CleanBC Commercial New Construction Program

Energy modelling guidelines

July 2021

BC Hydro Power smart | cleanBC BETTER BUILDINGS

Contents

Introduction

The purpose of CleanBC New Construction Incentives ("the program") is to provide an offering that will assist customers in the design and construction of new high performance, more electrified buildings in the Province of British Columbia and encourage customers to switch from fossil fuels to electricity in order to reduce greenhouse gas (GHG) emissions.

A key objective will be to continue to encourage the design and development industry to adopt an integrated design process and building performance modelling as standard practices, and as a result, promote higher performing, energy efficient and more electrified buildings.

Electrification Measures (EMs) will be focused on the building heating system/plant only (space heating, ventilation, service hot water heating and process heating systems). Customers should still pursue non–electrification measures (building envelope, lighting, equipment loads, fans, pumps etc.) to a certain efficiency level, but without the program's capital incentive support. It will be advantageous for customers to design energy efficient buildings by reducing building loads and integrating mechanical systems in a way that maximizes utilization of a heat pump (low temperature hydronic systems, extensive use of heat recovery, heat storages etc.) to an extent that no gas would be required as a backup heating source. This will ideally result in a highly efficient electrified building with lower energy bills in comparison with an average (non–optimized) new building.

Similarly with the previous BC Hydro's New Construction Program, BC Hydro will work with developers and their design teams early in the design process, and provide them with a range of tools and program support.

Purpose of this guideline

This guideline has been prepared to clarify the energy modelling responsibilities and tasks required to complete an energy modelling study. It may help to:

1. Orient consultants on the overall energy modelling concept, objectives, and approach
2. Outline the energy modelling process and report deliverables
3. Provide additional energy modelling resources and equipment efficiencies not available under the ASHRAE 90.1 2016 and NECB 2015 Standard.

This document is not intended to be an exhaustive set of technical requirements or best practices for energy modelling. These guidelines are to be used in addition to rules for energy performance modelling established in building performance modeling industry.

BC Hydro technical contacts

To obtain further information about the program's modelling requirements, please contact:Bojan Andjelkovic, **bojan.andjelkovic@bchydro.com**

1 Program introduction

Through the program, design teams incorporate life cycle costing principles, which account for ongoing energy and maintenance costs when evaluating and choosing components and systems. The best way to make these decisions is through an integrated design process and by using energy modelling software as a design tool in the earliest design stage. The program incentive offer would help further electrification of the heating system/plant design by providing energy modelling funding. The purpose of the program is not to simply encourage customers to switch from fossil fuels to electric resistance heating systems in order to reduce greenhouse gas (GHG) emissions, but incenting an energy efficient heating design that will ideally result in lower customer's monthly energy bills from the heating plant originally proposed during the schematic design stage (before the electrification optimization).

2 Eligibility

2.1 Project eligibility

To be eligible, the project must:

- Be new construction or major building renovation[1]
- Be at the end of the schematic design stage
- Have a proposed hybrid heating plant (heat pump with natural gas boiler boost/backup) or 100% natural gas boiler heating plant (* 100% electrically heated buildings should not apply)
- Offer a potential annual electrical energy increase
- Offer an estimated greenhouse gas emissions reduction compared to the initial design of minimum 400 tCO^2 over the measure life
- Be located in the BC Hydro service territory, including New Westminster

2.2 Consultant qualification requirements

2.2.1 LEAD CONSULTANT

All lead consultants must be pre-qualified. The lead consultant role is to coordinate the project's deliverables, such as the Energy Study Proposal and Energy Study Report, in addition to acting as a project manager in charge of building design on behalf of the client. The lead consultant can be an energy modeller, mechanical consultant, or architect.

In order to qualify, a lead consultant must:

- be a member of the BC Hydro Alliance of Energy Professionals ("the Alliance"). This requires $2M in liability insurance, references for proven track record, and a safety background check from WorkSafeBC. Contact **alliance@bchydro.com** to join
- complete and submit the Lead Consultant application form.

2.2.2 APPROVED MODELLER

A modelling (or mechanical engineering) consultant company must demonstrate that the modeller designated to perform energy modelling work has the appropriate training and experience. The modeller does not need to be an Alliance member to qualify.

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[1]Major building renovations defined as one of the following, all of which require a building permit and certified building plans by a licensed professional:

- Change of use and reconstruction of an existing building space or space within; or
- Change Construction work of a nature requiring the building or space within to be out of service for at least 30 consecutive days; or
- Renovations that are worth at least 50% of the existing building's value and impact the building envelope.

The consulting company must submit the following documents to our Conservation and Energy Management engineering department:

- Modeller's CV that briefly outlines overall technical and building performance modelling experience
- Two to three page summary that outlines three recent building performance modelling projects that they have worked on. The project description should include modelling scope, methodology, and software.

An approved modeller must supervise and review all modelling work prepared by a non-approved modeler.
If the approved modeller is not a Professional Engineer (P Eng), the modelling report must be read and signed off by the P.Eng in-charge of a building design.

2.3 Approved energy-modelling software

An energy-modelling study must be performed using 8,760-hour whole building computer simulation software (tested with ASHRAE 140 Standard). Acceptable software for whole building analysis includes:

- DOE 2.1e,
- EE4 version 1.7,
- EnergyPro,VisualDOE
- DOE2.2 and derivations (eQuest PowerDOE),
- EnergyPlus and derivations (Design Builder, Open Studio, Simergy, Trane TRACE 3D Plus, Bentley Hevacomp and Bentley AECOsim Energy Simulator V8i)
- IES Virtual Environment
- ESP-r
- TRNSYS
- Trane Trace 700 (Version 6.1 and higher)
- Carrier E20-II HAP

The program promotes the practice of using the best modelling software program (or combination of programs) for each building system configuration. The goal is to reduce complex modelling workaround methods by using the modelling software programmed to simulate building systems in the most detailed and physically correct manner. The program also promotes continued training and education to increase accuracy and overall modelling quality.

To ensure accuracy and the level of details required to expedite our review of the energy-modelling study, we require:

1. Hydronic radiant heating/cooling slab/ceiling panel systems with natural, mixed mode and displacement ventilation systems must be modeled with either of:
    a) IES VE and EnergyPlus
    b) Others: ESP-r, TRNSYS/TRNFLOW – acceptable, but not used in B C
2. DOE2 based programs are accepted only for the following radiant heating systems:
    a) All perimeter radiant heating-only panels and fin-tube convector heating
    b) Heating-only slabs (controlled by room sensible air temperature sensors) that do not receive significant direct solar gains. Thermal and energy performance from most heating-only systems does not depend significantly on taking advantage of thermal mass and off-peak operation of equipment
    c) Heating-only slabs (controlled by room sensible air temperature sensors) with displacement ventilation in rooms with insignificant stratification effect (ceiling height is less than 10 ft.) In that case, splitting the room volume into occupied and unoccupied zones will not be required
    d) Perimeter radiant heating only panels, chilled beams (with typical overhead/low level ventilation)
    e) If building has only one radiant heating/cooling system that serves 10% or less of the total building conditioned area

These requirements are based on the report "Contrasting the Capabilities of Building Performance Simulation Programs", July 2005 (pages 21 to 46): **ibpsa.org/proceedings/bs2005/bs05_0231_238.pdf**

3 Project baseline

The program's baseline is the proposed building schematic design model (subject to BC Hydro Approval). This model represents a reference design which could be improved by additional heating systems optimization (not strictly related to a fuel switch measures) modeling from the heating plant originally proposed during the schematic design stage (before the electrification optimization). **The baseline model should comply with applicable energy code(s), legislations or by-laws and should not take into account the organizations or project specific aspirational goals, specifications, or any other voluntary efficiency/sustainability targets, unless these are mandatory and are fully funded independent of this program. Projects with voluntary efficiency/sustainability targets would require modeling changes of heating system/plant, mainly to comply with heating source ratio provided in the program's tiered incentive table.** To qualify for this program, the improved energy efficient design model should result in an increase of heating system electrical energy consumption and significant reduction of fossil fuel consumption as a result of higher heat pump utilization and other electrification measures related to the heating system.

The program requires that code compliance and building loads reduction modelling have been already performed during the schematic design and prior to the program application.

For projects subject to the BC Building Step Code, a modeling consultant will be required to submit (in PDF or other electronic format) either the Schematic Design Modeling Report or BC Building Energy Step Code Modelling Report which demonstrates/verifies the claimed heating source ratio in the Pre-Screen tab of the program Workbook. Projects whose baseline model defaults to 100% natural gas heating source (as per program's tired incentive table) are exempted from this requirement.

The program's definitions of concept and schematic design models are aligned with the ASHRAE Guide: Achieving Zero Energy—Advanced Energy Design Guide for Small to Medium Office Buildings (pg. 47) as per below.

3.1 General Design and Modelling Stages

CONCEPT DESIGN (CD) PHASE MODEL—FOR INFORMATION ONLY

During the concept design phase the design team will determine the basic configuration of the building. Modeling during this phase may include simple box modeling and conceptual design modeling which can provide the following information:

- Impact of building massing and orientation on building energy consumption
- Impact of window-to-wall ratio on building energy consumption
- Availability of free cooling at the site
- Availability and importance of passive solar heating
- Potential energy savings from daylighting
- Potential energy impact of external shading strategies
- Potential for photovoltaic (PV) energy production
- General energy use patterns for the specific building use at this location
- Comparison of the energy use intensity (EUI) of this preliminary building with the energy targets

SCHEMATIC DESIGN (SD) PHASE MODEL- FOR INFORMATION ONLY

The goal of the schematic design phase is to develop a unified approach to the building configuration and systems, including floor plans, sections, and elevations, along with general recommendations for lighting systems and HVAC systems. Building performance simulations at this phase provide information on the difficulty of achieving certain energy code requirements. These modeling efforts must begin to include the specific information about how the building will be used in order to assess the feasibility of the goal. Modeling during the schematic design phase should include:

- General location of functional spaces
- Orientation of glazed areas and strategies for lighting and solar control
- Thermal performance of walls and roofs
- Conceptual selection of mechanical systems

The energy conservation strategy should maximize the potential for energy savings. The schematic design phase does not solve the energy problem, but it does establish the potential for the solution.

The best set of energy strategies will be unique, based on the specifics of the project. Developing these strategies involves understanding the energy and cost trade-offs for including or excluding any specific strategy. Energy efficiency and design elements interact with each other—the best strategies both enhance the design as well as save energy. Having a pathway to get to the energy target and types of strategies that are needed is critical for starting the discussion about how to achieve the goal. Energy efficiency strategies can be added to the model sequentially (incrementally, not cumulatively) to evaluate their impacts.

Note:

The CleanBC New Construction Program application (both Pre-Screen and Energy Study Proposal submissions) should start upon completion of this schematic design/modeling stage.

DESIGN DEVELOPMENT (DD) PHASE MODEL

During the design development phase, a much greater level of detail is applied to the design decisions made during the schematic design phase. More specific information concerning building envelope elements, mechanical distribution systems, lighting design strategies, and operating assumptions are incorporated. Specific products or components, with specific performance parameters, are selected. For operable systems, sequences of control are identified. The internal operating conditions are further detailed. During this phase, detailed economic analyses may be performed to inform product selection. Different alternatives for these design elements should be evaluated in this phase via detailed building energy modeling iterations.

Note:

The CleanBC New Construction Program study report workbook submission should take place at 75% or upon completion of this design development stage (but not later than 3 months before ordering and purchasing the proposed electrification measures).

APPLICABLE NEW CONSTRUCTION MEASURES CAN INCLUDE THE FOLLOWING:

- Heat recovery chiller
- Air-to-water heat pump
- Air-to-water heat pump water heater
- Ground source heat pump
- Air-to-air rooftop heat pump
- Water-to-water heat pump
- Exhaust air heat recovery heat pump
- Sewage heat recovery heat pump
- Electric boiler*
- Electric water heater*
- High-efficiency (>75%) HRV**
- Air source VRF
- Water source VRF
- Distributed water to air heat pumps

* Electric boiler and electric water heater will be accepted only if all other more efficient heat pump options are not feasible, or as a backup heating source. Electric baseboard heaters will not be accepted as a measure if they are proposed to be the main space heating system.

**HRV is an eligible electrification measure if combined with electrified (heat pump based) space heating system and if it is not required by Code, or municipal bylaws.

BC Hydro expects that code compliance and building loads reduction modelling have been already performed during the schematic design and prior to program application. This schematic design model will become (if accepted by BC Hydro) the projects program baseline with some modifications for heating source and heating system type (see the Appendix B).

TIERED INCENTIVE BASELINE TABLE

Building type	BC Energy Code Requirement	Incentive rate in $/tCO_2e$ over measures lifetime	Baseline heating source*
MURBs up to 6 stories	BCBC	30	100% Gas
	Step 2 TEDI	35	100% Gas
	Step 3 TEDI	60	100% Gas
	Step 3+ TEDI with GHGi < 8 $kgCO_2/m^2$	100	As proposed in schematic design
	Step 4 TEDI with GHGi < 4 $kgCO_2/m^2$**	120	As proposed in schematic design
MURBs over 6 stories	BCBC	30	100% Gas
	Step 2 TEDI	35	100% Gas
	Step 2 TEDI with GHGi < 8 $kgCO_2/m^2$	60	As proposed in schematic design
	Step 3 TEDI	60	100% Gas
	Step 3 TEDI with GHGi < 8 $kgCO_2/m^2$	100	As proposed in schematic design
	Step 4 TEDI with GHGi < 4 $kgCO_2/m^2$**	120	As proposed in schematic design
Office	BCBC	30	100% Gas
	Step 2 TEDI	60	100% Gas
	Step 2 TEDI with GHGi < 8 $kgCO_2/m^2$	100	As proposed in schematic design
	Step 3 TEDI	100	100% Gas
	Step 3 TEDI with GHGi < 4 $kgCO_2/m^2$**	120	As proposed in schematic design
Retail	BCBC	30	100% Gas
	Step 2	60	As proposed in schematic design
	Step 2 TEDI with GHGi < 8 $kgCO_2/m^2$	100	As proposed in schematic design
	Step 3 TEDI	100	100% Gas
	Step 3 TEDI with GHGi < 4 $kgCO_2/m^2$**	120	As proposed in schematic design
Hotel/Accommodation	BCBC	30	100% Gas
	CoV Rezoning	100	As proposed in schematic design
Warehouses	BCBC	30	100% Gas
Institutional (healthcare and university)	BCBC	30	100% Gas

Building type	BC Energy Code Requirement	Incentive rate in $/tCO_2e$ over measures lifetime	Baseline heating source*
Institutional (schools)	BCBC	60	100% Gas
Other public (pool-rec center)	BCBC	30	100% Gas

* Applies to all building heating systems (space, ventilation and domestic hot water heating)

** Rezoning projects in the City of Vancouver choosing Passive House Standard certification path default to this baseline

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Additional rules:

If a project is receiving additional funding from another Ministry of Energy, Mines & Low Carbon Innovation energy efficiency or low-carbon incentive program, that amount will be deducted from the total incentive the applicant is eligible to receive through the Clean BC Commercial New Construction program.

If the project is further electrified from the baseline and is built to 100% electric space, ventilation and domestic hot water heating (with no gas boiler as a backup) the project is eligible to receive a 10% bonus of the Capital Incentive. Subject to the final Site Inspected findings and adjustments. The minimum bonus is $10,000 and maximum is $50,000.

3RD PARTY THERMAL ENERGY PROVIDER (TEP):

- Where it is demonstrated that the Developer is incurring the upfront incremental capital cost to construct a more efficient TEP system, then CleanBC would look to fund incentives for plant GHG saving benefits below the baseline.
- Demonstrated proof would be in the form of progress draws including summary of costs that the developer has paid for the plant.
- If the TEP designs, builds and owns the system and incurs the upfront incremental capital cost of the project then CleanBC will not fund any portion nor claim any plants GHG savings.

BASELINE HVAC AND SHW SYSTEM TYPES

When a project baseline heating source defaults to 100% gas heating source, the baseline HVAC and SHW systems/plants should be modelled as per table in Appendix B of this guideline. Special cases to be reviewed/agreed with CleanBC program engineer.

The model should be compliant with the following Codes, legislations or by-laws (whichever applicable):

- ASHRAE 90.1 2016
- NECB 2015
- BC Energy Step Code—if enacted by municipal government policy (or chosen as a compliance path option in BC Building Code)
- City of Vancouver Rezoning Policy where applicable.

In addition to the above, in order to become eligible for a program application, the project schematic design must achieve the following mandatory program requirements:

- Maximum building envelope heat loss rate and heat recovery ventilation requirements equivalent to BC Energy Step Code level enforced by municipal governments' policies (i.e. City of Vancouver Rezoning Policy).

Maximum values of building envelope heat loss rates were derived from the energy models developed for BC Energy Step Code. They are independent of building operating schedules, heating system types, internal loads, building floor area and building shape. Heat loss rate (HLR) must be extracted from the schematic design (Baseline) energy model at the peak heating load day/hour and represents above ground building envelope transmission heat loss related to heat transmitting surface area:

- HLR (in W/m^2) = Sum of peak transmission heat losses (in W) through building envelope (roof, windows, walls, doors)/total above ground building envelope area (in m^2)
- Heat recovery ventilation (if required for the certain climate zone—check the table below) is represented by minimum ventilation sensible HRV effectiveness (in %)

Here are the values that must be reported in the project assessment worksheet (Pre-Screen tab) of the program workbook and submitted along with other project details for project application eligibility evaluation to program engineering team:

Building type	Location	ASHRAE climate zone	Step	HRV effectiveness	Envelope surface heat loss (opaque + window), W/m^2
MURB	Vancouver	Climate Zone 4	Step Code 1	None	27.8
MURB	Vancouver	Climate Zone 4	Step Code 2	60%	27.8
MURB	Vancouver	Climate Zone 4	Step Code 3	60%	23.5
MURB	Vancouver	Climate Zone 4	Step Code 4	60%	16.0
MURB	Kamloops	Climate Zone 5	Step Code 1	None	44.2
MURB	Kamloops	Climate Zone 5	Step Code 2	60%	37.8
MURB	Kamloops	Climate Zone 5	Step Code 3	60%	34.6
MURB	Kamloops	Climate Zone 5	Step Code 4	80%	23.0
MURB	Prince George	Climate Zone 6	Step Code 1	None	34.8
MURB	Prince George	Climate Zone 6	Step Code 2	60%	29.2
MURB	Prince George	Climate Zone 6	Step Code 3	60%	24.8
MURB	Prince George	Climate Zone 6	Step Code 4	80%	13.6
MURB	Fort St. John	Climate Zone 7	Step Code 1	60%	36.5
MURB	Fort St. John	Climate Zone 7	Step Code 2	80%	22.7
MURB	Fort St. John	Climate Zone 7	Step Code 3	80%	18.7
MURB	Fort St. John	Climate Zone 7	Step Code 4	80%	11.6
Retail	Vancouver	Climate Zone 4	Step Code 1	None	15.03
Retail	Vancouver	Climate Zone 4	Step Code 2	60%	13.13
Retail	Vancouver	Climate Zone 4	Step Code 3	60%	12.68
Retail	Kamloops	Climate Zone 5	Step Code 1	None	22.85
Retail	Kamloops	Climate Zone 5	Step Code 2	60%	18.22
Retail	Kamloops	Climate Zone 5	Step Code 3	80%	14.30
Retail	Prince George	Climate Zone 6	Step Code 1	None	25.67
Retail	Prince George	Climate Zone 6	Step Code 2	60%	16.81
Retail	Prince George	Climate Zone 6	Step Code 3	80%	15.11
Retail	Fort St. John	Climate Zone 7	Step Code 1	None	30.19
Retail	Fort St. John	Climate Zone 7	Step Code 2	80%	16.93
Retail	Fort St. John	Climate Zone 7	Step Code 3	80%	13.03

Building type	Location	ASHRAE climate zone	Step	HRV effectiveness	Envelope surface heat loss (opaque + window), W/m²
Office	Vancouver	Climate Zone 4	Step Code 1	None	29.76
Office	Vancouver	Climate Zone 4	Step Code 2	None	26.86
Office	Vancouver	Climate Zone 4	Step Code 3	None	18.90
Office	Kamloops	Climate Zone 5	Step Code 1	None	49.69
Office	Kamloops	Climate Zone 5	Step Code 2	60%	46.56
Office	Kamloops	Climate Zone 5	Step Code 3	60%	40.62
Office	Prince George	Climate Zone 6	Step Code 1	None	58.02
Office	Prince George	Climate Zone 6	Step Code 2	60%	41.34
Office	Prince George	Climate Zone 6	Step Code 3	60%	33.41
Office	Fort St. John	Climate Zone 7	Step Code 1	None	61.69
Office	Fort St. John	Climate Zone 7	Step Code 2	60%	25.70
Office	Fort St. John	Climate Zone 7	Step Code 3	60%	23.10
Hotel	Vancouver	Climate Zone 4	Step Code 1	None	25.33
Hotel	Vancouver	Climate Zone 4	Step Code 2	None	15.72
Hotel	Vancouver	Climate Zone 4	Step Code 3	90%	14.69
Hotel	Vancouver	Climate Zone 4	Step Code 4	90%	13.74

For other building types not indicated in the above table, the proposed schematic design building envelope performance and ventilation heat recovery must meet or exceed the referenced building energy efficiency standard (ASHRAE 90.1 2016 or NECB 2015) mandatory and prescriptive requirements.

Energy performance guidelines or building labelling targets (such as LEED, Passive House Standard, or performance specifications), unless required by current legislation, code, or by-law, are considered voluntary guidelines to be followed and would not affect our approved project baseline.

3.2 Modelling resources

COMNET COMMERCIAL BUILDINGS ENERGY MODELLING GUIDELINES AND PROCEDURES

This energy-modelling resource is available for download at:
buildingrating.org/document/comnet-commercial-buildings-energy-modeling-guidelines-and-procedures

The manual offers guidance to building energy modelers, ensuring technically rigorous and credible assessment of energy performance for commercial and multi-unit residential buildings. It provides a streamlined process that can be used with various existing modelling software and systems, across a range of programs.

DOE COMMERCIAL PROTOTYPE BUILDING MODELS

This energy modelling resource is available for download at:
energycodes.gov/commercial-prototype-building-models

These prototype buildings—derived from DOE's Commercial Reference Building Models—cover all Reference Building types (with the exception of supermarkets), and also an additional prototype representing high-rise apartment buildings. As Standard 90.1 evolves, PNNL makes modifications to the commercial prototype building models, with extensive input from ASHRAE 90.1 Standing Standards Project Committee members and other building industry experts.

BUILDING AMERICA BENCHMARK RESEARCH

The Building America Analysis Spreadsheets are available in a New Construction version at:
energy.gov/eere/buildings/building-america-analysis-spreadsheets

The spreadsheets provide the set of standard operating conditions—including hourly and monthly profiles for occupancy, lighting, appliances, and miscellaneous electric loads (MELs)—developed by Building America to objectively compare energy use before and after a retrofit, and against a benchmark new construction building.

ENERGY STAR MULTI FAMILY HIGH RISE PROGRAM SIMULATION GUIDELINES

This energy modelling resource is available for download at: **energystar.gov/ia/partners/bldrs_lenders_raters/downloads/mfhr/ES_MFHR_Simulation_Guidelines_Rev02_redline.pdf?8fd5-1967**

4 Application process and energy modelling study submission requirements

The program requires the submission of the CleanBC New Construction Incentives Energy Modelling Study Proposal and Report Workbook. The workbook was developed to serve three purposes:

1. To show required information and inputs needed for the technical review in the project application eligibility assessment (pre-screen), proposal and study approval process
2. To standardize energy study reporting format
3. To minimize duplication in documenting and submitting information for review phases (proposal and study reviews)

The workbook is to be completed and returned in digital format, as part of the mandatory requirements for energy study funding under the program. It is highly recommended that consultants read the instruction worksheet which has detailed step by step instructions before the workbook use for the first time.

4.1 Project eligibility screening (pre-screen worksheet)

The application's eligibility assessment starts after the schematic design development stage is complete. This model should already have confirmed the project's code compliance, analyzed energy efficiency measures and should provide the most cost effective schematic design for the project. The schematic modeling cost is not eligible for the program's modeling funding. Typically after schematic modeling, the mechanical design team would propose the following heating plant configurations:

- Hybrid heating plant (heat pump with natural gas boiler backup)
- 100% natural gas boiler, or
- 100% electrical heating source such as electric boiler, service hot water heater, electrical baseboard or 100% heat pump based heating plant are not eligible for application

If the design team finds that the proposed schematic design heating plant could be further optimized for higher heat pump utilization (and therefore creating efficient electrical energy consumption growth), it should fill out the project pre-screen worksheet in the workbook and send it to BC Hydro's Key Account Manager and Program Engineering team. This pre-screen section of the workbook is to be submitted along with the associated preliminary calculations / estimates that support the electrical energy consumption increase and fuel offset claims.

BC Hydro Engineering will use this worksheet to review the proposed electrification baseline (schematic design model data), estimated electrification measures' electricity consumption growth / fuel offset data and associated incremental costs. It is essential that the project consultant fill out all applicable fields in the pre-screen worksheet as this data will directly influence acceptance of the project. Multi-type building projects shall have inputs broken down by building type.

4.2 Energy study proposal (proposal worksheet)

The project is eligible to submit an application (which is the Proposal tab of the workbook) if the schematic design heating plant/systems could be further optimized (electrified) during the detailed design phase. If the schematic design model is a step code compliance model, the model must be updated with actual internal loads and occupancy/operating schedules. City of Vancouver Modeling Guideline's standardized modeling inputs are not acceptable as they have been developed strictly for Step Code compliance purpose. If actual internal loads and schedules are not defined/known, the latest ASHRAE 90.1 standard internal loads and schedules are to be used. More details are provided in the later sections of this guideline. The data provided will be evaluated by BC Hydro Engineering and, if accepted, the project will proceed to the study report stage. Detailed design modeling update cost related to the electrification measures is eligible for the Program's modeling funding.

The project application, proposal/study report submission and program process requirements and timelines will be discussed at the project application kick-off meeting.

At the energy study proposal stage, the workbook (with completed proposal worksheet) is to be submitted. Consultants are welcome to submit the proposals to the customer in their preferable proposal format. However, the consultant's proposal(s) do not need to contain project technical details, but just a reference to this workbook (proposal worksheet tab only). BC Hydro Engineering will use this worksheet to review the proposed modelling study scope and cost. The modelling consultant shall fill out all applicable modeling inputs fields to the best of their knowledge. Multi-type building projects should have inputs broken down by major building type (i.e. more than 10% of the combined conditioned area).

4.3 Energy study report (study inputs, study results and incremental capital cost spreadsheets)

Only a proposed building design model optimized for higher electrical heating source utilization will be modelled for program capital incentive purposes. The program baseline model is already available/agreed upon at the program application stage and may need to be updated with actual internal loads and operating/occupancy schedules obtained from the design team during detailed design phase. Electrification measures (EMs) shall be run separately and combined (if applicable) into one proposed electrification bundle.

At the energy study report stage, this workbook is the only document required for study review. Consultants are welcome to organize and present the study results to the customer in their preferred format. This customer-oriented report could be in an executive summary format and have the study report workbook referenced as an appendix.

The approved study proposal workbook must be used as starting point for study report inputs. The study inputs worksheet tab (automatically populated once the proposal tab is filled out) must be updated at the study report submission stage. During the detailed design and modelling stage, modelling inputs agreed upon at the proposal stage may change and study inputs worksheet should indicate all those changes. Edited cells will be automatically highlighted in yellow to give an indication to both the modeller and reviewer that assumptions/inputs have been changed from the proposal stage.

The study results worksheet is the central location for all simulation results (project baseline, EMs and proposed bundle). If this worksheet is properly filled out, the summary worksheet of the workbook will be automatically populated. At the same time, the Incremental Capital Cost Calculator (ICCC) worksheet will automatically get the EM names of modelled measures from the study results worksheet.

The energy modeller must add EM technical details required for the cost consultant to fill out the incremental capital costing information. The cost consultant can submit the costing information in their own preferred format, but in that case the modelling consultant must copy over those numbers to the ICCC worksheet in the study report workbook.

The hourly simulation results (8,760 hours) from the simulation program for both baseline and proposed models must be copied into Baseline and Proposed Models' Hourly Results worksheet tabs. Results in these worksheets are to show total building electricity and gas hourly data for each major building type separately.

Any additional building systems and modelling process details must be added at the bottom of the study inputs worksheet. If required, consultants are also welcome to add additional worksheets to the end of this workbook with additional calculations and project details.

Please refer to the instructions worksheet tab for more specific worksheet inputs details.

4.4 Post-tender energy study report update (if applicable)

Post-tender modelling updates will be required in the event that the building design and/or building size has been significantly changed after the approval of the pre-tender study report, and in cases where some of the approved EMs have been excluded by the applicant after the tender.

In this case, the study report workbook must be updated (study inputs, study results and ICCC worksheets) and resubmitted to the program engineer for additional review. The additional modelling and reporting fees related to this update can be submitted to the program engineer for approval with a proper justification and estimate of additional modelling hours required to complete this task.

5 Other modelling requirements

5.1 Building envelope thermal bridging and effective building envelope opaque U-values

The program requires effective building envelope opaque U-values calculation/ reporting/usage referencing the methodology and data presented in Building Envelope Thermal Bridging Guide (BETBG). The low resolution version of the guide can be downloaded from the program web page under “resources”. Each energy study report submission must report opaque building envelope effective U-values calculations and include them in the model.

Current prescriptive opaque envelope U-values in many energy codes, including ASHRAE 90.1 2016 and NECB 2015, represent only clear wall structure assembly U-values, but do not include the additional heat loss from the building envelope interface details. The BETBG research has shown that thermal bridging at interface details, especially at slabs, parapets and glazing transitions can be sources of significant heat flow through the building envelope. These additional heat flows were not accounted for in envelope heat loss calculations, which resulted in overestimated building envelope performance in building simulations.

To help consultants perform the effective opaque U-values calculations, the program has provided the Enhanced Thermal Performance Spreadsheet which is also available on the program’s web page under “resources”. This enhanced spreadsheet is intended to be a helpful tool in combining thermal performance values for building assemblies into an overall R- and U-value. The methodology for calculations in this spreadsheet follows the approach given in the BETBG. Submission of this spreadsheet (or consultant’s spreadsheet with similar format), along with the Energy Modelling Study Proposal/Report Workbook, is mandatory for a project submission in the program.

PROPOSED BUILDING MODELS

Effective opaque U-values calculations will be required for the proposed building envelope design. These calculations can be performed by energy modellers, architects or building envelope consultants. If performed by the energy modeller, selection of details will require discussion/coordination with the architect and/or building envelope consultant. A good collaboration within design team is essential for the success of the project.

Effective opaque U-values step-by-step calculation methodology is provided in the BETBG in section 1 4— “Example Utilization of the Catalogue”. In addition to this, the recommended calculation/modelling methodology during the schematic and detailed modelling stage (along with calculations Excel file example and set of example PDF drawings) is provided in the “Building Envelope Thermal Bridging Guide Working Example” package on the program web page.

Building energy simulation software commonly used in Canada currently does not have capabilities to directly input linear transmittance values into energy simulations. Some modelling programs already de-rate insulation layers to account for steel studs, but this takes in account only thermal bridging through clear wall assemblies, and does not take in account the most influential building envelope interface details (slabs, parapets, window to wall transitions). The overall U-value that includes the effects of linear and points transmittances must first be determined without the assistance of the energy modelling software to ensure that the correct thermal transmittances will be processed by the model.

The following linear transmittances must be taken in account in the overall building envelope U-value calculation: slab edges, balconies, parapets and windows to walls transitions). Points transmittances can be excluded except in special cases where they significantly influence overall building envelope performance (by more than 10%).

Many modelling programs use construction layers to build up the building envelope assemblies based on material properties. To account for thermal bridging, all the material properties should be left as is, while only the insulating layer R-value should be de-rated such that the correct overall U-value determined from calculation is matched with the output by the software. This method allows for the functions that account for thermal mass to be approximated by the software.

The clear field U-values can be determined using tables in Appendix A of the ASHRAE 90.1 2016 standard. This appendix has tables for example steel stud wall assemblies, but there are a numbers of other tables for other types of assemblies. If the clear field envelope assemblies are substantially different from what is in the Appendix A tables, they can always be calculated using BETBG. BETBG has an extensive catalogue of 300+ assemblies including clear field U-values for a variety of constructions and configurations.

The clear field U-values given in the BETBG catalogue are based on the ASHRAE 1365-RP methodology, which include air films. Many energy modelling programs calculate air films separately. The air films for the modeled details in this BETBG are listed with the material properties in each of the details in Appendix A. The thermal resistance of these air films may need to be subtracted out before entering R- or U-values into an energy modelling program.

5.2 Mechanical ventilation

BCBC indicates that mechanical ventilation systems, not specifically described in ventilation subsection, must be designed, constructed and installed as described in ASHRAE Handbooks and Standards.

BCBC and Vancouver Building By-Law (VBBL) references ASHRAE 62.1 2001 (excluding addendum N) version for ventilation rates.

NECB 2015 specifies that minimum rates as per code should be used, which means ASHRAE 62.1 2001 (excluding addendum N) version.

ASHRAE Standard 90.1-2016 lists ASHRAE Standard 62.1-2013 in its table of references.

The program references also ASHRAE 62.1 2013 whenever BCBC does not specifically prescribe ventilation rates, or does not reference specific ventilation standard.

Mechanical ventilation rates should be consistent in the baseline and proposed model. The only exception to this rule is a proposed design with displacement ventilation system decoupled from heating/cooling system (supply air temperature is cooler than room air and delivered at a low velocity to achieve unidirectional flow and thermal stratification). In that case, a ventilation effectiveness credit can be applied to the proposed model in terms of using higher zone air distribution effectiveness Ez of 1.2 (as described in ASHRAE 62.1 Standard) in calculation of the minimum zone outdoor air rate.

Mechanical ventilation of underground garages must comply with BCBC 6.2.2.3 requirements. If not specified otherwise, intermittent garage exhaust fans operation must be modeled with a four hr/day runtime for MURB garages and with a six hr/day runtime for commercial garages. Both baseline and proposed models must be modelled with the same garage ventilation control strategies prescribed by BCBC.

RESIDENTIAL VENTILATION

For BCBC Part 3 MURBs, the program references BCBC which prescribes minimum dwelling units ventilation requirements in 6.2.2.1 as well as in 9.32.3.3, 9.32.3.4 and 9.32.3.5. The MURB baseline building design dwelling units ventilation rates must be modeled the same as the proposed design ventilation rates.

BCBC (and therefore new construction program) references ASHRAE 62.1-2001 standard ventilation rates for all spaces in Part 3 residential buildings. However, for self-contained mechanical ventilation systems serving only one dwelling unit, required ventilation must comply with Part 6.2.2 or Subsection 9.32.3.

Dwelling units' kitchen and bathroom fans (with intermittent operation) must be modelled in both baseline and proposed models using the same exhaust ventilation rates, which do not exceed the rates provided in BCBC Table 9.32.3.3 B by more than 50%. If not specified otherwise, intermittent exhaust must be modelled with a two hr/day runtime.

On September 17, 2014, the Building and Safety Standards Branch issued the Bulletin No B14-05 which outlines changes related to residential dwelling units ventilation. Here is a brief overview of the proposed changes:

Effective December 19, 2014 residential dwelling units, such as houses, apartments and secondary suites will be required to have a principal ventilation system that exhausts air from bathrooms and kitchens and supplies fresh air to bedrooms and living areas (9.32.3.3). The principal ventilation system is intended to create a continuous flow of air through the dwelling unit, making it easier to control issues related to moist and contaminated air, such as mold and mildew. To satisfy the exhaust requirements of a principal ventilation system, every dwelling unit needs to have one fan that exhausts air continuously (24hr/day) at the minimum exhaust rates outlined in Table 9.32.3.5. Some small dwelling units in mild climates are permitted to supply fresh air through passive vents (9.32.3.4 (6)), but for most dwelling units exhaust and supply will require a mechanical fan (Copied from Bulletin No B14-05).

As per these new ventilation requirements, a principal ventilation system must mechanically provide supply air to living room and each bedroom (except as provided in 9.32.3.4 (6)). These BCBC ventilation requirements are optional for self-contained ventilation systems in Part 3 MURBs dwelling units (as indicated in 6.2.2.1 (3)). In such cases previous standard market practice MURB ventilation system (over-pressurized corridors with door undercuts for ventilation air supply) will not be accepted as program baseline residential ventilation system. The BCBC provides five separate compliance paths for mechanical distribution of supply air that utilize different systems, including forced-air heating systems, HRV's, ERV's, and central-recirculation ventilation systems (9.32.3.4). To eliminate any modelling re-work, it is essential for an energy modeller to communicate and coordinate proposed and baseline ventilation modelling strategy with the program engineer.

5.3 Service water heating

Regardless off the code compliance path and referenced standard, average daily service hot water demands must be used from the ASHRAE 90.1 2016. User's Manual Table 7-B (Source: Table 7, Chapter 49 of the 2007 ASHRAE Handbook—HVAC Applications). These demands are aligned well with the results of the latest ASHRAE research projects.

5.4 Internal loads

NON-RESIDENTIAL BUILDINGS

It is essential to use actual internal loads (lighting, plug loads, occupancy densities) and occupancy/operating schedules whenever available.

Proposed design lighting loads and schedules shall be always obtained from electrical engineer in charge for building lighting design. Lighting energy modeling shall follow space by space method.

If actual plug loads cannot be obtained from electrical consultant, acceptable plug loads for all buildings (except MURBs) may be taken from the ASHRAE 90.1 2016 User's Manual Table G-D.

If the design team selects NECB 2015 as compliance energy efficiency standard, and actual plug loads cannot be obtained from electrical consultant, acceptable plug loads may be taken from the NECB 2015 Division B, Part 8 Table A-8.4.3.2.(2)-A and Table A-8.4.3.3.(2)-B

In all cases, actual operating schedules shall be used whenever available. Actual schedules should represent the design team's best estimate of the expected operation of the proposed design.

RESIDENTIAL BUILDINGS

All regulated and non-regulated loads (including dwelling units' lighting, plug loads, appliances and building elevators) must be modelled in MURB models.

It is essential to use actual internal loads (lighting, plug loads, occupancy densities) and occupancy/operating schedules whenever available. If these internal loads cannot be obtained from the design team, the following parameters shall be used.

The following dwelling units' non-regulated loads must be modelled equally in MURB models:

- All home appliances and other dwelling units' miscellaneous electrical loads:
  - **Low: 2.68 W/m²** (senior homes, student dormitories, single occupancy, no in-suite laundry, no dishwashers). With LPD of 5 W/m2 the total in-suite EUI is 29.87 kWh/m².year. (1,970 kWh/year).
  - **Medium: 5 W/m²** (predominantly young couples without kids, both working, with in-suite laundry and dishwasher). With LPD of 5 W/m² the total in-suite EUI is 43.2 kWh/m².year. (2,849 kWh/year)
  - **High: 7.17 W/m²** , (typical family with one or more kids, with in-suite laundry and dishwasher). The total in-suite EUI is 55.76 kWh/m².year. (3,678 kWh/year).
- Use 62% sensible and 11% latent ratio, These numbers are derived for an average dwelling unit size of 710 ft² (Resource: DOE Commercial Prototype Building Models—which references Building America Research Benchmark and BC Hydro Loads Analysis Group Apartment Buildings Report. Note that ENERGY STAR® Multi Family High Rise Program Simulation Guidelines references the Building America Research Benchmark as well. However, the DOE source is more current and takes in account higher efficiency of households electrical equipment). The following operating schedules must be used in simulations:

Day	Times of day																							
	1a	2a	3a	4a	5a	6a	7a	8a	9a	10a	11a	12	1p	2p	3p	4p	5p	6p	7p	8p	9p	10p	11p	12
All	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.8	1.0	1.0	0.9	0.9	0.8	0.7	0.6

Resource: Building America Research Benchmark Report (total 15.8 daily full load hours of operation).

- **Dwelling units' lighting power density:** 5 W/m² (0.47 W/ft²). This number is derived for an average dwelling unit size of 850 ft² (Resource: Building America Research Benchmark Report. Note that NECB 2015 standard in-suite lighting power density is aligned well with the number in Building America Research Benchmark report). The following lighting schedules must be used in simulations:

Day	Times of day																							
	1a	2a	3a	4a	5a	6a	7a	8a	9a	10a	11a	12	1p	2p	3p	4p	5p	6p	7p	8p	9p	10p	11p	12
All	0.1	0.1	0.1	0.1	0.2	0.4	0.4	0.4	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.4	0.6	0.8	1.0	1.0	0.7	0.4	0.2

Resource: Building America Research Benchmark Report (total 7.9 daily full load hours of operation).

- **Occupancy density:** Two people for the first bedroom, one additional person for each bedroom thereafter. Studios, and single room occupancies may assume one person per unit.

This dwelling units' non-regulated loads and schedules are applicable for typical multi-family residential building projects. For non-typical residential projects with lower occupancy density (students dormitories, senior apartments and healthcare residential buildings) the ASHRAE 90.1 hotel-motel (or more applicable) power densities/schedules must be used.

If average dwelling unit size in the building is different from 710 ft² or 850 ft², the plug and lighting loads W/ft² must be recalculated.

5.5 Lighting power densities and schedules

Proposed lighting power densities in non-dwelling unit spaces (if not specified differently) must be modelled as per ASHRAE 90.1 2016 Table 9.6.1. Proposed lighting schedules (if not specified differently) must be modelled as per Tables G-D to G-M in ASHRAE 90.1 2016 User's Manual.

If the design team selects NECB 2015 as compliance energy efficiency standard, the proposed lighting power densities in non-dwelling units spaces (if not specified differently) must be modelled as per NECB 2015 Table 4.2.1.6. Proposed lighting schedules (if not specified differently) must be modelled as per Tables A-8.4.3.2(1)A to K.

Total annual lighting hours of operations for non-dwelling units spaces are provided in Appendix A as a reference.

5.6 Modeling of proposed building lighting controls

- Occupancy based/time limiting controls in spaces where they are not mandated by Std 90.1-2016 or NECB 2015, must be modelled either through adjustment of the lighting operating schedules (if the routine occupancy/ space use pattern is well known) or by the lighting power adjustment factors listed in Std 90.1-2016 Table G3.7
- Daylighting controls must be modelled explicitly in the internal daylighting module of the modeling software.

PROPOSED BUILDING EXTERIOR LIGHTING

The additional exterior lighting controls, not mandated by Std 90.1-2016 or NECB 2015, must be modelled through adjustment of the lighting operating schedules and power where applicable.

5.7 Elevators

Elevators can consume up to 10% of total building energy, so they must be accounted for in models. Program references elevators modelling assumptions from the NREL's report "U S Department of Energy Commercial Reference Building Models of the National Building Stock", which is publically available at **nrel.gov/docs/fy11osti/46861.pdf**

If not specified otherwise, the total numbers of elevators installed in different building types and associated motor power is provided in the following table:

Building type	Number of elevators	Motor power (kW/each)
Medium office	2	14.6
Large office	6	18.5
Secondary school	2	14.6
Small hotel	2	14.6
Large hotel	6	18.5
Hospital	8	18.5
Outpatient healthcare	3	14.6
Mid-rise MURB	2	14.6
High-rise MURB	3	18.5

For buildings with fewer than six stories, elevators use hydraulic motors with mechanical efficiency of 58% (heat gain will be applied to the first floor core zone). For buildings six stories and higher, elevators use traction motors with mechanical efficiency of 64% (heat gain will be applied to the top floor core zone).

The following elevators operating schedules will be used in simulations:

- Medium and large office:

Day	Times of day																							
	1a	2a	3a	4a	5a	6a	7a	8a	9a	10a	11a	12	1p	2p	3p	4p	5p	6p	7p	8p	9p	10p	11p	12
M-F	0	0	0	0	0	0	0	0.35	0.69	0.43	0.37	0.43	0.58	0.48	0.37	0.37	0.46	0.62	0.12	0.04	0.04	0	0	0
Sat	0	0	0	0	0	0	0	0.16	0.14	0.21	0.18	0.25	0.21	0.13	0.08	0.04	0.05	0.06	0	0	0	0	0	0
Sun	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

- Secondary school:

Day	Times of day																							
	1a	2a	3a	4a	5a	6a	7a	8a	9a	10a	11a	12	1p	2p	3p	4p	5p	6p	7p	8p	9p	10p	11p	12
M-F	0	0	0	0	0	0	0	0	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.15	0	0	0	0	0	0	0	0
Sat	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sun	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

- Small and large hotel:

Day	Times of day																							
	1a	2a	3a	4a	5a	6a	7a	8a	9a	10a	11a	12	1p	2p	3p	4p	5p	6p	7p	8p	9p	10p	11p	12
All	0.05	0.05	0.05	0.05	0.1	0.2	0.4	0.5	0.5	0.35	0.15	0.15	0.15	0.15	0.15	0.15	0.35	0.5	0.5	0.4	0.4	0.3	0.2	0.1

- Hospital:

Day	Times of day																							
	1a	2a	3a	4a	5a	6a	7a	8a	9a	10a	11a	12	1p	2p	3p	4p	5p	6p	7p	8p	9p	10p	11p	12
M-F	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.5	0.75	1	1	1	0.75	1	1	1	1	1	0.52	0.52	0.52	0.28	0.2	0.2
Sat	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.4	0.46	0.7	0.7	0.7	0.51	0.51	0.51	0.51	0.51	0.25	0.2	0.2	0.2	0.2	0.2	0.2
Sun	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2

- Outpatient healthcare:

Day	Times of day																							
	1a	2a	3a	4a	5a	6a	7a	8a	9a	10a	11a	12	1p	2p	3p	4p	5p	6p	7p	8p	9p	10p	11p	12
M-F	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.5	0.75	1	1	1	0.75	1	1	1	1	1	0.52	0.52	0.52	0.28	0.05	0.05
Sat	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.4	0.46	0.7	0.7	0.7	0.51	0.51	0.51	0.51	0.51	0.25	0.05	0.05	0.05	0.05	0.05	0.05
Sun	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.05	0.05	0.05	0.05	0.05	0.05

- Mid and high-rise MURB:

Day	Times of day																							
	1a	2a	3a	4a	5a	6a	7a	8a	9a	10a	11a	12	1p	2p	3p	4p	5p	6p	7p	8p	9p	10p	11p	12
All	0.05	0.05	0.05	0.05	0.1	0.2	0.4	0.5	0.5	0.35	0.15	0.15	0.15	0.15	0.15	0.15	0.35	0.5	0.5	0.4	0.4	0.3	0.2	0.1

5.8 Indoor temperature set points

Both baseline and proposed models must use the same indoor heating/cooling temperature set points and the same setback temperature set points. The only exception to this rule is radiant heating/cooling system with decoupled displacement ventilation controlled by a globe temperature sensor.

Modelling software must be capable of properly modelling operative (effective or dry resultant) temperature and radiant heating/cooling systems controlled by operative temperature sensors. The concept of having the same temperature set points in baseline and proposed models still applies, but in this case will apply to equal operative temperatures. Since the baseline HVAC model is usually an all–air system, operative temperature is equal to dry bulb temperature, which is not the case for radiant heating/cooling systems. Appropriate thermal comfort analysis (Percentage People Dissatisfied – PPD) must be provided.

5.9 Minimum equipment efficiencies

ASHRAE 90.1 2016: The program references minimum HVAC equipment efficiency tables listed in Tables 6.8.1–1 to 16, and service water heating equipment efficiency requirements listed in Table 7.8.

NECB 2015: The program references minimum HVAC equipment efficiency tables listed in Table 5.2.12.1 and service water heating equipment efficiency requirements listed in Table 6.2.2.1.

Note that any equipment efficiency regulated by BC Energy Efficiency Act supersedes ASHRAE 90.1 and NECB minimum equipment efficiencies requirements.

5.10 Radiant heating/cooling systems with displacement ventilation

Splitting room volumes into occupied and unoccupied zones will be required for all radiant heating/cooling systems (floors, ceilings, slabs and panels) coupled with displacement ventilation in rooms with significant stratification effect (floor to ceiling height more than 10 feet). In the case of under–floor air distribution of displacement ventilation (coupled with radiant ceiling slabs or panels), the floor ventilation supply air plenum must be modeled as a separate zone.

5.11 Under floor air distribution (UFAD) and thermal displacement ventilation

Splitting room volumes into occupied and unoccupied zones will not be required for rooms conditioned with typical under floor air distribution (UFAD) systems or thermal displacement ventilation (systems with supply air velocities and temperatures higher than typical displacement ventilation, but lower than UFAD systems)

5.12 Infiltration

Infiltration rate shall be modeled as per BC Building Code or Step Code requirements. A proposed model shall have the same infiltration rate as a schematic model (electrification baseline). Infiltration is not constant in pressurized buildings and it should not be modelled with constant rate and 24/7 schedule.

A good source of information on infiltration in commercial buildings is the PNNL Report 18898 “Infiltration Modelling Guidelines for Commercial Building Energy Analysis”, publicly available at: **efiling.energy.ca.gov/GetDocument.aspx?tn=65229**

Energy modelling study Q&A

Who should I contact if I have technical questions?

If you have any technical questions, or are unsure on how a measure or system should be simulated, contact the engineer appointed to the project It is important that simulation issues be resolved early, to avoid additional work later on. Don't hesitate to call or e-mail with any questions or clarifications.

Do we need to provide total capital costs, or just the incremental cost of the measure?

The LCC analysis conducted for the studies will use the incremental costs. When submitting completion documents, we require total capital costs for both the baseline and the electrification measure, where these have been explicitly identified in the tender documents.

What level of costing detail is required?

The costing for the identified electrification measures should be broken out in sufficient detail that we can review it and assess its accuracy. At a minimum, major equipment should be broken out, as well as labour and materials. Incremental cost estimates must be provided by either:

- a registered Quantity Surveyor, or
- a qualified contractor selected by applicant

What rate should we use for electricity?

All energy costs must be based on current rates for gas and electricity. This must include energy charges, demand charges, taxes, and any other applicable components of the rate structure. See details at our Business Rates Overview **bchydro.com/accounts-billing/rates-energy-use/electricity-rates/business-rates.html**

General Q&A

What simulation program can be used for whole building analysis?

Any programs that use 8,760-hour simulations and have been tested according to ASHRAE Standard 140 can be used. The list of the approved modelling software is provided in Section 2.3 above.

Are we asking for an ASHRAE 90.1 or NECB reference building as the baseline?

No, the program baseline is the completed schematic design model with additional mandatory requirements listed in Section 3.

Appendix A:

Lighting annual hours of operations (for non-dwelling units spaces)

Building area type	Annual hours	Corridor/ lobby for elevator	Washroom	Locker room	Stairway
Automotive facility	3210	3880	3100	3100	2910
Convention centre	3530	3880	3100	3100	2910
Courthouse	2820	2930	2340	2340	2200
Dining: bar lounge/ leisure	4740	5220	4180	4180	3920
Dining: cafeteria/ fast food	4590	5220	4180	4180	3920
Dining: family	4750	5220	4180	4180	3920
Dormitory	3870	8760	2380	2380	5260
Exercise centre	2820	2950	2360	2360	2660
Fire station	5880	8760	7010	7010	6570
Gymnasium	2870	2950	2360	2360	2660
Health-care clinic	3290	2930	2340	2340	2200
Hospital	4720	8760	7010	7010	6570
Hotel	3310	8760	1630	1630	6570
Library	3610	3880	3100	3100	3490
Manufacturing facility	3760	3880	3100	3100	3490
Motel	3620	8760	1630	1630	6570
Motion picture theatre	2620	2980	1740	1740	2680
Multi-unit residential building	6210	8760	7010	7010	4820
Museum	3500	3880	3100	3100	3490
Office	2870	2930	2340	2340	2200
Parking garage	5760	8760	7010	7010	5260
Penitentiary	4450	8760	2340	2340	5260
Performing arts theatre	1940	2980	830	830	2680
Police station	4100	8760	7010	7010	6570
Post office	3140	3880	3100	3100	2910
Religious building	2350	2180	1740	1740	1960
Retail area	3750	3880	3100	3100	3490
School/ university	2580	2930	2340	2340	2200
Sports arena	4170	5220	4180	4180	4700
Town hall	3040	3370	2700	2700	2530
Transportation	5190	8760	7010	7010	7880
Warehouse	2830	2830	2260	2260	2120
Workshop	3580	3880	3100	3100	2910

Appendix A:

Lighting annual hours of operations (for non–dwelling units spaces)

Common space types	Annual hours
Atrium	3880
First 13m in height—per m (height)	3880
Height above 13m—per m (height)	3880
Audience/seating area—permanent	
for auditorium	2980
for motion picture theatre	2180
for performing arts theatre	1040
Classroom/lecture/training	2330
Conference/meeting/multipurpose	3370
Corridor/transition	*
≥2.4 m wide	*
<2.4 m wide	*
Dining area	
for bar lounge/leisure dining	5220
For family dining	5220
Dining other	5220
Dressing/fitting room for performance arts theatre	2800
Electrical/mechanical	1000
Food preparation	5220
Laboratory	
Lab for classrooms	2420
Lab for medical/Industrial/research	2930
Lobby	
For elevator	*
For motion picture theatre	2950
For performing arts theatre	2950
Lobby other	3880
Locker room	*
Lounge/recreation	5220
Office	
Office enclosed	2300
Office open plan	2930
Sales area	3880
Stairway	*
Storage	1910
Washroom	*
Workshop	3880

Building type specific space types	Annual hours
Automotive repair garage	3880
Bank—banking activity area	2930
Convention centre	
audience seating	3880
Convention—exhibit space	3880
Courthouse/police station/penitentiary	
courtroom	2930
confinement cell	5820
judges' chambers	2930
penitentiary audience seating	2930
penitentiary classroom	2260
penitentiary dining	5220
Dormitory—living quarters	2970
Fire station	
engine room	8760
sleeping quarters	2970
Gymnasium/fitness centre	
Fitness area	2950
Gymnasium—audience seating	2950
Play area	2950
Hospital	
Hospital corridor/transition area ≥2.4 m wide	8760
Corridor/transition area <2.4 m wide	8760
Emergency	8760
Exam/treatment	3880
Laundry—washing	3880
Hospital lounge/recreation	5220
Medical supply	8760
Nursery	8760
Nurses' station	8760
Operating room	8760
Patient room	5820
Pharmacy	3880
Physical therapy	3880
Radiology/imaging	8760
Recovery	8760

Building type specific space types	Annual hours
Hotel/motel	
hotel dining	5220
hotel guest rooms	2040
hotel lobby	8760
highway lodging dining	5220
highway lodging guest rooms	2040
Library	
card file and cataloging	3880
reading area	3880
stacks	3880
Manufacturing	
Manufacturing corridor/transition area ≥2.4 m wide	3880
corridor/transition area <2.4 m wide	3880
detailed manufacturing	3880
equipment room	3880
extra high bay (> 15 m floor—to—ceiling height)	3880
high bay (7.5 m to 15 m floor—to—ceiling height)	3880
low bay (<7.5 m floor—to—ceiling height)	3880
Museum	
general exhibition	3880
restoration	2930
Parking garage – garage area	6730
Post office – sorting area	2930
Religious building	
Religious audience seating	2180
fellowship hall	2180
worship pulpit, choir	2180
Retail	
retail dressing/fitting room	3680
mall concourse	3880
retail sales area	3880

Building type specific space types	Annual hours
Sports arena	
Sports audience seating	2950
Court sports arena—class 4	2950
Court sports arena—class 3	2950
Court sports aren—class 2	2950
Court sports arena—class 1	2950
Ring sports arena	2950
Transportation	
Air/train/bus—baggage area	8760
Airport—concourse	8760
Seating area	8760
Terminal—ticket counter	8760
Warehouse	
Fine material storage	2830
Medium/bulky material	2830
Medium/bulky material with permanent shelving that is >60% of ceiling height	2830

Appendix B:

CleanBC New Construction Program – Baseline Heating System Types Selection Table

(For buildings that default to 100% gas heating source as per tiered incentive baseline table)

Proposed building type		Baseline HVAC and SHW system type
Residential	Heated and Cooled	System 1
	Heated only*	System 2
Public Assembly < 11,000 m^2		System 3
Public Assembly > 11,000 m^2		System 4
Retail and 2 floors or fewer		System 3
Non residential & 3 floors or fewer & < 2,300 m^2		System 3
Nonresidential & 4 or 5 floors & < 2,300 m^2 or 5 floors or fewer & 2,300 m^2 to 14,000 m^2		System 5
Nonresidential & More than 5 Floors or > 14,000 m^2		System 6
Heated Only Storage		System 7

* Heated only buildings with proposed electric resistance baseboards in-suite heating system will not default to hydronic baseboards baseline system (System 2). The baseline space heating system in that case will remain to be electric baseboards with fossil fuel ventilation and SWH.

CleanBC New Construction Program – Baseline HVAC and SHW System Descriptions

System No.	System Type	Fan Control	Cooling Type	Heating Type***	Ventilation Type***	Service Hot Water System Type***
1. PTAC	Packaged terminal air conditioner with hydronic heating coil**	Constant Volume	Direct Expansion	Hot Water Fossil Fuel Boiler	Fossil Fuel Rooftop Make Up Air Unit	Hot Water Fossil Fuel Boiler
2. HBB	Hydronic Baseboards	–	–	Hot Water Fossil Fuel Boiler	Fossil Fuel Rooftop Make Up Air Unit	Hot Water Fossil Fuel Boiler
3. PSZ-AC	Packaged rooftop air conditioner	Constant Volume	Direct Expansion	Fossil Fuel Furnace	Fossil Fuel Furnace	Hot Water Fossil Fuel Water Heater
4. SZ-CV-HW	Single-zone System	Constant Volume	Chilled Water	Hot Water Fossil Fuel Boiler	Hot Water Fossil Fuel Boiler	Hot Water Fossil Fuel Water Heater
5. Packaged VAV w/Reheat	Packaged rooftop variable air volume with reheat	VAV	Direct Expansion	Hot Water Fossil Fuel Boiler	Hot Water Fossil Fuel Boiler	Hot Water Fossil Fuel Boiler
6. FC	4-pipe Fan Coils with DOAS System	Constant Volume	Chilled Water	Hot Water Fossil Fuel Boiler	Hot Water Fossil Fuel Boiler	Hot Water Fossil Fuel Boiler
7. Heating and Ventilaiton	Warm air furnace, gas fired	Constant Volume	–	Fossil Fuel Furnace	Fossil Fuel Furnace	Hot Water Fossil Fuel Water Heater

** 4-pipe fan coils if it was proposed in schematic model (proposed and baseline HVAC system will be the same in that case)

*** Baseline fossil fuel boiler or service hot water heater efficiency will be as per referenced energy efficiency standard (ASHRAE or NECB). If a connection to a fossil fuel or hybrid (heat pump / fossil fuel boiler) based exisiting district energy system (DES) is mandatory, the baseline and proposed models heating source will default to DES with its efficiency and GHG emission.