GHG Calculator
For Municipal Projects

User Guide

A Microsoft Excel Add-in to estimate energy and GHGs for municipal policies and capital projects.

Version 1.1.1
November 21, 2023

Introduction to the GHG Calculator

The GHG Calculator is a Microsoft Office Add-in for Excel. It is intended to provide municipal decision-makers with a reasonable and accurate estimate of the energy consumption and GHG emissions impact associated with projects under consideration as part of municipal budgeting and capital planning processes.

Model input assumptions, including energy sources and emissions factors, are currently made available for projects in the City of Calgary, the Regional Municipality of Durham, the City of Fredericton, and the City of Ottawa.

Project Funders

The GHG Calculator has been developed with the funding support of the City of Calgary, the Regional Municipality of Durham, and the City of Ottawa.

About This Document

This document provides an overview of the functionality and instructions for use of the GHG Calculator by SSG, an Add-In for Microsoft Excel created and maintained by Sustainability Solutions Group (https://ssg.coop).

About SSG

For over 15 years, SSG has worked with cities and communities to achieve low-carbon, energy efficient, healthy, and equitable futures. Recognizing that cities are faced with multiple challenges, we identify solutions that support multiple community objectives and enhance democracy. We have extensive knowledge and expertise in all aspects of climate change mitigation and adaptation planning, including collecting data and preparing energy and GHG inventories and projections.

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1 Getting Started

1.1 System Requirements

The GHG Calculator is an add-in for Microsoft Excel. It is available for Excel versions v16.0 and newer, including:

- Excel 2019 or later on Mac
- Excel on Mac (Microsoft 365)
- Excel on Windows (Microsoft 365)
- Excel on the web

1.2 Regional Data Availability

The GHG Calculator currently has model input assumptions, including energy sources and emissions factors for projects in the City of Calgary, the Region of Durham, the City of Fredericton, and the City of Ottawa.

Please contact SSG (email: ghg-calculator@ssg.coop) to inquire about getting region or city-specific data added for your municipality.

1.3 How-To Videos

A series of tutorial videos are available for the GHG Calculator at https://ghg-calculator.ssg.coop/documentation/

1.4 Support

For additional information or support beyond this document, please visit https://ghg-calculator.ssg.coop/support/

1.5 Installing the Excel Add-In

The GHG Calculator can be installed in two ways:

1.5.1 Installing directly from within Excel

1. click **Insert > Add-ins > Get Add-ins**
2. search for the add-in by typing *GHG*
3. select the add-in and click **Add**

1.5.2 Using your web browser to launch the installation

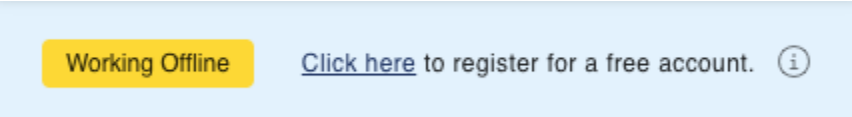
1. Visit Microsoft AppSource using the following link: https://appsource.microsoft.com/en-us/product/office/WA200004453
2. Click **Get it now**

1.6 Online Database Features

Users can optionally register to use the GHG Calculator's online database features. When registered and signed-in, all projects and actions created by a user are automatically saved and synchronized with the online database. Additionally, registered users are able to share projects and actions with any other registered users of the system.

1.6.1 User Registration

Registration is free and easy. To register for an account, click on the register link shown at the top of the dashboard.



1.7 GHG Calculator Dashboard

The dashboard is displayed when the GHG Calculator first loads in Excel.

The dashboard contains a list of all projects that you have created. For each existing project, you can:

- Expand the panel to show basic project information
- **View** the project actions (View Project Actions)
- **Edit** the project information (Edit Project Settings)
- **Delete** the project

- **Add** or **Update Workbook** to add or update the project in the current workbook

You can create a new project by clicking on the **New Project** button.

1.8 Working with Projects and Actions

The GHG Calculator organizes data into projects and actions.

1.8.1 Projects

Projects contain basic information about a collection of capital and/or policy actions including a title, description, tags for categorizing and organizing projects, sharing settings, and contact information.

All actions are defined within projects. You can create a new project for each action, or you can choose to group actions together into a single project. However, before creating any actions, a project must first be defined.

A Project Summary worksheet containing the energy and emissions calculations of each action within a project is added to the currently open Excel workbook for each project you create.

1.8.1.1 Project Sharing

This feature is only available to registered users.
If you create a free online account, you can save your projects to the online database and specify sharing settings for viewing and editing. Projects can be shared with any other users who are registered online with the GHG Calculator.

1. Edit project settings

2. Turn on Project Sharing
3. Add or remove users whom you would like to share the project with.

Each individual user whom a project is shared with is granted one of the following levels of permission:

Admin	User can edit and delete the project and create, edit and delete any actions in the project
Edit	User can create, edit and delete any actions in the project
View	User can view the project and project actions

NOTE: *The system does not automatically notify individuals if a project has been shared with them. If you share a project with another user, it is recommended to notify them so they can access the project. Users will need to download the add-in and create an online account to access the project you have shared with them.*

1.8.2 Actions

Actions are used to define climate change mitigation activities. Actions are typically used to describe municipal corporate activities, but they could also be used to model community activities in many cases.

Actions contain detailed information about a given activity. Inputs and assumptions are defined based on the type of activity being modeled.

An action details worksheet is generated for each action you create. The action worksheet contains energy and emission estimates from the start year of the action through 2050, as well as a list of the inputs and assumptions that were used for the calculation.

Actions are broken down into two main types: Capital Actions and Policy Actions.

1.8.2.1 Capital Actions

Capital Actions describe any mitigation activities that are specifically tied to capital and infrastructure investments. They are organized into the following sectors:

- Buildings
- Energy & Renewables
- Financial activities
- Fleet & EV infrastructure
- IT
- Parks
- Urban Forestry & Ravines
- Transportation & Transit Infrastructure
- Waste
- Water and wastewater infrastructure

1.8.2.2 Policy Actions

Policy Actions describe any policy-based mitigation activities. They are organized into the following sectors:

- Buildings
- Land Use
- Transportation
- Waste

1.8.2.3 Action Input Assumptions and References

There are many different types of action, each with their own unique form and model logic. Descriptions are provided in the section GHG Calculator Module Definitions, as well as directly in the add-in. References are provided for input assumptions specific to different actions, as well as general assumptions like emissions factors and GWP values.

Module descriptions can be viewed by clicking on the **Info** button with any given module.

Emissions Factors are displayed in the output action details worksheets.

GWP can be viewed by clicking on the GWP information button on the Action summary view.

1.9 Creating a Project

To create a project:

1. Go to the **Dashboard.**
2. Click on the **New Project** button on the main dashboard.
3. Fill in the fields with as much information as possible and click **Save**.

1.10 Creating Actions

To create an action:

1. If not already viewing a specific project, from the **Dashboard** click on a single **Project** and click **View.**
2. Click on the **Create a new capital action** button to create a new Capital Action
   Or
   Click on the **Create a new policy action** button to create a new Capital Action.
3. Complete the 4-step form to create a new action. The final step gives a summary of the modeled results.
4. On the final step click **Save** to add the action to the project and add a new worksheet to the workbook.

2 Capital Actions Table

The following table contains a list of all capital actions available along with the calculator module that contains the model logic.

Sector	Subsector	Category	Module
Buildings	*All Buildings subsectors have the same categories of actions available to them.* *Subsectors are:* Apartments Arena Community Centre Condominiums Daycare Duplex or Fourplex Field house Fire hall Long term care homes Office Other Paramedics Police Pool Recreation Centre Row housing Single Detached housing Transit depot Transit station Vehicle depot Warehouse	Building Energy Performance Improvement	Building Energy Performance Improvement
		Building Equipment Switch	Building Equipment Switch
		Generic Emissions Project	Generic Emissions Project
		Generic Energy Project	Energy Source Change
		New Building Construction	New Building Construction
		Solar Generation	Solar Generation
Energy & Renewables	Distributed Generation	Renewable Electricity Generation	Local Generation
		Generic Emissions Project	Generic Emissions Project
	Emissions Offset Project	Power Purchase Agreement	Power Purchase Agreement
		Renewable Energy Certificate	Purchase RECs

	Energy Source Change Project	Energy Source Change	Energy Source Change
		Generic Emissions Project	Generic Emissions Project
Financial Activities	Generic Emissions Project	Generic Emissions Project	Generic Emissions Project
Fleet & EV Infrastructure	EV Infrastructure	Generic Emissions Project	Generic Emissions Project
		Generic Energy Project	Energy Source Change
		Install EV Chargers	Install EV Chargers
	Existing Vehicles	Generic Emissions Project	Generic Emissions Project
		Generic Energy Project	Energy Source Change
		Replace Existing Vehicles	Replace Existing Vehicles
	New Vehicles	Generic Emissions Project	Generic Emissions Project
		Generic Energy Project	Energy Source Change
		Procure New Vehicles	Procure New Vehicles
IT	Generic Emissions Project	Generic Emissions Project	Generic Emissions Project
Parks, Urban Forestry, & Ravines	Generic Emissions Project	Generic Emissions Project	Generic Emissions Project
	Tree Planting	Tree Planting	Plant Trees
Transportation & Transit Infrastructure	Bike Lanes	Construct New Bike Lane	Generic Transportation Infrastructure
		Generic Emission Project	Generic Emissions Project
		Modify Existing Bike Lane	Generic Transportation Infrastructure
	Bike Shares & Escooters	Generic Emission Project	Generic Emissions Project
		Generic Energy Project	Energy Source Change
		Modify Existing Bike Share / Escooter Program	Generic Transportation Infrastructure
		New Bike Share / Escooter Program	Generic Transportation Infrastructure
	Parking Lot	Change Parking Lot Development	Change Parking Lot Development
		Generic Emission Project	Generic Emissions Project
	Roads	Construct New Roads	Generic Transportation Infrastructure
		Generic Emission Project	Generic Emissions Project
		Modify Existing Roads	Generic Transportation Infrastructure

	Street Lights	Generic Emissions Project	Generic Emissions Project
		Generic Energy Project	Energy Source Change
		Street Lighting Project	Street Lighting Project
	Trails	Construct New Trails	Generic Transportation Infrastructure
		Generic Emission Project	Generic Emissions Project
		Modify Existing Trails	Generic Transportation Infrastructure
	Transit Networks	Construct New Transit Network	Generic Transportation Infrastructure
		Generic Emission Project	Generic Emissions Project
		Modify Existing Transit Network	Generic Transportation Infrastructure
Waste	Diversion Programs	Compost Program	Compost Program
		Generic Emission Project	Generic Emissions Project
		Recycling Program	Recycling Program
	Energy Systems	Generic Emissions Project	Generic Emissions Project
		Generic Energy Project	Energy Source Change
		Methane Capture and Reuse	Methane Capture and Reuse
		Reuse Waste Energy	Reuse Waste Energy
	Processing Systems	Generic Emissions Project	Generic Emissions Project
		New Garbage Processing System	Improve Garbage Processing
Water & Wastewater Infrastructure	Pumping Stations	Add Pumping Station	Add Pumping Station
		Generic Emissions Project	Generic Emissions Project
		Generic Energy Project	Energy Source Change
	Generic Emissions Project	Generic Emissions Project	Generic Emissions Project

3 Policy Actions Table

The following table contains a list of all policy actions available, along with the calculator module that contains the model logic.

Sector	Category	Module
Buildings	Bulk Procurement of Renewable Electricity	Bulk Procurement of Renewable Electricity
	Bulk Procurement of RNG	Bulk Procurement of RNG
	Commercial Building Retrofit Program	Building Energy Performance Improvement
	Establish Embodied Carbon Limits	Establish Embodied Carbon Limits
	Generic Emission Project	Generic Emissions Project
	High Performance Homes	New Building Construction Policy
	High Performance Non-Residential Building	New Building Construction Policy
	Household Retrofit Program	Building Energy Performance Improvement
	Require EV Infrastructure Policy	Require EV Infrastructure Policy
	Solar PV Program	Local Generation
	Use Alternative Refrigerants Instead of High GWP Refrigerants	Alternative Refrigerant Policy
	Zero Emissions District Energy System	Generic Zero Emission Project
Land-use	Generic Emission Project	Generic Emissions Project
	Improve Street Connectivity	Improve Street Connectivity
	Increase Employment Density	Increase Employment Density
	Increase Residential Density	Increase Residential Density
	Optimize Passive Solar Orientation	Optimize Passive Solar Orientation
	Protect Agricultural Lands	Protect Agricultural Lands
	Protect Forests	Protect Forests
	Provide Transit-Oriented Development	Transit Oriented Development
	Reduce Greenfield Development	Reduce Greenfield Development
Transportation	Clean Air Zone Policy	Clean Air Zone Policy
	Commute Trip Reduction Policy	Commute Trip Reduction Program
	Congestion Charge Policy	Congestion Charge Policy
	Differentiated Parking Prices Policy	Differentiated Parking Prices Policy
	Electric Vehicle Car Share Policy	Electric Vehicle Car Share Program
	Generic Emission Project	Generic Emissions Project
	Limit Residential Parking Supply Policy	Limit Residential Parking Supply Policy
	Reduce Transit Fares Policy	Reduce Transit Fares Policy
Waste	Generic Emission Project	Generic Emissions Project

	Waste Diversion Policy	Waste Diversion Policy
	Waste Reduction Policy	Waste Reduction Policy

4 GHG Calculator Module Definitions

4.1 Add Pumping Station

The Add a Pumping Station module estimates the additional emissions associated with the addition of a water or wastewater pumping station based on the expected fuel consumption and fuel source of the pumping station. This module does not account for the construction or embodied emissions of implementing the pumping station.

Example

- If a water treatment facility needed to add a new electric booster pumping station to provide treated water to a new community development, the module can calculate the total annual energy used by the pump, and emissions generated based on where the pump draws its electricity from.

4.2 Alternative Refrigerant Policy

The Alternative Refrigerant Policy module calculates a percentage reduction in the emissions produced from refrigeration systems when high Global Warming Potential (GWPs) refrigerants are replaced with alternatives with lower GWPs. Doing so may require retrofitting equipment or purchasing new equipment.

4.3 Building Energy Performance Improvement

The Building Energy Performance Improvement module is used to estimate the energy consumption and GHG emissions for the operational needs of existing buildings based on the building's archetype, area and the types and proportions of fuel used to heat and cool the space and water in the building.

The module:

- Assumes that the building project involves improving the energy efficiency of an existing building with measures such as adding insulation, replacing windows and doors, and sealing air leaks.
- Uses the forecast grid electricity emissions factor for the location you select, and assumes the building is completed on January 1 of the year you specify as the Start Year.
- Displays the 'business-as-usual' (BAU) energy and emissions as zero, representing the situation before the building retrofit is completed.
- Does not calculate energy and emissions associated with the construction process, construction vehicles or equipment, or the embodied emissions in construction materials.
- Displays:
    - A summary of projected annual energy used and tonnes of emissions generated, as well as the emissions factors and Global Warming Potential values (GWPs) used for the calculations.
    - The projected energy used and emissions produced for each year between the project's start date and 2050.

Examples

- Calculating the emissions saved in a single-family home by adding insulation and replacing windows.
- Calculating the emissions savings achieved by renovating the envelope of a commercial building sufficiently to reduce its natural gas consumption by 20%.

4.4 Building Equipment Switch

The Building Equipment Switch module is used to estimate the emission reduction resulting from the difference in energy consumption between two pieces of equipment used to serve the same end use. The module does not account for the embodied emissions of the equipment themselves.

Examples

- Calculating the energy and emissions saved by removing a natural gas furnace from a residential duplex, and replacing it with an air source heat exchange system, supplemented by electric heat.
- Calculating the energy and emissions impact of removing a natural gas boiler heating system from a shopping centre, and connecting it instead to a district energy system.

4.5 Bulk Procurement of Renewable Electricity

The Bulk Procurement of Renewable Electricity module tracks the emission reduction associated with the purchase of renewable electricity as a lump sum of annual CO2e reduction. Estimation of emissions depends on the scale and terms of the purchase.

4.6 Bulk Procurement of RNG

The Bulk Procurement of RNG module tracks the emission reduction associated with the purchase of RNG as a lump sum of annual CO2e reduction. Estimation of emissions depends on the scale and terms of the purchase.

4.7 Change Parking Lot Development

The Change Parking Lot Development module captures the emission reduction achieved as a result of a change to a parking lot. Because there are too many variables involved to create an accurate formula to calculate the emissions savings from all possible parking lot changes, this module requires that the user estimate and enter the expected ‘before’ and ‘after’ emissions, and the capital cost to make the change. The module then calculates the savings in emissions, and the cost/ savings to make the change per tonne of emissions eliminated.

Example

- A lot with 20 parking spaces could have three existing spaces replaced with a secure bike parking area. The emissions impact of this could be seen to consist of eliminating the commute trips taken by three average vehicles to that lot for one year. The user would need to determine the average length of a commute trip to that lot and the 'average commuting vehicle' to calculate how much this change in emissions would be. He/ she would then enter the total emissions attributed to the vehicles in the lot before the change is made, and the total emissions after the change, as well as the cost to add the secure bike parking. The module will calculate the cost per tonne of emissions eliminated.

4.8 Clean Air Zone Policy

The Clean Air Zone Policy module estimates the emission reductions associated with targeted action taken for an urban zone to limit the use of fossil fuels within its boundaries. This aims to reduce the use of fossil fuels for purposes such as transportation or stationary energy through the displacement of such fuels with a cleaner alternative, resulting in a reduction in emissions.

4.9 Commute Trip Reduction Program

The Commute Trip Reduction Program module calculates the emissions saved when employers create voluntary programs that encourage carpooling, transit, walking and biking to commute, and discourage single-occupant vehicle commuting. The result is a reduction in vehicle kilometers/ miles traveled (VKT/ VMT) and a corresponding reduction in emissions generated.

4.10 Compost Program

The Compost Program module estimates the reduction of GHG emissions that can be achieved by diverting organic waste from the landfill to a managed composting program. The organic waste can include food, food-soiled paper, yard waste, and non-hazardous wood waste. Effective composting, unlike a landfill, releases very little methane.

Diverting organic materials out of the waste stream can also reduce the number of trips required by waste transfer vehicles, reducing their fuel consumption, and further reducing the emissions associated with managing waste.

Notes:

- This module only calculates the impact of composting on the direct emissions from waste; it does not include any impact on transportation.
- Emissions from waste occur as a result of decomposition rather than combustion to generate energy. As a result, redirecting organic waste from a landfill to composting is one of the few climate actions that does not impact energy consumption.

Example

- A city wants to start a pilot composting program in a neighbourhood community garden. Based on waste audits, they believe there is at least 8,000 tonnes of compostable material they can collect annually from the pilot area. The cost of the pilot program will be $4,000 in compost bins and $3,000 in transportation costs. The module uses this tonnage and cost information and calculates a) the reduction in landfill emissions that this pilot program will achieve, and b) the cost of the program per tonne of emissions eliminated.

4.11 Congestion Charge Policy

The Congestion Charge Policy module calculates the emissions avoided through the implementation of congestion charges on roadways. The implementation of congestion charges contributes to reducing inefficiencies in the transportation network that lead to excess energy consumption and encourages alternative transportation modes and pathways that are more efficient, leading to a decrease in emissions.

4.12 Differentiated Parking Prices Policy

The Differentiated Parking Prices Policy module calculates the emissions saved when variable parking prices are implemented to encourage adoption of alternative fuel vehicles

or more efficient vehicles. The result is a reduction in fossil fuel consumption and a corresponding reduction in emissions generated.

4.13 Electric Vehicle Car Share Program

The Implement Electric Vehicle Car Share Program calculates the emissions avoided by increasing car share access in a community. This encourages car sharing and decreases vehicle ownership, reducing vehicle miles/ kilometers traveled (VMT/ VKT), thus reducing emissions. It further reduces emissions by ensuring the car share trips are taken in electric vehicles, which are more energy-efficient, and generate the emissions associated with producing electricity rather than fossil fuels.

4.14 Energy Source Change

The Energy Source Change module estimates the emission reduction associated with the difference between two energy-consuming systems that fulfills the same end use. The module captures the emission reduction associated with the difference in fuel consumption and fuel source. It does not capture the embodied emissions of the systems.

4.15 Establish Embodied Carbon Limits

The Establish Embodied Carbon Limits module estimates the emissions reduction associated with the difference in embodied carbon limits based on existing and target embodied carbon limits and existing embodied emissions.

4.16 Generic Emissions Project

The Generic Emissions Project module captures the emission reduction associated with a project as a generic estimate of CO2e reduction. There is no methodology that is specific to this class of activities. Estimation of emissions is left up to the user based on the scale and nature of the activity.

4.17 Generic Transportation Infrastructure

The Generic Transportation Infrastructure module estimates the emission reductions associated with the difference in vehicle travel resulting from an infrastructure project. It does not account for construction or embodied emissions from the infrastructure itself.

Example

- An example of a project that this module can provide estimates for is the creation of a new transit route between a residential neighbourhood and downtown. The module can calculate the emissions and energy saved as a result of residents switching from commuting in personal vehicles to using the new transit route.

4.18 Generic Zero Emission Project

The Generic Zero Emission Project module tracks the emission reduction associated with the implementation of a zero emission district energy system as a lump sum of annual CO2e reduction. Estimation of emissions depends on the scale and parameters of the district energy system.

4.19 Improve Garbage Processing

The Improve Garbage Processing module estimates the emission reductions resulting from the difference between improved and existing waste processing systems, based on the scale of waste handled and the emission factors associated with each of the systems.

Example

- A waste facility implements a sorting process that separates wood waste from the rest of the waste stream. The wood waste is then burned to heat the facility rather than being sent to the landfill to decompose. This module requires the volume of wood waste being removed from the waste stream, and the relative reduction in emissions per tonne of waste as a result.

4.20 Improve Street Connectivity

The Improve Street Connectivity module calculates the emissions savings expected when a neighbourhood is designed with a higher-than-average density of vehicle intersections. More vehicle intersections increases connectivity, resulting in local trips becoming shorter and generating less emissions.

4.21 Increase Employment Density

The Increase Employment Density module calculates the emissions avoided as a result of reducing vehicle miles/ kilometers traveled (VMT/ VKT) when a community has a higher density of jobs than average. This increased density results in shorter and fewer trips being taken in single-occupancy vehicles, and thus a reduction in GHG emissions.

4.22 Increase Residential Density

The Increase Residential Density module calculates the emissions avoided as a result of reducing vehicle miles/ kilometers traveled (VMT/ VKT) when a community has a higher density of dwelling units than average. This increased residential density results in some trips becoming shorter and more trips being taken using active modes of transportation, transit, or car pooling.

4.23 Install EV Chargers

The Install EV Chargers module calculates the grid electricity emissions associated with installing new electric vehicle chargers, based on the emissions factor for the electricity source used, in the year of installation. It does not include emissions from construction or embodied carbon of the infrastructure, nor does it provide an estimate of avoided emissions resulting from electrifying vehicle fleets.

Example

- A city decides to install a single EV charging station in its fleet facility. This facility has a solar PV system on the roof which will provide the power needed to charge the two electric vehicles nightly at this charging station. Based on the expected charging required by the vehicles, the module will display the total additional power required, and the fact that this will generate no additional emissions, due to the fact that the power will come from a solar PV system.
- If the facility in the first example did not have a solar system on the roof, the city could connect the charging station to grid power. This example could also be entered into the module. In this case it would still display the total additional power required for charging, and it would display the amount of emissions generated by the provincial grid in the year selected to provide that amount of power.

4.24 Limit Residential Parking Supply Policy

The Limit Residential Parking Supply Policy module calculates the emissions avoided by reducing the amount of parking available at a residential location. Reducing parking creates scarcity, and adds time and inconvenience to trips made in private vehicles. This disincentivizes these types of trips, which results in a shift to other modes of transportation, and a decrease in emissions.

4.25 Local Generation

The Local Generation module estimates the percent of emissions from electricity use that are eliminated as a result of installing a wind or solar power system. You will need to know the amount of power (in kWh) the installed system will provide annually, the total electricity demand (kWh), the carbon intensity of the installed system (‘0’ for a zero emission system), and the carbon intensity of the local electricity grid.

4.26 Methane Capture and Reuse

The Methane Capture and Reuse module estimates the emissions that can be eliminated by capturing landfill gas (which is about 50% methane) and either burning it to generate energy, utilizing it in a combined heat and power (CHP) plant, exporting it, or flaring it into the atmosphere. Flaring reduces emissions by converting the methane into energy, water, and CO2 (a much less powerful greenhouse gas than methane). Burning the gas to generate electricity converts the methane into CO2 as well, but it also converts the energy produced into electricity. This in turn reduces the need to generate electricity from other sources.
CHP utilizes the energy released from burning the methane for a combination of heat and electricity generation.

4.27 New Building Construction

The New Building Construction module is used to estimate the energy consumption and GHG emissions for the operational needs of a new building(s) based on the building's archetype, area and the types and proportions of fuel used to heat and cool the space and water in the building.

The module:

- Assumes that the building project is for new construction and not expansions or renovations.
- Uses the forecast grid electricity emissions factor for the location you select, and assumes the building is completed on January 1 of the year you specify as the Start Year.
- Displays the 'business-as-usual' (BAU) energy and emissions as zero, representing the situation before the building is completed.
- Does not calculate energy and emissions associated with the construction process, construction vehicles or equipment, or the embodied emissions in construction materials.
- Displays:
    - A summary of projected annual energy used and tonnes of emissions generated, as well as the emissions factors and Global Warming Potential values (GWPs) used for the calculations.

- The projected energy used and emissions produced for each year between the project's start date and 2050.

Examples

- Calculating the energy required and emissions generated from a 320 m2 daycare facility that has an energy unit intensity (EUI) of no more than 25 kWh/m2/year, using only electricity as a fuel source.
- Calculating the difference in energy required and emissions generated for a new 2000 sq foot home built to a Passive House standard (with an EUI of 15 kWh/ m2/ year) if all energy needs are met by zero-emissions electricity generated on-site, versus using natural gas to heat space and domestic water (constituting 50% of total energy used), and grid-sourced electricity to run air conditioning and plug load (constituting 50% of total energy used).
- Calculating the difference in energy required and emissions generated for a new commercial property that uses 50% less energy / sq foot than an average existing commercial building, and is heated and cooled (constituting 60% of total energy use) by a zero-emissions system like a ground-source heat exchange system rather than a natural gas furnace.
- Calculating energy and emissions impacts related to implementing policies requiring new building construction to adhere to high performance energy standards.

4.28 New Building Construction Policy

The New Building Construction Policy module estimates emissions reductions that will occur if a building is constructed to a high performance energy efficiency standard rather than the existing (or conventional) energy efficiency standard. The module allows the user to identify the total area of the building, and the energy that would be used by fuel type for both the 'high performance' and 'conventional' standards, and calculates the difference in energy use and emissions.

4.29 Optimize Passive Solar Orientation

The Optimize Passive Solar Orientation module estimates the emission reduction associated with the optimization of passive solar orientation based on the capacity of solar

generation to be optimized. The module assumes a 15% improvement to generation as a result of the orientation optimization.

4.30 Plant Trees

The Plant Trees module calculates the CO2 sequestered by growing trees. The amount of carbon sequestered depends on many factors including the species and health of the tree, and how exposed it is to sunlight. Healthy trees will not only sequester carbon dioxide, but can also provide significant cooling to buildings and outdoor spaces, air purification, water filtration, and mitigation of stormwater overflow risk during storm events.

4.31 Power Purchase Agreement

The Power Purchase Agreement module tracks the emission reduction associated with the purchase of renewable electricity as a lump sum of annual CO2e reduction. Estimation of emissions depends on the scale and terms of the purchase.

4.32 Procure New Vehicles

The Procure New Vehicles module estimates the emission reduction resulting from the operation of new vehicles added to a fleet based on the expected driving distance and efficiency of the vehicles. It does not account for the embodied emissions of the vehicles themselves.

Examples

- A city may commit for example, to purchase three new electric sedans per year, which they will charge using grid-supplied electricity. The module in this case will calculate the additional electricity used, and grid emissions produced as a result of this net increase in vehicles to the city fleet.
- A university may commit to purchase two new trucks per year, which they will charge using an existing zero emissions source of power such as power from a solar PV system on campus. The module will again calculate the additional electricity used to charge the new trucks, and it will indicate that no emissions are generated from the production of this power.

4.33 Protect Agricultural Lands

The Protect Agricultural Lands module allows you to identify the quantity of emissions captured and sequestered in lands used for agricultural purposes, and protected from development. As crops grow in these areas, both the vegetation and soils absorb GHG directly from the air. The carbon from carbon dioxide is converted into the increasing mass of the plant as it grows, and only oxygen is released back into the atmosphere. When the crops are harvested, the carbon remains sequestered in the harvested materials, and more crops can be grown in the same land area, absorbing further GHGs.

4.34 Protect Forests

The Protect Forests module allows you to identify the quantity of emissions captured and sequestered in trees and the soils in which they grow, as a result of a forested area being protected from development. Both trees and the soils in which they grow absorb greenhouse gasses directly from the air. Carbon dioxide absorbed in this way is broken down, and the carbon is transformed into the physical growth of the tree, and the oxygen is released into the air. The carbon remains sequestered in the wood of the tree even after

the trees die or are harvested, unless they begin to decompose. As trees are removed from a forest, new ones can be planted in their place to continue absorbing more GHGs.

4.35 Purchase RECs

The Purchase RECs (Renewable Energy Credits) module tracks the emission reduction associated with the purchase of RECs as a lump sum of annual CO2e reduction. Estimation of emissions depends on the scale and terms of the purchase.

4.36 Recycling Program

The Recycling Program module estimates the reduction in emissions that can be achieved by diverting recyclable waste away from landfills and back into the pool of 'raw' materials. The reductions are achieved in several ways. Firstly, there is less waste in landfills, decomposing and releasing methane. Secondly, re-using materials reduces the need to extract, produce and transport new raw materials upstream in the manufacturing process. As a result, the emissions associated with each of upstream processes are also reduced.

This module only calculates the impact of removing the waste from the landfill and avoiding the methane emissions.

4.37 Reduce Greenfield Development

The Reduce Greenfield Development module estimates the emission reduction associated with limiting greenfield development based on the difference in area of greenfield development and the land use change emission intensity associated with greenfield development.

4.38 Reduce Transit Fares Policy

The Reduce Transit Fares Policy module calculates the emissions avoided when citizens opt to take transit rather than drive in personal vehicles. Reducing fares is an incentive to switch from driving or taking other forms of transportation to taking transit.

4.39 Replace Existing Vehicles

The Replace Existing Fleet Vehicles module estimates the emission reduction resulting from the replacement of vehicles in a fleet based on the differences in the efficiency and fuel source of the vehicles. It does not account for the embodied emissions of the vehicles themselves.

Example

- A city may have ordered two electric pick-up trucks which it is scheduled to receive in 2025. It will replace two existing diesel trucks with these electric models, and retire the diesel trucks earlier than their normal life-expectancy as a result. The trucks will be charged using grid-supplied electricity. The module in this case will calculate the difference in energy used between the diesel and the electric vehicles, the difference in emissions between using the diesel fuel and electricity to run the vehicles, and the overall cost (or savings) per tonne of emissions avoided.

4.40 Require EV Infrastructure Policy

The Require EV Infrastructure Policy module tracks the emission reduction associated with the policy of implementing EV infrastructure requirements as a lump sum of annual CO2e reduction. Estimation of emissions depends on the scale and terms of the policy.

4.41 Reuse of Waste Energy

The Reuse Waste Energy module calculates the emissions that can be eliminated by making use of energy that can be extracted from waste. This generically encapsulates the displacement of existing fuel consumption through the generation of energy vectors such as heat, electricity, or biogas from a variety of waste treatment processes such as incineration, anaerobic digestion, or methane capture and reuse.

4.42 Solar Generation

The Solar Generation module calculates the emissions savings when a solar PV system is installed and begins providing electricity to a building, reducing the electricity that building needs to draw from the grid. The emissions saved will reflect the reduction in grid electricity consumed and the emissions intensity of the local electricity grid.

Example

- An example of a project that this module can provide estimates for is calculating the emissions saved by installing a 4kW solar PV system on the rooftop of a home.

4.43 Solar PV Program

The Solar PV Program captures the emissions reduction resulting from a program which incentives electricity to be generated from onsite PV systems, displacing the electricity demand that would ordinarily be supplied by the local electricity provider. Electricity generation provided by local electricity providers have varying carbon intensities based on the portfolio of energy sources. Because PV systems generate zero GHG emissions, this measure displaces the
emissions that would have been produced had electricity been supplied by the local electricity provider, and thus results in a reduction in GHG emissions.

4.44 Street Lighting Project

The Street Lighting Project module identifies the emissions reduction resulting from replacing 'conventional' bulbs in street, traffic or park lights with energy efficient bulbs. The module requires the user to enter the total annual energy consumption of the existing bulb(s) - whatever type they may be - and the energy consumption of the more efficient bulb(s) with which they're being replaced, along with the cost. From this the module calculates the total annual energy savings, the emissions reduction, and the cost per tonne of emissions eliminated.

4.45 Transit-Oriented Development

The Transit-Oriented Development module calculates the emissions avoided as a result of reducing vehicle miles/ kilometers traveled (VMT/ VKT) when transit is readily accessible to an urban area that includes a mixture of residences, businesses, and services. The ready availability of transit reduces the number of single-occupancy vehicle trips to and from the area, eliminating the emissions from those trips.

4.46 Waste Diversion Policy

The Waste Diversion Policy module estimates the emission reduction associated with a difference in waste diversion and handling based on the affected population and waste emission factors associated with the existing and target diversion policies.

4.47 Waste Reduction Policy

The Waste Reduction Policy module estimates the emission reduction associated with a difference in waste generation based on the affected population and per-person waste generation intensities.

5 Modules and Actions Cross-Reference Table

The following table contains a list of all calculator modules and the capital and/or policy actions that each module is used for.

Module	Action Type	Sector	Subsector	Category
Add Pumping Station	Capital	Water & Wastewater Infrastructure	Pumping Stations	Add Pumping Station
Alternative Refrigerant Policy	Policy	Buildings		Use Alternative Refrigerants Instead of High GWP Refrigerants
Building Energy Performance Improvement	Policy	Buildings		Commercial Building Retrofit Program
	Policy	Buildings		Household Retrofit Program
	Capital	Buildings	All Subsectors	Building Energy Performance Improvement
Building Equipment Switch	Capital	Buildings	All Subsectors	Building Equipment Switch
Bulk Procurement of RNG	Policy	Buildings		Bulk Procurement of RNG
Bulk Procurement of Renewable Electricity	Policy	Buildings		Bulk Procurement of Renewable Electricity
Change Parking Lot Development	Capital	Transportation & Transit Infrastructure	Parking Lot	Change Parking Lot Development
Clean Air Zone Policy	Policy	Transportation		Clean Air Zone Policy
Commute Trip Reduction Program	Policy	Transportation		Commute Trip Reduction Policy
Compost Program	Capital	Waste	Diversion Programs	Compost Program
Congestion Charge Policy	Policy	Transportation		Congestion Charge Policy
Differentiated Parking Prices Policy	Policy	Transportation		Differentiated Parking Prices Policy

Electric Vehicle Car Share Program	Policy	Transportation		Electric Vehicle Car Share Policy
Energy Source Change	Capital	Buildings	All Subsectors	Generic Energy Project
	Capital	Energy & Renewables	Energy Source Change Project	Energy Source Change
	Capital	Fleet & EV Infrastructure	EV Infrastructure	Generic Energy Project
	Capital	Fleet & EV Infrastructure	Existing Vehicles	Generic Energy Project
	Capital	Fleet & EV Infrastructure	New Vehicles	Generic Energy Project
	Capital	Transportation & Transit Infrastructure	Bike Shares & Escooters	Generic Energy Project
	Capital	Transportation & Transit Infrastructure	Street Lights	Generic Energy Project
	Capital	Waste	Energy Systems	Generic Energy Project
	Capital	Water & Wastewater Infrastructure	Pumping Stations	Generic Energy Project
Establish Embodied Carbon Limits	Policy	Buildings		Establish Embodied Carbon Limits
Generic Emissions Project	Policy	Buildings		Bulk Procurement of RNG
	Policy	Buildings		Bulk Procurement of Renewable Electricity
	Policy	Buildings		Generic Emission Project
	Policy	Land-use		Generic Emission Project
	Policy	Transportation		Generic Emission Project
	Policy	Waste		Generic Emission Project
	Capital	Buildings	All Subsectors	Generic Emissions Project
	Capital	Energy & Renewables	Distributed Generation	Generic Emissions Project
	Capital	Energy & Renewables	Energy Source Change Project	Generic Emissions Project

	Capital	Financial Activities	Generic Emissions Project	Generic Emissions Project
	Capital	Fleet & EV Infrastructure	EV Infrastructure	Generic Emissions Project
	Capital	Fleet & EV Infrastructure	Existing Vehicles	Generic Emissions Project
	Capital	Fleet & EV Infrastructure	New Vehicles	Generic Emissions Project
	Capital	IT	Generic Emissions Project	Generic Emissions Project
	Capital	Parks, Urban Forestry, & Ravines	Generic Emissions Project	Generic Emissions Project
	Capital	Transportation & Transit Infrastructure	Bike Lanes	Generic Emission Project
	Capital	Transportation & Transit Infrastructure	Bike Shares & Escooters	Generic Emission Project
	Capital	Transportation & Transit Infrastructure	Parking Lot	Generic Emission Project
	Capital	Transportation & Transit Infrastructure	Roads	Generic Emission Project
	Capital	Transportation & Transit Infrastructure	Street Lights	Generic Emissions Project
	Capital	Transportation & Transit Infrastructure	Trails	Generic Emission Project
	Capital	Transportation & Transit Infrastructure	Transit Networks	Generic Emission Project
	Capital	Waste	Diversion Programs	Generic Emission Project
	Capital	Waste	Energy Systems	Generic Emissions Project
	Capital	Waste	Processing Systems	Generic Emissions Project

	Capital	Water & Wastewater Infrastructure	Pumping Stations	Generic Emissions Project
	Capital	Water & Wastewater Infrastructure	Generic Emissions Project	Generic Emissions Project
Generic Transportation Infrastructure	Capital	Transportation & Transit Infrastructure	Bike Lanes	Construct New Bike Lane
	Capital	Transportation & Transit Infrastructure	Bike Lanes	Modify Existing Bike Lane
	Capital	Transportation & Transit Infrastructure	Bike Shares & Escooters	Modify Existing Bike Share / Escooter Program
	Capital	Transportation & Transit Infrastructure	Bike Shares & Escooters	New Bike Share / Escooter Program
	Capital	Transportation & Transit Infrastructure	Roads	Construct New Roads
	Capital	Transportation & Transit Infrastructure	Roads	Modify Existing Roads
	Capital	Transportation & Transit Infrastructure	Trails	Construct New Trails
	Capital	Transportation & Transit Infrastructure	Trails	Modify Existing Trails
	Capital	Transportation & Transit Infrastructure	Transit Networks	Construct New Transit Network
	Capital	Transportation & Transit Infrastructure	Transit Networks	Modify Existing Transit Network
Generic Zero Emission Project	Policy	Buildings		Zero Emissions District Energy System
Improve Garbage Processing	Capital	Waste	Processing Systems	New Garbage Processing System
Improve Street Connectivity	Policy	Land-use		Improve Street Connectivity

Increase Employment Density	Policy	Land-use		Increase Employment Density
Increase Residential Density	Policy	Land-use		Increase Residential Density
Install EV Chargers	Capital	Fleet & EV Infrastructure	EV Infrastructure	Install EV Chargers
Limit Residential Parking Supply Policy	Policy	Transportation		Limit Residential Parking Supply Policy
Local Generation	Capital	Energy & Renewables	Distributed Generation	Renewable Electricity Generation
Methane Capture and Reuse	Capital	Waste	Energy Systems	Methane Capture and Reuse
New Building Construction	Capital	Buildings	All Subsectors	New Building Construction
New Building Construction Policy	Policy	Buildings		High Performance Homes
	Policy	Buildings		High Performance Non-Residential Building
Optimize Passive Solar Orientation	Policy	Land-use		Optimize Passive Solar Orientation
Plant Trees	Capital	Parks, Urban Forestry, & Ravines	Tree Planting	Tree Planting
Power Purchase Agreement	Capital	Energy & Renewables	Emissions Offset Project	Power Purchase Agreement
Procure New Vehicles	Capital	Fleet & EV Infrastructure	New Vehicles	Procure New Vehicles
Protect Agricultural Lands	Policy	Land-use		Protect Agricultural Lands
Protect Forests	Policy	Land-use		Protect Forests
Purchase RECs	Capital	Energy & Renewables	Emissions Offset Project	Renewable Energy Certificate
Recycling Program	Capital	Waste	Diversion Programs	Recycling Program
Reduce Greenfield Development	Policy	Land-use		Reduce Greenfield Development
Reduce Transit Fares Policy	Policy	Transportation		Reduce Transit Fares Policy
Replace Existing Vehicles	Capital	Fleet & EV Infrastructure	Existing Vehicles	Replace Existing Vehicles
Require EV Infrastructure Policy	Policy	Buildings		Require EV Infrastructure Policy

Reuse Waste Energy	Capital	Waste	Energy Systems	Reuse Waste Energy
Solar Generation	Capital	Buildings	All Subsectors	Solar Generation
Solar PV Program	Policy	Buildings		Solar PV Program
Street Lighting Project	Capital	Transportation & Transit Infrastructure	Street Lights	Street Lighting Project
Transit Oriented Development	Policy	Land-use		Provide Transit-Oriented Development
Waste Diversion Policy	Policy	Waste		Waste Diversion Policy
Waste Reduction Policy	Policy	Waste		Waste Reduction Policy

6 Other Resources

Many of the actions and associated model logic for this tool have been derived from the *Handbook for Analyzing Greenhouse Gas Emission Reductions, Assessing Climate Vulnerabilities, and Advancing Health and Equity* by the *California Air Pollution Control Officers Association*. The guide can be found at https://www.caleemod.com/handbook/index.html .