Deep Energy Reduction Retrofit at Eagle Bluff, Lanesboro, MN   Dated Material: March 22, 2011

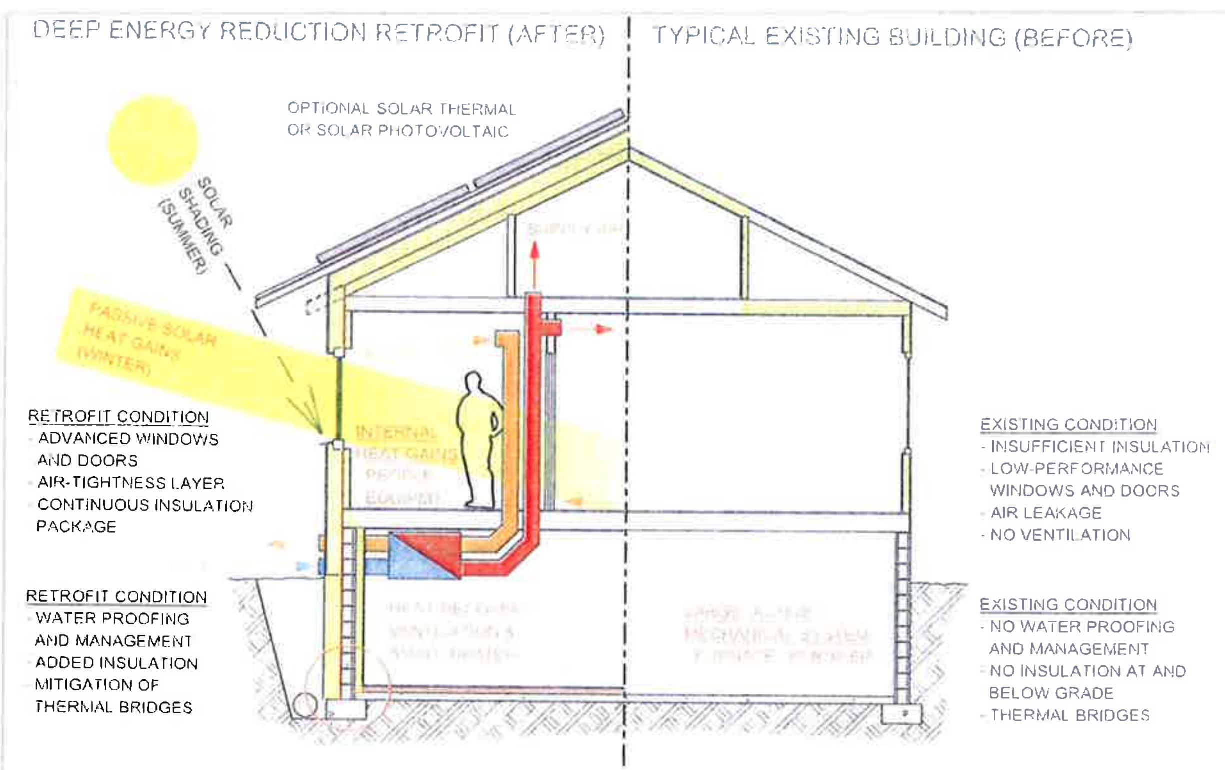
Eagle Bluff, a non-profit residential environmental learning center has completed a Deep Energy Reduction Retrofit on our oldest, most energy inefficient building: the Eagle Bluff residence. The goal of the project was to reduce the overall energy consumption of the residence by more than 70% and to offset all the remaining energy use for its operation to achieve carbon neutrality. Because the residence is an early 1970's stick framed 1-1/2 story detached single family home-perhaps like yours - imagine your own energy savings if you followed this path.

A Deep Energy Reduction Retrofit (DERR) is described by Affordable Comfort, Inc. as "a comprehensive sustainable building improvement that offers significantly reduced environmental impact and energy impact *while enhancing comfort, indoor environmental quality and durability."*

Nationally, it is estimated that over 60% of existing residential structures can be upgraded with a Deep Energy Reduction Retrofit. It depends on the condition and performance of the existing building that is evaluated on a case-by-case basis.

The energy savings at the Eagle Bluff residence will be monitored and displayed for demonstration and learning purposes. Eagle Bluff will use the project as a significant part of our curriculum for both students at the learning center as well as the community at large.

During the retrofit, we also focused on food sustainability. While most energy efficient homes usually have visually pleasing kitchens that are not designed for food sustainability, we created a sustainable working facility that includes space for food preparation, preservation, storage and utilization. We believe this is an important component in a sustainable, energy-efficient home.



General Information:
The project design team, including a diverse group of consultants, completed a rigorous design process that included elements to seal the building envelope as tight as possible, the use of state-of-the-art insulation, installing a whole house air handling system with an environmental recovery unit, adding solar thermal hot water and photovoltaics, the addition of recycled glass countertops and reclaimed materials and using local resources when appropriate. LED lights were used whenever possible and cfls or halogen lights were used everywhere else. All features will be monitored for interpretation on the web.

Insulation Goal – R50:
Six inches of XPS (extruded polystyrene) were added on the basement level and below ground

- Six inches of polyisocyanurate (PIC) were installed above ground
- Vaulted ceiling R value Goal = R70
    - PIC foam was added in the attic and between the vaulted ceiling roof trusses
    - One inch air channel between roof deck and foam
    - One inch of rigid PIC for thermal break between roof trusses and the sheetrock

Windows and Doors - Goal – R8:
Loewen triple pane windows (R7.9) and double pane doors

- U = 0.25 North and East
- U = 0.19 West and South

- Elimination of 7 sliding glass doors, one North facing door and window and two large Northeast facing windows
- Addition of two windows to the South
- Minimization of the overhang to allow for passive solar gains.
- Motorized upper windows for venting

Siding Goal – Minimal Maintenance, Durability, Recyclability and Woodpecker Proof

- Nichiha cement fiber board siding was used on all exposed exterior basement walls
- Fabral metal siding was used on all other exterior surfaces to provide a challenge for the woodpeckers.

Solar Thermal - Goal – Domestic Hot Water and Building Heat Supplement:

- 200 sq ft of Heliodyne collectors, a Resol controller, a 400 gallon storage tank and the in place hydronic heating system.
  - Heliodyne collectors have a blue sputtered coating (tinox) that has a 20% better performance rating in cold weather.
- The system was designed and installed by the Century Community College, Solar Thermal class, Todd Fink, Instructor out of White Bear Lake, MN working in cooperation with Bill Butler of the Energy Independence Group.

Solar Photovoltaic – Bring the house as close to carbon neutral as possible – use green energy to offset former fossil fuels.

- A 5.64 kw system was installed by Winona Renewable Energy and brought on-line (grid tied) on May 31st.
- Data from the Enphase Monitoring system will become available on our website Fall, 2011.
- When tied with the solar thermal system, should provide green heat and power for the house.

Flooring Goal - Utilization of Locally Grown and Sustainably Harvested Hardwoods:

- Select and Better, multi-width and length, hard maple flooring
- Locally grown, harvested and processed.

Pantry - Goal – Encourage Sustainable Food Production, Storage and Utilization

- Shelves are made from reclaimed lumber obtained from a grainery that was used for five generations by the director's family.
- Storage for all canned goods, cooking supplies and utensils

Water - Goal – Minimize Water Usage

- Low flow showerheads and dual flush toilets were added
- Rain barrels and rain gardens will be used to control and utilize roof runoff water.

Funding Sources: principal funding for this project was provided by the Minnesota Environmental and Natural Resources Trust Fund (ENRTF), as recommended by the Legislative Citizen's Commission on Minnesota's Resources (LCCMR) demonstrating sustainable energy practices at the state's six residential environmental learning centers and turning them into regional educational sites.

A Green Design Grant from the Beim Foundation, Eagle Bluff 2010/Aurora funds and the ENRTF provided financial support to cover the costs of project consultants.

Sponsors provided demonstration products, in-kind donations, product discounts or cash donations.

This deep energy reduction retrofit was the result of a team effort from the consultants, sponsors and vendors listed below. It could not have been accomplished without their support and guidance. We appreciate their contributions to our building's sustainability. We strive to encourage others to adopt similar practices!

Project Consultants:

Ron Kirk, Architectural Consultant, Kirk Project Management, Roseville, MN
Tim Eian, Passive House Architect, TE Studio Limited, Minneapolis, MN
Mike LeBeau, Solar Thermal Consultant, Conservation Technologies, Duluth, MN
Pat O'Malley, Building Envelope Consultant, Building Knowledge , Minneapolis, MN

DERR Sponsors:
Jeff Vilen Construction, WHV, Kirk Project Management, Community Electric, Loewen Windows, ProBuild – Rochester and Corporate, Century Community College, Solar Thermal Class, Home Depot and Behr Paints, Classic Carpets and Interiors, Eco Countertops, CCrane Co., Bright Ideas, Rochester

Design Team:
Ron Kirk, Architectural Consultant, Kirk Project Management, Roseville, MN
Jeff Vilen, Builder, Jeff Vilen Construction, Zumbro Falls, MN
Joe Yennie, Builder, Jeff Vilen Construction, Pine Island, MN
Ray Schmitz*, Energy Enthusiast/CERTS, Rochester, MN
Bob Ashton*, Builder, Stone Bridge Builders, Rochester, MN
Christian Milaster*, The Because Group, Lanesboro, MN
Kevin Schreurs*, Energy Enthusiast, Rochester, MN
Doc Schoepski, Director of Operations, Eagle Bluff
Darin Johnson, Operations Manager, Eagle Bluff
Joe Deden & Mary Bell, house residents, Eagle Bluff
*Eagle Bluff Board members

Vendors:
Builders: Jeff Vilen, Jeff Vilen Construction, Zumbro Falls, MN
Joe Yennie, Pine Island, MN
Tom McNamara, Zumbrota, MN
Scott Stacy, Pine Island, MN
Building Supplies: ProBuild, Rochester, MN
Cabinets: Eli Swartzentruber, Canton, MN
Counter Tops: recycled glass, Eco Countertops, Eric Wills, Stone Systems, Mpls, MN
Energy Audit: Joe Gibbons, The Because Group, Rochester, MN
Thermal Imaging and Blower Door Tests
Heating and Air Conditioning: Winona Heating & Venting, Co, (WHV), Winona, MN
Alan Leisen, WHV, Engineer
Jeff Demorest , WHV, Installer
Steve Scott, WHV, Service Technician
Electrical: Community Electric, Dan Anderson, Lanesboro, MN
Flooring: Select and Better Maple, Upper IA Millworks, Allan Gingerich, Cresco, IA
Installation: Jacob and Joseph Hershberger, Canton, MN
Finishing: Classic Carpets and Interiors, Kurt Bill, LeRoy, MN
Insulation: Dave's Insulation, Kasson, MN
Lighting: Bright Ideas, Dave Sorenson, Rochester, MN
LED Geobulbs and PowerVivid floodlights, Lisa Wilson, CCrane Co, Fortuna, CA
Dining Room Pendants, hand blown by Laremy Ellsworth, St Charles, MN
Paint: Low VOCs, Home Depot and Behr Paints, Rochester, MN

Painter: Good Job Painting, Eric Gehrke, Lanesboro, MN
Radon Abatement: Jeff Engen, Radon Mitigation Services, Mabel, MN
Rain Gardens: Haugstad Construction, Fountain, MN
Siding: 1) Nichiha Cement Fiber Board Siding, Norandex, Rochester, MN
2) Fabral Steel Siding, Brian Jorgenson, Cleary Building Corp, Kasson, MN
Solar Photovoltaics: 5.6 kw system, Tim Gulden, Winona Renewable Energy, Winona, MN
Solar Thermal: 1) Energy Independence Group, Bill Butler, Mpls, MN &
2) Century College Solar Thermal Class, Todd Fink, Instructor, White Bear Lake, MN
Solar panels used: Heliodyne panels with a Resol Controller
Table and Chairs: Harmony Cabinet Shop, Eli Hershberger, Harmony, MN
Windows and Doors: Loewen Windows, Synergy Products, Jeff Gove, Rochester, MN

Future Projects – The Aurora Campaign

Eagle Bluff has embarked on a campaign that will create a fully sustainable energy demonstration facility for students and adults and build leaders for a sustainable world. By creating a campus that is independent of fossil fuels, Eagle Bluff will remain true to our mission and philosophy of hands-on learning by teaching participants what it means to live a sustainable lifestyle. Becoming a carbon neutral facility brings Eagle Bluff into the age of sustainable energy and ensures that children have access to experiences and educational resources to prepare them for the economic and environmental opportunities that sustainable energy will create for Minnesota.

The Deep Energy Reduction Retrofit of the Eagle Bluff residence is the first project completed as part of this campaign. Your input and support would be appreciated.

- Phase One
  - Campus energy upgrades per McKinstry recommendations $180,000
  - Lighting upgrades: exterior, trail and general light $20,000
  - Solar hot water $220,000
  - Small wind, <40 kw on-site, for net metering demonstration $100,000
  - Geothermal demonstration for Schroeder building $50,000
- Phase Two
  - Medium wind @ 265 kw on-site to provide green power source $500,000
  - Electric car or plug-in hybrid car $40,000
- Phase Three
  - Large wind off-site or Natural Gas Fuel Cell $600,000+

In addition, Eagle Bluff in conjunction with our five sister organizations has formed The **Earth**Sense Alliance (ESA) to address similar concerns. The mission of the ESA is to advance the ideals of sustainability, education and community by leveraging on the collective resources and efforts of our member non-profit residential environmental learning centers.

For further information, please contact: Joe Deden, Eagle Bluff, 507-467-2437 or director@eagle-bluff.org

Photo History:


Old wood burning furnace in basement which used @ 17 cords of split, dried oak firewood a year and the new solar thermal system utilizes the in-place hydronic heating system.


A three inch correction was made on the north wall and a nine inch correction was made on the west wall to correct previous construction errors. Six inches of XPS was added to all basement walls.


PIC insulation which has lower imbedded energy was used on all other exteriors walls and for interior foamed surfaces. One inch of rigid foam was added to provide a thermal break on the ceiling.

An air handling system is an important component of an air tight building.

Thermal imagining was used to verify the thoroughness of construction both inside and out.

Blower door test were used to verify air tightness. Air tightness went from over 6+ Air Changes per Hour (ACH) at 50 Pascal's of pressure to 0.45 ACH, >92% improvement.

Eagle Bluff Environmental Learning Center,				
Deep Energy Reduction Retrofit - Eagle Bluff Residence Project Costs				
ITEM	**AREA (sf)**	**$/SF**	**IMPROVEMENTS SCOPE SUMMARY**	**COST**
Architectural and consultant fees			Overall building concepts and guidance for the design team.	$17,000
Site prep			Erosion control measures and permits.	$1,700
Correction of existing conditions			West wall 9" recessed, north wall 3" recessed, correction of overhangs on north and south. Labor and materials.	$20,600
Basement walls	1,250	$16.24	Excavate, water proof, add 6" rigid XPS insulation, Nichiha siding. Labor and materials.	$20,300
Above grade walls	2,725	$18.07	Remove existing decks. Establish air tightness. Add 6" polyisocyanurate. Metal siding. Labor and materials.	$49,230
Roof: interior vaulted ceiling and attic	2,500	$6.68	Remove existing insulation and vapor barrier. Establish venting. Spray with min. 5.5" polyisocyanurate insulation including attic walls. Restore finishes. Labor and materials.	$16,700
Windows and doors	530	$67.55	Loewen triple pane windows and double pane doors - $33,208. Labor and materials.	$35,800
Mechanical systems			95%, two stage, variable speed furnace. 16 SEER heat pump. Environmental recovery ventilator. Programmable thermostats. Ductwork.	$20,000
Electric allowance			Disconnecting and reconnecting all affected exterior and interior electrical	$2,000
Lighting: fixtures and led bulbs			Use lighting fixtures that utilize led bulbs whenever possible.	$4,500
Deck and retaining wall allowance			Allowance for new east and south deck. Materials for replacement retaining wall.	$2,600
Demolition and waste			Recycle all scrap metal, reclaim appropriate wood, scrap remainder.	$1,600
Field testing			Blower door and thermal imaging to insure quality and performance.	$500
Subtotal (Cost of Construction)				**$192,530**
General Contractor's Fee				$17,503
Total Cost				**$210,033**

Notes:

$188,000 of funding was provided by the Minnesota Environmental and Natural Resources Trust Fund as recommended by the Legislative-Citizen Commission on Minnesota Resources to demonstrate sustainable energy practices at the state's six residential environmental learning centers and to turn them into regional education sites.

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND

Promoting and advancing the development of healthy, durable, and sustainable shelter for Alaskans and other circumpolar people through applied research.

REMOTE

Residential Exterior Membrane Outside -insulation TEchnique

February 26, 2007

The Building Enclosure

The design of the building enclosure is one of the most crucial elements in making a home healthy, durable, and efficient. The building enclosure or envelope must provide support along with providing protection from outside elements (wind, water, soil gas and extreme temperatures) and also from interior water vapor. To do this effectively, the building must be sealed. The number of holes cut in the envelope for heating, plumbing and electrical conduits & the number of different contractors cutting these holes makes it virtually impossible to get a perfect seal. An imperfect seal allows water vapor into the building envelope where it can compromise the insulation and the building support if not allowed to dry out.

The Challenge: ***How can the building envelope be sealed from exterior precipitation & interior water vapor without trapping the inevitable leakage of moisture inside the envelope?***

The REMOTE wall system was designed to address the problem of water vapor in residential building components. The discussion below covers the basic science & history behind this building technique.

Moisture Control

Building assemblies need to control the migration of moisture both by vapor diffusion & vapor pressure. Water vapor will move from areas of higher concentrations of water molecules to lower concentrations (wetter to drier), or areas of higher air pressure to lower air pressure. Moisture will also move from warmer areas to colder areas. Water vapor can condense on a relatively cooler surface. This creates greater problems as the condensation now lowers the vapor pressure in that site which acts as a further magnet for moisture. Moisture inside the building envelope can cause structural damage to wood framing and drywall, lower the effective value of the insulation in the envelope & cause indoor air quality problems by creating an environment allowing for mold growth.

Please visit the CCHRC website for additional information and to view progress reports on this and other studies conducted at the Cold Climate Housing and Research Center.

http://www.cchrc.org/Reports

REMOTE wall under construction in Fairbanks, Alaska showing vapor barrier, insulation, window framing and furring in place for siding.

REMOTE wall under construction showing exterior vapor barrier, deck blocking & window detail.

Continued from pg. 1

In cold climates, moisture often moves from the living space (where it is relatively warm & moist) toward the exterior through the building envelope until it reaches the dew point & condenses. To address this, common practice has been to install a vapor barrier on the interior side of the framing & insulation. As noted above, this method is less than perfect due to the many penetrations necessary. Since it is likely that some moisture will get into the wall, it needs a way out before damage can occur, so the exterior needs to be vapor permeable.

This has worked fairly well in cold, dry climates, but requires great care in installing and sealing the vapor barrier (labor intensive) and fails in cold, wet climates where the building must be sealed on the outside of the envelope.

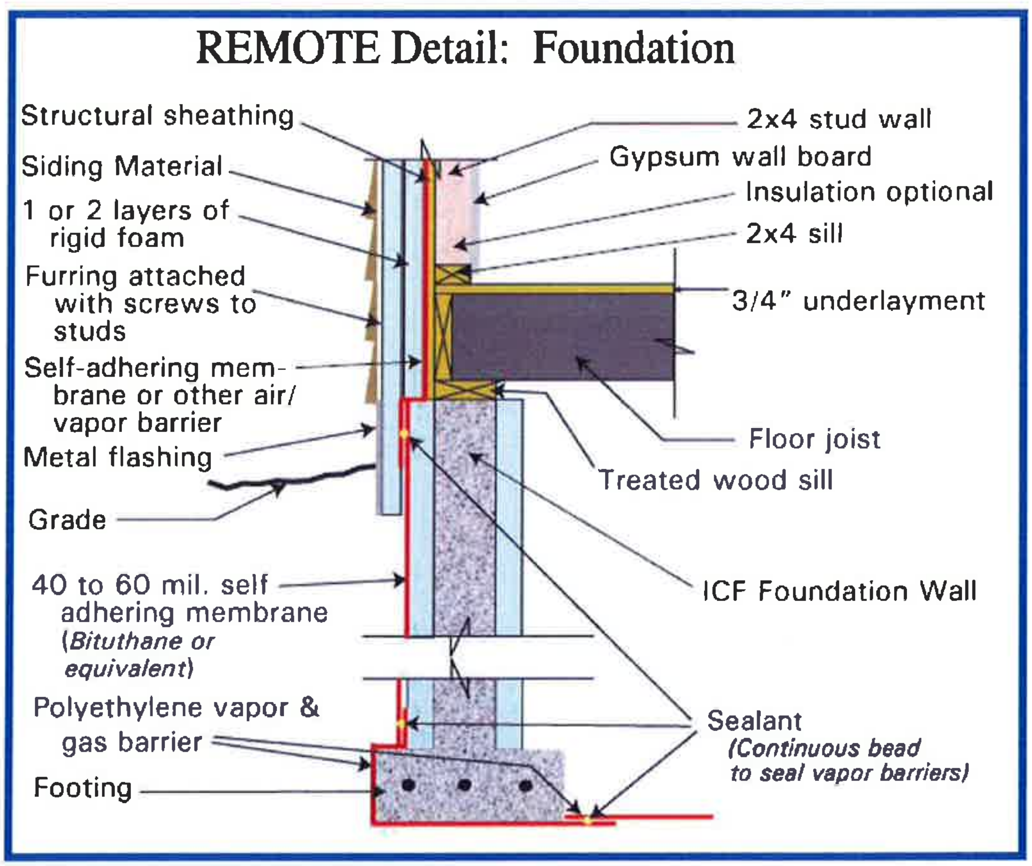
PERSIST (Pressure Equalized Rain Screen Insulated Structure Technique) is, in simple terms, a peel-and-stick impermeable membrane located on the exterior of a framed structure with foam insulation to the exterior of the membrane. This method of construction protects the framing components from precipitation and keeps them on the warm side of the thermal envelope. In PERSIST, a 'second' roof is required to provide an overhang and protective roofing material.

REMOTE is an Alaskan modification of the PERSIST technique which allows more space for insulation in the roof of a structure and eliminates the need for constructing the 'second' roof. This modification allows for more cost effective construction and a higher R-value where it is most needed; in the ceiling. While PERSIST wraps the structure on 5 sides, REMOTE wraps the structure on 4 sides & allows more flexibility in handling the ceiling and floor.

Wall Design— The benefit of insulation on the exterior of the structure is twofold:

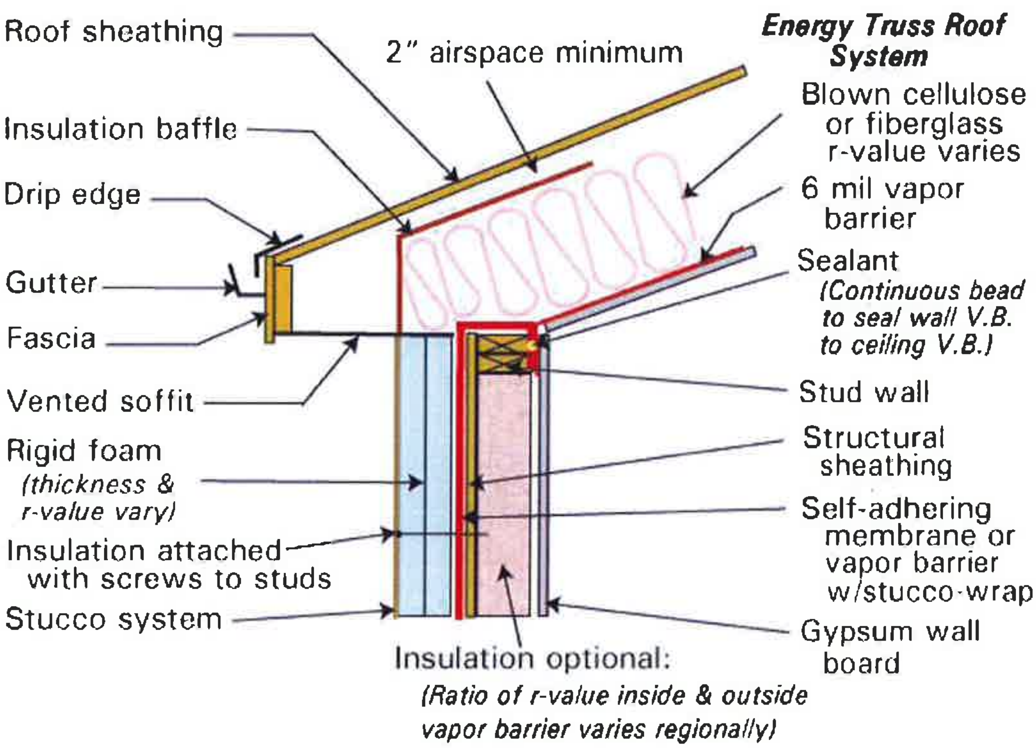
1) With insulation installed to the exterior of the structure, condensation within the building envelope is eliminated. The dew point is now located outside the moisture barrier and not inside the wall structure. Any precipitation that penetrates the exterior sheathing can drain off.

2) The exterior insulation also eliminates concerns of thermal bridging in the framing significantly increasing the effective R-value of the insulation. With cavity insulation, the framing members can reduce the rated R-value of the insulation up wards of 35% to 40%. With the REMOTE wall, the warm interior allows the building components to dry to the inside.

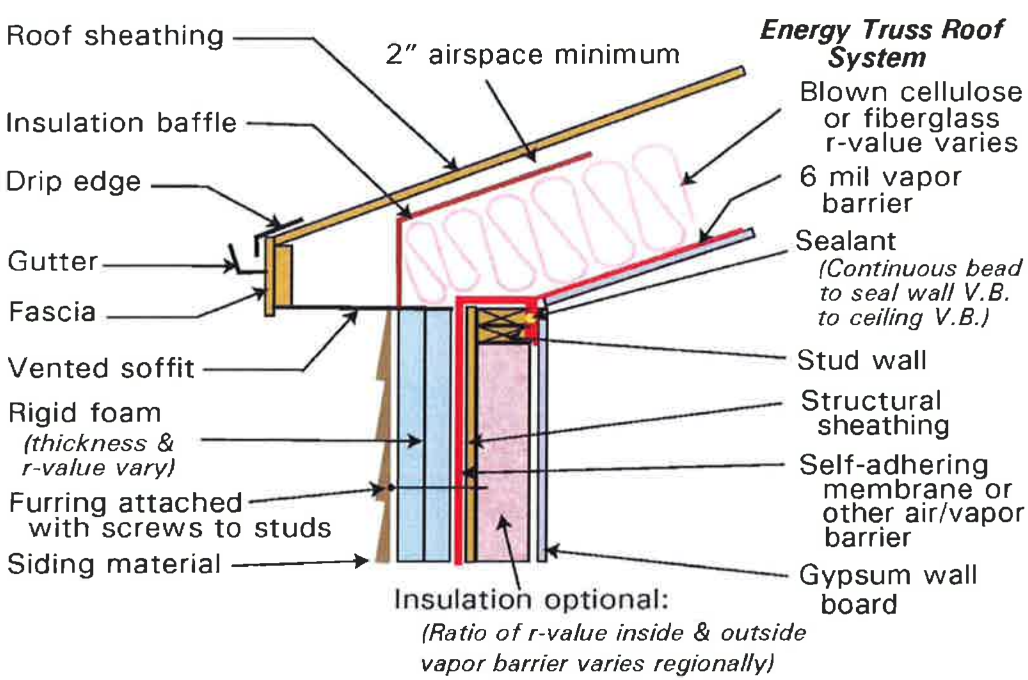


This REMOTE Detail shows how wall components are connected to a foundation. Foundation details are not included due to the variety of foundations possible.

REMOTE Detail: With Stucco



REMOTE Detail: With Siding



The outside-insulation technique allows building with 2x4 walls, which saves on material costs.

Insulation in the stud cavity is optional but care must be taken not to include an R-value amount that would move the dew point back inside the wood framing (see chart on pg. 4). Research in cool, wet climates shows that stud cavity insulation may be better left out entirely to improve the capability of the wall to dry from the inside.

Research has proved that the REMOTE shell creates a very tight air envelope. This mean that very little energy is wasted heating infiltration air, but like any tight wall system, requires a good mechanical ventilation system. Sealed combustion appliances in the living area are required or make-up air must be provided.

Research Results

Final Reports of all these studies can be found at: http://www.cchrc.org/Reports.

A house using the REMOTE wall system building technique under construction in Juneau, Alaska.

REMOTE Wall System Study:

In 2002, CCHRC undertook a study to assess the performance of two residential dwellings in Fairbanks. Both structures were fairly new & constructed by the same builder. One employed a standard wall system with an interior vapor/air barrier and the other used the REMOTE wall system. The wall components interior of the sheathing in the REMOTE construction never approached the dew point and the air tightness was much better than that of the standard house.

Building America in Alaska Report:

In 2004, a building technology class in Juneau tested wall section performance in S.E. Alaska in a Mobile Test Lab developed by CCHRC. Nine wall sections were examined using styles commonly used in the area and a REMOTE style wall. The moisture content of the structural sheathing increased in every wall during the monitoring except the REMOTE wall.

Mobile Test Lab—Wall Systems for South East Alaska:

A follow-up study in 2005-2006 used the Mobile Test Lab to evaluate eight REMOTE wall sections with different components & included wetting of the stud space to determine the drying capacity of the wall sections. The results showed the walls performed well except for two sections that included insulation inside the stud cavity which retained elevated humidity inside the wall at a dangerous level.

Suggested maximum cavity insulation for an Exterior-Insulation type wall for selected Alaska cities*

Heating Degree Days	Not to exceed Fraction of Insulation on Warm Side of Vapor Barrier	Alaskan Cities within Selected Heating Degree Day Range
Less than 12,000	1/3	Juneau, Anchorage
12,000—14,000	1/4	Bethel
Greater than 14,000	1/5	Fairbanks, McGrath, Nome, Kotzebue, Barrow

** The heating degree days can vary greatly within an area due to micro-climates. For example, a site in the hills around Fairbanks may experience less than 14,000 heating degree days due to temperature inversions common in winter.*

Mobile Test Lab with wall sections in Juneau