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The purpose of Alaska Building Science News is to bring timely building science information to Alaskans in order to improve the quality and durability of the housing stock in Alaska as well as save energy and maintenance expenses for homeowners.

We hope that ABSN Newsletter will become a mainstay in your information menu in the future. If you would like to receive ABSN's newsletter electronically, please let us know by e-mail. This newsletter can be found on our website: www.uaf.edu/ces/faculty/seifert

GREAT HOME IDEAS FOR OUR TIMES

by Rich Seifert

This issue will be devoted to recent advances and building concepts from Alaska that are "pushing the envelope" toward the ultimate low-energy design and performance we all need to strive for. As fuel oil and other energy costs rise steadily and intimidate us all, Alaskans are responding with some grand new plans and homes to cope with the future and protect themselves with their own wits and good sense. Since the energy specialist role in Cooperative Extension is a nexus of information about these new efforts, I want to share them with all who are interested.

Low-energy houses are a substantial part of any attempt to become self sufficient in energy and to lower vulnerability to ever-increasing costs of fossil fuels. Alaska has always been a place of great motivation and experimentation in housing and energy. This is particularly true in the Interior, where the climate, aptly called subarctic continental, is a major factor in fuel use and housing operation. The challenge of living in an extreme climate demands that we search long and hard for the best combinations of insulation, materials, ventilation systems and fuel. While research is proceeding, individuals often go where research might not, exceeding the normal bounds

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and testing new concepts without waiting for research results. We're nothing if not impatient to make things better and to lower our costs and increase our reliance on natural energy flows.

So this issue of the newsletter is devoted to the urgent local attempts and experiments in homes built by Alaskans for the Alaskans who love this place and want to live here with minimal costs and maximum comfort. We'll see how they are doing, what they expect to achieve and how things are working. As always, this is a fascinating glimpse of a human enterprise that brings out the best in us — trying to build that most human of objects, a great, comfortable, healthy house that you love to live in, that feeds your life and affords you peace of mind.

The homes are presented in chronological order of their review and finish status.

Home No. 1: The octagonal super-insulated, ultimate low-energy, fossil fuel-free attempt of Karl Kassel and his family.

This home is rather far from the urban core of Fairbanks, but the choice of its location was aesthetic rather than pragmatic. It is about 25 miles northwest of town and is off the electrical grid. It is in an area, (Murphy Dome) where many homes have been built off grid, so the owners must supply their own utilities. The house is octagonal, and the rationale for that is based on several thoughtful considerations. Kassel has told me that the octagon shape is his choice because it has a shorter perimeter length than a simple rectangular plan would have to enclose the same floor area. This means that, theoretically, less wood and framing and materials in general are needed to enclose the same floor area — a basic efficient use of materials. A second advantage of the octagon shape is that it allows a masonry wood stove to be placed directly in the middle of the home. With wedge-shaped rooms all emanating from the center of the octagon, each room can be in direct contact with the masonry stove and, therefore, can be heated radiantly by the masonry stove. A few photographs with captions will serve to further illustrate the details of the home and show its layout.

The following text and list describes more technical details of the Kassel home (called "Sunset Roost" by its owner) taken from the owner's description contained in the May 2011 Solar Homes Tour brochure for Fairbanks:

Sunset Roost is an off-grid, super-insulated ,passive-solar 1,860 square-foot octagon house that includes many natural artistic interior design elements. The structure is heated and energized by

Figure 1. A view from the west of Karl Kassel's home. Note the large window area for passive solar gain. The siding is log siding (the house is not a log structure). The walls are insulated with Styrofoam insulation and are rated at R-65. There is no basement or crawl space. The house is built on the surface of the soil and insulated under the concrete floor with Styrofoam as well. Note, too, that the site is fairly windy, a fact I gleaned from the lack of snow on the roof when I visited in winter. Normally, one would expect to see major snow accumulation on the roof, but that is clearly not the case for this location, which is on a ridgetop northwest of Fairbanks.

a unique synergistic system of renewable sources. The home sits atop a hill with expansive views to the southwest, which present memorable sunsets behind Denali during the winter months (hence the name Sunset Roost). Large windows allow solar gain and contain the relaxed, homey interior environment while providing access to inspiring vistas. In many regards, this home defies labels and must be experienced to be truly appreciated or understood.

Technical clues:

- 3kw wind turbine on an 80-foot guyed tilt-up tower
- 1600w solar PV
- 160 square feet of flat-plate solar collectors
- award-winning masonry heater with hydronic loop for domestic hot water
- house and two-thirds of domestic hot water heated with two cords of firewood for the entire winter
- large indoor planters for decoration and thermal mass
- extensive rock work throughout house for decoration and thermal mass
- 12,000-gallon seasonal thermal storage (water) tank
- 120-gallon domestic hot water tank
- 50-gallon preheat tank
- radiant floor heat (not needed or used yet) provided by a variety of sources
- R65 remote walls
- R85 roof
- argon-filled, triple-pane fiberglass frame windows
- home heated over seven months exclusively by passive solar (68°F minimum indoors)
- 6kw diesel generator (run three times between Christmas and May 7)
- propane on-demand hot water heater for backup or top-off as required
- soaking tub in master bath kept warm by the masonry heater
- flooring: stained concrete, cork and bamboo
- interesting accessories: owner-made cabinet door pulls and towel racks, etc.
- ENERGY STAR appliances, dual flush toilets, LED and CFL lighting

Figure 2. The masonry stove in Karl Kassel's home. The stones are all from the local region. The main firebox is the lower door, and the baking oven is the smaller upper door. The strategy of operation for this type of stove, which has firebrick and refractory (a high-temperature ceramic fire box lining) inside the firebox, is to burn fuel quickly at very high temperatures. As the stove heats up, flue gases pass through a series of serpentine channels inside the stove before exiting, transferring heat to the large mass of the stove (typically around 10-12,000 pounds of concrete and stone) and lowering the exhaust temperature to around 110°F. Heating the fuel, typically wood, to this high temperature allows full combustion and results in the very clean burn characteristic of masonry heaters.

Through efficient basic design, Sunset Roost embodies exceptionally comfortable living with minimal energy consumption. Renewable energy sources supply the vast majority of the demand. This is one of the most energy efficient homes in Alaska.

As I mentioned, the home is heated with a masonry wood stove, a technology used for centuries in Scandinavia, Russia and the Baltic countries. The masonry stove for this house is shown in figure 2. It was built by local mason Dan Givens, who has created several of the masonry stoves for these ultra-efficient homes in the Fairbanks area.

The Kassel home also uses solar collection of heat for hot water and has a storage tank (12,000 gallons) for storing extra available heat. A wind generator provides some electrical production as well, since the home is off the grid. Excess generation can also be stored in batteries and used to add heat to the tank through electrical resistance heating, dumping extra wind power into heat if no other storage is available.

Home No. 2: Thorsten Chlupp's family home.

Thorsten Chlupp is a professional builder (d/b/a REINA Construction) and helped to construct the Kassel home. When he finished that, he embarked on his own home, but it is quite different in emphasis, look and heating plan from the Kassel home. Thorsten took many of his prime concepts from the experience of the very impressive German program and experience network known as the "passiv haus" concept (www.passiv.de/English/PassiveH.HTM).

It is important to point out just exactly what the goal of a "passiv haus" is (I'll just use the very clear "passive house" English translation to refer to this concept from here on). In answer to "What is a passive house?," the website cited above provides this brief explanation:

> A passive house is a building in which a comfortable interior climate can be maintained without active heating and cooling systems (Adamson, 1987, and Feist, 1988). The house heats and cools itself, hence "passive."
>
> For European passive construction, a prerequisite to this capability is an annual heating requirement that is less than 15 kWh/(m²a) (4755 Btu/ft²/yr), not to be attained at the cost of an increase in use of energy for other purposes (e.g., electricity). Furthermore, the combined primary energy consumption of living area of a European passive house may not exceed 120 kWh/(m²a) (38,039 Btu/ft²/yr) for heat, hot water and household electricity.
>
> With this as a starting point, additional energy requirements may be completely covered using renewable energy sources.

It is helpful to readers to give a few more indications of what exactly that specification means. A house that will meet the passive house specification would need an amazingly small amount of heat, essentially as little as possible, depending on the climate. To get a sense of how much heat or equivalent fuel this is, it is useful to convert the kWh into fuel-oil gallons or cubic feet of natural gas. The specification of heating capacity is 4,755 Btu/ft²/yr. If the house is, say, 1,200 square feet in floor area, this totals to a need of only 7,135,000 Btus per year. This is only about 75 gallons of fuel oil, or 72 therms of natural gas. The fuel costs for these two options at May 2011 rates would be about $300 for the fuel oil and about $75 for the natural gas. For most homeowners this would be a near-miraculous reduction in fuel requirements. For comparison's sake, it is also notable that this amount of heat could be supplied by about a half cord of wood. Below is a tabular listing of the basic specifications of a passive house, again taken from the passive house website:

> Compact form and good insulation: All components of the exterior shell of the house are insulated to achieve a U-factor that does not exceed 0.15 W/(m²K) (0.026 Btu/h/ft²/°F).
>
> Southern orientation and shade considerations: Passive use of solar energy is a significant factor in passive house design.

Energy-efficient window glazing and frames: Windows (glazing and frames, combined) should have U-factors not exceeding 0.80 W/(m²K) (0.14 Btu/h/ft²/°F), with solar heat-gain coefficients around 50 percent.

Building envelope air-tightness: Air leakage through unsealed joints must be less than 0.6 times the house volume per hour.

Passive preheating of fresh air: Fresh air may be brought into the house through underground ducts that exchange heat with the soil. This preheats fresh air to a temperature above 5°C (41°F), even on cold winter days. (Ed. Note: clearly this particular specification is not based on Alaska reality. In order for this to occur, you must heat the soil during summer! This is what Thorsten Chlupp actually does.)

Highly efficient heat recovery from exhaust air using an air-to-air heat exchanger: Most of the perceptible heat in the exhaust air is transferred to the incoming fresh air (heat recovery rate over 80 percent).

Hot water supply using regenerative energy sources: Solar collectors or heat pumps provide energy for hot water.

Energy-saving household appliances: Low-energy refrigerators, stoves, freezers, lamps, washers, dryers, etc. are indispensable in a passive house.

Figure 3 shows various aspects of Chlupp's house.

Figure 3. An early April, 2011 view of the south façade of the Chlupp house near Fairbanks. The design includes 12 Heliodyne flat-plate solar collectors that supply heat to a large vertical tank inside the house, as well as other heat storage and transfer elements of the house. Most of the windows are south-facing for ample solar gain and are shuttered with custom-made shutter systems. Some of the heat is also used to warm the soil around an air intake tube for supply air to the heat recovery ventilation system (HRV) exchanger, which is done during summer to provide preheated air for the ventilation of the house during winter. The insulation for the house is cellulose, a superb low-embodied energy insulation made in Alaska. And Chlupp used lots of it — 12,000 pounds to be precise. The walls are 22 inches thick and filled with cellulose; the ceiling had to be strengthened to handle the load of about 30 inches of cellulose in the attic, which provides the 100+ R-value of the attic. The wall R-value is about 70. The point of maximizing insulation to minimize heat loss couldn't be more clearly expressed than in this superbly insulated home. In addition to the heat storage in the 7,000 gallon tank in the house, there is additional heat storage designed into the floor — 3 feet of sand surrounded by a foot of Styrofoam insulation under the slab floor of the house. This is also charged with heat from the solar collector system.

Figure 4. The masonry heater in the Chlupp home, also built by Dan Givens.

Figure 5. The open ventilating window at the base of the large south window in the Chlupp house. It was open for cooling and ventilation the day I visited in early April and the house was a comfortable 70°F even though it was below freezing outside.

Figure 6. A close-up view of the shutter system on the Chlupp residence. This is only one of the largest of several shutter types that Chlupp used in his home. This one slides on a garage door slide system (a sort of pocket-door arrangement) so that the shutter is always exposed on the house wall outside. In other parts of the home (not shown) shutters are designed for use on the inside of the windows and slide into the wall when not in use and are out of sight.

Home No. 3: Jen Reed and Ian Wright.

Figure 8. A view of the north side of the house. Note the near absence of windows on the north side (a good thing!) and the various roof lines (complicated!). The metal roof has snow “jacks,” also called snow stops, to prevent snow from sliding off the roof so that spring snow melt can be collected into a future cistern system for nonpotable uses.

Ian Wright, like Mr. Chlupp, is a professional builder (d/b/a Woodwright Custom Homes) whose business focuses on improving the efficiency of local housing stock in response to future energy demands. Wright paired his building experience with the design aesthetics of his wife, Jen Reed. As artists, they each sought to incorporate architectural interest into their superefficient home design. Like all of the homes in this series, their home reflects the search for the ultimate design for low energy use and modern, healthy air quality, along with durability and comfort. After years of research, Wright incorporated into the home design what he saw as the most sensible elements of efficient building technology, economic pay-off, carbon footprint considerations and front-loading of resources for a post-peak oil world. This home is not yet complete, but it is still quite elucidating in its similar approach to super-insulation, use of a masonry stove for winter solstice heat, and solar passive and active design. Wright also built his own masonry stove, as you will soon see. This home has urethane foam spray-in-place insulation in the walls and uses sheathing and siding materials that are uniquely different from the other two homes.

Figures 7 and 8 show different views of the exterior of the house.

Figure 7. A view of the Reed/Wright house from the southwest. Two types of exterior siding are used. One is a corrugated metal siding with an oxidizing finish that “rusts” to form a protective, completely maintenance-free surface and is very weather-tight and durable. The other, a brown, woodlike siding, is actually a cementitious siding with a wood grain finish on it, and it is fire-proof and durable as well. These sidings were selected, along with yellow cedar decking, because of their ability to weather/age aesthetically while eliminating effort for reapplication of potentially toxic, costly, petroleum-based protective coatings. The house is three stories and will ultimately have solar flat-plate collectors for heating and hot water.

Figure 9. An interior view of the Reed/Wright House.

Figure 10. The front of the masonry heater in the Reed/Wright home.

Figure 11. The water tank/heater is located on the third floor to allow for thermosiphoning of heated water from the masonry stove.

Next I'll do a little tour of the interior of the Reed/Wright house. Figure 9 is a view of the kitchen area, with the peninsula/breakfast bar, looking toward the southwest corner of the house. Figure 10 is a view of the very different style of masonry wood heater, which Jen designed and Ian and Dan Givens each built portions of. The centrally-located concrete facade has a standard firebrick and refractory firebox, but it is upright in orientation to provide a smaller footprint inside the home and to differentiate living spaces within the open floor plan. There is also a heat exchange water line embedded in the masonry stove for use as a water-heating coil. This coil is plumbed to a water tank on the third floor, which is shown in figure 11. This arrangement allows for thermosiphoning of water (circulating to the tank without a pump) as the water is heated by the masonry wood stove.

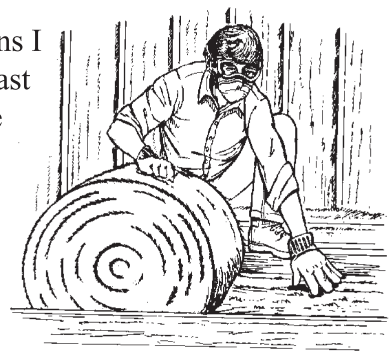
Additional home features include emphasizing use of local materials (river stones for masonry heater, spruce and birch for framing and finish materials), incorporating repurposed local industrial waste (scrap steel for exposed framing, fly ash concrete additive for foundation), using sustainably manufactured materials (cork and bamboo flooring) and choosing high-efficiency appliances, lighting, heat-recovery ventilation and toilets.

It is important to mention the different choices of insulations for all three homes. Wright chose urethane because he wanted, first and foremost, superbly insulated walls with minimal air leakage, but he also didn't want the walls to be inordinately thick, and he didn't want to pay for the shipping of structural insulated panels (SIPS), which he considered but rejected on the basis of cost for shipping. His choice of urethane was mostly determined by the fact that urethane can be compactly shipped and installed on site quickly and with good air sealing results. Chlupp chose cellulose for several reasons as well. First, it has the least embodied energy (meaning that it is very efficient to make) and is made of local materials within Alaska, and second, it has the additional virtue of adding useful heat capacity as mass for storage of heat to his home. Both of these homes have slabs for heat storage as well, as does the Kassel home. And all three use in-slab heating as an option, although the need for this seems to be unclear, and perhaps it is not all that useful in such houses. Its expense may not be worth it for houses that can use a masonry heater for the winter solstice heating needs, although distributing the heat from solar collection to an in-floor heating slab may be quite useful. These types of optimization and testing are what these brave home explorers are doing for the rest of us. They are using their skills, the sun and local materials to move toward that ultimate goal of heating without the need for ever-more expensive and problematic fossil fuels, while living in a healthy and beautiful space. We thank them for their efforts and look forward to discovering their insights.

Figure 12. Another exterior view of the Reed/Wright home. The home has fiberglass windows all around and one of the tilt-turn windows is open for ventilation (third floor) in this photo. Note also the vent/exhaust on the east side of the basement floor, which is for a Toyotomi fuel-oil-fired heater used for back-up heat. This is ultimately to be displaced to the degree possible by the solar collection of heat. The site also has many years supply of wood for the masonry stove, so that minimal fossil fuel will be needed.

AN UPDATE ON FEDERAL RENEWABLE ENERGY AND ENERGY CONSERVATION TAX CREDITS

By Rich Seifert



In many conversations I have had over the past several months, I have encountered much uncertainty and confusion about federal tax credits. Many are not sure what they are, whether they expire soon and what is available for this year and future years. Tax credits have indeed changed, with a new law passed in 2011. Following is a summary of the changes from the main cited web page (www.energystar.gov/index.cfm?c=tax_credits.tx_index).

This article is intended to give the very latest information for 2011 on these tax credits and their pending reductions or present terms (during which they will be in effect). It is important to know that several energy conservation tax credits have in fact changed this year and may be discontinued after 2011. Several, however, continue at the original rates established in 2009. Here are the changes due the 2010 federal act:

> On December 17, 2010, President Obama signed the Tax Relief, Unemployment Insurance Reauthorization, and Job Creation Act of 2010. This law extends the tax credits for energy efficiency into 2011, BUT at lower levels. The levels revert back to those in effect in 2006 and 2007, which were 10 percent of the cost of the improvement, up to $500, with a $200 max for windows, and with several other set maximums.

Highlights:

- $500 lifetime limit. If you got over $500 in these tax credits from 2006 to 2010, you are not eligible for anything more.
- 10 percent up to $500 for insulation, roofs and doors.
- Windows capped at $200, but qualification now ENERGY STAR.
- Furnace and boilers capped at $150, and all furnaces and boilers must meet 95 AFUE.
- $50 for advanced main air circulating fan.
- $300 for air conditioners, air source heat pumps, water heaters and biomass stoves.

Perhaps the most disconcerting of these changes is the first notice, that if you got a $500 tax credit for ANY purpose related to energy conservation or efficiency from 2006 through 2010, you are ineligible for any further tax credits. This is highly regrettable and negative, but it is the law now.

Here are further details describing what purchases and materials qualify for the 2011 year:

Tax Credit:

How much: 10 percent of cost up to $500 or a specific amount from $50 to $300.

Expires: December 31, 2011.

Details: Must be an existing home and your principal residence. New construction and rentals do not qualify.

Biomass Stoves

Biomass stoves burn biomass fuel to heat a home or heat water. Biomass fuel includes agricultural crops and trees, wood and wood waste and residues (including wood pellets), plants (including aquatic plants), grasses, residues and fibers.

Tax Credit Amount: $300.

Requirements: Thermal efficiency rating of at least 75 percent.

Gas, Propane or Oil Hot Water Boiler

These are heating units that use water circulated throughout the home in a system of baseboard heating units, radiators and/or in-floor radiant tubing.

Tax Credit Amount: $150.

Requirements: AFUE $\geq$ 95

Tax credit included installation costs.

www.energystar.gov/index.cfm?c=tax_credits.tx_definitions&dts=afue

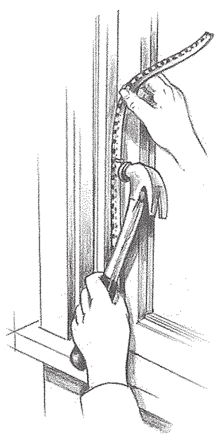
Insulation

Adding adequate insulation is one of the most cost-effective home improvements that you can do.

Tax Credit Amount: 10 percent of the cost, up to $500.

Requirements: Typical bulk insulation products — such as batts, rolls, blow-in fibers, rigid boards, expanding spray, and pour-in-place — can qualify.
Products that air seal (reduce air leaks) can also qualify, as long as they come with a Manufacturers Certification Statement. These include:

- Weather stripping
- Spray foam in a can, designed to air seal
- Caulk designed to air seal
- House wrap



Tax credit does NOT include installation costs, but you can install the insulation/home sealing yourself and get the credit.

Roofs (Metal and Asphalt)

Qualified roof products reflect more of the sun's rays, which can lower roof surface temperature by up to 100°F, decreasing the amount of heat transferred into your home.

Tax Credit Amount: 10 percent of the cost, up to $500.

Requirements: "Metal roofs with appropriate pigmented coatings" and "asphalt roofs with appropriate cooling granules" that also meet ENERGY STAR requirements.

Tax credit does NOT include installation costs.

Windows, Doors, Skylights

Energy efficient windows, doors and skylights can reduce energy bills.

Tax Credit Amount: 10 percent of the cost, up to $500, but windows are capped at $200.

Requirements: Must be ENERGY STAR qualified.

You do not have to replace all the windows/doors/skylights in your home to qualify. And it doesn't need to be a replacement either — installing a new window where there wasn't one previously (like in an addition) qualifies.

Tax credit does NOT include installation costs.

Geothermal Heat Pumps

Geothermal heat pumps are similar to ordinary heat pumps but use the ground instead of outside air to provide heating, air conditioning and, in most cases, hot water. Because they use the earth's natural heat, they are among the most efficient and comfortable heating and cooling technologies currently available.

Requirements:

Closed Loop: EER ≥ 14.1; COP ≥ 3.3
Open Loop: EER ≥ 16.2; COP ≥ 3.6
Direct Expansion: EER ≥ 15; COP ≥ 3.5

Tax credit includes installation costs. (Editor's note: These COPs are high and would be difficult to achieve in Alaska.)

Finally the solar tax credits have remained the same and will continue until 2016 (at least that is the plan at present).

Solar Energy Systems

How much: 30 percent of the cost, up to $500 per .5 kW of power capacity.

Expires: December 31, 2016.

Details: Existing homes and new construction qualify. Must be your principal residence. Rentals and second homes do not qualify.

All this information is from the previously cited web page, and its source is the ENERGY STAR web page of the federal government, a collaborative project of the U.S. Department of Energy and the Environmental Protection Agency. It is intended to clarify the coverage and rates for the federal tax credits as they presently exist for 2011. Stay tuned for things to change.

ONE PLANET ONE PLANET VISION

Tools and inspiration to help you create a sustainable future

One Planet Vision is a website from BioRegional that provides tools and inspiration to help companies, organizations and individuals use the One Planet Living framework (www.oneplanetvision.org) to live and work within a fair share of the earth's resources. The site is filled with real life case studies and useful free tools like our One Planet Action Plan sustainability toolkit for businesses and ecological footprint calculator for individuals.

THE 10 PRINCIPLES

The ten principles of one planet living are a framework to help us enjoy a high quality of life within a fair share of the earth's resources:

1. Zero carbon
Making buildings more energy efficient and delivering all energy with renewable technologies.

2. Zero waste
Reducing waste arisings, reusing where possible, and ultimately sending zero waste to landfill.

3. Sustainable transport
Encouraging low carbon modes of transport to reduce emissions, reducing the need to travel.

4. Sustainable materials
Using sustainable products that have a low embodied energy.

5. Local and sustainable food
Choosing low impact, local, seasonal and organic diets and reducing food waste.

6. Sustainable water
Using water more efficiently in buildings and in the products we buy; tackling local flooding and water course pollution.

7. Land and wildlife
Protecting and expanding old habitats and creating new space for wildlife.

8. Culture and heritage
Reviving local identity and wisdom; support for, and participation in, the arts.

9. Equity and local economy
Inclusive, empowering workplaces with equitable pay; support for local communities and fair trade.

10. Health and happiness
Encouraging active, sociable, meaningful lives to promote good health and well being.