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From: BUILDER March 2011 | Posted on: March 8, 2011
Energy Saver

Passive Resistance

Bring on a heat wave or deep freeze. This cozy little house stays comfortable year-round without green gadgets or a typical HVAC system.

By:
Jenny Sullivan

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Passive Resistance

The Passive House uses 83% less energy than the average home.

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Nestled in seven pristine acres of Hudson Valley forest, this intimate little spec home is sustainable, but not in the way you might think. It has no solar panels, no geothermal system, and no wind turbines, yet it's expected to consume only one-tenth of the heating and cooling energy used by the average three-bedroom home. How does it work?

Like a thermos.

Think of it as a 1,650-square-foot version of that super-insulated bottle that keeps your coffee hot or your iced tea cold, except in reverse. Its ultra-tight shell keeps extreme temperatures out, most of the time with little to no mechanical intervention. And its main power sources are things nature provides for free: sunlight, shade, earth, and breezes.

Created by architect Dennis Wedlick and custom builder Bill Stratton, the "Hudson Passive Project," as it's known, doesn't follow the same certification playbooks most American green builders have come to rely on. Rather than adhering to LEED or similar blueprints for sustainability ("I equate LEED with the IRS," Wedlick says. "It's about as much paperwork and it's easier to cheat ... .") the house is built to stringent standards set by the Passive House Institute in Germany. Under this rubric, certification is an all-or-nothing deal that's wholly contingent on hard metrics (BTUs and pascals), not a points-based system. And the emphasis is on passive engineering and resource conservation. The design relies on simple architecture—not technology—to capture or shield the sun, depending on the season. The construction then ensures that not a single unit of precious thermal energy escapes before it is fully maximized.

Details

Project Hudson Passive Project, Claverack, N.Y.

Architect Dennis Wedlick, Dennis Wedlick Architect, New York

Builder Bill Stratton, Bill Stratton Building Co., Old Chatham, N.Y.

Developer Frank Sciame, Sciame Development, New York

Building science consultant The Levy Partnership, New York

Mechanical consultant CDH Energy, Cazenovia, N.Y.

Grant funding New York State Energy Research and Development Authority, Albany, N.Y.

Just how tight is this home's envelope? Very. It received a blower door test score of .149 (the average score for a conventional home of similar size is 5.0). Based on the meticulous energy modeling that drove its design, Stratton predicts that its utility bills will come in around $1,200 per year—a notable cut below the $5,000 most local residents pay for their heating bills alone.

"Photovoltaics, wind, and geothermal technologies are often touted as the answer, but green energy alone is not the solution," Wedlick says, noting that even renewable energy becomes wasted energy if it is allowed to seep right back out of a leaky building.

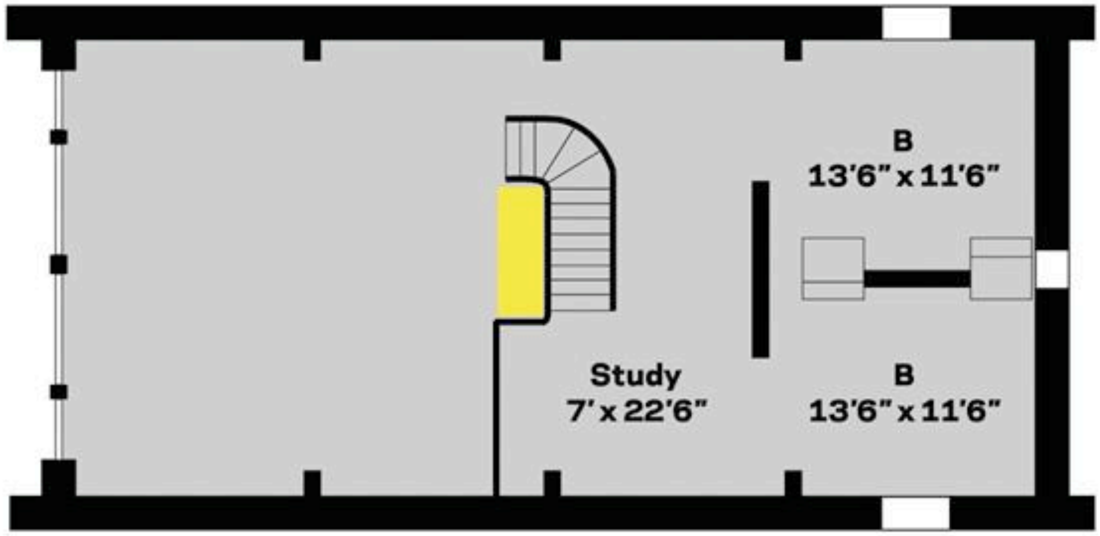
"Imagine sleeping outdoors on a cold winter night with a sleeping bag that has holes in it every 16 inches," he explains. "That's what happens when the blankets of insulation keeping a house warm can only be fitted between wall studs that stand every 16 inches, instead of completely wrapping the exterior structure."

How does this unconventional house do it better? With a carefully engineered combination of solar orientation, calculated thermal bridging, and an extremely thick skin.

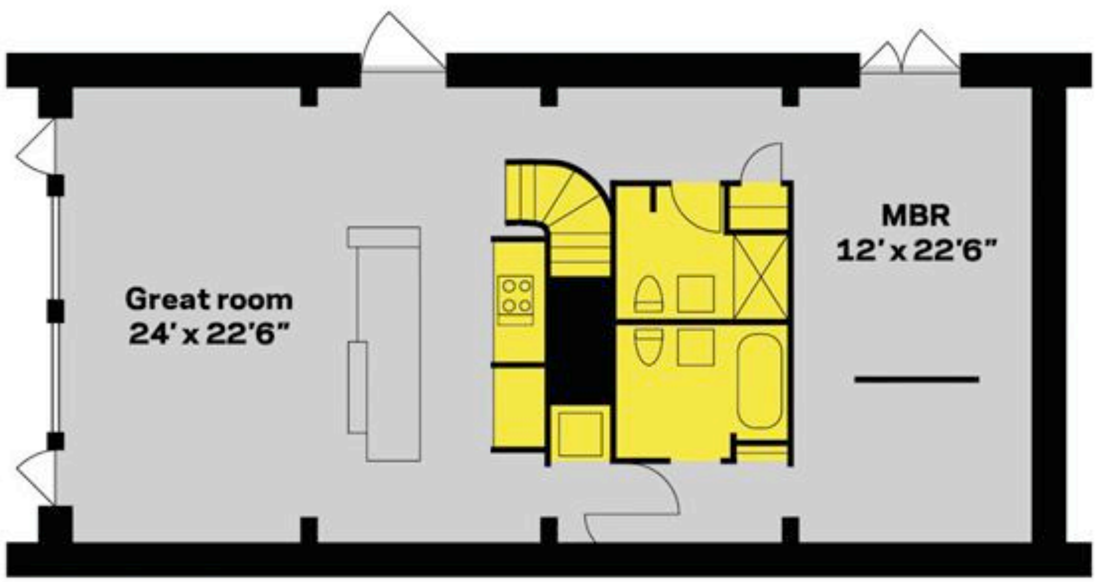
Seems Right Simple massing reduces the number of cracks and crevices where temperate air could potentially escape. Thermal energy loss is also mitigated by stacking and concentrating the utility core (yellow highlighted areas in the floor plans) to allow shorter duct runs.

ARCHITECTURE

For starters, let's talk anatomy. Inspired, in part, by the Iroquois "long houses" that peppered the Hudson Valley landscape for centuries before modern A/C, the building is essentially one big rectangle with a high ceiling, and that's no accident. Simple and economical to build, this form works in tandem with a large, south-facing window wall to make the most of what nature provides. In winter, the cathedral ceiling affords extra volume space to retain the sun's heat. In summer, those same tall ceilings—combined with strategically placed skylights and operable windows—allow warm air to vent up and out when the house is open to the breeze. The plain box has other advantages, too. Its simple shape minimizes the number of joints in the envelope, reducing the potential for air leakage. "Simpler building forms also allow more compact mechanical runs," Stratton points out. When duct, plumbing, and electrical runs are shorter, less energy is lost during transmission.



Second Floor

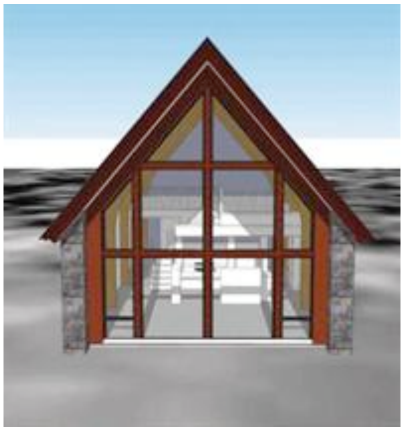


First Floor

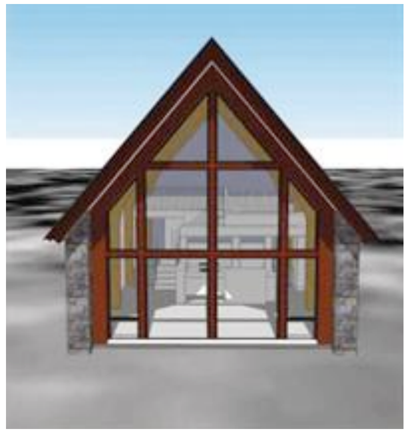
SUNLIGHT

Solar orientation is another key ingredient. This house's most striking feature—that 23-foot-tall wall of south-facing glazing—is a show-stopper, but it's also one of the most important pieces of equipment. In winter, when the sun is low in the sky, the monumental window allows the house to draw the sun's warmth inside, where it commingles with heat generated by appliances and body heat. "The key is to have high solar gain on the south windows while also having a high R-value in all of your windows to retain the heat inside," Wedlick explains.

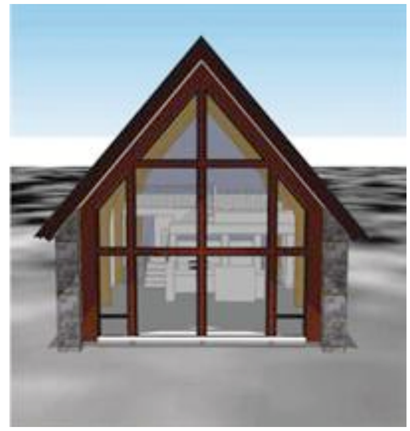
In summer, when the sun's position is higher, the window configuration achieves the opposite effect. Deep overhangs block the sun's rays from above, and the home's super-insulation keeps its interiors cool. At this point, extra high R-values in the walls, roof, and floor reverse roles and help to offset the need for conventional A/C. As cool temperatures are absorbed into those mass walls, they take on cave-like properties, maintaining a comfortable temperature inside. Thermal window shades on both ends of the house also help control heat loss and gain, depending on the season.



January/December

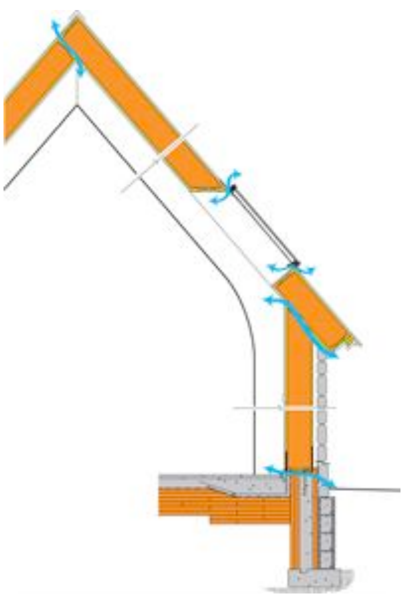


March/September



June

High or Low? The sun's position changes with the seasons, and this house exploits that natural phenomenon. Come summer, when the noon day sun is high, deep eaves provide shady cover. In winter when its position is low, generous glazing invites its rays inside. During transitional months, the angles allow some solar gain, but not too much.



The Envelope Please
Structural insulated panels (SIPs) form a tight cocoon, allowing the house to maintain temperate internal conditions year round. To further reduce the potential for thermal bridging, the construction team mapped out and sealed

up all the spots where materials and components come together.

Credit: Dennis Wedlick Architect

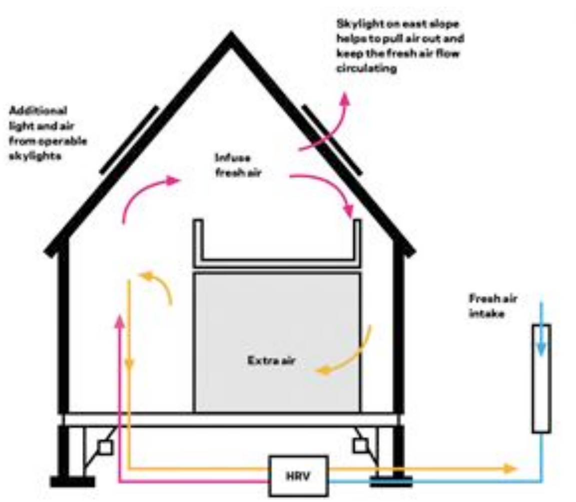
SUPERINSULATION

What the typical custom home spends on souped-up mechanical systems, this house invests in its envelope. Its timber-framed skeleton of glulam trusses is skinned with SIP walls and double-paned windows with a transparent layer of vinyl between the panes. And here’s the real kicker: The slab foundation and roof are heavily insulated too. Pouring the concrete slab on top of high-density rigid insulation improved the floor’s insulation values by 600 percent over conventional construction, Stratton says.

To seal the deal (literally) the construction team used caulk, tape, and tight joinery to minimize thermal bridging in areas that are typically prone to heat gain and loss, such as sill plates and planar edges where walls meet up with the roof and foundation.

The end result is a monolithic shell that functions as one colossal thermal mass. “None of the structure of the house touches the outside,” Wedlick points out. The prefab walls are R-50, the roof is R-53, and the slab-on-grade concrete floor is R-60.

Now that's a tight thermos.



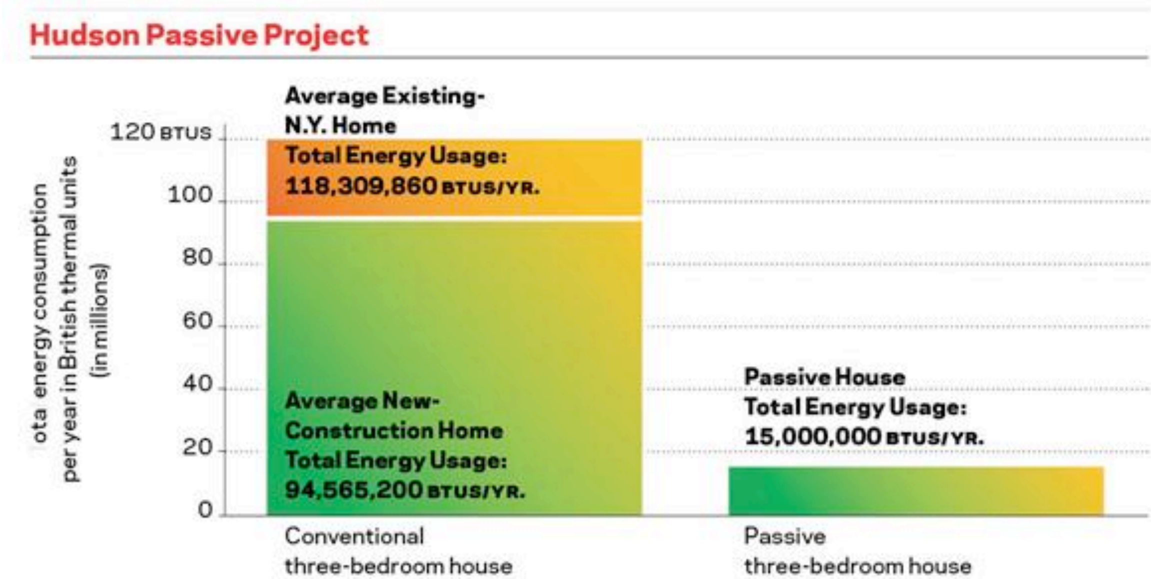
Retention Strategy Rather than automatically generating heat, the house focuses first on maintaining the temperature it's already captured inside. A heat recovery ventilator gets rid of stale air, but not before mining it first to extrapolate its thermal energy.

FRESH AIR

The structure does have an HVAC system, albeit an atypical one. Its essential mechanism is a heat recovery ventilator (HRV)/air exchanger that brings a constant influx of fresh air inside the home while ensuring that comfortable conditioned temperatures (be they warm or cool) aren't wasted and expelled through exhaust airflows.

"With the HRV, the incoming air basically 'steals' heat from the outgoing air as it passes through a heat exchanging chamber," Wedlick explains. "This constant pull of fresh air gives a passive house dramatically better air quality than a conventional home, even though it's tightly sealed. In winter, the HRV is the home's primary heat source in the sense that it's providing the most efficient recovery of heat."

As a backup, the house is also equipped with two point source electric heat pumps for supplemental heating and cooling needs, plus electric baseboard heaters in the master bedroom and main living area. But Wedlick believes much of this is over-engineering. "I'm predicting that only one of the two heat pumps will ever be used for heat," he says.



R-Value Comparison	N.Y. State Building Code	Hudson Passive Project
Walls	R-21	R-50
Roof	R-38	R-53
Slab	R-10	R-60

SPECS

WALLS

Vermont Timber Frames 12 ¼ inches EPS
SIPs

Total wall R-value: R-50

ROOF

Vermont Timber Frames 12 ¼ inches Neopor SIPs

Total roof R-value: R-53

SLAB

6-inch concrete slab, 10 inches at perimeter

Six layers of 2-inch EPS insulation under slab set on a 6-inch gravel bed

Two layers of 2-inch XPS on interior of foundation wall

One layer of 2-inch XPS on exterior of foundation wall

Total slab R-value: R-60

WINDOWS

Serious Windows 725 Series (vertical windows)Average R-value: R-6

FAKRO FPL PreSelect (roof windows)

Total R-value: R-5

VENTILATION

Zehnder ComfoAir 200 HRV Heat recovery efficiency: 92%

Mitsubishi Mr. Slim, MSZ-FE12NA and MUZ12NA (heat pump 1) Heating capacity (at 47 deg. F): 13,600 BTU/hCooling Capacity: 12,000 BTU/h SEER (energy efficiency): 23

Mitsubishi Mr. Slim, MSZ-FE09NA and MUZ09NA (heat pump 2)Heating capacity (at 47 deg. F): 10,900 BTU/h Cooling capacity: 9,000 BTU/h SEER (energy efficiency): 26

Cadet Electric Baseboard Heat, Three 36-inch units; 750W/each

SOLAR SHADING

Hunter Douglas Blinds, Architella ?-inch, semi-opaque (south and west windows shade product) South and west shades R-value: 1.56

Hunter Douglas Blinds, ?-inch, semi-opaque

(roof windows shade product) Roof window
shades R-value: 1.06

DOMESTIC HOT WATER

Stiebel Eltron Tempra 29 Plus Electric
Tankless Water Heater

Energy efficiency: 99%

More than 20,000 passive homes have been built in Europe, but the Hudson Passive Project is one of only a dozen in the U.S. so far. Built for $200 to $250 per square foot, it's on the market for $595,000. That's not exactly entry level pricing, although Stratton is quick to point out that not all of its hard costs went toward energy-saving features. "A lot of that cost is in high-end finishes," he says, noting the prototype's custom pine millwork, bluestone exterior cladding, and other goodies. "You don't have to have marble countertops and custom cabinetry to build a passive home," he says. "In the end, you are probably adding 10 percent in costs to build a passive house."

Passive building certainly isn't the only means to a more sustainable future, but it is an approach Wedlick hopes more builders will at least investigate. "If the ideal now is to create homes that are easier for builders to build and cheaper to heat and cool, then let those priorities drive the design," he says. "None of this requires skills that builders don't already have. For production builders, every development starts with a prototype, right? Why not start with the passive house as a prototype and then value-engineer from there? The hardest thing will be changing building codes as they currently apply to mechanical systems."

As a passive house ambassador, this iconic dwelling certainly has some persuasive performance numbers to go with its good looks. And its architecture conveys an air of familiarity. Unlike the starkly modern passive homes that predominate in Europe, this barn-like abode feels very much a part of the American landscape. In fact, its backdrop isn't unlike the one that inspired the immortal words of poet Robert Frost: "The woods are lovely, dark and deep. But I have promises to keep. And miles to go before I sleep." If this building approach lives up to its promises, more will follow in its footsteps.

Visit http://hudsonpassiveproject.com to see construction photos and additional energy modeling diagrams.

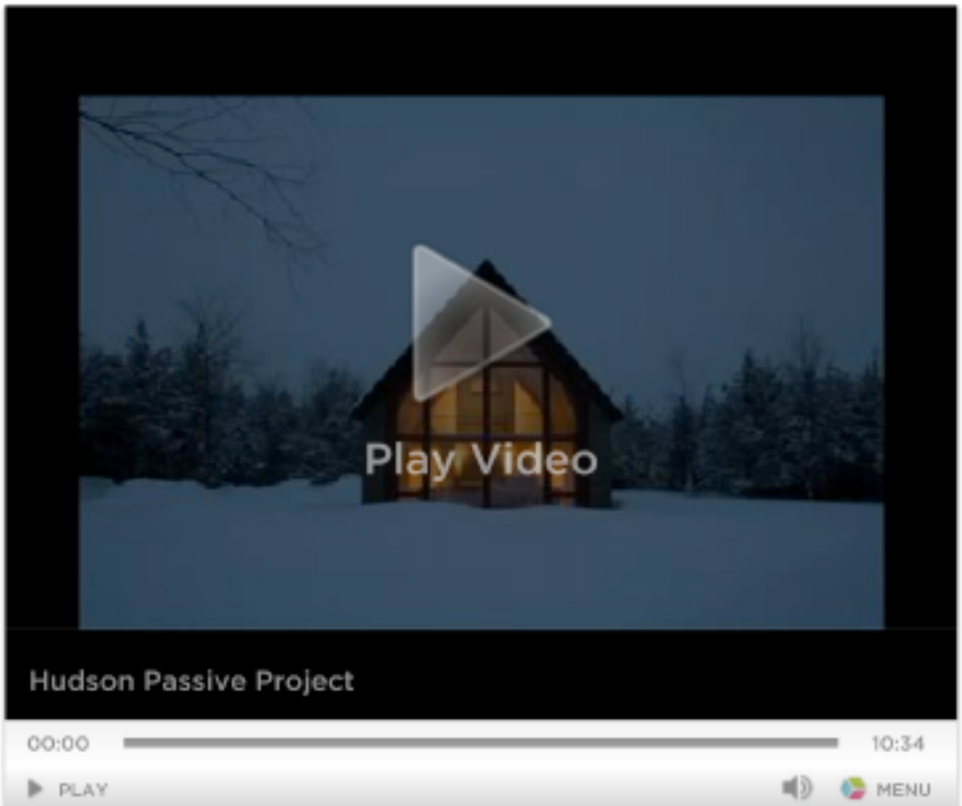
How Does a Passive House Work?

The basic premise can be summarized in a cup of coffee, says architect Dennis Wedlick.

Energy efficiency and sustainability are not new concepts in homebuilding. Centuries before the advent of modern A/C, ancient civilizations mastered the art of passive heating and cooling by paying attention to factors such as massing, building orientation, prevailing breezes, window placement, and materials. Visit the ruins of Pompeii today in the heat of August and you'll find that its atrium homes still feel comfortable inside.

How do they do it? That's what New York-based architect Dennis Wedlick sought to find out when he began investigating the principals of passive design and construction. Turning his focus locally, he researched the Iroquois long houses that populated the Hudson Valley long before the arrival of roads and subdivisions. He studied the rigorous building science methodology of the Passive House Institute, which emphasizes energy *conservation* over renewable energy *production*. Then he went to school on the one piece of modern technology that makes the passive equation even better -- the energy recovery ventilator (ERV), which maximizes thermal energy while ensuring healthy indoor air quality inside the confines of a tight shell.

To summarize his findings, Wedlick published a paper, The Good Home Paper, to explain and advocate the benefits of passive design and construction. Then he put his newfound knowledge to the ultimate test, joining forces with builder Bill Stratton to create a spec home that proves the hypothesis. The Hudson Passive Project, as this prototype is known, uses only one tenth the heating and cooling energy of a conventional stick-built home. How does it work? Wedlick explains the concept in his own words. It's as simple as a cup o' joe.



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