RENOVATING FOR ENERGY SAVINGS

Case studies

October 2004 Issue 5

Split-Level Homes

Split-level houses have been built since the late 1940s. Over 475,000 have been built in all parts of Canada.

What you've got

- Three-level split: two-storey portion with an attached one-storey portion with a crawl space
- Four-level split: two-storey portion with an attached one-storey portion with a full basement
- Bedrooms are typically in the two-storey portion with a family room or den on the ground level
- In some designs, the mid-level has a vaulted ceiling.
- A built-in garage on the lowest level, may have been closed in to provide extra living space

How it's built

Actual construction details used in your house may differ, and over the years some improvements may have been done.

This is simply a general description:

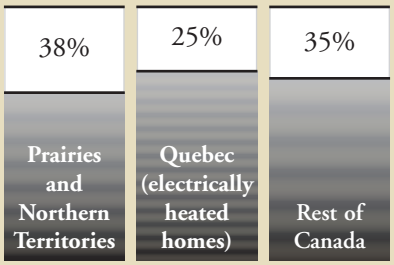
- Exterior walls: 2 x 4 in. studs with RSI 2.08 (R-12) batt insulation
- Ceiling insulation: RSI 3.5 (R-20)
- Windows: double-glazed or single-glazed with storms (except for coastal B.C.)
- Exterior doors: hollow core wood panels (earliest) or solid wood
- Foundation: undeveloped basements and crawl space foundation walls are seldom insulated

Improvements can

- Reduce energy use for space heating
- Reduce drafts
- Reduce summer overheating
- Reduce moisture and condensation problems
- Reduce noise from outside the house
- Reduce greenhouse gas emissions
- Improve indoor air quality
- Improve humidity levels in dry northern houses
- Increase comfort level

POTENTIAL ENERGY SAVINGS

If all of the recommended improvements presented here are carried out, overall energy use can be reduced as shown below. Actual energy use is affected by weather and lifestyle, so specific energy savings may vary. If you, or a previous owner, have already carried out some energy-saving measures, the actual reduction in energy use will differ. The energy savings presented here are based on computer simulations done specifically for this type of house in each Canadian region.



How to select energy-saving improvements for split-level homes. These improvements will save energy and reduce your heating bills, while making your house more comfortable to live in.

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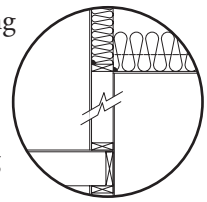
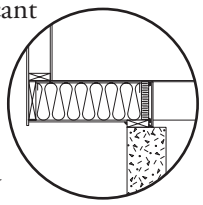
Problems and Opportunities

- Air leakage is distributed throughout the house, but is often concentrated where the second floor meets the attic of the lower section, and where the crawl space meets the basement. Many splits have a cantilever (overhang) on the front face of the main floor that has significant air leakage and affects comfort levels. Combining all air leakage paths in an average split level house would result in a hole about 874 cm^2 (or roughly 11 x 11 in.).
- In some houses the crawl space is not heated but vented to the outside, with the floor above insulated. If the crawl space is heated (open to the basement) there should not be any vents to the outside.
- Older houses do not generally have an effective ventilation system to maintain proper indoor air quality. There may be a noisy bathroom fan and a kitchen range hood fan. Split levels often have uneven temperature distribution because of their layout.

Draftproof Everywhere!



- Draftproof or air seal the wall and ceiling area where the two-storey portion meets the one-storey portion, the top of foundation walls, around window and door frames. Other areas include ceiling penetrations around light fixtures and wiring, attic hatches, and service penetrations through the exterior walls.
- Air seal and insulate the walls and ceilings of attached garages where there is living space to the side and above the garage. Special attention needs to be given to the air sealing here to reduce the chance of exhaust fumes entering the house from the garage.



- A cantilever (overhang) will have significant air leakage and affects comfort levels. Where possible, draftproof and insulate from the interior at the floor joist area. Exterior draftproofing of this area should be included in an exterior insulation/new siding retrofit. Exterior grade plywood fitted into the underside of the overhang should be sealed to the header above and the top of the stud wall of the lower floor. Don't forget to insulate overhanging floors.
- Where one-piece bath or shower enclosures are installed against exterior walls, there may be significant air leakage because of a break in the air barrier. Caulk around the whole exposed face and the wall/floor junction behind the baseboard along the exterior wall. When these units are on basement floors, there is often a gap in the concrete slab where the drain exits. For friction, fit a piece of rigid foam insulation and seal the edges. If the drain is inaccessible, caulk around the exposed face of the enclosure.

For details on draftproofing, see *Keeping the Heat In* by Natural Resources Canada.

Space Heating System

Consider replacing your warm-air furnace or boiler with a new high-efficiency unit. Your heating contractor can do a heat loss calculation to properly size the furnace for your home's requirements. If your home has central air conditioning, the new furnace will also have to be matched to the existing A/C unit. In some cases, space and water heating systems can be integrated so that only one boiler or heating unit is required to carry out both tasks.

Improvements that can save energy in Split-Level homes in Canada.

The best time to carry out energy-saving improvements is when you are planning other renovations. Carry out the air sealing and insulation upgrades before you invest in a new heating or mechanical system. A tighter house with better thermal properties has a smaller heating load and a different ventilation requirement. A qualified contractor can help you with this.

Exterior Doors

Consider replacing older, wooden exterior doors with metal, insulated units, which are more durable, easier to weatherstrip, and maintain their appearance with lower maintenance needs. Keep the weatherstripping in good condition on all existing doors and storms.

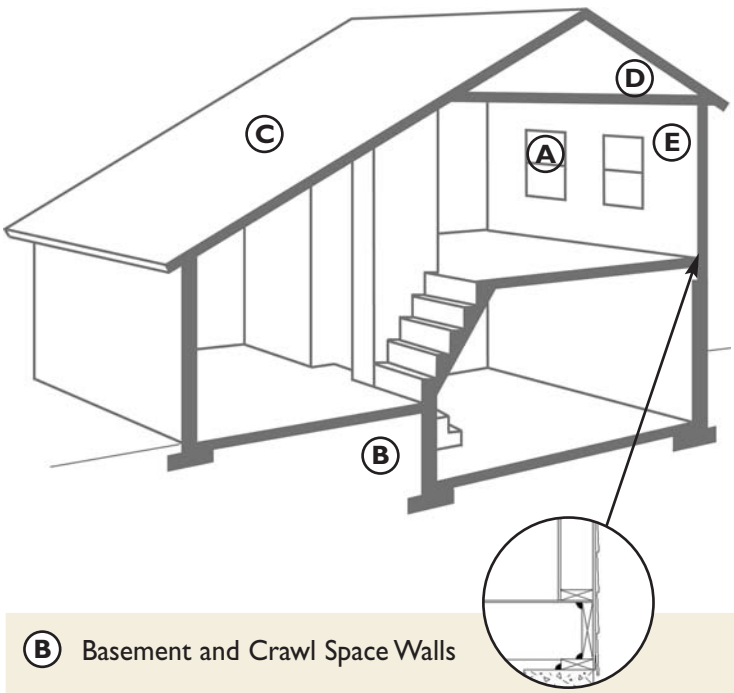
If your main entry faces the direction of the prevailing winter wind with little protection, adding a vestibule or air lock entry may improve comfort by tempering cold air when the door is opened.

Ⓐ Windows

Energy-efficient windows greatly improve comfort levels, virtually expanding the usable space in the house as the area near the windows is no longer cold and drafty. Replacing windows can also improve house appearance, and increase resale value. The most energy efficient choice is high performance units with selective glazing (such as double-glazed units with a low-e coating, argon gas fill and insulated spacers and frames). Wood-frame windows can be retrofitted using custom double-glazed inserts. If window repair is required, replacements should be high-performance units.

For new and existing windows, seal the joint between the windows frame and wall, and keep weatherstripping and storms in good repair.

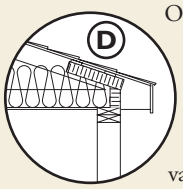
Original picture windows and bay or bow window units should be replaced. When new units are installed, ensure that they are air sealed at the frame/wall opening joint. Cavities below or under the window unit itself should be completely insulated. Spray-in foam conforms to odd shapes better than batt or rigid board insulation. As well, older split-level homes may have aluminum frame 'sashless sliders', (where the glazing sits directly in tracks in the frame). Reduce condensation problems by installing new sliders set in sashes, or adding magnetic storms to the interior. These windows are most likely reaching the end of their usable life and should be replaced.



Ⓒ Ceiling/Roof Insulation – *Increase to at least:*

- RSI 7 (R-40) natural gas or oil space heating
- RSI 9 (R-52) electric space heating
- RSI 5.6 (R-32) in coastal British Columbia

The amount of insulation you can add will depend on roof structure and access. If the middle section ceiling is vaulted, it may be more difficult to increase insulation levels here. Rigid board insulation can be added on the interior, but must then be covered with a fire-rated material, such as gypsum board.



Older split-levels often have low-slope roof trusses that have very little height at the edge, leaving little room for insulation. The best choice here is blown-foam insulation, giving high R-values and good air sealing. Friction-fit high-density rigid board at the eaves will also give higher insulation values in this area but is more labour-intensive. Leave room for ventilation, or install ventilation baffles (shaped foam or plastic) where the roof sheathing passes over the exterior wall into the soffit area.

Ⓑ Basement and Crawl Space Walls

Before insulating foundation walls, make sure they are in good repair and check site drainage. Good drainage means no moisture problems once the walls are insulated. If existing moisture problems cannot be fixed, insulate the walls from the outside (at least 600 mm (2 ft.) below grade for poured concrete, from top to bottom for concrete block).

If there are no moisture problems in your poured or concrete block foundation, draftproof and insulate foundation walls (including heated crawl space walls) for their full height. This includes the rim joist and joist space in the floor above, to at least RSI 2.1 (R-12) or RSI 3.5 (R-20) if using electric heat.

Heated crawl space; close off vents after insulating the walls and install a moisture barrier over the crawl space floor. The moisture barrier can be a 6-mil polyethylene sheet over the ground or the concrete, with all seams overlapped, weighed down with a few stones and sealed at the edges.

Unheated crawl space vented to the outdoors: insulation in the floor above should be increased to at least RSI 3.5 (R-20). A moisture barrier should also be applied to the crawl space floor.

(E) Exterior Walls

If you redo the siding on your house, take this opportunity to increase insulation levels and do some air sealing. Insulation can be blown into the wall cavities from the outside. If the wall cavities are already insulated, add a layer of exterior insulation and a house-wrap air barrier. If at the same time, you can replace the windows with better-performing units, the combined retrofit gives your older house a facelift, better energy efficiency and higher levels of comfort while saving you money on labour costs. Obtain a professional contractor's advice on how to approach this retrofit.

General Energy Efficiency Notes

- Cover hot water pipes within 3 m (9 ft.) of the water tank with pipe insulation—and if possible, insulate all accessible hot water pipes.
- Insulate electric hot water tanks with an insulation blanket.
- Install programmable thermostats to lower temperatures at night or during the day when your home is unoccupied: stay at or above 16°C (61F) minimum temperature to prevent condensation and mold problems, and maintain heat in all rooms.
- Replace leaky dampers and repair chimney flues on woodstoves and fireplaces.
- Glass doors on fireplaces will reduce air leakage up the chimney when not in use.
- Consider other options for fireplaces: an electric fireplace insert (no fuel safety issues), EPA-rated insert unit, or convert to a direct-vent natural gas fireplace insert.
- Gas fireplaces: look for direct-vent units with intermittent electronic ignition systems, or other easy means of turning off and relighting the pilot light.
- Replace your old oil- or gas-fired water heater with a side-wall vent unit or a high-efficiency electric water heater. This eliminates the chimney and associated air leakage and backdrafting problems.

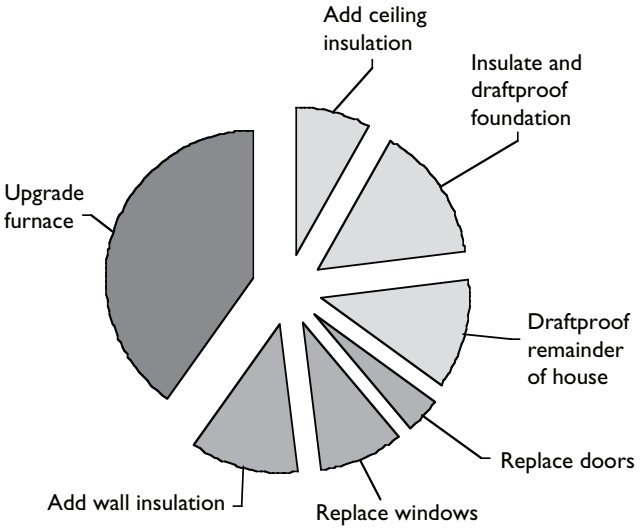
  Check into integrated space and water heating systems (i.e., a boiler for space heating fitted with a “tankless coil” or “indirect heater” that provides domestic hot water). A solar hot water system can produce up to 60 per cent of your annual water heating needs. Solar hot water systems, instantaneous water heaters and other options are becoming more affordable as they become more readily available.
- Before replacing your existing furnace or boiler, carry out any air sealing, draftproofing, insulation upgrades and other energy-saving improvements to the walls, windows and doors—and then give your whole heating system a tune-up.
- **It is important to know how airtight your house is to ensure there is no backdrafting of flue gases into the house when exhaust fans are operating. A combustion safety test, carried out by a qualified contractor, can indicate if depressurization is a potential problem.**
- Control energy loss in the furnace room by installing automatic, motorized duct dampers on the combustion air line. The same can be done on the fresh-air intake of most furnaces. This prevents large amounts of cold air from entering the plenum between firing cycles.
- Oil heating systems are often oversized. Changing to a smaller nozzle size can improve system performance.
- Controlled air change—fresh air in, stale air out—is important for good indoor air quality. If you have a forced-air heating system it may be possible to add a heat recovery ventilator (HRV) to the system. In houses without forced-air heating or fuel-fired equipment, a good quality quiet fan in a central bathroom or hall and an exterior-exhausting range hood fan may be an appropriate option. Your ventilation system should be designed and installed by a qualified technician to ensure that the operation and venting of any combustion appliance in the house is not compromised.
- In the coldest periods of winter, the indoor humidity should be between 30 and 35 per cent to avoid condensation on windows. Invest in a low-cost hygrometer to monitor the relative humidity levels in your home. If winter humidity levels are too high, try increasing your ventilation rate (for example, by running a small bathroom fan continuously).
- When winter humidity levels are low, it is often due to excessive air leakage. Better air sealing will raise humidity and save energy. If, after air sealing work has been completed, there is still a problem with low humidity levels, a humidification system may be required.

Other energy-saving improvements

- Water-saving fixtures: low-flush or dual-flush toilets, faucet and shower flow restricters, front-loading clothes washer that reduce water heating loads.
- Energy-efficient appliances: replace and recycle older refrigerators, freezers, electric ranges and dishwashers with Energy Star® rated models.
- Energy-efficient lighting: the average house has 27 lightbulbs in it. On average, lighting in a house consumes 1,800 kWh annually. Switch to fluorescent, compact fluorescent and task lighting.

Average Energy Savings by Improvement

Based on computer simulations, the pie chart below indicates an ***average percentage of potential total energy savings*** that can be expected for each type of improvement: insulation and draftproofing 27%; door and window replacement 12%; exterior wall insulation 12%; furnace upgrade 40%.



Special Health and Safety Considerations

When you make improvements to your home you change the way it operates. This can affect the health and safety of the house and occupants. Review the following table carefully before carrying out your energy improvements.

If you do this	It can cause this	Can be solved by this
Draftproof your house	Depressurization by exhaust fans could cause backdrafting of combustion flue gases.	Replace combustion appliances with direct-vent appliances or incorporate make-up air. If there is a fireplace or woodstove, ensure there is adequate venting and that combustion air is available.
Check ventilation	Exhaust-only ventilation can lead to excessive depressurization and spillage of flue gases from combustion equipment. Supply-only ventilation can lead to excessive pressurization and condensation/frost problems.	Have a qualified contractor carry out a depressurization test to determine if a balanced ventilation system is required.
Upgrade the furnace	Higher noise levels if the ducts are not properly sized for the higher airflows.	Size the heating system for both the heating load and existing ducting, seal all exposed ductwork connections to reduce vibration.
Install high-efficiency water heater and furnace	Reduced air-change rate, stuffiness and higher humidity levels because high-efficiency sealed combustion units exhaust very little house air compared to a standard unit with a chimney.	Install a proper ventilation system.
Replace the windows	Increased airtightness can lead to higher humidity levels, resulting in condensation on the windows and other cooler surfaces.	Install a proper ventilation system with automatic humidity control.

CMHC's
Renovating for Energy Savings series

Issue 1 Pre-World War II Houses
Issue 2 Post-War 1½-Storey Homes
Issue 3 Post-1960s Two-Storey Homes
Issue 4 1960s-70s One-Storey Homes
Issue 5 Split-Level Homes
Issue 6 Split-Entry Homes
Issue 7 Mobile Homes
Issue 8 Duplexes and Triplexes
Issue 9 Row Houses
Issue 10 Homes with Walkout Basements
Issue 11 Common Additions

Additional Information and Resources
CMHC Canadian Housing Information Centre (CHIC)

- ***Building, Renovating and Maintaining***
  www.cmhc.ca/en/co/renoho/index.cfm
- ***About Your House***
  www.cmhc.ca/en/co/co_001.cfm

Natural Resources Canada

- **Office of Energy Efficiency**
  www.oee.nrcan.gc.ca Tel. 1-800-387-2000
- **Publications**
  www.oee.nrcan.gc.ca/publications/infosource
- **Keeping the Heat In**
  www.oee.nrcan.gc.ca/keep_heat_in/

Canadian Home Builders' Association (CHBA)

The impact of specific improvements for your house can also be provided by technicians and qualified trades persons. The Renovation Council of your local Home Builders' Association can provide some references, or contact the CHBA
www.chba.ca Tel. 613-230-3060

- **In Quebec, please contact the APCHQ** (Association provinciale des constructeurs d'habitations du Québec) at www.APCHQ.com tel. 514-353-9960 or ACQ (Association de la construction du Québec) at www.ACQ.org Tel. 514-354-0609
- **The Renovation Roadmap**
  Web site developed by CHBA, CMHC and NRCAN
  www.myhomereno.com

Provincial Governments

Provincial Government departments will frequently provide detailed recommendations for your region.

Local Utilities

Your local energy utility can usually provide detailed recommendations for your region.

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