, such as home chargers. The dealers should also be aware of local home charger installation service providers to recommend, and insurance and roadside assistance options that may be specific to EVs. The City and local dealerships can set annual EV sales targets and track the makes, models and sales costs of EVs sold in Greater Sudbury. Tracking this information over time will help evolve the car dealership campaign.

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[64] https://www.plugndrive.ca/electric-vehicle-discovery-centre
[65] https://pluginbc.ca/outreach
[66] http://www.timetoelectrify.ca
[67] https://cleantechnica.com
[68] https://www.electrifyamerica.com

Deliver a Workplace EV Promotion Campaign

The City should work with local employers to achieve four EV outcomes:

1. Transitioning business fleets to EVs, where applicable;
2. Installing workplace EV charging stations for employee and visitor use;
3. Assigning preferred parking spaces to EVs; and
4. Improving employee EV awareness.

Working with community partners, the City can develop and deliver a workplace EV campaign that will help dispel EV myths, promote EV ownership and green fleets. Sample workplace campaigns from which to draw inspiration include those of Metro Vancouver,[69] the Clean Air Partnership,[70] and WorkplaceCharging.com.[71]

Deliver an Industry and Institutions Campaign

The City should also work specifically with industry to deliver industry-specific workplace EV campaigns, with a focus on helping industrial businesses transition their unique vehicle fleets to EVs. This work may involve awareness campaigns citing precedents in specific industries (such as Goldcorp's Borden mine[72]), and providing guidance on cost/benefit analysis (e.g. electric fleet capital, operation and maintenance costs versus ICE fleet costs and ventilation requirement costs in mines).

Establish Partnerships

There are many potential partners for education and awareness campaign support, as well as from which to source EV information such as market trends, EV station locations, EV assistance, etc. Greater Sudbury has EV-specific community organizations with which to partner, as well as other local environmental organizations. Other important partnerships include business and industry champions, institutions such as locally-represented higher levels of government, universities, colleges and hospitals, automobile dealerships and their support associations (e.g. CAA North and West, Trillium Automobile Dealers Association, Ontario Vehicle Sales Regulator) , and automotive writers and publications. A partnership strategy coordinated by the City should identify champions in each of these areas with which to partner in delivering its campaigns, and sign memorandums of understanding (MOUs) with them to establish campaign delivery goals, roles, responsibilities, expectations and timelines.

Charging Infrastructure Provision

The primary charging station strategy recommendation is to take a phased approach in their installation to supply visibility, encourage EV ownership, and keep pace with demand. Charging infrastructure can be installed in two phases, as summarized below and detailed in Appendix 1.

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[69] http://www.metrovancouver.org/services/air-quality/climate-action/transportation-programs/ev-workplace/Pages/index.aspx

[70] https://www.cleanairpartnership.org/wp-content/uploads/2018/11/CAP-Workplace-EV-policy.pdf

[71] http://www.workplacecharging.com

[72] https://www.goldcorp.com/English/portfolio/development-projects/borden/default.aspx

Phase 1: "Create Visibility, Generate Demand"

Under Phase 1, placing charging stations adjacent to government and institutional buildings is recommended because it creates awareness of the technology, and shows municipal support for EV use. This phase can be a quick start as the City can use its own property to install the charging stations while creating a network in key areas such as recreation centres and libraries. In Phase 1, new charging stations would be installed for public buildings, high population or driver centres (e.g. downtown) and Science North.

Phase 2: "A Connected City"

Under Phase 2, EV charging station infrastructure would scale up with additions to commercial and curbside locations. Workplaces, retail hubs and downtown centres are prime targets for added charging infrastructure, allowing charging while at work or running errands. Phase 2 is contingent on Phase 1 results; if use of public chargers installed in Phase 1 is frequent, the City should increase curbside chargers.

Other EV Charging Station Recommendations

1. **Prioritize DC Fast Charging station installation over Level 2 and Level 1 chargers.** Given the commuting trends from rural communities to the city, it is recommended that the majority of chargers at public facilities, in the downtown core, and in retail hubs are DC Fast Chargers. This will help reduce "range anxiety" of those travelling within the region.

2. **Perform ongoing financial analysis to ensure capital costs, return on investments, and charging fees are up to date and appropriate as charging infrastructure costs change** The cost of procuring and installing a DC Fast Charger is approximately $4,000-5,000.[73] 14 new charging stations in the city core could cost between $56,000 and $70,000, which could be recouped through charging fees. For example, Vancouver charges $16.00 per hour to use DC Fast Chargers and anticipates a payback period of 25 years under low-moderate EV uptake. See Appendix 3 for this calculation.

3. **Engage with Hydro Sudbury for optimal charging station locations, and potentially cluster charging stations near Science North to capitalize on the Smart Micro Grid.** To ensure effectiveness and reliability in public charging stations, particularly DC Fast Chargers, engagement with Hydro Sudbury or other local utilities is recommended. Hydro Sudbury has developed a Smart Micro Grid at Science North to support and facilitate the number of local renewable energy producers in Greater Sudbury. A major goal of the micro grid is to provide energy to the community in the case of increased demand or power outages. This centre can also serve as a promotional area for EVs and their charging.

4. **Continuously monitor EV uptake and charging station use to enable proactive municipal programming that increases EV uptake** Before increasing the number of public charging stations, such as in Phase 2, monitoring of

[73] Vancouver's EV Ecosystem Strategy." 2016. Renewable Energy Strategy. City of Vancouver: Engineering and Sustainability. https://vancouver.ca/files/cov/EV-Ecosystem-Strategy.pdf.

uptake can provide information on the number of stations needed and whether to charge fees/what fees to charge. If there is low charge frequency and duration at public stations but the number of EVs increases, then drivers may be charging at home or work. If there is consistent charging in the city centres or recreation centres, then the City can consider increasing the number of stations and/or charging higher rates.

More detailed charging station analysis and recommendations rationale can be found in Appendix 1.

Governance and Leadership

Greater Sudbury can reduce its corporate emissions and lead by example by taking EV initiatives in its fleet and public buildings. Using EVs and providing charging infrastructure makes the viability of EVs visible to the public and signals the City's support in transitioning to a new era of vehicles.

Update City Fleet Purchasing and Replacement Policies

An accounting exercise should be performed for the City fleet (including public transit vehicles) that assesses the operation and maintenance costs of current vehicles and the timing and cost options for their anticipated replacement. This information can be compared to the costs of new and replacement EVs, as well as their operation and maintenance costs. This exercise will provide an accurate schedule of costs and fleet turnover. The study may find that replacing some combustion engine vehicles before their end of life with EVs is a money-saving approach. The City can seek out funding from sources like FCM to transition its fleet. The City can also approach car dealers for bulk purchase pricing, and/or issue an RFP for EV purchase to collect bids from EV sellers.

The City should perform an inventory of vehicle fuel use for non-vehicle energy end use. This will yield information on energy requirements for mobile City operations, and how these requirements might be met by renewable energy. For example, portable rechargeable lithium-ion batteries and vehicle-mounted or mobile solar panel arrays can be installed in City vehicles whose power source is required to operate non-vehicle equipment, thus avoiding reliance on combustion engine vehicles (typically idling engines to power equipment). These power supplies could also provide backup power for EVs themselves.

Showcase City Fleet EVs and Charging Stations

As part of the education and marketing campaigns, the City should make its EV fleet and charging stations visible using the City's EV strategy branding. Charging stations are an opportunity to provide more information about EVs; websites and printed materials can be displayed in charging areas.

Update City Purchasing Policies

The City should update all purchasing policies and practices to favour EV use and encourage uptake. This includes specifying preference for couriers and other service providers with EV fleets, and including statements of EV preference in City tenders and requests for proposals (RFPs).

Hire an EV Strategy Manager in the Planning Services Division

Having dedicated staff is one of the best approaches to ensuring a consistent and coordinated approach to the City's EV strategy. An EV Strategy Manager in the Planning Services Division could oversee changes to Greater Sudbury policies and bylaws, coordinate marketing and education campaigns, and lead the development of subsidy and incentive programs.

Summary

As battery manufacture costs decrease and acceptability increases, the electric vehicle market will grow over the coming decades. Greater Sudbury is expected to have 2,455 EVs by 2035 and 4,612 by 2050 at current estimated market uptake rates. Despite increasing sales, however, the rate of transition from internal combustion engine vehicles to electric vehicles is insufficient to have a major contribution to reducing transportation emissions over the short term, as demonstrated by the EV uptake scenario modelling summarized in this report. The City of Greater Sudbury can help accelerate the EV transition with strategies and actions that are mostly low cost.

Greater Sudbury can achieve emissions reductions of over 1900 ktCO2e (50% under 2016 transportation emissions) and energy use reductions of almost 30 million GJ under a moderate effort scenario that sees almost 19,000 EVs on the road by 2050. With more aggressive actions, the city can realize almost 3000 ktCO2e in emissions reductions (72% under 2016 transportation emissions) and over 42 million GJ in energy savings, with over 82,000 EVs on the road by 2050.

The EV strategy action options are many. In implementing this strategy, the City should consider which actions are complementary and mutually beneficial in light of its municipal powers, leadership on the issue, and community and business partnerships. Once a branding strategy is developed, many quick win actions can be implemented on short timelines with small budgets. WIth support from its partners, the City should be able to achieve substantial emissions reductions in the transportation sector by making EVs visible and viable throughout the city.

Appendix 1: Public Charging Stations Strategy

A public charging strategy, when compared to home and workplace charging, can be seen as a more aggressive approach to encouraging EV uptake. Public charging stations make the upcoming EV technology more visible and show residents that they are able to meet their daily travel demands without fear of losing charge. Recommendations on phasing for charging stations are provided below where efforts are scaled up depending upon use of stations. The city can, in tandem, provide incentives for home and workplace charging infrastructure.

Phase 1: "Create Visibility, Generate Demand"

Strategy: Increase public infrastructure, and concentrate charging stations in high density population areas.

Making charging available and visible is a primary EV encouragement approach for the City. Priority areas for charging stations include:

- City public facilities;
- Recreation facilities;
- Libraries;
- Retail hubs;
- Employment hubs;
- Hospitals; and
- High-visibility curbside locations.

The downtown core will host the highest density of charging stations due to greater population and employment density, and the number of residents without off-street parking.

Charging infrastructure planning will have to consider electrical loads to ensure increased demand for electricity will interface well with capacity.

Phase 1 Rationale

Phase 1 promotes visibility and encourages early EV uptake, providing several benefits including:

- Ensuring there are visible and ample charging stations in key locations throughout the city;
- Cost analysis that provides charger installation costs;
- Broad visibility due to wide charger distribution among destinations and land-use types; and
- Providing consumer confidence via charging station presence.

Phase 1 Location Criteria

The following locations are prioritized for EV Charging stations:

Table 9. Location criteria for Phase 1 EV infrastructure.

Location	Description
Public Buildings	Museums, theatres, recreation centres, libraries, City and senior government administration buildings.
High Population Centres	EV charging stations placed no more than 5km from one another in dense neighbourhoods, where population density exceeds 1,500 person per km^2. This area can be generally bounded by City Centre in Sudbury.
Clustering at Science North	In this phase, an EV charging cluster at Science north should be considered as the micro grid can provide local renewable power and act as a solution to future issues resulting from high demand causing peaks in the electrical grid.

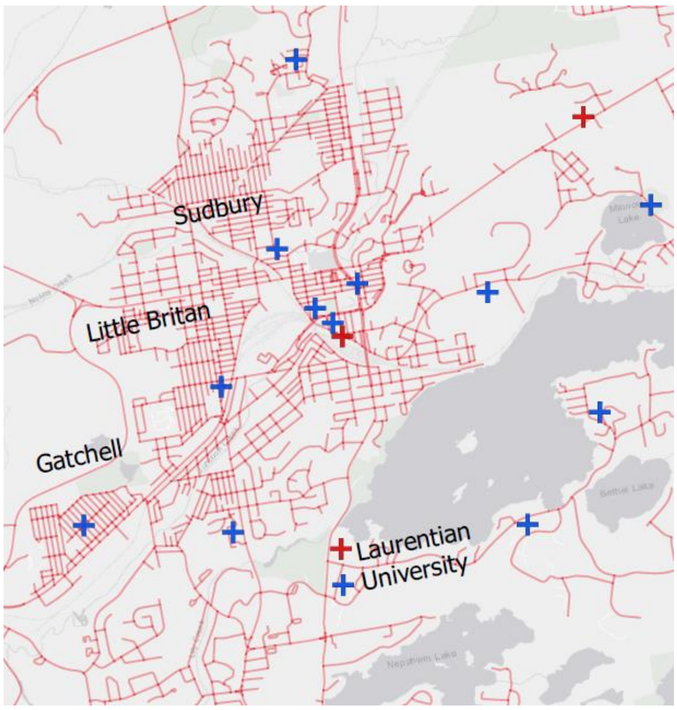
Phase 1 Analysis

Phase 1 greatly increases the charging infrastructure available. 34 additional stations are suggested, for a total of 45. Key Phase 1 statistics are summarized in Table 10. A complete list of charger locations is summarized in Table 11.

Table 10. Phase 1 EV statistics.

Description	Statistic
Number of new stations	34
Total stations	45
Average distance between stations	10-12 km (Rural) 2-5 km (Urban)
Number of stations in city core*	16
Public Charging Stations per 10,000 residents	2.7

*There are currently 8 charging stations in the City Core.



Legend
- Phase 1: Institutional Stations
- Existing EV charging stations
- Roads

Figure 17. Phase 1 charging locations (City Core).

Table 11. Phase 1 locations for EV charging stations.

Location	Address	City
BarryDowne College	1390 1400 BARRYDOWNE RD	Sudbury
College Boreal	21 LASALLE BLVD	Sudbury
Laurentian University	935 RAMSEY LAKE RD	Sudbury
Workplace Safety North	60 RED CROSS BLVD	Sudbury
Sudbury Outpatient Health Centre	865 REGENT ST	Sudbury
Health Sciences North	41 RAMSEY LAKE RD	Sudbury
Health Sciences North	680 KIRKWOOD DR	Sudbury
The Parkside Centre	140 DURHAM ST	Sudbury
Sudbury Curling	300 WESSEX ST	Sudbury
Carmichael Arena	1298 BANCROFT DR	Sudbury
Cambrian Arena	795 CAMBRIAN HEIGHTS DR	Sudbury
Gatchell Pool	43 IRVING ST	Sudbury
Sudbury Community Arena	240 ELGIN ST	Sudbury
Gerry McCrory Countryside Sports Complex	235 COUNTRYSIDE DR	Sudbury
TM Davies Community Centre	325 ANDERSON DR	Sudbury
Greater Sudbury Airport	5000 AIR TERMINAL DR	Sudbury
Greater Sudbury Public Library	Main Library 74 MACKENZIE ST	Sudbury
Rayside-Balfour Museum & Public Library	158 ST AGNES ST	Sudbury
Raymond Plourde Arena	1919 HELENE ST	Sudbury
Centennial Arena	4333 CENTENNIAL DR	Sudbury
Howard Armstrong Rec Centre	4040 ELMVIEW DR	Hanmer
New Sudbury Public Library (GSPL)	1346 LASALLE BLVD	Sudbury
South End Public Library (GSPL)	1991 REGENT ST	Sudbury
Capreol Arena	20 MEEHAN AVE	Capreol
Garson Community Centre	100 CHURCH ST	Garson
Coniston Community Centre	70 GOVERNMENT RD	Coniston
Raymond Plourde Arena	334 REGENT ST	Raymond
Onaping Pool	2 2R0, HILLSIDE AVE	Onaping
McLelland Arena	11 BALSAM ST	Copper Cliff
Skead Community Centre	3971 SKEAD RD	Skead
Dowling Library	79 MAIN ST W	Dowling
I J Coady Memorial Arena	13 SECOND AVE N	Levack
Chelmsford Community Centre	215 EDWARD AVE	Chelmsford
Chelmsford Library	3502 ERRINGTON AVE	Chelmsford

Phase 2: "A Connected City"

Strategy: Scale up EV charging stations, target curbside locations near commercial areas, and reduce distances between stations to 10 minutes driving.

This phase will meet increased charging demand by adding curbside charging stations and stations near commercial and curbside locations. Consistent with current practice and consumer preference, charging stations could be targeted to be no more than 10 minutes driving (at 50 km/h) distance apart.[74] This practice is based on surveying done by the City of Vancouver relating to how likely a consumer would switch from a gas powered to an electric vehicle. The caveat here is that Vancouver has different urban densities which results in different travel patterns. Phase 2 actions should be implemented in balance with any significant increase in home and workplace charging station installations; if there are large gains in these locations, the need for public charging will be reduced.

Phase 2: Rationale

This phase continues to create more charging capacity in the city to meet demand. It includes:

- Meeting a target of installing charging stations no more than 10 minutes drive apart;
- Increasing commercial destinations' charging stations;
- Expanding infrastructure to provide options for commuters in different towns in Greater Sudbury; and
- Increasing charging stations in the city core as population and employment density increase.

[74] Based on current practice in City of Vancouver to have DC fast chargers in 10 minutes drive distance within city boundaries.

Phase 2: Location Criteria

Charging station priority locations are summarized in Table 12.

Table 12. Location criteria for Phase 2 EV infrastructure.

Location	Description
City-Wide	Charging stations placed no more than 9km apart (based on 10 minutes of driving at 50km/h) at curbside and commercial locations.

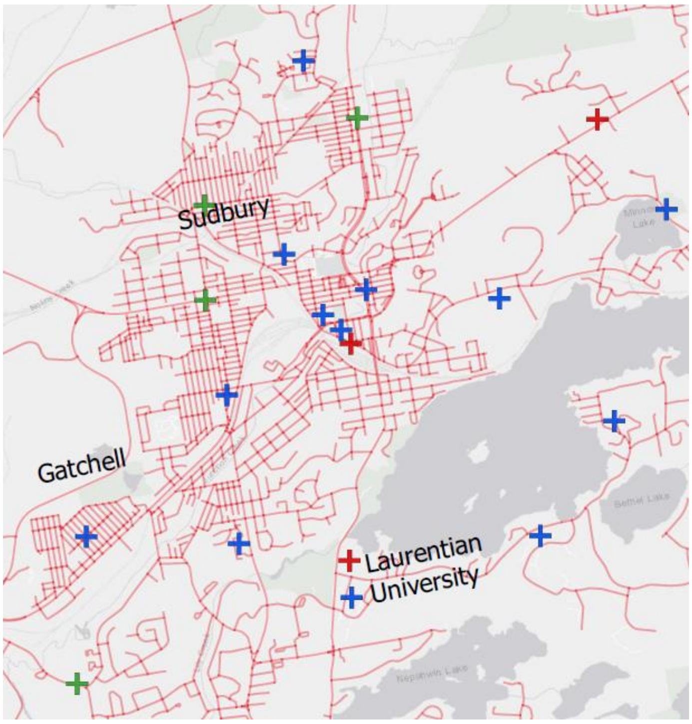
Phase 2: Analysis

A city-wide map of charger locations is found in Appendix 2. Key statistics for this phase are summarized in Table 13. A list of charger locations is provided in Table 14.

Table 13. Phase 2 EV statistics.

Description	Statistics
Number of new stations	15
Total stations	60
Average distance between stations	8-10 km (Rural) 2-4 km (Urban)
Number of Stations in city core*	21
Public Charging Stations per 10,000 residents	3.63

*There are currently 8 charging stations in the city core



Legend
+ Phase 1: Institutional Stations
+ Phase 2: Curbside Stations
+ Existing EV charging stations
— Roads

Figure 18. Phase 2 EV charging stations (city core).

Table 14. Approximate locations of Phase 2 curbside charging stations.

Street / Commercial Centre	City
CONCESSION STREET	Nickel Centre
2ND AVE	Sudbury
ELM STREET	Sudbury
KATHLEEN STREET	Sudbury
NOTRE DAME AVENUE	Sudbury
KELLY LAKE ROAD	Sudbury
ERRINGTON AVENUE	Chelmsford
MAIN ST W	Dowling
ST JAMES ST	Onaping
15 RIX ST	Falconbridge
OLD HWY 69	Hanmer
MAIN ST	Val Caron
METHE ST	Chelmsford
OLD HIGHWAY 17	Whitefish
OLD WANUP ROAD	Wanup

Appendix 2: Municipal Case Studies

Kingston EV Strategy Strategic Actions[75]

1. Convert appropriate light duty municipal fleet vehicles to EVs upon their scheduled replacement dates;
2. Continue monitoring opportunities for electrification of heavy duty municipal fleet vehicles;
3. Install and operate public EV charging stations on municipal property throughout the City;
4. Promote the environmental and economic benefits of EV use to Kingstonians and monitor uptake of EVs locally;
5. Ready local infrastructure for increasing EV charging demand; and
6. Determine demand for EV charging among municipal employees commuting to work

Toronto EV Parking Requirements[76]

A required component of the Toronto Green Standard (TGS) – Tier 1 which applies to all new mid to high-rise residential development and all industrial, commercial and institutional (ICI) development, requires the physical provision for electric vehicle charging when excess parking is being provided above the required number of parking spaces denoted in the Zoning Bylaw. These required parking spaces must be distributed on each parking level of the building.

In the case of the ICI sector, when exceeding the required minimum number of parking spaces required under the Zoning bylaw, any excess spaces must be dedicated as priority parking spaces for low emitting vehicles (LEV), carpooling or car sharing.

A voluntary component of the TGS – Tier 2 encourages electrical provision for at least 2% of residential parking spaces for future EV charging.

[75] "Kingston EV Strategy." 2018. City of Kingston. 2018. https://www.cityofkingston.ca/residents/environment-sustainability/climate-change-energy/electric-vehicle-charging-stations.
[76] Preparing Toronto for Electric Vehicles: https://www.toronto.ca/legdocs/mmis/2017/pw/bgrd/backgroundfile-107507.pdf

City of Vancouver EV Ecosystem Strategy for Homeowners and Businesses[77]

Goals:

The City will expand access to home and workplace charging, supporting Aims 1, 2, 3 and 5.
1. Maximize access to EV charging (Have DC fast Chargers within 10 minutes drive of one another.)
2. Improve community experience and knowledge in vehicle charging
3. Displace fossil fuel kilometres travelled with electric kilometres
4. Establish an electric vehicle ecosystem to support the transition to 100% renewable transportation before 2050.

Residential The residential pilot program will be limited to "garage orphan" homeowners (one- and two-family homes with no access to off-street parking). In this case, a homeowner will be permitted to install a Level 1 or Level 2 charger (equivalent to a typical electrical outlet of 120V or 240V) at the back of curb, which will be fed from the house's utility panel. The charger will only be available to the homeowner. Parking will be limited to a maximum of three hours between 9am and 10pm; however the City reserves the right to amend the parking restrictions as required. The cost to buy, install, maintain and remove the EV charger will be borne by the homeowner. The homeowner will be required to enter into a license agreement with the City and the City will retain the right to remove the station. Neighbours within the residential block will be notified prior to the installation.

Non-Residential For non-residential applications (e.g., retail businesses), the applicant will be enabled to install an EV charging station in front of their business that will be fed off the business's power supply. Charging will be available to the public and free of charge (under the B.C. Utilities Act, a private company can't resell Curbside Electric Vehicle Charging Pilot Program – RTS 12046 5 electricity). The parking space will be metered, to ensure reasonable turnover at the charging station. The cost to buy, install, maintain and remove the EV charger will be borne by the applicant. Advertising will not be permitted. Accepted applicants will be required to enter into a license agreement with the City and will be responsible for all costs of installation and maintenance. Adjacent businesses will be notified prior to the installation.

User Costs
The following introductory rates are additional to the parking rate at a given location, although the two fees will likely be collected at the charging station. Fees are charged in addition to regular on-street charges.

- Level 2: $2.00/hr
- DC Fast Charging (50kW): $16/hr.

[77] Vancouver EV Ecosystem Strategy: https://vancouver.ca/files/cov/EV-Ecosystem-Strategy.pdf

Appendix 3: Payback Analysis for DC fast Chargers[78]

Item	Unit	Qty.	Per Session Monthly
Typical Session Energy (kWh)		25	
Installed Capacity (kW)	50		
# Sessions	-	1	125
Usage Length (regardless of energy consumption) (hours)	0.5	0.5	62.5
Fixed Costs			
Capital cost	$40,000		
Labour & Installation	$50,000		
Annual Network Fee	$225		$18.75
Basic Daily Utility Charge	$0.24		$7.39
Annual Maintenance	$200.00		$16.67
Variable			
Electricity Cost ($/kWh)	0.088	$2.20	$275.00
Demand Charge ($/kW)	4.92		$246.00
Rate Rider	5%		$26.42
Swipe Transaction Fee ($/txn)	0.91	0.91	$113.75
Total Variable Costs		$3.11	$661.17
Total Operating Costs			$703.97
User Fees Revenue	$16.00	$8.00	$1,000.00
Net Revenue over operating			$296.03
Annual Revenue over operating			$3,552.31
Simple Payback (yrs)			25.336

[78] "User Fees for City Owned and Operated Public Electric Vehicle Charging." 2017. Council Meeting. Vancouver EV Ecosystem. City of Vancouver. https://council.vancouver.ca/20170627/documents/rr1d.pdf.

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Appendix 3

Greater Sudbury CEEP

Public Engagement Summary

Prepared by SSG

August 2019

POWER NOW
GREATER SUDBURY
Our energy future.

Contents

Introduction

The Greater Sudbury CEEP community engagement process aims to answer the question “What are the elements of Greater Sudbury’s low carbon future and how will we get there?”

The engagement process component of CEEP development is called PowerNow! And focuses on five key objectives:

- Producing outcomes that reflect the values, priorities and aspirations of a diversity of Greater Sudbury residents and stakeholders;
- Encouraging a sense of ownership among residents and stakeholders, leading to a sustainable and legitimate path forward;
- Supporting residents’ and stakeholders’ understanding of critical issues and contexts for this project, as well as relevant trade-offs;
- Building community connections and capacity, supporting increased social capital and long-term benefit; and
- Building and enhancing trust between residents, stakeholders and local government.

The process has four major engagement streams:

1. In-person public events;
2. On-line public engagement;
3. Stakeholder Working Group (SWG) meetings; and
4. Interviews and meetings with City Directors.

In-person Public Events Summary

Public Workshop #1 | October 4, 2018

Attendance: 43 people

The session was attended by representatives from the City of Greater Sudbury, Laurentian University, Greater Sudbury Utilities, ReThink Green, Science North, the Sudbury Star, Glencore, as well as interested Greater Sudbury residents.

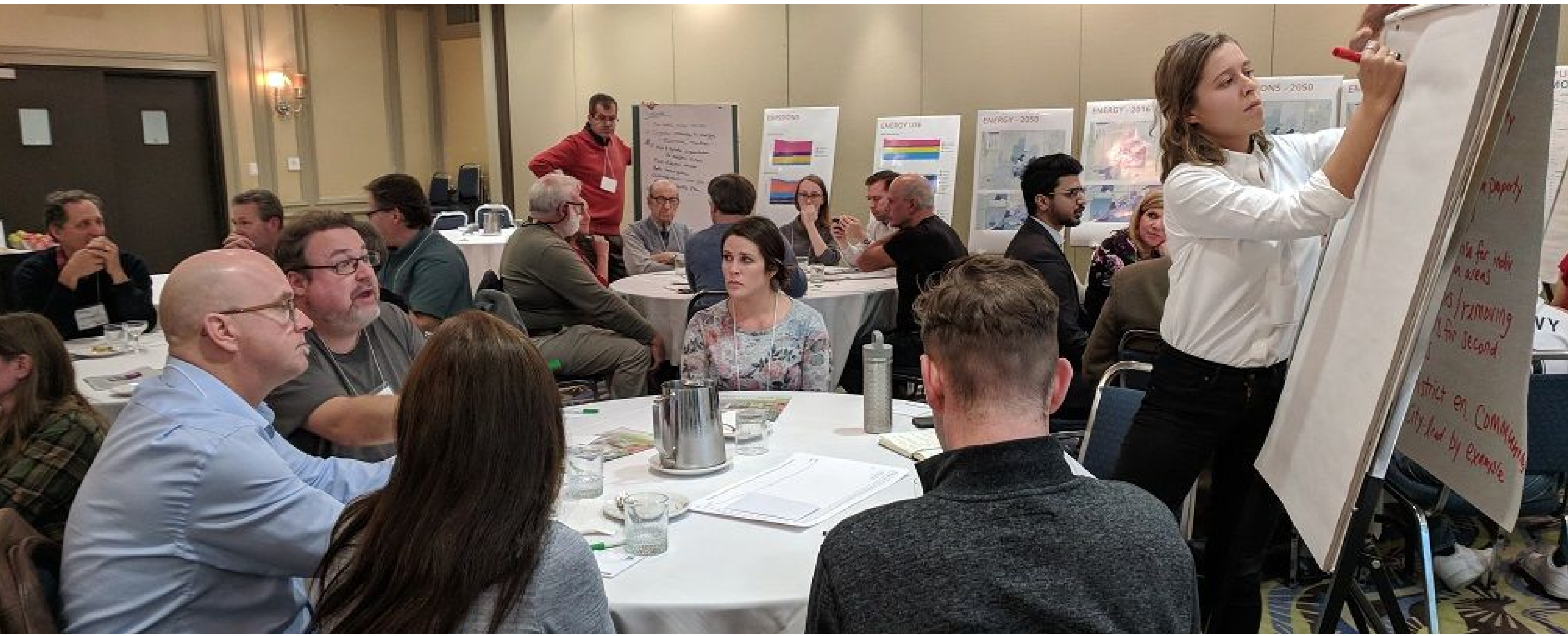
The goals of the first engagement session were to take stock of Sudbury's current state of energy and emissions, develop a collective vision of Greater Sudbury in the future, and to discuss actions to reduce emissions.

Greater Sudbury's 2016 energy and emissions baseline information and the results of modelling a business-as-usual energy and emissions scenario between 2016 and 2050 were presented to participants.

A Future Greater Sudbury
Grouped in tables of five to seven people, workshop participants were asked to discuss how they envisioned a low-carbon, healthy, and vibrant Greater Sudbury in the future.

Most participants wished to see more affordable and accessible active transit, with better bike lane connectivity, as well as a more expansive network that could reach from major commercial centres, downtown, and to trail networks. Safety was noted as an important component of a successful system, as some participants currently felt discouraged by vehicular traffic to use bike lanes.

Similarly, many participants expressed a desire for greater walkability in neighbourhoods. Many found this to be the case in the downtown core, where there is greater density and walking access to amenities. This was expressed as something that could be widely expanded across the city. A desire for greater urban intensification and mixed-use neighbourhoods to improve walkability in Greater Sudbury was noted.



High efficiency homes and buildings were also noted as important to participants. There was interest in buildings that included rooftop solar energy generation or green roofs, which could also support a local food supply system.

Participants also commented on building a thriving local business sector, and the importance of supporting local supply chains and operations. Again, this complemented a greater reliance on locally sourced foods, accessible in grocery stores, schools, and across the city. Furthermore, with an economy strongly rooted in mining, participants noted that Greater Sudbury could become a leader in using renewable energy in the mining sector.

The vision of the future city saw greater use of renewable energy for its energy needs. Electrification was cited as an important component of the vision, including greater use of electric vehicles, building electrification (for heating and cooling), as well as electric mining operations. Electricity would be supplied by both the Ontario electricity grid and local solar PV on rooftops and in rural areas.

Many participants felt that technology could empower new energy use patterns and greater energy use efficiency. This included car sharing programs, traffic controlled lighting systems to reduce idling, building heat systems that could be remotely controlled, and accessible electric charging stations, among other technologies.

Ultimately, the visioning exercise showed great ambition of Greater Sudbury residents in achieving a low-carbon city.

Wedge Analysis

The final portion of the workshop explored how Sudbury could meaningfully reduce emissions. Provided with the city's BAU emissions projection and specific actions with their respective emissions reductions, participants were asked to choose the actions that they felt could reasonably occur in the City by the year 2050 to achieve their vision and typical municipal emissions reduction goals (80% reduction by 2050).. In contrast to the visioning session, the wedge analysis brought on greater critique of possible actions, outlining key barriers to the envisioned future City.

Actions for existing buildings were related to retrofits. Two participant groups thought that 50% of homes could be 50% more efficient by 2050. Other groups saw considerable difficulties in high rates of retrofits, and felt as though reaching 25% of homes would be more feasible. All groups highlighted the importance of improving the energy efficiency of the building stock, but perceived that it would be hard to implement in practice, due to the upfront financial capital required, and because retrofits are generally pursued through individual decision making.

In contrast, many felt that introducing heat pumps into buildings to replace natural gas heating was more feasible. Half of the groups thought that 25% of homes could use heat pumps. The other half felt that 10% penetration was a more realistic number. Participants noted the currently low natural gas prices in the province, which disincentivizes uptake of heat pumps.

Most participants had very high ambition for increasing the share of electric vehicles. All groups decided that 25% market share of electric vehicles was possible by 2050, and most thought that it could be even higher. Electric vehicles were perceived to be an inevitable future for Greater Sudbury, mostly through changing market factors.

Implementing active transit was perceived to be difficult, despite strong desire for greater active transit in the visioning exercise. Participants felt as though the City's land-use patterns are too sprawling to meaningfully introduce active transit because average trip distances are too high.

Reducing emissions in industry divided participants. Some felt as though industry has made important strides, but finding greater efficiencies in the system could be difficult. Additionally, participants noted that the City actively promotes new mining operations, which could play a role in increasing total industry emissions. The Vale smelter project was noted as an example of transformative emissions reductions in the industry. Overall, most groups felt that industry could be 25% more efficient by 2050.

Finally, participants analyzed the feasibility of local solar PV and wind projects. Many felt as though historical political contention could limit the uptake of larger renewable energy projects. Solar PV on rooftops was considered to be more politically feasible. Ultimately, most tables thought that rooftop PV could supply 25% of buildings energy requirements by 2050.

The overall emissions reduction scenarios developed by tables were between 359 and 650 kilotonnes carbon dioxide equivalent (ktCO2e) total emissions in 2050. With current emissions estimated at 1,302 ktCO2e in 2016, the scenarios were associated with a 49.9% to 72.4% reduction in emissions.

In-person Workshop #2 | April 24, 2019

Attendance: 40 people

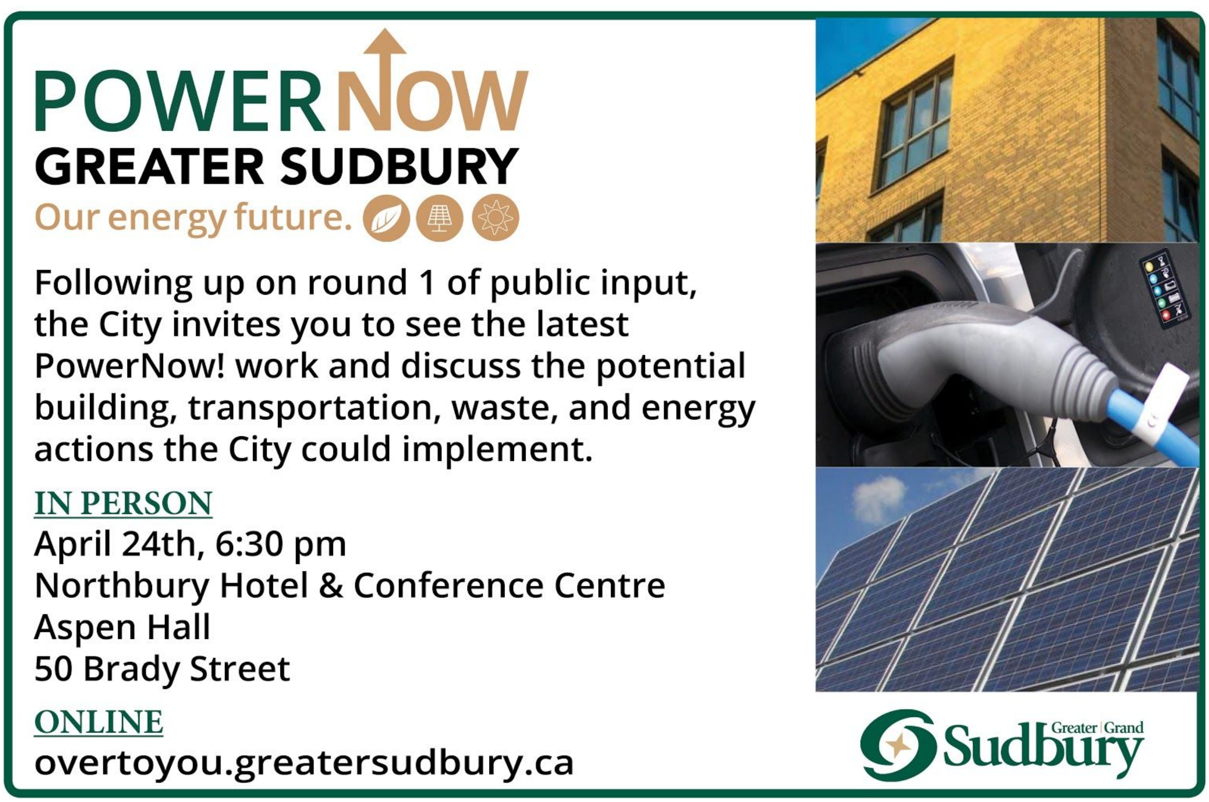
The second in-person workshop was attended by 45 people and had some media presence. The modelling results of a moderate ambition low-carbon scenario (LCS) were presented, in which actions to achieve an emissions reduction target of 65% below 2050 levels were explored. This target was based on the outputs of the first public engagement session in which an ambitious low-carbon vision was expressed for Greater Sudbury, but a less ambitious emissions reduction target was arrived at in performing the actions wedges exercise.

In small groups of 5-7 people, participants discussed the LCS results by topic:

- Personal electric vehicles;
- Home retrofits, heat pumps, and water efficiency;
- Commercial building retrofits and recommissioning;
- Solar energy and energy storage;
- Increased transit, walking, and biking; and
- New homes.

Participants rated the actions presented in each topic for their priority (low, medium, high) and level of ambition (too low, about right, too high). Potential partners in delivering the actions and priority places to implement the actions were identified. Opportunities and precedents for the actions were discussed, as were the potential challenges with their implementation.

Summaries of the table topic discussions can be found in Appendix 1. Participants typically felt that the level of priority for most actions should be high and the stated level of ambition was too low. Many felt that a 65% emissions reduction by 2050 was insufficient, and thus the actions modelled to achieve this target needed to be strengthened to achieve a high emissions reduction target of at least 80% by 2050. This attitude marked a shift from the first public engagement workshop, at which most participants felt a 65% emissions reduction was reasonable.



Stakeholder Working Group Engagement

November 21, 2017 | 23 people
April 18, 2018 | 32 members
December 5, 2018 | 22 people

A Stakeholder Working Group (SWG) met twice during the project to date. Organizations invited to participate on the SWG include: City of Greater Sudbury, Greater Sudbury Utilities, Hydro One, Union Gas, Laurentian University, Collège Boréal, Cambrian College, NORCAT, the four local school boards, Atikameksheng Anishnabek, Wahnapitae First Nation, United Way, reThink Green, Greater Sudbury Chamber of Commerce, Greater Sudbury Housing Corporation, Sudbury and District Home Builders Association, Glencore, and Vale.

The first meeting engaged SWG members to discuss potential actions to be considered in the CEEP, as well as potential barriers to actions implementation. Many members felt that the CEEP should be well-integrated into other City plans and decision-making processes to bring about conditions that have considered energy and emissions outcomes. Many members focused on the importance of engaging the mining sector. Transportation was seen as an important area of focus, with increased EV uptake and transit as key actions to investigate. Buildings energy efficiency and renewable energy generation (especially solar) were seen as economic and sustainability opportunities on which the community could capitalize, becoming a leader in Northern Ontario in these areas. The SWG felt that action should be taken quickly.

Action barriers identified by the SWG included lack of political will, challenges for small businesses to act, lack of education on sustainability issues amongst residents and business owners, achieving deviation from the status quo, and financing the actions. Some discussion centred on whether important energy and emissions actions could be planned and taken regardless of political context.

The second SWG session involved a multi-criteria analysis (MCA) exercise in which members weighed the importance and priority of eight potential actions in each of the transportation, building, energy, and land-use sectors (32 actions total). The exercise outputs present the SWG's prioritization of actions in each of the four sectors. These aren't necessarily the most effective actions to take or the "best bang for the buck" actions to take, but rather a balanced consideration of the actions resulting in their preference ranking - the actions that have the most support from the group. The MCA outputs helped determine what actions were investigated and modelled by the consulting team. The MCA outputs are summarized in Appendix 2.

Directors Engagement
February - April 2019

Interviews were held with directors of several City departments, including:
- Water and Wastewater
- Environmental Services
- Planning Services
- Transit Assets and Services
- Assets and Fleets
- Housing Operations
- Housing Services
- Leisure Services
- North East Centre of Excellence Senior Health
- Building Services

The interviews provided insights on Greater Sudbury's current energy efficiency and production, and emissions reduction efforts. Salient points from the interviews follow.

Environmental Services
- Many waste reduction efforts are underway.
- Percentage diversion rate targets have not been set as achieving them is too far out of the City's control (i.e. much of waste diversion and treatment is under provincially jurisdiction).
- There is room for improvement on industrial, commercial, and institutional (ICI) waste diversion.
- Waste diversion from multi-family buildings is typically expensive and challenging.
- The landfill is looking to expand its life through a variety of programs. It is also looking at better ICI diversion programs and expanding its landfill gas capture rate.

Water and Wastewater
- Water pumps are being periodically replaced with more efficient models.
- The City water rebate programs are effective in reducing costs.
- Water treatment facilities are currently at secondary treatment levels with activated sludge.
- Looking at water and wastewater metering systems for improved data and automation of water efficiency processes.
- National and provincial facility benchmarking initiatives are useful for best practices knowledge sharing.

Planning Services
- Greater Sudbury projects low population growth over the next 30 years.
- Ageing population is resulting in denser housing.
- 80% of building permit growth is occurring within the growth boundary.
- There are some redevelopment and adaptive reuse projects underway.
- The recently updated Official Plan has climate-updated policies.
- Residential and commercial renovations of existing structures are more common than new builds.
- The regreening tree planting program has been largely successful.

- There is some room for improvement on direction for energy efficiency and emissions reduction in neighbourhood development, as well as in transportation integration.

Transit Assets and Services
- Transit is currently a 'hub and spoke' system, with routes emanating from the downtown hub.
- The recent Transit Action Plan has been adopted, increasing service to high-demand areas, reducing infrequently used routes, and offering service on Sundays.
- There is an upward trend in transit use and revenues over the last few years.
- Park and ride lots are well used.
- There is room for improvement in the promotion and effectiveness of the TransCab and Handi-Transit programs.
- The Employer Pass Program needs more resources to be successful.
- RIght-sizing the fleet is under consideration.

Assets and Fleets
- Energy is considered in decisions on a case by case basis
- The wastewater treatment plants are large energy users.
- Early replacement of assets to improve energy efficiency and paybacks can be considered on a case-by-case basis.
- Building energy improvement upgrades happen as a result of benchmarking against similar buildings in other cities and monitoring.
- There is currently no plan to electrify the City fleet.
- The City fleet is being right-sized.
- Distributed EV charging infrastructure would alleviate some EV use concerns.
- Some heavy equipment vehicles may be difficult to electrify.

Housing Operations
- Social housing: 1843 units, 384 buildings.
- Housing Revitalization Plan includes:
  - Selling 145 scattered houses - getting rid of 3-5 bedroom homes.
  - Building more single bedroom homes (10 year wait for these currently).
  - Helping to subsidize tenants to live where they want.
  - Targeting ⅓ market, ⅓ rented, ⅓ affordable for new buildings.
- Selling current assets can help pay for retrofitting remaining assets.

Housing Services
- The seniors centre underwent upgrades several years ago and was successful at significantly reducing its energy and water use.
- A 245kW solar PV system is part of the upgrades.
- The social housing portfolio has just under 5000 units - half owned by the City, half owned/run by non-profits and cooperatives.
- There is high demand for social housing units.
- Most of the stock needs to be updated to 2019 building code standards.

Leisure Services
- Greater Sudbury has 14 arenas, 5 pools, playfields and rinks.
- Most facilities have upgraded lighting (LED) and arenas have low-emission roofs.

- One community arena has a 245kW solar PV array.
- Building condition assessments determine energy efficiency needs - every 5 years.
- There is a need to develop more of an organizational culture about energy efficiency - need energy champions, real-time data for facilities

Directors Engagement Session

April 25, 2019

The City Directors were engaged in a 2 hour session in which a project presentation was given outlining the modelling results for the Business as Usual and Low-carbon scenarios. In groups of 5-8, the Directors then discussed 5 topics, guided by lists of associated questions (Appendix 3). Topics included:

- Municipal and personal electric vehicles;
- Transit and active mobility;
- Solar PV and district energy;
- Waste, wastewater, and renewable natural gas; and
- Buildings.

Directors discussed the challenges, opportunities, implementation details, and next steps associated with potential actions and policies in each of the areas. Next steps for many of the actions involved updating City policies, standards, and plans. Opportunities involved finding funding for infrastructure and programs, and engaging existing and new staff to implement actions. Potential challenges identified included resistance to change, the dissipated geography of Greater Sudbury, lack of political will, and investments required. More details on the directors engagement session can be found in Appendix 4.

Online Engagement

Project information was posted on the CIty website under the Clean Energy page of the Environment and Sustainability Department at the outset of the project. Project information and surveys were posted leading up to, in parallel with, and following in-person public engagements via the “Over To You” area of the website. Between September 2018 and April 2019 the site received 535 unique visitors. 22 visitors participated in a survey about energy and emissions in Greater Sudbury, contributing ideas on:

- Where we live (buildings);
- How we move around (transportation);
- Where our energy comes from (energy generation);
- Our waste (solid waste and wastewater); and
- Our forest and natural areas.

The survey results showed support for electrifying personal and transit vehicles, offering incentives, programs and regulations for energy efficiency in new and existing buildings, and residential solar panels purchasing. 18 actions were suggested as well. Online engagement is summarized in Appendix 5.

Engagement Summary

There has been a noticeable shift in climate change awareness and in the sense of urgency for action over the course of the project engagement events, as evidenced by a recent citizens’ petition to declare a municipal climate emergency, and the adoption of that declaration by council. The first public engagement session demonstrated the public’s appetite for action in achieving a sustainable future for Greater Sudbury, although participants struggled to achieve an 80% emissions reduction target by 2050, expressing doubts that some actions could realistically be implemented. The second public engagement showed more ambition in achieving the 80% emissions reduction by 2050 target and participants’ contributions to the actions discussion demonstrated strong support for action by the City and the community. Media presence at the event demonstrated the level of community concern for the topics discussed.

The Stakeholder Working Group provided important guidance on actions consideration and modelling. The diversity of members - representing community groups, businesses, industry associations, institutions, and residents - contributed to a balanced perspective on what considerations to make in their sectors.

The Directors provided valuable insights into actions that are already being taken in Greater Sudbury, as well as direction on what gaps currently exist in the City’s and community’s approach to addressing climate change. Their involvement in the project will be crucial to the CEEP’s successful implementation.

Engagement of various groups and individuals over the course of the project has shown that there is wide support for energy and emissions action in Greater Sudbury, especially when actions support the well-being and economic development of residents and businesses. It has also shown that there are legitimate concerns in how policy and action will be successfully implemented given a range of challenges. The engagements indicate that with strong leadership from the City, business, industry, and residents are keen to participate in addressing climate change issues by taking ambitious action.

Engagement Summary Appendix 1: Public Workshop #2 Discussion Notes

Personal Electric Vehicles

All new personal vehicle sales will be electric by 2030. Some internal combustion engine vehicles will still be on the road, but they will no longer be cost competitive or widely available for purchase.

Priority – High **Ambition** – Too Low

Potential Partners

- Public school system (education)
- All levels of government
- MSM
- Auto retailers / servicers (CAA / tow's / mechanics)
- NGO's – reThink Green, Coalition for a Liveable Sudbury, Bike Sudbury, CCL, EVOGS, Fridays for Future

Priority Places to Implement

- Hotels, malls, 4-5 chargers (LV3)
- Libraries, civic buildings, schools
- Airports, outlying community malls
- Small business EV fleets
- School buses
- Initiatives for business to install a charging station
- Charging stations at church

Opportunities and Precedents

- Government grants (vehicles / charging stations)
- Carbon pricing (gas $) → at the municipal level too!
- Public events (Earth Day)
- Restructure our tax system (streamline) tax the 0.1%
- Find political champions!
- Incentives to make this transition happen more quickly

Potential Challenges

- Regulations
- Charging stations
- What will we replace the gas tax for infrastructure maintenance?
- Some politicians
- Manufacturing retooling
- Battery technology
- Disinformation campaigns, social media
- Industry lobbyist
- Charging stations need to be everywhere
- Grid capacity – transformer upgrades required in areas that add EVS

Home retrofits, heat pumps, and water efficiency

Home retrofits save 50% heating/cooling energy and 30% electrical energy (e.g. appliance and wall plug energy use.) 70% of the remaining home heating/cooling demand is supplied by heat pumps. Water efficiency improves by 2% per year for 30 years.

Priority – High **Ambition** - Too Low

Potential Partners

- United Way
- reThink Green
- SUN Coop
- Province + Feds + industry + contractors
- LCBS – Low Carbon Building Skills
- Green On
- Certification & Standards
- LU School of Architecture, Colleges, Post-secondary (qualified labor)
- GSU, Union Gas, EnergyStar
- Municipal Green Bank + incentives
- "Energysproing"
- Building code
- CMHC
- Home Builders Association
- Partner = affordable housing targets + keep senior in home, heating = affordable

Priority Places to Implement

- Social housing + low-med income + rental housing + student housing
- Multi-family housing + institutions, large landlords + seniors home (Pioneer)
- Provincial + Federal incentives??

Opportunities and Precedents

- Rising fuel prices
- Carbon tax
- Packages for insulation
- House wrapping
- Bring back old programs
- Opportunities → better house, quick wins for City
- Precedents → Heat source expertise, community-wide retrofit effort
- Regreening for energy "do it again" grey water
- At mortgage renewal have lender demand retrofitting of some sort

Potential Challenges

- Old housing
- Cold weather – risk for heat pumps
- Flooding and rain storms
- Zoning by-laws for tiny/laneway housing

- Very expensive to do but worth it
- Costs – competing with family priorities
- Low insulation
- → Commun*ity-wide retrofit effort*

Other notes

- + house durability
- Encourage space for vegetable gardens – reduce – grassy
- Make water bills more reflective of water usage
- Stop using potable water for toilets
- Very important – need concerted effort to bring parties together to make it happen
- CIty must (1) declare a climate emergency (2) appoint a climate adaptation coordinator
- Water is wasted every time you turn on the hot water tap. There is a solution using a recirculation pump available in US but not in Canada. Why not?

Commercial building retrofits and recommissioning

80% of all commercial buildings are retrofit to use 50% less heating/cooling energy and 30% less electricity. Large buildings' heating, ventilation, air conditioning, and energy systems are recommissioned (recalibrated) every 5 years to optimal energy efficiency operation.

Priority – Medium **Ambition** – Too Low

Potential Partners

- Chamber of Commerce
- Real estate developers
- Trade schools (technologies) / Unions
- Architects / engineering firms
- Banks / insurance companies
- Builders associations
- Utility companies
- Telecom companies
- City – make building standards that require this
- This is a union town – unions must be made partners
- Lack of technical & service industry
- Green Economy North (program of reThink Green)

Priority Places to Implement

- Institutional & healthcare – larger impact
- City-owned buildings – can model and lead by example
- Retail (big box) (malls)
- Schools

Opportunities and Precedents

- IESO – up to 2020 provincial
- Federal incentives?
- Aging equipment / replacement education

- Broader Energy Star type program
- Regulation target
- Rising prices for energy
- Municipal pollution taxes could help pay for institutional retrofits

Potential Challenges

- Leased buildings
- Technology sizing
- Capital costs
- Lack of accessible info / complex
- Aging grid / system constraints
- Making maintenance a priority
- Effect on taxes
- No supports technical skills
- Poor building codes
- Lack a 4-year Full Civil Engineering Program at LU
- Challenge non-locally owned businesses. National companies (e.g. Tim Hortons, TD Bank, etc.)
- Leased building is a huge challenge because you need landlord and tenants to cooperate.

Increased transit, walking, and biking

By 2050, 20% of trips are made by walking or biking (these typically are less than 5 km long). Also, another 25% of trips are made by transit (bus, taxibus). These actions involve increasing transit frequency on popular routes, adding bus routes, and installing walking and biking infrastructure like sidewalks and bike lanes.

Priority – High **Ambition** – Low

Potential Partners

- Transit – CGS – Schools – RRA – Hospital – Post Secondary
- Bike Sudbury
- Employers, developers / real estate / land use planning / so people can walk to where they need to go

Priority Places to Implement

- Master Plan – densification of town centers
- Inter Centre Transit
- Transit Action Plan implementation
- Support city densification
- All major streets = complete streets
- All community and neighbourhoods connected by transit & AT infrastructure
- Smart growth!
- Areas in town – not accessible by walking – no sidewalks

Opportunities and Precedents

- Greater recognition of climate change crisis
- TDM plan (transportation demand management)
- Culture shift at CGS provides opportunity for updated planning, but more shift needed
- Bike share – car sharing
- Make prices for good equitable across venues
- Encourage employees to have cars for professional use so I can take the bus instead of my car

Potential Challenges

- City takes $ out of dense areas making it hard to upgrade centers for walking
- Resistance to change
- Lack of downtown plan
- Many outlying towns widespread
- Winter -40ºC
- Please clear sand out of bike lanes at the end of winter. I can't ride my bike. Pot holes are a serious concern too.

Solar energy and energy storage

Add 10MW of solar farm energy (equivalent to the Capreol solar farm) each year from 2022 to 2050, feeding into the Ontario electricity grid for distribution, avoiding some use of electricity produced by natural gas plants. Also 50WM of electricity storage is proposed, for use during peak electricity demand periods, also avoiding natural gas powered electricity production.

Priority – Medium-High **Ambition** – About Right

Potential Partners

- GSU
- Hydro One must be on board
- SUN Coop
- Private industry investment
- N-VIRO biosolids → carbon capture → Wastewater gas capture (e.g. Calgary) → use solar to lift H2O into dams
- Small nuclear?
- C. capture also lots of trees

Priority Places to Implement

- Solar for home heating
- Strategically placed in new developments for local distribution
- Storage and renewable at landfill
- Store energy at Hydro Dams, e.g. Coniston Dam, Stinson Dam
- Sudbury dump to power water treatment plant
- Need transmission line

Opportunities & Precedents

- Utilize old mining sites

- Learn from others
- Lots of land for solar farm
- Job creation?
- Incentives to finance building (return on investment)
- Industrial heat recovery
- Solar enabled building code
- Local generation = less risk from the grid going down
- More use of solar hot water

Potential Challenges
- Time to build?
- Capacity of the grid → Hydro One
- Aging infrastructure on roofs → Solar enabled building code
- Snow on solar panels
- Upfront capital is high
- Buy-in from community to invest $ in this (importance)
- Tradeoff of emissions to create solar panels

New homes

New homes will be 15% more efficient every 5 years, approaching 90% more efficient by 2050 (i.e. Passive House Standard efficiency). The amount of new single family detached homes built each year will decrease toward 2050 – in that year only 10% of new homes will be single family. Thus most new homes will be smaller, more energy efficient row/townhomes and apartments.

Priority – Medium **Ambition** – Too Low

Potential Partners
- Home Builders
- Province (building codes, regs.)
- City – zoning, building, OP, dev. fees, codes
- Real Estate Board
- Downtown core (condos)
- Assisted living, long-term care
- Affordable housing planners strategy and those stakeholders
- Have lenders (mortgage) operators to increase efficiencies

Priority Places to Implement
- Downtown – for attractions, living, condos
- Subdivisions not yet finalized
- Around community hubs, groceries (South End, New Sudbury)
- Decommissioned buildings = use land
- Social housing & affordable housing & senior house build
- Education about smaller homes
- Increase town density

Opportunities and Precedents

- Industry promotes efficient homes, condos
- Home care programs (stay at home longer)
- Planning subdivisions to include stages of life (apartment → house → condo)
- Economies of scale / bulk pricing
- Connect home builders with retrofit needs & initiatives / targets
- Incentives / partner with utilities
- Property tax break for efficient homes
- Provincial subsidies – windows
- Funding opportunities (FCM, etc. – especially if we have a plan)
- Be a leader in the field
- Land-use planning connecting it all – located so that transportation is also low carbon for residents in their new homes
- Tiny homes to rethink houses
- Smaller homes in co-housing settings
- Smaller houses are easier to clean

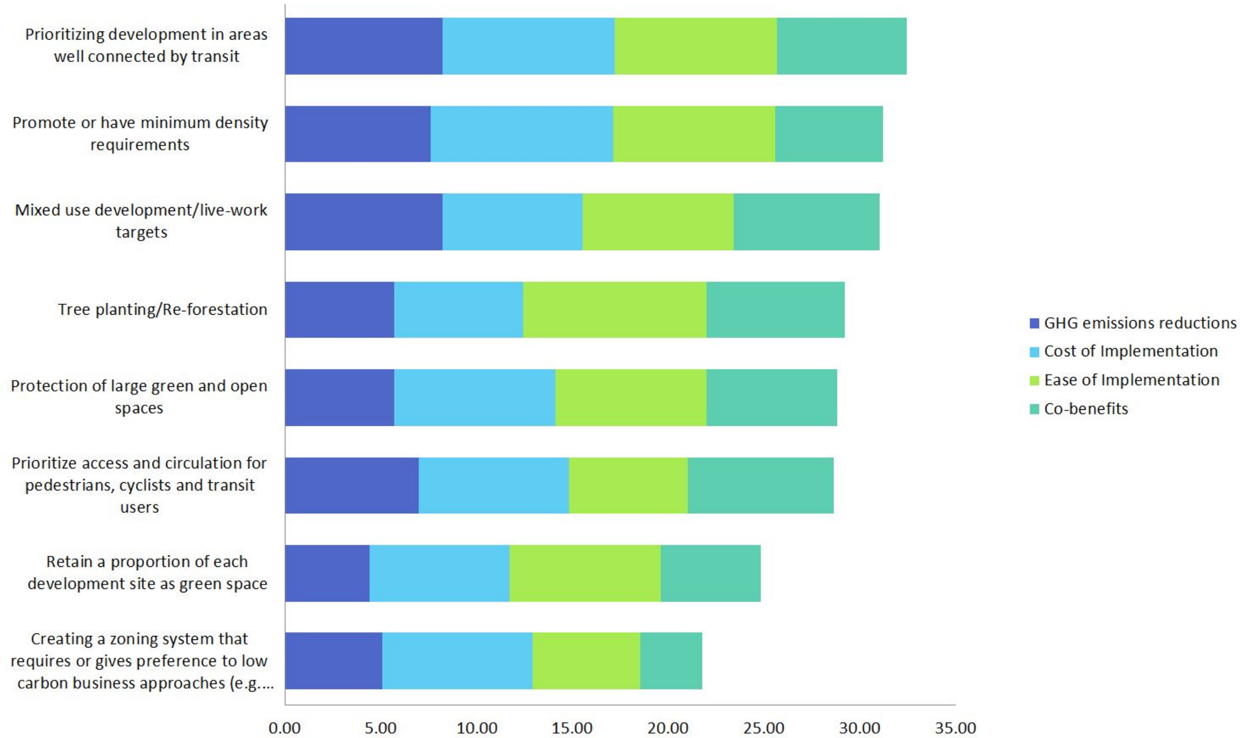
Potential Challenges

What conditions or competing interests might interfere with implementing this action?

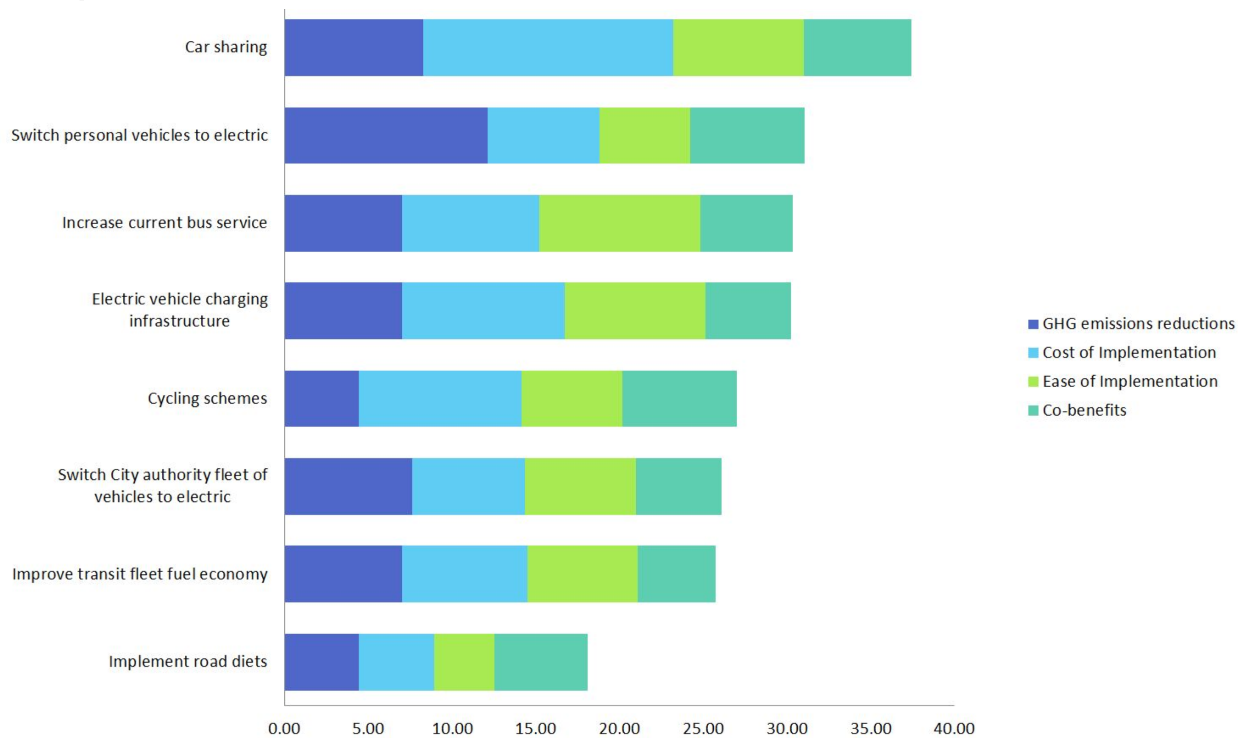
- Culture change away from single detached
- Cost of building efficient
- Acceptance of technology
- Cap on # of solar approved on grid
- Smaller homes should be some kind of financial benefit

Engagement Summary Appendix 2: Stakeholder Working Group Multi-criteria Analysis Action Prioritization Outputs

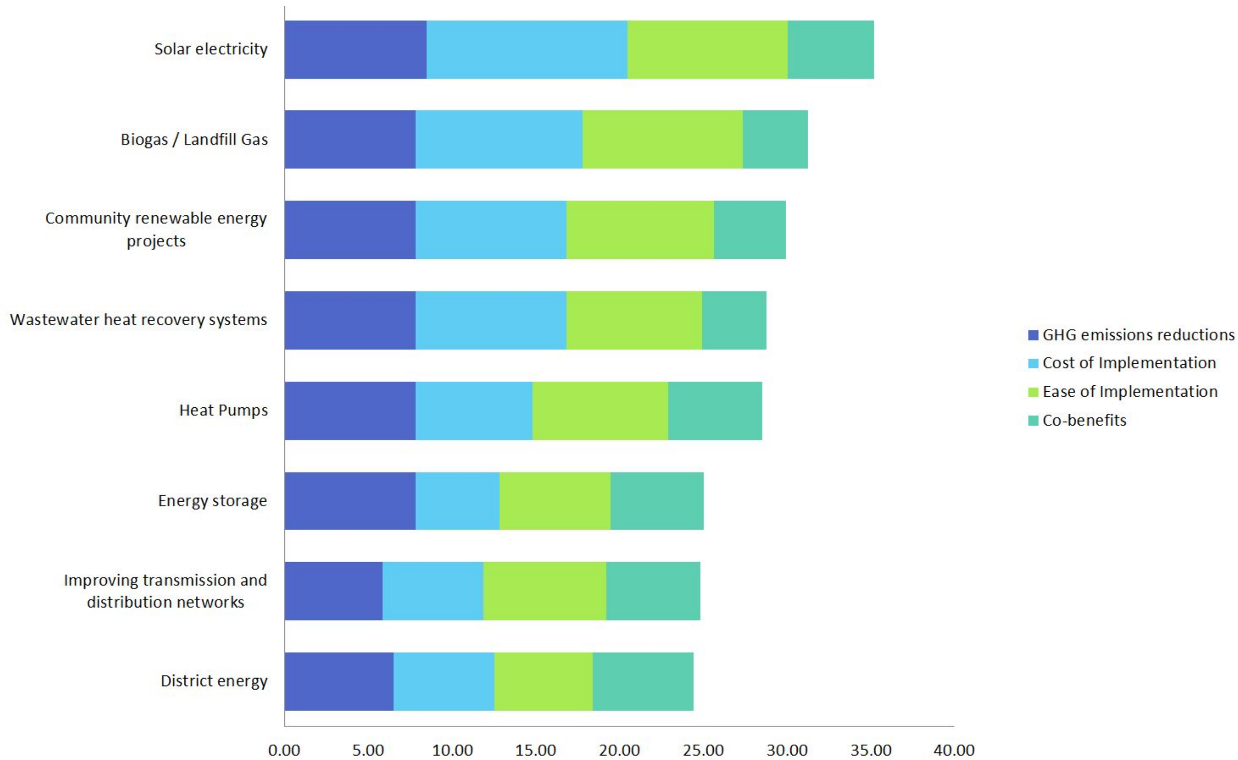
Land-use



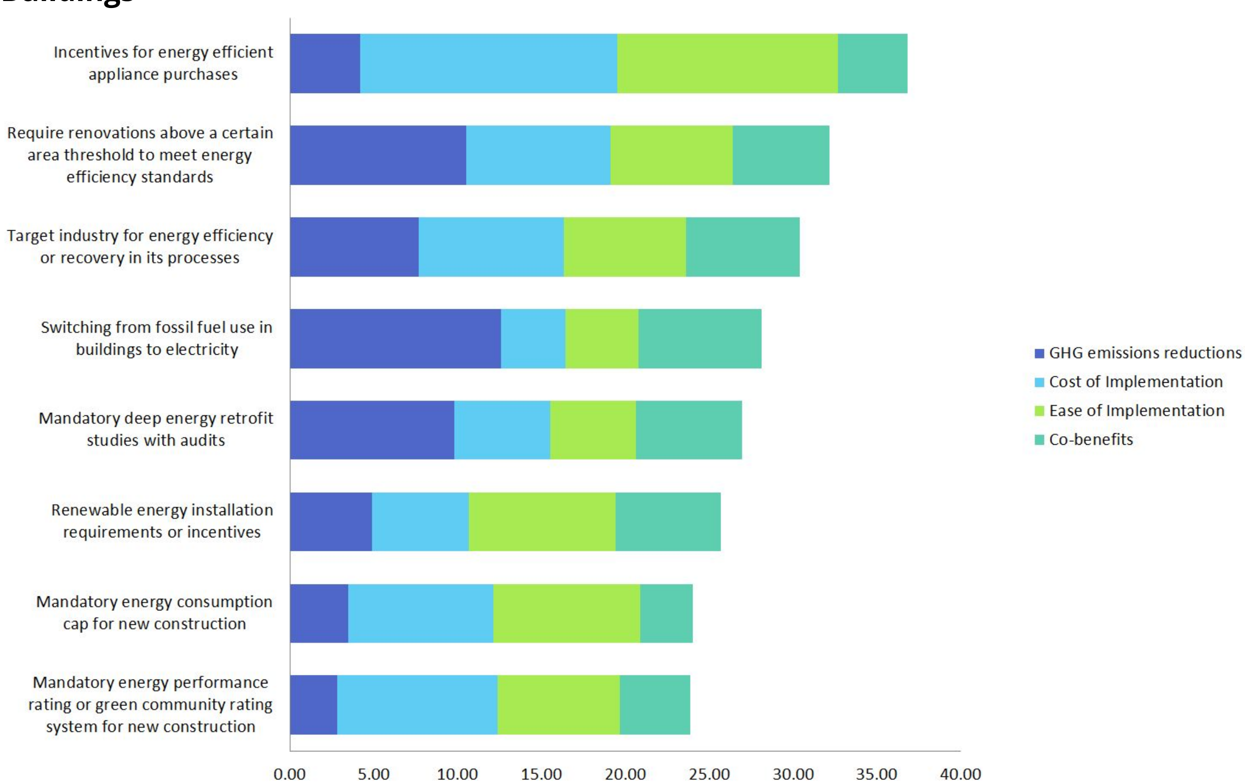
Transportation



Energy Supply



Buildings



Engagement Summary Appendix 3: Directors Engagement Session Questions

Solar PV and District Energy Groups

+10MW solar install every year starting in 2022 (i.e. Capreol size)

•What is the arrangement with utilities?
•Who has to be involved?
•Where to install?
•Who will own and operate the facilities? Who will keep the revenues?

12MW solar array on civic buildings

•What are the priority buildings?
•How could this be combined with a public bulk solar purchase program?
•What are the next steps?

Expand District Energy Systems

•What is required to connect more existing and future buildings up to existing DE systems?
•Where is there opportunity for new DE systems?

Electric Vehicles Groups

All new personal vehicles are electric by 2035
All new commercial vehicles are electric by 2030
Municipal fleet is electrified by 2035
Mining vehicles are electrified by 2035
Transit vehicles are electrified by 2040

Civic charging infrastructure

•What are the priority buildings?
•Where is curbside priority areas?
•What parking, traffic and land-use bylaws need to be considered?
•How would the City charge fees?

Personal/business charging infrastructure

•How can the City partner with employers to encourage charger installations?

Municipal fleet and transit

•What needs to change in the turnover/purchasing strategy to electrify the fleet?
Personal vehicles
•Can the City provide EV purchase incentive programs? Can it partner with dealers to encourage stocking EVs?

Transit and Active Mobility Groups

25% of trips made by public transit by 2050
20% of trips are made by walking and cycling by 2050

Increased transit service and use
•How can frequency and routes be further increased and optimized?
•How can the City partner with employers to offer transit incentive programs?
•What infrastructure improvements are needed?
•What mobile technology improvements could be made?

Walking and cycling
•Where can bike lane and sidewalk infrastructure be improved/implemented?
•What enhancements can be made to active mobility encouragement programs?
•How can the City partner with employers to offer incentive programs to employees?

Buildings Groups
Retrofit 80% of buildings to reduce 50% thermal energy demand & 30% electricity demand
Recommission large building systems every 5 years
New buildings are 15% more efficient every 5 years (90% by 2050)
Detached homes are 10% of new building stock by 2050 (focus on row/townhomes and apartments in infill areas)

Retrofit incentives
•What rebate programs can the City offer? (e.g. LED lights, low flow fixtures, windows & doors, energy audits, etc.)
•How could a PACE (property assessed clean energy) financing program be implemented?
•How can partnerships with utilities help?

Policy
•How can the local building code be updated every 5 years with improved energy efficiency requirements?
•What needs to be done to restrict suburban development and focus on infill?

Waste, Wastewater and RNG Groups
Waste diversion
•How can the City increase recycling and composting rates?
•How can the City partner with retailers in producing less packaging?
•How can the City partner with ICI groups to decrease their waste?
•What is the best solution for organic waste? How can the City implement it?

Renewable natural gas
•What are the opportunities to generate renewable natural gas for use in current natural gas systems? What volumes could be produced?
•How can current landfill methane capture be increased? Is it viable to supply the WWTP with methane for its operations?

Wastewater
•What are the most useful policies to implement to reduce wastewater volumes? How can they be implemented?
•How can the timeline for water pump replacement be accelerated?

Appendix 4: Directors Engagement Session Outputs

Municipal and personal electric vehicles

Priority Buildings

- Lorne St. garage, transit depot
- All roads/linear depots
- TDS
- LEL, emergency service depots
- Arenas, libraries, parks, customer service centres
- Pioneer Manor

Priority Curbside Areas

- Downtown
- Police satellite stations
- Potential problem with installation of charging infrastructure
- Could be low priority

Personal/Business Charging Infrastructure

- Incentivize through CIP areas
- User pay: infrastructure set up by private sector based on market
- Requirement by zoning, parking bylaw, and subdivision plans for new installations
- Tax on combustion engines to encourage switching to EVs = fund new infrastructure
- Educate on “range anxiety”
- One-time grant
- Tax exemption for certain number of years for each charging spot

Municipal Fleet and Transit

- Seek authority for electrification. Seek sources of funding for increased costs, 2035 time frame.
- Partner with other municipalities and by sector (e.g. EMS vehicles)
- Update the turnover/purchasing policy
- Bulk purchasing with other municipalities

Personal vehicles

- Provide resident incentives
- Partner with provincial and federal governments
- Link to PTIF or other programs
- Economic development incentives for parking or structures that accommodate EVs
- Credit in building permits for providing EV chargers

Fees

- User fee per kW - tax subsidy for civic vehicles
- Pay by plate technology
- Employee lots through payroll deduction
- Included in pay parking fees
- Possibility to provide via third party

Transit and Active Mobility

Opportunities

- TAP
- Funding ICIP
- Aligning HR policies to support transit
- Plan and build necessary infrastructure (e.g. priority lanes)
- TDM
- Active transportation coordinator position
- Revisit transit/action transportation priority in capital prioritization tool
- Sidewalk priority index
- Grow ridesharing
- Make transit cheaper to use than parking downtown

Challenges

- Cultural change
- Distances
- Investment
- Political will, resource constraints, competing priorities
- Lack of sidewalks and inconsistent approach for sidewalks in new developments
- Climate

Implementation Details

- 10-year plan for bus rapid transit
- Amend official plan and zoning
- Implement actions that grow ridership
- Mobile technology for on-demand service
- Monitor transit trends

Partners

- Employers
- Post secondary
- Secondary schools/consortium

Next Steps

- Update and create programs
- Update and create development standards
- Capital prioritization

Solar PV and District Energy

- All new buildings should be considered for new PV installations
- KED/Junction and other 640 CGS buildings should be evaluated
- Buy in bulk for discounts and lower payback periods
- Update building policies to encourage/require solar PV systems

Waste, Wastewater and RNG

- Consider landfill bans to increase diversion of organics and recyclables
- Increase composting rates
- Cap waste pickup amounts at 1 bag/household
- Consult ICI groups on how to reduce waste, increase waste diversion
- CIty should develop an organics action plan
- Existing landfill could be expanded or additional landfills created with methane capture systems to increase RNG production
- New homes could have heat recovery systems (greywater)
- Biodigesters and biosolids carbon capture methods could be employed at wastewater treatment plants
- Advanced metering could provide better water and wastewater data
- Create a water reservoir for greywater
- Encourage use of phosphate free biodegradable products
- Improve water pumping efficiency

Buildings

Opportunities

- Affordable housing retrofits have been effective but were reliant on grant funding
- LIC/Pace program of interest; has not been evaluated in Sudbury as of yet
- Bulk retrofits as economic development could be a powerful approach
- New dwellings are not cheap (~$400k); incremental costs of low carbon options may not be too expensive
- Possibility of using land-use policy to require/incentivise high performance new construction
- Some dwellings are in a rough condition and would benefit from retrofits

Challenges

- Lack of interest
- Low cost housing (small envelope from which to finance retrofits)
- Expertise of contractors
- Limited number of new dwellings/buildings

Next Steps

- Evaluate an LIC program
- Investigate strategies for new construction