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Insulating an Existing House

Many homeowners would like to stay in their current home, but they have difficulty affording the heating bills with ever-rising fuel costs. After taking measures to increase the efficiency of their furnace or boiler, many homeowners realize they will need to do more to retain heat. Often, they don't know how to add insulation to their home — or if they have room to add it.

Low-Energy Retrofit — Priority Checklist

(Adapted from the Environmental Building News, July 2007)

The following checklist assumes that you are starting with a fairly standard existing house relative to energy features: for example, an uninsulated basement; 2x4 walls insulated with R-11 fiberglass; a flat ceiling insulated with R-19 fiberglass; insulated-glass windows or single-pane windows with storm windows; a relatively leaky five to seven air changes per hour at 50 pascals (ACH50); and an atmospherically vented furnace or boiler. Within each category, the checklist starts with easy, low-cost measures and includes progressively more costly or difficult measures. Note that some later measures avoid the need for earlier measures, so this should not be considered a step-by-step action list.

Once you have selected those items from the priority list, you may want to seek a professional energy audit to get a better idea of your current energy use and the value of the energy savings.

HOUSE ENVELOPE	
Air seal foundations and attic	Identify and seal major holes in the foundation and attic; patch holes and seal seams along duct routes through unconditioned spaces.
Fix moisture problems and insulate basement walls	Identify and repair any moisture problems (including drainage and site moisture problems) in the basement or crawl space and insulate walls (R-15 to R-20) — if walls are suitably flat — with high-density EPS or XPS board insulation. Cover insulation with non-paper-faced drywall or another durable, protective surface if the basement space is being finished.
Air seal the house	Hire a weatherization contractor or energy auditor to locate (using a blower door) and seal cracks and leaks in the house envelope, especially at floors and ceilings. Weatherstrip windows and doors. Note that tightening a house often causes higher moisture levels indoors that may have to be dealt with. Radon levels should also be closely monitored.
Add insulation in attic	Air seal the attic first! Install additional insulation (e.g., cellulose) on top of existing insulation in the attic floor. Depending on existing conditions, it may be necessary to remove the attic floor to expose joist cavities to fill with insulation. In general, it is cost-effective to add more insulation than can fit in the joist cavity; additional insulation can be added on top of the floor, or the floor can be raised using cross joists to increase cavity thickness. If existing insulation is removed prior to installing new insulation, air seal the exposed ceiling from above prior to insulating.

Upgrade windows	Replace existing windows with tight-sealing, double-glazed (or preferably triple-glazed) gas-filled low-e windows or storm windows on either the interior or the exterior of the prime windows. When upgrading windows or adding storm panels, address moisture control and drainage. Consider different glazings for different orientations to exclude some of the unwanted solar gain.
MECHANICAL SYSTEMS	
Tune heating and air conditioning systems	Tune up equipment and inspect controls to ensure that mechanical systems are working at top efficiency. Replace air filters in furnaces and heat pumps.
Insulate water heater	Insulate storage-type water heaters, even newer models, with an insulation blanket. Electric water heaters can be covered more completely; gas water heaters require that areas be left uninsulated to provide for combustion air supply. Also insulate hot water pipes to slow the cooling of hot water in the pipes.
Reduce hot water demand	Install low-flow showerheads and faucet aerators to reduce hot water demand. When there are long hot water piping runs, install on-demand recirculation systems to reduce losses.
Replace furnace or boiler	Replace atmospheric-venting furnaces or boilers with new, sealed-combustion (or power-vented) high-efficiency models.
Install mechanical ventilation	Many energy retrofit measures will increase airtightness to the extent that poor air quality and condensation problems from excessive indoor humidity may occur. To remedy this, install a mechanical ventilation system or a heat-recovery ventilator to capture heat from the exhaust air stream.
HOUSE INTERIOR	
Replace incandescent lights	Install fluorescent or LED lighting as an energy-saving alternative to incandescent lighting. Compact fluorescent lamps (CFls) easily replace incandescent light bulbs; linear fluorescent fixtures (specify electronic ballasts and T-5 or T-8 lamps) can provide indirect lighting. Lighting energy savings can also be achieved with better controls, including occupancy sensors, and task lighting that replaces area lighting.
Upgrade appliances	Buy a plug-in electricity usage monitor to judge the efficiency of appliances, and replace inefficient equipment. A new refrigerator, for example, may use only a third as much electricity as one from the 1980s. Recycle old refrigerators rather than keeping them for back-up use. Some utilities in Alaska make these energy-use meters available to customers.
Turn off the TV	Really turn it off. Many, but not all, televisions and other entertainment equipment continue to use power even when "turned off." To be sure that the equipment is really off, put it on a power strip and get in the habit of switching that off when equipment is not being used. When buying a new TV, consider both the standby and the operating power consumption. Be aware that digital recording devices, such as TiVo, tend to draw significant power (25 to 35 watts) even when not recording, and they are typically left on 24/7 to be ready for reset recording.
Turn off cable modems and routers	Internet connection equipment, including cable modems and wireless routers are significant electricity consumers in many homes — often surpassing even televisions. If doing so will not interrupt crucial services like phone service, plug these devices into power strips and switch them off at night and when the house is unoccupied.

Practice a low-energy lifestyle	Homeowners should be encouraged to alter their lifestyles in ways that reduce energy use by limiting water use, turning off lights when not in the room, making use of task lighting, etc. Also, carefully consider the need for any proposed addition and its impact on the occupants' total energy consumption.

A list of energy raters is available at the Alaska Housing Finance Corporation website: www.ahfc.state.ak.us.

Before proceeding with retrofits to improve energy efficiency, carefully review the following sections to be sure you understand the necessary details required to do a "best practices" job. Sequencing of vapor barriers, placement, careful installation of insulation to eliminate voids, use of appropriate caulks and sealants, selection of materials, and material compatibility are all crucial details which will ensure a very satisfactory, energy-efficient result.

Understanding the house as a system is very important in taking the correct and effective steps in a retrofit. For example, knowing where to place vapor barriers to prevent moisture problems, understanding heat flow and knowing the properties of various types of insulation are extremely important. These concepts and others are covered well in the "Alaska Residential Building Manual."

Ceiling

Lack of ventilation and vapor barrier in the ceiling is often evident by moisture stains and water leaking out of electrical outlets during the spring thaw. Ice dams at the eaves are another sign that warm air is leaking into the roof cavity or that it is inadequately insulated.

The following steps should be taken if additional insulation is installed in the ceiling.

1. Lift the existing insulation and check for the existence of a vapor barrier. The vapor barrier usually consists of a clear sheet of polyethylene (Visqueen). Older houses may have a double sheet of rosin paper cemented to an asphalt coating, which may be coated on one side with a thin sheet of aluminum foil. The vapor barrier must be securely fastened with acoustical sealant, staples and vapor barrier tape under the ceiling joists to be effective. All air sealing should be completed BEFORE any new insulation is added to the attic.
2. If there is no vapor barrier evident, then a vapor barrier must be installed before placing any type of insulation. Vapor barriers may be installed using the following guidelines.
   a. There is no satisfactory technique for installing and sealing a polyethylene sheet between the joists. If urethane is used without an additional vapor barrier, specification of water vapor permeability of the urethane should be provided by the applicator in writing. It is best to use a polyethylene vapor barrier for urethane foam applications.
   b. If any loose fill (cellulose, vermiculite, rockwool, fiberglass) insulation is used, a 6-mil polyethylene sheet must be installed on the underside of the ceiling and sealed along the seams and edges with non-hardening caulking compound. Then, 1- x 2-inch nailers should be installed under the vapor barrier. These may be covered with acoustical tile, sheetrock or paneling.
   c. Where possible, all openings around plumbing vent stacks, plumbing walls, electrical wiring, lighting fixtures and chimneys should be tightly sealed against water vapor and air migration into the roof cavity. Recessed lighting fixtures should be removed and the openings tightly sealed against warm air and water vapor leakage. Inspect exhaust fans located in the attic before installing insulation. Replace if needed.
   d. All access openings and stair wells from the interior of the house into a cold roof cavity or attic should be tightly sealed against mi-

gration of warm air and water vapor. Access openings into a cold attic should be placed in the gable ends of the roof rather than in the ceiling.

e. When placing additional insulation in the roof cavity, special precautions must be taken not to restrict air movement or obstruct vented soffits over the insulation at the eaves, particularly with trusses constructed of 2- x 4-inch top and bottom chords. It may be desirable to place a 2- x 24-inch strip of rigid urethane under the eaves instead of blanket, batt or fill insulation. Baffles can also be placed against the underside of the roof sheeting. New products are also available for this purpose.

f. The plate (top) of interior partitions should be vapor proofed with vapor resistant paint and the edges sealed with caulking when no other vapor protection has been provided.

Stud Frame Wall

Lack of insulation in a wall may be evident by blistering of paint on exterior siding, frost or condensation behind furniture and drapes, or staining of sheetrock nailheads.

Follow the steps listed below to insulate an existing wall.

1. Remove a section of exterior siding and sheathing in several locations and determine if the wall is insulated and/or vaporproofed. No insulation should be blown into the wall until it is properly vapor proofed.
2. The wall may be vapor-proofed by installing a sheet of at least 6-mil polyethylene over the existing interior wall covering. The vapor barrier should be sealed airtight at all edges and seams. The polyethylene may be covered with sheetrock or paneling.
3. The interior of the wall may also be vaporproofed by a vapor resistant wallpaper. Regular vinyl wallpaper may be waterproof and washable, but not necessarily vaporproof. The permeability should be specified by the manufacturer and not be greater than 0.750 perms.
4. After the wall has been properly vaporproofed, rockwool or cellulose may be blown into the wall through 1½- to 2-inch plugs cut through the exterior siding and sheathing in every cavity between the studs. Cavities under windows should also be insulated.

This photo shows several aspects of a house, which is poorly insulated at the studs — you see condensation and mold not only at the top of the wall where the wall plate is, but also in the corner and at each stud. This is an extreme example of a phenomenon called "ghosting of the studs" where the surface of the wall on the inside of the stud is cooler and therefore condenses out moisture and other vapors on the cool surface resulting in thermal bridging. Photo by Scott Waterman

A house retrofit showing both the exterior wall being framed in and a new superinsulated window being installed in the rough opening of the old wall. Both of these are examples of how to retrofit both windows and walls with more insulation and a better performance window.

Detail of a home in the final retrofit stages. The wall is being covered on the exterior with Tyvek homewrap; the siding is then installed so that cellulose insulation can be sprayed in the wall cavities and below the windows as the siding is attached. The finished wall is then sealed and the insulation is contained by the Tyvek on the exterior. This system worked extremely well, but it only worked well because the new window openings were sealed with foam sealant and the vapor barrier caulked to the inside of the window frame. The vapor barrier itself was of good quality and had the confidence of the retrofit team that it did indeed stop most of the moisture at the inside wall.

5. A more expensive and drastic method is to remove all interior wall covering, place 3½ inches of insulation between the studs, cover with 6-mil polyethylene and then install new gypsum board or paneling.

Basement

An uninsulated basement can cause a large portion of the heat loss in a house. Heat loss may be evident by melting of snow along the foundation wall.

The following steps may be taken to insulate a basement of an existing house.

1. It is always more effective and less likely to cause basement moisture problems if the basement can be insulated on the outside of the wall and below grade (below the soil surface). There are excellent extruded polystyrene rigid board insulations that are ideal for this application. Insulating basements and heated crawl spaces from the outside prevents moisture problems and keeps inside wall surfaces warmer and dry. It is highly preferable to any interior insulation on basement walls and should be the preferred option whenever possible. Always protect the outside surface from physical damage and insects with a permanent protective sheathing.
2. The basement of an existing house may be insulated from within by installing 2- x 4-inch nailers at 16-inch centers on the wall. Place 2 to 3 inches of insulation between the nailers and over this place a 6-mil polyethylene vapor barrier. The vapor barrier may be covered with gypsum board and suitable paneling. Foamed plastic may be sprayed between the nailers. However, a polyethylene vapor barrier should be placed over the insulation and nailers. Rigid foam plastic insulation board may also be used.

Closed Crawl Spaces

The masonry crawl space of a home can account for almost half of the heat loss, depending on the temperature required to maintain a warm floor surface temperature. Heat loss is often evident by melting of snow along the foundation wall.

The guidelines below may be used to insulate a closed crawl space.

1. Excavate a trench along the wall to the depth of the footer for placement of insulation. Attach 2 or perhaps 3 inches of rigid polystyrene or urethane board on the interior of the masonry or concrete foundation wall depending on the severity of the climate. Sprayed-on urethane may also be used on the exterior of the foundation, as can extruded polystyrene. Spray on foams need durable protective sheathing to keep from being damaged.
2. Any foundation vents should be replaced with permanent closures.
3. For additional comfort and fuel savings, the floor of the crawl space may be covered with a 2-inch layer of rigid polystyrene. A 6-mil polyethylene vapor barrier should be placed

under the insulation. The insulation should be covered with 4 to 6 inches of sand and gravel. This system also can aid in reducing radon induction into a crawl space or basement.

Floors Over Unheated Crawl Spaces

A floor over an unheated crawl space should be provided with as much or greater insulation than is in the ceiling, since it is the closest surface upon which we work, play and relax during waking hours.

Slab-On-Grade

Insulating the floors and foundations of a house with a concrete floor is difficult at best. Ideally, in a new home, the perimeter of the floor area should be insulated with at least 2 inches of polystyrene or urethane, with a 48-inch strip laid around the perimeter. It is very costly to provide sufficient heat to raise the floor surface temperature to a temperature comparable to room air temperature. A cold floor results in stratification of air so that the thermostat must be set at 75 degrees F to maintain a comfortable temperature at the floor. This can result in temperatures near the ceiling as high as 85 degrees F.

The following steps may be taken to insulate the foundation wall of a slab-on-grade house.

1. Excavate a trench around the perimeter of the house and install 2 inches vapor-resistant, extruded polystyrene high-density board. The insulation should extend at least 32 inches below the surface. Foamed-in-place urethane is excellent, but it necessitates excavating a 4-foot-wide trench to assure uniform foaming of insulation by the applicator. A rigid urethane or polystyrene board only requires a 1-foot-wide trench in which to place the insulation. The foam plastic insulation above grade should be plastered or in some way protected against deterioration by ultraviolet light of the sun and mechanical damage by rodents, dogs and other pests.
2. A floating slab with spacing around all edges should be insulated by placing rigid slab edge insulation along the edges.

To insulate an existing concrete slab-on-grade, the following steps may be taken.

1. Install 2- x 3-inch or 2- x 4-inch pressure-treated "sleepers" over the existing slab, keeping in mind that the true dimensions taken up will be around 1.5x2.5 inches or 1.5x3.5 inches. A ¾-inch space should be left at the ends of sleepers to allow for possible expansion caused by moisture adsorption.
2. The space between the sleepers may be insulated with 2 inches of polystyrene or urethane rigid board or foamed-in-place urethane.
3. A wood subfloor and/or finish flooring should be placed over the nailers. A ¾-inch clear space should be left around the perimeter of the subfloor and finish flooring to allow for possible expansion. A ¼-inch opening should be left behind or under the base molding to facilitate natural removal of water vapor that may condense out under the floor, particularly during summer when the heat may be turned off.

Exterior Retrofit of Vapor-Sealed Insulation

Insulation products with low water vapor permeability are used for exterior retrofit of insulation. These insulations include closed-cell polystyrene foams and foil-faced plastic foams, which are usually available in 2- x 8-foot or 4- x 8-foot sheets. Both types of insulation are excellent vapor barriers and, therefore, must be applied with special precautions to the exterior of structures. Otherwise, moisture could accumulate in the wall and be trapped by this new exterior vapor barrier.

Be sure to refer to manufacturer's recommended installation procedures whenever you use these types of insulation, and contact your local Cooperative Extension Service for further information.

Insulate well and stay warm!

For More Information

"The Alaska Residential Building Manual," HCM-00051, UAF Cooperative Extension Service

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