Photo: © Jim Westphalen

No Fossil Fuels Here

BY RYAN HARB AND SIMI HOQUE

The most economical path to zero net energy is "to use the passive energy of the sun and supplement the remaining energy needed with renewable energy, which in our case, is wind," says David Pill, Vermont's greenest homeowner.

"The key is to understand that you need to use all the passive strategies you can before using any renewables. We used the sun for passive heating and daylighting and we used the earth for the ground source heat pump." Pill said.

"If we had not captured that passive energy, the wind energy would never have covered our basic energy needs," he said.

Pill and his wife, Hillary Maharam, of Pill-Maharam Architects, are this year's winners of the Northeast Sustainable Energy Association (NESEA) Net Zero Energy Competition. Pill's 2,800 square foot residence, located in Charlotte, VT, generates more energy than it consumes. Originally, the couple set out to create a living space for their family of four that had as little environmental impact as possible. Now, they reside in Vermont's first LEED Platinum-rated house—the highest rating attainable from the US Green Building Council. The home is also Energy Star® rated (5+ Star with a HERS rating of 0) and is Vermont Builds Greener certified.

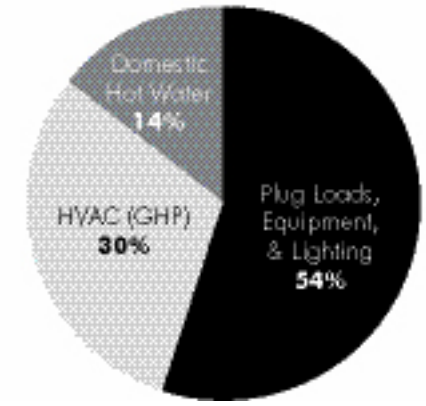
A Model for Green Homes

Vermont is known for its especially unforgiving winters and conventional wisdom says it's impossible to heat a house in the Green Mountain State without burning fossil fuels. Pill sought to prove otherwise.

"Since you cannot take back CO_2 and pollutants emitted into the atmosphere by burning fossil fuels and transporting them to your house, we made a firm decision not to use any fossil fuels on site," wrote Pill in his award submission. The result was an all-electric house in which all appliances, for cooking, heating and domestic hot water, are powered by a renewable energy source: the wind.

A Bergey 10 kilowatt net-metered wind turbine generates enough electricity to power all appliances, lighting, heating, and hot water. Using Energy 10 software,

Building Electrical Use by Load Type



energy consultant Andy Shapiro estimated that 6500 kWh were needed per year to achieve net zero energy status. Photovoltaics would have cost $45,000 after rebates to produce that much energy. For wind, it was just $28,500 after rebates, a savings of approximately $16,500.

To further reduce his impact, Pill chose a [3 ton] Econair ground source heat pump rather than a conventional hydronic or forced hot air system. The ground source heat pump extracts water from a nearby well and heats it in one of two storage tanks. From there, the water circulates throughout the house as part of the radiant floor heating system. "The radiant floor makes a huge difference," says Pill. "We keep the thermostat between 61 and 66 in the winter."

A passive solar design helps maximize energy efficiency through a variety of techniques. The house faces true south to obtain optimal sunlight on a daily basis. The first floor has a 4" concrete slab for thermal mass. Second floor window overhangs and a light-colored exterior prevent overheating during the summer. There is no need for artificial lighting or heating on most sunny days.

A Super-insulated Envelope

The underlying strategy was to build a conventional house with the contractor's normal framing crew. Pill chose 2 x 6 framing with studs at 24 inches on center to minimize the amount of wood. Greater stud spacing means more room for insulation. Closed cell urethane foam insulation was sprayed into the stud cavities for superior thermal resistance. Mitigating thermal bridging was done by installing polyisocyanurate (rigid foam board) on the exterior.

The entire wall assembly has an R-value of 40, which is well above what local building codes call for. Although more expensive, Pill said "The cost was minimal compared to the benefit."

Pill explained how meticulous he was

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when it came to air sealing the home's interior. All two stud corners are filled with foam and these are topped with a layer of taped sheathing. On top of all this is a layer of Tyvek house wrap, which creates a highly efficient air barrier. The places where joints and studs met were all sealed and there was caulking used on every joint to guarantee building tightness. The roof is insulated very similarly and has an R-value of 56.

The basement was also insulated very specifically. There are 4 inches of EPS insulation under the basement slab and 2 inches glued to the foundation walls. The framing is 2x4 (24" O.C.) with blown-in cellulose insulation. The basement ceiling is lined with denim (the same material that blue jeans are made from!) to separate the home's conditioned space from the unconditioned.

Thermally efficient fiberglass windows with orientation-specific glazing are used for additional energy efficiency. South facing windows have a solar heat gain coefficient of 0.61, a visible transmittance of 0.63 and a U-value of 0.17. The remaining windows have a SHGC of 0.37, a VT of 0.57 and a U-value of 0.15. Each window is triple pane, low-e, and has an argon gas filling.

Annual Energy Consumption

From January 10, 2008 through January 9, 2009, the Pill-Maharam residence consumed just 6094 kWh—five to seven times less than the total equivalent energy consumed in a typical Vermont home.

Photo: © Jim Westphalen

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Interior views of the 2,800 square foot residence of husband-wife architect team, David Pill and Hillary Maharam, located in Charlotte, VT. This home was the 2008 winner of the NESEA's Net Zero Energy Competition.

During the same period, the renewable energy system produced 6286 kWh, resulting in a year one net energy gain of 192 kWh.

Low Impact, Low Energy Materials

Pill's house uses only Energy Star® appliances and carbon fluorescent lighting. Low flow plumbing fixtures were selected to conserve water and local materials such as concrete countertops and sustainably harvested wood were handpicked to further reduce embodied energy. In addition, all wood was FSC certified, all paints and finishes were low/no VOC, and a metal roof was selected for its high durability.

Pill's house also has low-flow toilets (made by Toto) and intentionally lacks air conditioning. Natural cross ventilation is utilized on most days when it is warm outside and when the humidity is low. A Venmar heat recovery ventilator supplies fresh air and exhausts stale air to prevent moisture and pollutants from accumulating (due to the building's extremely efficient envelope). Finally, a wastewater heat recovery system brings heat from the shower drain back to the domestic hot water tank. This alone saves a significant amount of energy.

Even on the coldest day of the year, if the sun is shining, the house will maintain 70 degrees Fahrenheit without the ground source heat pump. "You can get right up to the windows and not feel cold at all because there is no air movement," says Pill. Not even so much as a draft.

But outside, the wind is blowing.

Ryan Harb is a Masters Candidate in green building at UMass-Amherst. Simi Hoque is an Assistant Professor, Department of Natural Resources Conservation at UMass-Amherst.

David Pill and Hillary Maharam's home is on the 2009 Green Buildings Open House Tour.

Low-Impact Design
- Previously developed site
- 99% of work completed within existing footprint
- Restoration of land for agricultural use

Exceptionally Efficient Envelope
- R40 walls
- R21 basement walls
- R56 roof
- R26 under basement slab
- Triple pane, low-e, argon gas filled windows

Local and Sustainable Materials
- FSC Certified wood
- Metal siding and roofing
- Locally crafted concrete countertops
- Local sustainably harvested maple flooring & hardwoods
- Cellulose insulation
- Denim insulation
- Reclaimed fir columns
- Low/no VOC paints and finishes