Methodology, Baseline & Business as Planned

District of Muskoka GHG Inventory and Emission Reduction Strategy

Prepared by:
LURA Consulting
ICLEI Canada

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Contents

Introduction

This document summarizes the energy and emissions baseline inventory and the business-as-planned future scenario. It provides a high-level overview of the methodologies, approaches, and data sources used, as required for the first milestone of the Partners for Climate Protection Program. An energy and greenhouse gas (GHG) baseline and forecast reveal how a community consumes energy and generates waste, helps identify opportunities for strategies to reduce energy and emissions, and provides the necessary baseline from which progress is measured.

Baseline Energy and Emissions Profile

The approach for the baseline energy and emissions profile, outlined below, reflects current best practices for the preparation of a Community Greenhouse Gas Emission Reduction Strategy. The approach follows the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC)[1] BASIC level of reporting, considered the international best-in-class approach for quantifying emissions at the local level. Developing a GPC-compliant inventory aligns with the Partners for Climate Protection (PCP) Protocol[2] and meets the requirements for PCP Milestone 1 (quantifying emissions) and the Global Covenant of Mayors (GCOM) Badge 1 (quantifying emissions).

The baseline energy profile and GHG emissions inventory cover energy and emissions occurring inside the municipal boundary (Scope 1) and emissions occurring as a consequence of the use of grid-supplied electricity within the District of Muskoka (Scope 2). Energy consumed outside the municipal boundary (and the associated emissions generated) as a result of activities taking place within Muskoka is not included (Scope 3), such as the consumption of goods that were manufactured outside Muskoka. Figure 1 outlines the emission scopes below[3]. As per the GPC protocol, all emissions from Scope 1 and Scope 2 are included in the baseline inventory. Energy costs were estimated using the City of London's Energy Expenditure Calculation Tool based on electricity and natural gas rates as per the 2018 Ontario Energy Board (OEB) rate orders for the utilities operating within the municipal boundaries.

[1] World Resources Institute. (2014). Global Protocol for Community-Scale Greenhouse Gas Emission Inventories: An Accounting and Reporting Standard for Cities.
[2] ICLEI Canada. (2014). PCP Protocol: Canadian Supplement to the International Emissions Analysis Protocol.
[3] Figure sourced from Global Protocol for Community-Scale Greenhouse Gas Emission Inventories: An Accounting and Reporting Standard for Cities.

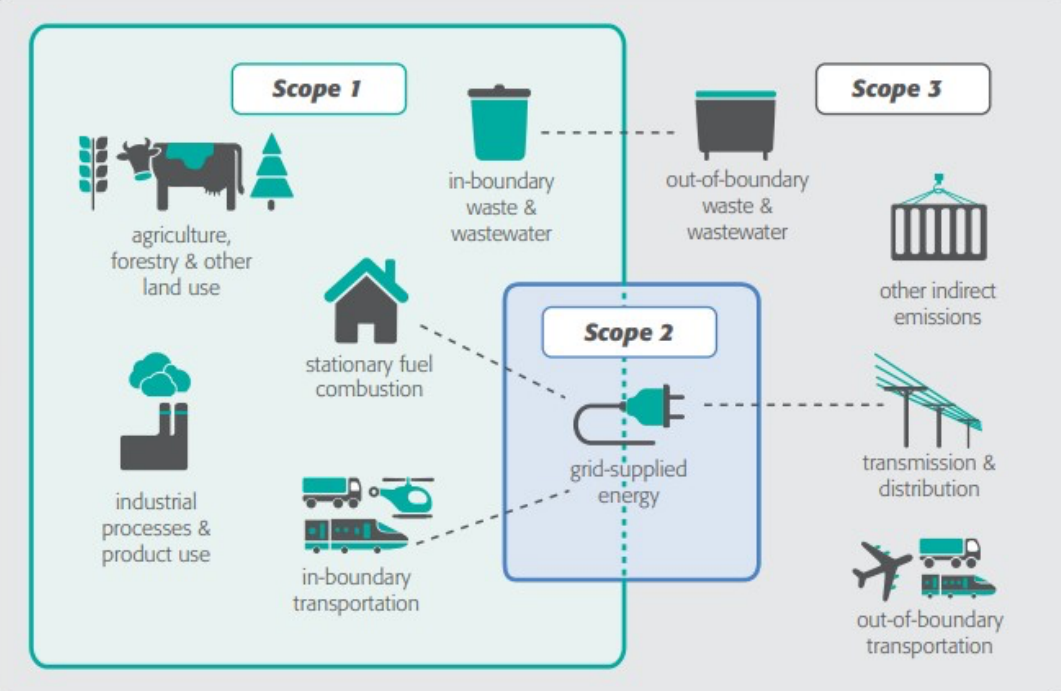

Figure 1: A visual representation of emission Scopes 1, 2 and 3

2018 was selected as the baseline year, as it is the most recent year with a complete dataset. Based on a projected Compound Annual Growth Rate (CAGR) of 0.74% the year-round 2018 population of Muskoka is estimated to be 61,500 with employment at 29,033[4]. With a CAGR of 0.58%, the seasonal population is estimated to be 82,853 in 2018. All data is for the 2018 calendar year unless otherwise indicated in Table 1 below. Fuel consumption data was prioritized, but where data was unavailable, activity data was modelled using robust assumptions based on the PCP and GPC Protocols and industry best practices.

[4] Population and employment data from the District of Muskoka 2019 Forecast and Growth Allocation Report by Hemson Consulting Ltd.

Table 1: Data & Assumptions Community Baseline Energy and Emissions Profile Data & Methodology

	Category	Energy Use	Energy Costs	GHG Emissions
Building Energy (differentiated by Residential, Commercial/Industrial Subsectors	Natural gas (Scope 1)	Metered energy data was provided by Enbridge Gas Distribution. Data was segmented by the following rate classes: Residential, Commercial, and Industrial.	Natural gas prices for residential customers were sourced from the Ontario Energy Board[5]. Non-residential prices were sourced from 2018 OEB rate orders for Union Gas, a subsidiary of Enbridge	2018 emission factors from Environment and Climate Change Canada's National Inventory Report[6] (the most recent federal report on Canadian emissions) were used to convert energy use into GHGs (for specific factors, see Table 28 below).
	Electricity (Scope 2)	Metered energy data was provided by Lakeland Power, Elexicon and Hydro One. Data was segmented by Residential and Commercial/Industrial rate classes.	Electricity prices were sourced from the Ontario Energy Board (OEB)[8] for Elexicon Energy, Lakeland Power and Hydro One. For residential and commercial classes, prices were available on-peak, mid-peak and off-	2018 emission factors from Environment and Climate Change Canada's National Inventory Report[7] (the most recent federal report on Canadian emissions) were used to convert energy use into GHGs (for specific factors, see Table 28 below).

[5] Ontario Energy Board. 2019. Historical Natural Gas Rates. https://www.oeb.ca/rates-and-your-bill/natural-gas-rates/historical-natural-gas-rates#enbridge

[6] Environment and Climate Change Canada. (2020). National Inventory Report 1990–2018: Greenhouse Gas Sources and Sinks in Canada. Canada's Submission to the United Nations Framework Convention on Climate Change.

[7] Environment and Climate Change Canada. (2020). National Inventory Report 1990–2018: Greenhouse Gas Sources and Sinks in Canada. Canada's Submission to the United Nations Framework Convention on Climate Change.

[8] Ontario Energy Board. Historical Electricity Rates. https://www.oeb.ca/rates-and-your-bill/electricity-rates/historical-electricity-rates

Category	Energy Use	Energy Costs	GHG Emissions
		peak times; a weighted average was taken to arrive at a price for the full calendar year. All sub charges (rate components, loss factors, delivery, transmission, regulatory charges, and other fees and taxes) were used for the analysis and were sourced from 2018 OEB rate orders.	
Propane (residential, commercial, institutional, industrial), **Fuel Oil** (residential, commercial, institutional, industrial), **and Wood** (residential) (Scope 1)	Propane, fuel oil, and wood consumption was estimated as real consumption data could not be provided by fuel distributors. According to Natural Resources Canada's Comprehensive Energy Use Database, heating oil, propane, and wood fuel represented 2%, 2%, and 7% of residential fuel use in 2017 respectively. For the commercial/institutional subsector, propane represents 5% of energy	Propane and fuel oil prices were sourced from Kent Group Ltd[9] Wood prices were calculated based on the average price of a cord of wood in Muskoka[10] and the average GJ per cord of wood[11].	

[9] Kent Group Ltd. 2019. Petroleum Price Data. https://charting.kentgroupltd.com/#dataAnalytics
[10] Bracebridge Realty. https://bracebridgerealty.ca/faq/index.php?id=79
[11] Kuhns, M., & Schmidt, T. Wood Heating. Utah State University Forestry Extension. https://forestry.usu.edu/forest-products/wood-heating

	Category	Energy Use	Energy Costs	GHG Emissions
		consumption, light fuel oil represents 1%, and heavy fuel oil 0.1% (while both are used in space heating, heavy fuel oil has a higher specific gravity and different emission factor and can also be used to generate electricity). Propane, fuel oil, and wood consumption was estimated using fuel mixes from NRCan relative to the real consumption data of electricity and natural gas, as per **GPC Section 6.3.** CO_2 emissions from wood are considered biogenic, and part of the natural carbon cycle.		
Stationary Energy	Fugitive Emissions from Natural Gas (Scope 1)	Fugitive emissions (methane released through equipment leaks, evaporation, venting, flaring, and accidental releases during the distribution of natural gas) were calculated using the International Panel on Climate Change (IPCC)[12] default emission factor applied to total natural gas consumption, and following the approach laid out in **GPC section 6.4.**		Fugitive emissions from equipment use, such as hydrofluorocarbons (HFCs) from air conditioning units, would fall under the Industrial Processes and Product Use sector, which is not required for GPC BASIC level of reporting and is therefore not included here.

[12] 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 2: Energy, Chapter 4: Fugitive Emissions.

	Category	Energy Use	Energy Costs	GHG Emissions
Transportation	Personal Vehicle Use (Scope 1)	On-road transportation energy use was calculated using the fuel sales method, as per **GPC Section 7.3.1.** Data for gasoline and diesel sold in Huntsville in 2018 was provided by Kent Group Ltd. As per provincial requirements, it was assumed that 5% of gasoline[13] is ethanol and 4% of diesel is biodiesel[14]. Total fuel sales were apportioned to vehicle sub-categories (car, light truck, heavy truck) using vehicle ownership data from the National Inventory Report "Trends in Vehicle Populations" as well as Natural Resources Comprehensive Energy Use Database [15]. Electricity consumption from electric vehicles could not be disaggregated from building energy	Gasoline and diesel prices were sourced from Kent Group Ltd.	2018 emission factors from Environment and Climate Change Canada's National Inventory Report[16] were used to convert energy use into GHGs (for specific factors, see Table 28 below). The per capita emissions from Huntsville were calculated and multiplied by the total year-round and seasonal population of the District to estimate the total GHG emissions in the District.

[13] O. Reg. 535/05: Ethanol in Gasoline under Environmental Protection Act, R.S.O. 1990, c. E.19

[14] O. Reg. 97/14: Greener Diesel - Renewable Fuel Content Requirements for Petroleum Diesel Fuel under Environmental Protection Act, R.S.O. 1990, c. E.19.

[15] Car, Light Truck, Medium and Heavy Truck Energy Use and GHG Emissions by Energy Source.

[16] Environment and Climate Change Canada. (2020). National Inventory Report 1990–2018: Greenhouse Gas Sources and Sinks in Canada. Canada's Submission to the United Nations Framework Convention on Climate Change.

Category	Energy Use	Energy Costs	GHG Emissions
	consumption, so it is embedded in the residential and commercial/institutional subsectors.		
Off-Road Vehicle Use (Scope 1)	Off-road transportation energy use was calculated from total provincial usage from the NRCAN Comprehensive Energy Use Database for 2017 and scaled to Muskoka based on population.		2018 emission factors from Environment and Climate Change Canada's National Inventory Report[17] were used to convert energy use into GHGs (for specific factors, see Table 28 below).
Muskoka Transit (Scope 1)	Total 2018 fuel use for Huntsville Regular Transit, Specialized Transit and Bracebridge Transit were provided by municipal staff. For Bracebridge Mobility only total mileage in 2018 and vehicle type was available from municipal staff. Total fuel use was estimated based on the combined city and highway fuel efficiency of a Ford T-150 Wagon (3.5 L Engine)[18].	Gasoline and diesel prices were sourced from Kent Group Ltd.	2018 emission factors from Environment and Climate Change Canada's National Inventory Report[19] were used to convert energy use into GHGs (for specific factors, see Table 28 below).

[17] Environment and Climate Change Canada. (2020). National Inventory Report 1990–2018: Greenhouse Gas Sources and Sinks in Canada. Canada's Submission to the United Nations Framework Convention on Climate Change.
[18] Natural Resources Canada. (2018). Fuel Consumption Guide.
[19] Environment and Climate Change Canada. (2020). National Inventory Report 1990–2018: Greenhouse Gas Sources and Sinks in Canada. Canada's Submission to the United Nations Framework Convention on Climate Change.

	Category	Energy Use	Energy Costs	GHG Emissions
Waste	Emissions from landfilled and biologically treated (composted) waste			Emissions from landfilled solid waste were calculated using the methane commitment model (GPC **Section 8.3.2**). The tonnes of residential solid waste generated in 2018 were retrieved from the Resource Productivity and Recovery Authority (RPRA) Data Call Reports (Data was only available for the residential sector). Landfill waste composition was determined using the default values for North America from the IPCC Guidelines for National Greenhouse Gas Inventories[20]. Emissions from the biological treatment of waste were calculated using the method for Direct Emissions from Biologically Treated Solid Waste (**GPC Section 8.4)**. Total tonnes of wet and dry waste were retrieved from the RPRA Data Call Reports. Emission factors for wet and dry composting waste from the IPCC Guidelines for National Greenhouse Gas Inventories[21] were used to convert composting waste into GHGs.

	Category	Energy Use	Energy Costs	GHG Emissions
Wastewater	Emissions from wastewater (Scope 3 emissions)	Energy used to operate wastewater facilities is captured under stationary energy commercial/institutional sectors. *Energy used to operate wastewater facilities is disaggregated and attributed under stationary energy in the corporate inventory, while emissions from the decomposition of wastewater are attributed to the community inventory).		Emissions from the treatment of wastewater were calculated using the approach in the IPCC Guidelines for National Greenhouse Gas Inventories.[22] The organic content of the wastewater (kg BOD/yr), nitrogen content of effluent (kg N/yr), sludge disposal and treatment pathways (Centralized aerobic treatment plant, anaerobic digesters for sludge, shallow lagoons and anaerobic deep lagoons) were determined from the District of Muskoka Water and Wastewater Compliance Reports. Emission factors for the treatment pathways were determined using the default values from the IPCC Guidelines for National Greenhouse Gas Inventories[23].

[20] 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 5: Waste, Chapter 3: Solid Waste Disposal.
[21] Ibid.
[22] 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 5: Waste, Chapter 6: Wastewater Treatment and Discharge.
[23] Ibid.

	Category	Energy Use	Energy Costs	GHG Emissions
Agriculture	Emissions from Livestock and Manure Management (Scope 1)			Emissions from livestock were calculated using the approach in **GPC Section 10.3.** Farm data from Muskoka was retrieved from 2018 livestock counts published by OMAFRA.

Table 2: Data & Assumptions Corporate Baseline Energy and Emissions Profile Data & Methodology

	Category	Energy Use	Energy Costs	GHG Emissions
Buildings	Natural gas (Scope 1)	Metered energy data was provided by the District Municipality of Muskoka 2019 Conservation and Demand Management Plan and Review.	Natural gas prices paid by the District of Muskoka were provided by the Facilities Department.	2018 emission factors from Environment and Climate Change Canada's National Inventory Report[24] (the most recent federal report on Canadian emissions) were used to convert energy use into GHGs (for specific factors, see Table 28 below).
	Electricity (Scope 2)	Metered energy data was provided by the District Municipality of Muskoka 2019 Conservation and Demand Management Plan and Review.	Electricity prices paid by the District of Muskoka were provided by the Facilities Department.	
Transportation	Municipal Fleet & Equipment (Scope 1)	Corporate fleet energy use was calculated from fleet data provided by municipal staff. As per provincial regulations, it was assumed that 5% of gasoline[25] is ethanol and 4% of diesel is biodiesel[26].	Actual fuel expenditures were provided by municipal staff. The average price paid per litre was $1.117 for gasoline and 0.982 for diesel.	2018 emission factors from Environment and Climate Change Canada's National Inventory Report[27] were used to convert

[24] Environment and Climate Change Canada. (2020). National Inventory Report 1990–2018: Greenhouse Gas Sources and Sinks in Canada. Canada's Submission to the United Nations Framework Convention on Climate Change.

[25] O. Reg. 535/05: Ethanol in Gasoline under the Environmental Protection Act, R.S.O. 1990, c. E.19

[26] O. Reg. 97/14: Greener Diesel - Renewable Fuel Content Requirements for Petroleum Diesel Fuel under Environmental Protection Act, R.S.O. 1990, c. E.19.

[27] Environment and Climate Change Canada. (2020). National Inventory Report 1990–2018: Greenhouse Gas Sources and Sinks in Canada. Canada's Submission to the United Nations Framework Convention on Climate Change.

	Category	Energy Use	Energy Costs	GHG Emissions
		Electricity consumption from electric vehicles could not be disaggregated from building energy consumption, so it is embedded in the residential and commercial/institutional subsectors.		energy use into GHGs (for specific factors, see Table 28 below).
Streetlights	Electricity (Scope 2)	Emissions from streetlight electricity consumption were calculated from total kWh and m^3 provided in the District Municipality of Muskoka 2019 Conservation and Demand Management Plan and Review.	Electricity prices paid by the District of Muskoka were provided by the Facilities Department.	2018 emission factors from Environment and Climate Change Canada's National Inventory Report[28] were used to convert energy use into GHGs (for specific factors, see Table 28 below).
Wastewater Facilities	Electricity (Scope 2)	Emissions from electricity and natural gas consumption in wastewater facilities were calculated from total kWh provided in the District Municipality of Muskoka 2019 Conservation and Demand Management Plan and Review.		

[28] Environment and Climate Change Canada. (2020). National Inventory Report 1990–2018: Greenhouse Gas Sources and Sinks in Canada. Canada's Submission to the United Nations Framework Convention on Climate Change.

There are a few categories from the GPC BASIC level of reporting, which were not included in the inventory. An explanation of their exclusion is included below.

- Building Energy
    - Energy Industries: Not occurring within the District of Muskoka.
    - Agriculture, forestry, and fishing activities: The consumption of energy and the associated emissions from this subsector would be included in the Commercial/Institutional or Manufacturing sectors. Energy consumption data from the utilities were not disaggregated by this subsector.
    - Fugitive emissions from mining, processing, storage, and transportation of coal: Not occurring within the District of Muskoka.
    - Institutional building energy data was not available disaggregated from the commercial and industrial sector. Institutional energy and emissions data was obtained from Broader Public Sector (BPS) Energy and Greenhouse Gas Emissions Reports for 2017 (please see Appendix A). BPS organizations are required to report this information under O. Reg. 507/18.

- Transportation
    - Freight Rail: Not occurring within the District of Muskoka.
    - Aviation: Not occurring within the District of Muskoka. The aviation sector only includes helicopter and airplane flights within the limits of Muskoka (inter-town flights that depart and land in Muskoka in the same trip). Since flights departing from and arriving at the Muskoka Airport do not begin and end within the municipal boundaries energy and emissions from this subsector are not accounted for in this analysis.
- Waste
    - Incineration and open burning of waste generated in the city: Not occurring within the District of Muskoka.

Additional Data and Outputs

Following well-established methodologies (as referenced above), the above data and assumptions have been used to generate a profile of energy consumption, energy expenditures, and emissions generated in the District of Muskoka in 2018. The following information will be presented, graphically and as data tables:

- Total energy consumed in Muskoka in 2018, by sector and source. Sector refers to building energy (residential, commercial, industrial, institutional etc.), transportation (private/personal, public transit, etc.), and waste. Source refers to the fuel type (natural gas, electricity, etc.).
- Total energy dollars spent by residents and businesses in Muskoka in 2018, by sector and by source.
- Total emissions generated in Muskoka, by sector, source, and scope.

To ensure that data is understandable, digestible and comparable, data will also be presented in terms of intensity values.

- Energy will be represented as energy use intensity i.e. gigajoules (GJ) of energy consumption per metre of floor space (m^2), GJ per capita, GJ per household, and any other relevant indicators. This will be differentiated by residential only, as data was not disaggregated sufficiently to include a break down of the ICI sectors. Information on total number of households, age and floor space was obtained from Municipal Property Assessment Corporation data provided by the District of Muskoka.
- Energy expenditure will be represented as dollars spent per capita, dollars spent per household, and any other relevant indicators.
- Emissions will be represented as GHG emissions (tCO_2e) per capita, among others.

Data Collection Recommendations

- Request utilities to track consumption by facility type (residential, institutional, commercial, and industrial) and provide number of connected premises for each type
- Request gross floor area for all buildings in the District broken down by facility type and age of the building
- Conduct a transportation survey to determine the number of vehicle kilometers that residents, permanent and seasonal, drive within the District annually
- Conduct a survey to determine the amount and cost of fuel that is used by recreational boaters annually
- Conduct a survey to determine the amount and cost of fuel that is used by off-road vehicles annually
- Conduct a GIS study to analyze the land use change that has occurred in the last 20 years (i.e. acres of forests to development)
- Conduct an audit of the solid waste stream that captures all sectors in the community
- Conduct a survey to determine the amount of fuel, propane, and wood that is used in residential, commercial, and industrial sectors
- Determine the gross floor area of all buildings owned and operated by the District
- Conduct a corporate waste audit to determine the tonnes of solid waste generated by the corporation and gather data on the waste stream concurrently

Community Baseline Energy Use and Energy Expenditures in 2018

In 2018, the District of Muskoka's residents and businesses used 14,916,047 GJ of energy to heat and power their homes and buildings and for transportation fuel within the District. In terms of energy dollars, the community of Muskoka spent $541,881,353 on energy in 2018 alone. On an individual basis, the average person used 103 GJ of energy per year and spent $3,539 on energy.

As shown in Table 3 and Figures 2 and 3, building energy, which includes residential buildings (year-round homes and cottages), institutional, commercial and industrial buildings (ICI Sector), accounted for 34% of energy consumption and 33% of energy costs. Transportation fuel use contributed 66% of all energy and 67% of energy costs, most of which was private vehicle use.

Table 3: Energy consumption and costs to the community by sector in 2018.

Sector	Energy Consumption (GJ)	Energy Costs ($)
Residential	2,826,679	$124,577,918
ICI Sector	2,250,688	$55,596,941
Transportation	9,838,680	$361,706,494
Total	14,916,047	$541,881,353

*Numbers may not total due to rounding

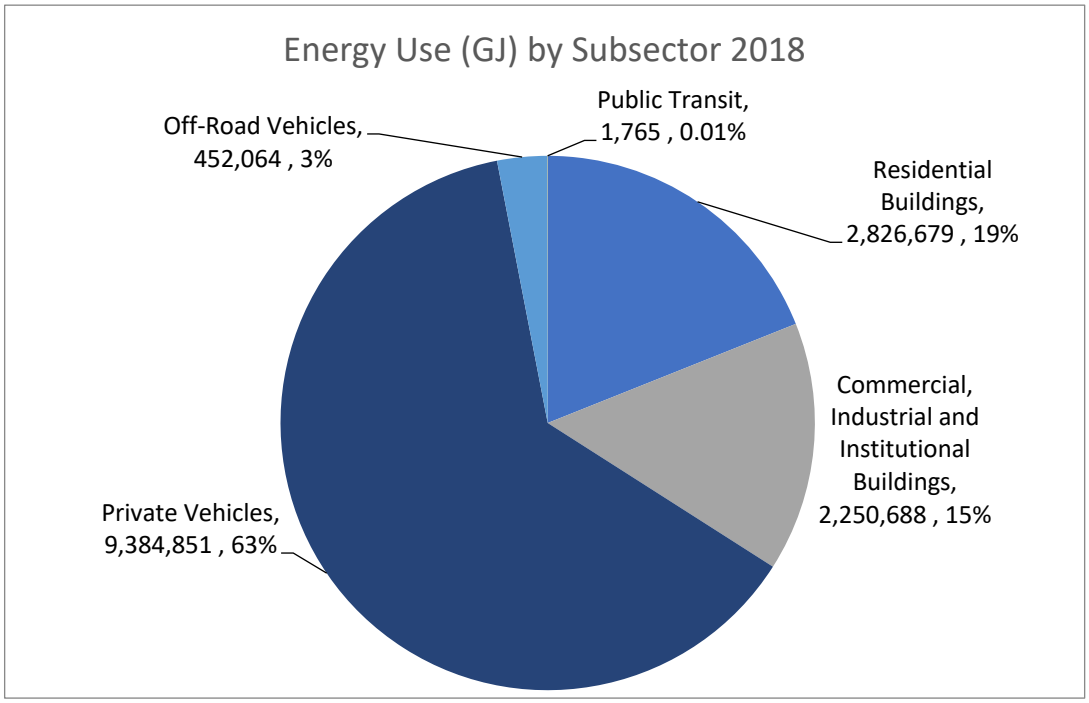

Figure 2: Energy consumption by subsector in 2018.

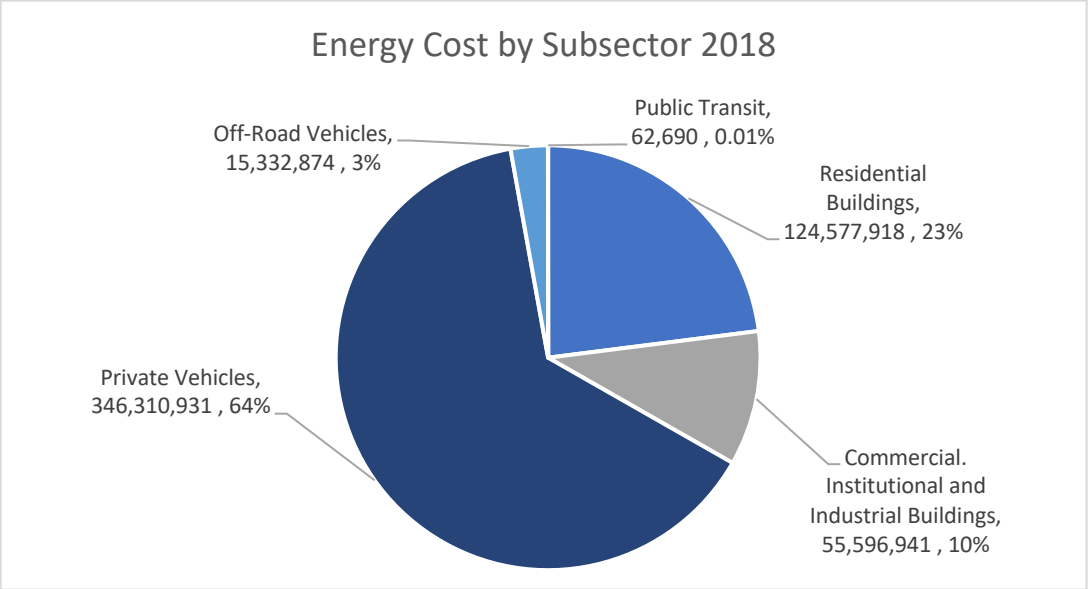

Figure 3: Energy expenditures by sector and subsector in 2018.

When looking at energy use by fuel type, gasoline was the most significant fuel type used across all sectors, making up 59% of fuel consumption and 59% of energy costs. This is followed by natural gas at 16% of energy use, however electricity is the next largest contributor to energy costs due to its higher price (Table 4 and Figures 4 and 5).

Table 4: Total energy consumption and costs by fuel type in 2018.

Fuel type	Energy Consumption (GJ)	Energy Costs ($)
Electricity	2,216,607	$142,695,709
Natural Gas	2,431,442	$29,444,716
Propane	53,511	$1,249,733
Fuel Oil	169,460	$5,984,072
Wood	206,348	$800,629
Gasoline	8,747,678	$319,772,296
Diesel	748,743	$24,099,914
Ethanol	313,489	$16,830,121
Biodiesel	28,770	$1,004,163
Total	**14,916,047**	**$541,881,353**

*Numbers may not total due to rounding

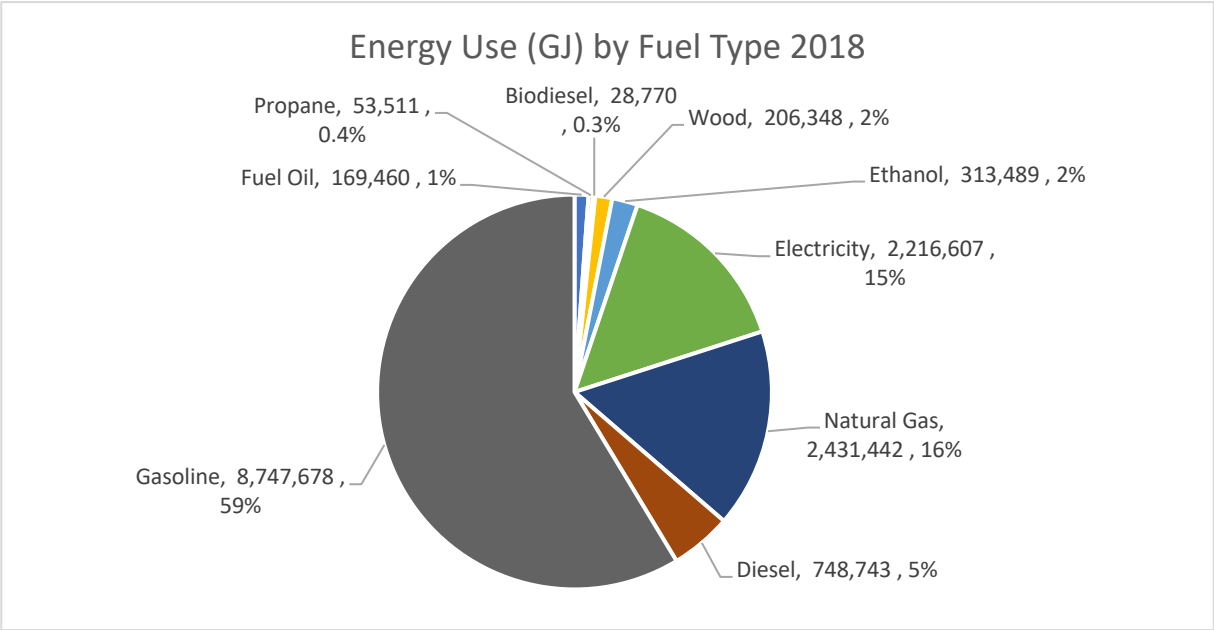

Figure 4: Energy consumption by fuel type in 2018.

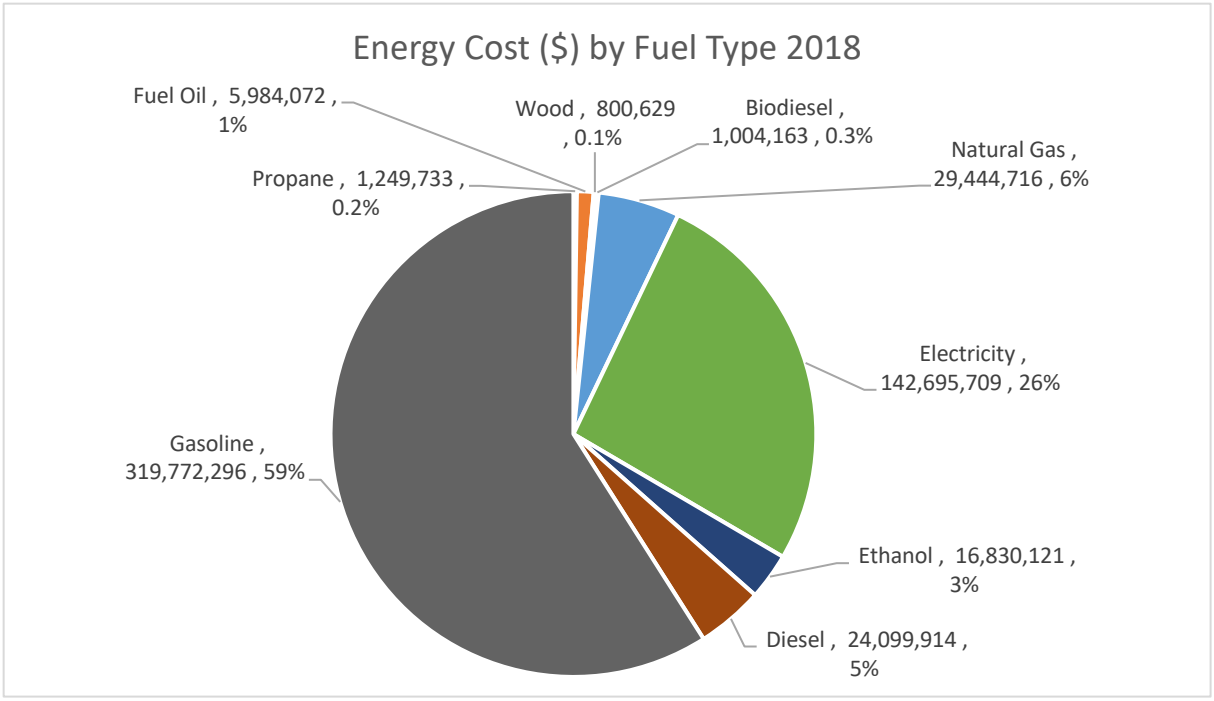

Figure 5: Energy Expenditures by fuel type in 2018.

Community Baseline GHG Emissions in 2018

In 2018, the community of Muskoka generated 897,068 tonnes of carbon dioxide equivalent (tCO_2e), or 6.18 tCO_2e per capita (Table 5 and Figure 6.)

Table 5: Total emissions by sector in 2018.

Sector	Emissions (tCO_2e)
Residential	79,175
ICI Sector	96,875
Fugitive Emissions	1,796
Private Vehicle	629,192
Off-Road	32,101
Muskoka Transit	122
Waste	24,344
Wastewater	31,524
Agriculture	1,939
Total	**897,068**

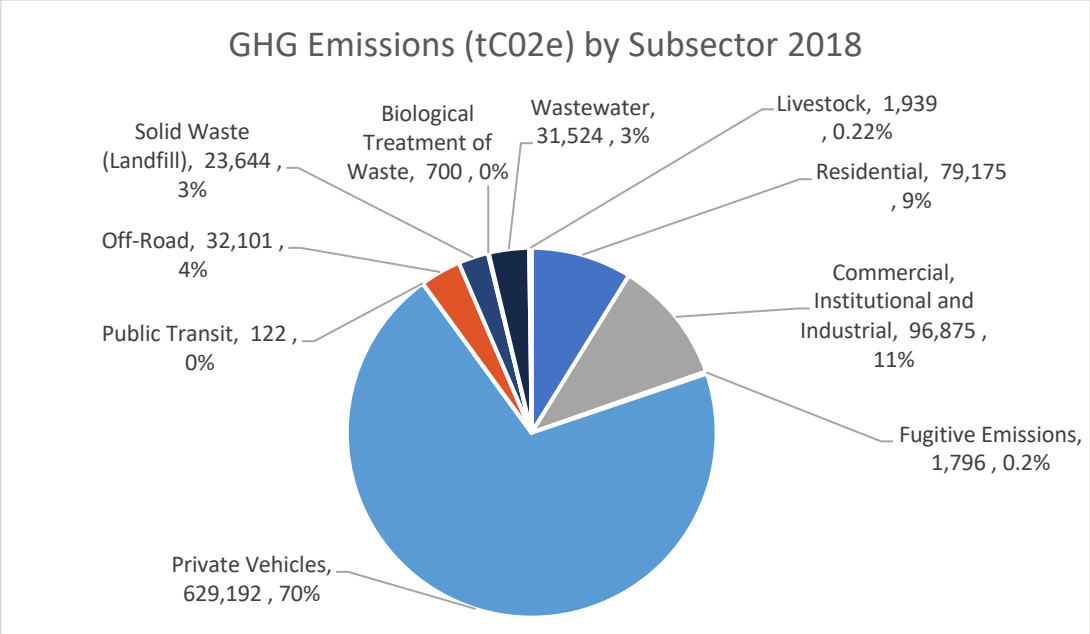

Figure 6: GHG emissions by subsector in 2018.

Building Energy

The building energy sector includes energy used for heating and powering residential buildings as well as the ICI Sector. Table 6 below outlines each subsector's energy use and energy costs.

Table 6: Energy consumption and costs by building energy subsector in 2018.

Subsector	Energy Use (GJ)	Energy Costs ($)	GHG Emissions (tCO_2e)
Residential	2,826,679	$124,577,918	79,175
ICI Sector	2,250,688	$55,596,941	96,875
Fugitive emissions**	--	--	1,796
Total	**5,077,367**	**$ 180,174,859**	**177,846**

** Fugitive emissions refer to the methane released through equipment leaks, evaporation, venting, flaring, and accidental releases during the distribution of natural gas.*

The residential subsector contributes most to energy use and costs in the sector using 56% of the total energy and 69% of total energy expenditures (Figures 7), however, the ICI sector generates 54% of emissions due to higher natural gas usage (Figure 9).

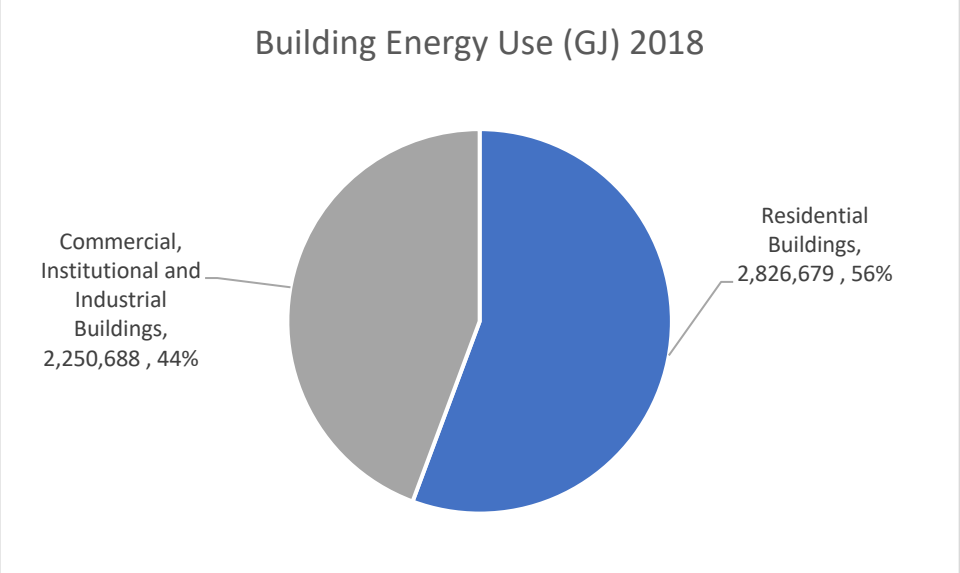

Figure 7: Energy Consumption by building energy subsector in 2018.

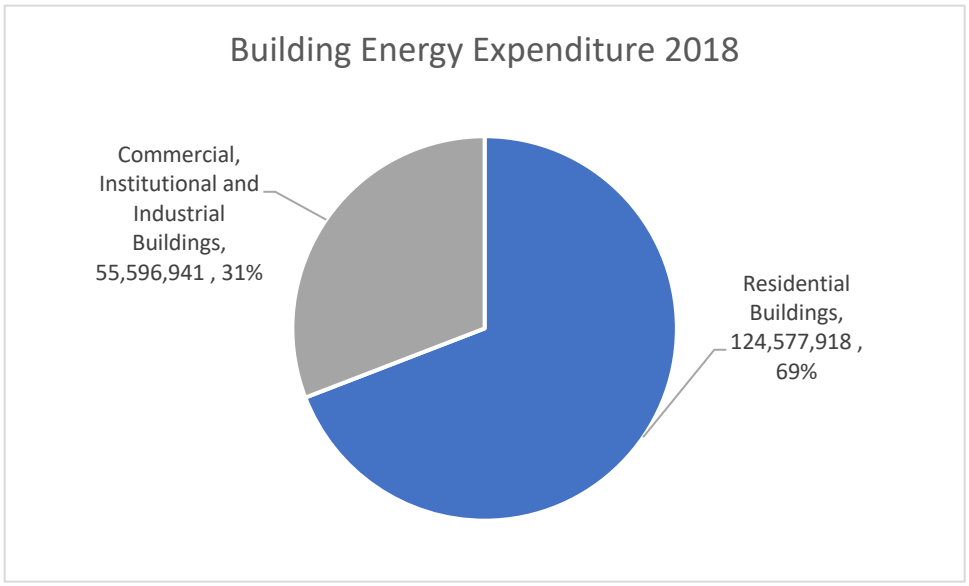

Figure 8: Energy expenditures by building energy subsector in 2018.

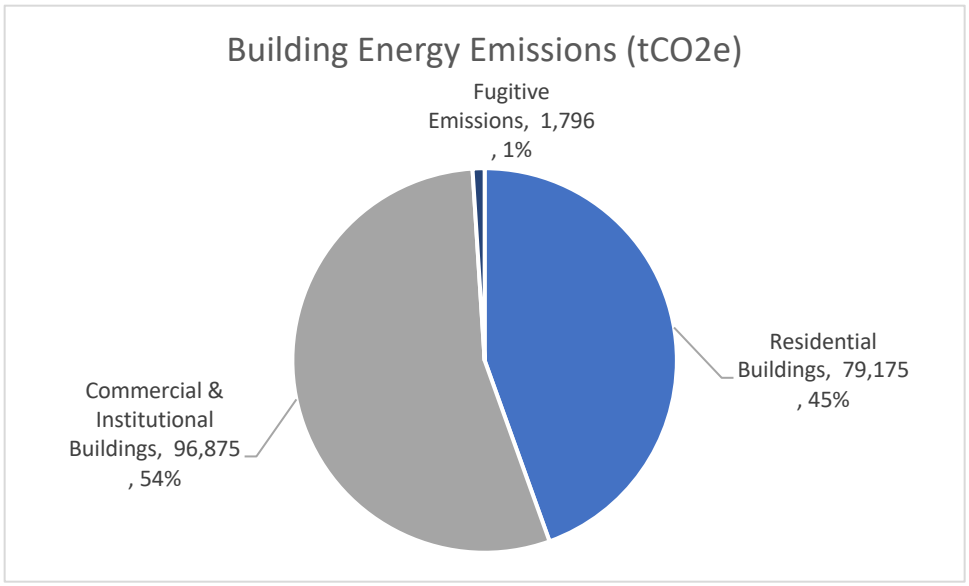

Figure 9: Emissions from building energy by subsector in 2018.

In the residential subsector electricity made up the largest share of energy use (61%), however in the ICI subsector natural gas made up the largest share of energy use (74%) and in the stationary energy sector overall, natural gas accounts for the majority of energy use (48%). Electricity contributes 79% of all energy expenditure in the building energy sector, as the price of electricity is higher relative to other fuels. While the commercial and industrial sectors have been combined for this inventory due to a lack of data segregation for electricity consumption, available natural gas consumption data for the industrial sector shows a total consumption of 875,141 GJ from 11 premises.

The District of Muskoka contains 456,861 households which are primarily made up of single-family detached homes (Table 7). The age of residential buildings has an even distribution with each age category falling within the range of 24-26% of all residential buildings[29] (Table 8).

Table 7: Type of residential dwelling in Muskoka in 2018.

Residential Dwelling Type	Gross Floor Area (m^2)	Percent (%)
Single Family Dwelling	6,098,349	97%
Duplex Row/Town House	63,428	1%
Multi-Unit Residential Dwelling	118,177	2%
Total	**6,279,955**	

Table 8: Age of residential homes in Muskoka in 2018.

Construction Period	Gross Floor Area (m^2)	Percent (%)
Pre 1960	1,550,147	25%
1960-1979	1,615,694	26%
1980-1999	1,478,381	24%
2000 and after	1,635,733	26%
Total	**6,279,955**	

Transportation

In 2018, transportation accounted for 66% of all energy use, 67% of energy costs, and 74% of emissions. Of this, 95% of transportation emissions are from on-road transportation, while 0.018% is from public transit buses in the District of Muskoka and 5% is from off-road vehicles (Table 9, Figure 10). The two tables below display the contributions of each subsector and fuel type to transportation emissions. Gasoline contributes the most representing 89% of transportation energy use in 2018 (Figure 11).

Table 9: Energy Consumption and costs by transportation subsector in 2018.

Subsector	Energy Use (GJ)	Energy Costs ($)	Emissions (tCO_2e)
Personal Vehicle Use	9,384,851	$346,310,931	629,192
Off-Road	452,064	$15,332,874	32,101
Public Transit (Bus)	1,765	$62,690	122
Total	**9,838,680**	**$361,706,494**	**661,415**

[29]Source: Municipal Property Assessment Corporation (MPAC), 2018, provided to the District Municipality of Muskoka

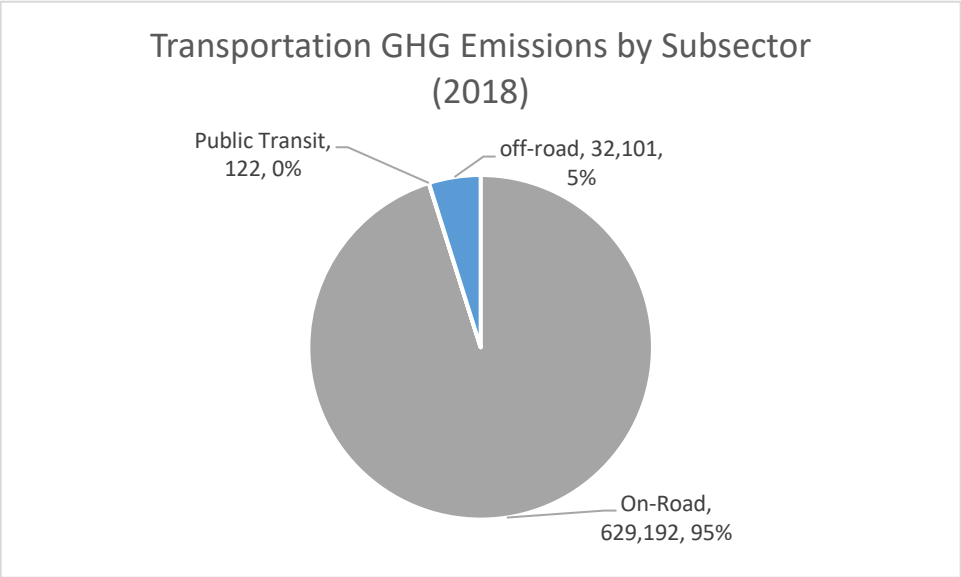

Figure 10: GHG emissions by transportation subsector in 2018.

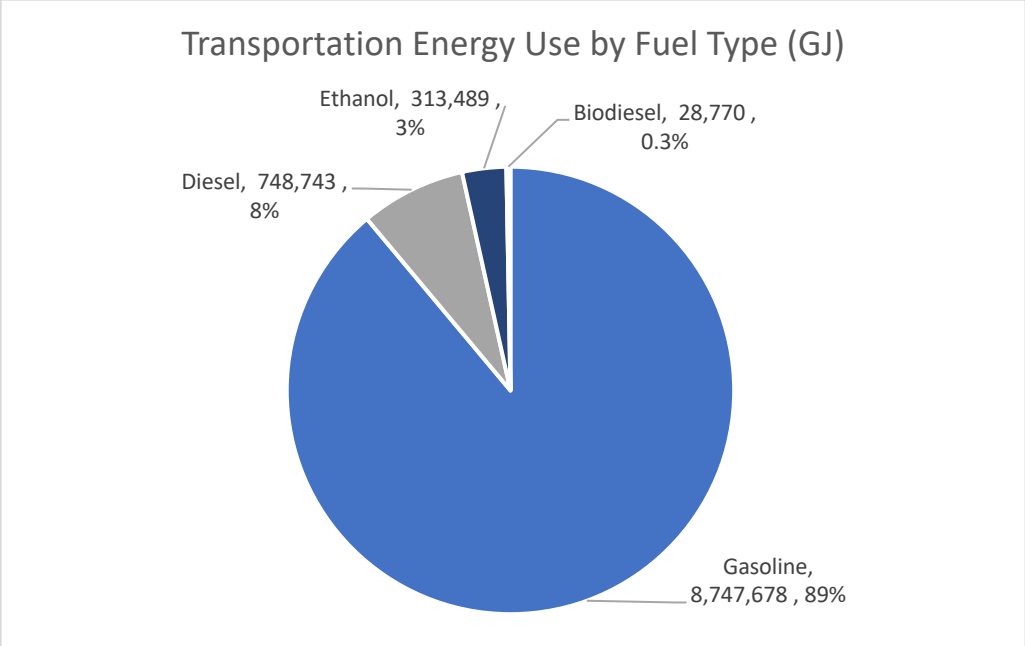

Figure 11: Energy use by transportation fuel use in 2018.

In 2018, the average person in Muskoka used 68 GJ of gasoline and diesel, spent $2,501 on transportation fuel, and generated 4.57 tCO_2e per capita. Total vehicle kilometers travelled were 2,925,860,820, and public transit kilometers travelled were 158,165 km.

Agriculture

Emissions in this category are the result of CH_4 produced from enteric fermentation in livestock, as well as CH_4 and $N0_2$ as a result of manure management practices. Due to the small amount of livestock in the District of Muskoka this category only contributes 0.22% to overall community GHG emissions.

Waste and Wastewater

The waste and wastewater sectors include emissions from solid waste and wastewater that is generated within the District of Muskoka. Waste emissions account for 6.2% of emissions in 2018, or 0.39 tonnes of GHGs per capita (Table 10). The waste sector only includes emissions from the disposal of waste and the treatment of wastewater, rather than the energy used in that waste disposal which is included under building energy consumption. As a result, energy values for waste are not included in the energy use and expenditures section above.

Table 10: Waste and wastewater GHG emissions by subsector in 2018.

Subsector	GHG Emissions (tCO_2e)
Solid Waste (Landfill)	23,644
Biological Treatment (Compost)	700
Wastewater	31,524
Total	**55,868**

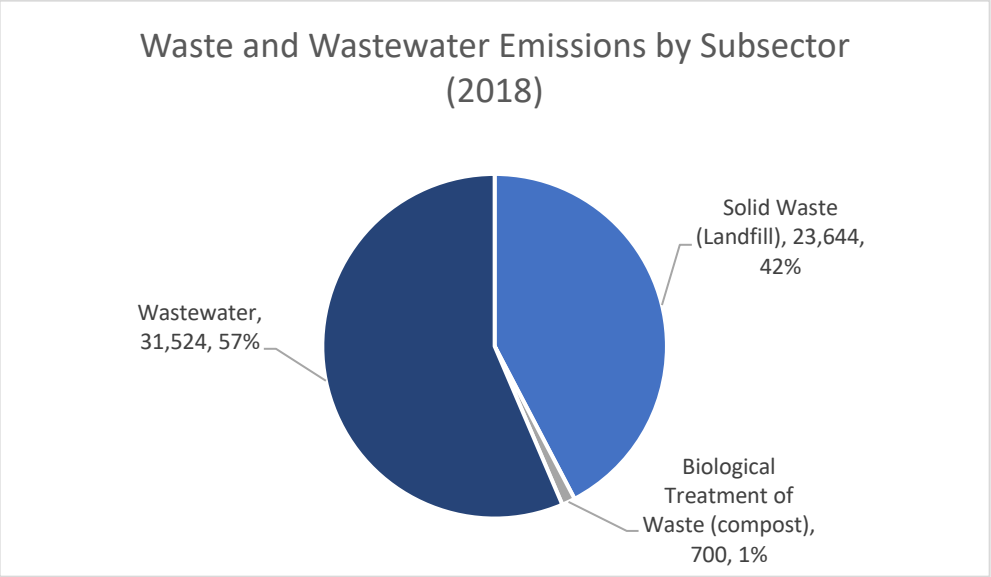

Figure 12: Waste emissions by subsector in 2018.

In 2018, residents of Muskoka produced 14,726 tonnes of waste, or 0.10 tonnes of waste per person, lower than the provincial and national averages which are 0.70 and 0.69 respectively[30]. This generated 23,644tonnes of emissions from landfilled waste and 700 tonnes from the composting. Waste stream data was not available so default values from the *Intergovernmental Panel on Climate Change Guidelines for National Greenhouse Gas Inventories 2006*, were used[31] as illustrated in Table 11.

*Data on commercial and industrial waste streams were not available for Muskoka.

Table 11: Share of the waste stream based on default values for North America.

Waste Stream	Share of Waste Generated (%)
Food	34%
Garden	0%
Paper/Cardboard	23%
Wood Products	6%
Textiles	4%
Plastics	33%

[30] Statistics Canada. 2020. Disposal of waste, by source. https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3810003201

[31] IPCC. (2006). 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Volume 5 Waste, IPCC Waste Model spreadsheet.

Municipal (Corporate) Baseline Energy Use and Energy Expenditures in 2018

In 2018, the District of Muskoka used 130,887 GJ across their corporate facilities, vehicle fleet, streetlights and wastewater. In terms of energy dollars, the District of Muskoka spent $3,915,091 on energy in 2018 alone*.

As shown in Table 12 and Figures 13 and 14 energy use in wastewater facilities accounted for 49% of energy consumption and 54% of energy costs. Buildings are the next largest energy user accounting for 35% of energy consumption and 30% of energy expenditures.

Table 12: Municipal energy consumption, expenditures and GHG emissions in 2018.

Sector	Energy Consumption (GJ)	Energy Costs ($)	GHG Emissions (tC02e)
Buildings	46,145	$1,177,631	1,355
Fleet	20,626	$588,189	1,422
Streetlights	532	$21,583	4
Water and Sewer	63,584	$2,127,666	1,161
Total	**130,887**	**3,915,069**	**3,942**

*Numbers may not total due to rounding

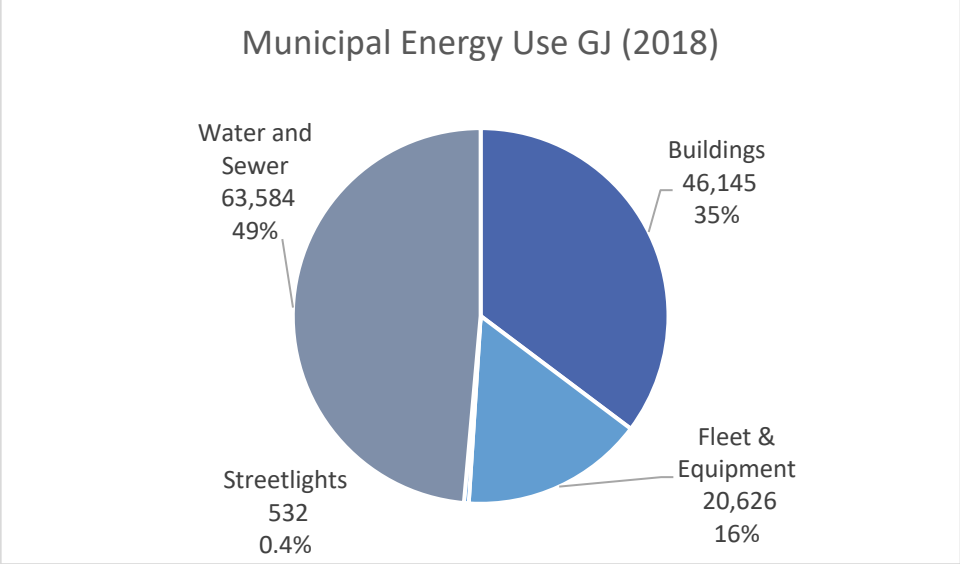

Figure 13: Energy Consumption by the Municipality in 2018.

*Total energy spending may vary from actuals due to use of 2019 data to fill in fleet sector data gaps. In addition energy rebates are not included in this analysis.

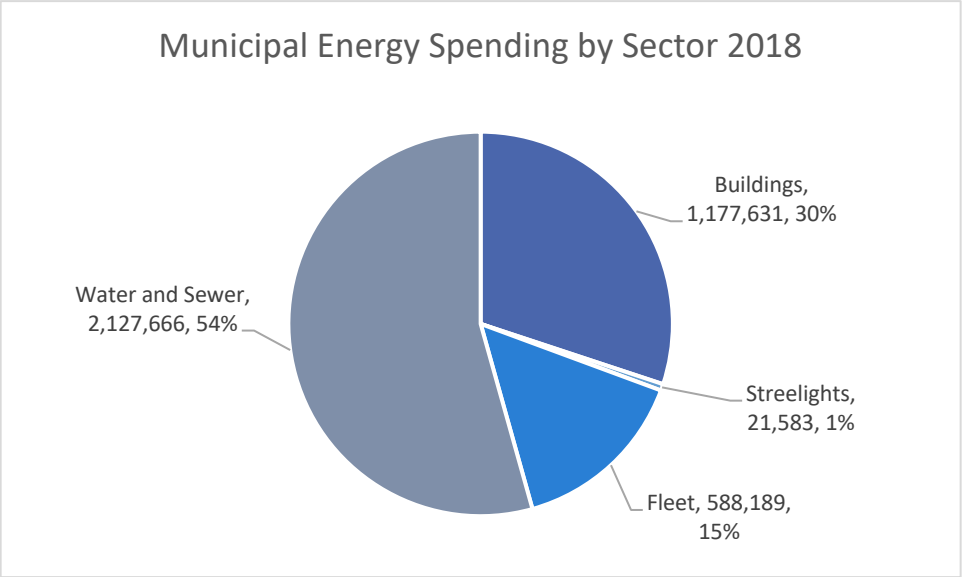

Figure 14: Municipal energy expenditures in 2018.

When looking at energy use by fuel type, electricity was the most significant fuel type used across all sectors, making up 55% of fuel consumption, followed by natural gas at 29%. (Table 13, Figure 15). The vehicle fleet was the largest contributor to GHG emissions (36%) followed by buildings (34%) and wastewater facilities (29%), as shown in Figure 16.

Table 13: Total municipal energy consumption and costs by fuel type in 2018.

Fuel type	Energy Consumption (GJ)	Energy Costs ($)
Electricity	72,662	$2,946,861
Natural Gas	37,599	$380,019
Gasoline	8,637	$282,850
Diesel	11,990	$305,339
Total	**130,887**	**$ 3,915,069**

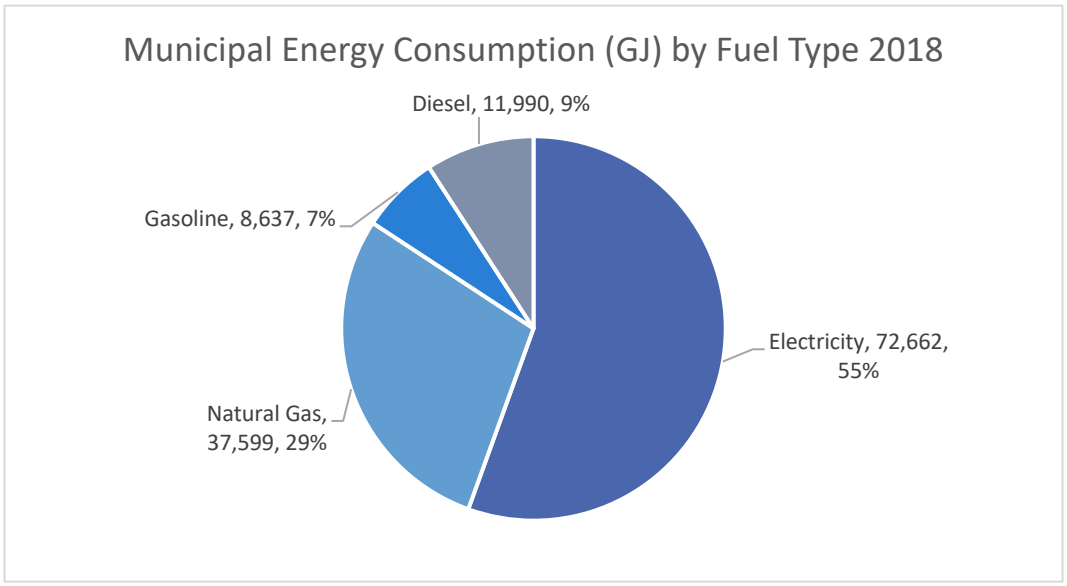

Figure 15: Municipal energy consumption by fuel type in 2018.

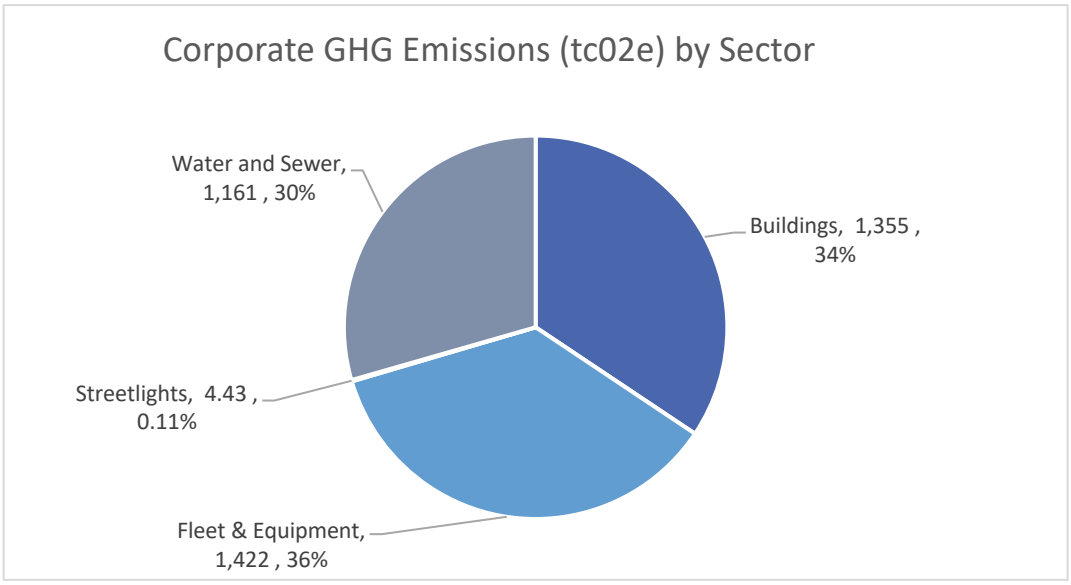

Figure 16: Municipal GHG emissions by sector in 2018.

Municipal Buildings and Facilities

The buildings sector accounts for all energy used for heating and powering corporate buildings. Table 14 and Figures 18 and 19 below outlines the total energy consumption, cost and GHG emissions from each asset category. Housing contributed the most to this sector using 45% of total energy, 49% of energy costs and 41% of emissions.

Table 14: Total municipal energy consumption, costs and GHG emissions by asset in 2018.

Asset Category	Energy Consumption (GJ)	Energy Costs ($)	Greenhouse Gas Emissions (tc02e)
Administrative Offices	6,982	163,320	226
Airport	843	25,889	19
Paramedic Services	2,705	66,696	83
Housing	20,763	572,169	550
Long-term Care	13,022	279,247	457
Roads	631	21,660	11
Solid Waste	1,200	48,650	10
Totals	46,145	1,177,631	1,355

*Numbers may not total due to rounding

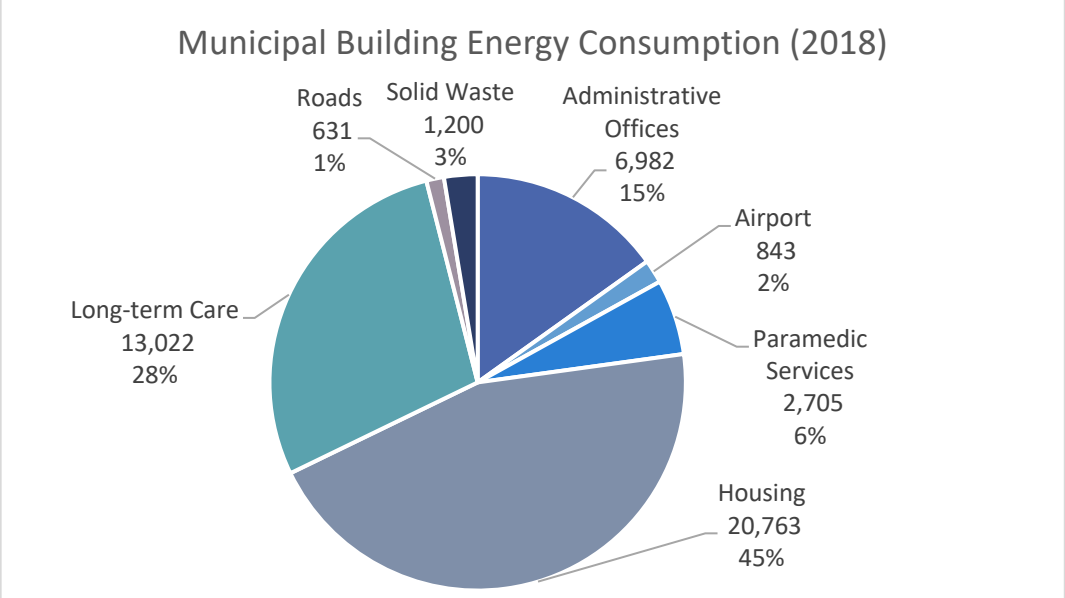

Figure 17: Municipal building energy consumption in 2018.

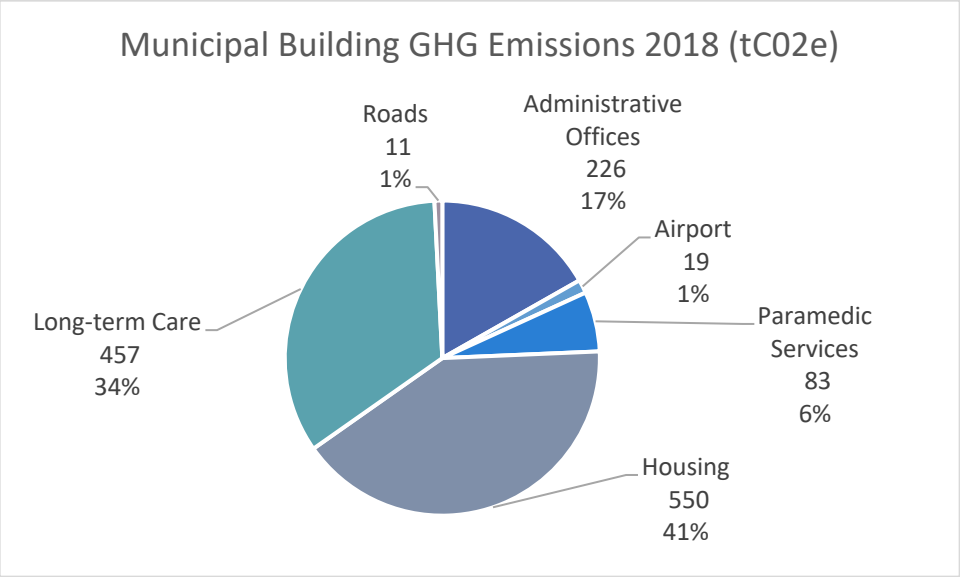

Figure 18: Municipal building GHG emission in 2018.

Municipal Corporate Fleet

The municipal corporate vehicle fleet is the largest source of GHG emissions in the corporate inventory, accounting for 36% of all emissions. As shown in Table 15 and Figures 21,diesel made up 58% of fuel use and therefore also accounted for the majority of energy costs and emissions (Figure 19 and 20).

Table 15: Municipal vehicle fleet fuel use, energy costs and GHG emissions in 2018.

Fuel Type	Energy Consumption (GJ)	Energy Costs ($)	GHG Emissions (tC02e)
Gasoline	8,637	282,850	577
Diesel	11,990	305,339	845
Total	20,626	588,189	1,422

*Numbers may not total due to rounding

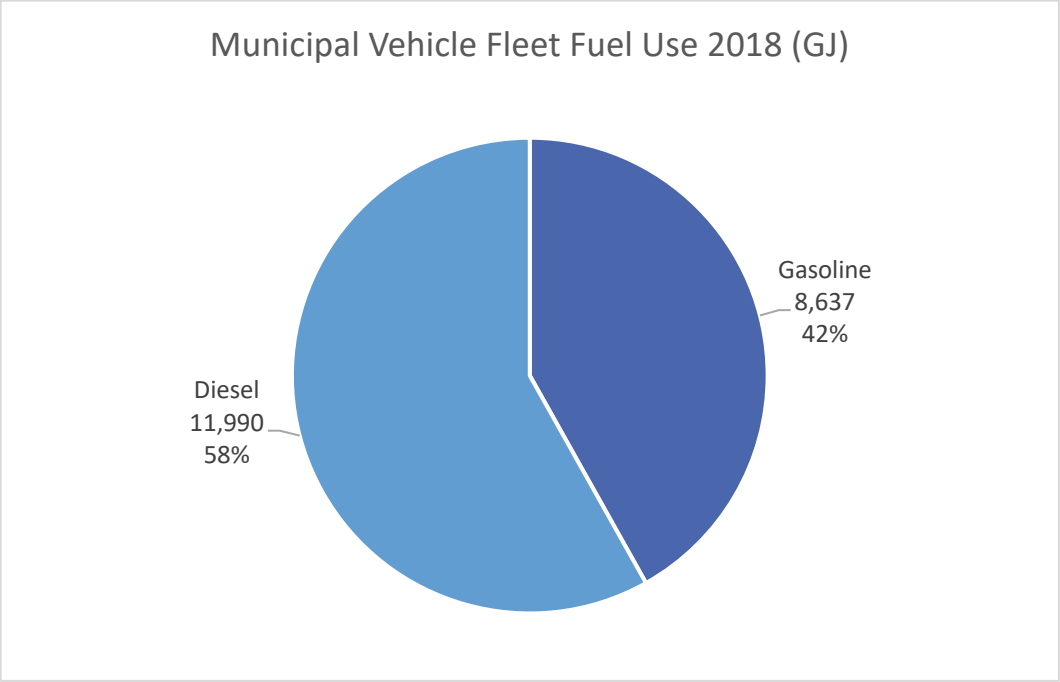

Figure 19: Municipal vehicle fleet fuel use in 2018.

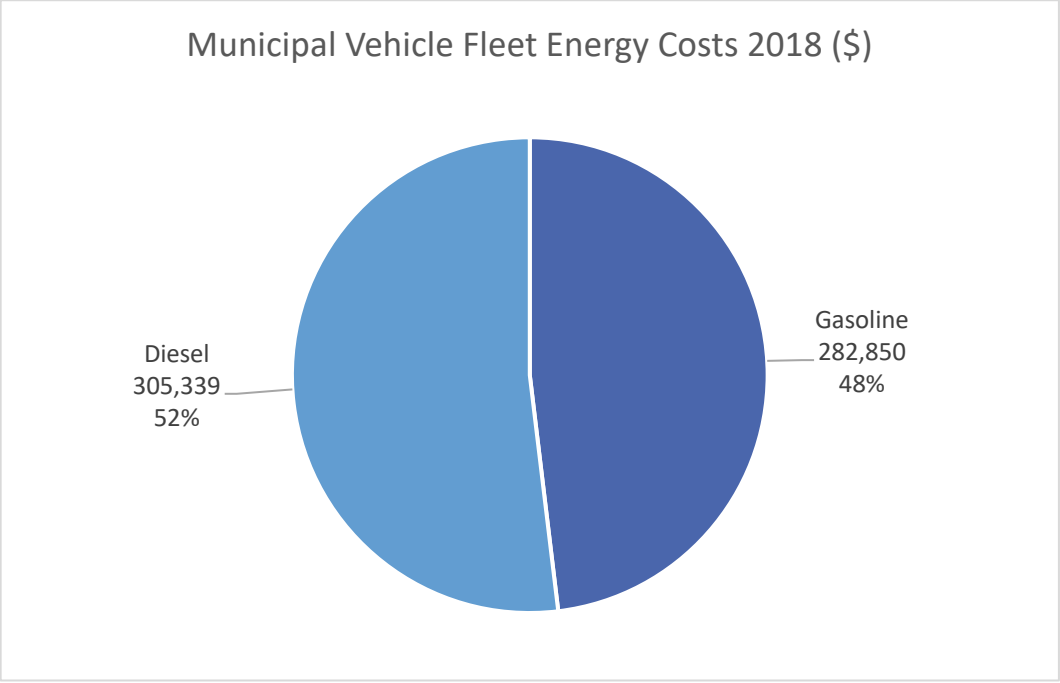

Figure 20: Municipal vehicle fleet energy costs in 2018.

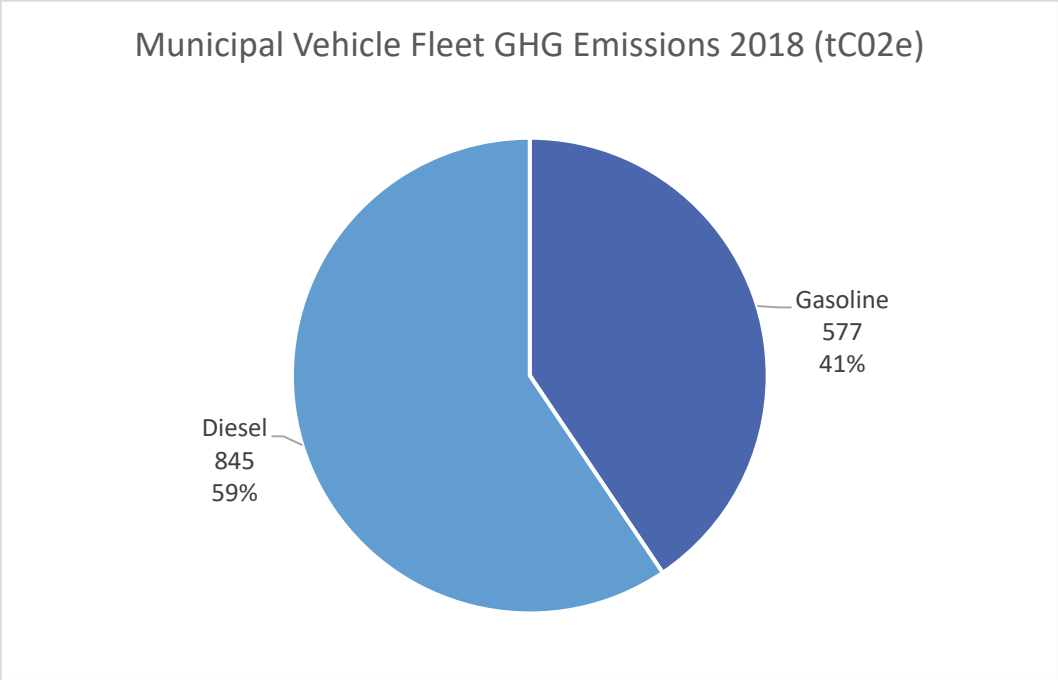

Figure 21: Municipal vehicle fleet GHG emissions in 2018.

Street lighting

Street lights consumed 532 GJ of electricity in 2018, contributing 0.1% to total GHG emissions and 1% of total energy costs as shown in Table 16.

Table 16: Municipal streetlighting energy consumption and GHG emissions in 2018.

Asset Category	Electricity Consumption (kWh)	Electricity Consumption (GJ)	GHG Emissions (tC02e)	Energy Cost ($)
Streetlighting	147,826	532	4	21,582.60

Water and Wastewater

Electricity and natural gas consumption in water and wastewater facilities was the largest source of corporate energy use and energy spending, accounting for 49% of total energy use and 54% of total energy spending. However, this sector contributed 29% to total GHG emissions due to the higher use of electricity over natural gas.

Comparison to District of Muskoka 2019 Conservation and Demand Management Plan

In comparison of the GHG emissions in the 2019 CDM to this inventory, the total emissions values from electricity consumption in the CDM are higher than this report (Table 17). This is due to the use of emissions factors in the CDM based on Broader Public Sector Reporting calculations from 2013. As carbon intensity has improved in Ontario since the closure of the last

coal plant in 2014, electricity emissions factors are significantly lower in 2018 than in 2013 due to renewable energy and nuclear power generation becoming the main electricity generation sources. The District of Muskoka intends to update the electricity emissions factors in the next CDM to align with the emissions factors used in this inventory. The ICLEI/LURA inventory also includes energy use, costs and emissions from the corporate fleet of vehicles which was not included in the 2019 CDM Plan as shown in Table 15.

Table 17: Comparison of the District of Muskoka inventory and the 2019 CDM Plan

	ICLEI/LURA Inventory	2019 CDM	Difference
Asset Category	tC02e	tC02e	%
Administrative Offices	226	268	19%
Airport	19	27	42%
Paramedic Services	83	101	22%
Housing	550	715	30%
Long-term Care	457	524	15%
Roads	11	18	65%
Solid Waste	10	27	167%
Streetlights	4	12	167%
Water and Sewer	1,161	1,837	58%
TOTAL:	2,520	3,715	47%

Business-as-Planned Energy and Emissions Forecast

The Business-as-Planned (BAP) scenario is developed to understand future energy consumption, energy costs and emissions for the District of Muskoka, assuming no action is taken to reduce energy or emissions. The BAP's methodologies and assumptions reflect the consultant team's expertise in building emissions and energy models for municipalities and follows best practices. The methodologies and assumptions used align with the Government of Ontario's Community Emissions Reduction Planning: A Guide for Municipalities[32]. Energy consumption, costs and GHG emissions were modelled from 2018 to 2031, 2041, and 2050, in line with population and employment forecasts. The BAP forecast is not an absolute picture of future energy and emissions but instead serves as a tool to guide decision making on energy and emissions mitigation strategies.

Community Energy and Emissions Projections

The primary driver in the modelled BAP scenario is population and employment growth, which will lead to more houses, more businesses, more cars on the road, and more waste, and therefore changes to energy consumption and emissions. However, changes that occur outside the influence of the municipality, such as actions from higher levels of government and technology changes driven by broader economic trends will also influence the energy consumption and emissions of Muskoka in the future.

Specifically, in the building sector, the impact of population and economic growth are offset somewhat by modest energy efficiency retrofits and some improvement to the energy performance of new buildings. As a result, the energy and emissions of the building sector stay relatively stable until 2050.

Contrarily, the transportation sector's energy use and associated emissions will decrease from 2018 to 2030, as a result of improved fuel economy and more electric vehicles[33]. However, after 2030, the business as planned scenario assumes a stabilization of fuel economy improvements and electric vehicle uptake, thus the population becomes the dominant force, reducing the rate at which emissions are decreased after 2030 through to 2050.

Waste emissions increase in proportion to population growth. Table 27 presents a detailed list of assumptions used in the BAP projections.

[32] Government of Ontario. 2017. Community Emissions Reduction Planning: A Guide for Municipalities. Retrieved http://www.downloads.ene.gov.on.ca/envision/env_reg/er/documents/2018/013-2083.pdf

[33] Canada Energy Regular. (2018). *Market Snapshot: Vehicle emission standards will reduce gasoline use.* Retrieved from https://www.cer-rec.gc.ca/nrg/ntgrtd/mrkt/snpsht/2018/07-03vhclmssns-eng.html

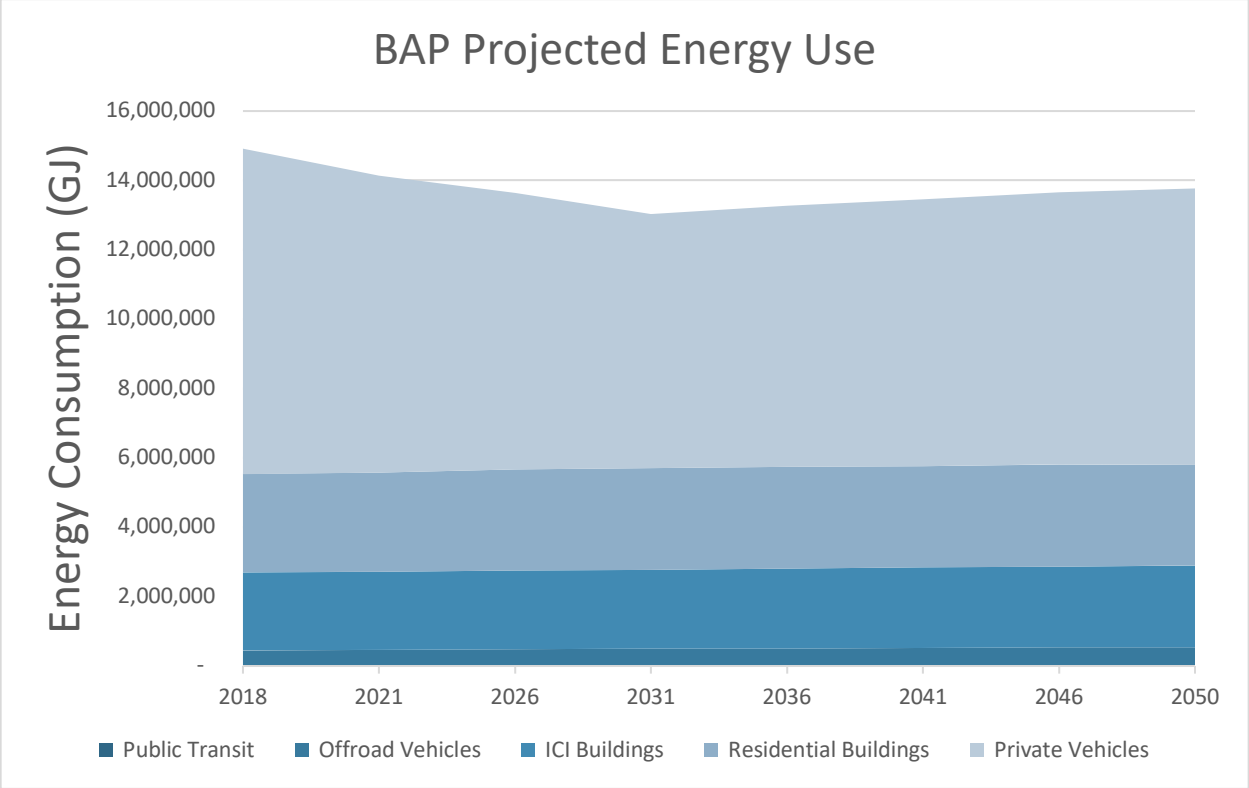

Figure 22: Projection of energy use under a business-as-planned scenario, by subsector.

Table 18: 2018 energy use and projected energy use in 2031, 2041, and 2050 assuming no further action is taken to reduce energy use in the District of Muskoka.

Sector	2018 Energy Use (GJ)	Projected 2031 Energy Use (GJ)	Projected 2041 Energy Use (GJ)	Projected 2050 Energy Use (GJ)
Stationary Energy	5,077,367	5,216,638	5,243,713	5,254,783
Transportation	9,838,680	7,807,247	8,205,905	8,517,897
Total	**14,916,047**	**13,023,885**	**13,449,618**	**13,772,681**

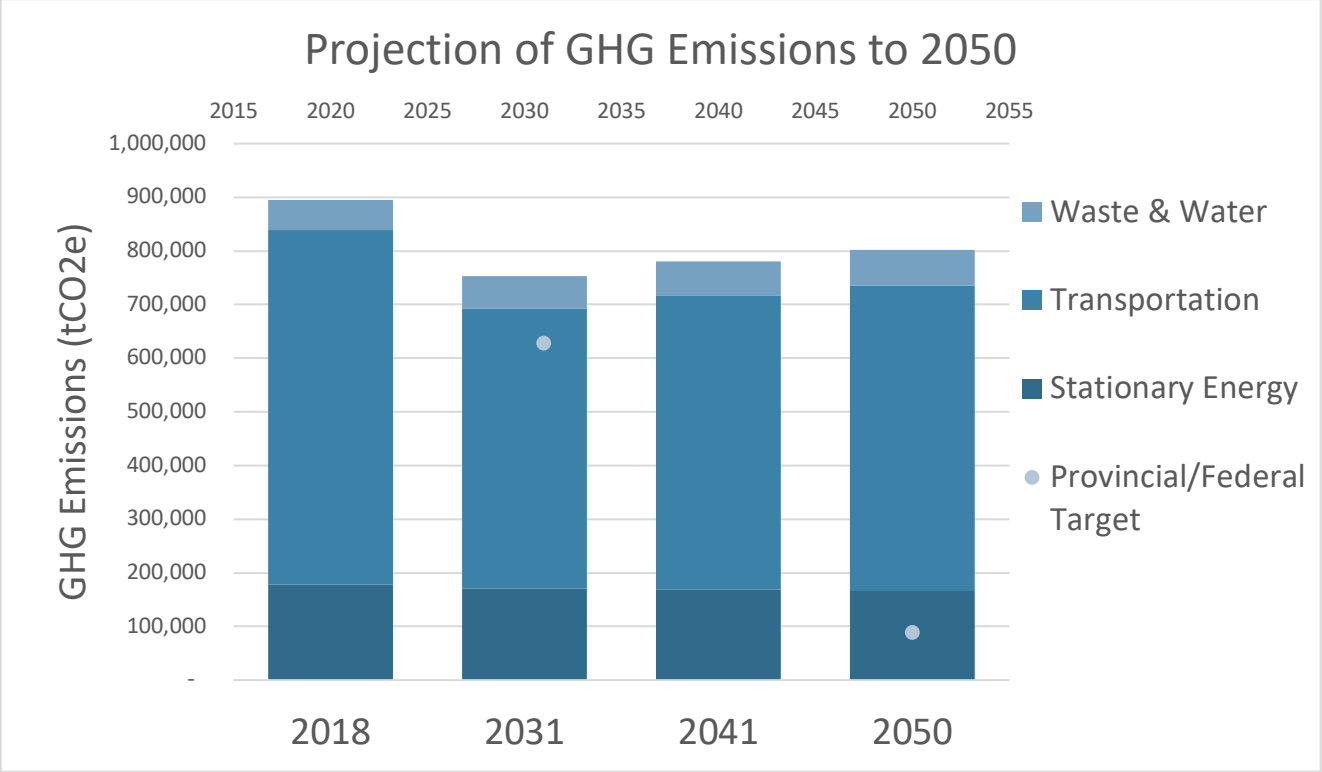

Figure 23: Projection of GHG emissions under a business-as-planned scenario, by sector.

Table 19: 2018 emissions use and projected emissions in 2031, 2041, and 2050 assuming no further action is taken to reduce emissions in the District of Muskoka.

Sector	2018 tCO_2e	2031 tCO_2e - Projected	2041 tCO_2e - Projected	2050 tCO_2e - Projected
Stationary Energy	177,846	170,671	168,638	166,225
Transportation	661,415	521,326	548,050	568,887
Waste	55,868	60,901	64,011	66,445
Agriculture	1,939	2,113	2,221	2,306
Total	**897,068**	**755,012**	**782,921**	**803,863**

*Numbers may not total due to rounding

Municipal (Corporate) Energy and Emissions Projections

As in the community modelled BAP scenario, the primary driver in the corporate model is population and employment growth increase which operations and expand the facilities required by the District. Regional changes that impact the community's energy consumption patterns will also affect energy consumption at the municipal level. Due to the energy profile of both the community and corporation, which includes varying fuel sources and energy sectors, the regional patterns will impact each model in different ways. A major difference between the two models is that the total energy consumption for the community is decreasing while the energy consumption for the municipality is increasing. The difference can be attributed to the percentage of vehicles that make up the energy profile. Transportation energy use accounts for 66% of the community inventory while fleet vehicles only account for 16% of corporate inventory. The fuel efficiency gains, therefore, have a much greater impact on the community BAP scenario than in the corporate BAP scenario making the overall trajectories different.

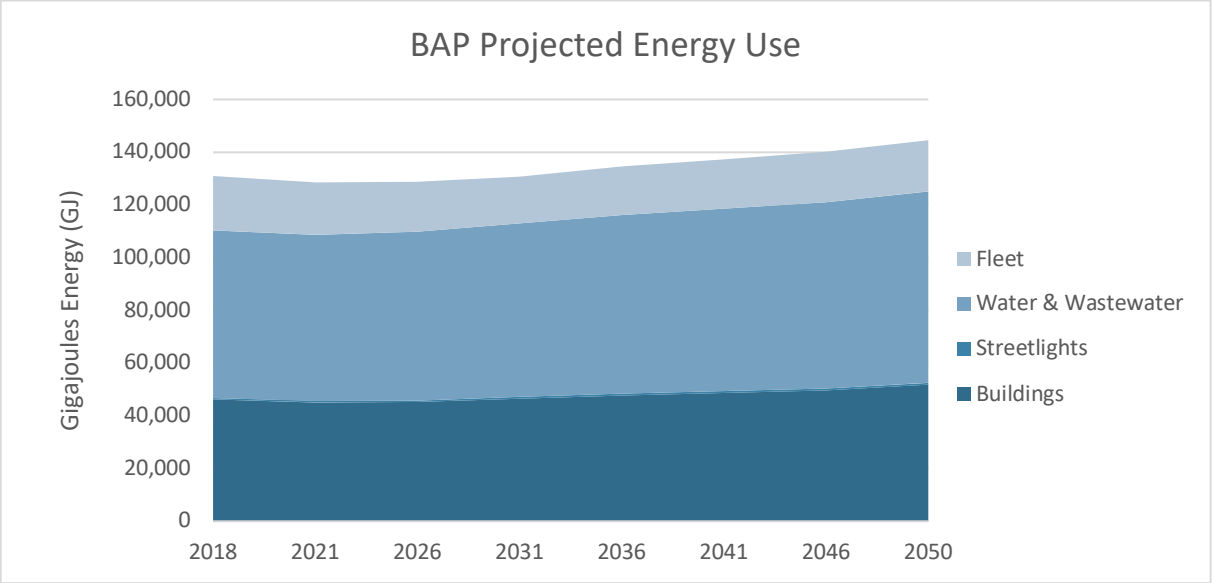

Figure 24 Projection of energy use under a business-as-planned scenario by operation type.

Table 20 2018 energy use and projected energy use in 2031, 2041, and 2050 assuming no further action is taken to reduce energy use in the District of Muskoka.

Sector	2018 Energy Use (GJ)	Projected 2031 Energy Use (GJ)	Projected 2041 Energy Use (GJ)	Projected 2050 Energy Use (GJ)
Buildings	46,145	47,191	49,426	52,545
Streetlights	532	580	610	633
Water and Wastewater	63,584	69,313	72,852	75,622
Fleet	20,626	17,829	18,740	19,452
Total	**130,887**	**134,914**	**141,627**	**148,252**

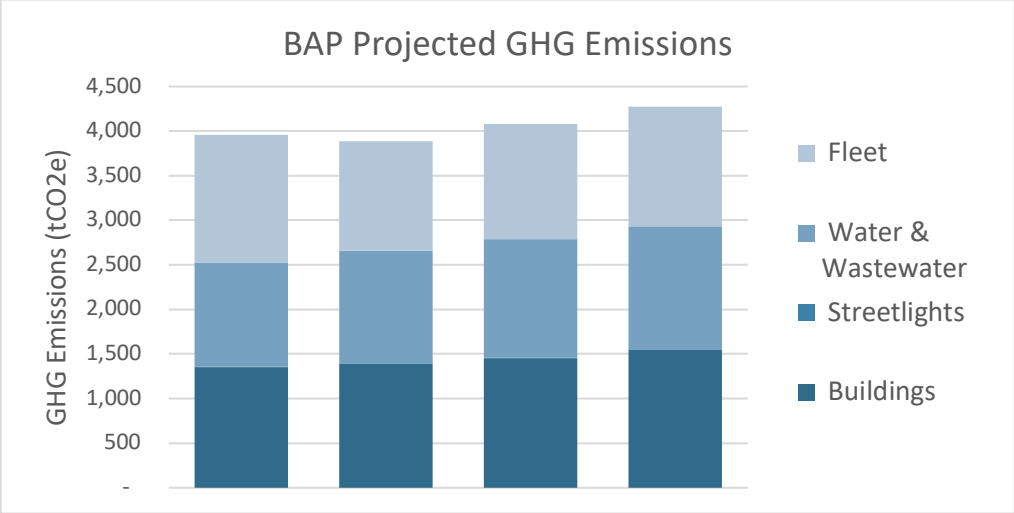

Figure 25 Projection of energy use under a business-as-planned scenario by operation type.

Table 21 2018 emissions and projected emissions in 2031, 2041, and 2050 assuming no further action is taken to reduce emissions in the District of Muskoka.

Sector	2018 tCO_2e	2031 tCO_2e - Projected	2041 tCO_2e - Projected	2050 tCO_2e - Projected
Buildings	1,355	1,389	1,455	1,546
Streetlights	4	5	5	5
Water & Wastewater	1,161	1,265	1,330	1,380
Fleet	1,422	1,231	1,293	1,343
Total	**3,942**	**3,890**	**4,083**	**4,275**

Business-as-Planned Cost Projections

The Business-as-Planned (BAP) also includes a forecast of energy expenditures in Muskoka by residents and businesses. Canada Energy Regulator projects what the energy prices look like in the future, under two scenarios, a "high cost" future where energy prices increase considerably, and a "low cost" future where energy prices increase by a smaller amount or decrease, depending on the fuel type and sector (Table 22).

Table 22: Canada Energy Regulator's projected changes in end-use energy prices for Ontario from 2018 by 2040, by fuel type and sector. Year-to-year values were used in the analysis, rather than the change over the whole period.

Sector	Fuel Type	High Scenario	Low Scenario
Residential	Electricity	22%	19%
	Natural Gas	22%	3%
	Fuel Oil	21%	-21%
Commercial	Electricity	36%	26%
	Natural Gas	30%	6%
	Fuel Oil	24%	-20%
Industrial	Electricity	15%	8%
	Natural Gas	32%	7%
Transportation	Gasoline	13%	-28%
	Diesel	18%	-29%

The cost projections were used to develop a range of expected energy expenditures for the District of Muskoka in the BAP scenario. They were applied to the forecasted energy use in the BAP scenario, of which fuel types increase or decrease to varying degrees based on the BAP assumptions (Table 27), such as expected changes to vehicle fuel efficiency or improved energy efficiency in new construction in the future. Given that both fuel use and fuel costs are increasing and decreasing to varying degrees but in an unrelated fashion, the expected changes to energy expenditures in Muskoka are complex and not necessarily linear. However, they provide a range of estimates for what one might expect the community to pay for energy in the future.

Community Energy Cost Projections

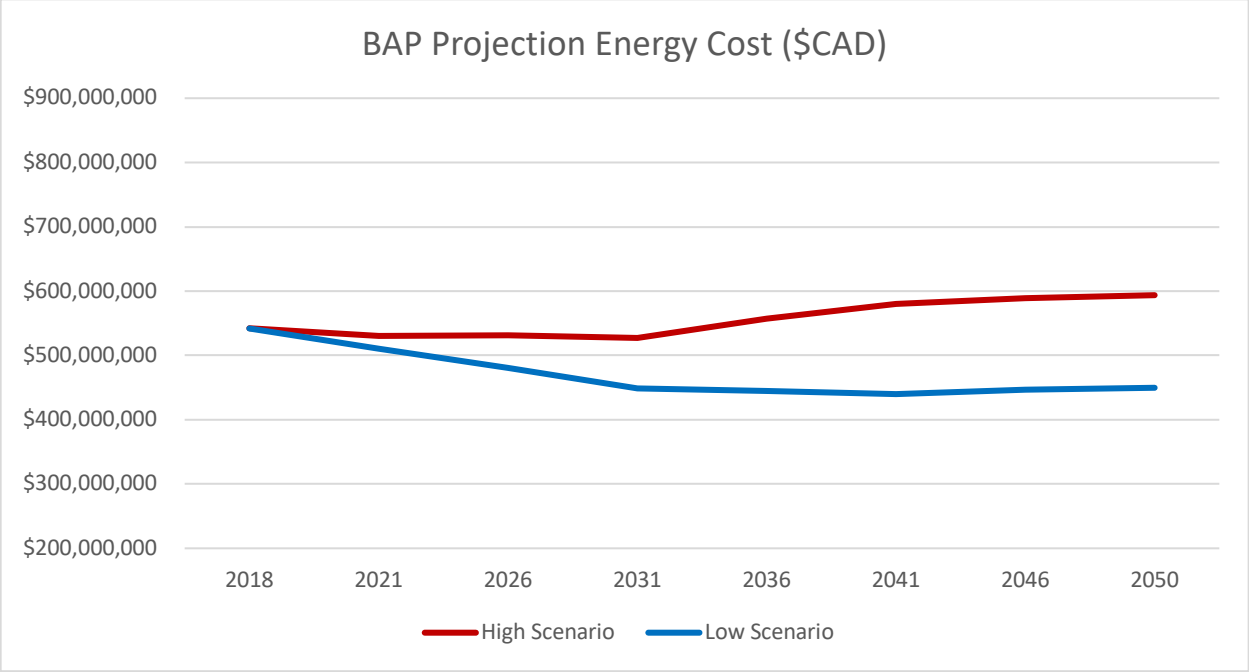

Figure 26: Projection of energy expenditures under a business-as-planned scenario, under a low and high cost scenario for the community of Muskoka.

Under the high-cost scenario, energy costs to the community are expected to decrease by 3%, to 2031 and then increase by 10% in 2050, from the 2018 baseline (Figure 26, Table 23). Alternatively, under the low-cost scenario, energy costs in Muskoka are expected to decrease by 17% by 2030 and 2050, from the 2018 baseline (Figure 26, Table 24).

Table 23: 2018 energy expenditures and projected expenditures in 2031, 2041, and 2050 under the Canada Energy Regulator's high cost scenario.

Sector	2018 costs $	2031 costs $	2041 costs $	2050 costs $
Buildings	$180,174,859	$214,150,648	$234,777,197	$235,334,318
Transportation	$361,706,494	$313,032,876	$345,241,921	$358,368,198
Total	**$541,881,353**	**$527,183,524**	**$580,019,119**	**$593,702,517**

*Numbers may not total due to rounding

Table 24: 2018 energy expenditures and projected expenditures in 2031, 2041, and 2050 under the Canada Energy Regulator's low cost scenario.

Sector	2018 costs $	2031 costs $	2041 costs $	2050 costs $
Buildings	$180,174,859	$206,486,783	$220,416,701	$221,546,721
Transportation	$361,706,494	$242,301,466	$219,430,469	$227,773,329
Total	**$541,881,353**	**$448,788,249**	**$439,847,169**	**$449,320,050**

*Numbers may not total due to rounding

Municipal (Corporate) Energy Cost Projections

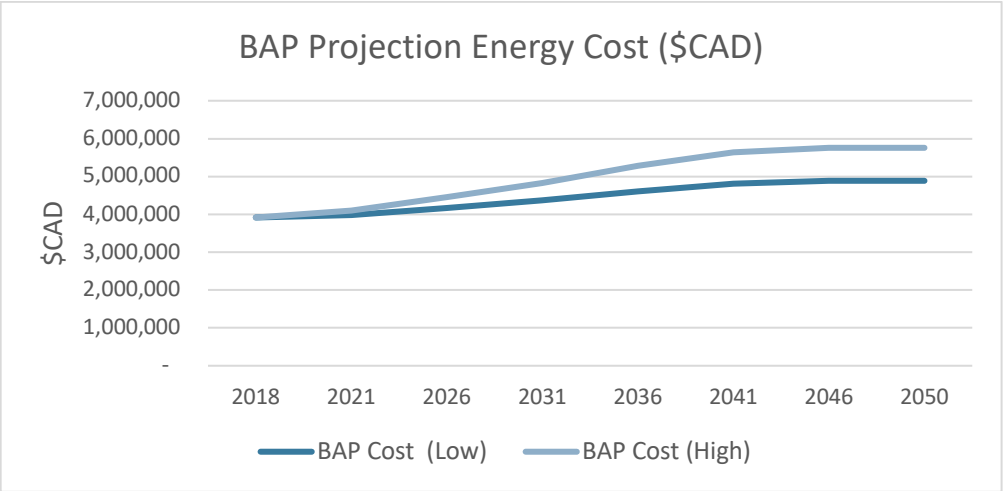

Figure 27 Projection of energy expenditures under a business-as-planned scenario, under a low and high cost scenario for the Corporation of the District of Muskoka.

Under the high-cost scenario, energy costs to the Municipality are expected to increase by 22%, 43% and 46% to 2031, 2041, and 2050, respectively, from the 2018 baseline (Figure 27, Table 25). Alternatively, under the low-cost scenario, energy costs to the Municipality are expected to increase by 10%, 21%, and 23% to 2031, 2041, and 2050, respectively, from the 2018 baseline (Figure 27, Table 25).

Table 25: 2018 energy expenditures and projected expenditures in 2031, 2041, and 2050 under the Canada Energy Regulator's high cost scenario.

Sector	2018 costs $	2031 costs $	2041 costs $	2050 costs $
Buildings	1,178,002	1,449,102	1,696,758	1,730,175
Streetlights	21,583	28,513	33,597	34,307
Water & Wastewater	2,127,914	2,805,622	3,302,517	3,372,274
Fleet	588,198	545,538	606,964	619,785
Total	**3,915,069**	**4,828,775**	**5,639,836**	**5,756,541**

*Numbers may not total due to rounding

Table 26: 2018 energy expenditures and projected expenditures in 2031,2041, and 2050 under the Canada Energy Regulator's low cost scenario.

Sector	2018 costs $	2031 costs $	2041 costs $	2050 costs $
Buildings	1,177,631	1,258,286	1,360,908	1,361,191
Streetlights	21,583	27,191	31,246	31,906
Water & Wastewater	2,127,689	2,661,714	3,046,544	3,110,895
Fleet	588,189	414,383	373,677	381,570
Total	**3,915,069**	**4,361,575**	**4,812,375**	**4,885,562**

*Numbers may not total due to rounding

Business-as-Planned Assumptions

Table 27: Description of sources and assumptions used in the BAP forecast.

Category	Source and Assumptions	Description
Demographics		
Population Projections	Based on a projected Compound Annual Growth Rate (CAGR) of 0.72% between the years 2016 and 2026, the seasonal and year-round 2018 population of Muskoka is estimated to be 144,620.	Population projections from the District of Muskoka's 2019 Forecast and Growth Allocation were used[34]. 2016 population 142,500 2026 forecast: 153,100 2036 forecast: 162,200 2046 forecast: 169,200
Employment Projections	Based on a projected Compound Annual Growth Rate (CAGR) of 0.56% between the years 2016 and 2026, employment in 2018 is estimated to be 29,084.	Employment projections from the District of Muskoka's 2019 Forecast and Growth Allocation were utilized[35]. 2016 employment 28,750 2026 forecast: 30,420 2036 forecast: 32,100 2046 forecast: 34,080
Stationary Energy (Buildings)		
New Building Construction: (residential)	New residential building construction grows proportionally to population growth.	
New Building Construction (commercial/ institutional and industrial)	New commercial and institutional building construction grows proportionally to employment growth.	
New Building Construction (corporate)	New corporate building construction grows proportionally to population growth.	
New Building Efficiency (residential,	Environmental Commissioner of Ontario. 2016. Conservation: Let's Get Serious Annual Energy Conservation Progress Report –	Energy efficiency in the Ontario Building Code improves by 13% every 5 years, the model assumes

[34] Population and employment data from the District of Muskoka's 2019 Forecast and Growth Allocation Report by Hemson Consulting Ltd.

[35] Population and employment data from the District of Muskoka's 2019 Forecast and Growth Allocation Report by Hemson Consulting Ltd.

Category	Source and Assumptions	Description
commercial/institutional, corporate)	2015/2016. Retrieved from http://docs.assets.eco.on.ca/reports/energy/2015-2016/ECO_Conservation_Lets_Get_Serious.pdf	more conservative improvement of 13%. The last update was in 2017.
Existing Buildings (all)	Existing buildings remain constant; the demolition rate is estimated to be negligible.	
Existing Building Efficiency (all)	Acadia Centre. (2014). *Energy Efficiency: Engine of economic growth in Canada: A macroeconomic modeling & tax revenue impact assessment.* Retrieved from http://acadiacenter.org/wp-content/uploads/2014/11/AcadiaCenter_EnergyEfficiencyEngineofEconomicGrowthin-Canada_SUMMARY_FINAL_2014_1114.pdf	Approximately 1% reduction in energy use across all fuel types.
Fuel Mix	Fuel mix among residential, commercial/institutional, industrial and corporate sectors remains unchanged.	
Cost Projections	Fuel price projections sourced from Canada Energy Regulator's price projections from Canada's Energy Future 2018: Energy Supply and Demand Projections to 2040. Retrieved from: http://www.cer-rec.gc.ca/nrg/ntgrtd/ftr/2016/index-eng.html Cost projections for propane and wood were not available, so the same rate of growth for fuel oil was applied to propane. It was assumed that wood prices stay constant. Energy projections were not available beyond 2040; energy costs are assumed to remain the same.	
Stationary Energy (Other)		
Water and Wastewater Facilities (Corporate)	Energy used to power water and wastewater facilities per capita remains the same throughout the period, expansion is proportional to population growth.	
Streetlights (Corporate)	Energy used to power streetlights per capita remains the same throughout the period, expansion is proportional to population growth.	
Transportation		
Vehicle Efficiency	Canada Energy Regular. (2018). *Market Snapshot: Vehicle emission standards will reduce gasoline use.*	Fuel economy of passenger vehicles and light duty trucks

Category	Source and Assumptions	Description
	Retrieved from https://www.cer-rec.gc.ca/nrg/ntgrtd/mrkt/snpsht/2018/07-03vhclmssns-eng.html	increases by 40% between 2011 and 2030.
Electric Vehicle Uptake (Private Vehicle Use)	Latulippe, E, Mo, K. (2019). Outlook for Electric Vehicles and Implications for the Oil Market. Bank of Canada. Retrieved from: https://www.bankofcanada.ca/wp-content/uploads/2019/06/san2019-19.pdf	3.5 % of vehicles will be electric by 2030.
Electric Vehicle Uptake (Corporate)	Assumes no electric vehicles in the corporate fleet planned to 2050.	Not in current plans.
Vehicle Kilometres Travelled (Private vehicles and Corporate fleet)	Distances driven per capita remain the same throughout the period. Total kilometers travelled increased in proportion to population growth.	
Cost Projections	Fuel cost projections sourced from Canada Energy Regulator's cost projections from Canada's Energy Future 2018: Energy Supply and Demand Projections to 2040. Retrieved from: http://www.cer-rec.gc.ca/nrg/ntgrtd/ftr/2016/index-eng.html It was assumed that biofuels were embedded in the price of gasoline and diesel. Energy projections were not available beyond 2040; energy costs are assumed to remain the same.	
Waste		
Solid Waste	Solid waste generated per capita remains the same throughout the period, expansion is proportional to population growth.	
Biological Treatment of Waste	Compost generated per capita remains the same throughout the period, expansion is proportional to population growth.	
Wastewater (Community)	Wastewater generated per capita remains the same throughout the period, expansion is proportional to population growth.	
Agriculture		
Livestock	Livestock emissions per capita remain the same throughout the period, expansion is proportional to population growth.	
Fuel Carbon Content		
Biofuel Content in Gasoline	Low Carbon Transportation Fuels in Ontario: Amendments to Ethanol in Gasoline (O. Reg. 535/05) and Greener Diesel - Renewable Fuel Content Requirements for	Ethanol in gasoline will increase to 10% by 2020.

Category	Source and Assumptions	Description
	Petroleum Diesel Fuel (O. Reg. 97/14) Regulations. Retrieved from: https://www.ontariocanada.com/registry/view.do?postingId=25687	

Emission Factors

The GHG inventory covers the three most common greenhouse gases: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). The gases were converted to carbon dioxide equivalents (CO_2e), using the Intergovernmental Panel on Climate Change (IPCC) 4th Assessment global warming potentials. Sulphur hexafluoride (SF_6) is also included for electricity consumption. Hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and nitrogen trifluoride (NF_3) are reported in the Industrial Processes and Product Use (IPPU) sector, which is optional for the BASIC level of GPC reporting, and are therefore not included.

The emissions factors are sourced from Environment and Climate Change Canada's *National Inventory Report: 1990-2017*, the most recent federal report on Canadian emissions[36]. For electricity, the consumption factor was used, which includes SF_6 and electric energy losses (mainly) in transmission and distribution.

Table 28: Emission Factors, Environment and Climate Change Canada's National Inventory Report: 1990-2020.

Source	Unit	Carbon Dioxide (CO_2)	Methane (CH_4)	Nitrous Oxide (N_20)	Carbon Dioxide Equivalent (CO_2e)
Natural Gas: Residential and Commercial/ Institutional	tonnes/m^3	0.001888	0.000000037	0.000000035	0.001899355
Natural Gas: Industrial	tonnes/m^3	0.001888	0.000000037	0.000000033	0.001898759
Electricity	tonnes/kWh	0.000029	0.000029	0.000029	0.000029*
Propane: Residential	tonnes/L	0.001515	0.000000027	0.000000108	0.001547859

[36] Environment and Climate Change Canada. 2020. National Inventory Report 1990–2018: Greenhouse Gas Sources and Sinks in Canada. Retrieved https://unfccc.int/documents/224829

Source	Unit	Carbon Dioxide (CO_2)	Methane (CH_4)	Nitrous Oxide (N_20)	Carbon Dioxide Equivalent (CO_2e)
Propane: Commercial/ Institutional, Industrial	tonnes/L	0.001515	0.000000024	0.000000108	0.001547784
Fuel Oil: Residential	tonnes/L	0.002753	0.000000026	0.000000006	0.002755438
Fuel Oil: Commercial/ Institutional	tonnes/L	0.002753	0.000000026	0.000000031	0.002762888
Fuel Oil: Industrial	tonnes/L	0.002753	0.000000006	0.000000031	0.002762388
Heavy Fuel Oil: Residential, Commercial/ Institutional	tonnes/L	0.003156	0.000000057	0.000000064	0.003176497
Wood: Residential	tonnes/kg	0.001539	0.0000129	0.00000012	0.00155202
Gasoline, Light Duty Vehicles	tonnes/L	0.002307000	0.000000140	0.000000022	0.002317056
Gasoline, Light Duty Trucks	tonnes/L	0.002307000	0.000000140	0.000000022	0.002317056
Gasoline, Heavy Duty Vehicles	tonnes/L	0.002307000	0.000000068	0.000000200	0.002368300
Diesel, Light Duty Vehicles	tonnes/L	0.002681000	0.000000051	0.000000220	0.002747835
Diesel, Light Duty Trucks	tonnes/L	0.002681000	0.000000068	0.000000220	0.002748260
Diesel, Heavy Duty Vehicles	tonnes/L	0.002681000	0.000000110	0.000000151	0.002728748
Ethanol	tonnes/L	0.001508	**	**	
Biodiesel	tonnes/L	0.002472	***	***	
Diesel Train	tonnes/L	0.002681	0.00000015	0.000001	0.00298275

**Electricity CO_2e value includes electric energy losses (mainly) in transmission and distribution and emissions from SF_6.*

***Gasoline CH_4 and N_2O emission factors (by mode and technology) are used*

**** Diesel CH_4 and N_2O emission factors (by mode and technology) are used*

Global warming potentials (GWP) from the 4th IPCC Assessment, listed below, were used to calculate carbon dioxide equivalents (CO_2e)[37].

Table 29: Global Warming Potentials, 4th IPCC Assessment.

Greenhouse Gas	100-Year GWP
CO_2	1
CH_4	25
N_20	298
SF_6	22,800

Appendix A: Institutional Sector Energy and Emission Data

In 2017* the institutional sector used 1,237 GJ of energy for heat and power, emitting 7,541 tC02e. Natural Gas accounted for the majority of energy use at 53% followed by electricity at 46%.

Table 30: Institutional Sector Energy Use, Energy Intensity and GHG Emissions by facility type

Facility Type	Energy Use (GJ)	Energy Intensity (GJ/m2)	Emissions (tC02e)
School Boards	311,604	0.30	2,362
Post-Secondary Institutions	24,679	4.01	223
Public Hospital	229,439	0.99	1,156
Municipal	671,783	1.71	3,799
Total	1,237,504	1.75	7,541

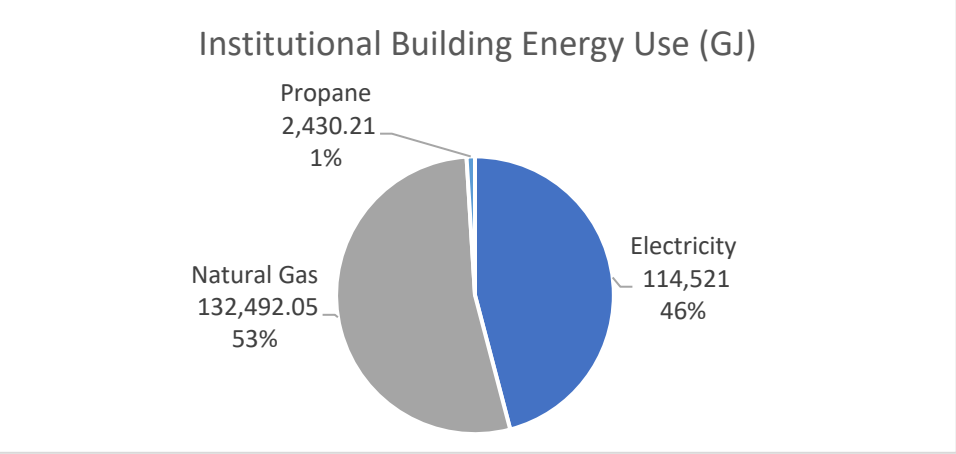

Figure 28: Institutional building energy use 2017 data

[37] IPCC. 2007. The Fourth Assessment Report (AR4). Retrieved https://www.ipcc.ch/site/assets/uploads/2018/05/ar4_wg1_full_report-1.pdf

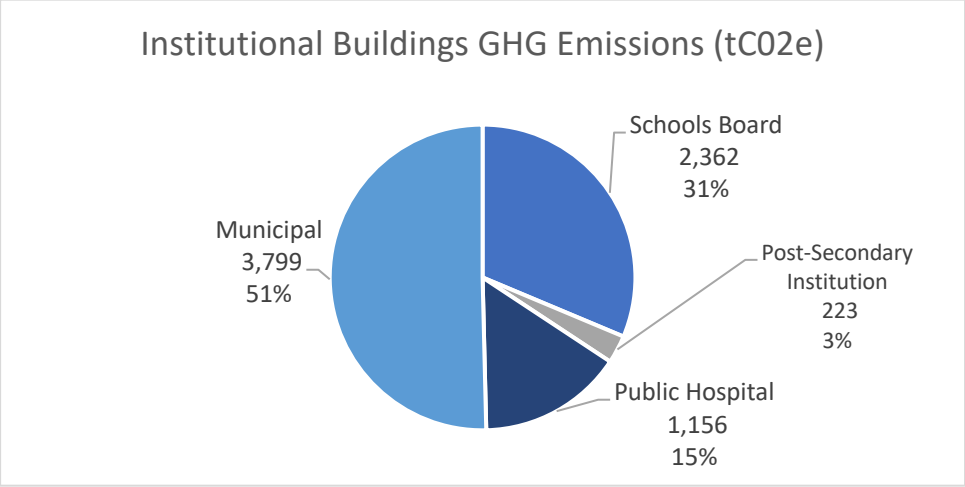

Figure 29: Institutional building GHG emissions 2017 data.