Design Considerations for Sustainable Housing: The Snug Home

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Energy considerations in housing

- The issues are real, the costs are high, and Mother Nature is not pleased with our wasteful habits!
- It's possible to build much better houses that are easy on the environment, easy on the pocketbook, are very comfortable to live in, and last a long time.
- The Snug House is one of these.

This house in Northern New York cost $40,000 to build. Its annual heating bill is $100!

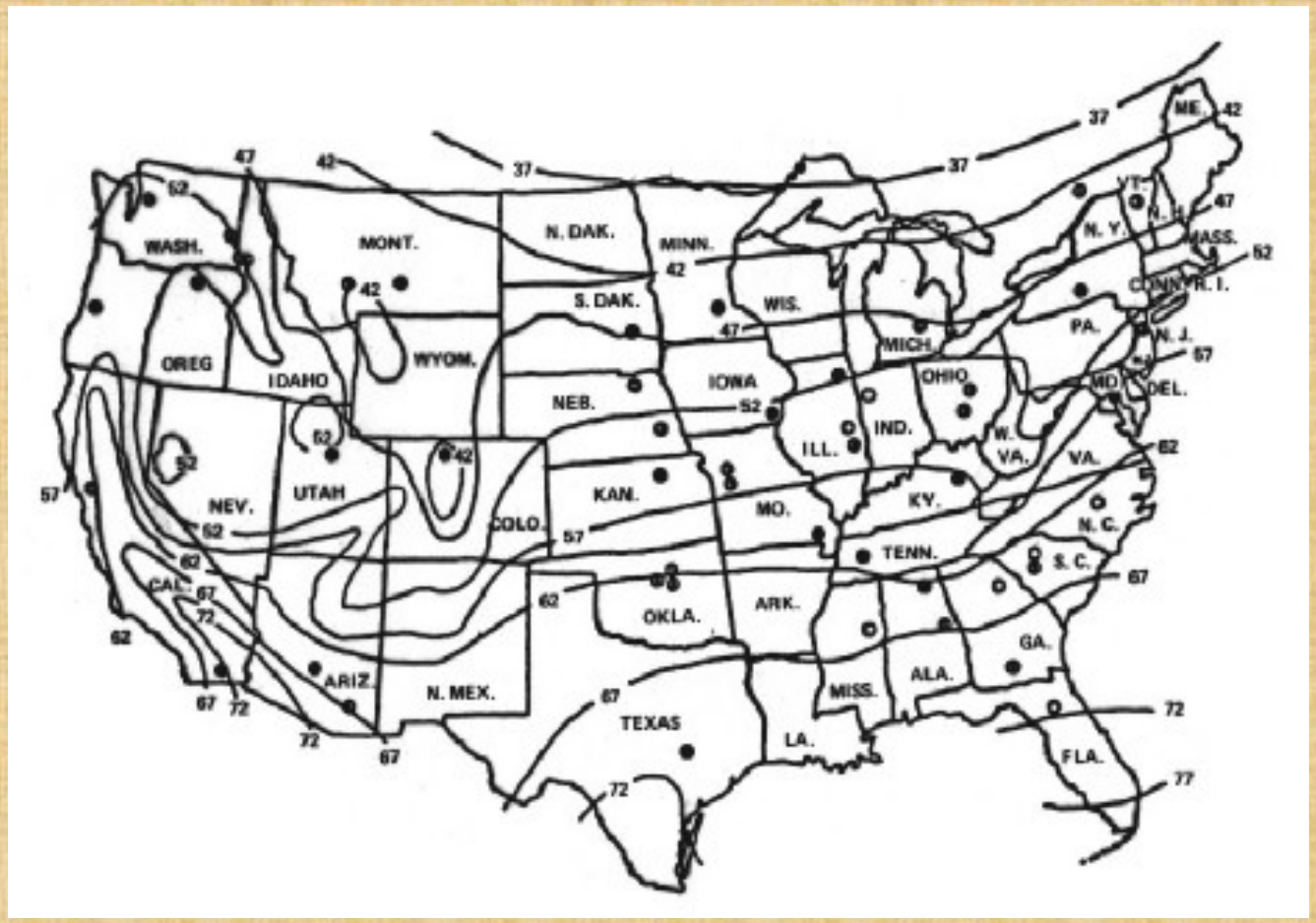
With no heat, this house doesn't go below 50°F when it's well below zero outside. Owner built for $25,000.

This house burns a cord of wood for the whole winter. (Paul Howells home, first “snug home” ever built)

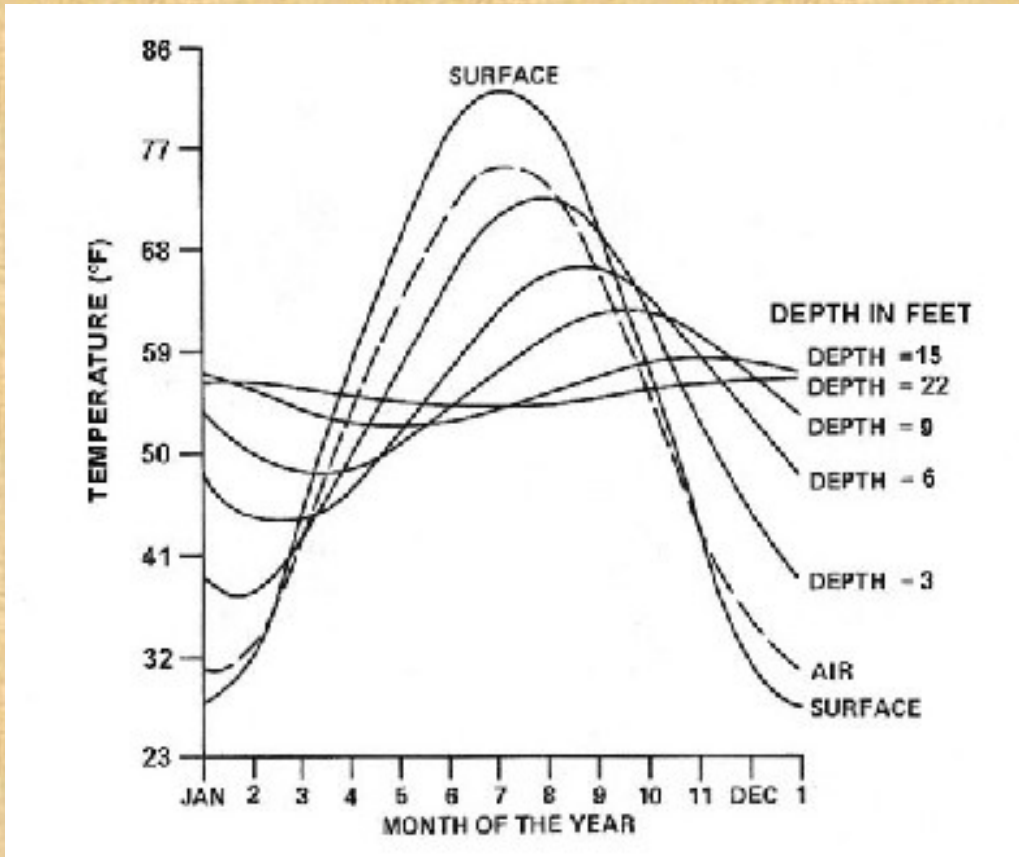
How do these homes work?

- They are coupled to the earth--and decoupled from the earth around them.
- They are super insulated with cellulose or fiberglass, sometimes both
- They are carefully air sealed with a continuous air tight vapor barrier.
- They utilize pole barn construction techniques, so they are fast, easy, and inexpensive to build.
- Consistent with adobe-style construction.

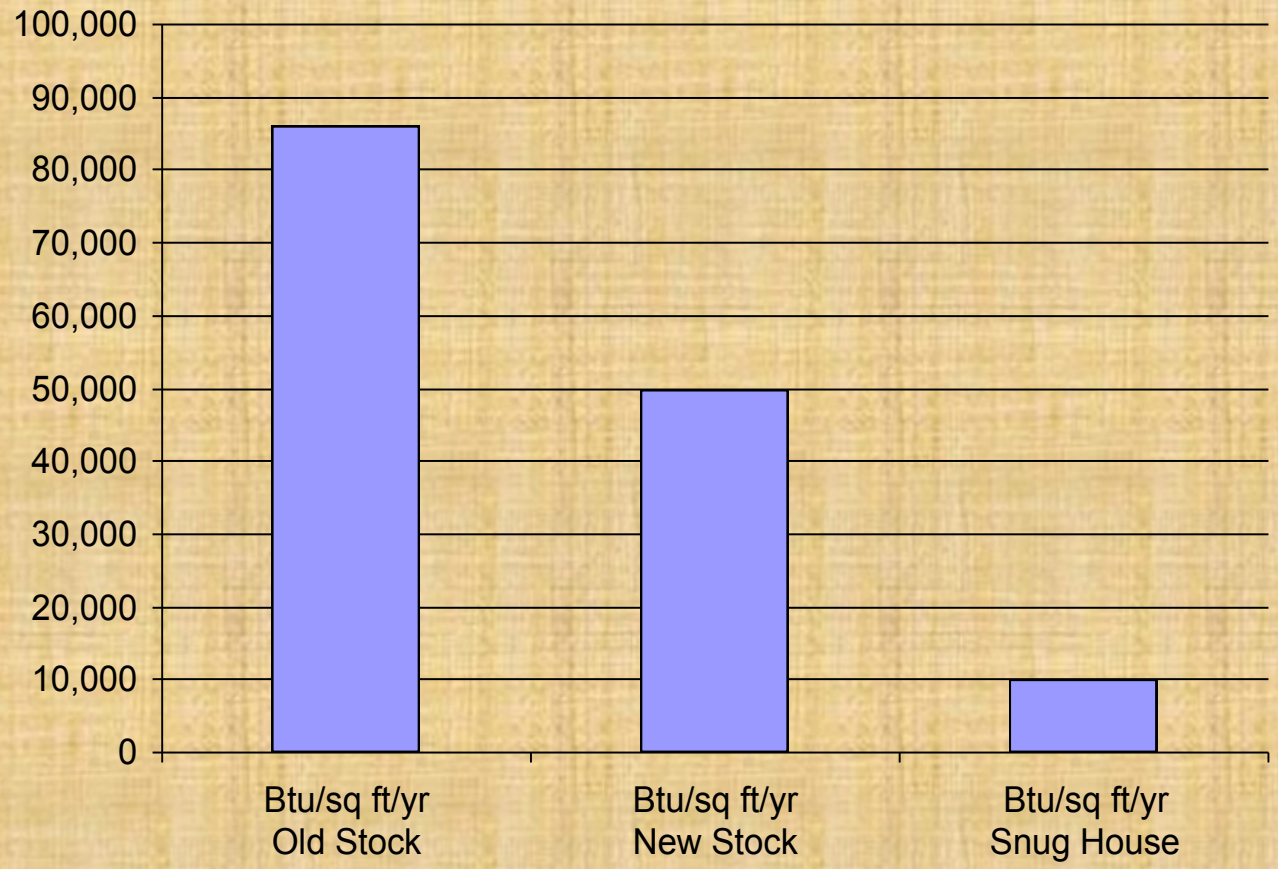
Deep earth temperatures in the US (Denver/Boulder is around 52°F, the average annual temperature)



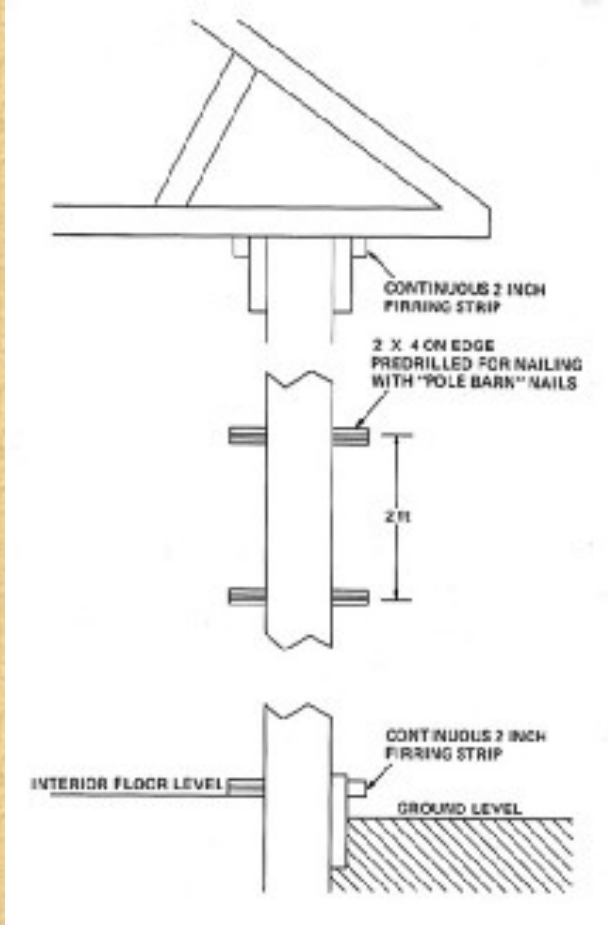
Surface temperatures follow air temperatures. As depth increases, seasonal variations decrease and approach average annual air temperatures.

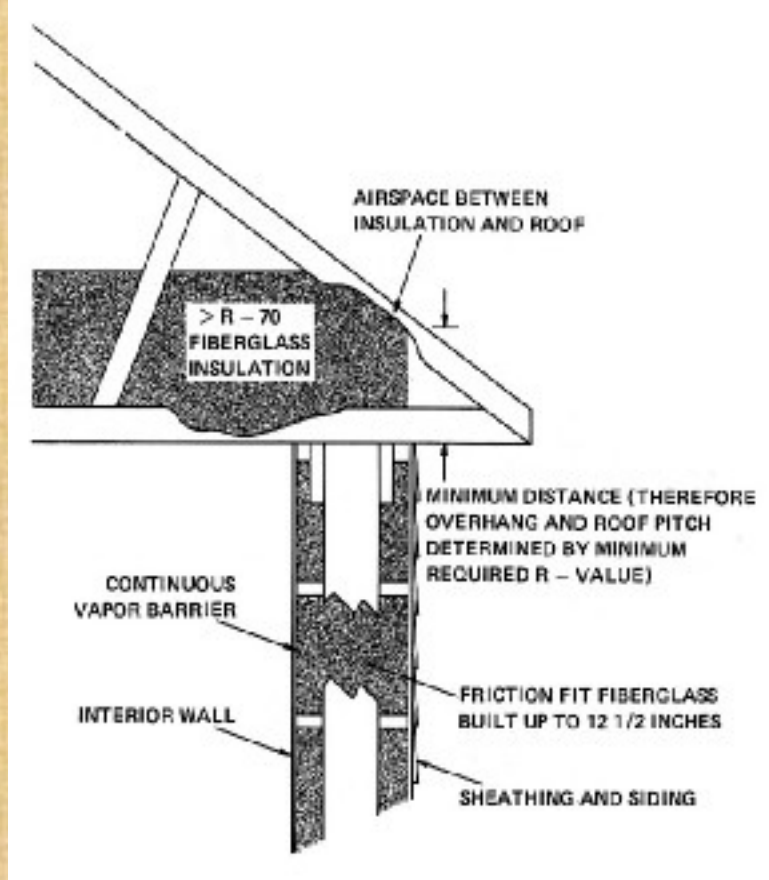


Annual energy consumption for Denver area climate and housing stock

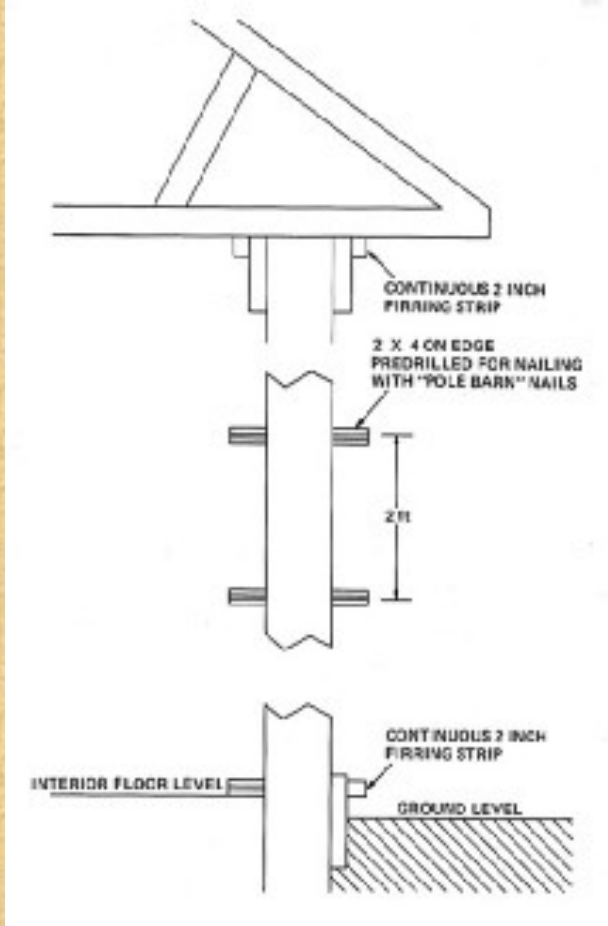


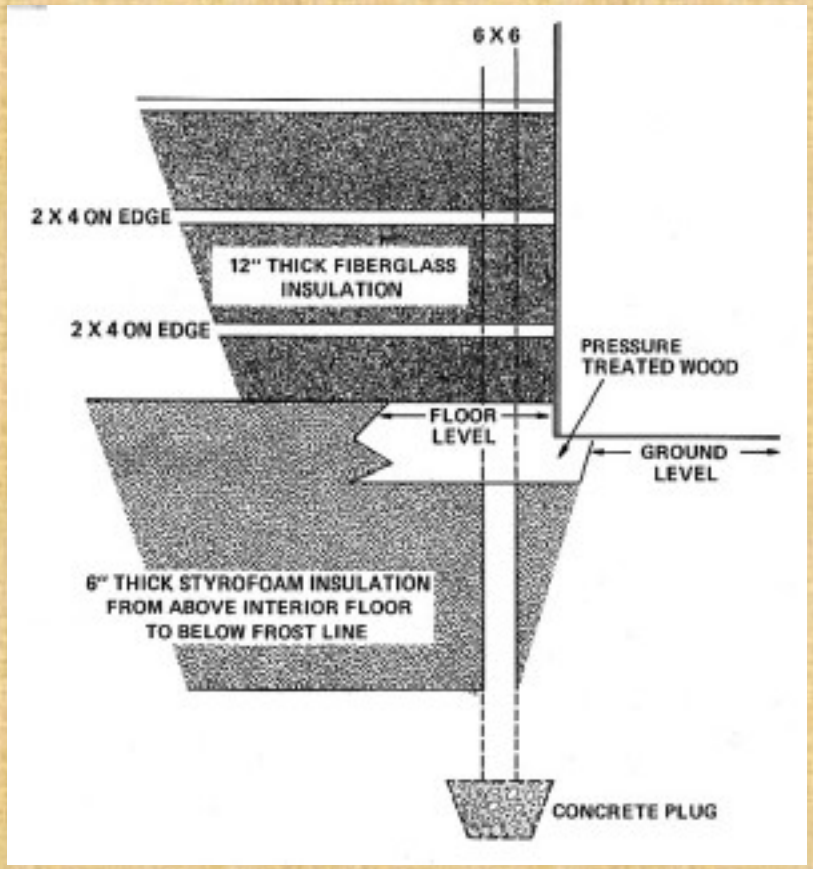
Section details: cellulose, fiberglass, urethane, or other insulations can be used in tandem to good effect





Foundation details. 6 x 6 poles are on 8 foot centers; concrete slab poured to top edge of closed-cell styrofoam (blue board™)





Structure underway. Computer-designed trusses make for fast work, ability to handle large snow loads.

Earth coupling detail

- This home uses 2x4s on flat edge
- Six inch thick blue board a full 4 feet into ground
- Bottom 2x4 plus back fill holds insulation in place for concrete pour

Concrete pour underway. Note continuous vapor barrier--solves moisture, radon, and air flow problems.

Vapor barrier: Key element in minimizing convective losses

- Vapor barrier can be installed between inner 2x4s and poles.
- This option allows for free installation of wiring, ventilation ducts, and piping.
- Then R-11 batts are installed before dry wall.

Window strategy

- Windows chosen for view and daylighting
- Not too many, but high-quality, double glazed with low-e coating or triple glazed windows best
- Exterior overhangs on south and west-facing facades prevent overheating

Thick walls leave room for plants and stereo speakers on window ledges

Small, airtight wood stove heats 1100 square foot home in cold climate. Interior brick wall provides useful thermal mass to modulate heat from stove.

Simple, attractive finish work

Interior decoration is as you like it

Attached greenhouse with dog. Greenhouse snuggles next to main house on two sides. St Bernards (and some people) produce 400 Btus per hour even while napping!

West elevation of country home with attached garage. Porch overhang limits glare until shortly before sunset.

Earth coupling enhances summertime performance, too. All of the virtues of a cave without the shortcomings of living under ground!

Passive solar addition to an existing snug home/machine shop

Tyvek™ on the outside helps, but the vapor barrier does the real work of limiting convective losses

The finished product

Owner built; very comfortable and charming home

Ventilation: two general choices

- Simple system with traditional bathroom and kitchen fans
- Low velocity adequate
- Use passive inlets
- Combustion air supply (with damper) for wood stove

- Heat recovery ventilator most elegant system
- Controlled to come on when using bathrooms, cooking, when humidity is high, or manually (with a wind-up timer)
- Combustion air supply (with damper) for wood stove

Radiant heating

- Radiant space conditioning via pipes imbedded in floor; alternatively in wall or ceiling panels
- Solves awkward distribution problems, consistent with overall simplicity of the house system
- If radiant floor, will need modest insulation beneath
- Baseboard convectors the least expensive option
- Excellent comfort and efficiency at relatively low supply water temperatures for radiant; a bit higher for convectors
- Individual control of spaces simple and inexpensive
- Small gas-fired boiler or (better) active solar can provide both space heat and domestic hot water
- District heating is another promising option for a group of homes in the same vicinity

District heating

- Tribal or neighborhood community, solar heating (with efficient gas boilers for back up)
- Super insulated piping to each dwelling, where heat exchangers supply domestic hot water and and space heating
- Simple energy metering at each house
- More cost effective to build and run
- True Green community!

Case study: a shed above Boulder, Colorado

- Applied the principles of the snug home to a 160 ft^2 shed in the mountains above Boulder, Colorado, heating degree days about 6500
- Structure has 8 square feet of south facing glazing, uses rough cut lumber and recycled door and window.
- Proved that a well insulated, very tight structure coupled to the earth will not go below freezing even with no internal heat

Job just begun, poles going into holes 4 feet deep on stone. (Poles treated with mix of paraffin and linseed oil in a base of turpentine)

Poles up; checking alignment with a surveyor's instrument

Progress after 18 person hours of labor (on right)

Styrofoam “blue board” around the perimeter ensures that the structure is coupled to deep earth and isolated from near-surface variations of the season. The slab is poured to the top of the blue board. Cellulose blown into the walls is in direct contact with the perimeter insulation, so there is no thermal bridging.

Perimeter insulation showing temperature sensors (thermocouples) in and out

Oriented strand board (OSB), which is light on the environment, is both glued and power nailed. Wheat board will also work.

Lining inside with reinforced 8 mil plastic. Will be power stapled later in preparation for blowing cellulose

Compressor-driven stapler drives in inch-wide staples, tightens plastic to frame

A small tube (1.5 inches od) is used to snake through a hole x'ed into the plastic. This ensures complete coverage with high-density cellulose. The result is excellent insulation and virtually no infiltration

Plastic is left over outlets and switches until covers are installed, then it's trimmed with a utility knife

Metal roof and cement board siding make structure fire resistant. Insulating doors; one trash picked, the other fabricated with 2 inches of blue board, cement board

Front view of final product. Frames with net keep deer from eating flowers. The blue frog is mostly harmless.

Back view of final product. Note 3 foot berm and water catchment system. Virginia creeper forthcoming!

Monitoring results

- Monitored temperatures at one foot intervals underground in and outside of structure, as well as oat and iat.
- Distribution as envisioned; iat never went below freezing in spite of oat temps at – 8 ºF.
- Heated with small electric resistance heater in mid winter; maintained 72 ºF iat.
- Measured 1 Btu/ft^2/HDD. About 15% of best new construction.

In summary…

- The snug house concept is broadly applicable to lots of housing designs
- It lends itself to the adoption of locally-available material and architectural styles like adobe or even logs
- It's very energy efficient, comfortable, solid, and long lasting
- It's easier to build and costs less than conventional housing or straw bale (and works much better)

Demo project anyone?

- Would love to combine the technique with such building blocks as Rastra™ (see www.rastra.com).
- Coupled with insulating shutters and innovative daylighting designs, could approach a truly zero energy home that's very comfortable and long lasting.

Option for treating wood for pole barns and similar structures

- TimberSIL is a product that combines wood and glass.
- Longer lasting than other treatment products and much easier on the environment.
- See www.timbersilwood.com

Feedback is most welcome

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