PEI CASE STUDY

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Minimum Code Compliant Home vs Passive Low Energy Home

Summary

This case study compares a Minimum Code* Compliant Home (MCH) that uses heating oil, to a Passive Low Energy Home (PLE) designed using the Passive House Planning Package. Our findings show that the average increase in initial cost for a PLE over MCH in PEI is 10% to 20%. But when the total cost of building ownership (TCBO) is considered, the TCBO savings are:

- $19,652 over 12-years (average Canadian home ownership term per house);
- $111,035 over 25-years (the mortgage term); and,
- $553,000 over 60-years (the useful life of a home prior to major renewal).

Background

Building owners, designers, accountants, economists, or government, do not use a consistent method of determining the investment value and cost savings when it comes to investing in energy efficient and/or sustainable building features. The most common techniques used are simple payback, return on investment (ROI), or net present value (NPV). However, these parameters do not show the real value of PLE. In part because they are often calculated over a short time period, such as 10 or 20 years, or over the useful life of a single building component. A better approach would be to:

- Evaluate the whole building as a sustainable design system, as opposed to a single component.
- Evaluate the useful life of the building, which could easily be 60-years before major renewal is required. This period could be extended considerably by making the building more sustainable and durable.
- Determine the value by calculating the TCBO. The TCBO is determined using the SEEFAR-Valuation© which includes all the costs of building ownership such as mortgage interest, utility costs, maintenance, GHG emission tax, property tax, insurance, using aggregate component life cycle analysis.

* National Building Code

It is important to understand that a Passive Low Energy Building could easily be defined as a building that can integrate and optimize all major building performance attributes, including energy efficiency, durability, life-cycle performance, and occupant productivity, sometimes referred to as a high-performance home.

The durability and sustainability of building materials is important because it has an impact on how often building components need to be replaced and at what cost. A recyclable metal roof with a 50-year plus life Is more durable than asphalt shingles with an 18-year life that end up in landfill. In addition, occupant comfort, productivity and a building free from harmful materials is important. To simplify the analysis for this study, however, we do not include a comprehensive analysis of options for more durable materials.

This case study is focused on a comparative analysis of the TCBO of a MCH (using heating oil) to a PLE (all electric) with International Passive House design features. The table below describes the construction features of each home:

Home Comparison Construction Design Features:

TABLE 1	PEI Minimum Code Compliant Home (MCH)	PEI Passive Low Energy (PLE)
Utility description summary	#2 Heating Oil - Electric	All Electric
R-value of above grade walls	R17	R60.2
R-value of attic space	R48	R78.8
R-value of below grade walls	R50	R43
R-value of foundation floor		R40.8
Area of conditioned space	2,117 ft^2	2,117 ft^2
Window type	Dual pane	Passive - U 0.14
Window area	227	227
Exterior door type	Insulated steel	R7.1
Heating system description	87% AFUE oil warm air furnace	1,500 watts of Electric baseboards
Ventilation system description	HRV	Zehnder 350 Comfoair 92% efficiency
Cooling system description	none	none
Water heating description	75% eff oil water heater	Electric tank
Lighting description	LED	LED
Appliance description	Electric	Electric

Table 2 shows the initial capital cost of the homes. The first row shows costs of the components that affect energy consumption; this includes many of the items described in the construction comparison. The first row also shows that the PLE home used in this analysis has a 40% higher cost for the energy configuration construction design.

The second row shows that the cost of non-energy-related components were intentionally kept identical to eliminate the impact of differences and therefore assume that the interior and exterior finishes, cabinets, and trims on both homes are identical.

The last row shows the total construction cost, which is 19% higher for the PLE home used in this analysis.

TABLE 2	PEI Minimum Code Compliant Home (MCH)	PEI Passive Home (HPH)	Total Cost Differences
Energy-related construction costs	$199,2666	$279,157	40%
Non energy-related construction costs	$211,700	$211,700	0%
Total Construction Costs	$410,966	$490,857	19%

There are additional inputs to the SEEFAR-Valuation© such as equipment cost, equipment life in years, energy costs and consumption, GHG burden, cost escalations, and others. These all have a bearing on the TCBO and are based on published industry information.

Results

TABLE 3	PEI Minimum Code Compliant Home (MCH)	PEI Passive Home (HPH)	Total Savings	Savings %
Greenhouse gas emissions (kg)	490,251	52,942	437,309	89.2%
Energy use index (EUI) (kWh/m2/year)	203	49	154	76%
TCBO* at 12-years	$274,197	$254,545	$19,652	7%
TCBO* at 25-years	$618,768	$507,733	$111,035	18%
TCBO* at 60-years	$1,741,812	$1,189,253	$553,000	32%

*These costs are independent of site purchase and site services (driveway, well, septic).

The first row shows that the greenhouse gas (GHG) emissions are 89.2% lower for the PLE . This reflects the low emission rate of PEI electricity as compared to the emission rate of heating oil in PEI.

The second row shows the Energy Use Index (EUI). The energy consumption is 76% lower for the PLE home. This is an important consideration because utility rates are rising faster than inflation due to the renewal investment demand of aging utility infrastructure.

Rows three, four and five compare the TCBO over 12-years; 25-years; and, 60-years.

In terms of the real costs of monthly utilities, the MCH will have an average monthly utility bill of $400 per month (at year one) while the PLE home will have an average annual monthly utility bill of $148 per month (at year one). At the current level of rate increases, it will take 40-years for the PLE to reach the same $400 monthly cost level, by which time the monthly costs for the MCH will have tripled.

After allowing for 1/10th of one percent difference in the annual market value retention rate of the PLE home, once the 25-year mortgage is paid off, the PLE home is projected to have $62,985 in higher net market value. This represents a 3.1% annual return premium on the $79,891 higher initial investment cost of the home.

This higher initial investment of $79,891 also produces a cost savings value stream with Net Present Value of $94,208 by the end of the 25-year mortgage term (2.71% discount rate). This means that the PLE home produces homeowner value in both lower TCBO and higher market value retention.

Every building has its own unique design and construction characteristics that need be accounted for in optimizing the investment value. The SEEFAR-Valuation© allows the user to conduct a scenario analysis process to evaluate the impact of the potential building components and design features. The energy use and durability are reflected the TCBO outcomes.

Scenario modeling can also demonstrate how the TCBO is affected by using more durable materials such as ceramic tile floors, metal roofing, more durable hot water tanks or more efficiency components that can reduce emissions and save money such as solar photovoltaic panels. This process will help to optimize the TCBO projections at the early design stage.

A SEEFAR-Valuation© methodology is the most definitive way by monetizing the relevant benefits of each design option and of comparative home designs.

Acknowledgments:

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A Note on Case Study Conclusions

The SEEFAR-Valuation© demonstrates that the life-cycle variance in the total cost of building ownership (TCBO) between different designs for two similar homes can easily be in the six-figure range. Therefore, drawing '*general*' conclusions about the TCBO differences between any two home types can prove to be misleading. The same risk applies when drawing TCBO conclusions based on units of '*building area*'.

As a matter of financial logic, homes that are more sustainable are more likely to have lower TCBO levels; larger homes are more likely to have higher TCBO levels; and, homes that reduce heat loss through high performance building envelopes can be expected to have lower TCBO levels than homes that offset heat loss through mechanical systems. For that reason, it is recommended that the type of aggregated, multi-component life cycle analysis used in the SEEFAR-Valuation© assessment be conducted on each home design option being considered.

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