

Passive solar could furnish a third of home heating needs

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Skylights are an aesthetically pleasing design choice, but they're also an underappreciated source of sustainable heat energy for buildings, according to a new study from UO researchers.

Passive solar heating systems collect [natural light](#) via skylights or windows and use it to directly heat spaces, without converting it to electricity. Based on a detailed analysis of heating needs and solar [energy](#) availability around the United States, such installations could supply a third of residential space heating needs nationwide, researchers found.

The findings, which appear in the November issue of *Renewable and Sustainable Energy Reviews*, are the first detailed survey of direct solar heating resources in the U.S.

The news is a boon for the increasingly urgent effort to move away from fossil fuels, said UO building scientist Alexandra Rempel, who co-led the new study alongside UO earth scientist Alan Rempel and engineer Sandipan Mishra of Rensselaer Polytechnic Institute. Heating uses about half of most people's home energy budget and is the biggest source of building-related carbon emissions. But most heating systems in the U.S. still rely on oil or natural gas.

"In the course of studying sustainable architecture, it became clear there were lots of resources we weren't tapping into," Alexandra Rempel said.

Passive solar heating was one of them. Although it's been used for centuries, it hasn't been widely put into practice as a deliberate sustainable design technique.

"People were dismissing the possibility that there could be enough solar energy available in [cold climates](#)," Rempel said.

That's partly because many passive solar [heating systems](#) in the U.S. have used vertical glass, like big windows. It's a good strategy when you have hot direct sun, Rempel said. But in cloudier and cooler climes, most diffuse solar energy comes from the upper reaches of the atmosphere, regardless of where the sun is in the sky. Tilted glass, like skylights set

into a sloped roof, is perfectly situated to capture that energy.

To find out just how much solar energy was being left unused, the Rempels and their colleagues integrated datasets cataloging solar radiation levels, outdoor temperatures and heating energy use across the U.S. at different times of year. The team, which also included former UO students Sierra McComas and Stacie Duffey, factored in many different variables, like the sun's position in the sky and the length of daylight hours.

And based on those calculations, they mapped out places and times of year when passive solar heat resources exceeded heating needs.

Per their calculations, there's about 7 megawatt hours of solar energy available per household annually, at times of year when homes need heating. Current technology could capture about 50 percent of that for use, assuming 10 square meters of glass per roof. That means direct solar heating could supply about a third of the heat a typical family needs in a year, if everyone installed a passive solar heating system.

"The idea isn't that it would take over traditional heating completely, but it would diminish the amount you need," Rempel said.

The paper provides detailed breakdowns for urban areas in different U.S. climates, data that could be useful for cities and regions looking to curb emissions. Cities with cold winters, like Boston and Chicago, and cities with frequent cloud cover, like Seattle, could particularly benefit.

For the Rempels, the work is more than just theoretical. During the pandemic, they installed a set of skylights in their own Eugene home, as well as sliding insulation panels to keep the [heat](#) in at night. Based on their typical energy usage and the size of their particular skylight, they've estimated that it'll reduce their heating bills by 80 percent.

Rempel is now connecting with architects and building designers, hoping to convince them of the merits of skylights in new construction, where it's cheaper and easier than adding them as a retrofit. In the future, she suggests, cities could provide incentives like rebates or tax breaks for buildings that incorporate passive solar heating, as there currently are for other sustainable design choices.

"Money is a go-to incentive," she said. But with skylights, which fill homes with light, "there's also the added experiential part."

More information: A.R. Rempel et al, Magnitude and distribution of the untapped solar space-heating resource in U.S. climates, *Renewable and Sustainable Energy Reviews* (2021). [DOI: 10.1016/j.rser.2021.111599](https://doi.org/10.1016/j.rser.2021.111599)

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