Integrated Energy Modeling Through Dynamic Visualization

THE RESEARCH

Whole-building energy modeling is increasingly being used in building energy code compliance, green building standard evaluation, and utility and government incentive programs. The use of energy modeling during the design phase can help teams stay on track to meet project goals and provides one of the greatest opportunities to realize ambitious energy and carbon reductions.

The integrated design process (IDP) is an interdisciplinary team approach to building design that looks at the building as a system. An important part of an IDP is an early stage design workshop, called an integrated design charrette (IDC) where relevant stakeholders can collaboratively set project goals. Having all stakeholders aligned early in the design process can help facilitate integrated thinking toward cost-effective design solutions.

Three case studies highlight an innovative process whereby the implementation of parametric energy modeling with dynamic visualization techniques in support of the integrated design process has led to better outcomes. The case studies focus on common design challenges found in multi-unit residential building design in Canada.

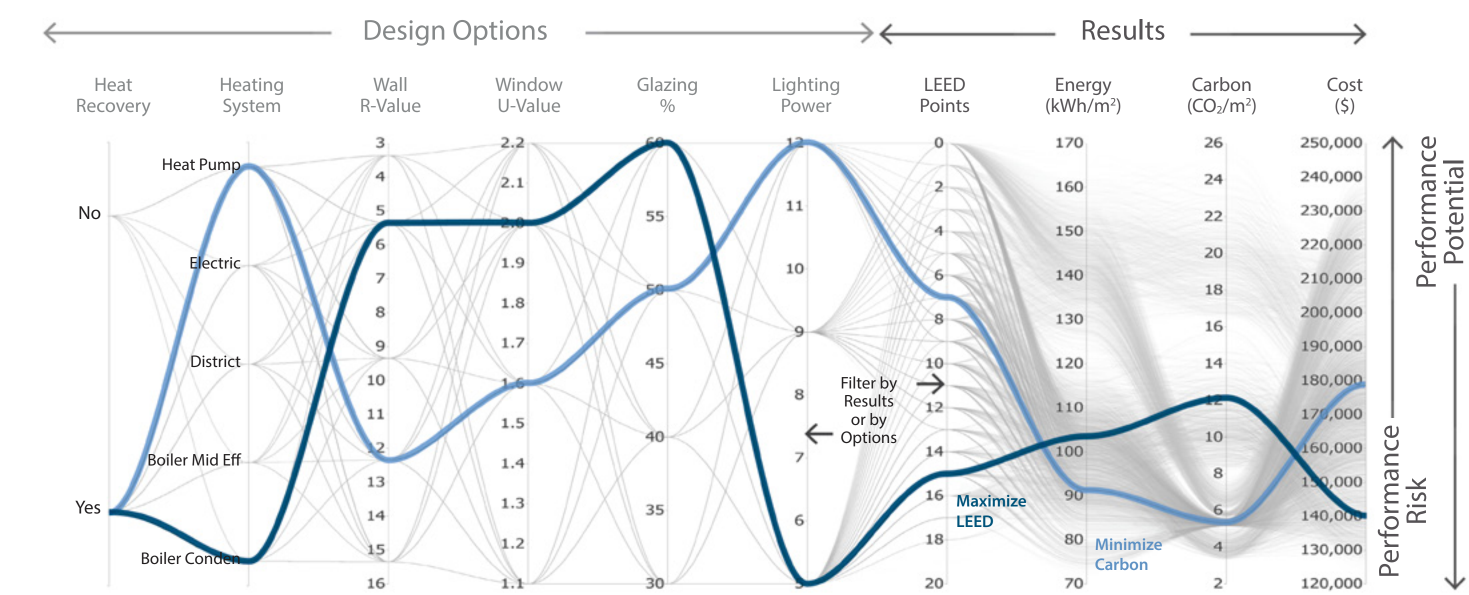
The Building Performance Map (shown below) is an effective way to highlight and communicate the performance impacts of various design criteria (that is, design options) alongside simulation results. Of the approximate 2,400 completed parametric simulations, 2 simulations are highlighted in blue. Although both simulations incorporate a heat recovery design option in this example, the combination of better thermal envelope (higher R-value walls, lower glazing U-value and glazing area) and lower lighting power, as represented by the light blue line, results in a ($40,000) higher cost compared with the combination of design criteria represented by the dark blue line.

Parametric simulations

Recent advances in both energy modeling software and computing power permit the execution of parametric simulations with greater ease. Parametric simulations can consider a large number of design variables (options) that, when combined together, create a large number of design permutations that can be used to assess the impact of a comprehensive set of design options, essentially exposing the full range of performance potential and/or performance risk of a particular building.

Dynamic visualization

Assessing the large amount of data associated with parametric simulations poses an enormous challenge. Design teams can easily be overwhelmed by the number of design options available to them. Dynamic visualization is one emerging strategy for organizing results of parametric simulations in a format that facilitates decision making in the design process.



Project decision makers can also quickly observe and assess the relative performance each combination of design criteria may have against other project objectives, such as energy intensity (kWh/m^2) or carbon intensity (CO_2/m^2).

KEY FINDINGS

Parametric simulations have significant advantages over a typical energy modeling process where discrete energy models are run at periodic stages throughout the design, such as the following:

- Engage energy modeling earlier in the design process by populating unknown design inputs with a range of potential variables rather than making uncertain assumptions with discrete values.
- Quantify the risk of unknown design/energy modeling inputs by showing the impact that a range in those assumptions has on performance.
- Reduce overall design input time (by the energy modeling process) by front-loading the process and having a range of potential results readily available early in the design rather than running discrete simulations periodically as the design changes over several months.
- Provide a complex picture of energy performance potential and performance risk early in the design process, allowing design teams to prioritize areas of highest impact.

IMPLICATIONS FOR THE HOUSING INDUSTRY

Within the integrated design process (IDP), the integrated design charrette (IDC) has demonstrated itself to be a powerful vehicle in which the key project stakeholders and decision makers are assembled together to collaboratively set and optimize project goals and objectives. Processes, such as dynamic visualization, get around many of the shortcomings in conventional energy modeling and building design by quickly considering and assessing the impacts of a gamut of design variables or options, with respect to the established project objectives, and identifying performance risks and potentials associated with those considerations.

Case studies

SINGLES COMPLEX INUVIK, NORTHWEST TERRITORIES

- A 17-unit, two-storey complex designed for the Northwest Territories Housing Corporation in Inuvik, N.W.T.
- Energy modeling was used to demonstrate a 25% energy use reduction requirement and explore a goal of 50% energy use reductions over the National Energy Code for Buildings (NECB) 2011.

700 BAY STREET, TORONTO, ONTARIO

- A 32-storey addition built over ground floor retail and adjacent to an existing 24-storey office and residential tower in Toronto, ONT.
- Energy modeling was used to develop an optimal solution that met project targets, in particular, the visualization tool allowed the project team to explore the impact a variety of design choices had on meeting multiple targets in concert (energy use, energy cost, peak electricity demand, and greenhouse gas emissions).

MAPLE, HALIFAX, NOVA SCOTIA

- A 32-storey, mixed-use building in Halifax, N.S.
- Energy modeling was used to develop an optimal solution to meet project targets and to explore the impact that a variety of design choices had on meeting energy reduction goals, lowering operating costs and increasing rental marketability through LEED certification.

FURTHER READING

Full report - *Integrated Energy Modeling Through Dynamic Visualization:*
ftp://ftp.cmhc-schl.gc.ca/chic-ccdh/Research_Reports-Rapports_de_recherche/2017/RR_Integrated_Energy_Modeling_Jun30.pdf

Project Manager: Silvio Plescia
Housing Needs
Canada Mortgage and Housing Corporation

Printed in Canada
Produced by CMHC 26-07-17

69158

cmhc.ca