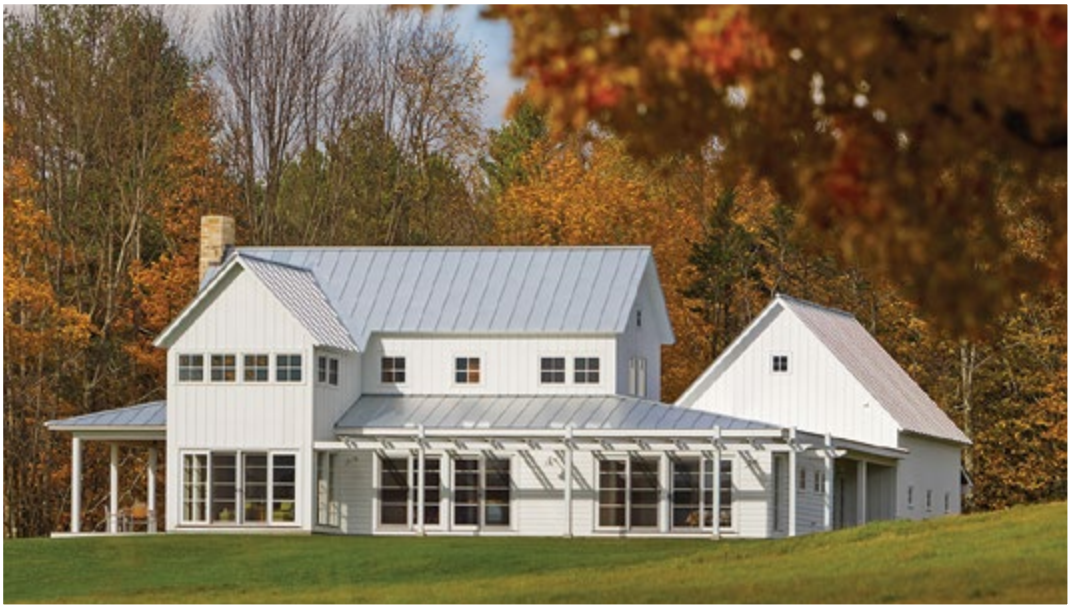
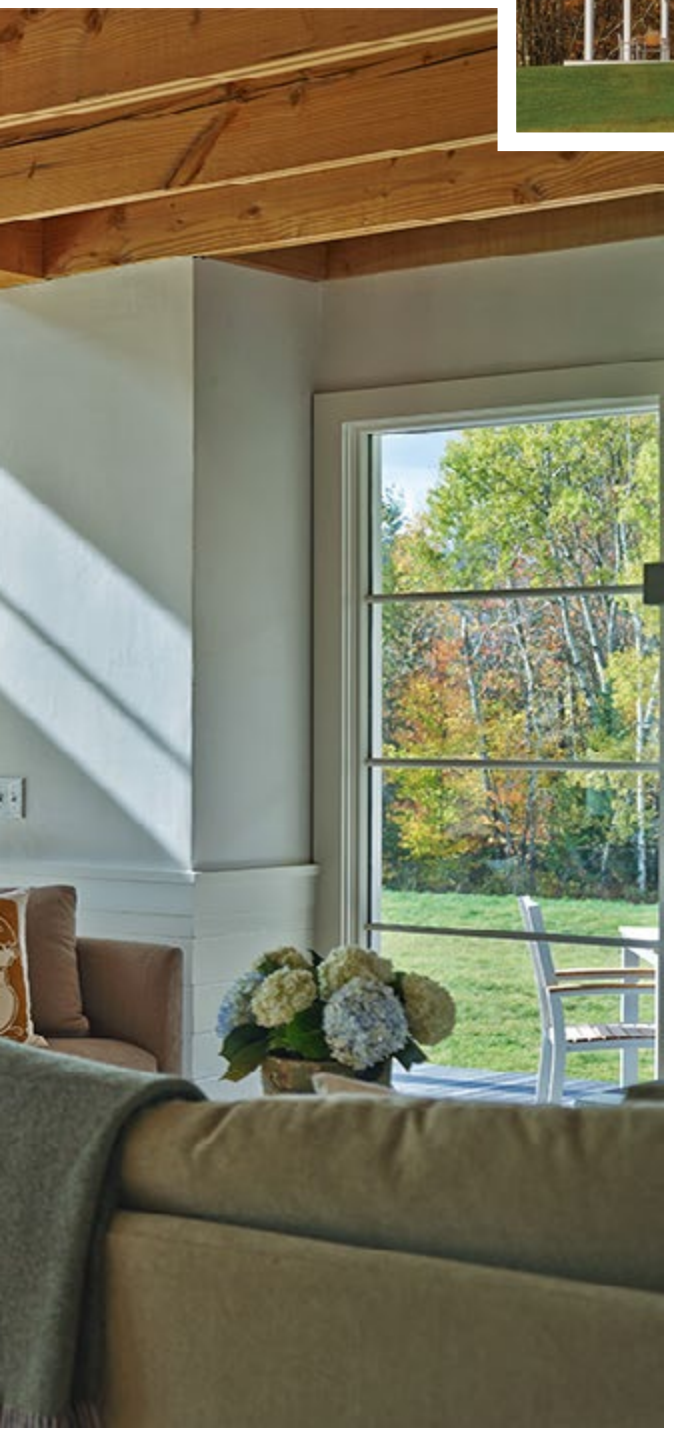
BY LEE GRUTCHFIELD, ARCHITECT AND PRINCIPAL OF TRUEXCULLINS

GREEN BUILDING AND NET-ZERO HOMES IN A NORTHERN CLIMATE

TruexCullins has the know-how





The idea of the self-perpetuating machine, an engine that can produce more energy than it uses, is as old as the wheel and as new as the spacecraft currently exploring our solar system. As architects, we see this idea at play in many of the houses we are now building—beautiful, light-filled homes that create their own clean energy.

Today's existing technologies and commonsense building practices enable us to construct ultra-insulated homes and to generate electric energy on-site. Builders or homeowners interested in moving closer to or even achieving what we call a net-zero house might find these technologies and design practices of interest.

THE SITE

When it comes to net-zero homes, location and orientation are absolutely critical. By properly orienting the home to the sun and the surrounding landscape, you can maximize the sun's ability to heat and create power for the structure, as well as the earth's ability to naturally insulate it.

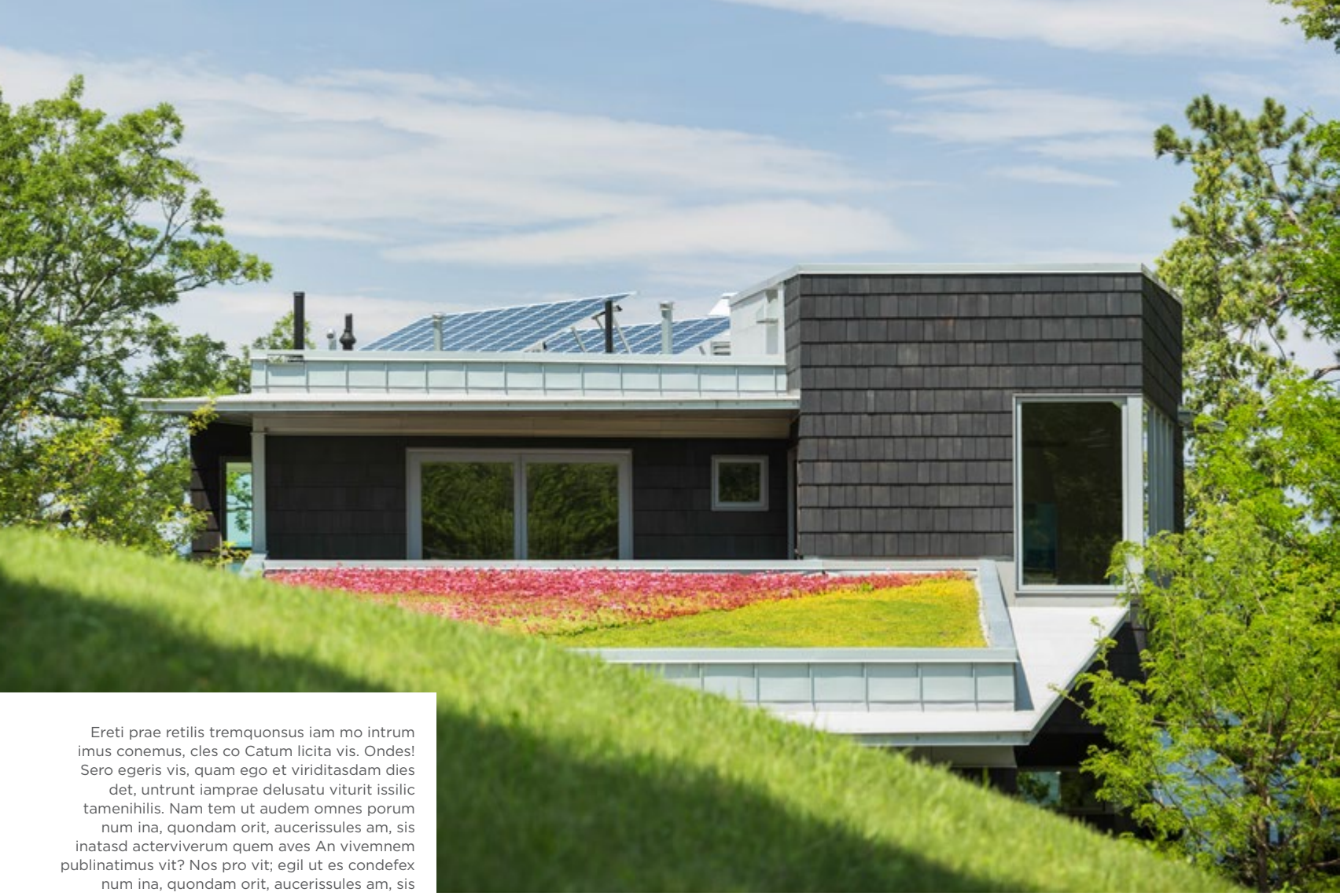
The ideal site is a south-facing hillside, with the broad side of the house facing directly south and the house slightly sunken into the hillside so that the home benefits from the earth's natural insulating properties on three sides. This orientation creates a microclimate where, on any given day in winter, temperatures on the south side of the house can rise well above surrounding areas.

Connections to local services and transportation are also important considerations when choosing a site for a net-zero home. Locating the home within walking or biking distance of services ensures that its residents' lifestyles are all the more sustainable.

THE ENVELOPE

We call the exterior walls, ceilings, and floor surfaces of a house the thermal envelope. These are the areas that need to be insulated from the winter cold of a northern climate. The science of insulating has improved vastly over the past 15 years, and ideas about how tightly to insulate a structure have changed as well.

We now know that the best way to control moisture, which can cause mold and decay in walls, is by making a home "tight" and controlling the flow of air into and out of the house. To ensure that a house is tight, we air-seal all the nooks and crannies



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to stop the transfer of outside air into the interior. To provide fresh air, we commonly use air handlers called Heat or Energy Recovering Ventilation systems (HRV or ERV). These units exhaust stale warm air to the outside. As the air exits the building, the system recovers its heat via a double-shelled duct, preheating the fresh, incoming air. The HRV or ERV uses minimal energy and runs continually at very low volume, yielding superb air quality.

In terms of insulation value in net-zero homes, we like to see R-20 for foundation walls below grade, R-40 for exterior walls above grade, and R-60 for roofs. These values are higher than most energy codes require but are critical for achieving net zero. One method of constructing exterior walls with an approximate R-40 insulation value is to build a double-stud wall, fill it with cellulose insulation, and apply two inches of foam to the outside surface. We prefer to use cellulose whenever possible because of its low environmental impact; it's made from recycled paper, boasts one of the best embodied energy profiles, and, compared to most other insulation materials, contributes very minimally to global warming in its manufacturing process.

WINDOWS

Windows are also an important part of the thermal envelope. Thanks to modern technological advances, it is possible today to use windows that have insulation ratings much higher than those of the past.

But a window's resistance to the transfer of heat is only one part of the equation. In a net-zero house, windows function to let in the sun's warmth. This "passive solar" energy is especially important on the south side of the house. We commonly use double-glazed windows (two panes of glass) on the south wall, which insulate fairly well but also let in substantial solar energy, and triple-glazed windows (three panes of glass) on the other three sides for increased insulation. Typically, we design the south-facing wall to feature the most glass surface, and the least amount of glass on the north side. Computer energy models help us to determine the optimal percentage of glass on a given wall. Roof overhangs and solar shades calibrated for maximum sun in winter and maximum shade in summer prevent the house from overheating.

ENERGY AND HEATING TECHNOLOGY

Photovoltaic panels mounted either on stands in the landscape or on the south-facing roof of the house (our preference) generate on-site electricity. In Northern

Vermont, the optimum pitch for roofs with stationary photovoltaic panels is approximately 40 degrees, or a 10/12 roof pitch. Most of our net-zero homes connect to the electric grid. In summer, when there is often a surplus of usable electricity, the houses feed energy back into the grid, while during the cold and cloud cover of winter, the home may draw energy from the grid.

When it comes to heating, many of our houses rely on a combination of passive solar energy and geothermal heating systems. These geothermal systems typically pump fluid through a deep well, extract heat from the fluid via a heat pump, then return the cooled fluid to the well to be reheated by the earth. Often, the extracted heat is circulated through special concrete floor slabs for radiant floor heating. We also commonly use solar hot-water panels mounted on the roof to heat hot water for domestic use.

HOUSE SIZE

Most of the net-zero homes we have designed range in size between 1,500 and 2,500 square feet of conditioned space. Generally speaking, the smaller the house, the easier it is to heat and cool. However, we would emphasize that green-building principles are certainly applicable to larger projects.

We like to think of the net-zero house not only as a beautiful and healthy place to live but also as a mini power plant. Think of the paradigm shift that would take place if all our housing developments were designed to be net-zero energy!

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