Homeowner's Guide to **an Energy Efficient Home**

Nova Scotian builders construct some of Canada's most energy efficient homes. The best of these homes cost less than $500 to heat annually. New construction offers a one time opportunity to lock in low energy costs at the lowest possible construction cost.

What are the Advantages of an Energy Efficient Home?

For some, the primary advantage of an energy efficient home will be low energy costs - now and into the future. A home that is inexpensive to heat today will become an even better investment when energy prices increase. But other people's motivation may include superior comfort, good air quality, and the higher resale value of a modern, energy efficient home.

The key to a comfortable home with low energy bills is to reduce the building's total energy requirements. Insulate all exposed surfaces to a high level, select efficient windows, tighten the home to reduce air leakage and install a high efficiency heat recovery system. The benefits of lower energy costs, improved comfort, and a healthier living environment will quickly repay additional construction costs.

Where Do I Start?

Energy efficiency starts at the planning stage. House orientation and design is obviously important. The products used to build the home such as insulation, windows, and other basic building components last a long time. The decisions you make now will determine your home's performance for decades. Smart homebuyers put their money into the building's structure and durable components. If corners must be cut, remember that often decorative elements (which have no payback) can be added or changed as funds become available. Windows may not be replaced for 40 years, but lighting, bathroom fixtures, or counters can be easily upgraded at any time.

Can I Afford an Energy Efficient Home?

Insulation upgrades, high efficiency mechanical systems and extra attention to detail will increase a high performance home's construction cost. However, when all of your monthly costs (principal, interest, taxes, and energy) are added together, a more costly and efficient home can actually cost you less to own and operate. As energy costs increase over time, monthly savings from owning an energy efficient home will grow. Construction costs, on the other hand, are fixed.

Over the years, homeowners who "can't afford" energy efficiency will spend thousands of dollars more than they should to heat their homes. A home with high heating requirements will always be expensive to heat, regardless of the type of heating system selected. On the other hand, a well-built energy efficient home can require so little heat that heating costs will always be affordable, regardless of the type of heating system or fuel selected.

How Much More Does an Energy Efficient Home Cost?

Builders have proven that the savings from carefully selected efficiency upgrades can be larger than the additional financing charges resulting from higher construction costs. Extra costs usually include more insulation, high-performance windows, and more efficient and effective ventilation—all desirable features in any home. Any home design or style can be energy efficient. It is the building's performance, not its appearance, which is different. Reduced energy costs can often result in a net positive cash flow, even if the cost of construction was higher.

How Do I Know if my Home is Efficient?

EnerGuide is Canada's most widely used home energy rating system. It is based on computer modeling of the home (or house plans), combined with a blower door test, to measure the completed building's air tightness.

This analysis gives the buyer a realistic estimate of future energy costs and allows buyers to compare the projected energy use of different houses.

Other certification systems for energy efficient home construction include ENERGY STAR®, R2000, LEED and Passive House. For all of these certifications, the home and sometimes materials used must meet minimum criteria and the home must be independently tested when it is completed.

Rebates for Energy Efficient Homes

Efficiency Nova Scotia provides rebates for new energy efficient homes through the use of licensed independent energy advisors. In order to receive rebates, a home must be registered in the program no later than 30 days after a building permit is issued. This allows time for a certified energy advisor to model the home's performance (based on the house plans) prior to construction and provide options for increasing the energy efficiency of the home. Exploring options at the planning stage allows energy upgrades to be added at the lowest possible cost. Once the home is built, a final test verifies the home's as-built performance. The result will determine what rebate applies.

How Much Insulation is Enough?

Today's higher recommended insulation levels reflect the impact of rising energy costs. Nova Scotia's building code requires minimum insulation levels for new construction. Past experience shows that exceeding minimum insulation levels will be a sound decision. Houses last a long time. The energy you avoid purchasing by building a more efficient home will never increase in price.

Minimum Effective Insulation Levels Required by Code

- Walls: R-17
- Ceiling: R-50
- Basement Walls: R-17
- Basement Floors: R-11 under slab

There are additional code requirements and specifications; please refer to the Nova Scotia Building Code for more details. Please note these are minimum requirements. Higher insulation levels are recommended.

What Type of Insulation Should I Use?

Cellulose and fibreglass insulation are typically the least expensive insulation materials so they are the best choices where space is available, such as in the attic. Rigid board and spray foam insulations are more expensive but have a higher R-value per inch. Generally, price increases with R-value. Rigid insulations and spray foam are best suited for use where space is limited, where they can perform two functions (insulating sheathing for example), or where other types of insulation are not suitable (underground). Foam insulation exposed to the interior must be covered by a fire-resistant material such as drywall.

Wall Assemblies

There are many ways to build an energy efficient wall. Your choice will likely depend on the builder's preference, cost of construction, and how complicated your home's design is. Look for building assemblies that provide high R values and a continuous layer of insulation over framing.

The real (also known as effective) performance and R value of a traditional 2" x 6" stud wall with non-insulating wood based sheathing is substantially reduced by heat lost via the studs. This type of wall with an R-20 fiberglass batt does not meet current NS building code (R-17) requirements; its effective R-value is approximately R-15.8. Cellulose insulation can also be used in walls. Wet spray cellulose insulation has a binder so it can be sprayed directly into a wall cavity. Dry cellulose installations require that a mesh is stapled to the wall interior to contain the insulating material.

Common ways to build an energy efficient wall include:

Insulated sheathing over a 2" x 6" stud wall is a common way to build a wall with an R value of up to approximately R-28. Rigid exterior insulation covers all wood framing to reduce thermal bridging and can either replace conventional wood sheathing or be installed over or under it.

Insulated Concrete Form Systems (ICF) - Concrete is poured into pre-manufactured forms made of rigid insulation complete with composite form ties. Typical R values for this type of construction are about R-22. Homes constructed this way are very solid, quiet and air tight as long as windows, doors and other openings are well sealed. A continuous layer of insulation on both sides of the concrete minimizes thermal bridging.

Double Wall Construction - This system uses both an inner and outer stud wall and a wider base and top plate. Offsetting the studs reduces thermal bridging. Usually only one of the walls is loadbearing. Very high levels of insulation can be added by increasing the space between the walls.

Foam insulation – High or low density foam can be sprayed on site into any type of framed cavity wall system. The addition of spray foam increases air tightness and allows for a higher R value per inch of wall thickness. For cost reasons, low density foam is more commonly used.

Structural Insulated Panels - A structural insulated panel, or SIP wall, creates a structural panel by bonding foam insulation to structural sheathing. Units come in pre-cut manufactured modules that are assembled on site.

Truss Walls - This system uses a truss to replace traditional wall studs. Increasing the space between the inner and outer truss members allows for high levels of insulation to be installed. This type of system is usually best suited to fairly simple buildings.

Wrap and Strap - This system straps the stud wall horizontally on the interior to allow for extra insulation and to minimize heat loss through framing members. The polyethylene air/vapour barrier is installed and sealed before the wall is strapped, so wiring can be run inside the barrier without any additional air sealing measures.

What Is Important in the Attic?

Blown-in attic insulation offers good coverage and avoids cutting and fitting batts around truss members. The four keys to making attics energy efficient are:

Air Sealing - Allowing warm, moist indoor air to leak into the cold attic space can cause a great deal of damage. It is especially important to air seal at the ceiling level of the top floor, since most leakage of indoor air occurs at the top of the building.

Even Insulation Levels - With standard roof trusses, space limitations near outside walls make it hard to properly insulate the ceiling. "Raised heel" trusses provide additional depth so the entire ceiling can be evenly insulated. For a cathedral ceiling, a parallel chord truss, or scissors truss can provide the space needed for high levels of insulation, while reducing heat losses that would occur through solid rafters.

Avoid "Wind Washing" at the Eaves - Cold ventilation air entering soffit vents must be directed past and over insulation. Install baffles made of solid material between roof trusses or rafters. Extending sheathing above the top plate can also function as a wind baffle.

Ventilation - Effective attic ventilation keeps the underside of the roof cooler, prevents ice dams, and keeps the attic cooler on hot days. Attic ventilation does not control interior humidity levels. It is not a substitute for a tight air seal at the attic ceiling.

Basement Insulation

During the summer months, the cool earth under the basement floors and against below grade walls can cool concrete surfaces enough to encourage condensation and mould growth. Ventilating the basement during the summer with humid outdoor air brings in more moisture and may increase condensation rates rather than cure the problem.

You can prevent basement wall and floor condensation by separating the cool earth from the concrete floor and walls (underfloor or exterior insulation) or preventing humid air from reaching the cool concrete (interior insulation). Fully insulated and air-sealed basements are not damp, reduce winter heating bills and improve occupant comfort.

Interior basement insulation systems should include some type of foam insulation against the concrete to avoid mould or mildew issues caused by the condensation of indoor air or moisture migrating through the concrete wall.

Are High Performance Windows Better?

Today's windows are two to three times more efficient than older models. ENERGY STAR® rated windows are now required under the Nova Scotia Building Code. Energy efficient windows can deliver comparatively large savings since windows are the coldest exterior surfaces of a well-insulated building. Insist on the following features:

- **Selective coatings or films -** to increase R-values. "Low-e" coatings are available from most manufacturers.
- **Heavy gases -** (usually argon) to reduce heat loss. These gases replace the air normally sealed between the glass panes.
- **Insulating spacers -** to cut heat loss at the edges of the glass. Older units used highly conductive metal edge spacers, which lowered the temperature at the window's edge and increase the potential for edge condensation.

- **High performance triple pane windows –** These windows reduce heat loss but can also reduce solar gain. Usually they are especially useful for larger windows that face north.

Window buyers should also select a window style that minimizes air leakage. Casement or awning windows are usually tighter than sliding window styles. Where possible, use a fixed window to reduce cost and increase energy savings.

For more information, see our "Homeowner's Guide to Windows"

Can a New House be too Airtight?

Absolutely not! Airtight construction is the key to energy efficiency. Sealing all the small cracks and holes helps insulation more effective, improves comfort, and protects the building from condensation damage. Tight construction allows control of indoor living conditions regardless of the weather outside. Mechanical ventilation, preferably a heat recovery ventilator, supplies the right amount of fresh air for health and humidity control without creating high energy costs or drafts. Independent surveys have found that air quality in registered R-2000 homes, for example, is better than in older construction.

Airtightness levels can be measured using blower door test equipment. This test determines how tight the building really is, and is a useful tool for finding hidden air leaks. This test is also used to calculate a home's EnerGuide rating.

In all new homes, and especially in tighter, efficient ones, care must be taken to ensure that all combustion gases from any heating device that burns oil, wood, or gas are safely exhausted to the outside. Some appliances may require outside combustion air.

Is a Ventilation System Necessary?

Effective mechanical ventilation is required by the National Building Code and is essential for humidity and pollutant control in new houses. Quality ventilation systems continuously supply fresh air to all living areas of the home and exhaust stale air from kitchens, bathrooms, and other areas where pollutants are produced. Normally, these systems run continuously at low speed. A high-speed option provides added ventilation for short periods of time whenever humidity or pollutant levels rise.

Heat recovery ventilators (HRVs) recover heat from exhaust air and use it to preheat incoming outdoor air. Better models can recover 70 to 80 percent of the energy in exhaust air. To work well, an HRV must be properly installed and balanced. Poorly designed or installed ducting will cripple the performance of even the best HRV units.

What is the Best Heating System?

The best investment in home heating is an energy efficient home that requires little heat and takes advantage of free heat from the sun. In these homes, nearly any type of heating system is affordable to operate. Choose the heating system that best meets your needs based on your comfort expectations, budget, and the characteristics of your home.

Owners of smaller homes built to R-2000, LEED, Passive House or ENERGY STAR® standards (or better) may find it difficult to justify an expensive heating system that promises to save on operating costs. Saving half of a $1,000 year heating bill does not quickly repay large cost upgrades. Savings may also be offset by extra maintenance costs.

For more information, see our "Homeowners Guide to Heating with Electricity" and "Homeowners Guide to Heating with Oil and Gas"

Can the Sun Help Me Heat My Home?

Passive solar energy can supply as much as 30 percent of the heating needs of an energy efficient home without increasing construction costs. Your home's windows can be an effective and inexpensive way to passively collect free heat from the sun. The key is to locate windows and living areas on the building's south side. This will maximize solar gain and available light. Spaces where windows are less important, such as garages, utility spaces, halls, and stairwells, should be kept to the north side.

Design or choose a home to fit your lot rather than try to impose a design in a location that does not suit it. To prevent overheating, avoid overhead glass and limit south-facing glass area to a maximum of 8 to 10 percent of the floor area of connected spaces. Solar heating contributions as high as 50 percent are possible, but require careful balancing of window area, heat storage, and heat distribution systems to avoid uncomfortable temperature swings.

There are also options for active solar heating. Roof-mounted solar thermal panels typically provide domestic hot water and are sized to supply about 40-60 percent of annual hot water needs. Solar water systems can also make a contribution to space heating if your home has a distribution system that operates at a low temperature such as radiant flooring. Solar air-heating panels, typically mounted on vertical walls, and can add additional heat to the home using the energy from the sun.

For more information, see our "Homeowner's Guide to Passive Solar Energy"

Can I Cut Other Energy Costs?

In an energy efficient home, both water heating and general household electrical bills can be higher than space heating costs. Energy efficiency is important when choosing products, appliances, and fixtures for your home.

Hot Water - Choose an efficient water heater, insulate all hot water pipes and use low flow shower heads and tap aerators.

Lighting - Select efficient compact fluorescent lights (CFLs) or Light Emitting Diode (LED) bulbs and fixtures. Also task lighting and appropriate fixture selection can help reduce lighting energy use.

Appliances - Insist on ENERGY STAR® rated appliances. This is important for fridges, dishwashers, freezers and front load washers.

Thermostats – Central home heating systems may be able to benefit from "smart" thermostats. These devices allow you to manage home energy use from your phone, profile energy use and optimize system performance based on past operation. Programmable thermostats can also reduce heating costs by automatically turning down heat settings at night or during periods when no one is home.

What's a "Net Zero" Building?

It is now possible to build a home that generates as much energy as it uses over the course of a year. These homes combine extreme energy efficiency with renewable energy generation from a solar photovoltaic system, a solar DHW system or possibly a wind turbine. Generally the most expensive part of the project is the renewable energy component. A "net zero ready" home has the required energy efficiency component but not enough renewable energy capacity to fully offset all of the home's energy use. Should the future price of the required renewable energy system drop or more funds are available, a Net Zero ready home can easily add enough renewable energy generation capacity to become fully self sufficient.

The average code-built home has an minimum EnerGuide rating of approximately 78. The average home rating under the New Home Construction program is 85 and homes have been built that are rated in the low to mid 90s. The highest EnerGuide rated building in Nova Scotia has a rating of 96.

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