Nova Scotia Community College

Greenhouse Gas Inventory 2021-2022

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April 2023

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Introduction

The Nova Scotia Community College (NSCC) has used energy consumption data from the 2008-09 fiscal year to establish a baseline for greenhouse gas (GHG) emissions and is using this baseline to meet targets for emissions reductions, as well as reductions in energy and water consumption. Since establishing that baseline, NSCC Facilities and Engineering has collected annual emissions data from all NSCC campuses to track GHG emissions reductions. The emissions accounted for include direct (scope 1), indirect (scope 2), and emissions resulting from commuting and business travel (scope 3). The college aims to reach a 60% reduction from baseline by 2030, an 80% reduction from baseline by 2040, and Net Carbon Zero status by 2050. The NSCC has already reached its goal of reducing emissions by 40% by 2020.

This document accompanies the Excel workbook "NSCC Emissions Inventory 2021-22" which includes a detailed breakdown of the NSCC's GHG emissions inventory. This document will describe the methods used in the development of the emissions inventory and will include references for resources that were used.

Scope of Project

The NSCC owns and operates 14 physical campuses across Nova Scotia. These properties are included in the GHG inventory. Properties that are leased or not financially operated by the NSCC are considered outside of the scope of the inventory. Facility emissions produced onsite and resulting from generation offsite are included in the inventory. Emissions from fleet vehicles, vehicle rentals, business travel, and student and staff commuting are also included. Emissions resulting from air travel are not yet included in the inventory as that data is not available.

Types of Emissions

The three main types of emissions are as follows:

- Scope 1: These are direct emissions that come from sources owned and controlled by the facility. At the NSCC, these emissions result from the use of on-site heating systems and cooking appliances. Scope 1 emissions also include emissions produced by the fleet vehicles attached to a campus. The most common fuels used were heating oil, propane, and natural gas, which each have specific emission factors allowing the emissions produced to be reported as CO_2 equivalent emissions.
- Scope 2: These are indirect emissions, which result from activities within the institution's boundaries but are generated by sources that are owned or controlled by another entity. They are produced in the generation of electricity or heat that is purchased from a source off-site. At the NSCC, this includes electricity purchased from Nova Scotia Power Inc (NSPI) at all campuses, steam purchased from heating at one campus, and onsite biomass boilers on two campuses which are operated by third parties.
- Scope 3: These are other indirect emissions that result from normal activities at the facility, such as commuting, business travel, and embodied emissions from purchased goods and materials. Since many of the NSCC's campuses are in rural areas, student and staff commuting contributes significantly to the indirect emissions of the college.

Reported Emissions

The emissions reported in this inventory include carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), which are primary emissions associated with the combustion of fossil fuels. Carbon dioxide accounts for the majority of gasses released from combustion, with methane being produced in much smaller quantities as a result of incomplete combustion. Nitrous oxide is produced in even smaller quantities, resulting from combustion in the presence of nitrogen. The global warming potential (GWP) of these gases is measured by their relative impact on the Earth's atmosphere, with carbon dioxide serving as the baseline with a GWP of 1. Methane and nitrous oxide have higher GWPs due to their atmospheric lifetimes, as well as their ability to trap infrared radiation and re-emit it into the lower atmosphere.

The NSCC's GHG inventory only accounts for these three gasses, as they are the only ones emitted as a result of the college's operations. Other greenhouse gasses such as hydrofluorocarbons (HFCs/HFCFs), perfluorocarbons (PFCs), sulphur hexafluoride (SF_6, and nitrogen trifluoride (NF_3) are not included in this inventory.

Scope 1 Emissions Inventory

Stationary Combustion

Methods

The NSCC has been using ENERGY STAR Portfolio Manager (ESPM) to record and analyse energy usage data from 2009 to the present day**.** Using energy usage data in the form of fuel bills, ESPM is able to calculate the direct (Scope 1) emissions associated with the energy use of NSCC facilities.

To calculate GHG emissions, Portfolio Manager uses a default fuel analysis approach, which only requires records of the type and quantity of fuel used. This approach assumes fuel-specific factors for heating value, carbon content, carbon to CO2 ratio, and carbon oxidation factor for each fuel type used. The methodology only accounts for the emissions that occur at the building and does not include emissions that occur during fuel extraction, processing, and transportation to the site. (ENERGY STAR Portfolio Manager)

This GHG analysis provides a straightforward estimation of direct CO_2 emissions. Estimating direct CH_4 and N_2O emissions is much more complex and dependant on many factors. However, CH_4 and N_2O emissions make up a very small percentage of a facility's total GHG footprint (<1%) so the calculation methods used, while not as precise as those used to estimate CO_2, are considered adequate for these purposes. (ENERGY STAR Portfolio Manager)

The direct emission calculation methods as described in the ENERGY STAR Portfolio Manager resource *Technical Reference: Greenhouse Gas Emissions (2022)* are as follows:

"To calculate direct GHG emissions:

1) All billed or metered site energy consumption for each fuel is converted from native units to million British thermal units (MMBtu). Fuels that are delivered, billed, or measured in mass or volume units (i.e., cubic feet, tons, gallons) are converted to energy using standard heat content factors.

2) Total site energy for each fuel is multiplied by a single CO_2-equivalent factor that incorporates the reference global warming potential of each gas (CO_2=1, CH_4=25, and N_2O= 298)
    a) In the US, these factors are computed at the national level (each fuel has one factor).
    b) In Canada, factors for fuel oil are applied at the national level, but factors for natural gas vary by province. Specific factors for each country are presented in the last section of this document.
3) Direct emissions are summed together across all fuels (e.g., oil, gas, etc.) and reported as a Direct Emissions Metric in Portfolio Manager.
4) Direct emissions are also added to the Total GHG Emissions."

Biomass

The province of Nova Scotia classifies biomass as a renewable energy source. The NSCC does not agree with this classification, and therefore includes biomass emissions in its Scope 1 and Scope 2 emissions inventories.

Two campuses were operating biomass burners on-site during the reporting period: Truro and Shelburne. The quantity of biomass used during this period was recorded in ESPM, and the resulting emissions were tracked separately from other onsite fuel consumption and are not included in ESPM's generated *Total GHG Emissions* reports.

The biomass emission calculation methods as described in the ENERGY STAR Portfolio Manager resource *Technical Reference: Greenhouse Gas Emissions (2022)* are as follows:

"To calculate indirect GHG emissions from wood:

1) All meters for wood (the only biomass fuel) are converted from native units to MMBtu.
2) Total site energy for wood is multiplied by a single CO_2eq factor that incorporates the contribution of CO_2, CH_4, and N_2O.
    a) In the U.S., there is one national factor applied.
    b) In Canada, a single national factor (different from the U.S.) is applied.
3) Emissions resulting from wood are reported as biomass emissions."

Results

The total amounts of GHGs emitted by on-site fuel and biomass combustion can be seen in the table below:

Total Direct GHG Emissions (MT CO_2e)	5841.3
Total Biomass Emissions (MT CO_2e)	384.0
Total Scope 1 GHGs (MT CO_2e)	**6225.3**

Figure 1: On-site combustion emissions summary

Fleet vehicle

Methods

NSCC Facilities and Engineering has a list of each vehicle owned by the college and the campus that they are assigned to. The average CO_2 emissions for each vehicle type, as well as CH_4 and N_2O, were sourced from NRCan's Fuel Consumption Guide. The 2020-2021 milage every fleet vehicle was collected from the respective campuses and compiled. The vehicles for which the exact mileage could not be found were assumed to have the average mileage of all other fleet vehicles.

The emissions factors provided by NRCan's Fuel Consumption Guide allowed the total amount of CO_2, CH_4, and N_2O emitted by fleet vehicles to be calculated. The CH_4 and N_2O emissions were then converted into equivalent tonnes of CO_2 by multiplying by their respective global warming factors.

Results

A summary of the total number of kilometers driven by fleet vehicles and the resulting GHG emissions can be seen below:

Total KMs	251,701.2826
Total CO_2 (MT)	75.3946
Total CH_4 (MT)	0.0025
Total N_2O (MT)	0.0010
Total GHGs (MT CO_2e)	**75.7618**

Figure 2: Fleet vehicle emissions summary

Observations

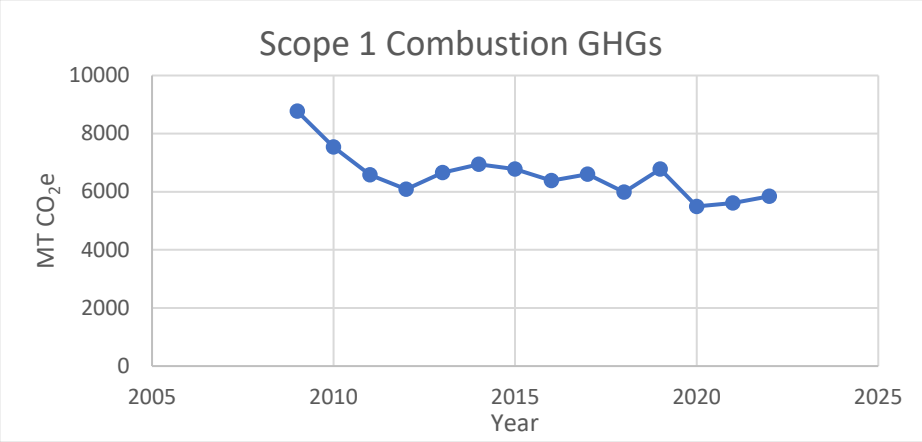

Figure 3: Scope 1 emissions trendline

Direct GHG emissions (not including biomass) have decreased since tracking began in 2009. There was a significant drop in 2020 due to the COVID-19 pandemic and the transition from onsite to online classes. Since 2020, emissions have been gradually increasing. This can be explained by the return to in-person learning, as well as ventilation system upgrades in several college facilities. Currently, biomass emissions are responsible for 6% of Scope 1 emissions produced onsite, and 1% of all Scope 1 emissions.

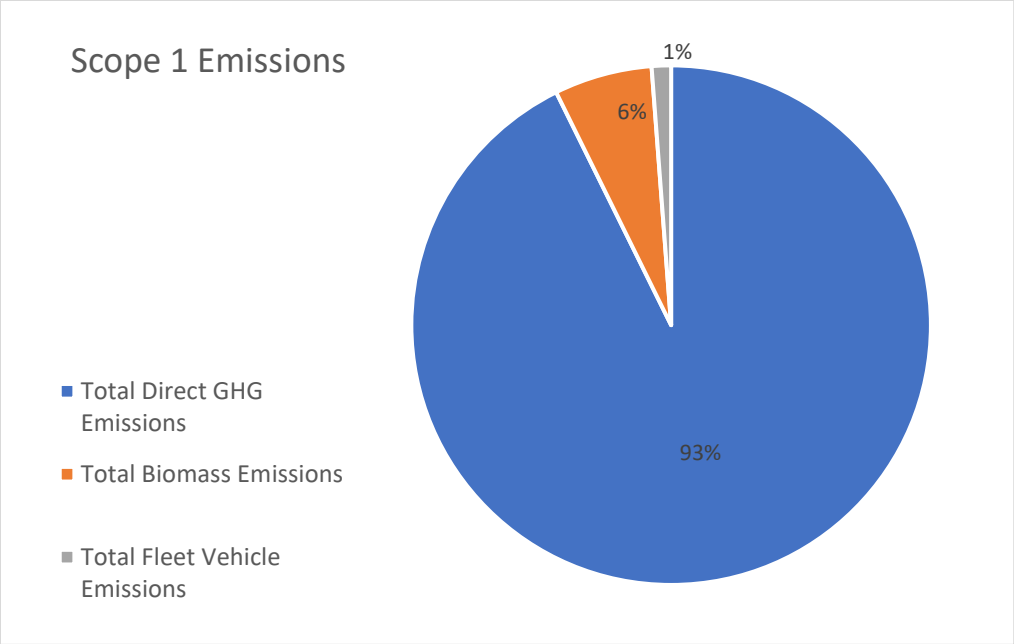

Figure 4: Scope 1 emissions pie chart

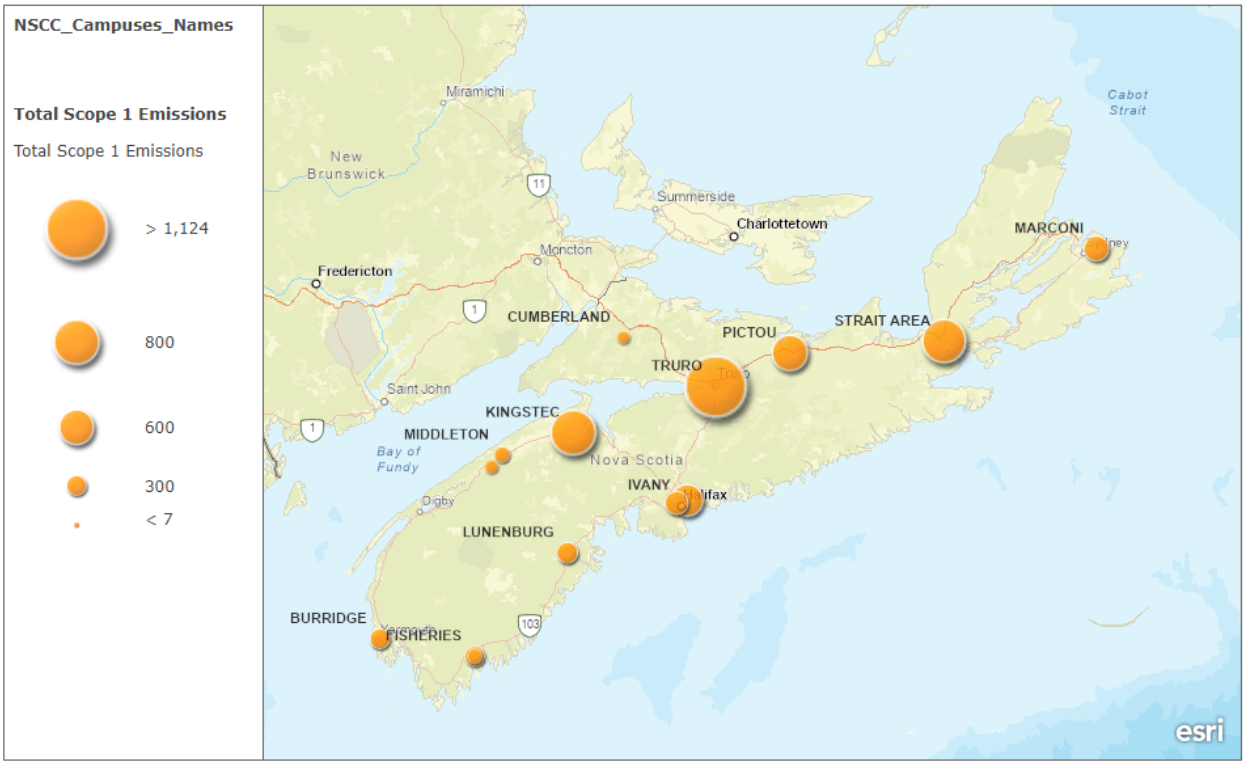

Figure 5: Scope 1 emissions by campus (MT CO2e)

Scope 2 Emissions Inventory

Electricity and Steam

Methods

ESPM was also used to report on indirect emissions, such as those produced by electricity or heat which is purchased from a utility. The emissions resulting from the generation of energy used by the facility are included in the inventory. Any emissions associated with energy losses due to the transmission and distribution of energy are attributed to the utility. The two main sources of indirect emissions at the NSCC are electricity and district steam.

Electricity:

ESPM takes regional GHG factors into consideration when calculating the GHGs associated with electricity usage. This is done using power plant and generation data provided by utilities and district systems. In Canada, the GHG factors are provided by "*Canada's National Inventory Report – Greenhouse Gas Sources and Sinks in Canada."*

The electricity emission calculation methods as described in the ENERGY STAR Portfolio Manager resource *Technical Reference: Greenhouse Gas Emissions (2022)* are as follows:

"To calculate indirect GHG emissions from electricity:

1) All billed or metered site energy consumption for each source is converted from native units to MBtu.
2) Total site energy for each source is multiplied by a single CO_2-equivalent (CO_2eq) factor that incorporates the contribution of CO_2, CH_4, and N_2O.
   a) In the U.S., these are regional factors according to the eGRID subregions.
   b) In Canada, factors are provided at the provincial level."

Steam

The NSCC Ivany Campus purchases steam from the Dartmouth General Hospital. The campus receives a monthly invoice from the Nova Scotia Health Authority for steam used, as measured by a condensate meter at the hospital. ESPM uses default emission factors to calculate the indirect emissions resulting from the generation of steam used.

The district steam emission calculation methods as described in the ENERGY STAR Portfolio Manager resource *Technical Reference: Greenhouse Gas Emissions (2022)* are as follows:

"To calculate indirect GHG emissions from district heating and cooling:

1) All billed or metered site energy consumption for each fuel is converted from native units to MBtu. Fuels that are delivered, billed, or measured in mass or volume units (i.e., pounds of steam) are converted to energy using standard heat content factors.
2) Total site energy for each fuel is multiplied by a CO_2-equivalent factor that incorporates the contribution of CO_2, CH_4, and N_2O.
   a) In the U.S., a single national factor is applied for each type of district system.
   b) Canada uses a similar national approach, but the factors are different from the U.S. factors.

3) Indirect emissions from district energy consumption are added to electric indirect emissions to compute your Indirect Emissions metrics in Portfolio Manager.
4) Indirect emissions are also added to the Total GHG Emissions."

Biomass

Methods

There are two campuses at which the NSCC purchases district heat produced by biomass. This means that the emissions from these systems are considered Scope 2. The quantity of biomass used at these sites during the 2021-2022 period was recorded in ESPM and reported separately from other Scope 1 and Scope 3 emissions.

The biomass emission calculation methods as described in the ENERGY STAR Portfolio Manager resource *Technical Reference: Greenhouse Gas Emissions (2022)* are as follows:

"To calculate indirect GHG emissions from wood:

1) All meters for wood (the only biomass fuel) are converted from native units to MBtu.
2) Total site energy for wood is multiplied by a single CO_2eq factor that incorporates the contribution of CO_2, CH_4, and N_2O.
   a) In the U.S., there is one national factor applied.
   b) In Canada, a single national factor (different from the U.S.) is applied.
3) Emissions resulting from wood are reported as biomass emissions."

Results

A summary of the amounts and sources of all Scope 2 emissions can be seen below:

Electricity (Grid) Emissions (MT CO_2e)	12020.7
District Steam Emissions (MT CO_2e)	3213.4
Biomass Emissions (MT CO_2e)	316.4
Total Scope 2 GHGs (MT CO_2e)	**15550.5**

Figure 6: Scope 2 emissions summary

The Scope 2 emissions are following a trend similar to that of the Scope 1 emissions. There was a significant reduction in emissions in 2020 due to the switch to remote learning. Scope 2 emissions have increased from the 2021 values, which can be explained by the gradual return to in-person learning. Additionally, the winter of 2021/22 was colder on average than the winter of 2020/21, which would have increased building heating loads and energy demands (Government of Canada - Environment and Natural Resources, 2023).

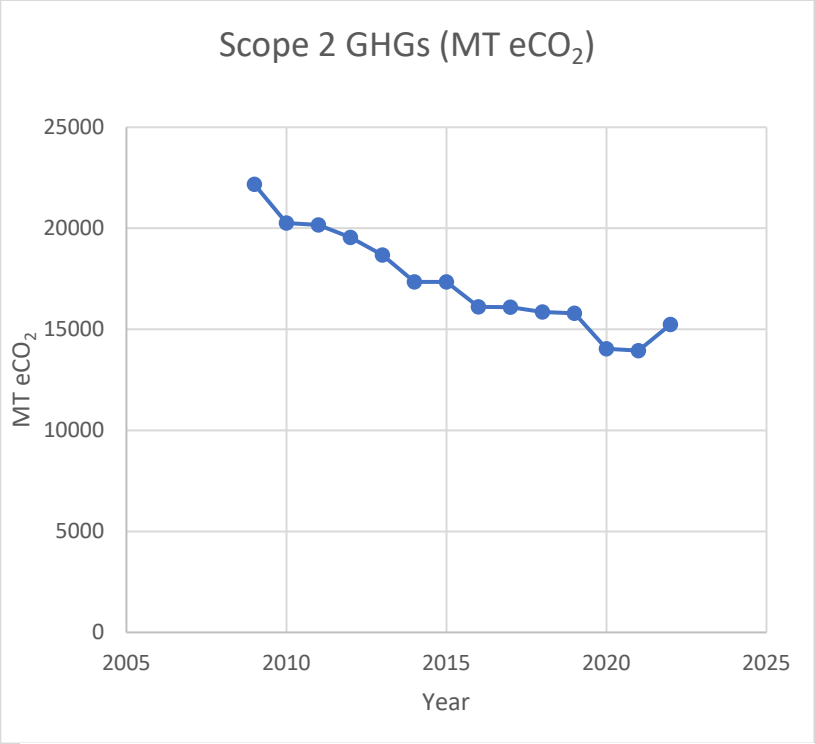

Figure 8: Scope 2 emissions trendline

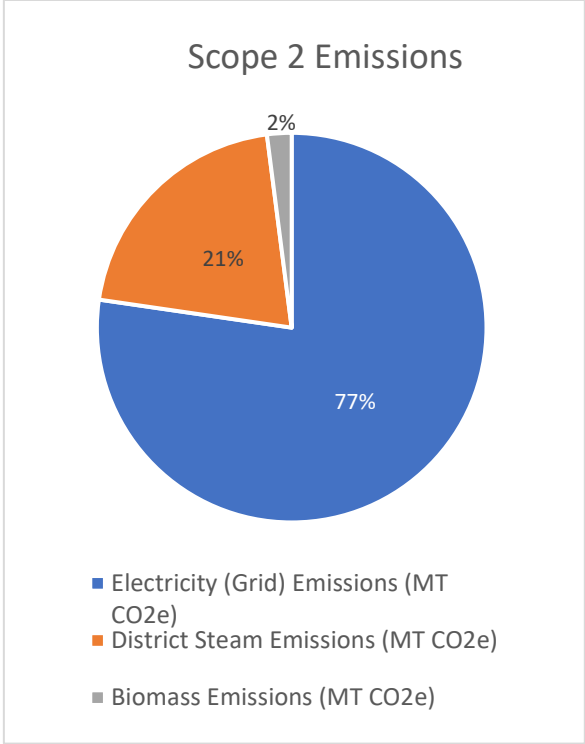

Figure 9: Scope 2 emissions pie chart

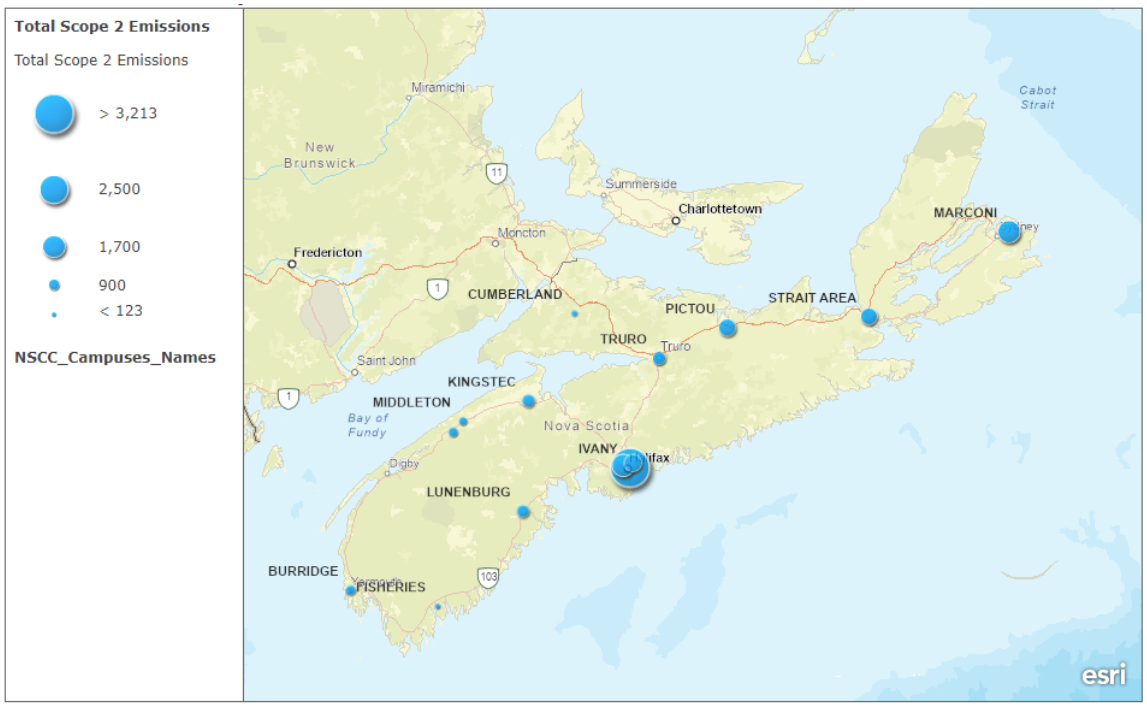

Figure 7: Scope 2 emissions by campus (MT CO2e)

Scope 3 Emissions Inventory

Staff and Student Commuting

Methods

Survey

To determine the estimated vehicle emissions per kilometer, NRCan's *Fuel Consumption Ratings* were used. Vehicle fuel efficiency can vary based on the age and type of vehicle. To improve the accuracy of the estimation, records of vehicle registration in Nova Scotia by type of vehicle were accessed on *StatsCan*. The vehicle registration data was used to calculate the average city and highway fuel consumption rates based on the numbers and types of different vehicles driven. The EPA's *Emissions Factors for Greenhouse Gas Inventories* report was then used to provide CO_2, CH_4, and N_2O emissions per volume of fuel used. These values were then used to calculate the estimated emissions per kilometer of travel, for both highway and city driving.

A trial survey was sent to students and staff of the AVC Middleton and AVC COGS campuses in February 2023 to identify any flaws in the survey phrasing and logic. Some corrections were made, such as the inclusion of an option for students who live on-campus, and an additional question to identify whether the respondent was a student or a staff member. The final survey was approved to be distributed by the college in late April, and received a total of 434 responses. In order to increase the sample size, the responses from the trial survey were added. The NSCC's recorded total staff and student numbers were used to determine the student-to-staff ratio, which was used to estimate the number of student and staff responses from the AVC campus survey.

Survey Response Analysis Methodology and Results

The student and staff responses were analysed separately. The same methodology was used for both.

One of the major differences between this survey and past commuting surveys was that it included a question asking the number of days that people commute. Several programs that the college offers are fully or partially online, so the assumption that students and staff drive to a campus five days per week is no longer reasonable.

Days per week commuting	Percentage of students	Estimated # of students
1	0.5%	49
2	4.1%	368
3	8.7%	783
4	22.2%	2002
5	49.1%	4421
None	*14.0%*	*1262*
Live on campus	*1.4%*	*122*

Figure 10: Commuting survey responses

The percentages of students who commuted a given number of days per week were calculated from the survey results, which were then extrapolated using the recorded total number of enrolled students to estimate the numbers of students commuting for each possible scenario.

The students who commuted 1-5 days per week were asked to provide their primary mode of transportation. Again, the percentages of students who chose different responses were calculated from the survey results, which were extrapolated to estimate the numbers of students using different modes of transportation. The majority of students (71%) indicated that they drove themselves to school.

Of the students who drove themselves to school, one indicated that they drove an electric vehicle. When these results were extrapolated, the estimated number of students driving electric vehicles was unreasonably high. This is a flaw due to the low sample size of the survey. As it is not possible to get the actual number of students driving electric vehicles at this time, the assumption has been made that there are no more than 20. This is estimated based on electric vehicle sightings at various NSCC campuses.

The number of students driving combustion vehicles was then sorted by the respondent's average one-way commuting distance. The percentage of responses for each option was used to extrapolate the survey results to estimate the number of students commuting each possible distance range. The estimated numbers of students were then multiplied by the median distance of the corresponding distance range. These values were then summed and multiplied by two (to account for both ways of a commute) to yield the total number of kilometers driven by students each day.

To calculate the total number of kilometers driven by students per week, the daily distance driven was multiplied by the percentage of students who commute one day per week. This yields the weekly mileage of the one-day-per-week students drive. The daily distance driven was then multiplied by the percentage of students who commute two days per week. This yields the number of kilometers that the two-day-per-week students would drive daily, which would then be multiplied by two to get their weekly milage. This process was used for the three, four, and five-day-per-week student numbers. The sum of each of the weekly mileages were then added to calculate the total number of kilometers driven by students each week. This number was then multiplied by the number of weeks in the academic term to yield the annual mileage of students who drive by themselves.

How far?	Percentage	Estimated # of students
<5km	17.3%	931.9
5-10km	20.4%	1099.0
11-25km	25.9%	1395.6
26-60km	20.8%	1119.8
61-100km	10.6%	572.5
100+ km	4.9%	265.3

Figure 11: One-way commute distances for students

This process for calculating the annual mileage was repeated for the students who carpool. The total number of kilometers driven was then divided by two, assuming that at least two students were in each carpooling vehicle.

The last mode of transportation considered was public transportation. It was assumed that the majority of students travelling on public transportation would be attending campuses in the Halifax area, and therefore the average distance travelled would likely be less than ten kilometers. Using the median estimated distance and the estimated number of students travelling by public transit, the estimated daily distance travelled via public transit was calculated. The weekly distance was calculated using the method used for the students who drove themselves.

The annual number of kilometers for each method of transportation were combined to yield the total annual kilometres driven by students.

The total number of kilometers driven by both students and staff were multiplied by vehicle emissions factors to determine the total amount of CO_2 emitted.

The methodology detailed above was repeated for the staff commuting survey results. The calculations explained above can be found in the "Scope 3 – Commuting" tab of the Excel workbook.

Vehicle Emissions Factors

The numbers and types of different vehicles driven by students and staff are not documented by the college. To calculate an accurate emissions factor to use in vehicle emissions calculations, Nova Scotia vehicle registration records by vehicle and fuel type were accessed from Statistics Canada. The percentages of different types of vehicles registered in Nova Scotia (e.g., passenger cars, pickup trucks, vans) were calculated. The highway and city fuel efficiencies of these different types of vehicles were calculated as well, taking the average efficiencies of vehicles manufactured since 2000. These average efficiencies by vehicle type were then multiplied by the corresponding percentages of vehicles registered, yielding the average highway and city efficiency for personal vehicles in Nova Scotia.

The survey included a question to determine whether a respondent's commute was mostly highway or city driving, but upon analysis if was found that the number of responses for both options were nearly equal. It was decided that a combined city and highway emissions factor would be used for all commuting distances rather than calculating city and highway commutes separately.

Results

The majority of Scope 3 emissions result from students and staff commuting to campus. This is to be expected, as the NSCC has many rural campuses.

	Annual Emissions (MT CO_2e)
Rentals	31.40
Commuting	10014.74594
Business Travel	56.06871601

Figure 12: Summary of Scope 3 emissions

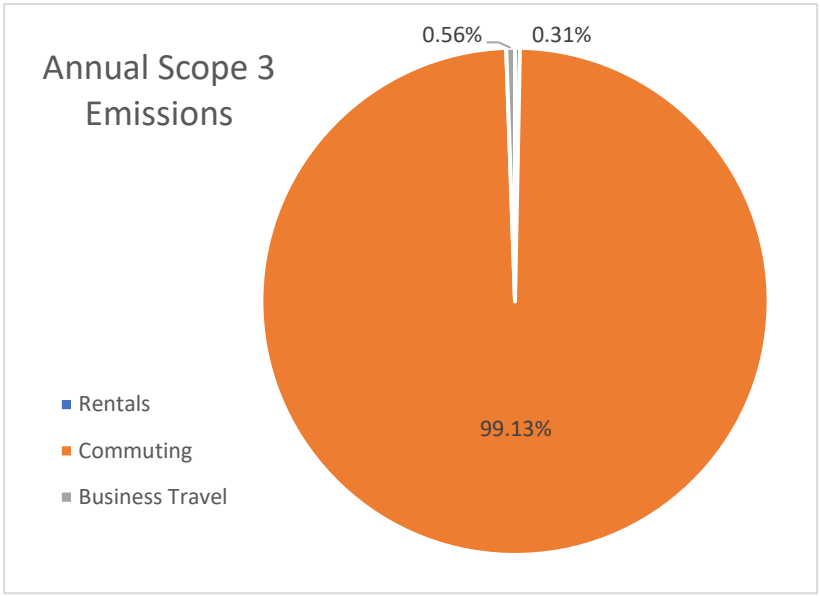

Figure 13: Scope 3 emission sources pie chart

Vehicle Rentals

Methods

Enterprise is the NSCC's primary provider of rental vehicles. The company provides the NSCC with breakdown of rental vehicle types and trip distances, as well as the resulting emissions from those rentals. After analyzing the data provided by *Enterprise*, it was discovered that the calculations failed to convert vehicle odometer readings to the correct units for the fuel consumption measures that were used in the calculations. This was corrected by using the vehicle odometer readings (in kilometers) and the vehicle emission factors calculated in the *Vehicle Emissions* tab of the workbook.

Results

The total distance driven by vehicles rented by the NSCC is **138,971 km.** The resulting emissions can be seen in the table below:

Total KM	138,971
CO_2 (MT)	31.27648977
CH_4 (kg)	1.353652177
N_2O (kg)	0.284979406
Total CO_2e (MT)	31.39525494

Figure 14: Rental vehicles emissions summary

Business Travel

Methods

A mileage analysis report was received from the NSCC online expense claims system, which employees use to report their travel expenses.

Results

The total distance driven for business purposes is **248,188 km.** The resulting emissions can be seen in the table below:

Total KM	248,188
CO_2 (MT)	55.8566136
CH_4 (kg)	2.41748441
N_2O (kg)	0.50894409
Total CO_2e (MT)	**56.068716**

Figure 15: Business travel emissions summary

Observations

These results do not include emissions due to air travel, as the college is not currently capable of collecting that data. However, emissions due to air travel would have been minimal during the reporting period due to COVID-related travel restrictions.

Air Pollutant Emissions

The air pollutant emissions calculated for this portion of the inventory include:

- Natural gas CH_4
- N_2O
- SO_2
- NO_x
- CO
- Filterable Particulate Matter (PM)

Air pollutant emissions for Scope 1 emissions were calculated by determining the emissions factors for each of the fuels burned onsite at the college, including natural gas, fuel oil #2, propane, and biomass. The emissions factors for these fuels were sourced from the ESPM Technical Reference Sheets, and the United States Environmental Protection Agency (US EPA) fuel combustion reference sheets.

The Scope 2 air pollutant emissions were calculated using emissions factors released by Nova Scotia Power Inc and the Government of Canada's National Inventory Report. Accurate emissions factors for carbon monoxide and particulate matter could not be found for electricity generated in Nova Scotia, so those two emissions have been omitted from this portion of the air pollutant inventory.

It was assumed that the district steam purchased by the NSCC was produced using natural gas, and the natural gas emissions factors used in Scope 1 were reused for this source. The biomass emissions factors from Scope 1 were also reused.

Scope 3 air pollutant emissions were calculated using the US EPA's emissions factors for greenhouse gas inventories, as well as emission factors accessed from the European Environmental Agency's resources. Sulfur dioxide was omitted from this portion of the air pollutant inventory as it is highly dependent on the quality of fuel, which can vary.

Results

	CH4 (MT)	N2O (MT)	SO2 (MT)	NOx(MT)	CO (MT)	Filterable PM (MT)
Scope 1	0.184216	0.039573	0.061731	1.57031	2.237208	0.718032514
Scope 2	0.272274	0.091424	40.78813	10.84112	1.130048	0.574473944
Scope 3	0.435572	0.091699		2.683044	44.7174	0.223587007
Total	**0.892061**	**0.222697**	**40.84986**	**15.09447**	**48.08466**	**1.516093465**

Figure 16: Air pollutant emissions summary

Summary

The largest portion of the NSCC's emissions is Scope 2, with the majority of Scope 2 emissions resulting from electricity consumption. Student and staff commuting is the next largest contributor to the total emissions inventory.

Operations at the NSCC during the 2021-2022 academic year were affected by the COVID-19 pandemic. Most of the college's emissions are trending downwards, and while the NSCC is doing much to meet its sustainability goals, the emissions reductions are mostly due COVID-19 protocols and an increase in remote learning.

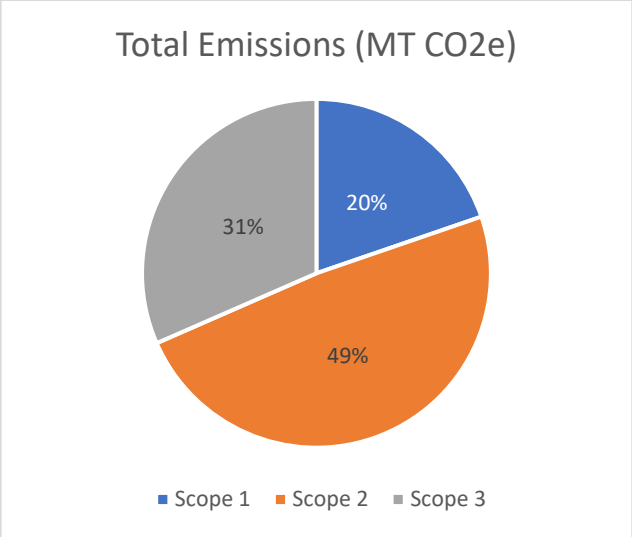

Figure 17: Total emissions pie chart

Total Emissions	(Metric Tonnes CO2e)
Scope 1	6301.06
Scope 2	15,550.50
Scope 3	10,076.58

Figure 18: Total emissions summary table

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