Infrastructure Canada

Canada

# THE GHG GUIDANCE MODULES

## Green Retrofits v1.0

Infrastructure Canada

Aussi disponible en français sous le titre : Les lignes directrices sur les GES modules : Rénovations écologiques v1.0



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# Disclaimer

This document is intended to be a learning tool for project developers and to introduce greenhouse gas (GHG) quantification and the consideration of GHG mitigation measures into project designs in the context of the Canadian environment. The GHG quantification approach presented in this document is to ensure consistency and comparability of GHG estimates between projects. The quantification processes here are not intended to be applied to crediting mechanisms or emission trading systems. However, specific aspects of this approach (i.e. baselines and mitigation measures) can be modified to demonstrate specific GHG performance in order to realize a program's particular GHG emission objectives or targets.

The scope of the GHG sources presented here is not purported to be a comprehensive life-cycle analysis of the project. Such an exercise can only be done credibly ex-post and with a large amount of information. For instance, GHG emissions resulting from embodied carbon or the decommissioning of the project are not considered. This guidance describes an approach to estimate GHG emissions ex-ante, when minimal information and resources are available. In addition, the methodologies proposed in this document are intended to capture the most significant of emission sources only.

Finally, this document is evergreen – meaning it will be periodically updated to remain aligned with advancing assessment methodologies. Please ensure you consult the Infrastructure Canada website to ensure you have the most recent version of this guidance before undertaking a GHG Assessment.

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# Introduction

This GHG guidance module provides information to help quantify greenhouse (GHG) emission reductions from undergoing retrofits or refurbishments in a building or facility. Emission reductions are based on the difference between the current operation of the building or facility (baseline) and the operation of the same building or facility that has implemented energy saving, clean energy or GHG mitigation measures (the project).

The GHG Guidance Modules provide a simple, sector-specific approach to GHG quantification for various projects across Canada. They are intended to be used by qualified professionals with expertise related to the project and preferably some level of GHG accounting experience. Each GHG Guidance Module (GGM) is based on international standards and sets out a pre-determined set of technical elements (i.e. baselines, activities and variables) and other considerations, required to quantify GHG benefits from a specific project type or sector.

The GHG Guidance Modules are built upon the following 3 principles:

1. Integrity – The Modules provide an approach to ensure GHG assessments are developed according to specific standards to ensure they have a consistency, comparability and transparency that allows intended users to make decisions with reasonable confidence.

2. Rationality – The Modules provide guidance that is intended to straightforward and logical to administer,, while ensuring a rigorous commitment to the environmental reliability of the system.

3. Legacy – the Modules build on experience and tools gained from existing project-based programs in jurisdictions across Canada, international standards and methodologies and existing Canadian projects

## Definitions:

Building/Facility: Built infrastructure, such as an office building, sports or recreation complex, arena, community centre or library, long-term care home, etc., that contains energy consuming and GHG releasing components (Ex. equipment, systems, processes, technologies).

Green Retrofits: Actions or components of a building or facility that increase energy efficiency, decrease energy consumption, use cleaner forms of energy, or reduce GHG fugitive emissions. Ex. Installation of heat pumps, solar energy, green rooftops, LED lighting, ammonia based cooling systems, etc.

# Principles

When developing any type of GHG assessment or inventory, developers should follow relevant GHG standards, guidance documents and methodologies suggested by the specific program authority. However, as the process of GHG quantification has inherent flexibility and room for interpretation, developers of GHG assessments will still be faced with making specific decisions that are outside the scope of any guidance document. On these occasions, developers should make decisions based on the overarching objectives of integrity and credibility. To achieve these objectives, developers should follow a set of common GHG quantification principles, found throughout the many GHG standards, protocols and guidance documents worldwide.

The following principles have been adapted from the ISO 14064:2 Standard and should be followed when developing a GHG assessment of a project:

### Relevance
Selected sources (activities) of GHG emissions, data and methodologies must be appropriate to the project and the needs of the intended user.

### Completeness
Include all relevant GHG emission sources. Include all relevant information to support program criteria and the GHG emission estimates.

### Consistency
Developers should apply estimation methods and assumptions consistently across all aspects of the project and for all individual GHG emission sources. In other words, developers should maintain the same "quantification rules" throughout the GHG assessment.

### Transparency
All assumptions, methods, calculations, and associated uncertainties should be provided in order to allow intended users to make decisions with reasonable confidence and allow for successful validation and verification of the results.

### Accuracy
Estimates and calculations should be unbiased, and uncertainties should be reduced as far as practical. Calculations should be conducted in a manner that minimizes uncertainty.

### Conservativeness
Where there are uncertainties, the values used to quantify GHG emissions should err on the side of underestimating potential reductions.

# GHG basics

Baseline scenario: The baseline scenario is the "business as usual" or hypothetical reference case against which the GHG performance of the project is measured. A variety of baseline approaches are available to quantify GHG emissions from a project, although not all approaches are applicable to any given project type. The baseline is an important aspect to a GHG quantification reduction, and pending the choice of a baseline, can result in varying estimates of GHG emissions reductions.

Project scenario: The project scenario consists of the project activities, which include the GHG mitigation measures that go beyond standard codes and practice and are aimed to reduce energy and GHG emissions. The performance of the project and its mitigation measures are compared to an alternative hypothetical reference case with average energy intensity and GHG performance (i.e. the baseline scenario).

Sources & sinks: Under ISO 14064:2, a source is any process or activity that releases a greenhouse gas into the atmosphere, whereas a sink is any process, activity or mechanism that removes a greenhouse gas from the atmosphere. Although there are numerous sources and/or sinks related to a project or baseline scenario, only a few relevant (i.e. significant) activities are typically selected for quantification, as they are likely to result in significant amounts of GHG emissions.

Elements: GHG sources and sinks can be further broken down into the specific elements which are responsible for completing the activity and result in GHG emissions. For example, for the activity of heating a building, the associated element will be the stationary combustion unit such as a boiler or furnace. The specifications of an element, including how it operates, are important factors to identify and state in a GHG assessment, as they will impact the overall quantification

End variable: An end variable is the annual input/output or activity level of an element (i.e. the amount of fuel combusted in one year ) and estimated for each year of the project lifetime. End variables are generally calculated using specific data from an element or activity and gathered from various sources. Examples of end variables include: litres (L) of fuel, kilowatt hours (kWh) of electricity or tonnes (T) of hydrofluorocarbons (HFCs).

Emission factor: An emission factor is a representative value that relates the quantity of GHGs released with a specific level or output of an activity. Emission factors are based on the unique characteristics of elements or processes, and can also be specific to the location where an activity is placed. A common equation used to estimate GHG emissions from a project or baseline activity involves an end variable and a relevant emission factor, which is typically found in Canada's National Inventory Report. The equation is structured in the following way: GHG Emissions = End Variable (EV) × Emission Factor (EF).

Ex ante estimation: The estimation of GHG emissions prior to the development and operation of a project and actual generation of GHG emissions. As no actual data has yet been generated by the project at this stage, project proponents must look to comparable sources of data such as the following: similar projects completed by the proponent in the past; similar projects completed by others in the surrounding area; contracts, work plans or estimates for the project provided by third party contractors involved; any modeling work performed by project developers, energy consultants, etc.; and estimates developed to the best of the proponent's ability.

# GHG assessment table of contents

A general GHG assessment provides an estimation of the total GHG emissions and/or reductions resulting from a project and includes important information related to the quantification process such as the scope of the assessment, relevant sources and sinks, calculations and assumptions. Information should be provided in a clear and organized format, to ensure the principles of GHG quantification have been carefully followed and GHG estimates can be easily validated. An assessment is composed of the following main sections as shown in Table 1.0:

Table 1.0 Sample Table of Contents for GHG Assessment of a Project

| | | |
|---|---|---|
| Project Scenario | **Project Description** | The project description provides a brief overview of the project activities including the product or service provided by the project and any specific technologies that will be employed. |
| | **Project Location** | Provides information on the exact location of the project |
| | **Project Timeline** | Provides the project operation start and end date, as well as any potential significant maintenance and refurbishment events |
| | **Project Operation & GHG Emissions** | The GHGs from all project activities are identified and quantified in this section. |
| Baseline Scenario | **Baseline Description** | The baseline description provides an overview of the alternative scenario that would have happened in the absence of the project and describes how the baseline is functionally equivalent to the project. |
| | **Baseline Operation & GHG Emissions** | The GHGs from all baseline activities are identified and quantified in this section. |
| Total GHG Reductions | **Total GHG Reductions** | The GHG emissions reductions resulting from the whole project are presented in this section, including annual reductions and cumulative GHG reductions for the lifetime of the project. |
| ANNEXES | **Supporting Information** | References, list of documents used in quantification<br>Tables of equipment<br>Equipment specifications |

# GHG sources & measures

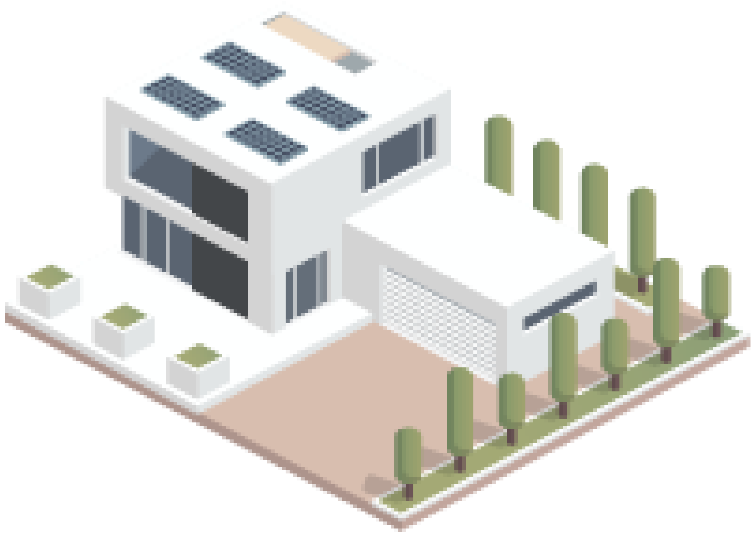
GHG emissions from the buildings sector are the result of a few different activities, namely the use of grid electricity, the combustion of fossil fuels for heating and leaks from refrigerants from air conditioners, chillers, and other equipment. Other indirect sources of GHG emissions include the generation and management of waste and wastewater and the embodied carbon of building materials.

There are a variety of "green" retrofits that can allow a building to use less energy to accomplish the same functions, and that result in fewer GHG emissions. Some of the most common measures for reducing energy and GHGs focus on implementing more energy efficient heating, cooling ventilation and refrigeration systems, installing of new windows, automatic controls and improved insulation. Other measures that reduce GHG emissions include sealing leaks of HCFCs in refrigeration and cooling systems or replacing systems with HCFC alternatives. The GHG impact of some measures is directly quantifiable, while others have a more indirect impact on the overall system, but are nonetheless important to achieving a low-carbon facility.

**Energy Efficiency & Demand:** Installing energy efficient lighting, HVAC, heat pumps and other equipment, as well as installing automatic controls for equipment and lighting.

**Design Features & Materials:** Optimizing natural daylight, installing window shading, using locally sourced materials, recycled or re-usable materials.

**Clean Energy:** Generation of clean energy on site such as solar, wind or geothermal.



**Improved Insulation:** Installing new windows, higher R-value insulation in roofs, walls, and basements.

**Natural Infrastructure:** Use of natural vegetation for stormwater drainage, green roofs for insulation and reduced energy use, and trees for natural shading and cooling.

**Refrigerants**: Minimizing leaks of refrigerants, replacing HCFC-22/HFC-134 with R438A/R422D in existing equipment, and selecting new equipment with refrigerant alternatives.

# Step-by-step instructions

This section provides step by step instructions for completing a GHG assessment for a green retrofit of a building or facility. Annex A provides a list of GHG sources and relevant information to be used along with these step-by-step instructions. For additional supporting information, please refer to the references in Annex C.

## Part 1: project scenario

### 1.1 Project Description

The project description lays out the foundation for the types of activities that may release or sequester GHGs from the project, and that will need to be quantified in the assessment.

**Key Actions**

- *Document a brief description of the building or facility and its main services.*
- *Record the size of the building (floor space area), its maximum operating capacity (and any expected fluctuations) and expected hours of operation.*
- *Describe any changes to the building characteristics ex. Will there be an increase/decrease in floor area or change of building activity?*
- *Identify any maintenance/repairs that will be needed throughout the operational lifetime of the project.*

### 1.2 Project Geographical Location

The identification of the project site is important as many data values will need to be sourced and obtained from the local area, including emission factors. Validators need to be able to assess if the proper values representing the area were used or not in the quantification of the GHG emissions, and to ensure all GHG sources or sinks have been properly accounted for in the assessment.

**Key Actions**

- *Record the address and/or GPS coordinates of the project.*
- *Document the project location on a map, delineating the project site and boundary of the project, ensuring all relevant components of the project are included.*
- *Identify if the project site is accessible by public transit or active transportation (cycling/walking).*

### 1.3 Project Timeline

It is important to know when the project will be constructed and in full operation, including if and when GHG emission reductions will start taking place and for how long. Other important dates are the maintenance and repair schedules which will result in downtimes and interruptions in service, which will also impact any emission reductions.

**Key Actions**

- *Record a detailed project timeline outlining the timing of operational activities. Specifically, the following estimated dates are required:*
  - *Date retrofits are to be implemented and complete*
  - *Operational start and end dates*
  - *Dates of any major maintenance/repairs/refurbishments expected*
  - *Expected lifetime of project  (30 year default)*
- *Identify any risks that could substantially affect the project's operational timelines.*

# Part 2: project operation

**2.1 Identification of Project GHG Activities & Elements**

In this section, all the relevant activities for the operation of the project are identified, including all elements.

Project GHG emissions are the estimated amount of GHGs emitted from the building's consumption of various energy sources and refrigerants with the new green retrofits in place. The most common sources of GHGs in buildings includes electricity use, heating and cooling of the building and fugitive emissions from heat pumps, refrigeration and cooling equipment.

An example of green retrofits for a building or facility can include energy efficient heating, cooling ventilation and refrigeration systems; installing of new windows, automatic controls and improved insulation; sealing leaks of HCFCs in refrigeration and cooling systems or replacing systems with HCFC alternatives. Implementing renewable energy on-site for meeting the building's energy demand is also included under this Module.

The project must also follow these requirements:

- Any significant changes in occupancy or use of the building expected to occur in any given year must be accounted for in the building's energy and GHG profile.

- It is important to note any interactive effects the various activities can have on one another, such as the increased need for heating with the installation of LED lighting (LED lighting releases less heat than incandescent lighting, resulting in higher heating requirements in winter, but lower cooling requirements in summer). Interactive effects should be accounted for in the energy modeling of the building.

- Note that equipment degradation is not currently accounted for under this GHG Guidance Module.

- Use of the energy and GHG modelling software RETscreen is also an option to help with the quantification of GHGs from the implementation of green retrofits in a building.

**Key Actions**

- *Using Table 2.0 Annex A as a guide, select all activities related to the project and document a brief description of each activity.*
- *List and describe all green retrofits that will be implemented in the building. How will these measures impact overall energy use or other GHG emissions of the building?*
- *If applicable, identify any interactive effects of the various activities.*
- *This information tends to be most useful when presented in a table or other legible format.*

**2.2 Quantification of Project Activity 1: Electricity (Grid)**

Electricity use during operations of the building are associated with heating, cooling and ventilation, domestic hot water, lights, plug loads, and other equipment using electricity.

**Key Actions**

- *Identify the amount of electricity (MWh) expected to be used in the retrofitted building on a yearly basis.*

- *Estimated electricity use should be available from energy modelling results, or obtained from similar projects in operation.*
- *Any expected changes in capacity or the use of the building must be reflected in the expected energy demand of the building.*
- *Obtain the provincial/territorial (P/T) electrical grid emission intensity for your location. Emission intensities should be dynamic and reflect cleaning of P/T grids in future years. P/T Emission intensities can be found in [Annex B](). For remote communities not connected to a P/T grid, use the emission factor (found in [Canada's National Inventory Report (2021)]() ) for the type of energy used to generate electricity in that location (ex. Diesel generators).*
- *To quantify GHG emissions, apply the following calculation:*

  ***Energy (MWh/year) x P/T Emission Intensity (tonnes $CO_2e$/MWh) = Emissions tonnes $CO_2e$/year***

  *Note: If replacing diesel or other fuel, substitute the P/T emission intensity for the respective fuel emission factor.*

- *The yearly energy use, emission intensities and the associated GHG emissions are most useful when presented in a table or other legible format.*
- *Document all assumptions and references used to calculate the electricity consumption of the building and the associated GHG emissions.*
- *Note: Any energy demand being met by generated on-site renewable energy should be reflected in section 2.5.*

## 2.3 Quantification of Project Activity 2: Heating & Cooling (non-electrical)

Especially in Canada with its cold winters, heating of a building results in a large amount of GHG emissions. Heating and cooling of building and facilities can be through the combustion of natural gas, fuel oil, propane, diesel and wood.

### Key Actions

- *Identify the amount of fuel (L, $m^3$or kg) of each type expected to be used in the retrofitted building for heating and cooling on a yearly basis.*
- *Estimated consumption of fuel(s) for heating & cooling should be available from energy modelling results, or obtained from similar projects in operation.*
- *Any expected changes in capacity or the use of the building must be reflected in the expected heating & cooling demand of the building.*
- *Obtain the relevant emission factors for your fuel type and combustion equipment. Emission factors can be obtained from [Canada's National Inventory Report (**2021**)](). Note that emission factors are presented for each of the three main gases: $CO_2$, $CH_4$ and $N_20$. To obtain an emission factor in units of $CO_2e$, multiply each emission factor for $CO_2$, $CH_4$ and $N_2O$ by their respective 100 year global warming potentials (1, 25 and 298 respectively) and add all three values together.*
- *To quantify GHG emissions, apply the following calculation:*

  ***Fuel ($m^3$) x Specific fuel combustion emission factor (tonnes /$m^3$) = Emissions tonnes $CO_2e$/year***
  *(Note: Fuel may be in either L, $m^3$ or kg - ensure the units are consistent with the chosen emission factor)*

- *The yearly fuel use, emission factors and the associated GHG emissions are best retained for future reference presented in a table or other legible format.*

*ent all assumptions and references used to calculate the fuel consumption of the building and the associated missions and include any relevant equipment specifications.*

**2.4 Quantification of Project Activity 3: Fugitive Refrigerant Emissions**

The 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories identify air conditioning, refrigeration, and fire suppression equipment and materials as potential sources of fugitive emissions during their life cycle. The fugitive emissions that should be included here are associated with the refrigerants used in heat pumps, air conditioning equipment and refrigeration equipment, including chillers to make ice in recreational complexes. Retrofit measures can include either minimizing leaks of refrigerants from equipment, replacing more potent refrigerants with less GHG- intensive refrigerants in existing equipment, or replacing older equipment with newer equipment using refrigerant alternatives.

**Key Actions**

- *Identify all the various types of equipment that include refrigerants in the building.*
- *Identify the type and amount of refrigerant (kgs/tonnes) in each piece of equipment and the expected level of operation of the equipment. Estimated cooling capacity and refrigerant capacity (kg) should be available from manufacturer specifications and/or project plans.*
- *Identify the appropriate annual leakage rates for the various types of equipment (note that leakage rates can vary on the phase of the equipment's life). Leakage rates can be found here: Table 2: GHG Protocol HFC Tool (Version 1.0).*
- *To quantify GHG emissions, apply the following calculation:*

  *Refrigerant capacity (kg) x Annual leakage rate (% of capacity) x GWP of refrigerant /1000 = Emissions tonnes $CO_2$e/year*

- *This calculation will require you to know the type of refrigerant, annual refrigerant leakage rate during operation, and the equipment lifespan for each piece of equipment.*
- *The EPA GreenChill Calculator can be used to estimate the GHGs associated with refrigerant leaks from refrigeration sources.*
- *The annual GHG emissions resulting from refrigerant leakage are presented in a table or other legible format.*
- *Document all assumptions and references used to calculate the refrigerant use/leakage and the associated GHG emissions.*

**2.5 Quantification of Project Activity 4: Renewable Energy Generation on-site (if applicable)**

If the building will be generating renewable energy on-site to avoid or minimize using more GHG -intensive grid electricity (or diesel fuel in remote regions), emission reductions resulting from the use of renewable energy can be accounted for in the GHG assessment.

**Key Actions**

- *Document the type of renewable energy that will be generated on-site including the capacity of the system. Identify when the energy system will be operational.*
- *Record the expected annual electricity that will be generated by the energy system. For wind and solar systems, ensure local wind and solar capacities are referenced.*

- *Confirm whether all or a specific % of the on-site clean energy generation will be used by the building. Any expected changes in the generation or use of the clean energy must be reflected in the annual energy generation estimates. Drop in annual output due to equipment degradation may be included if values are available.*
- *Obtain the provincial/territorial (P/T) electrical grid emission intensity for your location. Emission intensities should be dynamic and reflect cleaning of P/T grids in future years. Emission intensities can be found in Annex B. For remote communities not connected to a P/T grid, use the emission factor (found in Canada's National Inventory Report (2021) ) for the type of energy used to generate electricity in that location (ex. Diesel generators).*
- *To quantify GHG emissions, apply the following calculation:*

  ***Energy generated by system on-site (MWh/year) x P/T Emission Intensity (tonnes $CO_2e$/MWh) = Avoided Emissions tonnes $CO_2e$/year***

  *Note: If replacing diesel or other fuel, substitute the P/T emission intensity for the respective fuel emission factor.*

- *Further guidance on how to calculate GHGs from energy generation can be found in **INFC's Renewable Energy GHG Guidance Module.***
- *The yearly energy generation, emission intensities and the associated GHG emissions are most effectively presented in a table or other legible format.*
- *List all assumptions and references used to calculate the electricity generation and associated GHG emissions.*

## 2.6 Total Project Operational GHG Emissions

**Key Actions**

- *For each project activity, input the associated GHG emissions into a Table such as the one below.*
- *Calculate the total tonnes $CO_2e$ per year using the following equation:*
  **Activity 1 + Activity 2+ Activity 3 – Activity 4 = Total Project Emissions (tonnes $CO_2e$ /year)**
- *Sum all the years to obtain the cumulative tonnes $CO_2e$ over the project lifetime.*

**Table 2.0 Total Project Operational Emissions (in tonnes of $CO_2e$)**

| Year | **Activity 1 Electricity** | **Activity2 Heating/Cooling (Fuel-based)** | **Activity 3 Fugitive Emissions (Refrigerants)** | Activity 4 Renewable Energy Generation | **Total Project Emissions** |
|---|---|---|---|---|---|
| 2023 | | | | | |
| 2024 | | | | | |
| 2025…. | | | | | |
| 2030 | | | | | |
| 2031…. | | | | | |
| 2050 | | | | | |
| TOTAL | | | | | |

# Part 3: baseline scenario

**3.1 Baseline Description**

The Baseline Scenario is the "business as usual" or hypothetical reference case against which the GHG performance of the project is measured. Under this GHG Guidance Module, the most appropriate baseline scenario for green retrofits of a building would be the following:

**The continued operation of the existing building, which includes the consumption of various energy sources and refrigerants based on the current equipment and building characteristics and expected use of the building.**

The baseline must also follow these requirements:

- Any significant changes in occupancy or use of the building expected to occur in any given year must be accounted for in the building's energy and GHG profile.

- Capacity/occupancy of the building and any services provided (including any fluctuations over the lifetime of the project) must mirror those found in the project scenario. The level of output or services provided must be the same in the project as in the baseline, to ensure that the project is not reducing GHG emissions solely by producing less product or services.

- A historical baseline may be used only if building services and occupancy rate is considered stable and not expected to change in the foreseeable future. GHG emissions must be quantified by taking an average of the last three years of building operation. If a substantial event took place in one of the last three years, such as a fire or flood in the building and which would substantially alter the building's energy or GHG profile, that year may be excluded with justification and the immediate preceding year must be used in the calculation of the average.

- Note that equipment degradation is not currently accounted for under this GHG Guidance Module.

**Key Actions**

- *Document a description of the baseline scenario, which includes a description of the current building operational activities and services, and how they are different from the project scenario.*
- *If using a historical baseline, document the historical years that will be used to produce the average values for the various operational activities.*
- *Record the size of the baseline building (floor space area), its maximum operating capacity (and any expected fluctuations in capacity) and hours of operation.*
- *Include all assumptions under the baseline scenario as applicable.*

# Part 4: baseline operation

**4.1 Identification of Baseline GHG Activities & Elements**

In this section, all the relevant activities for the operation of the baseline are identified, including all elements.

The most common sources of GHGs related to buildings includes electricity use, heating and cooling of the building and the use of refrigerants in equipment and building components.

**Key Actions**

- *Using Table 2.0 Annex A as a guide, select all activities related to the baseline and document a brief description of each activity.*
- *Ensure all information is presented in a table or other legible format.*

**4.2 Quantification of Baseline Activity 1: Electricity (Grid)**

Electricity use during operations of the building are associated with heating and cooling, domestic hot water, lights, plug loads, and other equipment using electricity.

**Key Actions**

- *Identify the amount of electricity (MWh) expected to be used in the baseline on a yearly basis.*
- *Estimated electricity use should be available from energy modelling results, or obtained from similar projects in operation. An average of the last three years of the building's electricity use (found on invoices/utility bills) can also be used if using a historical baseline.*
- *Any expected changes in capacity or the use of the building as identified in the project scenario, should be reflected in the expected energy demand within the baseline scenario.*
- *Obtain the provincial/territorial (P/T) electrical grid emission intensity for your location. Emission intensities should be dynamic and reflect cleaning of P/T electrical grids in future years. Emission intensities can be found in Annex B. For remote communities not connected to a P/T grid, use the emission factor (found in Canada's National Inventory Report (2021) ) for the type of energy used to generate electricity in that location (ex. Diesel generators).*
- *To quantify GHG emissions, apply the following calculation:*

  ***Energy (MWh/year) x P/T Emission Intensity (tonnes $CO_2$e/MWh) = Emissions tonnes $CO_2$e/year***

- *The yearly energy use, emission intensities and the associated GHG emissions should be presented in a table or other legible format.*
- *Document all assumptions and references used to calculate the electricity consumption of the building and the associated GHG emissions.*

**4.3 Operational Activity 2: Heating & Cooling (non-electrical)**

Especially in Canada with its cold winters, heating of a building results in a large amount of GHG emissions. Heating and cooling of building and facilities can be through the combustion of natural gas, fuel oil, propane, diesel and wood.

**Key Actions**

- *Identify the amount of fuel ($m^3$/L/kg) of each type expected to be used in the building for heating and cooling on a yearly basis.*
- *Estimated levels of heating and cooling should be available from energy modelling results, or obtained from similar projects in operation. An average of the last three years of the building's fuel use (found on invoices/utility bills) can also be used if using a historical baseline.*
- *Any expected changes in capacity or the use of the building in the project scenario should be reflected in the expected heating and cooling demand within the baseline scenario.*
- *Obtain the relevant emission factors for your fuel type and combustion equipment. Emission factors can be obtained from [Canada's National Inventory Report (2021)]. Note that emission factors are presented for each of the three main gases: $CO_2$, $CH_4$ and $N_20$. To obtain an emission factor in units of $CO_2e$, multiply each emission factor for $CO_2$, $CH_4$ and $N_2O$ by their respective global warming potentials (1, 25 and 298 respectively) and add all three values together.*
- *To quantify GHG emissions, apply the following calculation:*

  ***Fuel ($m^3$) x Specific fuel combustion emission factor (tonnes/$m^3$ = Emissions tonnes $CO_2e$/year***
  *(Fuel may be in either L, $m^3$ or kg - ensure the units are consistent with the chosen emission factor)*

- *The yearly fuel use, emission factors and the associated GHG emissions are most useful when presented in a table or other legible format.*

*assumptions and references used to calculate the fuel demand of the building and the associated GHG*
*ons and include any relevant equipment specifications.*

**4.4 Quantification of Baseline Activity 3: Fugitive Emissions**

The 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories identify air conditioning, refrigeration, and fire suppression equipment and materials as potential sources of fugitive emissions during their life cycle. The fugitive emissions that should be included here are associated with the refrigerants used in heat pumps, air conditioning equipment and refrigeration equipment, including chillers to make ice in recreational complexes.

**Key Actions**

- *Identify all the various types of equipment that include refrigerants in the building.*
- *Identify the type and amount of refrigerant (kgs/tonnes) in each piece of equipment and the expected level of operation of the equipment. Estimated cooling capacity and refrigerant capacity (kg) should be available from manufacturer specifications and/or project plans.*
- *Identify the appropriate annual leakage rates for the various types of equipment (note that leakage rates can vary on the phase of the equipment's life). Leakage rates can be found here [Table 2: GHG Protocol HFC Tool (Version 1.0)].*
- *To quantify GHG emissions, apply the following calculation:*

  ***Refrigerant capacity (kg) x Annual leakage rate (% of capacity) x GWP of refrigerant /1000 = Emissions tonnes $CO_2e$/year***

- *The type of refrigerant, annual refrigerant leakage rate during operation, and the equipment lifespan should be recorded for each piece of equipment.*
- *The [EPA GreenChill Calculator] can be used to estimate the GHGs associated with refrigerant leaks from refrigeration sources.*
- *The annual GHG emissions resulting from refrigerant leakage are most useful when presented in a table or other legible format.*
- *List all assumptions and references used to calculate the refrigerant use/leakage and the associated GHG emissions.*

### 4.5 Quantification of Baseline Activity 4: Renewable Energy Generation on-site (if applicable)

If the existing building is generating renewable energy on-site to avoid or minimize using more GHG - intensive grid electricity (or diesel fuel in remote regions), emission reductions resulting from the use of renewable energy can be accounted for in the GHG assessment.

**Key Actions**

- *Document the type of renewable energy that is currently being generated on-site including the capacity of the system. Identify how long the energy system has been operational.*
- *Record the annual electricity that is generated by the energy system. For wind and solar systems, ensure local wind and solar capacities are referenced.*
- *Confirm whether all or a specific % of the on-site clean energy generation is being used by the building. Any expected changes in the generation or use of the clean energy must be reflected in the annual energy generation estimates. Drop in annual output due to equipment degradation may be included if values are available.*
- *Obtain the provincial/territorial (P/T) electrical grid emission intensity for your location. Emission intensities should be dynamic and reflect cleaning of P/T grids in future years. Emission intensities can be found in Annex B. For remote communities not connected to a P/T grid, use the emission factor (found in Canada's National Inventory Report (2021) ) for the type of energy used to generate electricity in that location (ex. Diesel generators).*
- *To quantify GHG emissions, apply the following calculation:*

  ***Energy generated by system on-site (MWh/year) x P/T Emission Intensity (tonnes $CO_2e$/MWh) = Avoided Emissions tonnes $CO_2e$/year***

  *Note: If replacing diesel or other fuel, substitute the P/T emission intensity for the respective fuel emission factor.*

- *Further guidance on how to calculate GHGs from energy generation can be found in **INFC's Renewable Energy GHG Guidance Module.***
- *The yearly energy generation, emission intensities and the associated GHG emissions are most effectively presented in a table or other legible format.*
- *List all assumptions and references used to calculate the electricity generation and associated GHG emissions.*

| 4.6 Total Baseline Operational GHG Emissions |
|---|
| **Key Actions** |

- *For each project activity, input the associated GHG emissions into a Table such as the one below.*
- *Calculate the total tonnes $CO_2e$ per year using the following equation:*

  **Activity 1 + Activity 2 + Activity 3 - Activity 4 = Total Baseline Emissions (tonnes $CO_2e$ /year)**

- *Sum all the years to obtain the cumulative tonnes $CO_2e$ over the project lifetime.*

**Table 4.0 Total Baseline Operational Emissions**
**(in tonnes of $CO_2e$)**

| Year | **Activity 1 Electricity** | **Activity2 Heating/Cooling (Fuel-based)** | **Activity 3 Fugitive Emissions (Refrigerants)** | **Activity 4 Existing Renewable Energy Generation** | **Total Baseline Emissions** |
|---|---|---|---|---|---|
| **2023** | | | | | |
| **2024** | | | | | |
| **2025….** | | | | | |
| 2030 | | | | | |
| **2031….** | | | | | |
| **2050** | | | | | |
| TOTAL | | | | | |

# Part 5: total net GHGs

**5.1 Total Net GHG Reductions**

The general equation for calculating total GHG emission reductions is:

**Baseline Emissions - Project Emissions = Total GHG Emission Reductions**

Emission reductions are calculated per year of the project lifetime, by subtracting the project emissions from the baseline emissions. Then all emission reductions for the given years are summed to obtain the total estimated emission reductions from the implementation of the Project.

**Key Actions**

- *Input the project and baseline emission values into a table (sample provided below). Under the Climate Lens, the following values are required to be highlighted:* ***Total Emission Reductions in 2030*** *(single year) and* ***Total Cumulative emissions over the project lifetime.***
- *Calculate the total GHG emission reductions by subtracting project emissions from the baseline emissions*.

**Table 5.0 Total Net GHG Reductions**
**(in tonnes of $CO_2e$)**

| Year | Baseline Emissions | Project Emissions | Total Reductions |
|---|---|---|---|

| | | | |
|---|---|---|---|
| 2023 | | | |
| 2024 | | | |
| 2025…. | | | |
| **2030** | | | |
| 2031…. | | | |
| 2050 | | | |
| **TOTAL** | | | |

# ANNEX A - Retrofit GHG activities and related information

| Activity 1 | Description | Elements | Data required | Sources of data | End variables |
|---|---|---|---|---|---|
| Electricity Consumption | Consumption of electricity used to operate the building and various equipment | Lighting system | Number/Type of lights<br>Wattage of lights<br>Annual operating hours per year | Internal records<br>Manufacturer information<br>Internal estimates<br>Energy audits<br>Average/default values | Electricity (kWh) |
| | | Space heating and cooling equipment | Number/Type equipment<br>Efficiency of equipment<br>Annual operating hours per year | Internal records<br>Manufacturer information<br>Internal estimates<br>Energy audits<br>Average/default values | Electricity (kWh) |
| | | Plug loads, various equipment (ex. water heaters, industry specific equipment | Number/Type equipment<br>Efficiency of equipment<br>Annual operating hours per year | Internal records<br>Manufacturer information<br>Internal estimates<br>Energy audits<br>Average/default values | Electricity (kWh) |
| **Activity 2** | **Description** | **Element** | **Data required** | **Sources of data** | **End variables** |
| Heating & Cooling (non-electric) | Consumption of energy for heating and cooling of the building | Furnaces, boilers, air conditioning, heat exchangers, geothermal, heat pumps and humidifiers | Number/Type equipment<br>Efficiency of equipment<br>Annual operating hours per year | Internal records<br>Manufacturer information<br>Internal estimates<br>Energy audits<br>Average/default values | Fuel (L, m3) |
| | | District heating System | GJ/MWh consumed (steam, heating water and/or chilled water)<br>System fuel mix and efficiency (default of 65%) | Purchase records<br>Energy bills<br>Metered energy records | Fuel |
| **Activity 3** | **Description** | **Element** | **Data required** | **Sources of data** | **End variables** |

| | | | | | |
|---|---|---|---|---|---|
| Operation of refrigeration, air conditioning and process equipment | Emissions of HFCs and PFCs leak out during the operation of equipment, during specific processes (ex. Making of an ice rink) or during maintenance and repair. | Commercial air conditioning systems, heat pumps | Type/# of units<br>Types of refrigerants used (ex. R-22)<br>Refrigerant charge capacity of each equipment<br>Annual leakage rate or average #lbs refilled in past year | Internal records<br>Manufacturer information<br>Internal estimates<br>Energy audits<br>Average/default values<br>IPCC Tables | HFCs<br>PFCs<br><br>(Kgs/tonnes) |
| | | Commercial refrigeration/freezers | Type/# of units<br>Types of refrigerants used<br>Refrigerant charge capacity of each equipment<br>Annual leakage rate or average #lbs refilled in past year | Internal records<br>Manufacturer information<br>Internal estimates<br>Energy audits<br>IPCC Tables<br>Average/default values | HFCs<br>PFCs<br>(Kgs/tonnes) |
| | | Industrial Processes (chillers) | Type/# of units<br>Types of refrigerants used<br>Refrigerant charge capacity of each equipment<br>Annual leakage rate or average #lbs refilled in past year | Internal records<br>Manufacturer information<br>Internal estimates<br>Energy audits<br>Average/default values<br>IPCC Tables | HFCs<br>PFCs<br>(Kgs/tonnes) |
| **Activity 4** | **Description** | **Element** | **Data required** | **Sources of data** | **End variables** |
| Renewable Energy Generation | The building can generate its own energy using renewable energy such as wind or solar. | Solar panels or wind turbines | Generation Capacity<br>Equipment models/age<br>Equipment efficiency<br>Equipment technical lifetime and degradation rate | Manufacturer specifications, Direct measurement/ metering | Electricity (kWh) |

**Notes:**

- Alternative sources: internal records, utilities, local survey data, Statistics Canada, Comprehensive Energy Use Database, Office of Energy Efficiency, Natural Resources Canada, etc.
- Sources of supporting information: *Bill of sale, invoices, contracts of service, engineering drawings, energy audits, energy modeling, electricity permits, building permits and energy bills.*

# ANNEX B - Average PT grid electricity emission intensities (tonnes/MWh)*

| Region | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alberta | 0.517 | 0.446 | 0.357 | 0.250 | 0.232 | 0.211 | 0.225 | 0.223 | 0.217 | 0.208 | 0.207 | 0.201 | 0.204 | 0.203 | 0.203 | 0.204 |
| | | | | | | | | | | | | | | | | |
| British Columbia | 0.004 | 0.002 | 0.003 | 0.003 | 0.004 | 0.002 | 0.002 | 0.002 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Manitoba | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| New Brunswick | 0.276 | 0.259 | 0.269 | 0.268 | 0.275 | 0.273 | 0.274 | 0.272 | 0.258 | 0.252 | 0.124 | 0.116 | 0.124 | 0.113 | 0.123 | 0.114 |
| Newfoundland | 0.091 | 0.068 | 0.012 | 0.012 | 0.012 | 0.011 | 0.011 | 0.011 | 0.011 | 0.010 | 0.010 | 0.010 | 0.011 | 0.010 | 0.010 | 0.009 |
| Northwest Territories | 0.058 | 0.067 | 0.062 | 0.051 | 0.017 | 0.008 | 0.008 | 0.008 | 0.010 | 0.012 | 0.014 | 0.016 | 0.020 | 0.014 | 0.013 | 0.009 |
| Nova Scotia | 0.634 | 0.562 | 0.458 | 0.457 | 0.463 | 0.464 | 0.417 | 0.401 | 0.384 | 0.361 | 0.118 | 0.116 | 0.112 | 0.109 | 0.105 | 0.101 |
| Nunavut | 0.747 | 0.747 | 0.744 | 0.712 | 0.635 | 0.498 | 0.480 | 0.469 | 0.470 | 0.455 | 0.457 | 0.442 | 0.435 | 0.447 | 0.454 | 0.458 |
| Ontario | 0.034 | 0.044 | 0.067 | 0.065 | 0.066 | 0.077 | 0.093 | 0.081 | 0.067 | 0.064 | 0.062 | 0.060 | 0.058 | 0.041 | 0.035 | 0.030 |
| Prince Edward Island | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Quebec | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Saskatchewan | 0.410 | 0.366 | 0.299 | 0.306 | 0.252 | 0.249 | 0.253 | 0.221 | 0.173 | 0.167 | 0.163 | 0.157 | 0.146 | 0.142 | 0.137 | 0.133 |
| Yukon Territory | 0.045 | 0.121 | 0.068 | 0.077 | 0.086 | 0.089 | 0.099 | 0.074 | 0.046 | 0.029 | 0.018 | 0.014 | 0.018 | 0.023 | 0.032 | 0.041 |

| Region | 2036 | 2037 | 2038 | 2039 | 2040 | 2041 | 2042 | 2043 | 2044 | 2045 | 2046 | 2047 | 2048 | 2049 | 2050 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alberta | 0.206 | 0.207 | 0.209 | 0.210 | 0.212 | 0.213 | 0.215 | 0.216 | 0.217 | 0.219 | 0.220 | 0.221 | 0.221 | 0.221 | 0.222 |
| British Columbia | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Manitoba | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| New Brunswick | 0.124 | 0.111 | 0.118 | 0.114 | 0.129 | 0.129 | 0.120 | 0.121 | 0.122 | 0.124 | 0.125 | 0.126 | 0.128 | 0.130 | 0.131 |
| Newfoundland | 0.009 | 0.009 | 0.009 | 0.009 | 0.008 | 0.008 | 0.008 | 0.008 | 0.008 | 0.008 | 0.007 | 0.007 | 0.007 | 0.007 | 0.007 |
| Northwest Territories | 0.008 | 0.006 | 0.006 | 0.006 | 0.008 | 0.025 | 0.026 | 0.031 | 0.020 | 0.018 | 0.016 | 0.017 | 0.019 | 0.020 | 0.022 |
| Nova Scotia | 0.094 | 0.088 | 0.088 | 0.086 | 0.084 | 0.082 | 0.081 | 0.079 | 0.076 | 0.074 | 0.074 | 0.074 | 0.074 | 0.074 | 0.073 |
| Nunavut | 0.470 | 0.482 | 0.488 | 0.488 | 0.501 | 0.505 | 0.515 | 0.523 | 0.525 | 0.529 | 0.535 | 0.544 | 0.547 | 0.556 | 0.561 |
| Ontario | 0.024 | 0.021 | 0.019 | 0.017 | 0.016 | 0.015 | 0.015 | 0.015 | 0.014 | 0.013 | 0.011 | 0.009 | 0.009 | 0.011 | 0.013 |
| Prince Edward Island | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Quebec | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Saskatchewan | 0.130 | 0.126 | 0.123 | 0.121 | 0.117 | 0.115 | 0.112 | 0.108 | 0.105 | 0.098 | 0.095 | 0.092 | 0.089 | 0.085 | 0.082 |
| Yukon Territory | 0.054 | 0.067 | 0.052 | 0.039 | 0.027 | 0.019 | 0.013 | 0.017 | 0.020 | 0.026 | 0.033 | 0.042 | 0.050 | 0.034 | 0.022 |

Notes:

1. Grid Emissions intensity is defined as: (utility generation emissions) + (industrial net sales to grid by sector) x (industrial electricity generation emissions factor) *divided by* electricity consumption from the grid.
2. Prince Edward Island: Emissions intensity for PEI production. P.E. uses New Brunswick emissions intensity because PEI production P.E. consists of non-dispatchable wind energy and the rest is imported.
3. British Columbia, Manitoba and Quebec: The power grids of British Columbia, Manitoba and Quebec are zero emissions. The generation of residual emissions is not considered relevant.
4. For alternative emission intensities from B.C. electricity consult the provincial emission intensities found here.
5. Alternative emission intensities from Quebec can be here.

Source: ECCC's Greenhouse Gas Emissions Projections. Link: Canada's Greenhouse Gas Emissions Projections - Environment and Climate Change Canada Data.
Last Modified by ECCC: June 2022

***Emission intensities will be updated periodically. Please refer to INFC's Climate Lens website for the most recent version of the Power System P/T Average Emissions Intensities Table.**

# ANNEX C – References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