building green in the GREENS

story: nancy wolfe stead / **photographs:** glenn callahan

Being green in "the Greens"—local slang for Vermont's Green Mountain chain—sounds like an oxymoron. We are, after all, known for having one of the coldest winters in the country. The brutal Artic Express blows an undiminished gale straight from the Artic Circle to Lamoille County, home to Stowe, Morrisville, and a few other small, rural towns. We brag publicly but inwardly whine about how to survive when it is 42 below zero. How can we ever contemplate living without our fossil-fuel-gobbling furnaces?

Nonetheless, there is a growing clamor for minimal energy or even energy-neutral building. Western Europe leads in this field and their construction techniques and efficiency standards for residential and commercial structures, first established by the German Passivhaus Institut, are now being incorporated into U.S. standards.

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INTERIOR SPACES: The interior is all flowing space and subtle angles. Architect David Pill loves angles for good reason: they add intrigue, warmth, and a hint of buzz to otherwise every day spaces. Cindy and George Jackman strove for continuity and airiness throughout the living areas by easing transitions between rooms and using warm-toned maple woodwork throughout. The maple was locally grown and milled. High ceilings create openness and every room has balanced daylight from both sides of the house. A four-foot overhang shelters the interior from summer sun.

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LIVING SPACES: The inviting living room has a game nook on the right. Three walls of shelving for books, games, and mementos create intimacy within the larger area. A game table, built by George for the family's hotly contested board games, is in the center.

The Scan-Anderson woodstove has soapstone panels, which are attractive and also retain heat. The stove has direct-vented air intake and does not draw warm air from inside.

The polished cement floor (also shown on the opening spread) is finished in a soft earth tone, and is used throughout the main floor with the exception of the master bedroom, which is finished in cork. The low angle of winter sun heats the four-inch-thick thermal mass and then releases warmth slowly over extended periods of time.

Considerable time was spent researching windows. The ultimate choice was Canadian brand Fibertec. The windows are triple-glazed, with krypton gas between the panes and low-E coating. The builder was really happy with them and their cost was significantly below their German competitor.

KITCHEN: Cindy had a frugal eye in most of the design process, trying to capture the most use with the least amount of space, until she got to the kitchen. Her orders were to make it big and make it useable, with a center island and lots of workspace. "I wanted cabinets and an island that would last a lifetime," she says. "Appliances last 10 years but the cabinets and countertop last forever." Upper left: This view of the kitchen showcases the Jackmans' desire for continuity and openness throughout the living areas.

The Verde Antique serpentine marble countertop comes from Rochester, Vt., and is as hard as granite. The cabinets, custom made in "character maple," were done by Stark Mountain Woodworking.

Realizing that overhead cabinet space was limited by the expanse of windows in the kitchen, Pill had the Jackmans get out all of their dishware and measure it. "Mapping out everything we owned changed a lot of our ideas," Cindy says. "A good one is putting all of our dishes in drawers. We were skeptical but now we love it."

STAIRCASE: Cindy wanted a staircase that was warm and inviting while George always had a vision of stairs falling in a cascading line. Satisfying both, the architect left builder Travis Cutler to figure out how to make tread and riser seem like one and master finish carpenter Chris Fradette muttering, "I never want to see a 22 ½-degree angle again."

Tiny, frigid Vermont is at the forefront of the movement in the U.S., and Stowe now has one of the most energy-efficient homes in the country. The Jackman home, finished early last winter, is one of only two certified Passive Houses in Vermont and joins a select group of just 36 nationwide. It is being monitored by Efficiency Vermont, which is using it as a model in defining new approaches to building design and construction.

Cindy and George Jackman didn't intend to become trendsetters. Their dream, George says, was "to build an energy-efficient home without sacrificing comfort, to have the highest possible indoor air quality, to use local products as much as possible, and to have a home requiring almost no maintenance."

Building the most energy-efficient house in Vermont was not on the list.

The couple bought a vacation home here while living in Lexington, Mass. They grew to love this area for the variety of recreational offerings and a school system they discovered would be superlative for their two children, Andrea and Ian. They hoped to move here some day, and started files of homes they liked, interesting new products and construction techniques, new technologies, and fun or useful ideas.

When George decided—suddenly—that he and Cindy could move north they connected with David Pill of Pill-Maharam Architects in Shelburne. Pill and his assistant, Karen Bushey, are dedicated to energy-efficient construction and the firm has won major awards in the sustainable building field. Pill likes to help people understand that "it is possible to build this way without doing anything extraordinary."

Pill's own home operates at net-zero efficiency, with offset for its modest energy consumption provided by a wind turbine and solar tracker. He is "fascinated that we can create a house in this climate that can sustain itself in winter. When it is sunny and 10 below it can be 70 inside with the heat generated from the

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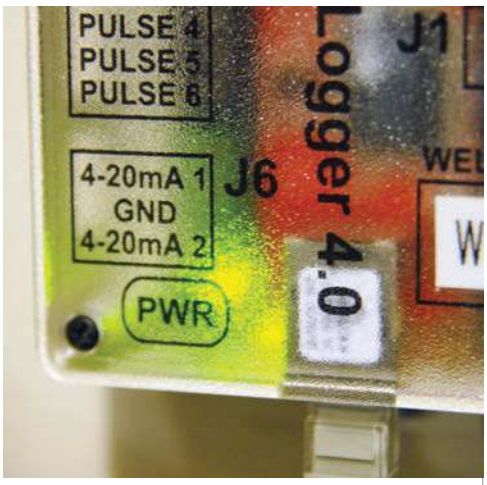
EXTERIOR: The Jackmans wanted a minimum maintenance home. Camping, skiing, and bike riding with the kids comes first. With that in mind, the two-floor center tower is sided with corrugated galvalume steel and the horizontal clapboard is Hardie Artisan pre-finished concrete-fiber with a 30-year guarantee. Both the standing-seam roof and Ipe deck require no finish.

THE GUTS: A sustainable energy glossary



The green energy field is a morass of acronyms. Here's a rundown of the most relevant ones.

ACH: Air Changes per hour is a measure of air tightness in a structure. In the old timber-frame home many of us grew up in or still own, breezes blow in and the air we just paid to heat blows out. A typical house of contemporary construction has an ACH of 5. The Passive House standard, the acme of green building, is .60. The Jackman house is .46.

HERS: The Home Energy Rating System measures a home's energy efficiency. Homes are scored between 100 and zero. A home with a score of zero qualifies as a zero energy building, meaning it uses no net purchased energy. The Jackman home's score 31.

HRV: Super tight construction requires ventilation for good air quality. A Heat Recovery Ventilator supplies fresh, tempered air and removes contaminants. It recovers a large percentage of the heat in air being exhausted and warms the fresh air from outside before it is circulated.

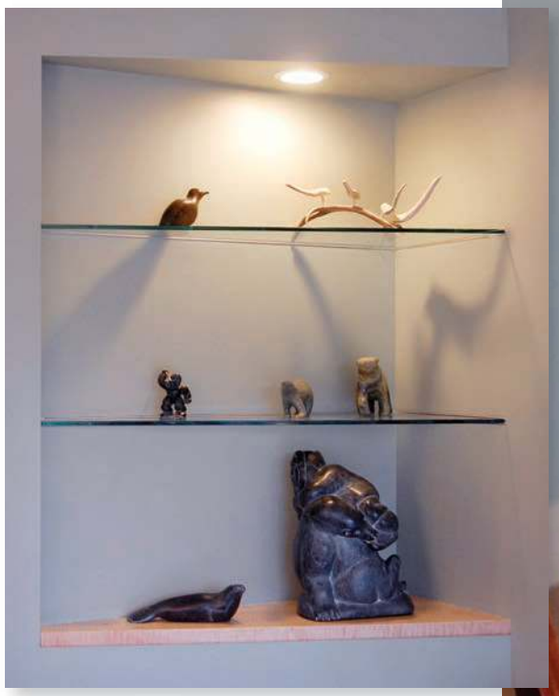
NZC: Net Zero Construction is the Holy Grail of the green movement, when the annual energy consumption of a building is offset at the site by energy produced by wind or sun.

PHIUS: Passive House Institute US is a national non-profit that promotes training, education, and research for energy-efficient building. U.S. Energy Administration research shows that buildings are responsible for 48 percent of gas emissions and consumption of 76 percent of all electricity in the U.S. The Passive House standard for a well-insulated, airtight building primarily heated by passive solar gain would slash estimated energy consumption by 90 percent. The Jackman house is one of two in Vermont certified by PHIUS and is judged the most energy efficient in the state. There are many more houses on design boards and several are in the process of certification at this time.

VOC: Volatile Organic Compounds. Many household items and materials used for construction—plywood, textiles, urethanes, paints—emit gasses, like formaldehyde, associated with manufacture. Ventilation and wise choice of building components helps minimize their harmful effects.

—Nancy Wolfe Stead

DINING SPACE: The dining room chandelier and sconces are Hubbarton Forge, as are most fixtures in the house. Their contemporary yet classic style is perfect for the architecture. A cabinet in the corner displays the couple's growing collection of Inuit art.



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passive solar aspect, good insulation, and good glazing."

Clients and architects meshed from the outset. "It was," Pill says, "a really great process, an exciting collaboration of my professional design knowledge and their needs. They had educated themselves on the latest techniques in building environmentally friendly houses. What the client brings to the project is a huge piece of what makes it successful."

An equally critical part of the team was the building crew of Donald C. Blake Jr., Inc., of Morrisville. Business partner and project manager Travis Cutler had worked with the Jackmans on an earlier remodeling project and there had been many conversations about ideas for the future home. Cutler was brought in from the beginning to work through the details.

"Early on I looked at wall assemblies, foundation solutions, roof systems, how they related to fuel efficiency, and cost," Cutler says. "I came up with a few new products that helped us achieve R-values and make the building airtight. If you fail that, you fail the project. We spent a long day at David's office scrutinizing the plans and identifying problem areas." Then he did a lot of research and proposed solutions. As a result, the company now employs state-of-the-art air-sealing strategies in all new construction.

A commitment was made not to use spray foam insulation because, as George describes, "of its nasty chemicals and off-gassing." Green builders view the foam and blowing agents as highly detrimental to the environment. Their alternative was packed cellulose.

"It is cheaper, offers the lowest cost per R-value, and is lowest in VOCs (volatile organic compounds), and greenhouse gasses," says George. The 2x8 walls were filled with dense-packed cellulose, which were covered with two sheets of polyisocyanurate rigid foam, each three inches thick. Huber Zip System, a high-performance wall sheathing and air-flow retarder was used as the combination structural sheathing and air barrier between the cellulose and rigid foam layers. According to George, "By putting more than half the insulating value of the wall structure outside the vapor barrier we more or less eliminated the cold surface of the vapor barrier and reduced the potential for condensation inside the wall."

When Pill designed a drainage plane behind the siding, with moisture-removing air flowing in from the bottom and out the top, it was up to Cutler to figure out how to attach siding, decks, and window trim through six inches of foam insulation. Equally complex was engineering a system for air-sealing the central roof system, which has four laminated spruce beams supporting two layers of nine-inch rigid insulation panels, the strand board sheathing the ceiling, and the standing-seam roof.

With large "high-tech" windows on the long south-facing wall, smaller windows on the home's other sides, four-inch concrete floors, and thick additional thermal mass on the walls, the building includes the best-known strategies for passive solar heating. Cutler was charged with finding an appropriate and efficient solution to supplementing the passive heat while respecting Cindy's requirement that no fossil fuels be used. He looked at various air-source heat pumps and other options before arriving at a ground-source heat pump with radiant-floor distribution. The ClimateMaster heat pump extracts heat from a 450-foot closed loop well to provide domestic hot water and radiant heat.

Super-tight construction requires supplemental ventilation. In winter, it defies common sense to exhaust nice warm air that one has paid to heat and take in frigid outside air. A Zehnder Heat Recovery Ventilator circulates fresh air in every room while recovering 93 percent of the heat in the air being exhausted. The same system can cool in summer.

Early in the building process the team realized the finished house was going to be very close to Passive House Institute US (PHIUS) criteria. Peter Schneider, a passive house consultant with Efficiency Vermont was brought in to help tweak the design to meet the strict requirements.

By way of background, Vermonters should be both aware and proud of how progressive their state is in the energy-efficiency field. Vermont Energy Investment Corporation (VEIC) is a non-profit organization dedicated to reducing the economic and environmental cost of energy consumption. The group, which has received international recognition for its work, created Efficiency Vermont, the first statewide energy-efficiency utility in the U.S. The organization provides technical assistance and financial incentives to businesses and homeowners making energy improvements, and is financed by a surcharge on electric bills. A second sub-agency, Vermont Energy Star, provides technical assistance and incentives for older home retrofitting and new construction.

Efficiency Vermont, says Schneider, is exploring ways to ensure 100 percent of new residential construction meets Vermont's new energy plan goal of net-zero energy building by 2030. Using its services, the Jackmans tested for proper air seal at two stages of construction. Finding and correcting air leaks resulted in their having, even without the photovoltaic component, one of the most energy efficient homes in Vermont.

Schneider says the Jackman house represents the "whole-house approach" with its passive solar siting and the simple geometry of roof lines and structure that permits airtight construction of roof and walls. Triple-glazed windows, thick walls, and concrete floors help maintain an even, constant temperature. Indoor lighting is high-efficiency CFLs or LEDs and window placement provides even wall-to-wall daylight. Indoor air quality is boosted by the Jackman's insistence on no- to low-VOC construction materials: paint and interior finishes are VOC-free, plywood is zero formaldehyde, and the insulation is zero to low-VOC.

Schneider is monitoring relative humidity, indoor air quality, temperature, heating, ventilation and air conditioning performance, and energy consumption at the house and expects to use his findings in defining new building approaches for the state. Last winter, an admittedly benign one weather-wise, Jackmans turned their heat on in mid-December and off on March 6.

KIDS SPACE: Andrea and Ian have the second floor to themselves. They played a big role in the design of their bedrooms and had free hand with décor. The photographer was not invited in.

All parties are hoping that in the near future, the house will achieve the coveted net-zero rating. George and Cindy are researching photovoltaic panels to offset their modest energy consumption. Technologies change swiftly, new products come to market weekly, and prices on the good ones fall as more people buy them.

The Jackmans estimate their building cost was 15 percent over standard code construction. They wanted to invest wisely by building the infrastructure that would get them to their long-term goal of no purchased energy. Some finish work has been postponed but George is an excellent carpenter and cabinetmaker. On his "honey do" list are cupboards and drawers in the mudroom, cabinets on either side of the movie screen in the rec room, and a handsomely finished home office for himself.

George notes, "Payback wasn't the driving issue. Doing the right thing was—good air quality, no toxins, no fossil fuels—but ten years from now, when fuel is so much more expensive, we'll be laughing." ■