JOINT PROFESSIONAL PRACTICE GUIDELINES

WHOLE BUILDING ENERGY MODELLING SERVICES

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AIBC
ARCHITECTURAL INSTITUTE OF BRITISH COLUMBIA

ENGINEERS & GEOSCIENTISTS BRITISH COLUMBIA

ARCHITECTURAL INSTITUTE OF BRITISH COLUMBIA

The Architectural Institute of British Columbia (AIBC) is an independent, professional self-governing body established in 1920 by provincial statue (the *Architects Act*) with the mandate to regulate the profession of architecture on behalf of the public.

aibc.ca

ENGINEERS & GEOSCIENTISTS BRITISH COLUMBIA

Engineers and Geoscientists British Columbia is the regulatory and licensing body for the practice of engineering and geoscience in the province of British Columbia. With over 34,000 members, Engineers and Geoscientists BC regulates and governs these professions under the authority of the *Engineers and Geoscientists Act* and is charged with protecting the public interest.

egbc.ca

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1. Foreword

The *Professional Practice Guidelines: Whole Building Energy Modelling Services* were jointly prepared by Engineers and Geoscientists British Columbia and the Architectural Institute of British Columbia. Funding and support for the development of these *Guidelines* was provided by BC Hydro, City of Vancouver and BC Housing.

These *Guidelines* apply to architects and engineers who are providing, procuring, contributing, and/or coordinating Building Energy Modelling services on buildings of all types and sizes, regardless of the requirements for professional design and review within Building Codes.

These *Guidelines* also apply to professionals providing services for whole Building Energy Modelling used to demonstrate compliance with regulations or programs, as well as energy modelling for assessing or optimizing the performance of existing buildings, and energy modelling as a design tool for developing higher performing buildings.

In B.C., Building Codes (other than the National Building Code of Canada) require professional design and field review by architects and engineers on buildings of specific sizes and types, including the parts of the Building Codes regulating energy efficiency. Smaller buildings that do not require professional design and review as defined by buildings codes may still be designed utilizing Building Energy Modelling by architects and/or engineers.

The purpose of these *Guidelines* is to standardize professional practice when architects and engineers are working on projects that utilize whole Building Energy Modelling.

While these *Guidelines* apply to architects and engineers, Building Energy Modelling requires coordination between various parties such as the Qualified Modeller and Client, as well as members of the design team such as the architect, mechanical engineer(s) (HVAC and plumbing services), and electrical engineer. For the purposes of these *Guidelines*, the design team includes the architects and engineers involved in the energy aspects of the building's design, whereas the project team includes the Owner/Client and sub-consultants who have an influence on the building's energy performance.

These Guidelines apply not only to the architect or engineer who is responsible for the energy model. In addition, architects and engineers (sub-consultants) who contribute to it, (for example, building enclosure consultants), must be knowledgeable of these *Guidelines* and their associated responsibilities.

These *Guidelines* address the standard of professional practice to be followed by architects and engineers when carrying out professional services related to Building Energy Modelling. Energy modelling does not predict or guarantee the building's energy performance from an operational standpoint. Actual building energy performance will differ from modelled outputs due to variations in occupancy, operations, maintenance, weather, and other factors.

Questions relating to these *Guidelines* should be addressed to:

- Architectural Institute of B.C.: Maura Gatensby Architect AIBC, mgatensby@aibc.ca
- Engineers and Geoscientists BC: Harshan Radhakrishnan, P.Eng., hrad@egbc.ca

Questions relating to professional practice of engineers or architects should be directed respectively to:

- Architectural Institute of B.C.: practiceadvice@aibc.ca
- Engineers and Geoscientists BC: practiceadvisor@egbc.ca

1.1 COMPLIANCE WITH THESE GUIDELINES

A Member's failure to follow one or more of these *Guidelines* does not necessarily mean that the Member has failed to meet their professional obligations. Determining whether a Member has met their professional obligations will involve a comparison of the Member's services to these *Guidelines* and the expected actions of a reasonable and prudent Member in similar circumstances.

2. Definitions

Architectural Institute of British Columbia (AIBC)

The Architectural Institute of British Columbia (or Architectural Institute of B.C.) is an independent, professional self-regulatory body established in 1920 by provincial statute: the *Architects Act.* The AIBC's mandate is to regulate the profession of architecture on behalf of the public. aibc.ca

ASHRAE

The American Society of Heating, Refrigerating and Air-Conditioning Engineers. International technical society focused on building systems, energy efficiency, indoor air quality, refrigeration and sustainability within the built environment. ashrae.org

ASHRAE 90.1
Energy Standard for Buildings Except Low-Rise Residential Buildings

An international standard referenced in the BCBC and the VBBL that provides minimum requirements for energy efficient designs for buildings except for low-rise residential buildings.

Authority Having Jurisdiction (AHJ)

The governmental body responsible for the enforcement of any part of the Building Code or the official or agency designated by that body to exercise such a function (Building Code defined term).

BC Energy Step Code

Progressive performance targets, "steps," for new buildings, incorporated into the BCBC, used by local authorities to encourage or require the construction of more energy-efficient buildings. All steps require Building Energy Modelling.

British Columbia Building Code (BCBC)

The British Columbia Building Code, applicable to all jurisdictions except the City of Vancouver and federal lands. bccodes.ca

BC Hydro

BC Hydro is a Crown corporation, owned by the government and people of British Columbia with a mandate to generate and supply electricity to its customers within the Province of B.C. bchydro.com

Building Code(s)

The British Columbia Building Code, the City of Vancouver's Building By-law and the National Building Code of Canada. Not all references to 'Building Codes' apply to the National Building Code of Canada.

Building Enclosure Engineer

An Engineers and Geoscientists BC Member who focuses his or her practice in the field of building enclosure engineering and is qualified to do so as described in the Engineers and Geoscientists BC Professional Practice Guidelines – Building Enclosure Engineering Services.

Building Energy Modelling

The use of computer software to estimate the energy use of a building over a period of time under a certain set of conditions, sometimes referred to as building performance simulation.

Canadian Green Building Council (CaGBC)

The Canada Green Building Council is a not-for-profit, national organization that focuses on the advancement of green building and sustainable community development practices in Canada. The CaGBC is the license holder for the LEED green building rating system in Canada. cagbc.org

Canadian Home Builders Association of British Columbia (CHBA-BC)

A not-for-profit organization for the housing industry in B.C. composed of member companies representing new home builders and renovators, land developers, trade contractors, product and material manufacturers, building product suppliers, lending institutions, insurance providers, and service professionals.

City of Vancouver's Building By-law (VBBL)

The building bylaw used as the Building Code in the City of Vancouver. bccodes.ca/vancouver-bylaws.aspx?

Client

The party who contracts with an architect or an engineer for the provision of Building Energy Modelling services by the architect or the engineer.

Coordinator

The architect or engineer responsible for coordinating the work that is represented by the energy model. For design projects, the Coordinator is the Coordinating Registered Professional (CRP), as defined in the Building Code when a CRP is required.

Coordinating Registered Professional (CRP)

A Registered Professional retained to coordinate all design work and field reviews of the Registered Professionals required for a project. This is a Building Code defined term.

Energy Modelling Report

A report conveying key characteristics such as: inputs, assumptions, methodologies, energy performance results, and pertinent descriptions of the building energy model.

Energy Modelling Supervisor (EMS)

An architect or engineer directly supervising a Qualified Modeller.

EnerGuide

EnerGuide is the official mark of the Government of Canada for its energy performance rating and labeling program for houses as well as a variety of energy using consumer items, including heating and ventilating equipment, as well as household appliances and electronics. nrcan.gc.ca/energy/products/energuide/12523

Engineers and Geoscientists BC

Formerly known as the Association of Professional Engineers and Geoscientists of British Columbia or APEGBC. Engineers and Geoscientists BC regulates and governs these professions under the authority of the *Engineers and Geoscientists Act*. The association is charged with protecting the public interest by setting and maintaining high academic, experience, and professional practice standards.

FortisBC

FortisBC is an electric power and gas distribution/retail company in British Columbia. fortisbc.com

Letters of Assurance (LoA)

Documents within Section 2.2.7 in Part 2 of Division C of the BC Building Code and the City of Vancouver's Building By-Law used to confirm and assure design and field review by Registered Professionals. Otherwise known as Schedules A, B, C-A and C-B. Refer to Guide to the Letters of Assurance in the B.C. Building Code. bccodes.ca

International Building Performance Simulation Association (IBPSA)

International Building Performance Simulation Association is a non-profit international organization of building performance simulation researchers, developers and practitioners dedicated to advancing and promoting the science of building performance simulation. ibpsa.org

IBPSA Canada – BC Chapter

The provincial branch of the association. bc.ibpsa.ca

Member

A registered member of the Engineers and Geoscientists BC or the Architectural Institute of B.C. Where appropriate for the purposes of these *Guidelines*, the term Member also includes an Engineers and Geoscientists BC's engineering licensee who holds a limited licence in engineering with an appropriate scope specified in the limited licence.

National Energy Code of Canada for Buildings (NECB)

Published by National Research Council (NRC) and developed by the Canadian Commission on Building and Fire Codes in collaboration with Natural Resources Canada (NRCan), the National Energy Code of Canada for Buildings provides minimum energy performance requirements for the design and construction of buildings. nrc-cnrc.gc.ca/eng/publications/codes_centre/2015_national_energy_code_buildings.html

Natural Resources Canada (NRCan)

Federal ministry supporting, developing and maintaining energy efficiency tools and programs, primarily in the residential sector, and provides training and licensing of energy advisors for residential dwellings.

Owner

Any person, firm or corporation controlling the property under consideration during that period of application, as applied to the Building Code. The Owner is often different when a building is being designed and constructed (for example, the developer), than when the building construction is complete and is being used for its intended purpose (for example, a strata corporation). The Owner may or may not be the Client contracting the Building Energy Modelling services with the architect or engineer.

Passive House

The Passive House standard for designating energy efficiency in a building, evaluated under particular metrics, for example, Primary Energy.

Passive House Canada | Maison Passive Canada: passivehousecanada.com
Passive House Institute US (PHIUS): phius.org

Proposed Building

A term used in a number of standards referring to the building being designed.

Qualified Modeller (QM)

Person responsible for Building Energy Modelling and analysis, who through education, training and experience, is competent in simulation, science and systems that pertain to building energy performance. A Qualified Modeller may or may not be an architect or engineer.

Reference Building (Baseline Or Budget Building)

A term that is typically defined within the standards used for comparative Building Energy Modelling.

Registered Professional

A person who is registered or licensed to practise as an architect under the *Architects Act* in the Province of British Columbia, or a person who is registered or licensed to practice as a professional engineer under the *Engineers and Geoscientists Act* in the Province of British Columbia. This is a Building Code defined term.

***Registered Professional of Record* (*RPR*)**

A Registered Professional retained to undertake design work and field review in accordance with the Building Code. This is a Building Code defined term.

***Supporting Registered Professional* (*SRP*)**

A Registered Professional who provides services to support the Registered Professional of Record for a particular component or sub-component of a design. See AIBC/Engineers and Geoscientists BC Practice Note 16: Professional Design and Field Review by Supporting Registered Professionals.
aibc.ca/resources/aibc-resources/practice-notes

2.1 ACRONYMS

ECM: *Energy conservation measure.*

GHGI: *greenhouse gas emissions intensity*

MEUI: *mechanical energy use intensity*

PE: *primary energy*

PTL: *peak thermal load*

TEDI: *thermal energy demand intensity*

TEUI: *total energy use intensity*

WUFI: *Wärme und Feuchte Instationär*

3. Overview

3.1 PURPOSE

These *Guidelines* provide guidance on the provision of services pertaining to building energy performance modelling and analysis, including, but not limited to, the responsibilities of members of a design team providing Building Energy Modelling services. They also address considerations that apply when hiring or evaluating the qualifications and/or work of a Qualified Modeller.

Guidelines cover minimum qualifications, professional practice, roles and responsibilities, and quality assurance for projects that involve whole Building Energy Modelling. Although these *Guidelines* include some provisions for all individuals associated with a project incorporating Building Energy Modelling services, these *Guidelines* are for architects and engineers involved with the provision of whole Building Energy Modelling services. These *Guidelines*, however, do not provide specific instructions or advice on how to conduct energy analysis and modelling.

An intended use of these *Guidelines* is to address the minimum qualifications that a Qualified Modeller and/or Energy Modelling Supervisor (EMS) must exhibit while providing various Building Energy Modelling services. The roles and responsibilities of the various stakeholders such as the Coordinator, Qualified Modeller, EMS (where required), and the members of the design team have been provided to define:

- general role and responsibilities of each of these stakeholders;
- design team roles and responsibilities during the various stages of a project; and
- roles and responsibilities as they relate to the various applications.

The designation of roles referred to in these *Guidelines* is independent of individuals. Therefore, design team members can perform various roles such as being the EMS and Coordinator at the same time.

3.2 SCOPE

These *Guidelines* pertain to the provision of professional practice and obligations associated with building energy performance analysis and modelling for new and existing buildings, in relation to Building Energy Modelling. Whole Building Energy Modelling can include other modelling tasks related to energy simulation, such as heat transfer calculations for enclosure components and assemblies, comfort analysis, lighting and daylighting simulation, indoor air quality and airflow analyses, computational fluid dynamics simulations and others, all which can help inform the development of the building energy model. These *Guidelines* do not apply to the related modelling tasks such as daylighting simulation, fire modelling or comfort analysis done in the absence of whole Building Energy Modelling; however, professionals are expected to apply due diligence to those as well.

These *Guidelines* address various applications of energy analysis and modelling, and the professional obligations associated with providing these services, including the roles and responsibilities of various design team members. In addition, they are intended for professional engineers and architects who act in the capacity of Coordinators, Qualified Modellers or those responsible for hiring and/or supervising Qualified Modellers.

Finally, these *Guidelines* speak to the minimum qualifications and quality assurance requirements of the Qualified Modeller. They can be used to assist in establishing the objectives, scope of professional services, level of effort, and terms of reference for an agreement between an architect or an engineer and the Client. However, these *Guidelines* are not intended for use as part of the contract between an architect or an engineer and the Client. For services and/or projects not specifically covered by these *Guidelines*, the intent of these *Guidelines* is to be maintained.

3.3 APPLICABILITY

These *Guidelines* apply to all Building Energy Modelling applications when modelling services are provided or supervised by architects or engineers.

3.3.1 MODELLING TOOLS

Building Energy Modelling tools are computer-based analysis programs used to define a virtual replica of a building and its energy systems based on a set of inputs and assumptions. The tools are used to analyze building systems, their interdependencies, and the effects from internal and external loads such as those influenced by weather and occupant use. Both dynamic (the hourly/sub-hourly simulation) and static (bin and degree-day based) tools are addressed by these *Guidelines*.

Building Energy Modelling may make use of numerous other modelling tools to provide inputs for areas such as heat transfer, daylighting, indoor air quality and airflow, computational fluid dynamics and others. Sometimes other evaluation procedures, such as airtightness testing, are used and interpreted into the energy model.

3.3.2 MODELLING APPLICATIONS

Building Energy Modelling plays a key role in several applications, including setting specific performance targets, such as those associated with energy performance obligations; the evaluation of energy performance; energy cost budgeting; identifying energy efficiency opportunities; demonstrating performance for incentive programs; and the confirmation of code compliance.

Energy models may be completed for new buildings, existing buildings, additions, and/or renovations. Projects may have more than one modelling requirement such as new buildings being modelled for code compliance that must also meet certification and rating programs. In all cases, they should consider all applicable building functions and systems, including the anticipated use and space conditions, enclosure, mechanical, lighting, electrical, process, and any other aspects necessary to appropriately model the building's energy consumption. All applications have obligations and responsibilities to which a Qualified Modeller must adhere.

The following sections identify the various purposes for which Building Energy Modelling services could be used.

3.3.3 OPTIMIZATION AND FORECASTING

Forecast modelling predicts or establishes energy performance targets given particular operating assumptions. Building Energy Modelling can be initiated by an Owner/Client to estimate a building's energy performance or establish targets given project-specific conditions. Optimization and Forecasting can include:

- An energy study of building energy-related components to optimize energy performance and/or assess possible energy conservation measures (ECMs).
- The forecasting of performance of the building due to anticipated modifications in the hours of operation, functional use, occupancy and so forth.

While estimation involves predicting or establishing energy performance targets given particular operating assumptions, often the goal of a model is to optimize a building's energy performance beyond the requirements of an energy code or standard by using multiple simulations to evaluate and compare design alternatives. This may include balancing different building systems, such as building enclosure and mechanical, to find the most advantageous solution for a given project. In optimization and forecasting projects, each modelling project should consider opportunities to improve energy efficiency within the project's constraints.

3.3.4 COMPLIANCE

Compliance modelling is performed to meet specific requirements of the Building Code and/or associated conditions, as well as all additional energy requirements. Another possible objective could be finding the most effective approach to complying with certification and rating programs. Compliance modelling can often be preceded by, or be the outcome of design optimization modelling.

Compliance modelling is typically required to meet the provisions of a referenced energy standard and/or specific targets, such as, but not exclusive to the following:

- Energy consumption
- Energy savings
- Energy use intensity, includes mechanical and total energy use intensity (EUI – kWh/m^2/yr)
- Primary energy
- Energy cost
- Energy cost savings
- GHG emissions (tonnes of carbon dioxide equivalent (CO_2e)
- GHG emissions intensity (GHGI – kg of CO_2e/m^2/yr)
- Thermal energy demand intensity (TEDI – kWh/m^2/yr)
- Peak thermal load (PTL – W/m^2)
- Percentage (%) better than code (specific to any or all the metrics listed above)

Some compliance modelling methods compare the Proposed Building with a code compliant Reference/Baseline Building, while others model the Proposed Building against specific targets. Modelling to demonstrate compliance with energy performance metrics includes specific Building Energy Modelling protocols that apply to the method of compliance and applicable standards.

Several methods of code compliance are applicable in British Columbia, and each one can necessitate some form of building modelling. For instance, both the NECB and ASHRAE 90.1 provide designers with alternative paths to demonstrate compliance, including various forms of Building Energy Modelling. This includes the following:

1. **Prescriptive Compliance:** Building components and systems must meet specific minimum requirements. Demonstration of enclosure requirements may dictate the application of heat transfer modelling of enclosure assemblies and/or glazing systems; however, it does not require whole Building Energy Modelling.
2. **Trade-Off Compliance:** For some applications, trade-off paths may require building energy simulation, with specific requirements on how to treat internal gains, ventilation and HVAC systems. Other trade-off options may require building enclosure modelling. These applications typically do not require whole Building Energy Modelling.
3. **Performance Compliance:** Performance paths include:
    a. **Comparative Modelling** – Whole building energy simulation to demonstrate compliance by comparing the Proposed Building design against a Reference Building (also referred to as Baseline or Budget Building).
    b. **Target Modelling** – Whole building energy simulation to demonstrate that the targets (TEUI, TEDI, etc.) have been met.

3.3.5 EXISTING BUILDINGS AND FACILITIES MANAGEMENT

Energy modelling of existing buildings is performed on actual buildings with an operational history for a variety of reasons, including, but not limited to:

- To determine present performance of existing conditions.
- A measurement and verification (M&V) effort to verify energy performance and/or savings for ECMs identified during design.

- To establish projected savings and as a basis for energy services contracts.

3.3.6 INCENTIVE PROGRAMS AND CERTIFICATION/ RATING SYSTEMS

Building Energy Modelling is performed to qualify projects for certification and incentives under programs such as those provided by certification entities, utilities, or authorities. Examples of such programs include:

- Benefits for achieving energy/GHG levels beyond code.
- Achieving a certification/rating, such as BOMA BEST, Passive House, LEED, and R2000.[1]
- Incentives based on modelled electricity/natural gas savings and demand reductions.

[1] Standard developed by Natural Resources Canada (NRCan) in coordination with key industry stakeholders for high performance energy efficiency for residential buildings.

4. Minimum Qualifications

4.1 PROFESSIONAL REGISTRATION

Building Energy Modelling, which is described in Section 3.3.2, does not require that the Qualified Modeller be a Registered Professional. The Qualified Modeller must have the qualifications described in Section 4.2.1.

On projects in which architects and/or engineers are engaged in providing the Building Energy Modelling services, Qualified Modellers who provide modelling services must be either (1) an architect or engineer, or (2) be under the direct supervision of an architect or engineer acting as an Energy Modelling Supervisor (EMS).

4.2 EDUCATION, TRAINING AND EXPERIENCE

Building Energy Modelling and analysis is a multidisciplinary field that requires specific education, training and experience associated with architectural, mechanical and electrical systems, which will be described further in this section. Architects and engineers shall undertake and accept responsibility for professional assignments only when qualified by training or experience. The EMS must require that the Qualified Modeller is made aware of and understands these *Guidelines* and the relevant parts of the EMS's respective code of ethics (Engineers and Geoscientists BC/AIBC).

Appropriate qualifications for modellers and their supervisors include core competencies such as theoretical and technical knowledge, building industry knowledge and experience, as well as professional development. To produce a representative model, these competencies must be effectively translated into practice. Both the Qualified Modeller and the EMS must understand the factors that may affect a model.

4.2.1 CORE COMPETENCIES OF THE QUALIFIED MODELLER

The areas of competency required by a qualified modeller include:

- Education (theoretical and technical knowledge)
- Building industry, codes and standards
- Experience
- Professional development

4.2.1.1 Education (Theoretical and Technical Knowledge)

A Qualified Modeller must have appropriate education and experience in the following areas of theory and technical knowledge as they relate to their modelling task(s) and the modelling of building performance.

Demonstrate education in building performance modelling, through:

- College or university courses, or
- Programs provided by professional organizations such as Engineers and Geoscientists BC or Architectural Institute of B.C., or industry groups such as ASHRAE, or IBPSA, CHBA-BC, and
- Demonstrable self-study.

Materials Knowledge

Have a working knowledge of the following properties for various building materials:

- Thermal conductivity
- Transmittance
- Emissivity
- Reflectivity and absorptivity
- Heat capacity

Building Physics

Have a working knowledge of:

- The definition of interior and exterior (climate) boundary conditions;
- The impact of location, climate, building shape, thermal mass and fenestration on building energy use;
- Relative humidity and the impact on a model;
- Mechanisms of heat transfer (conduction, convection, radiation), including thermal bridging, psi-values, chi-values of components/assemblies; and
- Calculation of heat transfer through elements and assemblies in conformance with good practice, such as are described in *ASHRAE Handbook Fundamentals* and other resources such as BC Hydro's *Building Envelope Thermal Bridging Guide*.

Building Systems

Qualified Modellers must review and understand the content of documents relevant to Building Energy Modelling (drawings and specifications), and must be able to apply this understanding to the energy model. They also must understand the following:

- Building enclosure components and influences, including the assessment and application of:
  - exposure conditions and orientation related to the building site and identification of appropriate external environmental loads;
  - appropriate building enclosure assemblies and components and materials for the given environmental conditions;
  - continuity of primary heat, and air control functional surfaces or barriers throughout the building enclosure;
  - determining whether a design adequately addresses the relevant performance issues within the context of modelling; and
  - building system interdependence with other systems and functional requirements including environmental control systems, such as lighting, heating, cooling and ventilation.
- Lighting equipment and controls, including the assessment and application of:
  - lighting consumption and associated internal heat gains; and
  - lighting controls, including daylighting and other sensors.
- HVAC systems, including the assessment of sensible/latent energy and the application of:
  - various systems, such as heating, cooling and district energy;
  - system limitations and benefits;
  - system flows, pressures and temperatures (air/hydronic);
  - equipment dynamics and interactions;
  - equipment capacity and partial load influences on efficiencies; and
  - system and equipment operations and controls.
- Service water heating, including the assessment and application of:
  - various equipment options and applications;
  - the effect of building fixtures and appliances on service water heating requirements; and
  - equipment operation and controllability.
- Additional inputs including the assessment and application of:
  - occupant loads and schedules;
  - plug loads;
  - process and miscellaneous loads and their schedules; and
  - renewable systems, for example, solar and wind.

Building Modelling Software

Qualified Modellers must have detailed technical knowledge of and experience with the capabilities and limitations of building modelling software tools applicable to the modelling requirement of the project.

In regard to building modelling software, the Qualified Modeller must be able to:

- Assess modelling software/tools to determine the appropriate software/tool for the specific application.
- Identify and understand the capabilities and limitations of the modelling software/tools being utilized.
- Evaluate, select, use, and interpret the results of Building Energy Modelling software where applied to whole building, and systems energy performance.
- Apply checks to verify that the results are as expected, and if not, re-examine the model to determine why. Unexpected or anomalous results must be resolved.
- Address software limitations and the need for additional calculations with the EMS or Coordinator, as appropriate.
- Translate drawings and specifications into a working model.
- Understand the typical relationship between model inputs and the results.
- Evaluate whether the modelled results are as expected.
- Interpret the model's output and provide context with the building's design phase.
- Understand and communicate the accuracy, limitations and application of energy modelling results, depending on the phase of the project or objective of the energy modelling scope.

4.2.1.2 Building Industry, Codes and Standards

Qualified Modellers must have an understanding of, and experience with, the applicable Building Code and energy efficiency requirements, and referenced standards applicable to the project.

Qualified Modellers must be familiar with construction practices. They must be able to interpret and understand construction documents including architectural, mechanical and electrical drawings, specifications, control sequence of operations, and shop drawings. In addition, the Qualified Modeller must have:

- A working knowledge of the communications and processes of building industry design teams, when providing building design services.
- The ability to interpret drawings/specifications to identify the building enclosure assemblies and details including opaque and fenestration properties, HVAC system types, mechanical zoning of HVAC systems, zoning of lighting and associated controls systems.
- A working knowledge of applicable local regulations, particularly with respect to application and professional design and review.
- A particular understanding of the relevant requirements of the Building Code including but not limited to thermal properties of materials, ventilation, heat transfer, lighting, HVAC and energy efficiencies.

4.2.1.3 Experience

Qualified Modellers must have experience in the application of building science principles and building systems as they relate to building performance modelling, and must demonstrate proficiency in the core competencies listed in these *Guidelines*. The Qualified Modeller must have experience relevant to the certification or rating system, for example, the application. Depth of the experience must be appropriate to the complexity of the modelling work. They must be able to demonstrate their experience through documentation acceptable to Architectural Institute of B.C. and Engineers and Geoscientists BC. These competencies include applying judgment where building performance is concerned, and the ability to:

- Understand the relationship between model inputs and the results.
- Understand and communicate the accuracy, limitations and application of energy modelling results, depending on the phase of the project or objective of the energy modelling scope.
- Make and/or source reasonable assumptions for missing or unavailable design information.
- Break down a building's performance by end use.

- Identify alternative energy performance strategies.
- Assess alternatives and make recommendations based on meeting project's objectives.

4.2.1.4 Professional Development

Qualified Modellers must maintain current knowledge in their area of practice. Educational activities must have defined learning objectives. They must be planned, educational, yield new knowledge for the qualified modeller, and be relevant to the field of energy modelling.

Acceptable continuing education options for remaining current and expanding capabilities include:

- Specific training in the use of software tools
- Courses, workshops, seminars, webinars, technical talks
- Reading texts and periodicals

As this is an evolving field of practice, it is recognized that travel, receptions, meals, networking, promotional and marketing activities, internet searches, and normal work activities have value; however, they are not considered continuing education in this context.

4.2.2 CORE COMPETENCIES OF THE ENERGY MODELLING SUPERVISOR

On projects in which architects and/or engineers are engaged in providing the Building Energy Modelling services, the work done by a Qualified Modeller who is not an engineer or an architect must be carried out under the direct supervision an energy modelling supervisor (EMS) in a manner consistent with professional engineer and architect's code of ethics and Quality Management Guidelines. The various purposes for which Building Energy Modelling services would be utilized are described in Section 3.3.2.

Like Qualified Modellers, appropriate qualifications for architects and engineers acting in the capacity of an EMS include core competencies which are considered fundamental to the provision of modelling services.

These core competencies include theoretical knowledge, as well as practical experience as described in these *Guidelines*. To produce a model that reflects a building and its associated systems and operations, these competencies must be effectively translated into practice, an EMS must be aware of numerous factors that may affect the model. The EMS must have an understanding of Building Energy Modelling and be able to apply their understanding to the development of the building energy model.

4.2.2.1 Education, Theoretical and Technical Knowledge

The same requirements as described in Section 4.2.1.1 for the Qualified Modeller apply to the EMS, except that a detailed knowledge of building modelling software is not required, only an understanding is required.

4.2.2.2 Building Industry, Codes and Standards

The same requirements as described in Section 4.2.1.2 for the Qualified Modeller apply.

4.2.2.3 Experience

The same requirements as described in Section 4.2.1.3 for the Qualified Modeller apply.

4.2.2.4 Professional Development

The same requirements as described in Section 4.2.1.4 for the Qualified Modeller apply.

5. Professional Practice

This section applies to architects and engineers acting in the capacity of a Qualified Modeller or EMS and all members of the design team who contribute to the energy model. Section 5.1 provides professional practice guidelines common to all building energy modelling applications identified in Section 3.3.2.

Professional Ethics

Architects and engineers are required to adhere to their respective Codes of Ethics, which do not apply to Qualified Modellers who are not architects or engineers. However, if an architect or engineer acting as an EMS is relying on the work of a Qualified Modeller, reasonable steps must be taken by the EMS to familiarize the Qualified Modeller with the relevant ethical standards of the two professions.

The EMS is responsible for the resultant project work of the supervised Qualified Modellers. Means by which the EMS can assist the Qualified Modellers in meeting ethical standards include:

- Discussing ethical standards and the professional obligations of architects and engineers;
- Providing guidance on energy modelling ethics specifically, no 'gaming' or 'fudging' to achieve a desired outcome;
- Providing a written policy document on ethical expectations;
- Requiring adherence to ethical standards in an employment or service contract, or in a separate agreement or memorandum of understanding; and
- Providing continuing education resources on professional ethics.

5.1 BUILDING ENERGY MODELLING SERVICES

Building Energy Modelling services may be rendered for a variety of applications through all stages of a building's life, starting with the pre-design stage for new construction, or the assessment of an existing building's operations.

The stages identified below will apply differently to the applications in Section 3.3.2. Not all stages will apply to every project.

- **Pre-design:** Advisory services and high-level energy analysis services may be performed, such as setting energy performance targets. Modelling may be limited to location, orientation, massing, archetype or feasibility studies.
- **Design (Schematic Design):** Building Energy Modelling early in the schematic design phase can provide significant value as the opportunities to influence design decisions and performance are highest. A significant number of assumptions may be required as detailed design information is typically not available.
- **Design (Design Development):** Modelling is typically performed to evaluate design options informing design decisions. The degree of uncertainty is reduced from the previous phase as the design progresses, and can also be fine-tuned to optimize.
- **Documentation (Contract Documents):** Building Energy Modelling may be required at this phase for building permit. Uncertainty of design conditions is minimal as most design and system parameters are typically known. Opportunities to influence the design are typically limited at this phase, though modelling can still play a role in value engineering.

- **Procurement (Bidding and Negotiation):** Building Energy Modelling may be required to assist with the evaluation of options that influence energy use, or value engineering decisions.
- **Construction (Contract Administration/Field Services):** Building Energy Modelling may be required to assist with the evaluation of proposed changes during construction that affect energy performance. Near the end of construction, Building Energy Modelling may be warranted or required to verify performance based on as-built conditions, on-site testing and/or commissioning.
- **Operations:** With existing buildings and facilities management applications, there may or may not be a design and construction phase, but energy modelling services may be used to:
  - Determine present performance
  - Establish targets or projected savings
  - Improve or optimize performance

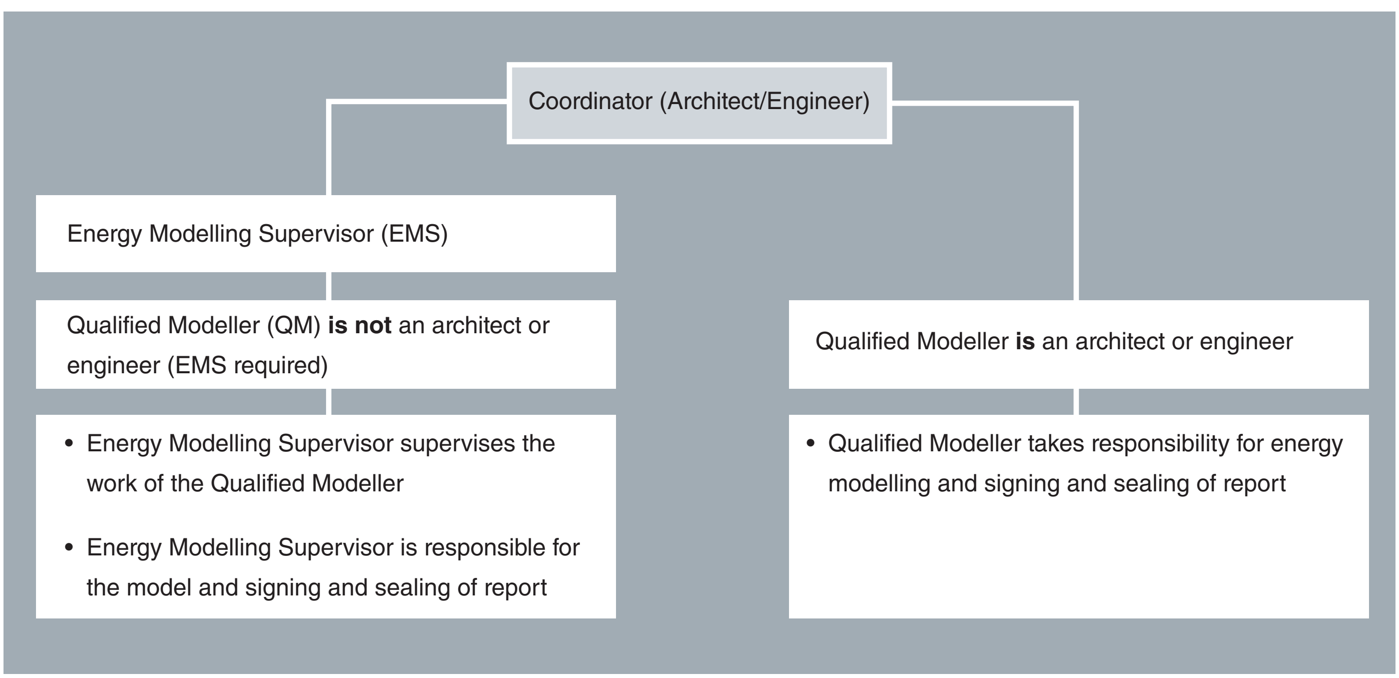
The following subsections apply to all Building Energy Modelling work independent of the application.

5.1.1 COORDINATION AND SUPERVISION

When retaining a Qualified Modeller, the architect or engineer responsible for coordinating the work that contributes to the energy model, such as the Coordinator, must consider the modelling application (Section 3.3.2), as well as the qualifications and professional registration(s) of the Qualified Modeller being retained. Figure 5-1 illustrates this relationship between the Coordinator of the project and the Qualified Modeller.

If the Qualified Modeller is an architect or engineer the Coordinator can rely upon the Qualified Modeller to seal all Energy Modelling Reports. If the Qualified Modeller is not an architect or engineer an Energy Modelling Supervisor (EMS) must directly supervise and seal all Energy Modelling Reports.

Figure 5-1 Coordinator Relationship with Qualified Modeller



5.1.2 WHOLE BUILDING ENERGY MODELLING TOOLS

Whole Building Energy Modelling tools must meet the requirements outlined in the code, standard, program, or other requirements such as re-zoning conditions, applicable to the project. The following lists some examples:

- ASHRAE 90.1 and NECB modelling tools must conform to ANSI/ASHRAE 140, Evaluation of Building Energy Analysis Computer Programs.
- Passive House certification projects must use the applicable version of Passive House Planning Package (PHPP, through the Passive House Canada) or WUFI Passive (WUFI Pro software from Fraunhofer IBP, through PHIUS), as applicable.
- EnerGuide Rating System (ERS) and CHBA NetZero home certification projects must use the applicable software version (HOT2000)[2] specified by NRCan.

5.1.3 ENERGY STATEMENTS ON DRAWINGS

The design team will provide energy statements on the permit drawings. The purpose of the energy statements on drawings is to identify, for the life of the building, the energy criteria and design used in a building's original design and subsequent energy related alterations. Energy statements on drawings to include, as applicable to the project:

- Bylaw/Code/Rating Systems used;
- Energy Code/Standard/Program used;
- Additional energy requirements (targets) used and modelled values achieved, such as rezoning conditions, TEUIs, MEUIs, TEDIs, GHGIs, PTL, and site/source/end-use;
- Climate zone used; and
- Method(s) used. For example; Compliance: prescriptive/trade-off/performance, building area, and space-by-space.

[2] Building Energy Modelling software for low-rise residential dwellings. The tool used for modelling residential dwellings for labeling programs (ENERGY STAR for New Homes, and R-2000)

5.1.4 ENERGY MODELLING REPORT

Building Energy Modelling information must be documented in the form of an Energy Modelling Report, regardless of whether it is required by Owner/Client or AHJ. If the Qualified Modeller is an architect or engineer, the report is the responsibility of the Qualified Modeller. If the Qualified Modeller is not an architect or engineer, the report is the responsibility of the EMS. The responsible architect or engineer signs and seals the Energy Modelling Report.

The Energy Modelling Report must describe the project in sufficient detail to allow another Qualified Modeller to understand the project building and the simulation process taken to arrive at the final projected energy performance. For comparative analyses, baseline model characteristics that vary from those of the proposed design or existing building model must be described and presented for ease of direct comparison. The report must also highlight any anticipated or noted issues that are anticipated to affect future performance.

If modelling is being completed for compliance, or for a program with particular requirements as some energy modelling standards provide specific set of rules and procedures that must be followed, the report must meet these requirements. In the absence of applicable standards with comprehensive reporting requirements, Energy Modelling Reports must include Section 5.1.4.1 through 5.1.4.8, as applicable to the project.

5.1.4.1 Project Overview

The Energy Modelling Report must present findings based on the model's results and the project goals or performance requirements. This would include clear statements on the project's status with respect to specific targets. The Energy Modelling Report must provide a summary of the building energy simulation results, as appropriate, but not limited to:

- Key indicators/targets applicable to type of modelling, standard or program, such as percent better than or TEUI, GHGI, TEDI, MEUI, PTL;

- Annual energy consumption by energy source for the building and, if applicable, comparative baseline(s);
- Annual energy consumption by end-use for the building and, if applicable, comparative baseline(s); and
- If utility costs are included, annual energy costs by energy source for the building and, if applicable, comparative baseline(s).

The report must also include the following project-specific information:

- Project name
- Project address or location identifier
- Project team
- General information: location, use/occupancy, modelled floor area, number of storeys
- The key energy modelling objectives
- Applicable Building Code
- Applicable energy code(s), standard(s), program(s), guideline(s) and/or other requirements
- Compliance path (if applicable)

5.1.4.2 Building Energy Simulation Overview

Include the following general information on the building energy simulation for the proposed design or existing building, and comparative baseline(s) if applicable:

- Modelled floor area and number of stories, making sure to distinguish new, renovation and existing construction; highlight areas/components that may be excluded.
- Building energy simulation software, version and purpose(s), such as performance optimization, comparative, target based, and calibration.
- Performance output key indicators.
- Applicable climate zone.
- Climate data or weather file and source.
- Description of building occupancy and operation schedules as they apply to key areas of the project; noting any special schedules for significant end-uses (if any).
- An overview of the building enclosure, HVAC, service water heating, power, lighting systems, connection to district energy systems, renewable energy systems, etc.
- Summary of key energy efficiency/conserving/production measures.

5.1.4.3 Building Simulation Details

Include information specific to all building systems that apply to the project:

Zoning
- Zoning diagrams, if necessary, such as for a 3rd party audit of the model.

Building Enclosure
- Describe assemblies, including insulation materials.
- List effective thermal performance for opaque assemblies (including thermal bridging), windows, doors, and skylights.
- Air infiltration, including describing assumptions and approach.
- Outline parallel conditions for the Baseline Building, where applicable.

Lighting
- If applicable, state methodology used for lighting calculations, for example, Building Area or Space-by-Space method.
- List interior lighting connected load for prominent space types; highlight unusual or atypical significant Baseline Building lighting power densities, such as space types that are not directly covered under an applicable standard; compare to applicable energy code/standard, if applicable.
- Describe interior lighting control scheme for each space type, using control devices such as occupancy sensors, daylight sensors, timers, etc.
- List exterior lighting load; compare to applicable energy code/standard allowance, if applicable.
- Describe exterior lighting controls, such as photocells, timers and occupancy sensors.

- Outline parallel conditions for the Baseline Building, where applicable.
- Provide the modelled loads for proposed and baseline scenarios, when applicable, for:
  - whole building lighting;
  - interior lighting zones of prominent spaces;
  - interior lighting zones with significant controls systems;
  - exterior lighting zones.

Plug/Process Loads

- Provide overall plug load and highlight major plug/process loads, such as data servers, cooking, appliances, and vertical transportation.
- Outline parallel conditions for the Baseline building, where applicable.

Plant

- Description of building plant equipment, which may include, but are not limited to the following: boilers, chillers, cooling towers, system pumps, central heat pumps, central plant heat recovery strategies (exhaust air, sewage, etc.) and service water heaters.
- Basis for determining the service water heating load.
- District energy system (DES) description, if applicable; include how the DES was represented in the building simulations, for example directly using scaled, virtual DES work-arounds, custom functions, post-processing, etc.
- Outline parallel conditions for the Baseline Building, where applicable.

HVAC Secondary Systems

- Description of HVAC secondary configuration(s), including key areas served and type of air systems, such as constant volume or VAV, displacement or overhead ventilation, dedicated outdoor air system serving fan coils chilled beams, VRF, and distributed heat pumps.
- Major HVAC features such as fan flows (maximums and minimums) and power, furnaces, heat pumps, air conditioners, heat recovery, economizers, humidification/dehumidification, zone control, and controls, such as economizers, supply air reset, demand controlled ventilation, night cooling, natural/mixed mode ventilation, etc.
- Description of the baseline system equipment and the steps taken to size the Baseline Building system equipment, if applicable.
- Designed and modelled equipment efficiencies.
- Description of methodology used to determine and simulate ventilation, and the ventilation standard(s) used. Highlight key differences in ventilation quantities in comparison to the standard (baseline) minimum requirements.
- Heating and cooling design set point temperatures as well as overnight and unoccupied set-back temperatures.
- Indoor air humidity levels, if applicable.
- Outline parallel conditions for the Baseline Building, where applicable.

Model Work-Arounds

- Where the simulation software is unable to accurately model a system component or its function, provide a description of the work-around implemented, including calculations and methodology used.

5.1.4.4 Renewable Energy Systems

For projects with renewable energy systems, provide the following information as applicable:

- Estimated renewable energy production, with an explanation of any relevant calculations.
- Description of renewable energy features, including system type, size and performance.
- Considerations associated with applicable utility cost savings if applicable, such as net metering conditions and rates.

5.1.4.5 Additional Calculations

This section is required if the Qualified Modeller uses exceptional calculations to supplement the energy simulation and/or energy performance calculations. This most often applies in cases where a desired feature is outside the scope of the modelling software capability. For example, exceptional calculations/methods may involve demonstrating additional process load savings, or translation of air tightness tests with respect to infiltration levels for modelling purposes.

A Qualified Modeller must fully describe exceptional calculation methods, which apply when:

- The simulation program does not adequately model a design, material, or device. In such cases, include documentation of the calculations performed and theoretical and/or empirical information supporting the accuracy of the method.
- Process loads are included. Provide the load levels and calculations for any associated savings, if applicable; reference any applicable standards associated with the type of process.

5.1.4.6 Utility Rates

If energy costs are required for the analysis, provide the following information:

- Description of applicable utility rates and rate structure used in the energy simulations.
- For projects using non-traditional fuels with no posted tariffs, such as biomass, provide the basis and calculations used to determine the applicable energy costs.

5.1.4.7 Warnings, Errors, Troubleshooting

Provide an explanation of major errors and warning reported by the simulation software. Include an assessment of unmet heating and/or cooling load hours.

5.1.4.8 Optional

The following items may be included with the modelling report, or possibly as backup documentation, as applicable:

- Zoning diagrams.
- Supporting documentation for utility rates.
- Historical utility/metering data.
- Checklists and data sheets.
- Outdoor air calculation spreadsheets.
- Calculations for model work-arounds, exceptional calculations, process energy savings, etc.
- Method and/or third-party software used to determine the thermal performance values.
- Supporting documentation for renewable energy systems and district energy systems.
- Control descriptions or sequence of operations.
- List of reports used in Building Energy Modelling; for example, air tightness, air balancing, load monitoring data, commissioning, etc.

5.2 ENERGY MODELLING SERVICES FOR SPECIFIC APPLICATIONS

These *Guidelines* are additional to the requirements outlined in Section 5.1. In each of these applications, optimization of a building's energy consumption requires an approach that allows equipment and systems to function together in an effective way that best meets the project requirements.

5.2.1 OPTIMIZATION AND FORECASTING

Optimization and Forecasting modelling can be done for both new and existing buildings. For Optimization and Forecasting modelling, the Coordinator is to obtain from the Owner/Client the documentation necessary to facilitate the simulations. These documents include, but may not be limited to, the following:

- Drawings and Specifications.
- Information on past upgrades or changes that affect energy performance (applicable to existing buildings only).
- Occupancy and scheduling data.

- Equipment schedules.
- Measured data; for example, equipment and systems flow rates, pressures, etc. This is applicable to existing buildings only.
- Utility bills and/or sub-metered energy data; for example, the most recent and/or most representative data for the appropriate period. This is applicable to existing buildings only.
- Building automation system information. This is applicable to existing buildings only.

If the project is being modelled to optimize energy performance outside of an energy code, standard or rating program, then the Client, Coordinator and Qualified Modeller or EMS will need to discuss the inputs, such as operating schedules, occupant profiles and other assumptions. In some cases, a relevant code, standard or rating program may be selected to outline some of the parameters based on industry standards. However, the team can also choose bespoke schedules, profiles and other inputs that more accurately represent the future operating conditions.

5.2.2 COMPLIANCE

For compliance, the Coordinator is to confirm with the Owner/Client:

- Code/Bylaw of the authority;
- The energy standard/code that the compliance is being designed to; and
- Any additional conditions by the authority that would affect compliance.

5.2.3 EXISTING BUILDING AND FACILITY MANAGEMENT

Modelling of an existing building's energy consumption requires an approach that represents existing equipment and systems as they function together.

For existing building projects, the Coordinator is to obtain from the Owner/Client the documentation necessary to facilitate Existing Building or Facility Management modelling. These documents must all represent the same period of time during the building's operations, and can include, but may not be limited to, the following:

- Drawings and specifications
- Information on past upgrades or changes that affect energy performance
- Occupancy and scheduling data
- Equipment schedules
- Building automation system information
- Measurement and verification tools
- Measured data; for example, equipment and systems flow rates, pressures, etc.
- Utility bills and/or sub-metered energy data; for example, most recent and/or most representative data for the appropriate period

The accuracy of documents received representing existing buildings must be confirmed. The dates on all data for compatibility must be confirmed.

5.2.4 INCENTIVE PROGRAMS AND CERTIFICATION/ RATING SYSTEMS

Modelling for incentive/certification requires an approach that represents equipment and systems as they function together and/or the whole building performance.

For incentive/certification, the Coordinator is to obtain from the Owner/Client the documentation necessary to facilitate incentive program/verification/rating system modelling such as:

- Incentive program requirements and conditions, such as utility website/documentation.
- Certification/rating system requirements, such as standards/guidelines.

For incentive/certification modelling of specific equipment/systems or whole buildings, the Coordinator is to obtain from the Owner/Client the documentation necessary to facilitate this modelling. These documents may include but not be limited to, the following:

- Drawings and Specifications.
- Current occupancy and scheduling data.
- Measured data; for example, equipment and systems flow rates, pressures, etc.
- Utility bills and/or sub-metered energy data; for example, most recent and/or most representative data for the appropriate period.

6. Roles and Responsibilities

Project teams must consider all applicable building functions and systems, including the anticipated use and space conditions, enclosure, mechanical, lighting, electrical, process, and any other aspects necessary to appropriately model the building's energy consumption. Not all projects require all design team members or project phases listed within this section.

The roles and responsibilities for professionals associated with Building Energy Modelling projects vary depending on the type of service being provided. Section 6.1 provides roles and responsibilities that are common across a variety of Building Energy Modelling applications, and Section 6.2 provides additional roles and responsibilities for specific applications.

6.1 ROLES AND RESPONSIBILITIES COMMON TO ALL APPLICATIONS

6.1.1 GENERAL ROLES AND RESPONSIBILITIES

6.1.1.1 Owner/Client

These *Guidelines* do not typically pertain to the Owner/Client directly; however, the project team has responsibilities when dealing with the Owner/Client. For example, the Coordinator will obtain agreement(s) from the Owner/Client as outlined in Section 6.1.1.2.

The Coordinator obtains the Owner/Client's project requirements. The Coordinator also has responsibilities to inform the Owner/Client about changes affecting the project's design and construction.

6.1.1.2 The Coordinator

As coordination is critical to the building energy modelling process, the Coordinator role is central for providing, procuring and contributing to Building Energy Modelling services, as well as key to providing project coordination. For Coordinator responsibilities with respect to the Owner/Client, see Owner/Client section above. On building projects that require a CRP, the CRP will be the Coordinator. The Coordinator will initiate communication between the design team and the Qualified Modeller.

The Coordinator's main role is to enable those contributing to the development of the energy model to work together effectively.

The Coordinator must consider the modelling application being performed (refer to Section 3.3.2), as well as the qualifications of applicable architects or engineers to determine the potential need for a Qualified Modeller or an EMS. On Existing Buildings and Facilities Management modelling, the coordination role may be limited. On such projects, if qualified, the EMS or Qualified Modeller may take on the role of the Coordinator.

The Coordinator must establish the energy efficiency objectives to be met on the project based on the Client's needs as well as any relevant AHJ requirements. The Coordinator will monitor all relevant communications and coordinate the project team through all phases of the project.

The Coordinator will obtain agreement from the Owner/Client on the following:

- Project specifics (use, occupancy, operation);
- Utilization of Building Energy Modelling; and
- Building Energy Modelling strategy, such as:
  - any energy standard or code or other requirements and/or specific targets;
  - the Building Energy Modelling application as defined within these *Guidelines*, such as compliance;
  - meeting minimum requirements (based on number of iterations);

– use of the model as a design tool;

– relationship to zoning and other incentives.

The Coordinator communicates the Owner/Client's project requirements and will inform the project team of the following:

- Communication strategy
- Project specifics
- Utilization of Building Energy Modelling
- Building Energy Modelling strategy
- Schedule
- Deliverables

The Coordinator will communicate to the builder/constructor any changes affecting the construction. The Coordinator is responsible to communicating to the Qualified Modeller/EMS any changes (change orders) during construction that may have a bearing on the energy performance of the project.

6.1.1.3 Design Team

The Design Team will:

- Assess the project's scope of work;
- Assess the project's goals;
- Review the Building Energy Modelling strategy as it applies to their scope of work;
- Provide information on the building design and systems that impact building energy consumption applicable to their scope of work;
- Make available current design documents and specifications;
- Review the Energy Modelling Report, including model inputs and results, as it relates to their design;
- Provide comments, as appropriate, to the Qualified Modeller or EMS throughout all project phases;
- Notify the Coordinator of changes to design aspects that would affect the model; and
- Notify the Coordinator of changes during construction that would affect the model.

6.1.1.4 The Qualified Modeller

The Qualified Modeller will:

- Assess the project's scope of work;
- Assess the project's goals;
- Assess the specific needs for the building energy model;
- Select the appropriate modelling tool based on the application/methodology to be used on the project, such as compliance, incentives and M&V;
- Review the necessary documentation from the design team;
- Apply the requirements from the relevant source(s), such as BCBC, VBBL, ASHRAE 90.1, NECB, LEED, Passive House, EnerGuide, etc.;
- Interpret and satisfy the requirements specific to the Building Energy Modelling application(s) for the project (Section 3.3.2);
- Apply appropriate project-specific parameters, such as climate zone and operation schedules;
- Recommend a Building Energy Modelling strategy;
- Outline the assumptions and conditions upon which the model is based;
- Identify missing information (Qualified Modeller makes modelling assumptions, not design assumptions);
- Confirm the deliverables associated with each model and phase;
- Execute energy model simulations and/or iterations;
- Assess the results and provide feedback at each model iteration;
- Communicate to the EMS (where there is an EMS) potential changes the model, and their implications; otherwise, communicate with the Coordinator; and
- Provide a final Energy Modelling Report as outlined in Section 5.1.4 of these *Guidelines*.

When the results are generated, the Qualified Modeller must inform the Coordinator that the model is ready for review by each member of the design team for confirmation of their inputs to the energy model.

When allocating a specialty modelling task to a specialist (enclosure assembly heat transfer, daylighting, air flow assessment, etc.) the Qualified Modeller will consider the following:

- In the case of subcontracting, Qualified Modellers are to inform the EMS of all subcontracts and their scope. Subcontractors must be Qualified Modellers and are to be directly supervised by the EMS.
- The circumstances surrounding the project and whether it is appropriate to delegate one or more of the energy modelling tasks.
- The level of complexity or critical aspects of the task.
- Whether the assisting specialist and/or non-member has the appropriate level of training and experience for the assigned task.
- The level of instruction required to convey the assisting specialist regarding the specific aspects, details, and background associated with the project required to satisfactorily complete the task.
- Subsequent review requirements.

6.1.1.5 The Energy Modelling Supervisor (EMS)

On projects with architects and/or engineers and where a Qualified Modeller is not a Registered Professional, an EMS is required to take responsibility for the modelling done by the Qualified Modeller, including sealing Energy Modelling Reports. The EMS is responsible for directly supervising the Qualified Modeller in accordance with these *Guidelines* and other applicable requirements for direct supervision by Engineers and Geoscientists BC and the Architectural Institute of B.C. The EMS must require that the Qualified Modeller is made aware of and understands these *Guidelines* and the relevant parts of the EMS's respective code of ethics (Engineers and Geoscientists BC/Architectural Institute of B.C.). The EMS is also referred to Section 6.1.1.4. and the professional ethics obligations in Section 5.

6.1.1.6 The Builder/Constructor

The Coordinator will inform the builder/constructor that the Coordinator must be apprised of any changes that impact the energy performance of the building.

6.1.2 DESIGN TEAM ROLES AND RESPONSIBILITIES DURING PROJECT PHASES

The purpose of this section is to further define the design team roles and responsibilities. Specific activities and functions are provided for context purposes only, and may or may not apply to a specific project or design process; however, in the event they apply, they are to be treated as requirements.

An architect must be the Registered Professional of Record for the architectural items in Letters of Assurance Schedules B and C-B and must have overall responsibility for the design and field review of the building enclosure. The *Architects Act* defines when an architect must be involved in a building project. The roles and responsibilities of Building Enclosure Engineers or other Supporting Registered Professionals engaged on a project will be defined by the Coordinator, who will confirm their responsibilities from the pre-design phase through to construction phase.

6.1.2.1 Pre-Design Phase

This section pertains to the scenario when a Qualified Modeller's services are available during the pre-design phase.

Coordinator

The Coordinator will:

- Assemble the team;
- Inform the team of these *Guidelines*, as well as expectation that these *Guidelines* will be followed;
- Inform the design team that the project will be modelled;
- Determine the Building Energy Modelling strategy to be used; and

- Inform the design team that their input will be required based on the energy modelling strategy.

Qualified Modeller

The Qualified Modeller will:

- Review these *Guidelines*.
- Provide input on Building Energy Modelling strategies appropriate to the specific needs of the project; including the following:
  - Information required from each design team member;
  - Energy performance targets;
  - Possible needs for work-arounds;
  - Specific data from utility providers, if required.
- Provide input on energy saving strategies relevant to the project.

Architect

The architect will:

- Coordinate per AIBC requirements;
- Review these *Guidelines*;
- Define the building type and location;
- Determine building enclosure strategies including effective thermal performance values, for example, R values and U values; and
- Review possible building systems and scenarios with each discipline.

Mechanical Engineer

The mechanical engineer will:

- Review these *Guidelines*;
- Provide input on mechanical design strategies appropriate to the specific needs of the project; and
- Propose appropriate system(s) based on project criteria.

Electrical Engineer

The electrical engineer will:

- Review these *Guidelines*;
- Provide input on electrical design strategies appropriate to the specific needs of the project; and
- Propose appropriate system(s) based on project criteria.

6.1.2.2 Design Phase (Schematic Design and Design Development)

This section pertains to the scenario when a Qualified Modeller's services are available during the design phase.

Coordinator

The Coordinator will:

- Inform any design team members and/or Qualified Modeller new to the project of:
  - these *Guidelines* and the expectation these *Guidelines* will be followed;
  - that the project will be modelled;
  - the Building Energy Modelling strategy to be used.
- Inform the design team that their input will be required based on the energy modelling strategy;
- Confirm AHJ submission requirements; and
- Convey AHJ submission requirements to all design team members and the Qualified Modeller as applicable.

Qualified Modeller

The Qualified Modeller will:

- Review these *Guidelines* (if joining the project during this phase);
- Provide input on Building Energy Modelling strategies appropriate to the specific needs of the project including:
  - information required from each design team member;
  - energy performance targets;
  - possible needs for work-arounds;

- specific data from utility providers if required.

- Provide input on energy saving strategies relevant to the project;
- Confirm architectural, mechanical, and electrical model inputs and assumptions with the Coordinator and applicable design team members;
- Simulate and report on the results to the Coordinator and design team to:
  - convey the project's status with respect to compliance and other requirements;
  - communicate new and revised characteristics and assumptions to the applicable design team members;
  - update the model to incorporate applicable design changes as appropriate;
  - provide modelling documentation that appropriately represents the project's design.

Architect

The architect will:

- Coordinate per AIBC requirements;
- Continue to refine and coordinate the design;
- Refine the building design characteristics, specifically but not limited to:
  - building form and massing; including geometry, orientation, and configuration;
  - occupancy types and space use (including transition spaces such as vestibules) and their intended levels of conditioning (heated, semi-heated, and unheated);
  - fenestration (windows, doors, and skylights) location and dimensions;
  - building enclosure systems, including air barrier and vapour barrier;
  - building enclosure performance including effective thermal performance values, such as R values and U values;
- Identify thermal bridges. Refine architectural design strategies appropriate to the specific needs of the project;
- Provide design documents to the Qualified Modeller (via the Coordinator).
- Respond to requests for information from the design team members and/or Qualified Modeller; and
- Continue to review possible building systems and scenarios with each discipline.

Mechanical Engineer

The mechanical engineer will:

- Continue to provide input on mechanical design strategies appropriate to the specific needs of the project;
- Continue to refine and coordinate the mechanical design;
- Continue to provide systems information to the Coordinator, relevant to the Building Energy Modelling, specifically, but not limited to the following:
  - mechanical systems performance specifications, relevant to:
    - > building and process equipment types, sizes, and performance characteristics (efficiency, part load curves, etc.) including the control systems and scheduling, supply, return, exhaust and outdoor air rates;
    - > zoning and system boundaries;
    - > renewable energy systems, including system type, size and performance.
- Provide specific data from utility providers, such as district/neighbourhood energy systems, to modeller;
- Prepare documentation as appropriate to satisfy the project's submission requirements; and
- Provide design documents to the Qualified Modeller (via the Coordinator).

Electrical Engineer

The electrical engineer will:

- Continue to provide input on electrical design strategies appropriate to the specific needs of the project;

- Continue to refine and coordinate the electrical design;
- Continue to provide systems information to the Coordinator, relevant to the building energy model, specifically, but not limited to the following items:
  - interior and exterior lighting systems, lighting controls, lighting loads and/or power densities, and plug/process loads;
  - renewable energy features, including system type, size and performance characteristics;
- Provide design documents to the Qualified Modeller (via the Coordinator).

6.1.2.3 Documentation Phase (Contract Documents)

This section pertains to the scenario when a Qualified Modeller's services are available during the documentation phase.

Coordinator

The Coordinator will:

- Inform any design team members and/or the Qualified Modeller, if new to the project of:
  - these *Guidelines*, and the expectation these *Guidelines* will be followed;
  - that the project will be modelled;
  - the Building Energy Modelling strategy used.
- Confirm AHJ submission requirements;
- Convey AHJ submission requirements to all design team members and the Qualified Modeller, as applicable; and
- Confirm all AHJ requirements have been met by all design team members and the Qualified Modeller, as applicable.

Qualified Modeller

The Qualified Modeller will:

- Review these *Guidelines*, (if joining the project during this phase);
- Provide input on Building Energy Modelling strategies appropriate to the specific needs of the project including:
  - information required from each design team member;
  - energy performance targets;
  - possible needs for work-arounds;
  - specific data from utility providers if required.
- Provide input on energy saving strategies relevant to the project;
- Confirm architectural, mechanical, and electrical model inputs and assumptions with the Coordinator and applicable design team members;
- Simulate and report on the results to the Coordinator and design team to:
  - convey the project's status with respect to compliance and other requirements;
  - communicate new and revised characteristics and assumptions to the applicable design team members;
  - update the model to incorporate applicable design changes as appropriate;
  - provide modelling documentation that appropriately represents the project's design.

Architect

The architect will:

- Coordinate per AIBC requirements;
- Continue to refine architectural design strategies;
- Continue to refine proposals and designs of appropriate system(s);
- Continue to refine the building design characteristics, specifically but not limited to:
  - building form and massing, including geometry, orientation, and configuration,
  - occupancy types and space use (including transition spaces such as vestibules) and their intended levels of conditioning (heated, semi-heated, and unheated);

- fenestration (windows, doors, and skylights) location and dimensions;
- building enclosure systems, including air barrier and vapour barrier;
- building enclosure performance including effective thermal performance values, such as R values and U values;
- identify thermal bridges.

- Continue to respond to requests for information from the design team members and/or Qualified Modeller;
- Continue to review possible changes to building systems and scenarios with each discipline; and,
- Prepare documentation as appropriate to satisfy the project's coordination, submission and compliance requirements including specifying air-tightness testing when required.

Mechanical Engineer

The mechanical engineer will:

- Continue to provide input on mechanical design strategies appropriate to the specific needs of the project;
- Continue to refine and coordinate the mechanical design;
- Continue to provide systems information to the Coordinator, relevant to the Building Energy Modelling, specifically, but not limited to the following:
  - mechanical systems performance specifications, relevant to:
    - > building and process equipment types, sizes, and performance characteristics (efficiency, part load curves, etc.) including the control systems and scheduling, supply, return, exhaust and outdoor air rates;
    - > zoning and system boundaries;
    - > renewable energy systems, including system type, size and performance.
- Provide specific data from utility providers (district/neighbourhood energy systems) to modeller;
- Prepare documentation as appropriate to satisfy the project's submission requirements.

Electrical Engineer

The electrical engineer will:

- Continue to provide input on electrical design strategies appropriate to the specific needs of the project;
- Continue to refine and coordinate the electrical design;
- Continue to provide systems information to the Coordinator, relevant to the Building Energy Modelling, specifically, but not limited to the following items:
  - interior and exterior lighting connected loads and controls, and significant plug loads and electrical process loads, including equipment types, sizes and performance characteristics;
  - renewable energy features, including system type, size and performance characteristics.
- Prepare documentation as appropriate to satisfy the project's submission requirements.

6.1.2.4 Procurement Phase (Bidding and Negotiation)

This section pertains to the scenario when a Qualified Modeller's services are needed during the procurement phase.

Coordinator

The Coordinator will:

- Monitor the procurement process for any changes that may affect the building energy model.
- Inform the Qualified Modeller of design changes that may affect the building energy model.

Qualified Modeller

The Qualified Modeller will:

- Simulate reported changes that may affect the building energy model and report the results to the Coordinator and applicable design team members, particularly as they relate to achieving the project's compliance and/or performance targets.

- Provide modelling documentation that represents the project's design, if applicable.

Design Team

The design team will:

- Continue to inform the Coordinator of design changes that may affect the building energy model.
- Maintain documentation as appropriate to meet project's requirements.

6.1.2.5 Construction Phase

This section pertains to the scenario when a Qualified Modeller's services are needed during the construction phase.

Coordinator

The Coordinator will:

- Inform the Qualified Modeller of design changes that may affect the building energy model.

Qualified Modeller

The Qualified Modeller will:

- Simulate reported changes that appreciably affect the building energy model and report the results to the Coordinator and applicable design team members, particularly as they relate to maintaining the project's compliance.
- Provide modelling documentation that represents the project's latest design.

Design Team

The design team will:

- Continue to inform the Coordinator of design changes that may affect the building energy model.
- Maintain adequate documentation.

6.2 ROLES AND RESPONSIBILITIES FOR SPECIFIC APPLICATIONS

This section lists roles and responsibilities that are in addition to the common items identified in Section 6.1. This list may not include all services required on all applications or building types. The responsible architect or engineer signs and seals the energy modelling report. For services and/or projects not specifically covered by these *Guidelines*, the intent of these *Guidelines* is to be maintained.

6.2.1 OPTIMIZATION AND FORECASTING

Optimization of a building's energy consumption requires an approach that allows equipment and systems to function together in an effective way that best meets the project requirements including additional objectives, such as:

- Reducing energy usage and associated utility costs;
- Reducing greenhouse gas emissions;
- Achieving compliance targets; and
- Achieving specified performance targets.

This section concerns roles and responsibilities concerning optimization and forecasting modelling projects.

Owner/Client

- The Coordinator will confirm with the Owner/Client as to the specific project goals and constraints, including specified performance targets and cost-effectiveness criteria.
- The Coordinator will facilitate the provision of information from the Owner/Client regarding the planned building operations, and specific changes being considered, if any. This may include building use, occupancy, and planned operation of the building.

Coordinator

For Coordinator responsibilities with respect to the Owner/Client, see Owner/Client section above.

- The Coordinator will provide information per 5.2.1. to the Qualified Modeller on the actual and/or anticipated operations of the building. This may also include the same information listed above for the Owner/Client.
- The Coordinator will provide information to the Qualified Modeller on project constraints.
- The Coordinator will determine which codes and standards were used to design the existing building.

Qualified Modeller

Modelling for various optimization objectives may warrant applying differing conditions and protocols. The Qualified Modeller will:

- Consider the inefficiencies of under-performing systems.
- Forecast modelling may use a baseline model(s) for operations and proposed alterations comparisons.
- If the project deviates from the Qualified Modeller's understanding of the building's intended performance, the Qualified Modeller must identify these differences to the Coordinator.
- Identify missing information, make only modelling assumptions and not design assumptions.

6.2.2 COMPLIANCE

Although the AHJ is responsible for enforcing the requirements of the Building Code and any additional energy requirements, a professional's responsibility is the same regardless of the level of enforcement by the AHJ.

Coordinator

On projects requiring professional design and review under Building Codes the Coordinator is the CRP. While hiring of a Qualified Modeller at any specific phase may not be a requirement, the Coordinator should discuss with the Owner/Client the advantage of Building Energy Modelling early in the project to take advantage of a model's potential as a design tool.

The Coordinator will:

- During the pre-design phase
  - Determine the Qualified Modeller and/or EMS;
  - Determine the Building Energy Modelling strategy to be used;
  - Identify the energy performance standard or target to be met.
- During the design phase
  - Confirm AHJ requirements and communicate them to design team and Qualified Modeller/EMS;
  - Communicate to the Qualified Modeller and/or EMS the design as it evolves.
  - Obtain compliance status updates from the Qualified Modeller and/or EMS.
- During the documentation phase
  - Confirm AHJ requirements and communicate them to design team and Qualified Modeller/EMS;
  - Communicate to the Qualified Modeller and/or EMS the design changes that affect the model;
  - Obtain compliance status updates from the Qualified Modeller and/or EMS.
- During the procurement and construction phases
  - Monitor the construction for any change that would affect the model;
  - Inform the Qualified Modeller of design changes that may affect the energy model;
  - Direct the Qualified Modeller and/or EMS to revise the model if necessary;
  - Provide Building Code assurances to AHJ, as required.

Qualified Modeller

On projects requiring professional design and review under Building Codes, a Registered Professional is responsible for the energy model, either as Qualified Modeller or EMS.

The Qualified Modeller will:

- During pre-design phase
  - Discuss with Coordinator the building energy modelling strategies appropriate to the specific needs of the project.
- During design and documentation phases
  - Simulate the building's energy performance, as required;
  - Convey to the Coordinator the project's status with respect to compliance;
  - Update the model to incorporate design changes;
  - Provide documentation of project status.
- During procurement and construction phases
  - Simulate, if required;
  - If the design changes, convey to the Coordinator the project's status with respect to compliance;
  - Update the model to incorporate design changes;
  - Provide documentation of project status.

Design Team

Each member of the design team, as applicable, will:

- During pre-design phase
  - Provide input on design strategies to meet the project's requirement.
- During design and documentation phases
  - Provide information to the Coordinator as required for the simulation;
  - Communicate to the Coordinator any revised characteristics and/or assumptions;
  - Each Registered Professional of Record is responsible for the assurances for their design's compliance as it pertains to the model. This is applicable to each Registered Professional of Record.
- During procurement and construction phases
  - Review proposed changes with respect to energy compliance;
  - Communicate to the Coordinator any change that could affect the energy model;
  - Confirm with Coordinator that any change is acceptable with respect to energy compliance.

6.2.3 EXISTING BUILDING AND FACILITIES MANAGEMENT

The roles and responsibilities associated with existing building modelling are mainly focused on the Qualified Modeller, although the Owner/Client and the Coordinator will have duties as well.

Owner/Client

The Coordinator will confirm with the Owner/Client as to the specific services required, including the desired result. In addition to confirming the type of energy audit and analysis that is desired for an existing building, the Coordinator will confirm with the Owner/Client the background and objective(s) to be attained through the exercise.

The Coordinator will facilitate the provision of information from the Owner/Client regarding the building operations.

Coordinator

The Coordinator role will vary depending on the scope and objectives of the existing building project. Some projects requiring significant renovation work will have a CRP that may provide for a Coordinator role, in addition to a design team. For some projects, however, the Coordinator role may be a representative of the Owner/Client, part of a facilities management team, and/or even the Qualified Modeller. The Coordinator will determine which codes and standards were used to design the existing building.

In addition to the roles referenced above with the Owner/Client, the Coordinator will provide information to the Qualified Modeller on the known operations of the building. If required, the Coordinator will coordinate a site visit for the Qualified Modeller to review/confirm aspects of the building's construction, systems and operations.

Qualified Modeller

The Qualified Modeller will:

- Request all necessary information from the project team pertaining to the existing conditions that would affect the energy simulation; this may also include utility data that could assist in the establishment of a building model of the baseline operations.
- Consider the existing conditions of the building/space, in the areas relevant to the energy performance simulation, specifically but not limited to the following:
  - building enclosure
  - HVAC
  - service water heating
  - power
  - lighting
  - tenant use
  - fuel types/energy sources
  - schedules (occupant, systems)
- Reference applicable industry standards for measurement and verification (M&V) and calibrated modelling.
- Perform as-built baseline modelling to reflect the existing conditions and actual operations of the building. Anticipated operational changes are then applied to reflect an updated baseline, which may be utilized to analyze potential energy management strategies.
- Inform the Client of any anticipated or noted performance issues identified during the data collection or model calibration process.
- Apply workarounds to compensate for the inadequacies of the software being used.
- Account for past metered energy use and predict utility bills, the Qualified Modeller must incorporate current schedule and load parameters, and metered data.
- Consider the inefficiencies of non-commissioned system components, and/or under-performing systems.
- Assess the simulation results of the existing building in comparison with the building's known energy performance as applicable to the project. This assessment will include the Qualified Modeller's interpretation of the results to provide an opinion of whether the simulation adequately represents the existing building's starting point in any comparative before versus after modelling scenario.
- If appropriate to the project's needs, create simulations of various phased improvement/upgrade scenarios to demonstrate the effects of commissioning, energy management and/or equipment replacement scenarios.

6.2.4 INCENTIVE PROGRAMS AND CERTIFICATION/RATING SYSTEMS

The roles and responsibilities associated with modelling related to incentive programs and certification/rating systems are wide ranging and dependent on the specific program/system.

Owner/Client

The Coordinator will inform the Owner/Client as to the specific project incentive programs and/or certification/rating systems available and may be applicable. The Coordinator will confirm with the Owner/Client the specific programs that are to be pursued.

Coordinator

For Coordinator responsibilities with respect to the Owner/Client, see Owner/Client section above. The Coordinator will inform the Qualified Modeller as to the incentive programs and/or certification/rating systems being pursued. The Coordinator will determine which codes and standards were used to design the existing building. The Coordinator will identify differences where certification/rating system requirements are incongruous with the building's proposed use and/or operating conditions.

Qualified Modeller

The Qualified Modeller will:

- Become familiar with the specific requirements for the program/system being pursued, including the information required for the incentive/certification documentation.
- Understand how an incentive program may be interlinked with a rating system, such as an incentive program which may require whole building modelling and provide study funding early in the design process, for a building that achieves a certain exceptional beyond-code rating.
- Understand the unique requirements for meeting the incentive program's requirements, such as specific modelling protocols and tools, requirements to provide a modelling study proposal, life-cycle costing analysis or incremental capital cost calculation submittals.
- Use appropriate tools meant to confirm eligibility requirements for the provision of incentives programs or certification/rating systems.
- Where incentives are based on actual operational conditions, provide modelling to represent the actual conditions.
- Confirm the acceptable comparative baseline, if applicable, for Building Energy Modelling as detailed by the incentive program or certification/rating system provider.
- As required, provide multiple models iterations for the building to satisfy program and compliance requirements.
- Where multiple Building Energy Modelling standards or guidelines exist, produce documentation to comply with each set of requirements.
- Complete, or assist in the completion of, all relevant incentive/certification documentation.
- Provide the required electronic model input files.

7. Quality Assurance

7.1 PEER REVIEW

Qualified Modellers who are architects or engineers may provide a third-party review of an energy model in accordance with professional engineering and architects' codes of ethics. This requires that reviewers inform (or make every effort to inform) the responsible Qualified Modellers, and EMS when applicable, as per the respective codes of ethics. It is advisable that the reviewing Qualified Modeller reviews the applicable code of ethics.

In the event a peer review is required; the review will check several components. For example, calculations and assumptions, to confirm that the modelling has been done according to accepted best practices, and to determine that intended outcomes, such as meeting performance targets, have been achieved.

7.2 DIRECT SUPERVISION

For projects in which engineers/architects provide Building Energy Modelling services, an architect or an engineer must act in the capacity of an EMS and directly supervise the Building Energy Modelling, if the Building Energy Modelling is done by a Qualified Modeller who is not an architect or engineer.

The EMS should have knowledge of the modelling carried out during all stages of the project, including modelling done at the conceptual stage, design/working drawings stage and at the construction stage. The EMS must demonstrate active involvement and ongoing interaction and input to make sure that energy modelling and associated results meet a reasonable standard of quality and veracity.

The EMS must direct and monitor the activities of the Qualified Modeller who is acting under their direct supervision. While direction may be satisfied by active involvement in the initial stages or concept development, monitoring implies an awareness of activities and work throughout the process; therefore, supervisors who conduct only a final review of the model results and are unaware of the modelling prior to the model results reaching them for review do not fulfill their direct supervision obligation.

Active involvement may be demonstrated through:

- Communicating the reason for Building Energy Modelling, the energy efficiency targets required to be achieved on the project and the details of the proposed design relating to energy efficiency;
- Explaining the types of information required as model outputs;
- Communicating the design changes that could impact the results from the energy model;
- Discussing the model assumptions and understanding the limitations of the modelling software;
- Providing input into the design optimization achieved through modelling; or
- Through evidence of regular consultation with the Qualified Modeller being supervised by the EMS throughout the project.

7.3 RETENTION OF PROJECT DOCUMENTATION

Retaining complete and easily retrievable energy modelling reports and supporting documentation is critical to professional practice. It facilitates quality assurance, and allows for expedient review by other qualified professionals, if necessary. When completing a Building Energy Modelling task, comprehensive reporting and supporting documentation enables a Qualified Modeller or an EMS to demonstrate that they have satisfied the applicable authority's requirements, for example, compliance to the BCBC, VBBL, LEED energy performance prerequisite. It may also allow for resolving contentious issues, meeting legal and regulatory requirements, documenting decisions, and defending claims. Further, comprehensive reporting may facilitate the ability to effectively undertake future work or make intellectual property readily retrievable for future solutions.

An Energy Modelling Report should thoroughly describe the project, allowing another qualified professional to fully understand the project building and the modelling process taken to arrive at the key energy performance indicators and results. Refer to Section 5.1.4 for further details concerning the Energy Modelling Report.

Such documentation and records must be archived and retained in accordance with professional engineering and architects' quality management guidelines and policies.

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