City of Vancouver *Land Use and Development Policies and Guidelines*

Planning, Urban Design and Sustainability Department

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MODELLING GUIDELINES FOR LARGE HOMES

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Version 2.0

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1. Application and Intent

The Modelling Guidelines for Large Homes are referred to by Article 10.2.2.20 in the Vancouver Building By-law. These guidelines apply to one and two family dwellings, with or without ancillary dwelling units (such as secondary suites, or other outbuildings) where the primary dwelling unit has a conditioned floor area greater than 325 m^2. These dwellings must comply with the following carbon emissions limits:

- March 1st, 2018 to May 31st, 2021: 3.0 tonnes CO_2 / year or less
- June 1st, 2021 and after: 2.0 tonnes CO_2 / year or less

For homes that must comply with this requirement, a certified energy modeller must complete an energy model in compliance with this guideline, and then fill out and submit the approved calculator checklist with Building Permit applications. The most recent version of the Large Homes GHG Calculator checklist can be found at www.vancouver.ca/home-energy

1.1. Policy Context

The intent of this policy is for exceptionally large new single family homes to demonstrate leadership in energy efficiency and low-carbon design. The policy was first approved by Council on January 27th, 2017 that established a 3.0 tonne CO_2 annual limit; an amendment was approved by Council on April 29th, 2020 to reduce the greenhouse gas limit to 2.0 tonnes CO_2 annually.

Specifically, new homes over 325 square meters (approximately 3500 square feet) are to be designed to limit the total greenhouse gas footprint to that of a 325 square meter (~3500 square feet) home. The larger the home above this threshold, the greater leadership in improved design, better building envelopes, and improved equipment that will be required to comply with the carbon pollution cap. This house size was identified as a small portion of the overall number of homes with a significant greenhouse gas footprint.

Vancouver's average new single family home size (including both East and West side developments) is 2,600 square feet. For reference, the average new home size in BC is 1,900 square feet. Large luxury homes have the opportunity and ability to demonstrate energy efficiency leadership. Greenhouse gas and energy modelling has shown that reducing greenhouse gases for homes of this size is straightforward with commonly used local methods and technology.

1.2. Definitions

EnerGuide: a national system managed by Natural Resources Canada in collaboration with its regional partners for the purpose of rating the energy performance of houses. The EnerGuide Rating System—Standard—Version 15 outlines the basis for rating new and existing houses under the EnerGuide Rating System. EnerGuide Rating. The energy performance rating of the house, stated in gigajoules per year, determined using the standard operating conditions and calculated by subtracting the annual renewable energy contributions from the annual energy consumption.

HOT2000: an energy simulation modelling software and design tool for low-rise residential buildings, developed and maintained by Natural Resources Canada and used for many different government programs and private sector applications.

Greenhouse Gas Total (GHGT): The total greenhouse gas emissions associated with the use of all energy on site, using the following emissions factors:

Table 1.2 Emissions Factors by Fuel Type	
Fuel Type	Emissions Factor (kgCO2e/kWh)

Natural Gas	0.185
Electricity	0.011
Low-Carbon Energy System	0.070

GHGT [kgCO2e/a] = Σ (Site Energy Use [kWh/a] x Emissions Factor [kgCO_2e/kWh])

GHGT shall be reported in tCO_2e per year.

1.3. Software

Buildings with a footprint of 600 m^2 and less shall use the most recent version of HOT2000 approved by NRCan for the ERS program. Alternate hourly modelling tools may be used if the CBO agrees that an exception should be made.

Buildings with a footprint greater than 600 m^2 shall use either HOT2000 or hourly energy modelling at the discretion of the registered professional. If an hourly modelling tool is used, the program shall be tested in accordance with ANSI/ASHRAE 140, "Evaluation of Building Energy Analysis Computer Programs."

1.4. Energy Modeller Qualifications

For projects that use HOT2000, modelling shall be performed by a Certified Energy Advisor (CEA) registered with Natural Resources Canada.

For projects that use hourly energy modelling software, modelling shall be performed in accordance with the EGBC/AIBC Professional Practice Guidelines.

1.5. Electric Resistance Heat

Electric resistance heat for buildings with a footprint greater than 600 m2 is not permitted for buildings that comply with the low emissions buildings guideline. Buildings that pursue Passive House certification may use electric resistance heat.

Buildings with a footprint less than 600 m2 may use electric baseboard heating, but are advised to consider the lifecycle cost/benefit of more efficient systems.

2. Modelling Requirements

2.1. Low Emissions Buildings

2.1.1. Criteria

Projects shall be designed to meet an annual GHGT less than or equal to:

- 3.0 tCO2e between March 1st, 2018 and June 1st, 2021
- 2.0 tCO2e after June 1st, 2021

The total GHGT footprint for a project is calculated using an approved energy model in accordance with these guidelines.

2.1.2. Submission Requirements

Building Permit Application

Applicants must submit:
An ordered list of measures that exceed the current VBBL requirements used to reduce GHG emissions, with the associated GHG reduction amount (tCO2e/yr) for each measure.
A complete GHG Calculator spreadsheet indicating the total GHG footprint of the development

Occupancy Permit Application

The complete GHG Calculator must be included with the Final As-Built Checklist at Occupancy permit inspection

2.1.3. Exemptions

Projects that are designed to the following do not need to comply with the Low Emissions Buildings requirements (2.1) or these guidelines:

- meet Passive House Requirements (or approved equivalent standard), or
- utilize all-electric services

3. Standard Assumptions

3.1. HOT2000

All models completed using HOT2000 software shall follow the current EnerGuide Rating System for all modelling guidelines including standard operating conditions and base loads.

3.2. Hourly Modelling Software

All models completed using an hourly modelling program shall follow the City of Vancouver Energy Modelling Guidelines, supplemented by the guidelines below which take precedence.

3.2.1. Schedules

Occupancy, lighting, plug load, ventilation fans, temperature setpoints, and DHW schedules shall generally be as per NECB 2011 for residential buildings (Table A-8.4.3.2(1)G).

3.2.2. Internal Gains and Domestic Hot Water

Occupancy – 2 people for the 1st bedroom, 1 additional person for each bedroom thereafter.

- Plug Loads – 1 W/m2
- Lighting – 0.3 W/m2
- Exterior lighting – 75 W
- Domestic Hot Water (DHW) – 0.0016 L/s/person (0.025 gpm/person), modelled as the peak hourly flow and modified by the schedule noted in Section 3.2.1.

3.2.3. Infiltration

Infiltration shall be modelled as a function of wind speed from the weather file according to the equation below. Infiltration shall be scheduled on at all times.

Infil (m3/s) = 0.00024 m3/s/m2 x (0.224 x Wind Speed), Wind Speed is measured in m/s
Infil (cfm) = 0.047 cfm/ft2 x (0.224 x Wind Speed), Wind Speed is measured in mph

The area in the equations above is reflective of total, above grade, envelope surface area (i.e. roofs, walls, windows).

If airtightness testing is performed, the tested infiltration rate shall be used in the model.

3.2.4. Ventilation

Ventilation rates are to be modelled as per the design.

Exhaust fans that are not part of the ventilation system (eg. kitchen exhaust or bathroom exhaust not conneted to an HRV or similar), shall have a runtime of 2 hours/day.

4. Non-Typical Loads

Non-typical loads are energy uses that are not captured within the typical base loads in the EnerGuide program. Where non-typical energy loads are present in the development, the modeller shall include the energy and GHG emissions from those loads in the total footprint of the development.

The following guidelines shall be used to account for non-typical loads. These guidelines can be followed by completing the *GHG Calculator for Large Homes*.

Energy use for secondary heaters can vary significantly depending on the frequency of use, temperature set-points, outdoor temperature, and number of units. Multiple gas appliances connected to the main gas line typically increase energy consumption by 3 to 9 GJ/year.

4.1.1. Indoor Fireplaces

Indoor fireplaces that are the only source of heat in an area shall be modelled as "always on" per ERS requirements.

For indoor fireplaces that provide secondary or supplementary heating, add the following:

- GJ for each additional fireplace with a thermal efficiency greater than 60%.
- GJ for each additional fireplace with a thermal efficiency less than or equal to 60%, or if the thermal efficiency is unknown.

4.1.2. Outdoor Fireplaces, Decorative Flames, and Plumbed/Piped Outdoor Space Heaters

For outdoor fireplaces, decorative flames (indoor or outdoor), and plumbed/piped outdoor space heaters, add the following for each unit:

- 3.3 GJ for small units (<30,000 btu/hr or 8.8 kW)
- 7.1 GJ for medium units (30,000 to 100,000 btu/hr or 29.3 kW)
- 13.7 GJ for large units (>100,000 btu/hr or 29.3 kW)

4.1.3. Plumbed/Piped Grills

Add 6 GJ for each plumbed/piped grill.

4.1.4. Rough-ins

Rough-ins that are intended for future installation of fireplaces, flames, heaters, or grills shall be included in the GHGT calculation. For each rough-in follow the above guidelines for the future intended use.

4.1.5. Exterior Heaters or Grills with Tanks

Exterior heaters or grills that are not plumbed/piped to a gas line can be neglected. These may include, for example, barbeques and space heaters with propane tanks.

4.2. Pools and Hot Tubs

4.2.1. Outdoor Pools

Outdoor residential pools come in a range of sizes and shapes and can generally be classified as in-ground or above-ground pools. Energy is used to operate the filter pump and for pool heating, typically only during the summer months.

For outdoor pools, add the following:

- [2.91 x water surface area (m2) – 1.06] GJ gas or electricity for pools with a gas or electric resistance water heater
- Energy consumption can be neglected for pools with solar water heaters or electric heat pump water heaters that meet at least 60% of the heating demand.

4.2.2. Indoor Pools

Like outdoor pools, indoor residential pool energy is used to operate the filter pump and for pool heating. Indoor pools are typically used year-round.

For indoor pools, add the following:

- [1.36 x water surface area (m2) – 0.30] GJ gas or electricity for pools with a gas or electric resistance water heater
- Energy consumption can be neglected for pools with solar water heaters or electric heat pump water heaters that meet at least 60% of the heating demand.

The structure enclosing the indoor pool is considered part of the heated volume of the house and is modelled as such, unless it is in a detached building (see Section 3.10.1).

4.2.3. Indoor or Outdoor Hot Tubs

This category refers to an indoor or outdoor freestanding vessel installed above ground, partially below, or in-ground. Energy use depends on variables such as the tub design, volume, use of insulated cover, pump horsepower and speeds, heating system, pump and motor efficiency and how the tub is used and operated.

Add the following energy consumption for indoor or outdoor hot tubs:

- 3 GJ electricity for pump energy
- 8 GJ water heating, fuel type consistent with design (eg. electricity for electric water heaters, natural gas for gas water heaters)

4.3. Heated Surfaces and Snowmelt Systems

Heated surfaces include heated driveways, heated walkways, and any other heated surface or snowmelt system. Electrically heated driveways use embedded heating cables to melt snow and ice. The energy use depends on the area being serviced, the annual hours of snowfall and the installed Watts-density of the melting system.

Add 0.1 GJ per m2 of heated area of the fuel type used for the heated surface system.

4.4. De-Icing Cable

Residential de-icing cables are mounted on the eaves of roofs, in roof valleys, in eaves-troughs/gutters and in downspouts to prevent melt-water from backing up under roof shingles. They can be controlled manually or by an automatic sensor. Energy use depends on variables

such as cable length, heating capacity per unit length, type of control and hours per year of operation.

Add 0.04 GJ per m of cable length of the fuel type used for the de-icing cable.

4.5. Spa Rooms

Spa Rooms include saunas, spas, aromatherapy rooms, steam rooms, and other similar spaces. Spa energy use can vary significantly based on the type of equipment, size, and frequency of use.

Add 17 GJ/year of gas or electricity for each gas- or electrically-heated spa room.

4.6. Secondary Cooking Areas

Secondary Cooking Areas include second kitchens, server kitchens, commercial kitchens, wok kitchens, and other secondary cooking areas.

Secondary cooking areas may use energy for exhaust ventilation (fan power and additional heating), plus electricity and/or gas for appliances.

Exhaust ventilation (eg. range hoods) shall be included in the energy model. Additional appliances shall be included in the energy and GHG footprint as follows: 565 kWh/year for each additional stove, oven, or cooktop using the fuel type present (electric or gas)

Additional refrigerators or freezers can be neglected from the GHGT calculation.

4.7. Refrigeration Systems

Refrigeration systems could include chilled wine cellars, server rooms, arena/ice refrigeration systems, walk-in freezers, other cold food/beverage storage, and other dedicated refrigeration systems. As refrigeration system energy is electricity, GHG emissions are likely to be insignificant, and therefore refrigeration systems can be neglected from the GHGT calculation.

4.8. Non-Typical Entertainment Facilities

Non-typical entertainment facilities may include movie theatres, games rooms, bowling alleys, and other entertainment spaces. Energy use can vary significantly depending on the equipment and use of the space. Non-typical entertainment facilities may be neglected if the energy uses are fully electric. For facilities with gas equipment, engineering calculations shall be used to determine typical annual energy use and GHG emissions added to the project footprint.

4.9. Outbuildings

4.9.1. Pool houses

A pool house is a dedicated building, detached from the main house, to enclose a pool. A separate energy model shall be created for a pool house building to reflect the design. The resulting energy consumption and GHG emissions shall be added to the project footprint. Pool energy consumption shall be added per Section 3.2.

4.9.2. Laneway House

A laneway house is a smaller, detached house located where the garage would normally go on a single-family lot. A separate energy model shall be created for a laneway house to reflect the design, with resulting energy and GHG emissions added to the project footprint.

4.9.3. Heated garages

Garages in this category may be attached or detached. Energy use depends on variables such as the size of the garage, the efficiency of its building envelope, the heating system used, the nature of use of garage and the heating temperature.

For attached garages, the structure enclosing the garage is considered part of the heated volume of the house and is therefore included in the energy model.

For detached garages, a separate energy model shall be created based on the design, and the resulting energy consumption and GHG emissions added to the project footprint.

4.9.4. Unheated garages

Garages in this category may be fully enclosed (walls on all sides) or partially enclosed (one or more sides open to the exterior).

Energy consumption may consist of three main sources: lighting, ventilation, and heating. A garage is defined as being unheated when the set point temperature is not higher than 4°C. This temperature reflects the fact that garages only need to be heated to keep pipes from freezing.

Unheated garages that use only electricity for lighting and/or fan power can be neglected from the GHGT footprint.

4.9.5. Gatehouse

A gate house is a small building or enclosure at the entrance to a property. Gatehouse buildings may be fully or partially enclosed, and may use energy for lighting, fans, and/or heating.

Gatehouse energy can be neglected if the space is not heated. If the space is heated, a separate energy model shall be created to reflect the design, with resulting annual GHG emissions added to the project footprint.

4.10. Electric Vehicle Charging Stations

Energy consumption from electric vehicle charging stations can be neglected in the GHGT calculation.

4.11. Elevators

As elevator energy is electricity, GHG emissions are likely to be insignificant, and therefore elevators can be neglected from the GHGT calculation.

4.12. Other Non-Typical Loads

Any other non-typical loads that are not covered by the EnerGuide Rating System or the above guidelines but are anticipated to produce significant GHG emissions (defined as greater than 0.1 tCO2e/year) shall be included with estimates based on good engineering practice.

5. References

EGBC/AIBC. (2017). Professional Practice Guidelines: Whole Building Energy Modelling Services Version 6 (Draft).

Natural Resources Canada. (2017). RETScreen4. Available online: http://www.nrcan.gc.ca/energy/software-tools/7465

Natural Resources Canada. (2016). EnerGuide Rating System HOT2000 User Guide Version 15.3.