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NRCan Material Carbon Emissions Estimator (MCE²) User Guide



Developed by Natural Resources Canada's
Local Energy Efficiency Partnerships (LEEP) team.

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RATIONALE FOR MCE²

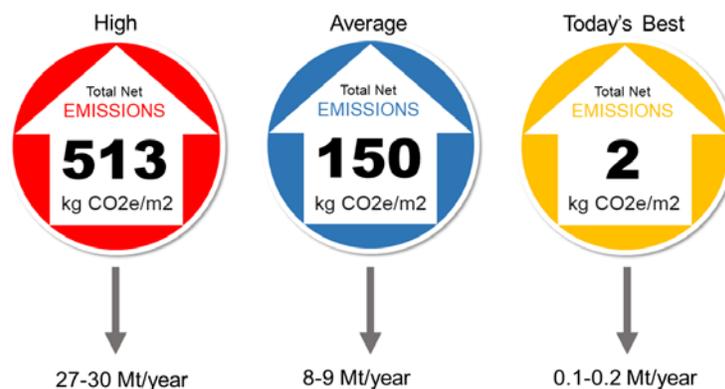
Why This Estimator Tool and Why Now?

This estimator tool is designed for Canada's home building industry. MCE² quantifies the greenhouse gas emissions (GHG) associated with specific low-rise, residential building designs by providing two important estimates:

- the GHG emissions associated with manufacturing required building materials, and;
- the estimated GHG emissions from operating the home (calculated using results from a [HOT2000](#) energy model).

Together, these results predict the overall GHG impact on the climate of a new home or renovation (its carbon use intensity, or CUI) and provides industry with insights for reduction opportunities.

MCE² focuses on **material carbon emissions** (often referred to as “up-front embodied carbon”), which measures emissions arising directly from harvesting and producing building materials. In 2021, Natural Resources Canada released a report that concluded that low-rise residential buildings may be responsible for an average of 150 kilograms (kg) of carbon dioxide equivalent (CO₂e) emissions per square meter of floor area (28 tonnes for a 2,000 square foot home).¹ Multiplying this estimate across all low-rise residential buildings constructed each year in Canada, this totals between 8 and 9 million tonnes of emissions, the equivalent of approximately three coal-fired power plants. The report also indicated that material carbon emissions (MCE) could be as high as 513, or as low as 2, kg CO₂e/m² for homes of the same design and energy performance, depending on the selection of materials. This difference highlights the significance MCEs may have on achieving emission reduction targets.



Average material carbon intensity (MCI) results from all models in NRCan study and potential contribution to GHGs annually from current volume of Part 9 housing construction.

1 Magwood, C., Ahmed, J., Bowden, E., Racusin, J. (2021). ACHIEVING REAL NET-ZERO EMISSION HOMES: Embodied carbon scenario analysis of the upper tiers of performance in the 2020 Canadian National Building Code. <https://www.buildersforclimateaction.org/uploads/1/5/9/3/15931000/bfca-enercan-report-web.pdf>

Currently, MCEs are not measured or regulated within the building sector. However, they represent a key opportunity to achieve major emission reductions as part of the efforts to meet Canada’s target of reducing emissions by 40 to 45% by 2030.

The MCE² tool introduces MCEs and is designed to support the homebuilding and renovation industries in making informed material choices to reduce up-front carbon emissions. MCE² is intended to open up a dialogue, and allows industry to take a leading role in carbon drawdown.

Data for estimations in MCE²

The background data for MCE² comes from Environmental Product Declarations (EPDs). These documents express the results of a “life cycle assessment” (LCA) that has been performed and reported according to product category rules (PCRs) prescribed by ISO standards². EPDs are performed or verified by a third party. EPDs cannot compare materials intended for different uses (i.e. we can’t compare emissions from a 2x4 to those from a floor tile). Even within the same product category, it can be difficult to compare EPD figures because the emission values expressed for each material may not be given in the same quantities of units (i.e. kilograms of brick can’t be compared to square meters of wood siding). MCE² attempts to normalize values expressed in EPDs to ensure that appropriate types of materials are compared in appropriate quantities and units.

NRCan has standard product sizes, code norms and best practices to allow an “apples to apples” comparison. There are limitations to the information in MCE², and we encourage you to read and explore the “**Limitations**” section of this guide.

Uses of MCE²

MCE² is intended to be used for projects that meet the requirements for Part 9 (low-rise) buildings. The tool can be used for planning new construction or renovations.

Users may apply the information about material carbon emissions in MCE² in several ways:

- **Material comparisons** – Users can explore and compare the relative emission profile of materials within each assembly and material category in the tool. See Section 2.3 for instructions on how to use MCE² for this purpose.
This can be helpful to familiarize yourself with the differences in material emissions in general, and to facilitate discussions with clients about particular material choices.
- **Schematic design stage** – Users can explore the overall MCE impacts of different design options early in the design process. For example, users can build simple models in MCE² to explore the difference between a single-story and multi-story version of the same building by using rough dimensions and average material values to determine if there is a less impactful option. See Section 8 to learn how to save and compare different scenarios for the same project.

2 ISO 21930:2017. Sustainability in buildings and civil engineering works — Core rules for environmental product declarations of construction products and services. <https://www.iso.org/standard/61694.html>

- **Building model optimization** – Users can build a detailed model of their building and explore the material options to help select the materials that will enable them to meet their emissions targets for the project. This can be done at an early stage, when major changes to structure and material choices are easier to make, and again later in development to refine material selections. See Section 8 to learn how to save and compare different scenarios for the same project.
- **Procurement** – Where MCE² offers emission information for competing products of the same type, these results can be used to specify brands for procurement to minimize emissions. Currently, this type of product-specific data is only available in some material categories.

Limitations of MCE²

It is important to note that MCE² has a number of limitations of which users should be aware. Users should read this section carefully so that they are fully informed.

The results from MCE² are not necessarily an accurate reflection of the actual material carbon emissions of your finished building. Users can think of these results like they would the results of a basic energy model for a building. Just as a simple energy model is a relatively good predictor of the comparative effectiveness of different efficiency strategies, such a model won't necessarily provide an exact estimate of how much energy the building will eventually use.

There are several factors to understand about this estimator and its accuracy:

1) All the data is based on EPDs

The calculations used to create an EPD can be compared to calculating the fuel mileage for a car or truck. A series of assumptions and generic data are used to predict the carbon footprint of a material. The rules for making EPDs ensure that these assumptions are similar for all products in a particular category, but this does not necessarily guarantee that the actual figure is a perfect representation of the actual emissions from manufacturing the material.

A range of uncertainty from 5 to 25% is typical in EPDs.

MCE² includes notes in the far right column when the data is not taken from EPDs:

Data source: EPD includes phases A1-A3 and B1 (VOC off-gassing)
Data source: LCA Study
Data source: ICE Database (UK)
Data source: other than EPD, LCA or database.

In these cases, there were no EPDs for these materials or products at the time the data was compiled. In order to represent these materials, MCE² leverages peer-reviewed life cycle assessments (most often 2 or 3 such studies) and use the A1 toA3 results from these studies. In a limited number of cases, MCE² uses results from the Inventory of Carbon and Energy (ICE) database of construction materials.

2) Assumptions in quantity calculations

In order to make MCE² simple to use and to minimize the number of inputs required, assumptions have been made in the calculations for material quantities. These factors represent well-established industry norms, but these may not reflect the actual design or execution of your project.

While the quantities of materials estimate in MCE² are unlikely to be a perfect match to your actual material use, the quantities are consistent between all the options. This means that the comparison of emissions between materials is accurate. For example, your project may use more or less framing material than MCE² estimates but the relative difference between the framing material options as depicted by MCE² will be consistent.

3) No waste factor for materials included

Every construction project generates offcuts and waste factors. In addition, when applied to carbon storing materials, the wasted material would likely end up in the waste stream, which would change the carbon storage balance. Including waste factors would also make building results less comparable. For these reasons, it may be prudent not to include waste factors for any material selections.

4) Not all of the materials in a building are represented

Many materials are not included such as:

- Mechanical, electrical and plumbing (MEP) systems and components
- Damp-proofing, air/vapour barriers and membranes
- Flashing, sealants, adhesives
- Doors
- Fasteners
- Appliances and fixtures
- Millwork, cabinetry and stairs
- Paints, stains and surface finishes

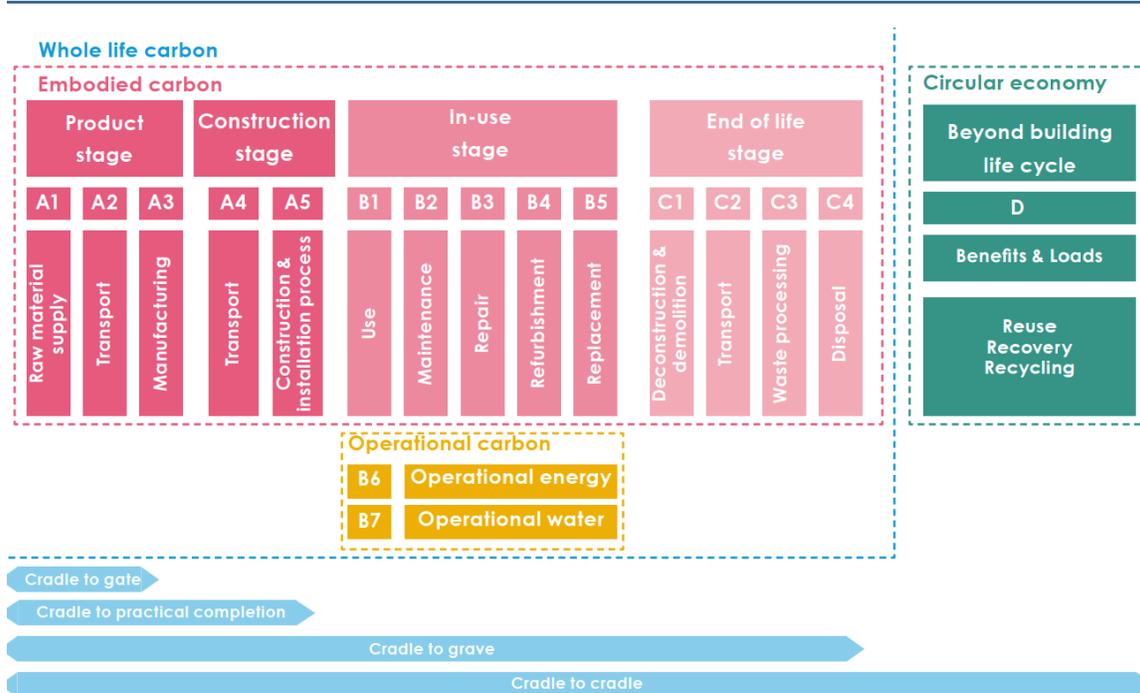
There is currently limited data available in some of these categories and/or the quantities of materials and emissions would be quite similar (i.e. the emissions for toilets don't have much variation according to the available data).

The total of all these missing elements could be quite sizable (as much as 50% of total MCE), so it shouldn't be assumed that the results from this estimator accurately reflect the entire carbon footprint of the building. Even a net carbon-storing result in MCE² may have net emissions if all of these missing materials were included in the total.

MCE² will be updated periodically as EPDs in these categories become available. It is unlikely that MCE² will be updated more than once every 6 months.

5) Based on “cradle-to-gate” or A1 to A3 emissions

The “material carbon emissions” included in MCE² are from stages A1 to A3 of a life cycle assessment. These product stage emissions represent 60 to 75% of all life cycle emissions from building materials, and 100% of the emissions over the next decades (prior to replacement for the materials included in MCE²).



Life cycle stages (adapted from LETI Embodied Carbon Primer, <https://www.leti.london/ecp>)

Getting building materials from the factory to the job site can add a significant quantity of emissions to the overall project. Typically, transportation to the construction site adds 5 to 10% to the total material emissions.

Users may want to learn about their supply chains and attempt to calculate the transportation emission of their projects.

The emissions from a construction site are likewise difficult to estimate, but average between 5 and 10% of the total materials emissions. There is a big difference between a job site powered by relatively clean electricity compared to a diesel generator. Heavy equipment operation time, the need for job site heating and even the commuting distances can all have significant impact. Users may want to be conscious of these factors and both calculate and mitigate these emissions.

It should be noted that job site emissions from stages A5 and/or B1 have been included in the MCE calculations for those materials that have a necessary, sizable and very predictable volume of emissions created on site. Examples include emissions from site-mixed foam insulation and from concrete poured into insulated concrete forms. These types of emissions are included in A5 in many EPDs but are more related to the static emission profile of the product than to construction site-specific activity.

6) No end of life emissions calculated

There are emission impacts at the end of life for a building component or a whole building. MCE² excludes end of life estimates for a few reasons:

- MCE² assumes a lifespan of 30 years. While there will be emissions released when these materials reach the end of their service life, MCE² is focused on immediate emission reductions due to uncertainty related to how materials will be handled at their end of life. All materials included in MCE² have an assumed lifespan of at least 30 years (with the exception of asphalt shingle roofing, for which the emissions figure is doubled to cover replacement).
- End of life for buildings and materials is hard to predict. The actual service life of a material or whole building is rarely the cause for replacement or demolition; instead, factors like property value, aesthetics and planning issues tend to bring about the demise of materials and buildings, not the expected service life.

7) LCA End of life assumptions

Currently, end of life options in LCA are generally limited to landfill, incineration or recycling. As knowledge of LCA advances, material end of life options will undoubtedly evolve. There are beyond the scope of MCE².

8) No costing information is included

MCE² does not attempt to include material costs as a comparative factor in this estimator. This is obviously important to builders and their clients, but we did not feel we could effectively capture costing data that would be relevant across North America, nor that it would remain current in the face of market fluctuations and product development. Builders can use their own costing information to bring that lens to these MCE results.

9) No building science or engineering advice about material substitutions

MCE² groups materials that can potentially function in each assembly type in which they are included. It should be noted that every material option has specific performance characteristics, and that building plans may need to be altered in order to successfully change from one material option to another.

HOW TO USE MCE²

The steps to use MCE² are outlined below. All efforts were made to minimize the number of inputs required from users and to make the material selection process as straightforward as possible.

1) Getting started

1.1 Open the Excel file

After downloading the Excel file from the NRCan website, double click on the file to open it.

You will be informed that the file contains macros, and you must select “Enable Macros” in order for MCE² to function properly.



1.2 Select your language preference

Choose whether you would like to use MCE² in English or French.



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**Material Carbon Emissions
Estimator (MCE²)**

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**Estimateur d'émissions de
carbone des matériaux (E²CM)**

LEEP Partenariats locaux en
matière d'efficacité
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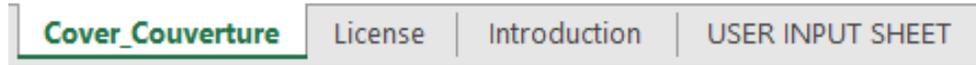
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1.3 Navigation tabs

All navigation in MCE² is done by using the tabs at the bottom of the spreadsheet. Select each tab in the order of appearance, from left to right, beginning with the License tab.



1.4 License agreement

Read the license agreement before using MCE². You will not be asked to accept the terms of the agreement. By downloading, installing, using or copying the software, you are agreeing to the terms of the license agreement.

BY DOWNLOADING, INSTALLING, USING OR COPYING THE SOFTWARE THE
LICENSEE HEREBY AGREES TO ADHERE TO THE TERMS AND CONDITIONS
BELOW:

1.5 Introduction

Select the Introduction tab. The information on this tab is similar to the Rationale section of this user's guide. Whether in this guide or on the Introduction tab, be sure to familiarize yourself with this material, as it explains the data and methodology of MCE² and puts the results generated into context.

2) User Input Sheet

The information you enter on the User Input Sheet is critical to the accuracy of MCE². Take every care to ensure that you are entering accurate information.

There are two ways to populate the User Input Sheet. If you have already built a HOT2000 energy model for your building, you can import that file, which will automatically populate a number of fields. If you do not have a HOT2000 file, you can populate the fields manually.

2.1 HOT2000 Import

To import a HOT2000 file, click on the green “import” tab.

The screenshot shows the top header of the MCE² application with the Canadian flag and the text 'Natural Resources Canada' and 'Ressources naturelles Canada'. Below this is a blue banner with the title 'Material Carbon Emissions Estimator (MCE²)' and the date 'April 2021'. The main content area displays 'Step 1 Import project data from HOT2000 (If no HOT2000 file, skip to Step 2)' and a large green button labeled 'Press Here to import HOT2000 Data'.

You will be asked to find and select the appropriate HOT2000 file from your computer. Select the file and initiate the import.

MCE² will import the relevant information from HOT2000 to the following areas of the User Input Sheet:

- Project information:

Step 2 Confirm or enter project information

Address:		Province:	ONTARIO
City:	OTTAWA	Postal code:	
Building Type:	Single	Evaluation date:	2019-10-08
Storeys:	Detached	File ID:	
Year Built:	Two and a half	File name:	
	Before 1920		
Heated Floor Area (above grade, m ²):	150.5		
Heated Floor Area (below grade, m ²):	46.5		
Heating Degree Days:	4500		

- Project dimensions (all fields in blue)

Step 3 Confirm or enter project dimensions HOT2000 values are imported to the BLUE cells below. If no HOT2000 file imported, then enter values into the BLUE cells. For all YELLOW cells below, manually enter all relevant values. Exclude any garage quantities.

COMPONENT	AREA/ VOLUME	UNIT	APPLICATION OF INPUT VALUE	DESCRIPTION OF REQUIRED UNITS										
FOOTINGS, PADS & PIERS	6.2	m ³	<table border="1"> <tr> <td>Footings Length</td> <td>×</td> <td>Footings Depth</td> <td>×</td> <td>Footings Width</td> </tr> <tr> <td>24.844</td> <td></td> <td>0.25</td> <td></td> <td>1.00</td> </tr> </table>	Footings Length	×	Footings Depth	×	Footings Width	24.844		0.25		1.00	Total cubic metres of all footings, piers and posts
Footings Length	×	Footings Depth	×	Footings Width										
24.844		0.25		1.00										
FOUNDATION WALL AREA	50.4	m ²	Foundation wall, exterior continuous insulation, interior framing, interior insulation, interior wall finish	Total wall area (exclude windows and doors)										
FOUNDATION SLAB/FLOOR AREA	33.2	m ²	Slab, aggregate base, sub-slab insulation, basement flooring	Square metres										
EXTERIOR WALL AREA	155.0	m ²	Framing, insulation, sheathing, exterior cladding, interior cladding of exterior walls only	Total exterior wall area (include gable ends; exclude window & door openings). Exclude all garage wall, garage partition wall and party wall areas										
WINDOW AREA	23.5	m ²	Windows	Square metres (include full area of glazing units)										
INTERIOR WALL AREA	120.0	m ²	Framing, insulation and interior cladding of interior walls	Square metres (one side only) of all interior walls. Quantity will be doubled for cladding materials										
FRAMED FLOOR AREA	150.5	m ²	Floor framing, subfloor, floor insulation, flooring	Square metres (includes all levels, excludes basement slab, stairs and other openings)										
CEILING AREA	197.0	m ²	Ceiling cladding/coverings	Square metres (all levels; include basement ceiling if applicable)										
ROOFING AREA	197.0	m ²	Roof framing, decking, roofing, and insulation parallel to roof deck	Square metres (include sloped and flat roofs; exclude overhangs and gable ends)										
ROOF INSULATION AREA	69.7	m ²	Roof insulation parallel to ceiling	Square metres of insulation in the roof cavity. Typically this is equal to the attic floor or top floor ceiling area.										
HEAVY TIMBER ELEMENTS	0.3	m ³	Heavy timber framing members (e.g. posts and beams)	Cubic metres of total wood volume in posts & beams. (Heavy steel members input in Structural Elements tab)										
PARTY WALL AREA		m ²	Party wall framing, insulation, sheathing, interior cladding.	Square meters of wall area that partitions one dwelling from another. Used for row housing units, apartment units, etc.										

- Energy consumption and operational emissions

Energy Consumption		Energy Generation
Elec. kWh/yr	N. Gas m ³ /yr	Elec. kWh/yr
14094	562	4649
Propane L/yr	Oil L/yr	Wood kg/yr
0	0	0

To override energy GHG intensities, use the Energy GHG tab.

Operational Emissions	
tonnes CO ₂ e / yr	t CO ₂ e / 30 yrs
1.5	46.4

Be sure to double check all the values imported from HOT2000 to ensure that they are accurate. Then, enter required information into any of the empty yellow fields, as per the instructions below.

2.2 Manual input

If you are not working from a HOT2000 file, you will need to enter all of the relevant information manually.

With the exception of the heated floor area sections, you are not required to complete the project information for MCE² to work. The heated floor area values are used to calculate the emissions intensity of your project (total emissions/floor area).

Heated Floor Area (above grade, m²) 150.5

Heated Floor Area (below grade, m²) 46.5

Complete all of the relevant building dimension sections, both blue and yellow fields. There are instructions in each dimension row to inform you of what each entry includes. Be sure to use these instructions to ensure you're capturing the correct dimensions.

For all **YELLOW** cells below, manually enter all relevant values. **Exclude** any garage quantities.

DESCRIPTION OF REQUIRED UNITS

Total cubic metres of all footings, piers and posts

All entries must be made in metric units. A calculator to convert imperial values into metric units can be found at the top right corner of the User Input Sheet.

UNIT CONVERSIONS											
Volume			Area			Length					
5.0	m ³ →	177	pi/ft ³	628	m ² →	6760	pi/ft ²	1.0	m →	3.3	ft
45.0	ft ³ →	1.3	m ³	26.0	ft ² →	2.4	m ²	100	ft →	30.5	m

There may be fields in the dimension area that do not apply to your project. These can be left blank.

If your project has a garage, the dimensions for the garage are entered separately, in rows 46 to 55. Note that row 46 identifies any attached garage wall area. Be sure this area is not duplicated in the exterior wall area field for the main building. This area of the spreadsheet may be hidden when you first open it. In that case, use the "+" sign on the far left side of the tool to expand the garage menu.

If you are entering your building manually, you can enter the expected annual operating energy into the appropriate yellow cell for the fuel type the project will use. If your project is in Canada, an estimate of the operating emissions will be populated in cells M16 and N16. Alternatively, if you have already calculated the operating emissions, you can enter that information directly into the appropriate cell.

Energy Consumption		Energy Generation
Elec. kWh/yr	N. Gas m ³ /yr	Elec. kWh/yr
14094	562	4649
Propane L/yr	Oil L/yr	Wood kg/yr
0	0	0

To override energy GHG intensities, use the Energy GHG tab.

Operational Emissions	
tonnes CO ₂ e / yr	t CO ₂ e / 30 yrs
1.5	46.4

These operational values will be incorporated into a chart on the **Results Tab** that compares operational emissions with material emissions. If the operational values are left blank, all the MCE functions in the tool will work accurately except the results chart.

2.3 Reference Use

It is not necessary to enter a complete set of building dimensions into MCE² if you want to generate results for just one or two assemblies in a building.

If you want to use MCE² as a reference tool to check MCE for a particular assembly or material, you can choose to enter just one dimension into the appropriate field (or an arbitrary value, such as 10 m²) and then go directly to the appropriate tab to find the results.

For example, if you want to compare MCE results for roofing, you can enter a value in the "Roofing Area" field (C36) and then go directly to the "Roof" tab and see the results.

2.4 Clearing Data

At the top of the User Input Sheet, you will see two blue buttons that enable you to clear certain information from the spreadsheet.

Clear All (User Input and all Assembly Tabs)

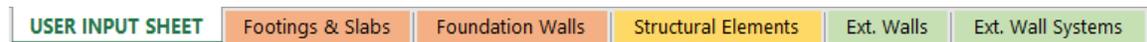
Clear This Sheet Only (User Input)

Please see Section 8 for instructions on how to use this feature of MCE².

3) Assembly Tabs

MCE² can be used to “build” a model project from the ground up. Each of the main building assemblies are presented on unique tabs, which can be accessed from the bottom of the spreadsheet. There are 13 assembly tabs; each tab imports relevant dimensions entered on the User Input Sheet.

Your screen may not show all of the assembly tabs in a single view. In this case you can use the navigation arrows on the bottom left of the Excel window to move between the tabs.



You do not need to complete the tabs in any particular order, as long as you ensure that you do complete all the relevant tabs for your building before you complete the project.

You can increase or decrease the size of the text on your screen using the adjustment bar on the bottom right corner of the Excel window.



3.1 General information about assembly tabs

Each assembly tab displays information in the same way.

At the top of the sheet you will find the name of the assembly tab and a dark grey bar that describes the information displayed in each cell, including the material category, the material name, the quantity (imported from the User Input Sheet), a percentage function, a selection column, and results fields that show the net MCE, the gross emissions and the gross CO₂ storage (if any).

An orange field in the top right keeps a running total of all the material results of all the selections you make on this tab.

SECTION 1 → COMPONENT MATERIALS FOR		FOUNDATION - FOOTINGS & SLABS				Clear This Sheet Only			
INSTRUCTIONS: (double-click)									
CATEGORY	MATERIAL	QUANTITY	%	SELECT	NET kgCO ₂ e EMISSIONS	SELECTED MATERIAL kgCO ₂ e CONTENT	kgCO ₂ e EMISSIONS	kgCO ₂ STORAGE	kgCO ₂ e SUBTOTAL FOR FOUNDATION FOOTINGS & SLAB
									5,342

3.1.1 Material Category & Materials

Each assembly tab is divided into “material categories” defined by a dark blue heading. Within each material category, there will be one or more “material options”, each with a lighter blue heading.

It is advisable to scroll down through the entire sheet to see the full range of categories available as you visit each assembly tab. This way, you will understand all categories included in the assembly tab and be able to assess those that apply to your project. You will not likely need to make material selections in each category, so you can ignore categories that don’t apply to your building model.

Under each material option, there will be an “average material option” in a light blue heading and one or more specific product options in white rows.

As an example, the “Basement Flooring” material category is shown below.

CATEGORY	MATERIAL	QUANTITY	%	SELECT	NET kgCO ₂ e EMISSIONS	SELECTED MATERIAL kgCO ₂ e CONTENT	kgCO ₂ e EMISSIONS	kgCO ₂ STORAGE
BASEMENT FLOORING								
HARDWOOD FLOORING								
	Hardwood flooring - AVERAGE	33.2 m2	100%		479		479	0
	Hardwood flooring / Typical Eastern Canadian, solid, pre-finished / 3.12" x 3/4" pre-finished	33.2 m2	100%		579		579	0
	Hardwood flooring / mafi / Natural Hardwood Planks / 3/4", 3 ply laminated solid, oil pre-finished	33.2 m2	100%		465		465	0
	Hardwood flooring / Action Floor Systems / / 25/32" x 3-1/4" FSC Certified	33.2 m2	100%		392		392	0
LINOLEUM FLOORING								
	Linoleum flooring / Gerflor / PLW Linoleum / 4.0 mm sheet style linoleum	33.2 m2	100%		-19		97	116
	Linoleum flooring - AVERAGE 2.5 mm	33.2 m2	100%		26		122	96
	Linoleum flooring / Forbo / Marmoleum / 2.5 mm sheet style linoleum	33.2 m2	100%		43		134	91
	Linoleum flooring / Forbo / Marmoleum Striato / 2.5 mm sheet style linoleum	33.2 m2	100%		-9		88	97
	Linoleum flooring / Armstrong / Sheet style / 2.5 mm sheet style linoleum	33.2 m2	100%		43		144	101
TILE FLOORING								
	Tile flooring - AVERAGE	33.2 m2	100%		590		590	0
	Ceramic tile / Tile Council of North America / / Industry average. Includes porcelain, pressed, mosaic and quarry tile	33.2 m2	100%		437		437	0
	Ceramic tile / StonePeak / Porcelain / Porcelain, standard grade	33.2 m2	100%		539		539	0
	Ceramic tile / Crossville / Porcelain / Standard grade	33.2 m2	100%		794		794	0
VINYL FLOORING								
	Vinyl flooring - AVERAGE	33.2 m2	100%		291		291	0

Be sure to scroll down to ensure that you are aware of all the options within a material category, as some sections are lengthy.

In the **quantity column**, you will see the relevant dimension you entered on the User Input Sheet (in this case, 93.4 m²). This is the quantity being used to determine the MCE of each material for your project. If this quantity does not seem correct, you can revisit the User Input Sheet to ensure the proper value was input.

In the **% column**, the default is set to 100%. You can use this function to allocate a percentage of the total area to more than one material option. In this example, the basement may have 65% of the flooring area in hardwood and 35% in tile. By changing the % column appropriately, the calculations will adjust so the correct MCE is shown for the appropriate area.

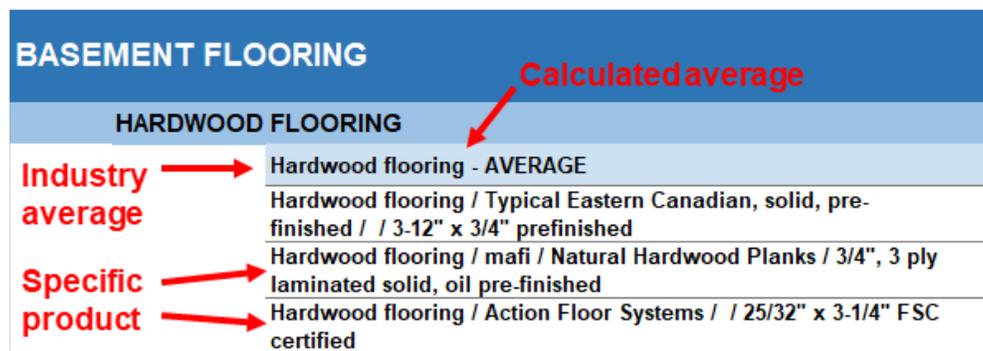
The **Net Emission** column shows you the MCE that will arise from each material. This is expressed as kilograms of carbon dioxide equivalent (kg CO₂e).

The **Emissions column** shows the gross emissions from the material and the **Storage column** shows the gross carbon dioxide storage in the material.

3.1.2 Material options

It is important to understand the nature of the material options displayed in MCE² in order to make appropriate material selections. The hierarchy of material options includes:

- **Material Name** – Displayed in a cell highlighted in blue, the material name defines a particular type of material appropriate for use in the assembly. For example, in the “Basement Flooring” category shown below, material names include hardwood, linoleum, tile, vinyl and laminate flooring. Depending on the category, the amount of material names will vary.
- **Material Average** – There are two types of averages in MCE². If the average is highlighted in a light blue cell, it is a calculated average based on all the relevant results of the particular material type. If the average is displayed in a white cell, then it is a value found on an “industry average EPD” in which multiple different manufacturers of the same material type have collaborated to present a single result to represent all of the relevant products. Wherever possible, the cell contains the manufacturer and/or product names that are included in the industry average EPD.
- **Product Specific** – For materials in white cells, the information relates to a specific product and as much relevant information is displayed in the cell to help identify the product and its specifications, including product name, description, thickness, thermal value and other key information that may inform your selection.



3.2 Additional Specifications

Depending on the Material Category, there may be additional specifications you need to enter in order for MCE² to complete its calculations. These additional specifications are displayed as yellow cells within the dark blue category names. Some examples include thickness, length, R-value and framing spacing, as shown below.

CONCRETE SLAB FLOOR(S)	THICKNESS:	4	in	=	0.102 m
HELICAL PIERS	TOTAL LENGTH OF ALL PIERS:		m		
SUB-SLAB INSULATION	R-VALUE:	10			
WOOD FRAME WALLS	FRAMING SPACING:	16	in. o/c		

Click on the yellow cell to enter the appropriate value for your project. In certain cases, you can enter any value. If you click on the cell, it may indicate the existence of a drop-down menu, as with framing spacing, in which case you must make one of the suggested choices.

3.2.1 R-Value Selections

Any value can be entered in the R-Value cells, regardless of whether or not a particular material is available in a thickness that will actually achieve that R-value. This enables you to select R-values that are appropriate for your project, but may result in a model that does not reflect actual product performance and size specifications.

To allow for additional flexibility, there are two different ways to enter R-values for insulation materials: you can define a desired R-value for all materials in the category **OR** choose specific R-values for specific materials.

- One R-Value Selected** – If you enter a value in the main R-value cell in the dark blue region, that R-value will be used to calculate the MCE of all materials in the category and the background calculations will assume the appropriate thickness of each insulation material required to achieve the desired R-value. Your selected value will automatically populate all of the R-Value cells in the category. This is useful when attempting to ensure that the same thermal performance can be achieved for the project regardless of the actual product specifications of the selected materials.

CONTINUOUS INSULATION (EXT. or INT.)	R-VALUE:	10			
--------------------------------------	----------	----	--	--	--

- **Variable R-values Selected** – Each material type can be defined with its own specific R-value. Typing in a specific value will automatically delete any value entered in the overall category R-value cell.

This feature serves two purposes. First, it enables you to select R-values for products that accurately reflect known product specifications and therefore allow you to compare MCE when insulation materials have more or less R-value per inch for a given thickness. Second, it allows you to include more than one insulation type in an assembly (for example, a different type of continuous insulation on the interior and exterior of a wall).

When using this feature, be certain that you are specifying an appropriate R-value in each material type you wish to select, as these cells will not auto-populate.

CONTINUOUS INSULATION (EXT. or INT.)		R-VALUE:
EPS FOAM BOARD	Material specific R-values	R-VALUE: 16
	EPS foam board - AVERAGE	155.0 m2
	EPS foam board / EPS Industry Alliance / R 4/inch, Type II, 15 psi (Type 2, 110 kPa)	155.0 m2
	EPS foam board with graphite / BASF / Neopor / R 4.7/inch, Type II, 15 psi (Type 2, 110 kPa)	155.0 m2
WOOD FIBER BOARD		R-VALUE: 22
	Wood fiber board - AVERAGE	155.0 m2

Any values you specify are used in the background calculations performed by MCE², so ensure that you are entering accurate numbers in the required units.

The emissions value of materials that require an additional specification will often display as zero (0) until the additional value has been entered. When you complete your entry by using the return (enter) key on your keyboard, the MCE values should populate the appropriate cells.

3.3 Making Material Selections

Once you are familiar with the Material Categories and Material Options on an assembly tab, and know when to fill in any additional specifications that are required, you are ready to make material selections.

Within the Material Categories, the comparative nature of MCE² becomes evident, as you can quickly assess the relative emissions of the required volume of each material for your building's size by scanning all of the results in the **Net Emission column**.

The tool enables comparison of emissions between materials and supports decisions on material selection in your projects.

When you wish to select a material for inclusion in your building model, enter the number “1” into the yellow “Select” cell in column H.

BASEMENT FLOORING							
HARDWOOD FLOORING							
Hardwood flooring - AVERAGE	33.2 m ²	100%	1	479	479	479	0
Hardwood flooring / Typical Eastern Canadian, solid, pre-finished / / 3-12" x 3/4" prefinished	33.2 m ²	100%		579		579	0
Hardwood flooring / mafi / Natural Hardwood Planks / 3/4", 3 ply laminated solid, oil pre-finished	33.2 m ²	100%		465		465	0
Hardwood flooring / Action Floor Systems / / 25/32" x 3-1/4" FSC certified	33.2 m ²	100%		392		392	0

When you have made your selection, the net emissions for that selection will show up in an orange cell in column J. This confirms that your selection has been successful and that this figure will be added to the subtotal for the appropriate assembly tab and to the overall total for the project.

3.4 Using the Percentage Function

The percentage function in column F will default to 100% on every tab. This means that the MCE calculations are being performed for 100% of the material quantity specified in columns D and E.

There are two instances in which you may wish to alter this percentage to more accurately describe your project:

- More than one material in the same position in the assembly – In many cases, you may be intending to use more than one material in an assembly. Common instances for this might include:
 - More than one type of flooring
 - More than one type of cladding
 - Interior walls that use different sized framing
 - Sloped and flat roofing sections

MCE² can accommodate these scenarios by using the percentage function to identify the percentage of the total area or volume used by each individual material, as shown below.

BASEMENT FLOORING							
HARDWOOD FLOORING							
Hardwood flooring - AVERAGE	33.2 m ²	30%	1	144	144	144	0
Hardwood flooring / Typical Eastern Canadian, solid, pre-finished / / 3-12" x 3/4" prefinished	33.2 m ²	100%		579		579	0
Hardwood flooring / mafi / Natural Hardwood Planks / 3/4", 3 ply laminated solid, oil pre-finished	33.2 m ²	100%		465		465	0
Hardwood flooring / Action Floor Systems / / 25/32" x 3-1/4" FSC certified	33.2 m ²	100%		392		392	0
LINOLEUM FLOORING							
Linoleum flooring / Gerflor / DLW Linoleum / 4.0 mm sheet style linoleum	33.2 m ²	100%			-19		0
Linoleum flooring - AVERAGE 2.5 mm	33.2 m ²	25%	1	6	6	6	0
Linoleum flooring / Forbo / Marmoleum / 2.5 mm sheet style linoleum	33.2 m ²	100%		43		43	0
Linoleum flooring / Forbo / Marmoleum Striato / 2.5 mm sheet style linoleum	33.2 m ²	100%			-9		0
Linoleum flooring / Armstrong / Sheet style / 2.5 mm sheet style linoleum	33.2 m ²	100%		43		43	0
TILE FLOORING							
Tile flooring - AVERAGE	33.2 m ²	45%	1	266	266	266	0
Ceramic tile / Tile Council of North America / / Industry average. Includes porcelain, pressed, mosaic and quarry tile	33.2 m ²	100%		437		437	0
Ceramic tile / StonePeak / Porcelain / Porcelain, standard grade	33.2 m ²	100%		539		539	0
Ceramic tile / Crossville / Porcelain / Standard grade	33.2 m ²	100%		794		794	0

In this case, the user has specified that 30% of the floor area will be covered in hardwood, 25% in linoleum, and 45% in tile, as indicated by the new values input into column F. In each case, the average value for the material has been selected in column H by entering the number 1. The MCE values have appeared in the orange cells in column J to confirm the entries.

NOTE that MCE² does not check to see if your total percentages add up to 100%, so it is up to you to be accurate with your calculations and entries.

NOTE that MCE² does not change the percentage for every material option in the material category, but only the row in which you have entered a new percentage value. Therefore, it is important to avoid comparing material options for which different percentage values exist in the sheet.

- **Intentional adjustment of percentage to compensate for material or construction differences** – The percentage function can be used to more accurately describe a project when the values embedded in MCE² do not reflect the intended construction. Common instances of these compensations might include:
 - Using a material shown in MCE² but at a different thickness or diameter than specified in the material option
 - Using a framing spacing that is not defined in MCE²

For example, you may know that you are going to use a ½-inch thick hardwood flooring, but MCE² only offers a ¾-inch version. You can adjust for this by using the percentage function, in this case entering 66% to reflect that your choice will require that much less material to cover the same floor area.

BASEMENT FLOORING					
HARDWOOD FLOORING					
Hardwood flooring - AVERAGE	33.2 m ²	66%	1	316	316
Hardwood flooring / Typical Eastern Canadian, solid, pre-finished / / 3-12" x 3/4" prefinished	33.2 m ²	100%		579	
Hardwood flooring / mafi / Natural Hardwood Planks / 3/4", 3 ply laminated solid, oil pre-finished	33.2 m ²	100%		465	
Hardwood flooring / Action Floor Systems / / 25/32" x 3-1/4" FSC certified	33.2 m ²	100%		392	

NOTE that MCE² does not check or verify your calculations for such adjustments.

4) Assemblies

There are 13 assembly tabs, arranged to reflect a “ground-up” construction sequence for a building. You do not need to visit the assembly tabs in order, nor do you need to make entries in every tab. Depending on your project, some of the assembly tabs may not apply.

Renovation projects, in particular, may only require the use of selected materials from a few assembly tabs. Regardless of the extent of the project, if all the materials required to complete the project are selected from the appropriate assembly tabs, the result will be an MCE estimate for that project.

Each assembly tab is described, and any particular considerations for the assembly are noted, below.

Footings & Slabs

Footings & Slabs

Concrete

Concrete is an option in two categories within this assembly tab, **Footings, Piers & Pads** and **Concrete Slab Floors**. Be sure your entries are being made for the appropriate category.

Concrete selections include three different strength values (25 MPa or less, 26–30 MPa and 31–35 MPa) common in Part 9 construction. Be sure that your choices reflect the engineering requirements of the project.

The MCE values for concrete are all derived from the industry average EPD issued by the Canadian Ready Mix Concrete Association. This EPD lists more mixes within each strength range than are included in MCE². We have selected mixes from across this spectrum to reflect the highest, mid-range and lowest MCE results, as well as the identified Canadian average.

If you are not certain about the mix you will be using, select the “industry average benchmark” in the appropriate strength category, as this reflects a reasonable value. If you know that you are using a mix that falls within one of the descriptions provided in the tool, select that mix.

If you have a specific EPD produced by your concrete supplier, you can either use the percentage function to adjust your result to reflect the actual EPD value, or see the instructions for the **User-Defined tab** and enter the EPD value there.

Rebar and Steel Reinforcing Mesh

Industry averages are used in these categories. If the size of rebar or mesh you are using is not represented, use the percentage function to adjust accordingly.

Foundation Walls

The Foundation Walls tab has a long inventory of options, and includes structural walls, structural wall systems (such as ICF), interior and exterior continuous insulation, framing, and related insulation and finishes for framing. Be sure to include all materials required for your project within the assembly.

If more than one material category will be used for your project's foundation walls, use the percentage function to adjust values accordingly. For example, if a project has a walkout basement, a portion of the foundation wall may be built with concrete masonry units and the remainder with treated wood, as shown below.

MASONRY UNIT WALLS						
CONCRETE MASONRY UNITS						
	CMU Walls 8" Hollow, No Grout - AVERAGE	50.4 m2	70%	1	798	798
	CMU - Normal weight / Canadian Concrete Masonry Producers Assn / 8" Normal weight blocks / 390 x 190 x 190 mm	50.4 m2	100%		1,113	
	CMU - Normal weight / Angelus Block Co. / 8" Normal weight blocks / 8 x 8 x 16 Precision	50.4 m2	100%		834	
If concrete grout and/or fill are being used for the CMU wall, be sure to add the volume of concrete separately.	CMU - Normal weight / Permacon / 8" Normal weight blocks / NW STD 20CM GLPW	50.4 m2	100%		895	
	CMU - Light weight / Canadian Concrete Masonry Producers Assn / 8" Light weight blocks / 391 x 190 x 190 mm	50.4 m2	100%		1,239	
	CMU - Light weight / Angelus Block Co. / 8" Light weight blocks / 9 x 8 x 16 Precision	50.4 m2	100%		983	
	CMU - Light weight / Brampton Brick / 8" Carbon Cure Lightweight blocks / Carbon Cure 15 MPa	50.4 m2	100%		1,780	
TREATED WOOD FOUNDATION						
	TREATED WOOD FOUNDATION - 2x8 framing @ 16" OC, 3/4" plywood sheathing	50.4 m2	30%	1	132	132

Structural Elements

This tab enables you to estimate the MCE for any large timber and/or steel posts and beams required for your project.

Wooden posts and beams – The units used for calculating MCE from these elements is cubic meters (m³). On the User Input Sheet, you will have been asked to calculate the quantity of cubic meters of these elements. A calculator is provided on the User Input Sheet to assist you in determining the correct value.

If your project uses more than one type of wooden post or beam material, calculate the total cubic meters and use the percentage function to attribute the correct volume to each material type you select.

Projects that intend to use a timber frame or post-and-beam frame can use this section to estimate MCE for this type of construction.

Steel posts and beams – There is no direct importation of information about steel posts or beams from the User Input Sheet. You must enter the appropriate information directly into the Structural Elements tab.

One option is available for steel posts; if your project requires a different size of steel post, you can use the percentage function to estimate the correct quantity of steel.

Options exist for a generic steel beam as well as specific steel beams. A drop-down menu defines a wide range of steel beam sizes.

Material Category	Length	Percentage	Quantity	Volume	Weight
Steel beam / W200x31 (W8x21) / American Institute of Steel Construction	5.2 m	100%	1	189	189
Steel beam / W200x22 (W8x15) / American Institute of Steel Construction					
Steel beam / W200x27 (W8x18) / American Institute of Steel Construction					
Steel beam / W200x31 (W8x21) / American Institute of Steel Construction					
Steel beam / W250x25 (W10x17) / American Institute of Steel Construction	m	100%		0	
Steel beam / W250x33 (W10x22) / American Institute of Steel Construction					
Steel beam / W250x39 (W10x26) / American Institute of Steel Construction					
Steel beam / W310x35 (W12x22) / American Institute of Steel Construction					
Steel beam / W310x39 (W12x26) / American Institute of Steel Construction					

In cases where the project does not require any timber or steel posts or beams, all fields in the Structural Elements tab can be left blank.

Exterior Walls (Ext. Walls)

The Exterior Walls tab contains a lot of material categories and material types. Be sure to scroll through the entire tab to familiarize yourself with all the options available for structural components, sheathing, and insulation.

Ext. Walls

MCE² does not ensure that any of the material categories offer the required structural properties for your project, nor that the variety of structural options offered meet the same performance criteria. The options have been selected to represent commonly used structural materials for Part 9 buildings and are considered comparable only on this basis. Builders should work with their engineering consultants to confirm that selected walls meet the structural requirements of their projects.

Framing options include a drop-down menu that allows a selection of 16-inch or 24-inch framing spacing. MCE² uses ASHRAE standards to determine framing factors for residential construction for the defined area of wall construction. If your project will use a different framing spacing, you can use the percentage function to estimate a more accurate volume of wood framing.

All steel framing for exterior walls has been assumed to be 16 gauge. If your project will use a different gauge of steel, you can use the percentage function to estimate a more accurate volume of steel framing.

The Concrete Masonry Units category is based on 8-inch wide blocks. If your project will use a different width of block, you can use the percentage function to estimate a more accurate volume of CMU. Note that if a CMU block wall will require concrete fill, this quantity of concrete needs to be calculated and entered directly on this sheet. A range of mix and strength options are provided for any concrete fill that is required.

CONCRETE FILL for CMU WALLS

CONCRETE
VOLUME

m³

NOTE: If your project plans to use a wall system such as SIP or ICF, you will find those options on the Exterior Wall Systems tab.

Exterior Wall Systems (Ext. Wall Systems)

This tab includes wall options that combine structural and insulation elements into an integrated system.

Ext. Wall Systems

The options for Insulated Concrete Forms (ICF) include a range of mix options for the required volume of concrete fill. Other materials in the ICF (insulation, internal structures, rebar) are estimated together based on standard practices derived from supplier specifications.

The options for SIP walls include the standard sizing and performance characteristics derived from supplier specifications.

Party Walls

This tab is used to select materials for party walls between multi-unit projects.

Estimating the MCE for a multi-unit building can be done in two ways:

- **Whole building** – All dimensions for the full project are entered into the User Input Sheet and all materials required to complete the whole building are selected in MCE².
- **Per-unit** – The dimensions for a single unit are entered into the User Input Sheet and only the materials required to complete one unit are selected in MCE². If the per-unit value is going to be multiplied by the total number of identical units, you must ensure that the area specified for the party wall will be split evenly between units to avoid double counting the MCE of the party wall. For example, to accurately estimate MCE for a project in which two identical units share a party wall, you should set the percentage function to 50%.

Cladding

This tab is used to select materials that will cover the exterior AND interior faces of your project's exterior walls. Be sure to include material selection(s) for the interior face at the bottom of the page.

Cladding

Windows

Many of the MCE values in the windows tab are not derived from manufacturer EPDs. In the window category, there was only one North American EPD for residential windows available for MCE².

In order to provide users with reasonable guidance on window MCE, Builders for Climate Action performed a study using a range of Tally models from leading window manufacturers to estimate material quantities for different frame types and applied EPD values for these materials plus average EPD values from window glass manufacturers. These estimates are identified with a note in column M, as shown below.

Windows

BfCA Study (Tally)

As more EPDs become available for residential window products, these values will be replaced with more comparable data.

Interior Walls (Int. Walls)

Framing options include a drop-down menu that allows a selection of 16-inch or 24-inch framing spacing. MCE² uses ASHRAE standards to determine framing factors for residential construction for the defined area of wall construction. If your project will use a different framing spacing, you can use the percentage function to estimate a more accurate volume of wood framing.

Int. Walls

For projects with a mix of wall framing sizes (such as 2x4 and 2x6), use the percentage function to allocate the appropriate square footage of each type of wall.

All steel framing for interior walls has been assumed to be 20 gauge. If your project will use a different gauge of steel, you can use the percentage function to estimate a more accurate volume of steel framing.

Interior walls that incorporate cavity insulation can be defined using the percentage function to allocate the appropriate square footage of the interior walls to be insulated.

Floors

The Floors tab includes floor framing, sheathing and finished flooring.

Floors

Framing options include a drop-down menu that allows a selection of 16-inch or 24-inch framing spacing. MCE² uses ASHRAE standards to determine framing factors for residential construction for the defined area of floor construction. If your project will use a different framing spacing, you can use the percentage function to estimate a more accurate volume of wood framing.

For projects that may use different floor framing sizes for different floors, you can use the percentage function to define the correct ratio of floor area for each framing size.

For projects that may require insulation in a framed floor, you can select the R-value and insulation material type. If only a portion of the framed floor area will be insulated, you can use the percentage function to define the correct ratio of floor area to be insulated.

Ceilings

Only ceiling finishes are defined in this tab. Ceiling insulation is captured in the Roof tab.

Ceilings

Roof

The Roof tab includes framing, sheathing, roofing and insulation.

Roof

For buildings with more than one style of roof framing, you can use the percentage function to define the correct ratio of roof area for each style of framing.

Framing options include a drop-down menu that allows a selection of 16-inch or 24-inch framing spacing. MCE² uses ASHRAE standards to determine framing factors for residential construction for the defined area of roof construction. If your project will use a different framing spacing, you can use the percentage function to estimate a more accurate volume of wood framing.

Roof cavity insulation can be defined based on either ceiling area or roofing area, using the drop down menu. For projects with flat ceilings where insulation will rest on the ceiling, select "Ceiling Surface." For projects with vaulted ceilings, select "Roof Surface."

R-VALUE:	60	INSULATION PARALLEL TO:	
			<input type="text" value="Roof surface"/> <input type="text" value="Ceiling surface"/>
69.7 m ²	100%		2,404

Garage

Garage

The Garage tab includes all the assemblies that may be required to construct a garage. All of the tab areas used to define the main building are repeated here. Be sure to scroll completely through the entire section to ensure you capture all the required materials.

Shared Assemblies – Be sure that you aren't duplicating materials when making selections on the Garage tab. Walls that are shared between the main building and the garage are defined in the Garage tab and should not be included in the total exterior wall area for the main building. Be sure to allocate roof and cladding areas accurately according to the building plans.

5) User-Defined Materials

The User-Defined Materials tab enables you to include customized entries that are specific to your building project in two ways:

5.1 Existing Database Materials

This section enables you to “mix and match” assemblies and materials in ways that were not possible within any of the assembly tabs.

The steps for using this section are as follows:

1. Decide if you are estimating a material that would be measured by volume (such as concrete), area (such as cladding), length (such as rebar) or R-value + area (insulation). There are distinct sections for each of these measurement types.

EXISTING DATABASE MATERIALS		
MATERIALS BY VOLUME		
	VOLUME	
	VOLUME	
	VOLUME	
MATERIALS BY AREA		
	AREA	
	AREA	
	AREA	
MATERIALS BY LENGTH		
	LENGTH	
	LENGTH	
	LENGTH	
MATERIALS BY AREA & R-VALUE		
	R-VALUE:	
	R-VALUE:	
	R-VALUE:	

- In the appropriate section, begin by opening the drop-down menu on the left side that will allow you to select the assembly for which you want to define the custom material choice. Each of the 13 assembly tabs are represented here. This selection will ensure that your custom entry is attributed to the correct assembly for subtotals and review purposes.

6	MATERIALS BY VOLUME		
7		VOLUME	
	Footings & Slabs	VOLUME	
	Foundation Walls	VOLUME	
	Structural Elements	VOLUME	
	Ext. Walls		
	Ext. Wall Systems	MATERIALS BY AREA	
	Party Walls		
	Cladding	AREA	
	Windows	AREA	
11		AREA	
12		AREA	
13		AREA	
14	MATERIALS BY LENGTH		
15		LENGTH	

- In the Materials area, open the drop-down menu that will allow you to select a material from the complete materials database. Materials are named as they appear in the assembly tabs. This is a long list, arranged alphabetically.

MATERIALS BY AREA		
	AREA	
	AREA	Window - double pane / Vinyl frame / / USA & CAN
	AREA	Window - double pane / Wood frame / / EU
	AREA	Window - double pane / Wood frame / / USA & CAN
	AREA	Window - double pane / Wood frame, aluminum cladding / / EU
	AREA	Window - double pane / Wood frame, aluminum cladding / / USA & CAN
	AREA	Window - triple pane / Fiberglass frame / / USA & CAN
	AREA	Window - triple pane / Vinyl frame / / USA & CAN
	AREA	Window - triple pane / Wood frame / / EU
	LENGTH	
	LENGTH	
	LENGTH	

- In the Quantity cell, enter the appropriate dimension to reflect the amount of material required for your project.

For an example, you can choose to apply metal panels to a portion of the ceiling area for your project. This was not an option within the Ceiling Assembly Tab. But, as shown below, you can specify “Ceilings” and “Metal Panels/Canadian Average” and 32.3 m² and the estimated MCE of 483 kg CO₂e is shown and will be added to your project total.

MATERIALS BY AREA						
Ceilings	AREA	Metal Panels - Steel / Canadian Sheet Steel Building Institute / 24 gauge	32.3 m ²	100%	1	483

5.2 Custom User-Defined Materials

The MCE² tool is as complete as possible, but new EPDs are released by manufacturers regularly and the tool may not include material options or EPD results for specific products that became available after the release of the tool.

The Custom User-Defined Materials tab enables you to define any material(s) and apply any EPD value(s) required for your project.

NOTE that MCE² cannot verify the accuracy of any information added into the Custom User-Defined Materials area. Only use this function of MCE² if you are confident that you fully understand the EPD data you are entering, and that you have properly matched the amount of material required for your product with the appropriate A1 to A3 GWP information from the EPD.

NOTE that MCE² does not perform any calculations in this area, but only records your entries into the Emissions and Storage cells (columns L and M) to the totals for the project.

To use this section:

- Write the name of the material into Column D. Include supporting information such as the EPD number and even your supporting calculations to ensure clarity and transparency.
- Specify the quantity of material required for your project in Column E, and the units for this quantity in Column F. There is no link between the quantity cell and the User Input Sheet.
- Enter the Emissions results for the material into Column L and the Storage results (if any) into Column M. MCE² will combine these and automatically populate the Net Emissions in Column J.
- Select your material by entering 1 into Column I, as you have done in all the previous assembly tabs. The MCE for your custom defined material will be highlighted in orange in Column K to confirm that the value has been added to your project total.

CUSTOM USER-DEFINED MATERIALS									
User-Defined	Cool new material! EPD### (2022)	10.0 m ³	100%	1	80	80	100	20	

Any Custom User-Defined Materials are displayed in a distinct area in the Review and Results tabs to inform the reader of the use of custom entries.

6) Review Tab

The Review Tab is intended to give you a chance to see all of the results from all of your selected materials in one place, providing an opportunity to scan all of your material selections and ensure that you have captured all the materials required for your project. You will find the total net emissions as well as gross emissions and gross storage at the top of the sheet and a list of materials colour-coded to their respective assembly tab. A “heat guide” is provided in Column D, which highlights, at a high level, the materials that contribute the most emissions and storage to your project. The Review tab is an excellent resource for project team meetings, to discuss and make decisions about potential improvements.

SECTION 12 → REVIEW			SELECTED MATERIALS	30,992	39,526	8,534
SECTION	CATEGORY	MATERIAL	NET CARBON FOOTPRINT [kg CO ₂ e]	CARBON EMISSIONS [kg CO ₂ e]	CARBON STORAGE [kg CO ₂ e]	
Footings & Slabs	STEEL REINFORCING MESH	Welded wire mesh / Serfas / / 6" x 6" x 6/6g / Norway	55	55	0	
Footings & Slabs	SLAB FLOOR(S)	Concrete - 0.25 MPa, Industry Average Benchmark / CRMCA / Can. Avg. /	1,028	1,028	0	
Footings & Slabs	SUB-SLAB INSULATION	XPS foam board - AVERAGE	2,347	2,347	0	
Footings & Slabs	BASEMENT FLOORING	Hardwood flooring - AVERAGE	316	316	0	
Footings & Slabs	BASEMENT FLOORING	Linoleum flooring - AVERAGE 2.5 mm	6	30	24	
Footings & Slabs	BASEMENT FLOORING	Tile flooring - AVERAGE	266	266	0	
Foundation Walls	CONCRETE FOUNDATION WALLS	Concrete - 0.25 MPa, Industry Average Benchmark / CRMCA / Can. Avg. /	3,121	3,121	0	
Foundation Walls	CMU FOUNDATION WALLS	CMU Walls 8" Hollow, No Grout - AVERAGE	798	798	0	
Foundation Walls	TREATED WOOD FOUNDATION	TREATED WOOD FOUNDATION - 2x8 framing @ 16" OC, 3/4" plywood sheathing	132	132	0	
Foundation Walls	FOUNDATION WALL CONTINUOUS INSULATION	XPS foam board - AVERAGE (excludes new NGX 250)	4,981	4,981	0	
Foundation Walls	INTERIOR FOUNDATION WALL FRAMING - WOOD	Wood framing & siding - SPF / American Wood Council & Canadian Wood Council / /	98	98	0	
Foundation Walls	FOUNDATION WALL INSULATION	Mineral wool batt - Foundation Wall Insulation - AVERAGE	519	519	0	

7) Results Tab

The Results Tab provides some visual summaries of the project that can help project teams and clients understand some key information provided by MCE².

7.1 Project Summary

The Project Summary section is a “snapshot” of the project, including key project information, a place to include a photo or schematic of the project, and the overall emissions results. Material carbon emissions are shown in dark blue cells in two forms: gross MCE and material carbon intensity (MCI), which is the total MCE divided by the square meters of heated floor area for the project. The MCI result is plotted on a colour range similar to the energy efficiency results from a HOT2000 model, showing how this project’s MCI rates compare to national averages.

Material Carbon Emissions Estimator (MCE2) Project Carbon Emissions Estimates

PROJECT SUMMARY Save This Scenario

Project Photo or Image Here
(Insert -> Pictures)

Project: MCE Model #1	
Evaluator: Your Name Here	
Location: Canada	
Home description: Two story single detached home	
Building Size: 1615 m ²	

Material Emissions		Operational Emissions	
tonnes CO ₂ e	kg CO ₂ e / m ²	tonnes CO ₂ e / yr	t CO ₂ e / 30 yrs
66.1	336	1.5	46.4

Material Carbon Intensity, kg CO₂/m²

Project Notes
Home is aiming to achieve XYZ level of performance...

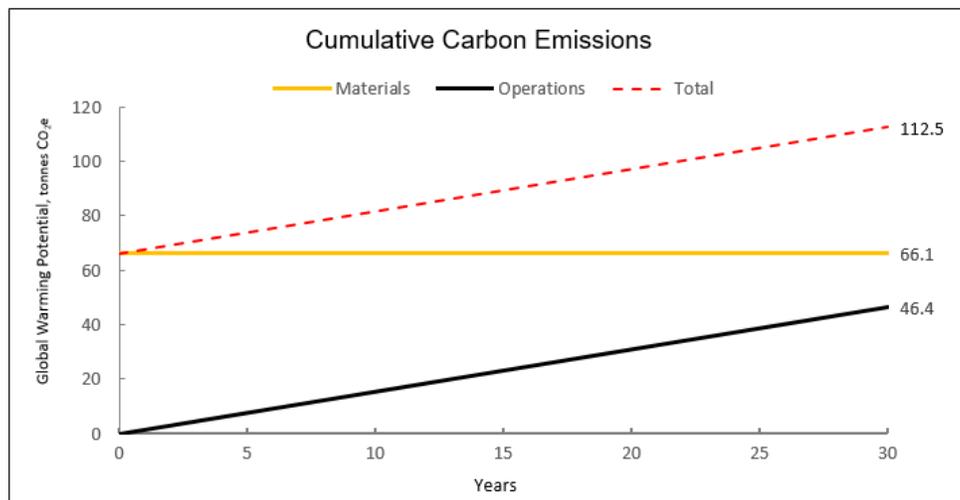
This portion of the Results tab enables you to add notes about the project, and provides a “snapshot summary” of the project to share with project teams and clients.

7.2 Project Emissions Timeline

Also on the Results tab is a Project Emissions Timeline that plots the total estimated emissions from your project over a 30-year period. There are three lines on this graph:

- **The MCE estimate** for the project is shown as a yellow line that remains flat across the 30 years to indicate the material emissions that have occurred before the building is inhabited. Any replacement of materials over the life of the home would cause an additional rise in this yellow line, but the majority of materials calculated in MCE² are not expected to need replacement within 30 years.
- **The operational emissions** for the project are shown as a black line that shows cumulative operating emissions over 30 years. This line begins at zero when the building is first occupied and grows at a steady rate as predicted by annual emissions estimations from HOT2000 (or the information provided on the User Input Sheet from a different modeling software). This is a simplified visual representation, and does not take into account seasonal variations or annual climate variability, nor any changes in fuel source emission intensity over time.
- **The carbon use intensity (CUI)** for the project is shown as a dashed red line that combines the MCE and operational emissions. The line begins at the height of the yellow MCE line to indicate that this is the level of emissions from the project during construction, and it rises at the same level as the black line to continue to add annual operating emissions to the total carbon footprint of the building.

PROJECT EMISSIONS TIMELINE



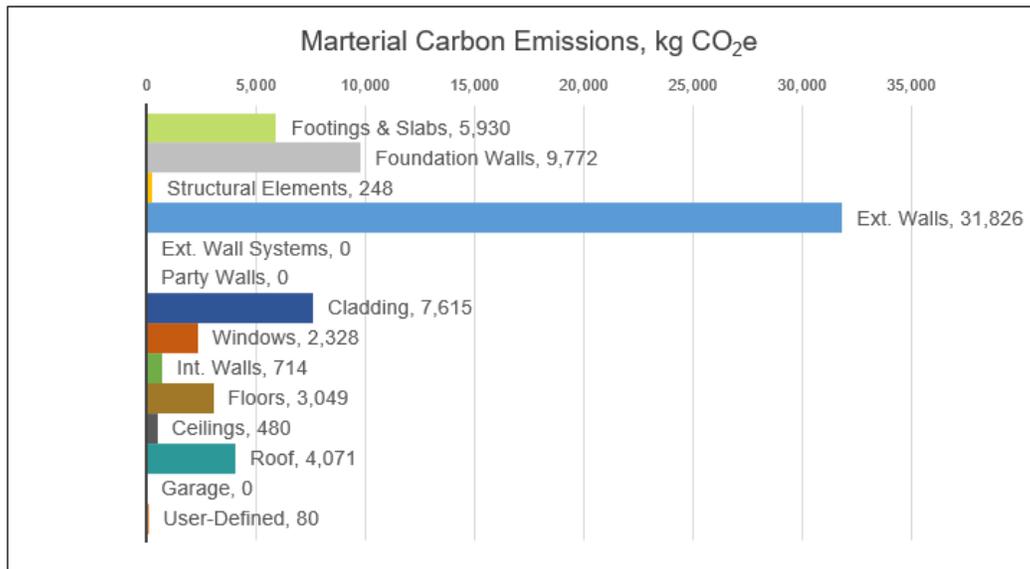
For the project shown in the illustration, the MCE is 66.1 tonnes of CO₂e. The annual operating emissions rise at 1.55 tonnes per year and accumulate to 46.4 tonnes by year 30. The overall carbon use intensity of the building at 30 years would be 112.5 tonnes.

7.3 MCE Visualizations

By scrolling further down the Results tab, a couple of helpful visualizations are provided.

Emissions by Element of the Home displays the subtotal results from each of the assembly tabs in the form of a graph.

EMISSIONS BY ELEMENT OF THE HOME



Top 10 Most Impactful Materials displays the material selections for the project that make the highest individual contributions to the overall MCE result.

TOP 10 MOST IMPACTFUL MATERIALS

Rank	kg CO ₂ e	Section	Material
1	30,604	Ext. Walls	XPS foam board - AVERAGE (exc
2	7,322	Cladding	Brick, Clay, Generic Modular / Bri
3	4,981	Foundation Walls	XPS foam board - AVERAGE (exc
4	3,121	Foundation Walls	Concrete - 0-25 MPa, Industry Ave
5	2,347	Footings & Slabs	XPS foam board - AVERAGE
6	2,328	Windows	Window - triple pane / Vinyl frame
7	2,273	Roof	Mineral wool batt / Rockwool / Saf
8	1,891	Footings & Slabs	Concrete - 0-25 MPa, Industry Ave
9	1,028	Footings & Slabs	Concrete - 0-25 MPa, Industry Ave
10	867	Floors	Hardwood flooring - AVERAGE

These two visualizations are intended to assist the project team and the client in understanding how the MCE for the project could best be reduced by calling attention to the assemblies and, in particular, the materials that have the biggest impact on the total MCE. These represent the construction elements where there may be opportunities for MCE reductions and can be the focus of efforts to reconsider the design and/or material selections for the project.

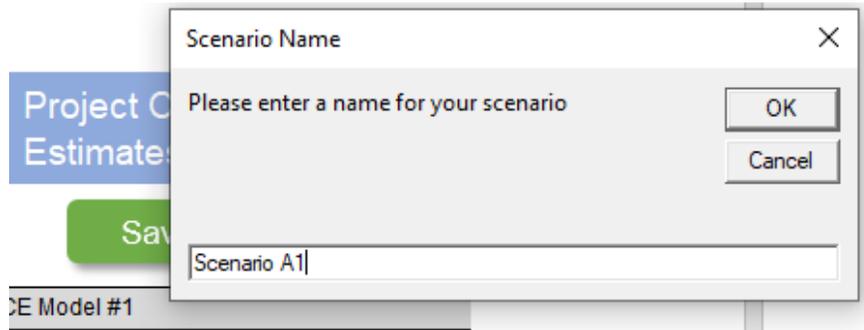
A **Recommendations** section on the Results tab allows the consultant or design team to note any particular strategies they may suggest for reducing MCE.

8) Saving Scenarios

MCE² is a comparative tool, and the Save Scenario function is intended to simplify the process of making comparative models of the same project. At the top of the Results tab, an option to save your current scenario is offered in a green button on the top right corner of the sheet.



Clicking on the “Save This Scenario” button will enable you to give a name to this particular scenario.



When you enter the name and click “OK” the results from the scenario will be displayed on the Scenarios tab.

 Natural Resources Canada / Ressources naturelles Canada		Project Carbon Emissions Scenarios				
Reset Calculator Delete Scenario Recalculate All Scenarios		How to use this TAB: 1. Users can save scenarios to this page in order to compare results generated in the calculator. 2. All data associated with the saved scenarios can be re-populated across the spreadsheet. 3. To populate a scenario in the estimator, users can select the scenario by clicking on the green button labeled "Reset Calculator" on the left. 4. Users can establish custom scenarios and apply these to different homes by loading a new geometry in the USER INPUT SHEET and clicking on the blue button on the left labeled "Recalculate all Scenarios". 5. This will calculate new values associated with the updated geometry for each saved scenario below.				
Notes	Scenario A1	Name of Scenario Here	Name of Scenario Here	Name of Scenario Here	Name of Scenario Here	Name of Scenario Here
	As designed home...	Type notes here	Type notes here	Type notes here		
MCE Total (tonnes CO ₂ e)	66.1					
Embodied Carbon per m ² (kg CO ₂ e / m ²)	336					
Footings & Slabs (kg CO ₂ e)	5930					
Foundation Walls (kg CO ₂ e)	9772					
Structural Elements (kg CO ₂ e)	248					
Ext. Walls (kg CO ₂ e / m ²)	31826					
Ext. Wall Systems (kg CO ₂ e)	0					
Party Walls (kg CO ₂ e)	0					
Cladding (kg CO ₂ e)	7615					
Windows (kg CO ₂ e)	2328					
Int. Walls (kg CO ₂ e)	714					
Floors (kg CO ₂ e)	3049					
Ceilings (kg CO ₂ e)	490					
Roof (kg CO ₂ e)	4071					

With the scenario saved, you can now go back through any or all of the assembly tabs and select different materials. At the end of your new selections, you can repeat the "Save Scenario" process and the results of the new scenario will appear next to the previous scenario. This enables easy comparisons across as many as six scenarios.

After you save a scenario, all of the existing dimension information and material selections from the previous scenario will be maintained. This ensures that the work you have done to make inputs is maintained.

If you intend to only make a small number of changes to a particular assembly tab, you can do so manually by deleting the "1" that is entered in Column H and selecting a replacement material.

If you want to "start from scratch" on any assembly tab, there is a Clear This Sheet Only button at the top right of the sheet that will erase all the selections previously made on that assembly tab and allow you to begin again.

EXTERIOR WALLS

Clear This Sheet Only

This can be helpful if your intention is to try a substantially different approach, rather than substitute single materials.

The User Input Sheet also provides an option to clear data in two ways, using the blue buttons at the top of the sheet.



Clear All (User Input and all Assembly Tabs)

Clear This Sheet Only (User Input)

The first of these clears all of the data from the User Input Sheet and all of the assembly tabs. This option allows you to start again with all new inputs.

The second clears only the User Input Sheet and leaves all the assembly tab data intact. This allows you to keep the same material selections and apply them to a new building. This is helpful if you have common assemblies and materials in your practice that repeat over multiple home designs.