Minnesota architects design with sunlight, wind, and climate. It’s called passive design, and it’s coming to forward-looking cities, neighborhoods, and campuses near you.

Perhaps you’ve heard of it but not experienced it yourself—at least not knowingly. Or maybe you’ve read that Minnesota winters are too extreme for it to work. Passive design—elemental design solutions for heating, cooling, ventilating, and lighting a building through non-mechanical means—is still the exception rather than the norm, even in residential architecture, the scale at which passive design is most easily achieved. But interviews with four Minnesota architects reveal that the movement is taking hold in our region, and that the harvesting of free energy from the sun and wind can lead to beautiful and meaningful architecture. Whether they’re striving for rigorous Passivhaus standards or just “commonsense” passive solutions, these architects remind us that the benefits of passive design go far beyond energy reduction to influence how we live and connect with our built and natural environments.
As a pioneer in zero- and low-energy architecture, Sarah Nettleton, AIA, is enthusiastic about the potential of passive design in Minnesota. “Passive is a mindset and an opportunity,” she explains. “It’s about how we live and the choices we make—choices about when to open a window or turn on the air-conditioning or furnace.” On this point, she says, the term passive is a misnomer. “A ‘passive house’ is actually an ‘active house’ where you’re going to open and shut the house; it’s the opposite of passive,” she says. “I call it ‘participatory green,’ which involves the user.”

Nettleton takes interested clients to houses that use passive strategies, shows them options, and explains that participatory green works best when the owners’ expectations and personal preferences are aligned with the lifestyle demands of passive. “In the U.S., we have specific expectations around comfort,” she says. “There’s a behavioral part to passive. Some clients like natural ventilation, for example, while others don’t. I don’t argue about it with clients. Passive is for homeowners who are motivated to be an active part of a larger solution.”

Case in point: The owners of the Spear House, a recently completed Nettleton project in

The Spear House

The LEED-Gold Spear House in St. Peter, Minnesota, pursued a number of passive and related strategies. For more on the project, visit www.sarahnettleton.com.

- The house is sited to optimize passive solar gain in winter, natural ventilation and shading during summer, and daylighting throughout the year.
- Direct-gain passive solar combines with an active solar thermal array to meet most of the owners’ heating needs. The concrete floor slab stores direct solar gain in winter.
- Daylighting is provided throughout the day and year. Windows are located to provide daylighting, natural ventilation, and views from multiple orientations.
- Natural cross-ventilation is the primary means of cooling during summer.
- Roof overhangs are designed to minimize heat gain and control direct solar gain in summer.
- Glazing has a high solar-heat-gain coefficient (SHGC).
- The active solar thermal array provides in-floor radiant heating. Three 250-gallon tanks are used for thermal storage.
- An electric boiler provides backup heating for the passive and active solar systems.
- A high-velocity energy recovery ventilator (ERV) controls air quality and reduces energy use.
- In-ground tubes are used to temper ventilation air and reduce energy consumption.
- A dual mini-split air-conditioner was added in response to peak summer cooling needs. Even in extreme summer conditions, the house needs to be air-conditioned only between 6:00 and 8:30 P.M.
Acclaimed architect, David Salmela, FAIA, is attuned to the ways that passive design can enhance our aesthetic experiences. “Passive design is about more than using the sun to warm your dwelling; it’s also about light and connecting you to what lies beyond the windows and walls,” he says. “Our attitude is affected by light. Light is integral to comfort, and I feel that the sun provides the most comfortable level of light. Sunlight and visual connection with the outdoors are appealing and relieve the eyes.” For these reasons, his design process always starts with the sun and the site: “The first thing I ask when I get a new project and visit the site is: What’s the sun pattern? Where’s the sun? The sun is the essential thing.”

This approach is beautifully illustrated by the award-winning classroom building Salmela designed for Bagley Nature Area, a 55-acre preserve on the campus of the University of Minnesota, Duluth. The 2,000-square-foot building, nestled into a hilltop clearing above a pond, combines active (photovoltaics) and passive solar features to meet the school’s lofty energy goals for the project. “We wanted to connect the building and its occupants with the land through generous glazing, and it was the glass element that led us to strive for higher energy performance,” Salmela explains. “Because of our cold winter climate, we delved into the German Passivhaus system. For example, we sited the building for south light, made the sunshades smaller to get more sun inside in winter, and did meticulous calculations for Passivhaus and LEED.”

But Salmela, like Nettleton, emphasizes that neither Passivhaus nor LEED offers a comprehensive path to exceptional passive design. “The Passivhaus system actually has a flaw: it’s only about saving energy,” he says. “The LEED system addresses many things that Passivhaus doesn’t, but LEED has a weakness in addressing the energy needed to maintain the building. We achieved LEED-Platinum certification and designed to meet Passivhaus criteria [certification is pending]. But we weren’t aiming for the labels; we were trying to do great architecture.”
The building is oriented to harvest sun for heating and wind for cooling and to use surrounding deciduous trees for summer shading.

- Large south-facing windows maximize direct solar gain in winter. The north façade has minimal openings and is well insulated.

- Vertical shades that double as bird screens are designed to prevent summer heat gain on the south, east, and west façades.

- Operable windows oriented to the east and west provide cross-ventilation. Stack ventilation is achieved by combining high ventilation louvers with low operable windows.

- All habitable rooms are daylit to minimize the need for electric lighting during the day and throughout the year.

- Solar tubes bring daylight to the middle of the room. Motion sensors and photocells control interior and exterior electric lighting.

- The building is designed to produce more energy than it uses. Energy consumption, estimated at 5,500 kWh per year, is 10 percent of that of a comparably sized building of standard construction. The grid-connected, south-facing photovoltaic panels are projected to produce between 7,500 and 8,500 kWh per year.

- The primary source of winter heating is direct solar gain from south-facing windows. An electric boiler with in-floor radiant heating is the backup heating system. An electric heat coil in the ventilation system provides supplementary heat.

- A heat-recovery ventilation (HRV) system distributes fresh air evenly within the building and recovers 85 percent of the heat before venting the air.

- Energy demand is reduced with high-R-value continuous insulation, high-performance windows, and airtight building construction.

- The building is all-electric, using no natural gas, oil, or wood.

- The vegetative roof provides additional habitat and keeps the building and surrounding area cool.

The University of Minnesota, Duluth’s LEED-Platinum Bagley Classroom Building exceeds Passivhaus criteria. Visit salmelaarchitect.com for more info.
“The first step in design is contextual,” say architects Vincent James, FAIA, and Jennifer Yoos, AIA, of VJAA. “It’s exciting once you see building that way—in terms of climate, microclimate, and more universal forces such as culture. We look at a region and consider how people lived comfortably before [mechanical] conditioning.” For Yoos and James, passive strategies such as daylighting, natural ventilation, direct solar gain, and shading are simply part of a larger conversation about design excellence.

“The first question we ask is: What’s the passive response to climate? We might use the term comfort more than passive and talk about the effect of natural ventilation or daylight.”

After working with leading energy and thermal consultants from Germany and other parts of the world, the two architects have gained insight into the distinctions between European and U.S. approaches to passive design and thermal comfort. “European consultants use more passive approaches and are holistic,” notes Yoos. “The ones we’ve worked with see the building as an organism, adapting and responding to the users and outside forces. Here in the U.S., design is based more on LEED and checklists. European standards for comfort vary by activity, with temperature levels based on an understanding of how people behave in different activities. While passive approaches may encourage design simplicity, there’s an understanding of the complexity of human behavior.”

Yoos and James explain that, while they use design guidelines such as LEED and the Passivhaus standard, good design must also integrate pragmatic and poetic considerations. “Some aspects of design are subjective—even how much glass is needed. You can’t answer that just quantitatively,” she says. “It’s about the quality of space, such as the light balance and connection to nature. How to connect to the landscape and be energy efficient? All subjective aspects have an impact.”

For more on passive design, visit the sites below.
Passivhaus Institut, Germany www.passiv.de
Passive House Institute, U.S. www.passivehouse.us
VJAA integrated passive and high-performance strategies in a recently completed residential addition in the Twin Cities. “The T42 House adapted the mass-produced 1939 Cape Cod kit-house to be a climate-specific response for Minnesota,” says Yoos. “We used the Passivhaus criteria for glazing area, thermal mass, and insulation. We also included a masonry wall and a whole-house fan to further respond to sun, wind, and light. On a sunny winter day, the clients don’t need the heater; they get a lot of solar heat. On an overcast day, they use the space differently. Originally, we planned to use solar thermal tubes in the floor, but we can see now that they won’t be needed.”

But passive design and related materials should produce more than just exceptional energy savings, say Yoos and James; they should also yield enhanced sense and spatial experiences for the occupants. “In the T42 House, we punched holes and used the central circulation and a new back stair to create a convection loop for air movement,” says Yoos. “The owners can feel warm air moving just through convection. A lot of these principles just feel good. Materials that hold heat or cold are comfortable.” Passive strategies also allow the owners to more meaningfully engage their surroundings and the seasons through changing light and thermal qualities. “The house makes them more connected to everything,” Yoos continues. “They feel the cool air exhaust at night, walk on the brick pavers. The masonry wall holds radiant heat for 24 to 36 hours. It’s amazing how the house makes them live differently day to day and week to week. It’s like a living organism.”

VJAA’s advice to clients and architects is to consider how passive strategies help solve multiple design issues. “If you can do multiple things with something, clients will invest in it,”

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