

Integrated Design Process

The EQuilibrium™ Sustainable Housing Demonstration Initiative is a national initiative created and led by Canada Mortgage and Housing Corporation (CMHC) that strives to balance the demands of our housing needs with those of our natural environment. The EQuilibrium™ Housing Initiative brings the private and public sectors together to develop and showcase homes that address occupant health and comfort, energy efficiency, renewable energy production, resource conservation, reduced environmental impact and affordability. One of the key elements that helped the EQuilibrium™ homes achieve high levels of performance was their use of the integrated design process. This process is highlighted in this EQuilibrium™ Housing InSight.

Integrated Design Process

Design as System

Modest improvements in the performance of houses (such as energy efficiency) can be achieved by relatively simple individual measures. However, achieving the very high levels of performance called for in the EQuilibrium™ Housing Initiative requires the coherent application of comprehensive knowledge of house design principles and innovative practices, technologies, and systems, to optimize the performance of the house as a system.

To design the house as a unified system requires a thorough understanding of the interaction of building form, structure, space planning (function), climatic conditions, building envelope, building services (for example, mechanical, electrical, plumbing, water and wastewater systems), and occupant behaviour. There are various examples in which a change to one element of a house will have an impact elsewhere:

- The required heating energy is reduced in a more efficient home. Smaller capacity heating systems reduce capital costs. However, if the system is not correctly sized for the reduced demand, needless capital expense can be incurred or frequent on-off cycling can occur, reducing the system efficiency.

- If passive solar-heated air is to move by natural convection, then open floor plans and appropriate interior volumes are required for an airflow path. However, open floor plans affect privacy and acoustic separation within the house.
- Building an airtight building envelope reduces heating and cooling energy requirements. However, reducing air leakage without incorporating mechanical ventilation can cause moisture to accumulate, odours to linger, and air to seem stale.

Design teams need to understand these and other house as a system interactions in order to create higher performance houses.

IDP—the Integrated Design Process

One widely adopted approach that has emerged for the design of “advanced,” “green” or “sustainable” buildings is the Integrated Design Process (IDP). The IDP is an interdisciplinary team approach, which facilitates thinking of the building as a system, and considers competing and complimentary aspects of the local site including code and bylaw requirements; climate; building form and space planning; envelope; energy efficiency; renewable energy potential; mechanical, electrical and other systems; landscaping and user preferences in the design of a building or community.

There is no single element of integrated design that is revolutionary. Rather it is the sum total of all of the elements and what the team does with them that differentiates the IDP from conventional design. The IDP differs in intention and emphasis from conventional design.

There are an increasing number of practitioners of the IDP. Each has a different, and valid, perspective on how to do it, based on their experiences and practices. Most would agree that there are common elements to every definition.

- *Goal-driven* with the primary goal being sustainability, but with explicit subsidiary goals, objectives and targets set as a means to get there.
- *Facilitated* by someone whose primary role is not to produce the building design or parts of it, but to be accountable for the process of design.
- *Structured* to deal with issues and decisions in the right order, to avoid locking in bad performance by making non-reversible decisions with incomplete input or information.
- *Clear decision making* for a clearly understood methodology for making decisions and resolving critical conflicts.
- *Inclusive*—everyone, from the owner to the operator, has something critical to contribute to the design and everyone must be heard.
- *Collaborative* so that the architect or building designer is not simply the form giver, but more the leader of a broader team collaboration with additional active roles earlier in the process.
- *Holistic* or systemic thinking with the intent of producing something where the whole is greater than the sum of the parts, and which may even be more economic.
- *Whole-building budget setting*—allows financial trade-offs, so money is spent where it is most beneficial when a holistic solution is found.
- *Iterative*—to allow for new information to inform or refine previous decisions.
- *Non-traditional expertise*—on the team, as needed, or brought in at non-traditional times to contribute to the process.

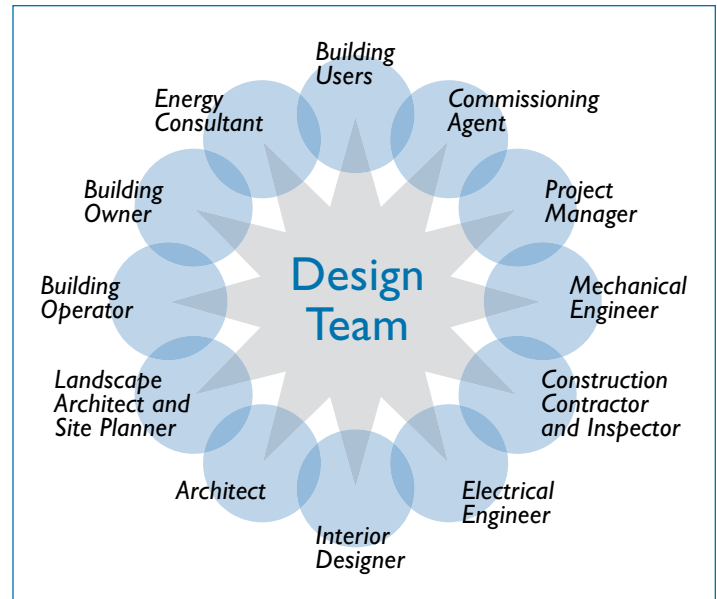


Figure 1 Areas of expertise that could help at a charrette¹

An integral part of the IDP is the integrated design charrette (IDC) where all of the relevant stakeholders (Figure 1) come together during the early stages of the project to set high-performance goals and develop design options that meet these goals. Having stakeholders work together on the design from the start can help eliminate costly changes later and has the potential for reduced construction and operational costs as a result of integrated and collaborative thinking.

¹ Lindsey, G., et al., 2003. A Handbook for Planning and Conducting Charrettes for High-Performance Projects. NREL Publication NREL/BK-710-33425, Golden, Colorado.

An IDC generally begins with each specialist giving the group recommendations for the performance goals based on their respective area of expertise. Once the group has agreed on goals, it then explores possible, compatible integrated solutions. Often during this process, team members will see different but complementary ways of improving ideas. It is during this holistic process that innovative, better and more cost-effective solutions often emerge.

Computer simulations are often performed during IDCs to help model the building performance, which can help designers reduce the size of or completely eliminate certain mechanical systems. Simulations can also be used to estimate the costs and benefits of different building design options and technologies which can be helpful in finding compromises between competing design options.

EQuilibrium™ Process

For the EQuilibrium™ Housing Initiative, the builder teams were provided with three resources to help guide them through the IDP²:

1. National Renewable Energy Laboratory's (NREL's) Handbook for Planning and Conducting Charrettes for High-Performance Projects.
2. Introduction to the IDP Excel worksheet outlining 116 potential key generic steps in the process.
3. CMHC's Integrated Design Process Guide.

Most of the EQuilibrium™ Housing teams had a core team including, in general, a builder and a couple of design professionals. This core team set the objectives, and ultimately made the design decisions. However, they established an IDP where they brought in other experts and stakeholders to help inform the process.



Figure 2 Breakout Group at Moncton VISION IDC, March 11 and 12, 2009

Given that many of the extended team members were not knowledgeable on all elements of sustainable housing design and its associated technologies, and the EQuilibrium™ Housing guidelines in particular, various teams utilized information sessions to help educate team members before moving on to the formal IDC design session. For example, the Riverdale NetZero team utilized a three-stage process in 2006 to develop their proposed design:

1. *Project Launch* - to help the extended team members and stakeholders to get to know each other and their interests, and expertise and to be introduced to the concept of an IDP and EQuilibrium™ Housing.
2. *Design Workshop* - where the core team presented a base case design to illustrate the technical and planning challenges, presented summaries of the technologies that might be used to meet those challenges and broke into four groups to discuss how some of the challenges might be met.
3. *Integrated Design Charrette* - where the team wanted to solve the technical challenges and advance the design substantially with a focus on optimizing energy systems and the architectural design.

² All three can be found at: www.cmhc.ca/en/inpr/su/eqho/eqho_007.cfm

Having the half-day design workshop a month before the main IDC allowed participants to think about and better understand the possible design and technology options and their respective challenges. The team created a website forum where the information presented at the design workshop was posted, and allowed participants to continue communicating between meetings.

As a small example of how the EQuilibrium™ Housing designs evolved during the IDC, the Laebon CHES team decided on providing more insulation when examining dynamics between space heating systems, and solar photovoltaic (PV) electricity generation. Two groups were tasked with determining the best potential options to supply space heating energy to the house. When the two groups were brought back together to discuss options, there was a very dynamic discussion combined with some real time modelling. Three options emerged:

- a solar thermal system with an electric heating backup;
- a geothermal system; or
- a solar thermal/geothermal combination.

All three of these systems would have a PV system to generate an equivalent amount of energy that the heating system would consume. When analyzing the costs of each heating and PV system combination, they found that it would be more cost-effective to revisit the amount of insulation used in the building. By increasing the insulation value in the home (for a cost of approximately \$5,000) they were able to reduce the heating load by roughly 50 per cent, which subsequently reduced the size and costs of the space heating and PV systems by a much more substantial amount.

Cost Implications

Most professionals that participated in the EQuilibrium™ Housing IDCs did so on a pro-bono basis. Being part of EQuilibrium™ Housing projects provided some marketing potential for participants and was a great learning opportunity. Even if design professionals were not paid, other costs were incurred such as event preparation, documentation, facility rental, catering, and report production.

The EQuilibrium™ IDC events tended to involve large numbers of people, in part because of the high level of interest in the initiative and also because of the desire to include potential sponsors and other stakeholders such as municipal officials and university researchers. It is not unusual to have such high numbers of participants in design charrettes. The IDC process emerged in the design of advanced energy-efficient commercial and institutional buildings that already utilize a large number of design professionals. The process was developed to take advantage of the dynamic of large groups of individuals interacting together; NREL's Charrette Handbook, which addresses IDCs for a range of building sizes and types, recommends 25 to 50 participants.

For a typical detached residence attempting to meet the EQuilibrium™ Housing performance objectives, a design team might be limited to an architect/designer, a general contractor, a developer (if applicable), an energy simulations expert, an expert in renewable energy systems, a mechanical systems contractor, and an owner (if known). Some experts may be able to serve more than one of those roles, depending on their experience. Using an IDP with a two-day charrette with five participants would lead to design costs in the range of \$5,000 to \$10,000.

At the single-family house level, the incremental capital costs for upgrading a new house to EQuilibrium™ Housing performance levels could be in the range of \$60,000 to \$110,000. A good portion of the added design costs could be recovered through a reduction in capital cost of the overall project through the identification of cost-saving measures as the Laebon CHES example highlighted.

As more homes are designed to achieve very high levels of performance, there will be more information available and more experienced builders and contractors to choose from, which will help shorten the design time and reduce the overall project costs. The team involved in the Riverdale NetZero EQuilibrium™ home have seen considerable cost savings from its first to its third net-zero energy consuming house, where incremental capital costs have decreased from \$110,000 for the first house to \$75,000 for the second and \$70,000 for the third.

Benefits

One of the strengths of the IDP is that it can lead to many different design solutions even when very stringent design goals are set. This was exemplified in the EQuilibrium™ Housing Initiative. Even though the performance goals of the program were very challenging, the winning projects are all unique in their own right.

The benefits of using charrettes early in the high-performance design process are many. Most importantly, charrettes can save time and money before construction while improving future project performance without incurring any penalties like redesign or rebuilding, which happens when projects are being “improved” during construction. NREL’s handbook outlines many advantages of IDCs, including that they:

- promote enthusiasm for a project and result in early direction for the project outcome;
- establish a multidisciplinary team that can set and agree on common project goals;
- generate early expectations or quantifiable metrics for final energy and environmental outcomes; and
- save time and money by soliciting ideas, issues, and concerns for the project design to help avoid later iterative redesign activities.

Summary

To achieve high levels of building performance, new building design methodologies can be applied. The integrated design process has been developed and utilized for the design of more sustainable building and community development projects. All of the builder teams participating in the EQuilibrium™ Sustainable Housing Demonstration Initiative followed this holistic design process to explore ways to improve the overall performance of their projects. Although the process has many benefits, when used for typical residential projects, the process needs to be adapted to work with fewer design participants.

For more information about this project and other EQilibrium™ Housing projects, visit the CMHC website at www.cmhc.ca or www.equilibriumhousing.ca.

EQilibrium™

What is EQilibrium™ Housing?

The national EQilibrium™ Sustainable Housing Demonstration Initiative, led by Canada Mortgage and Housing Corporation (CMHC), brings the private and public sectors together to develop homes that address occupant health and comfort, energy efficiency, renewable energy production, resource conservation, reduced environmental impact and affordability.

CMHC's EQilibrium™ Housing Initiative offers builders and developers across the country a powerful new approach to establish a reputation for building affordable, premium quality healthy homes that will meet the needs of Canadians now and well into the future.

EQilibrium™ Housing combines a wide range of technologies, strategies, products and techniques designed to reduce a home's environmental impact to an absolute minimum. At the same time, EQilibrium™ Housing also features commercially available, on-site renewable energy systems to provide clean energy to help reduce annual energy consumption and costs.

EQilibrium™ Housing InSight

EQilibrium™ Housing InSight publications present specific housing design strategies and technologies implemented in EQilibrium™ Housing demonstration projects.

CMHC

CMHC has been Canada's national housing agency for more than 65 years. CMHC is committed to helping Canadians access a wide choice of quality, affordable homes and making vibrant and sustainable communities and cities a reality across the country. To find out more about how the Government of Canada and CMHC are working to build stronger homes and communities for all Canadians, call CMHC at 1-800-668-2642, visit www.cmhc.ca or www.equilibriumhousing.ca.



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