Ontario Association of Architects

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Every Architect Needs to Know About Energy Modeling

Summary

The purpose of this practice tip is to provide fundamental information architects need to integrate energy modeling into their "business as usual" professional services. Architects who understand building energy performance and can evaluate the energy consumption of projects early in the design process are more capable of creating buildings that meet performance expectations.

Performance modeling systems, software, product information and websites are ever advancing and changing.

The information in this Practice Tip illuminates some of the business and building performance advantages of design phase energy modeling as well as cautions the energy modeler to use computational data carefully.

Products and names may be listed in this practice tip in order to improve the ease of access to further investigation of the topic. Specific references to energy modeling products are not endorsements by the OAA.

Background

What is Energy Modeling?

Energy Modeling is the calculation or computerized simulation of energy performance of a building or group of buildings using information about its configuration, composition and climate. Energy modeling is a design tool used to estimate the energy consumption of a building and all of its components such as heating, ventilation, air conditioning, hot water and lighting/electrical systems. By estimating the Energy Use Intensity (EUI) in the design process and comparing the actual energy use of the constructed building, architects, contractors and building owners are able to better understand how to create affordable, high performance, low energy buildings.

The building design, configuration, orientation and components (glazing, wall, roof and foundation assemblies) can be manipulated and optimized to improve energy performance (or EUI) of the building design. It is the action of testing design options and assumptions that makes energy modeling a powerful and critical design tool for the architect and design team. The design team can evaluate and prioritize investment strategies that will have the greatest improvement of the building's energy use.

Why use an energy model?

Architects have the knowledge and responsibility to design efficient buildings that use energy and resources wisely. To effectively design a low energy building, a high level of commitment and cooperation amongst the client, architect and engineers is required at all phases of the project but particularly at its outset. The energy performance of a building needs to be estimated (modeled), measured and then verified in order to assess its performance against design targets.

a) The primary advantage of using energy modeling in the design phase is to understand the parameters required to achieve high performance so that performance based decisions and improvements can be made early in the design phase.

b) Using modeling early in the design process enables architects to capture "low hanging fruit" by reducing the energy loads and consumption through passive design that includes factors such as orientation, solar heat gains, daylighting, solar shading and natural ventilation.

c) Buildings that are designed for efficient and effective thermal comfort, ventilation rates and air quality are more comfortable and healthier environments than the status quo; this translates into improved productivity of the people that occupy them.

d) Regulatory and building code authorities often and increasingly require energy performance verification to be submitted with building permit applications.

In order to verify and improve energy modeling, after a building is in use, its performance needs to be evaluated against its modelled energy use. Architects should encourage clients to support facility monitoring and providing access to energy records for such an evaluation subsequently.

Suggested Procedures

Understand the fundamentals

Knowledge of how people use buildings and how buildings consume energy is fundamental to effectively modelling energy consumption. As a start, architects should by learning and conducting basic energy evaluation simulations. Subsequently architects can invest in more in-depth and sophisticated energy modeling during the design phase to create more accurate energy conservation predictions for higher performance projects. Interest, commitment, time and financial resources are fundamental to understanding and implementing energy modelling and the following are some of the sources of information and tools available to architects.

a) National Energy Code of Canada.

b) Ontario Building Code – SB10 and SB11.

c) ASHRAE 90.1, and all standards on performance, thermal bridging.

d) Natural Resources Canada (NRCan) software tools.

e) Building Information Modeling software that incorporates energy modeling.

Simple energy models are very useful and effective to help guide design and the design team early in the process; other experienced consultants offer professional energy modeling services that may be advisable to use for complex building designs and conditions.

Prepare for and minimize risks

While energy modeling is undertaken to understand how buildings can be designed and built to be energy efficient, overly optimistic predictions can lead to unrealistic expectations and problems for the design team. Such problems can become the basis for disappointed clients and legal complications regarding professional responsibilities and the standards of care.

Some of the ways to avoid problems are as follows:

a) Architects and consultants must be clear that the accuracy of energy performance predictions is dependent upon completeness and constructability of design, quality of construction, materials, occupancy factors such as operation and hours of use of the building. Unrealistic expectations can easily become the basis for disappointed clients and legal complications regarding professional responsibilities and the standards of care. Read bulletins from Pro-Demnity on this issue.

b) Experienced users of energy modeling software modify and qualify their model results/claims based on experience and empirical data.

c) There is a variety of modeling software on the market; some are detailed and complex while other are simple and appropriate for early analysis of basic design decisions. It should be kept in mind that:

- Overly complex software is sometimes difficult to use and in practice, may go unused;
- Inexperienced users without adequate training can become discouraged; and
- Garbage in, garbage out applies to energy modelling.

d) Singular programs may not enable a complete understanding of a building so various modeling tools may be needed to understand aspects of the building's interaction with the environment such as daylight versus artificial light. Models should be used at the beginning of the design process and not just at the end to check if the design meets energy requirements.

e) Building users cannot be controlled. Operating characteristics (commissioning, temperature set-points, weather, and 'The Human Factor' can alter model predictions.

Implement Energy Performance Design Standards

Clients and project teams who want to create high performance buildings need to model building energy at all phases of the design process. Some of the requirements for energy modelling are listed below. Many authorities require that the energy performance of any proposed new or renovated project be evaluated (OBC SB-10 and SB-11 and TGS2014):

a) The Ontario and National Building Codes and the National Energy Code for Building allow energy modeling to replace prescriptive building code measures.

b) Participation in numerous conservation programs (such as LEED, GreenGlobes, PassivHaus) require energy performance modeling.

c) ASHRAE, and Client Energy Targets towards zero.

d) National Energy Code for Buildings 2015 proposed mandatory Energy Use Intensities (EUIs in kwh/m²/yr.) – i.e. in Climate Zone 5: Large MURBs-170 kwh/m²/yr. And Large Offices - 160 kwh/m²/yr.

e) Architecture 2030 - the Challenge:

Reduce energy consumption by 70% in 2015

- 80% by 2020
- 90% by 2025
- And 100% by 2030.

f) Thirty Party Envelope (Enclosure) BECx-Design, Field Review and Testing- Approved LEED v.4 has a new prerequisite for third party design review of an enclosure (called envelope in Canada)- Extension of Expertise- Approved LEED v.4 provides 3 additional new points for holistic building (envelope) commissioning-Risk Management.

g) Ontario Building Code SB-10 provides multiple compliance paths including NECB 2011.

h) ASHRAE 2010 - Practical Design Details essential.

References

1. eQUEST vs IES-VE vs EnergyPlus vs REM/Rate
   (Just like architectural software, different programs have different utilities).
2. CAN-QUEST - Canadian adaptation of eQUEST. To Download eQUEST.
   Beta release of CAN-QUEST available through NRCAN. Information on these and other tools can be found on the USDOE Building Energy Software Tools Directory website.
3. Passive House website, training courses
4. UCLA Energy Design Tools website. Climate Consultant 5 is a free tool available from the above address. You will need to download .epw climate data for your city from this website.
5. ASHRAE Fundamentals – Glazing / Fenestration / Window Table.
6. Architecture 2030 Challenge.
7. Building Owners and Managers Association International (BOMA).
8. CBIP Screening Tool reference buildings used as base line.

9. An Architect's Guide to Integrating Energy Modeling in the Design Process AIA 2012.
10. AIA and RMI: New power play: Deep energy retrofits emerge as promising market – AIA Document which helps Architects understand the growing energy retrofit market.
11. All Practice Tips within the PT.36 Series.

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