MUNCIPALITY OF THE DISTRICT OF WEST HANTS, NOVA SCOTIA
PROJECT N^{O}: 191-09428-00

CORPORATE AND COMMUNITY GHG INVENTORY

FEBRUARY 2020

WEST HANTS
NOVA SCOTIA

wsp

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WSP. 2019. *CORPORATE AND COMMUNITY GHG INVENTORY.* RAPPORT PRODUIT POUR MUNCIPALITY OF THE DISTRICT OF WEST HANTS, NOVA SCOTIA. 29 PAGES AND APPENDICES.

SUMMARY

This report outlines the results of the corporate greenhouse gas (GHG) emissions inventory for the Municipality of the District of West Hants (West Hants) for the 2018-2019 fiscal year (April 1, 2018 to March 31, 2019). The corporate inventory includes emissions created by West Hants through those activities over which the municipality has control. The community inventory includes emissions that the residents, businesses and industries in the community create through their activities. West Hants has no direct control over these emissions but may be able to have an influence through planning and program activities. The baseline year for the community inventory is 2016, as most of the information used to assess emissions comes from the 2016 Statistics Canada Census.

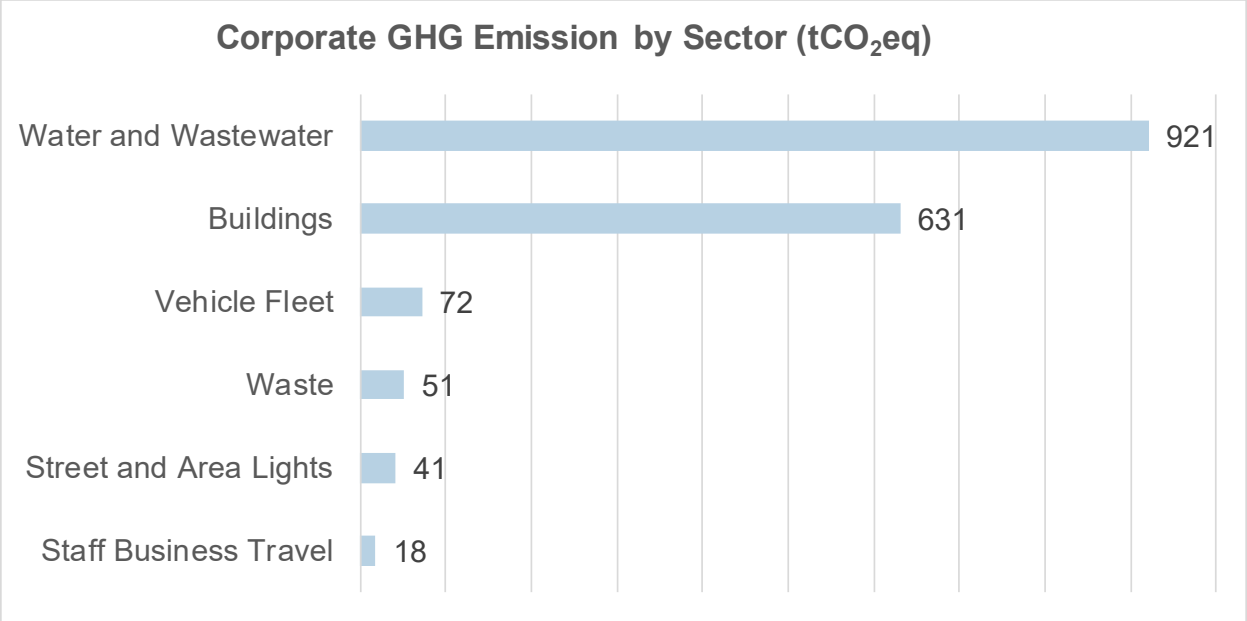
This inventory has been produced in connection with the Partners for Climate Change (PCP) Program managed by the Federal Canadian Municipalities (FCM) and the International Council for Local Environmental Initiatives (ICLEI). The inventory considers the activities of ten (10) main sectors of emissions (five for the corporate and five for the community), and two optional sectors as described in the table below. Per capita emissions for West Hants (15,0 tCO_2eq)[1] are relatively on par with provincial (16.9 tCO_2eq) and national (20.4 tCO_2eq) results for 2016.

The business-as-usual forecasted GHG emissions for 2030 show that a reduction of 44% is expected at the corporate level, while a decrease of 33% is expected at the community level. The achievement of these forecasted emissions is uncertain and not under the control of West Hants since it is primarily dependent on the decarbonization of power generation by provincial utility providers. The potential maintenance of coal-fired power plants and the delay in delivery of the Muskrat Falls Project are jeopardizing this provincial objective.

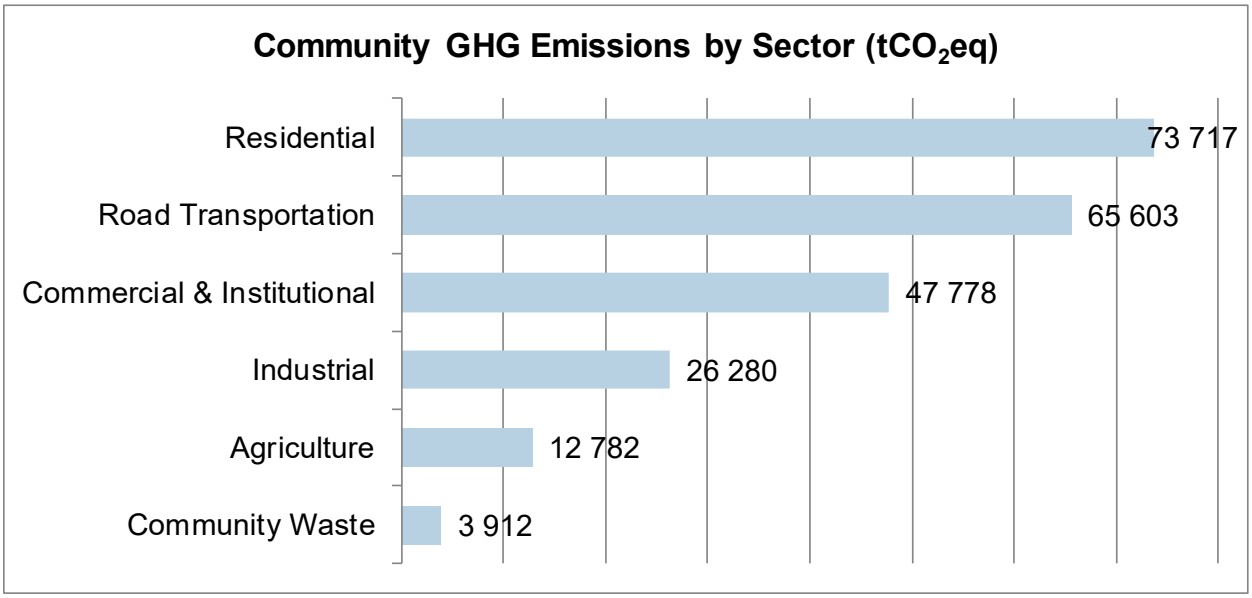
CORPORATE EMISSIONS INVENTORY 2018-2019		**COMMUNITY EMISSIONS INVENTORY 2016**	
SECTOR	**GHG EMISSIONS ($T\ CO_2\ EQ$)**	**SECTOR**	**GHG EMISSIONS ($TCO_2\ EQ$)**
Buildings	631	Residential	73,717
Street Lighting	41	Commercial and Institutional	47,778
Vehicle Fleet	72	Industrial	26,280
Water and Wastewater Treatment	921	Transportation	65,603
Corporate Waste	51	Community Waste	3,912
Staff business travel	18	Agricultural	12,782
TOTAL	**1,734**	**TOTAL**	**230,073**

[1] Greenhouse gas emissions are expressed in terms of metric tons of Carbon dioxide equivalent (tCO_2eq). Carbon dioxide equivalent is a measure used to compare the emissions from various greenhouse gases based upon their global warming potential.

Total corporate GHG emissions by sector



Total community GHG emissions by sector



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1 INTRODUCTION

Many communities around the world have taken action to reduce greenhouse gas (GHG) emissions by creating and implementing local action plans and establishing emissions reduction targets. In Canada, the Federation of Canadian Municipalities (FCM) created a network of proactive communities to tackle climate change, named Partners for Climate Protection (PCP). Located in Nova Scotia, the District of West Hants joined the PCP program and committed to reducing their GHG emissions at the corporate and community levels. Canada's National Inventory Report and national census show that Nova Scotia ranks 6th in 2016 in Canada with emissions of 16.9 tCO_2 eq/per capita, well below the leading province (Alberta, 68.9 tCO_2 eq/person) and below the national average (20.4 tCO_2 eq/per capita).

This section is an overview of the District of West Hants and a brief description of the PCP program.

1.1 MUNICIPALITY OF THE DISTRICT OF WEST HANTS

West Hants Planning and Development Department produced a series of 9 background reports for the planning strategy review giving an excellent portrait of the municipality. Key facts that put the results of this report in context are presented here.

The District of West Hants ("West Hants") is a rural municipality located on the north coast of Nova Scotia, 50 minutes north-west of Halifax. It is a community of approximately 1,240 km^2 with 160 km of coastline. A large portion is used for forestry, and 111 km^2 (50% of total agricultural zone) is considered active land for farming.

From 2011 to 2016, the population of Hants County, which includes the District of East Hants, slightly increased by 0.6%. Similarly, the population of the District of West Hants increased by 0.3%. However, West Hants' population is aging, with a large proportion of people falling in the 50 to 70 age bracket. .The population projection shows an increase to 18,120 in 2036 prior to declining to 14,117 by 2056.

The predominant housing style in West Hants is single-unit dwellings. Single- and two-persons households make up 65% of West Hants. On average, 89% of residents own their home. Over the last decade, approximately 50 to 70 building permits have been issued each year, most of them being single-units, mini and mobile homes. Less than 10% are duplex or multi-unit buildings.

The region is characterized by a service economy. Wholesale and retail sales are the largest industry category in the area, with the construction industry being a close second. In 2011, construction, retail trade and healthcare made up 39% of employment. The industrial sector in West Hants is characterized by gypsum extraction and processing, and forestry; both industries are declining and there have been few significant developments over the years. Unemployment rates are close to the provincial average (8-10%). Most of the West Hants work force (80%) is employed outside of West Hants, probably due to the relative proximity to Halifax, where job opportunities are greater.

Three public transit services are available in the area. Dial-A-Ride is a charitable organization offering transportation to people who are not able to drive or need to attend a medical appointment. Kings Transit offers transportation across the Annapolis Valley, with one stop in West Hants. Finally, the Windsor Senior Citizen Bus Society operates a 36-passenger bus for residents who live in seniors' residences. Recreational cycling is popular but since 80% of the employed people living in the municipality work outside of West Hants, it is not likely that cycling to work is a common method of transport.

Since 1998, recyclables and food waste have been prohibited from landfills in Nova Scotia. Therefore, West Hants has developed a comprehensive recycling and composting program. This includes backyard composting and a municipal green cart service for managing residential organic wastes.

1.2 PARTNERS FOR CLIMATE PROTECTION PROGRAM

The Partners for Climate Protection (PCP) program is a network of Canadian municipal governments that have committed to reducing greenhouse gases (GHGs) and to acting on climate change. The PCP program is administered by the Federation of Canadian Municipalities (FCM) in partnership with the International Council for Local Environmental Initiatives (ICLEI). Since its inception, over 250 municipalities have joined the PCP, making a public commitment to reduce emissions. The program consists of a five-milestone framework to guide municipalities in reducing GHG emissions at both the corporate and community levels. The five-milestone process includes:

- Milestone 1: Creating a greenhouse gas emissions inventory and forecast
- Milestone 2: Setting an emissions reduction target
- Milestone 3: Developing a local action plan
- Milestone 4: Implementing the local action plan or a set of activities
- Milestone 5: Monitoring progress and reporting results

In order to gain recognition for Milestone 1 of the PCP Program, communities need to complete two emissions inventories:

1. Corporate emissions inventory: inventory of emissions that West Hants creates through its activities (and over which it has control). This includes municipal government facilities and operations such as buildings, street lighting, water and wastewater treatment, municipal fleet and corporate solid waste.
2. Community emissions inventory: inventory of emissions that the residents and businesses in the community create through their activities. West Hants has no direct control over these emissions, but may be able to have an influence through planning and program activities. This includes the following sectors: residential, institutional, commercial, industrial, transportation, and community solid waste sectors.

This report presents both inventory results thus fulfilling West Hants requirements for Milestone 1.

2 METHODOLOGY

2.1 STANDARDS AND GUIDANCE DOCUMENTS

The following guidance, standards, and information sources were considered when developing the corporate and community GHG inventory:

- PCP Protocol: Released in 2014, this protocol is a Canadian supplement to the International Emissions Analysis Protocol (IEAP), which is a widely-used framework for local governments conducting GHG emissions accounting. PCP members can follow the PCP Protocol alone and be assured their work follows globally recognized standards;
- Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (2014);
- Guidelines for National Greenhouse Gas Inventories (IPCC, 2006);
- Canadian Standards Association (CSA) ISO 14064 Standard Part 1- Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals (2006).

2.2 BASELINE YEAR

For the purposes of the corporate inventory, West Hants selected fiscal year 2018-2019 as a baseline year. This fiscal year was selected due to the availability of recent and reliable information to assist in forming a realistic portrait of GHG emissions in West Hants.

For the community inventory, calendar year 2016 was selected as the baseline year. Most of the activity data required to assess GHG emissions are drawn from government sources, generally from the latest national census, which is dated 2016.

This baseline year serves as a basis for setting an emissions reduction target and acts as a point of comparison for the future.

2.3 GEOGRAPHIC BOUNDARIES

The geographic boundaries of this GHG inventory are defined as the District of West Hants and the community of Hantsport, which became part of the District of West Hants as of April 1st, 2015.

The Town of Windsor and the Municipality of the District of West Hants have voted to consolidate the two communities into one regional municipality beginning April 1, 2020. The GHG inventory presented in this report excludes emissions from activities of the Town of Windsor. The latter is expected to complete a separate GHG inventory in partnership with the Clean Foundation, the results of which can also be used to help achieve the Municipality's goals.

2.4 OPERATIONAL BOUNDARIES

A **corporate or municipal GHG inventory** outlines the GHG emissions generated as a result of a local government's operations and services. Its purpose is to identify the emissions within a local government's direct control or influence, and for which the local government is accountable as a corporate entity. This inventory covers facilities and operations over which West Hants has full authority to introduce and implement operating policies.

The **community GHG inventory** estimates GHG emissions generated within the community, from all significant activities occurring within the territorial boundaries of a community. It is to be expected that municipalities may have only limited control or influence over certain community activities.

It is worth mentioning the level of influence that West Hants has over services that are traditionally provided or frequently contracted by municipalities:

- Police services: Provided by Royal Canadian Mounted Police (RCMP) based on a contract of agreed-upon terms between the RCMP and the Municipality. The Municipality has little control over specific RCMP activities.
- Winter Maintenance of Roads: Provincial road maintenance is provided by the Nova Scotia Department of Transportation and Infrastructure Renewal (NSTIR). The municipality has no control over these activities. Snow removal in municipal streets is provided both by contractors and by the municipality in some areas (such as Hantsport).
- Solid Waste Collection, Transportation and Diversion: The existing landfill is owned and operated by GFL Environmental Inc., a leading North American provider of diversified environmental solutions. West Hants contracted GFL for waste management and as such, has substantial influence on this category of activity, which is within the scope of the inventory.
- Fire Protection: Service in Hantsport is provided by the municipality. However, fire protection for all other areas is provided by contractors. The Municipality may be able to influence the emissions of contractors.

Quantification protocols usually identify **three scopes of emission sources**: scope 1, 2 and 3. Scope 1 includes emissions from activities under direct control of the municipality; scope 2 includes indirect emission from the production of purchased electricity from the grid; and scope 3 includes indirect GHG emissions associated with the municipality's activities and operations but that are linked to sources owned or controlled by another organization (such as contractors). Classification of emission by scope is not a requirement of the PCP program. The concept is therefore left aside in this inventory report.

2.5 GREENHOUSE GASES

Per the UNFCCC/Kyoto Protocol requirements, GHG reporting should aim to include seven greenhouse gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF_6), and nitrogen trifluoride (NF_3). The last four gases are typically not emitted by sources which can be influenced or affected by a municipality. In some cases, quantification would require access to data that is not readily available in many communities.

Therefore, this inventory tracks three principal greenhouse gases: carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), expressed as a CO_2 equivalent (CO_2 eq). GHG emissions are reported in units of mass (i.e., ton of CO_2 equivalent). The CO_2 eq represents the quantity of CO_2 that would have the same impact on the atmosphere as the sum of the individual GHGs. This is accomplished by utilizing the appropriate Global Warming Potential (GWP) of each individual GHG (see Table 2-1). The GWP is a measure of the warming effect that a particular GHG has on the atmosphere relative to the impact of CO_2, the most abundant GHG. As such, an emission of one hundred tons (100 t) of methane is equivalent to 25 x 100 t = 2,500 t CO_2eq.

Table 2-1 Global warming potentials

GREENHOUSE GAS	GLOBAL WARMING POTENTIAL - 100 YEARS
Carbon Dioxide (CO_2)	1
Methane (CH_4)	25
Nitrous Oxide (N_2O)	298

While the PCP Protocol indicates the use of outdated GWP values (21 for methane and 310 for nitrous oxide), WSP has elected to use current GWP values which are consistent with Canada's 1990-2017 National Inventory Report. [2]

2.6 EMISSION TYPES

The PCP Protocol is clear on the scope of activities that need to be reported to meet the requirements of the program. The activity sectors, as well as emissions sources are outlined in Appendix 2 of the protocol. Some are mandatory, and others are optional, depending on the availability of local information and the desire of the municipality to develop an understanding of GHG emissions on its territory. Note that only the consumption of energy from wastewater treatment and the industrial sector has been calculated as part of this inventory, and that 'process' emissions such as the degradation of organic matter, have been excluded.

Activities captured for the West Hants inventory are outlined in Table 2-2. As indicated, West Hants decided to report on Staff business travel, an optional activity, as it can easily be reported based on kilometers traveled (tracked in expense request forms). West Hants also decided to report on agriculture, as agricultural producers are important stakeholders in this community.

Table 2-2 Activity Sectors Within the Scope of West Hants GHG inventory

	CORPORATE EMISSIONS SECTOR	PCP REPORTING REQUIREMENTS		COMMUNITY EMISSIONS SECTOR	PCP REPORTING REQUIREMENTS
1	Buildings	Mandatory	7	Residential Energy Consumption	Mandatory
2	Street Lighting	Mandatory	8	Commercial Energy Consumption	Mandatory
3	Vehicle Fleet	Mandatory	9	Industrial Energy Consumption	Mandatory
4	Water and Wastewater Treatment	Mandatory	10	On-Road Transportation	Mandatory
5	Corporate Waste	Mandatory	11	Community Waste	Mandatory
6	Staff business travel	Optional	12	Agriculture	Optional

2.7 DATA COLLECTION

The **corporate inventory** was conducted using the 2009 Union of Nova Scotia Municipalities (UNSM) Corporate Energy and Emissions Inventory spreadsheet V2.0. This spreadsheet was created by Stantec Inc., based on the Inventory Quantification Support Spreadsheet developed by the International Council for Local Environmental Initiatives (ICLEI). It was updated over the years, and WSP made further updates for this inventory.

The **community inventory** was conducted using a spreadsheet developed by WSP, based on ICLEI's Inventory Quantification Support Spreadsheet. It was adapted for West Hants to capture activity data relevant to selected calculation methodologies.

Wherever possible, activity data was collected by West Hants and then supplied to WSP for further validation. Assumptions and estimates were necessary when activity data was either unavailable or incomplete.

Sources of information for each source of emission are detailed in Section 2.8, where quantification methodologies are presented. One major source of information for the community inventory was Natural Resources Canada's National Energy Use Database (NEUD)[3].

[2] Environment and Climate Change Canada (2019). National Inventory Report 1990–2017: Greenhouse Gas Sources and Sinks in Canada.
[3] Natural Resources Canada (no date). National Energy Use Database http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/data_e/databases.cfm

The Comprehensive Energy Use Database (CEUD) provided an overview of sectoral energy markets in Canada and in each region of the country. Since CEUD information is only provided at the provincial scale, strategies were required to downscale the information to the municipal level. Access Nova Scotia was another organization which provided valuable information concerning transportation, and specifically regarding registered vehicles. A series of other sources were used to determine important characteristics of the community, including population, number of dwellings, industry statistics, etc.

2.8 QUANTIFICATION METHODOLOGIES

The PCP protocol offers guidance on calculation of GHG emissions for each source. GHG emissions related to activities are calculated using emission factors, which indicate the amount of CO_2 equivalent (eq) generated per unit of activity performed. Tables 2-3 and 2-4 summarize quantification methodology, as well as sources of information for each source.

Important sources of information for the inventory are referenced in the tables below:

- Canada's National Inventory report 1990-2017, which is listed as *NIR*.
- National Energy Use Database, specifically the Comprehensive Energy Use Database (CEUD). This database provided energy usage as well as GHG emissions information. To be consistent throughout the quantification process, energy use is the activity data that was extracted for calculation. This information has been converted to GHG emissions using documented emission factors.
- Canada Energy Regulator, Provincial and Territorial Energy Profiles – Nova Scotia, for 2017.
- Statistics Canada. 2017. Nova Scotia [Province] and Canada [Country] (table). Census Profile. 2016 Census. Statistics Canada Catalogue no. 98-316-X2016001. Ottawa. Released November 29, 2017. This document provides information at the provincial and local level that was used to downscale energy use.

Specific emission factors used for West Hants inventory are reported in the Corporate Energy and Emissions Spreadsheet as well as the Community quantification support spreadsheet.

Table 2-3 Corporate Inventory - Quantification Methodologies

SECTOR	GHG EMISSIONS CALCULATION	DATA SOURCE
Buildings		
Emissions from stationary fuel combustion	Quantity (Qty) of fuel used X Emission factor	**Qty of fuel used** – Fuel provider invoices **Emission factor** – NIR Table A6–4 Emission Factors for Refined Petroleum Products
Emissions from purchased electricity	Qty of electricity purchased X Provincial emission factor	**Qty of electricity purchased** – Nova Scotia Power invoices **Provincial emission factor** – NIR Table A13–4 Electricity Generation and GHG Emission Details for Nova Scotia
Street Lighting		
Emissions from purchased electricity	Qty of electricity purchased X Provincial emission factor	**Qty of electricity purchased** – Nova Scotia Power invoices **Provincial emission factor** – NIR Table A13–4 Electricity Generation and GHG Emission Details for Nova Scotia
Vehicle Fleet		
Emissions from combustion of motor fuels	Qty of fuel used X Emission factor	**Qty of fuel used** - Fuel provider invoices **Emission factor** - NIR Table A6–13 Emission Factors for Energy Mobile Combustion Sources
Water and Wastewater Treatment		
Emissions from stationary fuel combustion	Qty of fuel used X Emission factor	**Qty of fuel used** - Fuel provider invoices **Emission factor** - NIR Table A6–4 Emission Factors for Refined Petroleum Products
Emissions from purchased electricity	Qty of electricity purchased X Provincial emission factor	**Qty of electricity purchased** – Nova Scotia Power invoices **Provincial emission factor** – NIR Table A13–4 Electricity Generation and GHG Emission Details for Nova Scotia
Corporate waste		
Projected downstream (future) emissions from disposal of corporate solid waste	Methane Commitment mode (Total yield gas model)	**Total waste landfilled** - Estimation based on size of container, frequency of collection and observation of average load. **Composition of waste stream** – Calculation based on Divert NS 2017 waste report (May 31, 2018).
Emissions from composting of organics	Qty of organics X Emission factor	**Quantity of organics** – Estimation based on size of container, frequency of collection and observation of average load. **Emission factor** - 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 5, Waste - Biological Treatment of waste
Staff business travel		
Emissions from combustion of motor fuels – Road transportation	Qty of kilometers traveled X Fuel rate X Emission factor	**Qty of kilometers traveled** – Employee expense request forms **Fuel rate** –Oak Ridge National Laboratory (2017), Transportation Energy Data Book: Edition 36, Table 4.1 Summary Statistics for Cars, 1970–2015 **Emission factor** - NIR Table A6–13 Emission Factors for Energy Mobile Combustion Sources

Table 2-4 Community Inventory - Quantification Methodologies

SECTOR	GHG EMISSIONS CALCULATION	DATA SOURCE
Residential Energy Consumption		
Emissions from stationary fuel combustion	Qty of fuel used X Emission factor	**Qty of fuel used** – CEUD, Residential sector, Nova Scotia, Table 1 - Secondary Energy Use and GHG Emissions by Energy Source. **Emission factor** – NIR Table A6–4 Emission Factors for Refined Petroleum Products
Emissions from purchased electricity	Qty of electricity purchased X Provincial emission factor	**Qty of electricity purchased** – CEUD, Residential sector, Nova Scotia, Table 1 - Secondary Energy Use and GHG Emissions by Energy Source. **Provincial emission factor** – NIR Table A13–4 Electricity Generation and GHG Emission Details for Nova Scotia
Commercial Energy Consumption		
Emissions from stationary fuel combustion	Qty of fuel used X Emission factor	**Qty of fuel used** – Comprehensive Energy Use Database, Commercial/Institutional Sector, Atlantic Table 1: Secondary Energy Use and GHG Emissions by Energy Source **Emission factor** – NIR Table A6–4 Emission Factors for Refined Petroleum Products
Emissions from purchased electricity	Qty of electricity purchased X Provincial emission factor	**Qty of electricity purchased** – Comprehensive Energy Use Database, Commercial/Institutional Sector, Atlantic Table 1: Secondary Energy Use and GHG Emissions by Energy Source **Provincial emission factor** – NIR Table A13–4 Electricity Generation and GHG Emission Details for Nova Scotia
Industrial Energy Consumption		
Emissions from stationary fuel combustion	Qty of fuel used X Emission factor	**Qty of fuel used** – Comprehensive Energy Use Database, Industrial Sector – Aggregated Industries Atlantic, Table 1: Secondary Energy Use and GHG Emissions by Energy Source **Emission factor** – NIR Table A6–4 Emission Factors for Refined Petroleum Products
Emissions from purchased electricity	Qty of electricity purchased X Provincial emission factor	**Qty of electricity purchased** – Comprehensive Energy Use Database, Industrial Sector – Aggregated Industries Atlantic, Table 1: Secondary Energy Use and GHG Emissions by Energy Source **Provincial emission factor** – NIR Table A13–4 Electricity Generation and GHG Emission Details for Nova Scotia.
On-Road Transportation		
	Qty of fuel used X Emission factor	**Qty of fuel used–** Statistics Canada. Table 23-10-0066-01 Sales of fuel used for road motor vehicles, annual (x 1,000) **Emission factor** – NIR Table A6–13 Emission Factors for Energy Mobile Combustion Sources

Table 2-4 (cont.) Community Inventory - Quantification Methodologies

SECTOR	GHG EMISSIONS CALCULATION	DATA SOURCE
Community waste		
Projected downstream (future) emissions from disposal of corporate solid waste	Methane Commitment model (total yield gas)[4] GWP CH_4 X M X Lo X (1-f_{rec}) X (1-OX)	**Total waste landfilled** - Weight at scale of landfill facility **DOC (Degradable Organic Carbon)** – Calculation based on Divert NS 2017 waste report (May 31, 2018), and NIR part 2, section A3.6.1.2. Municipal Solid Waste (MSW) Landfills, equation A 3-87.
Emissions from composting of organics	Qty of organics X Emission factor	**Quantity of organics** – Weight at scale of composting facility **Emission factor** - 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 5, Waste - Biological Treatment of waste
Agriculture		
Enteric fermentation	Livestock headcount X Emission factor	**Cattle headcount** - Statistics Canada. Table 32-10-0424-01 Cattle and calves on census day. **Swine headcount** - Statistics Canada. Table 32-10-0426-01 Pigs on census day **Emission factor**: IPCC Vol. 4 Chapter 10 – Tier 1 method.

[4] FCM (2014). PCP Protocol, Option 1: Methane Commitment Model, page 50.

3 CORPORATE EMISSIONS INVENTORY

West Hants GHG emissions at the corporate level are outlined hereafter. It should be recalled that 2018-2019 fiscal year is the reference year for this inventory.

3.1 SUMMARY

Total GHG emissions from West Hants' municipal activities are estimated to be 1 734tCO_2eq (Figure A). West Hants' GHG emissions summary is characterized by the prevalence of emissions related to water and wastewater treatment, which accounts for 53% of emissions. In contrast, staff business travel, street lighting, waste and vehicle fleet are negligible contributors, each with only a couple of percent contribution. Emissions from buildings account for the second greatest source, at 36%. In terms of energy type, electricity is responsible for the majority of GHG emissions (82%), largely due to a high emission factor for this energy, which is produced mainly from fossil fuels (Figure B). Renewable energy represented 29% of the province's energy portfolio in 2017[5]. Light fuel oil is present with 7% of emissions and the remaining energy types are lesser still. Uncertainty about emissions from these sectors is low (approximately 5% or less).

3.2 BUILDINGS

Emissions for the buildings sector were calculated based on the amount of energy consumed. This data was made available by utility providers and fuel providers. Electricity and light fuel oil are the primary energy types used, with diesel and gasoline used sporadically, for a total of 631 tCO_2eq. (Table 3-1). The Brooklyn Fire Station/Civic Centre and Municipal Building contribute 50% of total emissions for this sector.

It is worth mentioning that WSP used Nova Scotia's latest official emission factor for electricity (0.720 kg CO_2eq/kWh). This emission factor is representative of the energy portfolio as of 2017, which relied significantly on non-renewable sources. However, the electric grid has evolved since then. As of November 2019, 30% of the electricity used was generated from renewable sources [6].

Uncertainty in these data is considered low, as direct activity data was obtained for GHG calculations.

For future work, energy use intensity (EUI) for each building will be useful information to help identify those with low energy efficiency performance[7].

[5] Nova Scotia Power (2018). Renewable energy on the rise; Nova Scotia Power reaches 29% renewables in 2017 https://www.nspower.ca/en/home/newsroom/news-releases/renewable-energy-on-the-rise.aspx
[6] Nova Scotia Power (2019). Today's power. https://www.nspower.ca/clean-energy/todays-energy-stats#%20
[7] Energy Star (2019). Technical reference - Canadian Energy Use Intensity by Property Type.

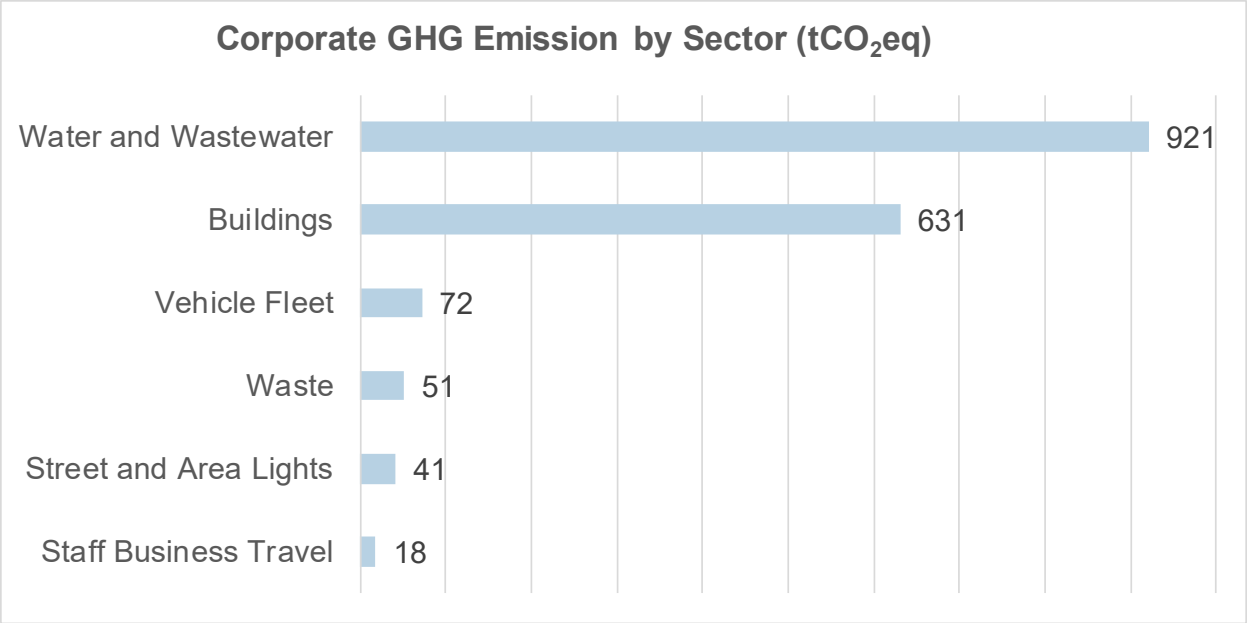

Figure A **West Hants Summary of GHG Corporate Emissions, by Sector**

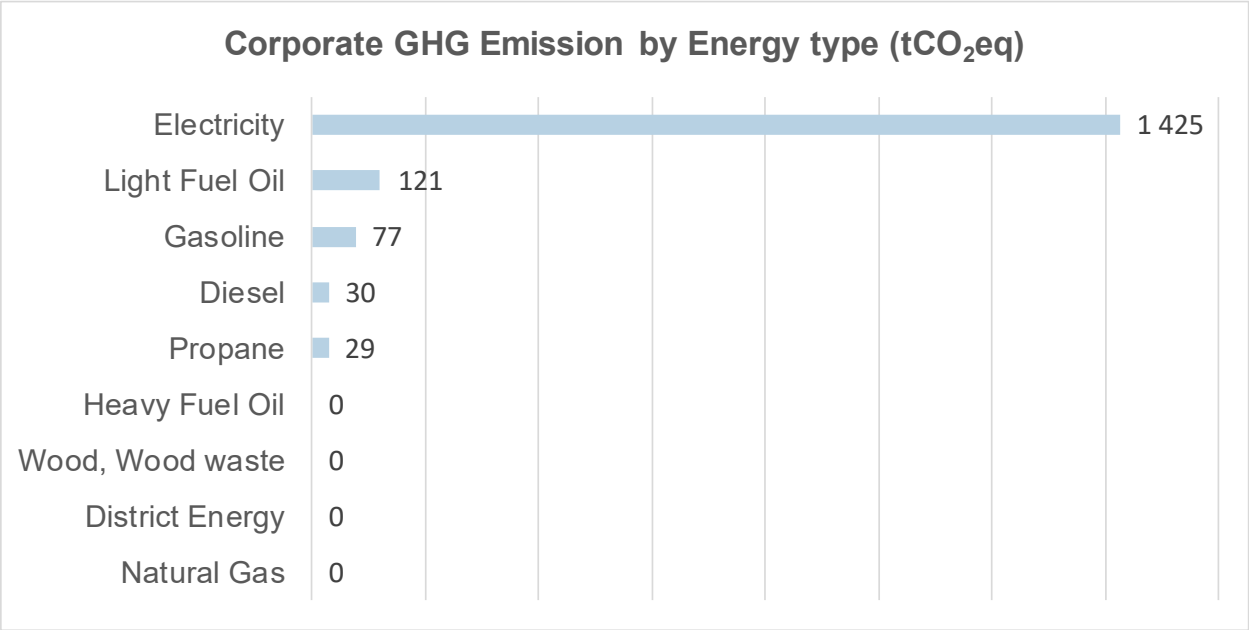

Figure B **West Hants Summary of GHG Corporate Emissions, by Energy type**

Table 3-1 Energy and GHG Summary Data – Corporate Buildings

Building	Electricity Use (kWh)	Light Fuel Oil Use (L)	Diesel Use (L)	Gasoline Use (L)	Total GHG Emissions (tCO2eq)
Brooklyn Fire Station and Civic Centre - 995 Highway 215	215,040	-	-	-	155
Municipal Building - 76 Morison Dr	211,380	-	329	-	153
Hants County Courthouse - 240 King St	26,160	22,250	-	-	80
Hantsport Town Hall - 20 Main St	52,430	-	1,290	5,215	53
Hantsport Fire Department - 5 Oak St	39,086	7,689	-	-	49
Public Works Shed - 19 Chittick Ave	18,597	11,876	-	-	46
Ball Field (Recreation Centre) - 54 Ball Park	28,274	-	-	-	20
Brooklyn Station 2 - 5984 Highway 14	24,480	-	-	-	18
Hantsport Library - 10 Main St	23,294	-	-	-	17
Police Station - 3 Oak St	12,222	2,020	-	-	14
Hantsport Music Fest - 10 Foundry Rd	16,744	-	-	-	12
Construction Trailer - 20 Pleasant St	8,806	-	-	-	6
Recreation Centre - 156 Eldridge	8,012	-	-	-	6
Total	**684,525**	**43,834**	**1,619**		**631**

3.3 MUNICIPAL VEHICLES FLEET

Emissions from the municipal vehicle fleet were calculated based on direct fuel usage, as reported by fuel suppliers, for a total of 72 tCO_2eq. (Table 3-2). Public works trucks are responsible for almost 50% of emissions. Other than administration vehicles, all other categories are within a 7-15% contribution.

Uncertainty on this data is considered low, as direct activity data was obtained for GHG calculation.

Table 3-2 Energy and GHG Summary Data – Municipal Vehicles Fleet

Vehicle or Vehicle Group Name	Gasoline Use (L)	Diesel Use (L)	Total GHG Emissions (tCO2eq)
Public Works Trucks	11,328	3,369	36
Recreation Trucks	4,681	44	11
Fire	0	2,662	7
Public Works Jugs/Other	70	2,012	6
Planning & Development Trucks	2,407	0	6
Recreation Other/Mowers/Trimmers	903	950	5
Administration Vehicles	803	0	2
Total	**20,192**	**9,038**	**72**

3.4 STAFF BUSINESS TRAVEL

Staff business travel on roads has been considered in the inventory. No staff business travel requires air or rail therefore these modes were not accounted for in this inventory. Emissions were calculated based on kilometers traveled, as reported by employees when requesting expense reimbursement, for a total of 18 tCO_2eq. (Table 3-3). It is assumed that vehicles run on gasoline rather than diesel, with a fuel rate of 9,0 L/100 km.

Uncertainty is considered moderate (approximately 5-20%) considering that a hypothesis must be made on the fuel consumption rating of the vehicles and on the type of fuel. Exclusion of air and rail transportation is a decision that can be revisited in the future if such traveling becomes significant.

Table 3-3 Energy and GHG Summary Data – Staff Business Travel

Vehicle or Vehicle Group Name	Gasoline Use (L)	Diesel Use (L)	Total GHG Emissions (tCO2eq)
Personal Vehicles	7,658	-	18

3.5 STREET LIGHTING SECTOR

Emissions from street lighting and outside cameras were calculated based on direct electricity usage, as reported by utility providers for a total of 41 tCO_2eq (Table 3-4). Street lighting accounts for 84% of GHG emissions for this sector.

Uncertainty on these data is considered low, as direct activity data was obtained for GHG calculation.

Table 3-4 Energy and GHG Summary Data – Street lighting

Location	Light Type	Total Use per Year (kWh)	Total GHG Emissions (tCO2eq)
Streetlights	LED	48,903	35
Clover Lane	Decorative Streetlights	3,942	3
Falmouth Mini Park	LED	1,205	1
54 Ball Park	LED	964	1
Irishman Rd	LED	241	-
Courthouse	LED	241	-
Brooklyn Fire Dpt	LED	241	-
2 Main St #lights	LED	241	-
10 Main St #lights	LED	241	-
Cottage Lane	40W Camera	175	-
Willow St	40W Camera	175	-
Willow St #cameras	40W Camera	175	-
Prince St	40W Camera	175	-
Avon St	40W Camera	175	-
Tannery Rd	40W Camera	175	-
Main St #cameras	40W Camera	175	-
School St	40W Camera	175	-
Fire Alarm		14	-
Total		**57,633**	**41**

3.6 WATER AND WASTEWATER TREATMENT

Emissions for the water and wastewater treatment sector were calculated based on the amount of energy consumed. Calculations assumed that the facility was well-run and there was no anaerobic activity in the effluent. These data are available from utility providers and fuel providers. Electricity is the primary energy used, with propane and diesel being used only sporadically, for a total of 921.1 tCO_2eq. (Table 3-5). Falmouth Sewer Plant, Falmouth Water Plant and Hantsport Water Treatment Plant are by far the most important contributor with 80% of GHG emissions for this sector of activity.

Uncertainty on this data is considered low, as direct activity data was obtained for GHG calculation.

3.7 CORPORATE WASTE

Emissions for corporate waste were calculated using an estimation of waste quantity, based on garbage container capacity, frequency of pick up, and typical filling rate. Waste composition and factors used to assess biogas emitted at the landfill and composting facility are presented in section 4 in the community inventory section. Emissions are estimated to be 51 tCO_2eq for this sector of activity.

Uncertainty for these results is considered high (approximately 20-50%), as weight of waste material has been determined through estimation.

Table 3-5 Energy and GHG Summary Data – Water And Wastewater Treatment

Facility	Electricity Use (kWh)	Propane Use (L)	Diesel Use (L)	Total GHG Emissions (tCO2eq)
Falmouth Sewer Plant - 48 Falmouth Connector	506,880	-	-	365
Falmouth Water Plant - 242 Eldridge Rd	279,300	-	-	201
Water Treatment Plant - 2160 Bishopville Rd	187,440	18,955	324	165
Lift stations				
Panuke Road	41,075	-	-	30
124 Across Gabriel	25,200	-	-	18
99 Francis St	22,460	-	-	16
905 Mountain Road	17,950	-	-	13
126 Halewood	17,575	-	-	13
708 Bowman Road	16,650	-	-	12
1201 Hillcrest Drive	14,250	-	-	10
422 Back Road	12,525	-	-	9
133 Dewolfe's Crossing	9,350	-	-	7
326 Ball Field	7,650	-	-	6
140 Meadow	6,850	-	-	5
33 Irven	6,800	-	-	5
Willow St #pump	6,270	-	-	5
Crossley Court	5,925	-	-	4
407 Windsor Back Road	5,375	-	-	4
2078 Highway 1 Falmouth	5,300	-	-	4
120 Green	5,200	-	-	4
115 Woodmans Corner	5,125	-	-	4

Table 3-5 (cont.) Energy and GHG Summary Data – Water And Wastewater Treatment

Facility	Electricity Use (kWh)	Propane Use (L)	Diesel Use (L)	Total GHG Emissions (tCO2eq)
22 Wilewood	4,515	-	-	3
19 Chittick Ave #pump	4,300	-	-	3
421 Windsor Back Road	3,750	-	-	3
152 Highway #1	3,550	-	-	3
Alexander Dr	3,432	-	-	3
604 Green Lane	2,625	-	-	2
Prince St	2,175	-	-	2
305 Town Road	1,980	-	-	1
126 Mapleton	1,925	-	-	1
Main St	1,711	-	-	1
Palmeter Drive	1,625	-	-	1
2 Main St	314	-	-	<1
20B Pleasant St	217	-	-	<1
422 Avon Valley Heights	-	-	-	-
Chlorinator	-	-	-	-
2 Willow St	-	-	-	-
Total	**1,237,269**	**18,955**	**324**	**921**

Table 3-6 GHG Summary data – Corporate waste

Type of waste / Management method	Quantity of Waste (tonnes)	Total Emissions (tCO2 eq)
Residential / Landfill	37	51
Organic / Composting	Not reported	-
Total	**37**	**51**

4 COMMUNITY INVENTORY

West Hants GHG emissions at the community level are outlined hereafter. It should be recalled that 2016 is the reference year for this inventory.

4.1 SUMMARY

Total GHG emissions from the community activities are estimated to be 230,073 tCO_2eq (Figure C). West Hants' GHG emissions summary is characterized by the importance of emissions related to residential buildings, which accounts for 32% of emissions. In contrast, the community waste and agricultural sectors seem negligible. Electricity is responsible for the majority of GHG emissions (50%) given that there is a high emission factor for this energy, which is produced mainly from fossil fuels (Figure D). Renewable energy represented only a small share (20%) of the province's energy portfolio in 2017. The significant use of gasoline, representing 21% of GHG emissions, demonstrates the intensive use of the automobile in road transport. However, there is significant uncertainty about the emissions and energy profile from the commercial and industrial sectors.

Validation methods have been used in most activity sectors to verify the accuracy of the results obtained, mainly scaling down the provincial emission and electricity use reported for the sectors at the national level[8]. This control was used to validate and qualify the uncertainty for these results, based on the observable difference between the results obtained for each method and the hypotheses made to make the assessments.

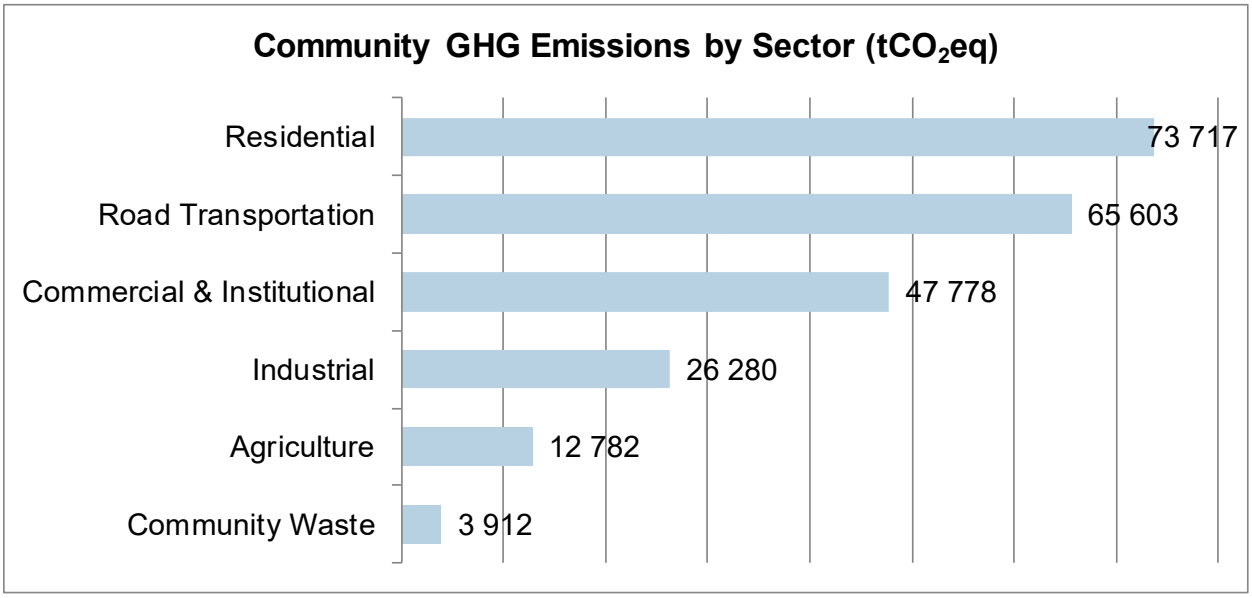

Figure C West Hants Summary of GHG Community Emissions, by Sector

[8] ECCC (2019). Canada - National Inventory Report 1990-2017. Table A11-6 GHG Emissions Summary for Nova Scotia, Selected Years.

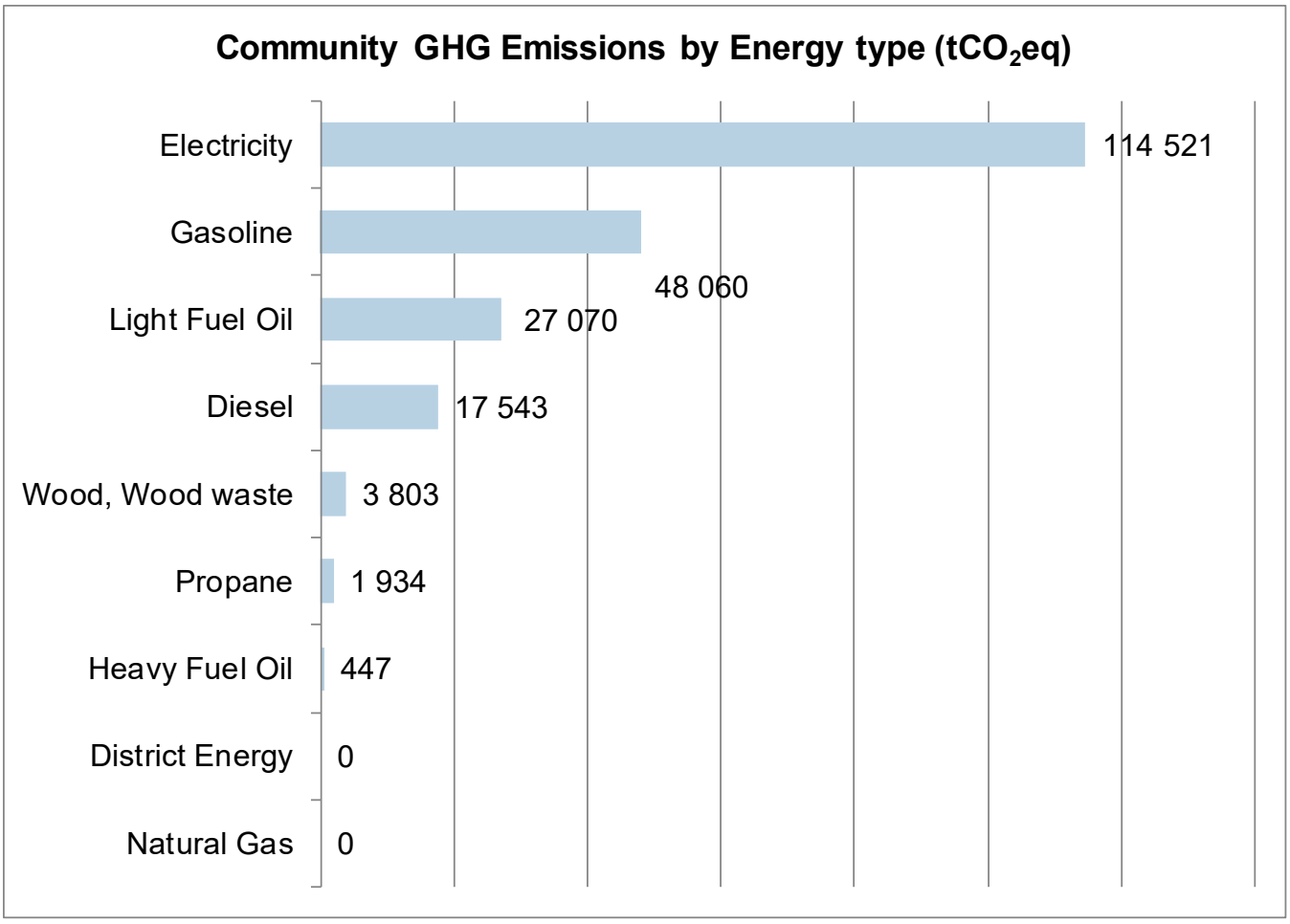

Figure D West Hants Summary of GHG Community Emissions, by Energy Type

4.2 RESIDENTIAL SECTOR

Emissions for the residential sector were calculated based on the amount of energy consumed. These data are not available at the local level. Therefore, the province's residential energy consumption has been scaled down based on the number of dwellings in West Hants. Population-based reduction has also been used to create a more accurate picture of residential sector emissions. The two ratios thus obtained were very similar to each other, resulting in an equally similar energy breakdown (Table 4-1). The data breakdown indicates that while natural gas is used in some parts of the province, it is not available in the municipality of West Hants. It was intentionally set to zero and the equivalent energy was added to light fuel oil consumption. This alteration induces a non-significant error on the distribution of energy (Table 4-2). Scaling down based on the number of dwellings results in emissions of 73,717 tCO_2eq.

The validation method was based on electricity consumption reported by Canada Energy Regulator for this sector in 2017 and scaling down provincial stationary combustion emissions based on dwellings; it resulted in emission of 73,484 tCO_2eq for West Hants. The scope and methodology for collecting data by Natural Resources Canada to produce the Comprehensive Energy Use Database is a hypothesis to explain the light variance observed.

Uncertainty on this outcome is considered moderate given the method for assessing West Hants' energy use. It is however useful for guiding reduction efforts, given the weighting provided by the breakdown of emissions by energy source.

Table 4-1 Population and Dwellings Information

Local Census Data, 2016	Nova Scotia	West Hants	Ratio
Population	923,598	15,368	0.0166
Private dwellings occupied by usual residents	401,990	6,426	0.0160

Table 4-2 GHG and Energy Summary Data – Residential Sector

Fuel Type	Energy Use - Nova Scotia (PJ)	Energy Use - West Hants (GJ)	Conversion to Natural Units	Units	Total GHG (tCO2 eq)
Electricity	16.0	255,768	71,046,549	kWh	53,285
Light Fuel Oil	13.9	225,395	5,877,318	L	16,195
Wood	11.6	185,431	0.19	PJ	3,691
Propane	0.6	9,591	353,531	L	547
Natural Gas	0.2	-	-	m^3	-
District Energy	-	-	-		-
Total	**42**	**676,185**			**73,717**

4.3 COMMERCIAL AND INSTITUTIONAL SECTOR

Emissions for the commercial and institutional sector were calculated based on the amount of energy consumed. These data are not available at the local level and have therefore been estimated from available data on the Atlantic Provinces (collectively). Energy consumption for the Atlantic provinces has been scaled down for West Hants based on the employment in the service sector. The data breakdown indicates that while natural gas is used in some Atlantic Provinces, including Nova Scotia, it is not available in the municipality of West Hants. It was intentionally set to zero and the equivalent energy was added to light fuel oil consumption. West Hants residents' ratio of employment in this sector as compared to jobs reported in the Atlantic Provinces was used to estimate the relative importance of this sector of activity for the municipality. (Table 4-3). Scaling down energy consumption data at the local scale based on the employment ratio results in emissions of 47,778 tCO_2eq. (Table 4-4).

The validation method was based on electricity consumption reported by the Canada Energy Regulator for this sector in 2017 and scaling down provincial stationary combustion emissions based on employment in this sector. It resulted in emissions of 38,079 tCO_2eq for West Hants. The scope and methodology for collecting data by Natural Resources Canada to produce the Comprehensive Energy Use Database is one hypothesis to explain this variance. Another hypothesis is the reduction of electricity use reported by Canada Energy Regulator (8% since 2005).

Uncertainty on this outcome is considered high and limits the interpretation that can be made of the results obtained. The energy consumption profile may differ greatly between the Atlantic Provinces, and the arbitrary distribution based on employment may lead to an erroneous representation for Nova Scotia.

Table 4-3 Employment in the Service Sector – Atlantic Provinces

	Employment in the Service sector	Ratio West Hants / Atlantic Provinces
Nova Scotia	374,715	0.0053
New-Brunswick	291,445	
Prince Edward Island	57,160	
Newfound Land & Labrador	186,495	
West Hants	4,855	

Table 4-4 GHG and Energy Summary Data –Commercial and Institutional

Fuel Type	Energy Use - Atlantic (PJ)	Energy Use - West Hants (GJ)	Conversion to Natural Units	Units	Total GHG (tCO2 eq)
Electricity	34.7	185,168	51,435,522	kWh	38,577
Natural Gas	8.1	-	-	m3	-
District Energy	-	-	-		-
Light Fuel Oil	11.9	106,725	2,782,920	L	7,689
Heavy Fuel Oil	1.1	5,870	140,663	L	447
Propane	3.5	18,677	688,421	L	1,066
Wood	-	-	-	PJ	-
Total	**59**	**316,440**			**47,778**

4.4 INDUSTRIAL SECTOR

Emissions for the industrial sector were calculated based on the amount of energy consumed. These data are not available at the local level and have therefore been estimated from available data on the Atlantic Provinces (collectively). Energy consumption for the Atlantic Provinces has been scaled down based on the employment in the industry sector (forestry, mining and quarrying, oil and gas, construction, manufacturing). West Hants residents' ratio of employment in this sector as compared to jobs reported in the Atlantic Provinces was used to estimate the relative importance of this sector of activity for the municipality. (Table 4-5). Scaling down energy consumption data at the local scale based on the employment ratio results in emissions of 26,280 tCO_2eq.

The validation method resulted in emissions of 22,502 tCO_2eq for West Hants and was based on: 1) electricity consumption reported by the Canada Energy Regulator for this sector in 2017; and 2) scaling down provincial stationary combustion emissions based on employment in this sector. Industrial sectors included Oil & Gas extraction (415 $ktCO_2eq$), Mining (4 $ktCO_2eq$), and Manufacturing (367 $ktCO_2eq$).

Uncertainty on this outcome is considered very high (over 50%) and strongly limits the interpretation that can be made of the results obtained. First, even though they are used as fuel sources, natural gas and heavy fuel oil were not reported on in the data obtained from the Comprehensive Energy Use Database. Second, the energy consumption profile may differ greatly between the Atlantic Provinces, depending on the industries present in each of them. The arbitrary distribution, on the basis of employment, may lead to an erroneous representation for Nova Scotia. Moreover, there are no pulp and paper plants in West Hants, and as such consumption of pulp liquor is not likely. However, forestry is important in the area, and dryers are often operated with wood waste as a source of energy. This would justify seeing energy data related to wood waste in the West Hants energy consumption profile.

Table 4-5 Employment in the Industry sector – Atlantic

	Employment in the Industry sector	Ratio West Hants / Atlantic
Nova Scotia	87,730	0.0080
New-Brunswick	79,680	
Prince Edward Island	19,220	
Newfound Land & Labrador	62,595	
West Hants	1,995	

Table 4-6 GHG and Energy Summary Data – Industrial

Fuel Type	Energy Use - Atlantic (PJ)	Energy Use - West Hants (GJ)	Conversion to Natural Units	Units	Total GHG (tCO2 eq)
Electricity	38.6	108,766	30,212,917	kWh	22,660
Natural Gas	X	-	-	m^3	-
District Energy	X	-	-		-
Light Fuel Oil	15.7	44,239	1,153,565	L	3,187
Heavy Fuel Oil	X	-	-	L	-
Propane	2.0	5,636	207,725	L	322
Wood waste and Pulp liquor	35.7	100,595	0.10	PJ	112
Total	**92**	**259,236**			**26,280**

X = No information reported

4.5 COMMUNITY WASTE

Depending on the type of waste management (landfill or composting), separate methods of assessing emissions are needed.

LANDFILLING

The calculation of biogas emissions at the landfill is calculated from the amount of landfilled waste and its composition. The methane commitment model (also known as total yield gas) method was chosen for its simplicity. West Hants will be able to easily replicate these calculations in the future, which would have been more difficult with the waste-in-place model (also known as first-order decay). The amount of waste from West Hants is known precisely, from the weigh scale at the site. Waste composition was calculated by WSP (Table 4-7), based on a recent characterization for West Hants landfill[9]. From there, factors required to assess GHG were determined (Table 4-8), and emissions were readily calculated (3,787 t CO_2eq).

Table 4-7 Waste composition

Waste Type	Waste Percentage
A - Paper, Cardboard	22.0%
B – Textiles	13.8%
C – Food	16.0%
D – Wood	1.9%
E - Garden waste	1.4%
F – Diapers	3.3%
G - Leather, rubber	0.4%

[9] Divert NS (2018). 2017 Waste audit report. 39 pages and appendices.

Table 4-8 Calculation factors

Calculation factors		Units
Lo	0.055	ton CH4/ton of waste
MCF – Methane Correction Factor	1	default value for anaerobic condition
DOC – Degradable organic carbon	16.5%	ton of Carbon / ton of waste
DOCf – Fraction of DOC dissimilated	0.5	default value
F – Fraction of methane in landfill gas	0.5	default value
Frec - Fraction of methane emission that are recovered at the landfill	0	1 = Existing landfill gas collection system 0 = None
OX – Oxidation factor	0	

COMPOSTING

Composting of organic waste is a biological treatment where CO_2 emissions are considered biogenic, and therefore not accumulated in a GHG inventory. However, methane and nitrous oxides are accounted for. The amount of organic waste from West Hants is known precisely from the weigh scale at the site (Table 4-9). Calculated emissions are 125 tCO_2eq.

Total GHG emissions for community waste is 3,912 tCO_2eq.

Table 4-9 GHG Summary Data – Community Waste

Type of waste / Management method	Quantity of Waste (tons)	Total Emissions (tCO2 eq)
Residential / Landfill	2,748	3,787
Organic / Composting	727	125
		3,912

The validation method, based on scaling down provincial emissions for solid waste disposal (360 $ktCO_2eq$) and biological treatment of solid waste (30 $ktCO_2eq$), results in emissions of 6,489 tCO_2eq for West Hants. Comparison with emissions calculated in this report is misleading, as waste emissions reported in the National Inventory Report are calculated using the first-order-decay model, which differs significantly from the total-gas-yield model. It is expected that emissions calculated for West Hants in this report would be higher considering the methodological foundations of the model used.

Uncertainty on this outcome is moderate considering that direct local data is available, but emissions are calculated using a recognized accounting methodology with average estimates for carbon content and moisture.

4.6 ROAD TRANSPORTATION

Emissions for the road transportation sector were calculated based on: 1) amount of fuel used; and 2) vehicle kilometers traveled (VKT). These data are not available at the local level and have been estimated from provincial data. The number of registered vehicles in West Hants was scaled down using the proportion of private dwellings. Number of registered vehicles in West Hants was confirmed by information provided by Access Nova Scotia.

Estimation of GHG emission based on fuels sales resulted in emissions of 65,606 tCO_2eq (Table 4-10), while estimation of GHG emission based on VKT resulted in emissions of 70,862 tCO_2eq (Table 4-11). This method gives additional insight into the distribution of emissions by type of vehicle. These data highlight the intensive use of light-duty gasoline vehicles and trucks, which account for 66% of emissions.

The validation of the results is made possible by the province's GHG emission data for the road transport sector. The provincial emissions were scaled down to West Hants based on the number of registered vehicles. Total emissions for the sector are 62,807 tCO_2eq. All three methods converge towards comparable results, which indicates that the uncertainty is moderate.

Table 4-10 Fuel use - West Hants Road transportation sector

Fuel	Registered Vehicles in Nova Scotia	Registered Vehicles in West Hants	Provincial Total Fuel Used (L)	West Hants Fuel Used (L)	Total GHG (tCO2 eq)
Gasoline	659,344	10,971	1,237,405,000	20,589,511	48,059
Diesel			384,649,000	6,400,277	17,547
Total			1,626,759,000	26,989,787	**65,606**

Table 4-11 GHG Summary Data - Road transportation

	Registered Vehicles in West Hants	VKT (km)	West Hants Fuel Used (L)	Total GHG (tCO2 eq)
Light-duty Gasoline Vehicles	6,447	111,499,905	10,034,991	23,423
Light-duty Gasoline Trucks	3,961	68,510,474	10,071,040	23,507
Heavy-duty Gasoline Vehicles	145	2,516,455	792,683	1,850
Motorcycles	156	2,705,189	146,080	341
Light-duty Diesel Vehicles	18	314,557	24,221	66
Light-duty Diesel Trucks	113	1,950,252	243,782	668
Heavy-duty Diesel Vehicles	1,284	22,207,711	7,661,660	21,005
Total	**12,124**	**209,704,543**	**28,974,457**	**70,862**

4.7 AGRICULTURE

Assessment of GHG emissions for the agricultural sector is limited to enteric fermentation and manure management, as no information was readily available to make an assessment for the following activities:

- Agricultural soils;
- Field burning of agricultural waste;
- Liming, urea application and other carbon containing fertilizers.

Quantification of enteric fermentation and manure management is based on headcount for cattle and swine. Although half of Canada's mink pelts come from Nova Scotia[10], there is no such farm in West Hants, so it was not included in the GHG calculation. Relevant information is available from Statistics Canada for the province, as well as for West Hants. Methane is the only GHG quantified in enteric fermentation, while methane and nitrous oxide are quantified in manure management (Table 4-12). Emissions for this sector result in 18,914 tCO_2eq.

[10] Nova Scotia Mink Breeders (2017). https://nsmink.ca/index.php/mink-farming

The validation of the results is made possible by the province's GHG emission data for the agricultural sector. The provincial emissions were scaled down to West Hants based on animal headcount. Total emissions for the sector are 12,782 tCO_2eq. Uncertainty is considered high, as IPCC Tier 1 factors have been used for the calculation[11]. These are not country, nor province specific; thus, the emissions are probably over-estimated.

Agricultural sector emissions are low at the provincial level (2.5% of Provincial total in 2016), but they are slightly higher for West Hants at 7.6%. To obtain more precise calculations, more information is required. Here are some ways to obtain the required data:

- Agricultural soils: a zero-emission balance should be expected if the area of cultivated land remains stable from year to year. However, if forest lands are converted, this loss of carbon sinks should be considered.
- Field burning of agricultural waste: the area of burnt land is generally known when this activity is carried out in a controlled manner. The fire department is informed when this activity needs to be carried out and could possibly contribute to data collection.
- Liming, urea application and other carbon containing fertilizers: the amount of fertilizer used by agricultural producers could be available from agrocentres, involved in the retail supply of crop production.
- Aquaculture: This farming mode will have an impact on GHG emissions as documented by research on salmon farming[12]. An LCA emission factor of 2.3 kg of CO_2eq per kg live weight was suggested for salmon farming in Canada[13]. Emissions from transportation need to be reported in the industrial sector rather than agricultural.
- Chicken farming: Statistics Canada 2016 census shows that 33 farms reported farming 7,896 birds in West Hants. This industry could warrant consideration in future inventories. According to IPCC, estimating the average annual population as the number of birds grown and slaughtered over the course of a year would greatly overestimate the population, as it would assume each bird lived the equivalent of 365 days. The average annual population should be estimated as the number of animals grown divided by the number of growing cycles per year. Tier 1 emission factors for enteric fermentation are not available from IPCC, thus there is insufficient data for calculation of emissions. Methane emission from manure management of poultry farming (0.03 $kgCH_4$/head) is very low compared to cattle (63 $kgCH_4$/head) and swine (13 $kgCH_4$/head).

Table 4-12 GHG Summary Data - Agriculture

Emission source	West Hants Headcount	Total CH4 (tCH4)	Total N2O (tN2O)	Total GHG (tCO2 eq)
Enteric fermentation				
Cattle - Dairy	3,934	504	-	12,589
Swine	343	<1	-	14
Manure Management				
Dairy Cows	3,934	248	<1	6,200
Market Swine	343	4	<1	112
				18,914

[11] IPCC defines the Tier approach as the level of complexity for the method used for assessing GHG. Tier 1 is the simplest method, while Tier 3 is the most demanding in terms of complexity and data requirement.

[12] Wright, Adam (2011). Salmon Aquaculture GHG Emissions - A Preliminary Comparison of Land-Based Closed Containment and Open Ocean Net-Pen Aquaculture.10 pages

[13] RIAS (2016). Comparing the Environmental Footprint of B.C.'s Farm-Raised Salmon to Other Food Protein Sources. 24 pages.

5 EMISSIONS FORECAST

The Partners for Climate Protection (PCP) Program requires that an emissions forecast be prepared to illustrate how emissions might grow under a "business as usual" (BAU) scenario. The forecast year chosen for West Hants is 2030, based on the PCP best practice which mandates choosing a forecast year 10 years from the baseline. The BAU forecast scenario presented hereafter takes into consideration actions that are currently planned and underway. It is based on Nova Scotia's current policies and programs and long-term targets.

Efforts to reduce GHG emissions are multiple in many sectors. However, the most well-known (and publicized) measures are those related to electricity production and road transportation. This is not without good reason; in 2016, these two sectors accounted for approximately 75% of the province's balance sheet. Trends in the agricultural and waste management sectors are not addressed in this report, nor are the specific initiatives of large industrial emitters which will be subject to a cap-and-trade system.

The main trends to consider in the construction of a BAU scenario are briefly presented below.

5.1 PROVINCIAL TRENDS IN GHG

Nova Scotia has surpassed the federal government's target of reducing greenhouse gas emissions by 30% below 2005 levels. Several projects contributed to the achievement of these results[14]:

- The installation of LEDs for street lighting is now mandatory, this gradual transition will reduce energy consumption of street lighting by 50%.
- The province has introduced various types of renewable energy, including wind energy. With the connection to the Maritime Link following the commissioning of the Muskrat Falls hydro power generating station (located in Newfoundland and Labrador), 40% of the electricity will come from a renewable source.
- Composting is a widespread practice in organic matter management, with 95% of citizens having access to curbside collection.
- Light fuel oil heating is losing ground in the residential sector, with the introduction of heat pumps in more than 100,000 homes as the primary source of heating. Per NRCan's Comprehensive Energy Use Database, this resulted in a 38% reduction of light fuel oil use between 2008 and 2016.
- Efficiency Nova Scotia's energy efficiency support programs in the residential sector also need to be considered. NRCan's Comprehensive Energy Use Database reports a total energy use decrease of 14% between 2008 and 2016.

The province's goal is to reduce GHG emissions to 45–50% below 2005 levels, by 2030. To meet this objective, the province is focusing on the development of renewable energy, introduction of a cap-and-trade program, and also on community education and outreach.

Nova Scotia's cap-and-trade program took effect on January 1, 2019[15]. It covers approximately 80% of GHG emissions in the province. Fossil fuel combustion and energy intensive industrial processes are the main sources covered by the cap-and-trade program: electricity generation, general stationary fuel combustion, cement production, and pulp and paper production, to name a few. More specifically, a 55% reduction in GHG emissions is expected in relation to the production of electricity.

[14] Government Of Nova Scotia (2019). What nova scotia is doing. Web site. Accessed on September 14, 2019. https://climatechange.novascotia.ca/what-ns-is-doing

[15] Nova Scotia Environment (2019). nova scotia's cap and trade program, regulatory framework. 33 pages.

A significant reduction was observed between 2005 and 2016, and there is still potential for a reduction of 45% between 2016 and 2030.

Through the Low Carbon Communities Program, the province provides funding for community planning, feasibility studies, public engagement sessions, program promotion and demonstration projects. The sectors of activity targeted by the program are transportation (active transportation, clean fleets and shared mobility) and electricity consumption (green buildings, electricity production and storage).

The result of Efficiency Nova Scotia's energy efficiency support programs in the residential sector were previously mentioned (-14% between 2008 and 2016). In an enlarged territory, a 1% decrease is reported in the Atlantic Provinces for the Commercial & Institutional sector, while the Industrial sector reports a decrease of 28%, mainly attributed to the pulp and paper industry.

5.2 NATIONAL TRENDS IN GHG

COAL-FIRED POWER PLANTS

The federal government committed to gradually shutting down coal-fired power plants by 2030[16]. Nova Scotia operates four plants that use coal or petroleum coke (Lingan, Point Aconi, Point Tupper, and Trenton) and has received an exemption to continue its use beyond that deadline under a so-called "equivalency agreement." Nova Scotia could continue to burn coal past 2040 to avoid construction of natural-gas fired plants that would need to be operated for a long period of time, slowing down conversion to renewable energy[17].

VEHICLE SALES

The sale of motor vehicles is doing very well in Canada at large, and in Nova Scotia specifically, as evidenced by a 15% increase in vehicles registered in the province between 2008 and 2018 [18]. There is no reason to believe that this trend will reverse, despite efforts to improve public transit in major urban centers and the introduction of public transit in many rural municipalities and small towns.

LOW EMISSION VEHICLES

In the road transportation sector, the arrival of electric vehicles (EVs) with a range of more than 300 km and the multiple models offered by the manufacturers will certainly have an impact on fuel consumption (gas and diesel) as well as on the requirements placed on the electricity utility and/or local electricity grids. According to a recent study by the Bank of Canada[19], a base-case scenario which assumes already-announced and probable environmental policies that are supportive of EV growth, estimates that EV use will rise from 0.3% to over 7% of the global car fleet. A more optimistic scenario projects that the number of EVs on the road by 2030 could reasonably range between 4 to 19% of the global fleet. Supporting this information, a recent study conducted by Nova Scotia Power forecasts that EVs will make up 10% of Nova Scotia's vehicle stock by 2030[20].

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16 Government of Canada (2018). Canada's coal power phase-out reaches another milestone. https://www.canada.ca/en/environment-climate-change/news/2018/12/canadas-coal-power-phase-out-reaches-another-milestone.html

17 The Chronicle Herald (2019). Coal fires most of Nova Scotia's energy; will we still be burning it in 20 years? https://www.thechronicleherald.ca/news/local/coal-fires-most-of-nova-scotias-energy-will-we-still-be-burning-it-in-20-years-307232/

18 Statistics Canada. Table 23-10-0067-01 Vehicle registrations, by type of vehicle. https://doi.org/10.25318/2310006701-eng

19 Bank of Canada (2019). Outlook for Electric Vehicles and Implications for the Oil Market. 9 pages and appendices. ISSN 2369-9639. https://www.bankofcanada.ca/2019/06/staff-analytical-note-2019-19/

20 City of Halifax (2019). Electric Vehicle Initiatives - ESSC Standing Committee Report - Item No. 12.1.1. Dated September 5, 2019.

The withdrawal of 10% of gasoline vehicles will have a positive impact on GHG emissions. However, introduction of an equivalent number of EVs adds a load on the power grid. Fuel rates of 18 kWh/100 km are common for EV cars, such as the popular Chevrolet Bolt[21]. Therefore, adding one EV to the grid (travelling 18,000 km/annum) could add 1.3 tCO_2eq to the balance sheet, using Nova Scotia's forecasted 2030 emission factor for electricity production. However, the anticipated reduction in energy consumption between a conventional vehicle and an electric vehicle can also be estimated based on the 2020 Grid Intensity of the Nova Scotia Power energy profile, and the 2030 estimated Grid Intensity. The results of the net reduction per vehicle type are tabulated in Table 5-1.

Table 5-1 Estimated reduction in GHG per kilometre driven

NOVA SCOTIA	2020		2030	
Gas --> Electric	**kg CO_{2e}/km**	**tCO_{2e} /annum***	**kg CO_{2e}/km**	**tCO2e/annum***
Passenger Car	-0.071	-1.278	-0.073	-1.314
Passenger Truck	-0.090	-1.620	-0.092	-1.656
Light Commercial Truck	-0.074	-1.332	-0.080	-1.530
Diesel --> Electric	**kg CO_{2e}/km**	**tCO_{2e} /annum***	**kg CO_{2e}/km**	**tCO_{2e} /annum***
Passenger Car	-0.073	-1.314	-0.060	-1.080
Passenger Truck	-0.215	-3.870	-0.237	-4.266
Light Commercial Truck	-0.186	-3.348	-0.199	-3.582

**Based on 18,000 km traveled per annum.*

In addition to the electric transition, there is a strong commitment from automakers to reduce fuel consumption rates significantly over the next decade, under the leadership of California[22]. A fuel rate of 6.5 L/100 km is targeted by 2026. In this inventory report, an average fuel consumption rating of 9.0 L/100km was used. Meeting the 2026 target would represent a reduction of 27% in fuel consumption. However, a recent study also revealed that the average age of cars and light trucks in the U.S. rose to 11.8 years in 2019 [23]. Therefore, it is likely that only a fraction of the vehicles on the road will benefit from significantly improved fuel rates.

Based on the previously mentioned facts, West Hants' regional fleet could have the following profile (Table 5-2).

Table 5-2 West Hants Projected regional fleet - 2030

	Number of vehicles
Registered vehicles 2016	12,124
Total registered vehicles 2030 [a]	14,000
Over 12 years of age	7,000
Low fuel rate vehicles	5,600
EVs	1,400

[a] Rounded number

[21] NRCan (2019). Fuel consumption report. https://fcr-ccc.nrcan-rncan.gc.ca/en#VehicleReport/196

[22] PBS (2019). California signs deal with automakers to raise gas mileage standards. Accessed on September 14, 2019. https://www.pbs.org/newshour/economy/california-signs-deal-with-automakers-to-raise-gas-mileage-standards

[23] Business Wire (2019). Average Age of Cars and Light Trucks in U.S. Rises Again in 2019 to 11.8 Years, IHS Markit Says. https://www.businesswire.com/news/home/20190627005234/en/Average-Age-Cars-Light-Trucks-U.S.-Rises/?feedref=JjAwJuNHiystnCoBq_hl-WepL6sRhX6ZA9uIKkLyMC2Ka1ah7uC6RdZY8DBvigxR7fxFuNFTHSunhvli30RlBNXya2izy9YOgHlBiZQk2LO4aHursdTgjq-KNSSWsKUa97ZTKjNldK1STeKrUjqbvg==

5.3 WEST HANTS GHG EMISSIONS FORECAST

Assumptions used to forecast the West Hants corporate and community GHG inventories were as follows (Table 5-3).

Table 5-3 Corporate Inventory Forecast assumptions

Sector	Contributing factors to 2030 forecast
Buildings	– Emission factor reduction of 44% for electricity consumption – 10% reduction in energy consumption
Street Lighting	– Emission factor reduction of 44% for electricity consumption
Water and Wastewater Treatment	– Emission factor reduction of 44% for electricity consumption – 10% reduction in energy consumption
Vehicle Fleet	– 28% reduction in fuel rate
Corporate Waste	No significant change
Staff Business Travel	– 28% reduction in fuel rate

Table 5-4 Community Inventory Forecast assumptions

Sector	Contributing factors to 2030 forecast
Residential	– Emission factor reduction of 44% for electricity consumption – 10% reduction in energy consumption – Increase of kWh use at the residential sector to supply electricity required by EVs.
Commercial and Institutional	– Emission factor reduction of 44% for electricity consumption – 10% reduction in energy consumption
Industrial	– Emission factor reduction of 44% for electricity consumption – 10% reduction in energy consumption
Road Transportation	– Increase of 15% in vehicles registered – 10% of total vehicle on road are EVs and 50% benefit from low-fuel rates. – 28% reduction in fuel rate
Community Waste	– No significant change
Agriculture	– No significant change

Table 5-4 details business-as-usual forecasted GHG emissions, at the corporate and community level. A reduction of 45% is expected at the corporate level, while a decrease of 35% is expected at the community level. The achievement of the forecasts is uncertain and largely not under the control of West Hants, since it is mainly attributable to the decarbonization of power generation by utilities. The potential maintenance of coal-fired power plants and the delay in delivery of the Muskrat Falls Project are jeopardizing this provincial objective.

Table 5-5 GHG Emissions forecast

Corporate Emissions inventory			Community Emissions inventory		
SECTOR	GHG EMISSIONS 2018-2019 ($t CO_2 eq$)	GHG EMISSIONS 2030 ($t CO_2 eq$)	SECTOR	GHG EMISSIONS 2016 ($t CO_2 eq$)	GHG EMISSIONS 2030 ($t CO_2 eq$)
Buildings	630	388	Residential	73,717	49,422
Street Lighting	41	21	Commercial & Institutional	47,778	28,783
Corporate Vehicle Fleet	72	52	Industrial	26,280	14,898
Water and Wastewater Treatment	921	453	Road Transportation	65,606	43,700
Corporate Waste	51	51	Community Waste	3,912	3,912
Staff business travel	18	13	Agriculture	12,782	12,782
TOTAL	**1,733**	**978**	**TOTAL**	**230,073**	**153,496**
	Reduction	**-33%**		**Reduction**	**-44%**

6 CONCLUSION

The first milestone of the PCP program is to get a current picture of GHG emissions and a forecast. This was done with low uncertainty for corporate emissions and high uncertainty for community emissions. West Hants has gone beyond PCP mandatory requirements, by assessing GHG emissions for staff business travel and the agricultural sector. West Hants now has the information needed to design an action plan and set reduction targets. These activities represent milestones 2 and 3 of the PCP program.

These emissions, calculated in an absolute way for a given baseline year, give an imperfect indication of the extent of the activities carried out by the municipality. An increase (or reduction) in the number of buildings managed by the municipality, in the fleet of vehicles, in the population on the territory, or of the services offered to citizens would have an impact on the GHG emissions balance. A performance indicator based on "intensity" would be useful to standardize emissions over the years, according to the evolution of infrastructures and equipment managed by the Municipality and services rendered to the population. The table below provides various intensity measures that West Hants could use in the future.

Table 6-1 Suggestion of GHG intensity indicators

SECTOR	ACTIVITY INDICATOR	GHG INTENSITY INDICATOR
Building	Floor area of building portfolio	tCO_2eq/m^2
Vehicle fleet	Hours worked	tCO_2eq/hours worked
Street lighting	Illuminated road length	tCO_2eq/km
Staff Business travel	Distance traveled	tCO_2eq/km
Residential	Population	tCO_2eq/per capita
Commercial and Institutionnal, Industrial	Employment	tCO_2eq/employee
Road transportation	Population	tCO_2eq/ per capita
Community Waste	Population	tCO_2eq/per capita