Down the p2z on Ronsman Road

Wm Hurrle

The situation

The city of Green Bay used its power of condemnation to create a vision corner at the entrance to its new University Heights business park on Highway 54. It took out our old, red barn. My work shop was in it, chickens and sheep, too. The turn lane into the 'park' added beside the highway cut down shielding trees and brought highway traffic damn near into the kitchen. Our 1897 brick farm house was doomed to be an orphan agricultural remnant in a sodium-vapor lit, gravel-dusted 'park,' acres covered with blank-sided steel boxes. Time to move on.

Design goals for the new place

- No mortgage, no bills, stay put. We are on the cusp of retirement's limited cash flows, seldom robust at best. The city's payout was enough to buy 2.5 A. of industrial farm field in the New Franken – Bay Settlement 'hood we've had property in for decades.
- Build a small farm's house, a homestead like the old place, maybe a doomstead, which fits with the agricultural work of the area and our Northern Tier climate.
- Peak oil is happening. The house has to be well down the path to zero (p2z) fossil carbon, has to anticipate the after culture, after the Oil Era. By 2050 the garage will be a stable and being C-neutral the law.
- Balance energy demand and supply by system integrations. Conserve capital.
- In turmoil attendant upon peak oil, the house may become a refuge for extended family. The spaces have to stretch to accommodate three family groups, to house enough people to work the gardens.
- Keep it simple, green, easy to maintain and resilient.
- Don't overspend; do a lot of it myself (and still doing).
- Go for the architecture of happiness, www.patternlanguage.com.

The process

- Let energy be the knife that shapes. That means lowering the surface to volume ratio, stressing air tightness, balancing insulation around the shell, heat recovery ventilation, passive solar design, active solar for hot water and heat, and photovoltaics (pv) to cover electrical demands. Efficiency—defense—first, solar gain second with a wood stove as backup and last, fossil carbon.
- Let the use of the inside spaces much shape the outward form. How it looks follows how it lives.
- Use Focus on Energy's, www.focusonenergy.com, Wisconsin Energy Star Homes (WESH) standards, Build America's Optimum Value Engineering, renewable energy rewards, federal tax credits, and program approved contractors.
- Focus on the comfort results of energy design solutions. It's as much about keeping us comfortable as it is about reducing energy use.

- Use common materials and construction methods shaped by building science's, www.buildingscience.com, understanding of vapor transmission and pressure diagnostics.
- Use the usual builder, which was Barton Designs, sub-contractor arrangements.

The results

Looking from the southwest, the house is two flattened cubes, 40'x 40', jammed together at a corner with rooms over the garage, 2,869 sf. The front corners of the southern part are cut off to reduce area, to follow the sun, and to let us live in a circular environment. There is a small crawl space for mechanicals and to hide in from bad wind. No basement. It is built on a slab supported by a frost wall.

The roof is metal, light colored for reflectance and with high emissivity. We don't have air conditioning. It doesn't get above 78 degrees in summer. Efficiency keeps heat out as well as it keeps it in. The raised seam roof above garage bonus rooms and a shop slopes at 45 degrees and has 2.7 kW of Uni Solar's thin film photovoltaic modules laminated on it; grid tied, no batteries, yet. Over the last 18 months production averaged 324 kWh-m. We use more but net zero is within reach, e.g. replace the energy hog 'fridge. On a good day we harvest and share over 17 kWh.

The walls are 2x6, 24" o.c. framed with the tricks of Building America's Optimum Value Engineering, ½" chip board sheathes, 1" of xps exolates, and local eastern white cedar, stood off ½" clads the building. Insulation is cellulose, wall R-value is R-25, R-50 cellulose is in the attic, R-20 xps on the slab edge and under it. The radiant slab is powered by a solar hot water system backed by a condensing, modulating LP boiler with outside air temperature reset. Fin-tube baseboard radiators deliver heat to rooms upstairs.

Delivery of a Solar Mine thermal collector. In a couple hours the crane and two guys set it at 60 degrees to max winter gain on a south-facing ground mount behind the house. The system is sized to meet needs on a normal, sunny winter day. Four, 10 W pv panels, hard to see on the far left, power a pressurized propylene glycol/water loop with a dc pump. Sunshine is the on/off switch. The solar loop first goes from the collector through an 85 gallon domestic hot water pre heat tank. In winter it then goes through a 200 gallon tank (via heat exchangers, the fluids don't mix) that stores heat for in-slab, low-temperature, hydronic heating, or, in summer, through a shunt loop on the frost wall's footing. A sausage of warmth circles the house's feet as it heads into winter.

Our feet are on a warm floor. With the thermostat set at 68, we are in the presence of comfort. It is ruled by the mean radiant temperature more than any other factor, a radiant 68 is perceived as comfortable as 72.8 degrees. All surfaces around us are warm. When the sun shines we bask in its 200 Btu/sf-h, 10 a.m.– 2 p.m. at winter solstice, increasing with day length, but warmth is there, sun up to sun down, if direct-beam power isn't. When clouds and deep cold rule, we light the wood stove, efficient, clean—it burns the smoke—and luxuriate in its radiant glow.

Wood isn't free, I was its slave at the old house, and harvesting solar energy has capital and maintenance costs, but wood is local, renewable, and sunshine a birthright. When daily life is supported by nature's energy flows, dependent connection to corporations and governments fades, and bonding with Mother Earth and all creatures who live by the sun grows. Pollution from Green Bay reduces afternoon insolation when west winds blow its cruddy air over us. As fossil carbon scarcity rearranges the polycon, our local sun power will increase. (Forgive the coinage, political-economy, polycon.)

Wisconsin's uniform dwelling code is ahead of the 'third world' states', but it is a minimum that lags behind the speed of carbon's monetization. WESH standards enable a high performance shell. The Ronsman Rd. house is a step farther down the continuum to a carbon neutral house. It is a near zero house, a 26 HERS (home energy rating score by Energy Star's *REMRate* software). Zero is best, 100 is code.

Propane burns to heat domestic hot water the sun hasn't, to dry clothes when they can't be hung out, and to cook. Space heat needs in the room over the garage sometimes call for LP boiler heat. Downstairs, and any time there is sun or wood heat, it doesn't fire.

On a 25 degree, cloudy winter day the house is heated by its own metabolism. Electrical use comes off as heat in the end, about 1,850 Btuh. The heat loss off the water tanks, about 1,650 Btuh, the critters' 1,000 Btuh, and diffuse sunlight through windows warms the house. Before bed, build a fire in the wood stove. In the middle of the night, add two pieces of stove wood. Repeat, four pieces per cloudy day.

On a sunny day the house stabilizes at 10 degrees or less outside. Passive gains keep the house at 69-73 degrees. There is enough heat in the 200 gal tank to carry us through the night, but on cold nights I build a fire, which takes care of downstairs and stored solar energy heats upstairs. (I'm still learning how to operate the place, and think I reflexively over burn wood.) The house has good thermal momentum, holding a temperature for 12-14 hours without fossil- or current-carbon inputs, dropping two degrees overnight when there isn't a fire.

By mid February we burned a cord of wood. We use about a gallon of LP-d to cook, dry clothes, and back up domestic hot water and heating. It's been a poor solar winter, too, lots of cloudy days. Usually 50% are sunny once we hit January. November and December are the worst, seeing maybe a third of potential sunshine hours.

Living in day light keeps spirits bright. No winter blues, seasonal affective disorder, for us. The house faces 10 degrees east of south to wake it warm on winter

mornings and to duck some summer afternoon heat when the sun hangs in the western sky. The 6% of floor area in south facing glass provides about 25% of winter heat needs. Glazing coatings are selected for direction. All have U-values around 0.30, but some are heat blockers, some heat gainers that let in energy. Every day we watch the drama of the sun arcing through the sky.

Passive design also means that an insulated garage and the outbuildings are on the north, tempering one side of the house's exposure, shucking winter winds. Landscaping, much of it edible, grows in permaculture patterning to further adjust micro climates.

Ventilation is by a Venmar heat recovery ventilator (HRV), about 75% efficient at exchanging energy, 73 cfm, 24/7, and spot ventilation by low-sone Panasonic bath fans and a range hood. There are designed holes, but no undesigned holes in the building shell.

Comparatives

Wisconsin builders are good, and good gets in the way of better. Everyone does 2x6 walls, attic insulation, efficient furnaces, and decent windows. Tightness averages 0.23 ACH (air changes per hour, measured with blower door technology). The number is a snapshot of over 100 spec homes. WESH homes average 0.14 ACH with the best 0.05 ACH and less. Ronsman measures 0.08 ACH. Air tightness is the most critical factor in building efficiency. The mantra: build it tight and ventilate it right.

Builder average 'mpg' for houses is around 3.5 Btu/sf-dd, British thermal units per square foot of heated space per degree day, a measure of how cold it's been. WESH homes cluster 2.5-3.0 Btu/sf-dd. Ronsman models at 1.9 Btu/sf-dd, the best at 0.7 Btu/sf-dd. The most telling number is Btu/sf(shell)-dd, however, and there Ronsman does okay, 0.59 Btu/sf(shell)-dd. The bonus room above the garage is a surface to volume penalty stroke. A Btu is about the heat in a wooden match, one heats 1 lb of water 1 degree F. A degree day is the difference between 65 degrees and the average outside temperature. We need to deal with about 5,500 of them in Cape Twisco.

Costs

The 2.7 kW pv system cost $20,000. PV runs $8-$10/W. Focus on Energy gave $10,000; federal tax credits, $2,000. The system is warranted for 20 years at 80% of power. It made over 3,600 kWh its first year, say 20 years x 3,000 kWh-a = 60,000 kWh for $8,000, that's $0.13/kWh. We bought electricity in bulk, up front for a fixed cost. The meter spins both ways at retail.

WPS (Wisconsin Public Service, the regional utility) is working on a new time of use deal; the PSC may order all utilities to do as WE, $0.22/pv kWh, and MG&E (other Wisconsin utilities), $0.25/pv kWh. With either plan, the numbers will look even better. The National Association of Realtors estimates every $1 reduction in utility bills translates into a $20 increase in the value of the house. It hasn't yet figured out what every dollar in energy production capacity will add to a home's value. The next step is a home that produces all the energy it uses, and beyond that one that produces enough to also offset energy embodied in it.

Carbon taxes are in legislative hoppers, poised for a 20-year ramp up. The trading unit is a tonne CO_2, a metric tonne, 2,205 lbs CO_2 equivalents, which include other greenhouse gases. People exercised by global warming such as Lester R. Brown, www.earthpolicy.org, want a $240/T C-tax, and many talk $20-$40/T. On the EU exchange a tonne avoided sells for about $30. Manufacturing a kWh releases about 2.0 lb

CO_2. Figure your liability: 650 kWh-m x 2.0 lb CO_2/ x $100/T, another $60-m on the bill and more money leaving the local economy.

At the February Energy Design Conference in Duluth, Kevin Coleman, Madison Environmental Group, laid out these CO_2 numbers, referencing DOE and USEIA:

Natural Gas	11.0 lb CO_2/therm
Propane	12.7 lb CO_2/gal
Heating Oil	26.0 lb CO_2/gal
Gasoline	19.6 lb/gal; life cycle, 24.3 lb CO_2/gal
Diesel	22.4 lb/gal; " " , 26.6 " " "
Ethanol	14.6 lb CO_2/gal, life cycle
Biodiesel	5.8 lb CO_2/gal, " "
Electricity	2.0 lb CO_2/kWh, the coal-gen Midwest average
Spend $1	0.5 lb CO_2

The solar thermal system has similar numbers: $15,000 up front, about $8,000 after the deals. (They change often. Solar thermal systems cost $75-$100/sf-collector.) The collector sees about 84 MMBtu-a incident on it and harvests maybe half that. Propane is $2.20/gal now or $24/MMBtu (MM, thousand thousand, i.e. a million. Fuel comparisons are done in MMBtu units.) Collectors and plumbing last a long time, easily 25 years x 42 MMBtu-a x $24/ = $25,200 of energy, figured at today's low price. If it generates $1,000 worth of LP in '08 and LP inflates at 7%-a, in its 25th year that will be $5,425 worth, if it is still available then. Great confusion between price and cost, too.

Finishing details continue to add to the total, but the house is typical for a custom home running in the $140/sf range, land and other improvements such as the well and septic system included.

Peak oil

But it isn't about price. Petroleum geologists say we are at peak oil, www.peakoil.net and www.postcarboncities.net. (Readers operating from alternative realities should start with www.bartlett.house.gov. Go to 'issues' follow to 'peak oil.' Roscoe, 80 years old, R-MD, is chair of the House Peak Oil Caucus, a voice to trust.)

Demand exceeds supply which will never be much more than recent years' 85-86 mbd, and those who control supply are only interested in keeping the market tight, in maximizing profit. This includes not letting the wheels of their customer's polycons fly off. Boiling the frog is the model. Predicting the shape of the decline's curve is inexact. The best we can do is to keep it as flat as possible and hope the many hazards to that don't dominate. There is no way to stop its downward direction.

No Tinkerbelle technology fixes, no magic 'free' market reversals of the entropy law are possible. Scarcity returns. Natural gas supplies in North America can rapidly become problematic, predicting when is less sure than peak oil. But similar mechanisms are at work, production peaked here years ago, discovery lags demand, and prices are already onerous, plant-closers for some industries. Fertilizer prices, natural gas is the feedstock, have tripled in a few years, ask a farmer. Fossil carbon is a one-way street, it goes up hill, and is a dead end.

Renewables don't remotely scale to replace fossil carbon in our polycon. Meta historic changes—a potentially brutal end to a destructive culture of competition, consumption and privatism, i.e. our now global civilization—is coming soon if you

believe people whose business it is to know the numbers. See www.dieoff.org, the usual fate of a species that exceeds its food supply, and we eat carbon. Powering down and re-powering with renewables (corn ethanol is jive, nukes, too, expressions of our predatory oligarchy's swindling power, not sense) ASAP is the sanest path. Cooperative community solutions—re-localizations—are the best way to manage the transition and hope to maintain civil order and an open, free society, www.communitysolution.org.

Opportunity for improvement in residential energy use lies in the accumulation of small things that heretofore have not been seen as important—or not been seen at all. Efficiency in water use is as required as thermal efficiency and green, recyclable/biodegradable building materials. We are a lot closer to a green, self-sufficient, carbon-neutral house than we think, and our houses produce far more green house gases than our vehicles. The Ronsman house is more cabin than castle. It's for use, not show. With an office, studio, mechanical room/laundry, and shop a third of the space is for production, and everything gardens in the household's bioeconomy.

Specifications

- HERS 26
- 2,869 sf-heated floor, 8,213 sf-shell surface, 25,203 cf volume, 3,898 sf enclosed
- Design load 29.5 kBtuh, annual heating use 40.4 MMBtu, 56.7 MMBtu-a, total
- Infiltration 590 cfm50, 1.4 ACH50, 0.08 cfm50/sf(shell)
- Heating intensity, 1.9 Btu/sf(floor)-dd, 0.59 Btu/sf(shell)-dd
- 2.7 kW of thin film pv laminates, grid tied
- 192 sf of solar thermal collector for hot water and space heat
- EPA-okay wood stove, 25 kBtuh
- CO_2 emissions, 4 T-a, estimated. Wisconsin residential average, 18 T-a.

Improvements for the next house

- A wet back on the bioburner to heat water when the sun doesn't. The solar thermal and wood heat storage systems would be integrated, routine in New Zealand. Wood is where sunshine is reliably stored in Wisconsin winters.
- Insulation levels appropriate to a carbon constrained world are R-20 below grade, R-40 above grade, R-60 in the attic and less than 1.0 ACH50, air changes per hour at 50 Pascals depressurization, i.e. blower door tested. EU *passivhaus* standards are even tighter, 0.6 ACH50. The next house's walls will be R-40, and it will be tighter.
- A GFX heat exchanger on the stand pipe. Gravity film heat exchangers are copper tubes with a flattened 3/4" copper pipe wound around them. They replace a section of the plumbing final waste pipe. Cold water flows in the ¾" pipe as warm, grey water swirls down the inside of the big tube, www.power-pipe.com.
- A 95% efficient EU HRV, not on the US market, yet.
- Larger surface radiators for rooms not heated by the slab. The fin-tubes are made for high-temperature, 140-180 degree, water. The slab set point is 68 degrees. Solar in December's short days makes 90-100 degrees in storage tanks, sized 1.0-1.5 gal/sf-collector, and Ronsman's are at the higher end of that. Larger surface area radiators would deliver more heat at solar's lower temps than the fin tubes.

- Go for more LED lights as they come on the market and for other appliance efficiency gains, ranked at www.energystar.com. They ever improve.
- Use R-10 xps on the exterior of the frost wall instead of R-5, which can't be easily flattened against the concrete, stuff always gets behind it; thus air.
- Put a solar thermal shunt loop on the footing inside the frost wall as well as outside, a controllable test of annual tempering, perhaps annual storage.
- Incorporate a heat exchanger in the ventilation air exhaust to boost domestic HW. Put a loop of pex tube on the outside of the footing trench to use for summer cooling in ventilation air. Hardware to do this is on the EU market now.
- Have one dual-flush and one composting toilet.
- Garages belong on the north side, but snow/ice dump off the roofs is a winter problem. Use a bituminous, not concrete, apron and roof diverters if possible. Besides shoveling the problem is frost heave where there is extra wetting.

Books at the building

- *Wisconsin Uniform Dwelling Code: Commentary* edn., hard copy from Document Sales, 800-362-7253, about $25, digital free, www.legis.state.wi.us/rsb/code.
- *Builder's Guide: Cold Climate* edn., Joe Lstiburek, a presenter the Energy Center of Wisconsin tours around the state, incisive applied physics. Lots of building section drawings. Get the book from www.eeba.org. Go to 'bookstore', about $35. It's the bible of building science and no safe, durable progress can be made without incorporating its knowledge.
- *The Passive Solar Energy Book*, Edward Mazria, 1979, Rodale Press, ISBN 0-87857-238-4 hardcover. It is out of print but can be found in soft cover, hard and an Expanded Professional Edition which has many tables.
- *A Pattern Language*, ed. Christopher Alexander, Oxford University Press, 1977, 1,171 pg., ISBN 0-19-501919-9, expensive. Libraries have it. Why we build what we do, through history and across cultures, boiled down into a few hundred related groups of patterns from the "distribution of towns", "structure follows social spaces", to "light on two sides of every room," and "child caves." It is not great on energy, but organizes design.

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