CANADIAN MUSEUM OF ARCHITECTURE

IN PERSPECTIVE

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THE ENERGY PERFORMANCE GAP

From the Federal Government down, just about everyone acknowledges that energy-efficient buildings are an essential requirement for our long-term survival. So, how do we determine energy efficiency?

Not very well, as it turns out. Studies indicate that the actual energy performance of buildings is often significantly lower than the calculated value. And, since actual measurements are seldom made, reliance is placed on design parameters.

Many software applications are available for simulating the energy performance of architectural designs. These calculated results are then used for evaluations of the designs and for the issuance of certificates. This somewhat theoretical process has become an important driver of building practices.

Whenever measurements are actually made, the difference between the calculated energy performance of a building and the measured performance is termed the energy performance gap, or EPG. It may be as high as 30%.[1]

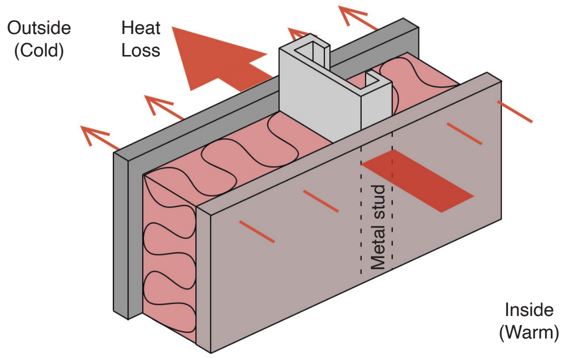
Professor Mohamad Araji of the University of Waterloo's School of Architecture has commenced a study to determine the EPG and the factors that give rise to it in a sample of residential buildings by comparing measured and calculated energy consumption. The research is funded by Mitacs and supported by the Canadian Museum of Architecture.

Professor Mohamad Araji.

THE STUDY

Building energy modeling is a complex subject touching on factors that range from materials science, through construction practices to human factors. Results are locality-dependent on microclimates and the quality of workmanship.[2] To analyze the large volume of data, the project provides for the use of machine learning algorithms, more specifically the development of a neural network, to relate actual to simulated results. The expected outcome is information that can supplement the use of simulation tools to enhance their accuracy.

Since heat transfers nonuniformly through walls, the study will pay particular attention to the role of various structural components that have a bearing on this process. Air escape can be a route for substantial heat loss and thermal bridging has long been a problematic issue.



An example of thermal bridging in a cavity wall. Heat loss is minimized by insulation. However, because of its high thermal conductivity, a structural metal stud increases transmission locally, reducing the overall insulation value of the structure.

A key tenet of sustainability in buildings is the minimization of heat transfer through the building envelope. This study seeks to better characterize the various sources of heat loss to, in the long run, improve energy efficiency in building design and construction.

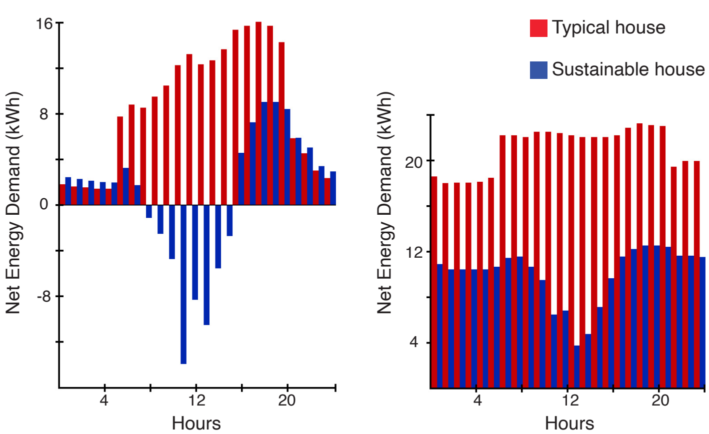
A DEMONSTRATION

A large amount of the world's energy expenditure is used to maintain building temperatures at comfortable levels. The CMA is preparing displays that illustrate various aspects of thermal control in buildings.

To explain the operation of an energy-efficient dwelling, a sustainable house has been designed and constructed as a model for the CMA. In addition to depicting energy-conserving design features, the display will include an animated system comparing the performance of this building with that of a conventional house of similar size.

Energy flows and the factors that affect them form the principal features of the demonstration that covers operation in both summer and winter. As the sustainable house incorporates a solar panel array, provision is included for directing excess electrical energy to the power grid.

In the end, the difference in performance is best illustrated by the net energy demand of the two buildings as shown in the following graphs.



Mid-Summer. *Mid-Winter.*

Net energy demand is the amount of external energy required to maintain set temperatures in the houses. Note the savings in the energy efficient building.

The residential sector in Canada represents 12% of total energy use.[3] It is expanding at a rate of 4% per year as a result of population growth. The preference for larger dwellings results in additional pressure. Designing for energy efficiency is essential and requires accurate methods that yield predictable results. The EPG project is a key step in this process.

Sustainable House model, north facade.

Sustainable House model, west facade.

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- Peter Brueckner

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  E-mail: communications@cmarch.ca