

**Guidance
Document**

COMMERCIAL BUILDING CALCULATOR



Prepared by the greenregistry.org | 2008

Guidance Document for Manitoba Green Registry: Commercial Building Calculator

IMPORTANCE OF THIS CALCULATOR	2
SCOPE OF ACTIVITY AND EMISSIONS.....	2
REQUIRED USER INPUTS	4
UNDERLYING METHOD AND DATA SOURCES	4
USING THE CALCULATOR.....	8

Importance of this Calculator

Buildings of all kinds contribute to greenhouse gas (GHG) emissions from the fuels they burn on site and electricity consumed for lighting, heating/cooling, water heating, and to run equipment (e.g. refrigerators) and machinery (e.g. fans). The GHG emissions result from the direct use of fuel, such as natural gas or heating oil, or indirectly through purchased electricity. Even with Manitoba’s abundant supply of hydro-electricity, there are GHG emissions associated with the generation of electricity. Buildings operated by businesses and organizations in the commercial and institutional sub-sectors of the Manitoba economy can present opportunities to reduce their carbon footprint and save money. Building owners and operators have a number of options available to them for reducing the GHG emissions from these activities, and in doing so, reduce their carbon footprint.

The Commercial Building Calculator provides the building owner or operator with a tool for measuring the GHG emissions that result from all of the energy end-uses described above. It does so by providing a user interface for inputting information about the building energy use, the location and size of the building, the type of equipment operated, and other parameters. Then options are provided that allow the building owner or user to consider actions that might lead to a reduction of GHG emissions from this baseline, along with the ability to purchase GHG emission offsets.

Scope of Activity and Emissions

The Commercial Building Calculator includes all of the GHG emissions associated with energy used in the commercial or institutional building, as well as the indirect GHG emissions associated with purchased electricity. This includes GHG emissions attributable to following end-uses:

Table 1. Energy end-uses analyzed in the Commercial Building Calculator

End use	Energy uses include
Space heating	Central heating systems (normal, medium and high efficiency), fuelled by either natural gas or heating oil, electric base boards, heat pumps, or wood stoves.
Space cooling	Electric or natural gas space cooling.
Water heating	Electric or natural gas water heating.
Auxiliary equipment	Auxiliary equipment includes stand-alone equipment powered directly from an electrical outlet such as computers, photocopiers, refrigerators and desktop lamps. It also includes equipment that can be powered by natural gas, propane or other fuels, such as clothes dryers and cooking appliances.
Auxiliary motors	Devices used to transform electric power into mechanical energy in order to provide a service, such as pumps, ventilators, compressors and conveyors.
Lighting	Light bulbs.

The calculator estimates emissions of the three main GHGs emitted from commercial building energy use, namely; carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O). In order to present a single metric for GHG emissions from commercial buildings, the three GHGs are normalized to their carbon dioxide equivalence (CO₂e) and presented as CO₂e. The commercial and institutional sub-sectors include the following establishments:

Table 2. Sectors included in the Commercial Building Calculator

Sub sector	Includes
Wholesale Trade	Businesses involved in the wholesale trade. Businesses, government agencies, or institutions, such as universities or hospitals purchase goods from wholesale trade establishments.
Retail Trade	Businesses involved in retail trade such as stores or shopping malls. These are largely entities selling products or services to the consumer.
Transportation and Warehousing	Businesses involved in delivering goods and warehousing services for the temporary storage and distribution of goods.
Information and Cultural Industries	Art galleries, libraries, and other similar facilities.
Offices	Office space used for delivery of business services, including financial, real estate, government or commercial operations.
Educational Services	Schools, colleges, and universities.
Health Care and Social Assistance	Hospitals, health care centres, and community centres.
Arts, Entertainment and Recreation	Cinemas, theatres, sports arenas and stadiums, and public recreation centres.
Accommodation and Food Services	Restaurants, hotels, conference centres, and other commercial accommodation.

There are four design principles that were followed in the development of the calculator:

- The **Calculator** is NOT intended to be an energy audit or GHG emissions-auditing tool. It is designed to generate a reasonable estimate of commercial building energy use and related GHG emissions in order to illustrate the effect of different operational changes, building retrofits, or other actions that affect energy use.
- The **Calculator** enables GHG emissions comparisons between the user and the average business of Manitoba in terms of the characteristics of the specific building where they operate their business or institution.
- The **Calculator** facilitates the comparison of different energy-using activities that contribute to total GHG emissions, such as space heating, space cooling, water heating, appliances, equipment and lighting.
- The **Calculator** has been designed to be user friendly and require minimal data inputs.

Required User Inputs

The Commercial Building Calculator includes a form with fields for users to input information about the building being evaluated. This information allows the calculator to estimate the energy use and GHG emissions for the specific type and size of building. The input fields are:

Field 1: the location of the building by address;

Field 2: the type of facility (e.g., office, warehouse, school) selected from a drop down menu;

Field 3: the size of the building (in square feet or square metres);

Field 4: the total fuel and electricity purchased over one year, by fuel type (including natural gas, heating oil, propane, wood, and electricity);

Field 5: the fuel source for space heating;

Field 6: the presence of a space cooling system;

Field 7: the fuel source for space cooling;

Field 8: the fuel source for water heating;

Field 9: the efficiency of the heating system, if known;

Field 10: the types of fuels used for auxiliary equipment, if known.

Underlying Method and Data Sources

The most accurate way to generate an estimate of the GHG emissions attributed to a building's fuel and electricity use is to multiply the amount of primary fuel (i.e. natural gas, heating oil, diesel, or wood) and electricity used over the course of a year by appropriate GHG emissions factors. Manitoba Hydro billing information includes the monthly consumption of natural gas (M³) and electricity (kWh). These can be added up to get the annual total and multiplied by fuel specific GHG emissions factors for Manitoba. These GHG emissions factors are taken from the National Greenhouse Gas Emission Inventory Report produced by Environment Canada yearly.¹

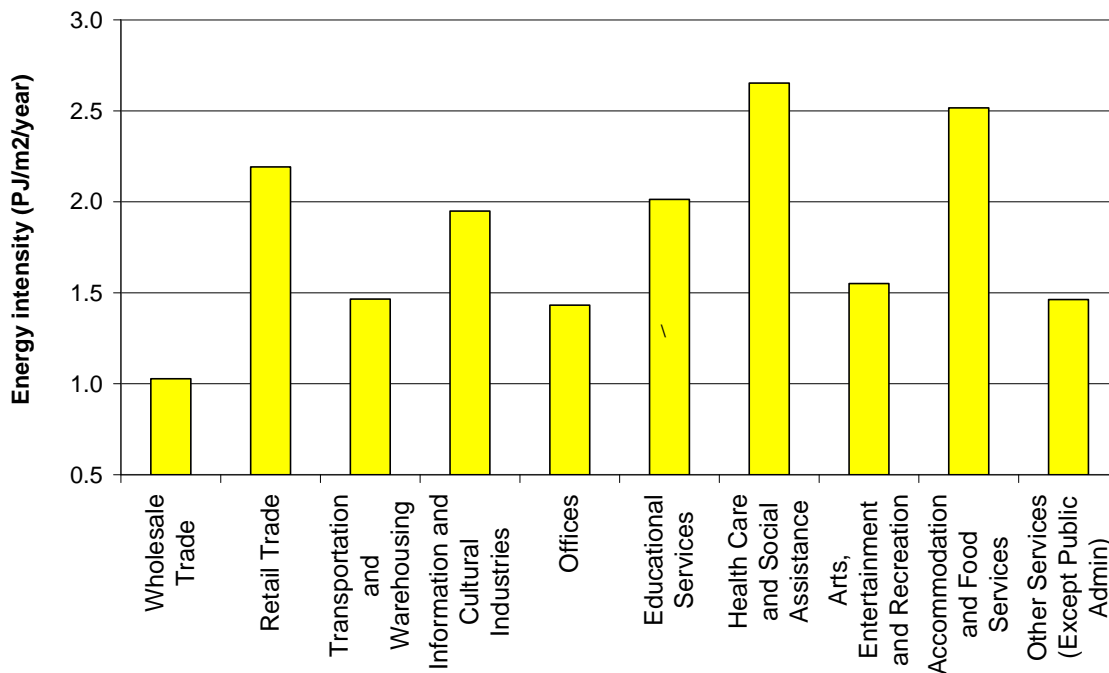
¹ National Inventory Report 1990-2005: Greenhouse Gas Sources and Sinks in Canada - The Canadian Government's Submission to the UN Framework Convention on Climate Change, April 2007

If the building owner, operator, or manager does not have annual totals for the fuel and electricity consumed, then the calculator estimates these values based upon statistics representative of the building stock in Manitoba as produced by the Office of Energy Efficiency (OEE) at Natural Resources Canada.²

The data available from the OEE allows energy and GHG emissions intensities (e.g. the GHG emissions from all fuels consumed for building energy purposes, per square metre, per year) to be estimated according to all of the end-uses in the building that require energy. The GHG emissions intensities vary based upon the type of building, the type of heating system, the thermal properties of the different building types, the number and technical characteristics of the cooling system, auxiliary equipment and motors, and lighting.

The GHG emissions intensity of a building varies by sub-sector, depending upon the amount and type of equipment operating inside the building requiring energy. This is presented as the amount of energy (in petajoules, of PJ) consumed per square metre or square foot of building space, per year.

Figure 1. Energy intensities in the commercial and institutional sub sectors



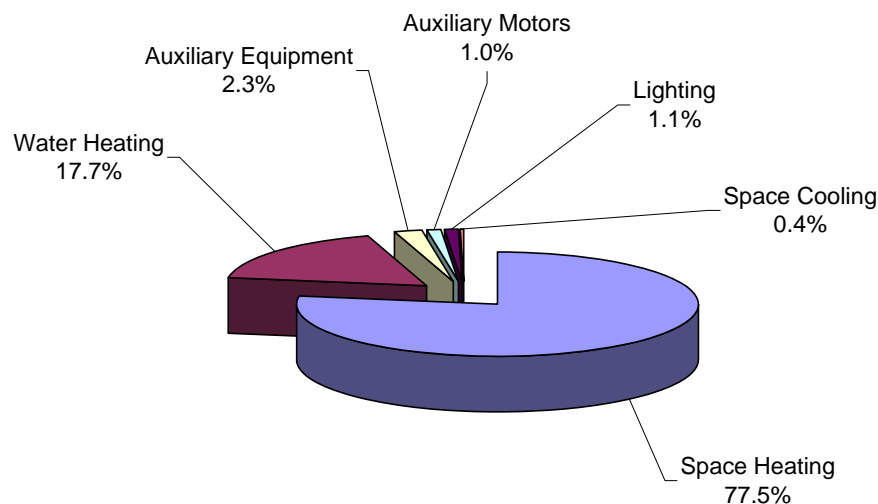
The *Health Care and Social Assistance* sub-sector is the most energy intensive, with each square metre of building space requiring about 2.7 PJ of energy per year. This is nearly 1.5 times higher than the lowest energy intensity sub-sector, whole sale trade. The *Health Care and Social*

² The Office of Energy Efficiency compile, on an annual basis, estimates of energy and emissions attributable to the Canadian building stock. Please see http://oe.e.nrcan.gc.ca/corporate/statistics/neud/dpa/comprehensive_tables/index.cfm?attr=0

Assistance sector is largely comprised of hospital buildings, with their relatively high energy intensity reflecting the amount of electricity used by medical equipment in these buildings. The sub-sector with the second highest energy intensity is the *Accommodation and Food Services* sub-sector. Again, this industry requires significant amounts of equipment to operate and deliver the services it provides.

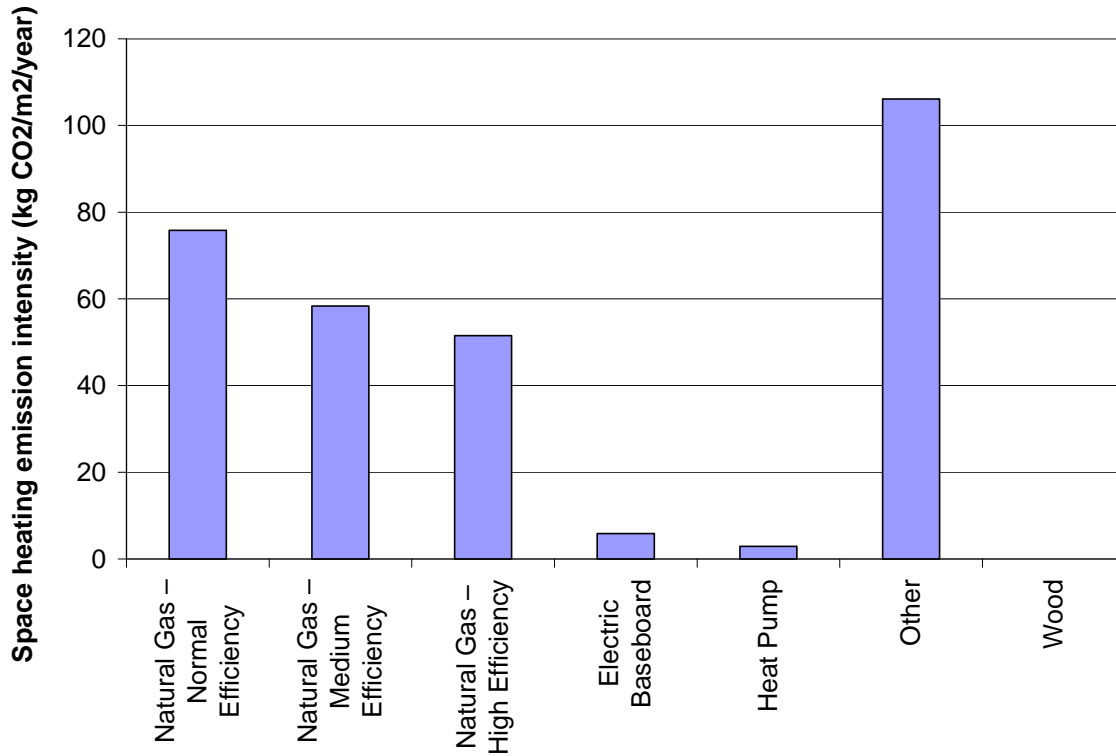
GHG emissions intensities range from about 34 kg CO₂e/m²/year to about 88 kg CO₂e/m²/year. The range reflects energy intensities since the proportional mix of energy use by end use, and the types of fuels used, are similar amongst the various sub-sectors considered. As suggested, the distribution of GHG emissions across the various end uses is similar across sub-sectors. This breakdown is shown in the pie chart below.

Figure 2. Proportional breakdown of CO₂ emissions in the commercial/institutional sector, by end use



As indicated by Figure 2, space heating accounts for the greatest percentage of GHG emissions from commercial and institutional buildings. However, it is important to note that this varies based upon the type of heating system in place. Depending on the sub-sector, natural gas heating systems make up 80% to 84% of all of the heating systems in Manitoba’s commercial and institutional sector. It is assumed that the majority of these are operating at ‘normal’ efficiency (defined by Natural Resources Canada as heating systems that are about 60% efficient). The OEE provides data on energy and GHG emissions by heating system, along with information on the stocks of the heating systems in service. This allows GHG emissions intensities to be produced on unit basis (see figure 3). We assume that variations in GHG emissions intensity on a unit basis are representative of variations in GHG emissions intensity on an area basis. For illustrative purposes, we show GHG emissions intensities for heating systems operated in buildings in the health care and social services sector of Manitoba’s economy.

Figure 3. GHG emissions intensities for different home heating systems operated in health care and social service centres in Manitoba (kg CO₂e/m²/year)³



The GHG emissions intensities vary from approximately 106 kg CO₂e/m²/year for heating systems fuelled by propane, heating oil, or coal (i.e. the ‘Other’ category), to less than 0.5 g CO₂e/m²/year for buildings fuelled only by wood.⁴

Within the emission calculator itself, GHG emissions factors are included for over 2,000 different buildings depending on the sub-sector, space heating system, water heating system, space cooling system, and auxiliary system involved.\

³ The specific energy efficiencies of the different home heating systems are shown below:

Heating Oil – Normal Efficiency	60%	Natural Gas – Normal Efficiency	62%
Heating Oil – Medium Efficiency	78%	Natural Gas – Medium Efficiency	80%
Heating Oil – High Efficiency	85%	Natural Gas – High Efficiency	90%
Electric Baseboards	100%	Wood	50%
Heat Pump	190%	Other (propane, coal)	50%

⁴ The emission factor for the combustion of wood only includes CH₄ and N₂O released during biomass combustion, and does not include the CO₂ attributable to the loss of wood from the forest. This is the same approach as used in the National Inventory of Greenhouse Gas Emissions, where these emissions are included only in the ‘Land Use, land Use Change, and Forestry’ sector. These emissions are currently not counted towards Canada’s national inventory totals as considered for the purposes of the Kyoto Protocol.

Using the Calculator

The Commercial Building Calculator is an important tool for measuring your organizations' carbon footprint. The Manitoba climate and business sector requires and allows for significant energy use in buildings for heating, cooling, lighting and operating appliances and equipment all year round. Understanding the GHG emissions arising from the operation of facilities is a valuable step in addressing operational costs and climate change in Manitoba. Commercial building energy use makes a large contribution to our carbon footprint but is also an area where small changes can lead to big improvements.

The Commercial Building Calculator can produce a meaningful estimate of energy use based on the size and type of building without precise data on energy use. It can be even more accurate if provided the actual electricity and natural gas from Manitoba Hydro billing information. This baseline measurement is the starting point for planning how to reduce GHG emissions. The calculator links the user to incentive programs and recommended actions for reducing commercial building energy use. Users can select the options that are appealing to their organization and see the results reflected in a lower carbon footprint over time. Energy efficiency in the business place is an important aspect of Manitoba's climate change strategy and a way for facilities operators to reduce their carbon footprint and save money.