Overcoming barriers to heat pump adoption in cold climates and avoiding the 'energy poverty trap'

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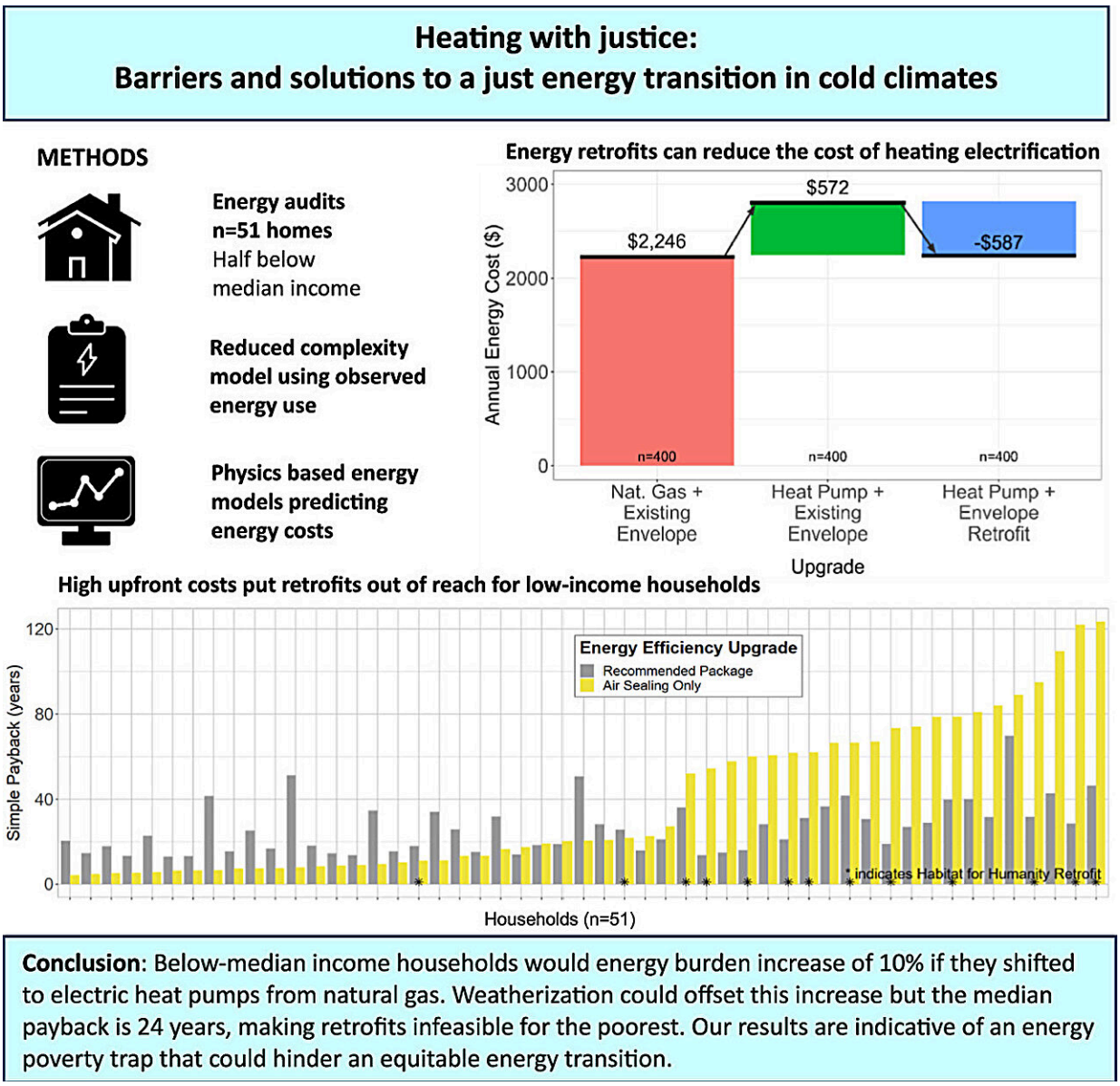

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Converting home heating systems from natural gas furnaces to electric heat pumps is seen as a way to address climate change by reducing greenhouse gas emissions.

But a new University of Michigan study of 51 Southeast Michigan households shows that switching to efficient, cold-climate heat pumps would increase annual utility bills by an average of about $1,100.

Home weatherization upgrades, such as adding attic insulation and sealing around doors and windows, could help reduce utility bills and make electric heating more affordable.

But those energy retrofits are expensive and are likely beyond the reach of many low-income households, which could lead to what the researchers call an energy poverty trap.

"The clean energy transition is hindered by an energy poverty trap because the extensive retrofits needed to make electrification affordable are themselves too expensive for low-income households," said study lead author Claire McKenna, a doctoral candidate at the U-M School for Environment and Sustainability.

"Our findings suggest that heat pumps are not a feasible economic alternative for households currently using natural gas, unless governments offset energy cost premiums through public funding. Policymakers should act to help lower the operating costs of heat pumps compared to natural gas for low-income households in cold climates."

The study was published online May 31 in the journal *Resources, Conservation & Recycling*.

Residential heat pumps are reversible air conditioners that use electricity to move heat from one place to another, providing both heating and cooling in a building. In the winter, heat pumps move heat from the outdoors into a building, and in summer they move heat from the inside to the outside.

Heat pumps are growing in popularity and for the last two years have outsold gas furnaces in the United States.

For their study, U-M researchers analyzed utility bills, thermostat settings and energy burdens—the proportion of income that households spend on electricity and gas costs—for 51 homes in Wayne and Washtenaw counties, half of them below median income levels. Then they used a heat pump coefficient-of-performance model to determine energy cost and energy-burden impacts of switching to a heat pump.

The researchers also hired a contractor to conduct energy assessments of the homes and to provide energy-retrofit recommendations, including estimated costs and savings. Members of the research team are from U-M's School for Environment and Sustainability, the Institute for Social Research and the School of Public Health.

The researchers found that converting homes to electric heat pumps would increase annual energy costs 58%, on average. Below-median-income households, which today experience a median energy burden of 6% (which is considered high and is twice the national average), would see that burden rise to 10% if they switched from natural gas heating to electric heat pumps.

Weatherization could offset the increase, bringing energy burdens back

down to pre-electrification levels. However, the median payback time for the retrofits was 24 years, making them "infeasible for the poorest," according to the study authors.

And it's not just the lowest income households that would feel the pinch of the heat pump transition.

Households earning $50,000 or more annually, which currently have a median energy burden of 2.6%, would see that number rise by more than one percentage point, on average, indicating that "energy burden could become a concern for households which are currently energy secure," according to the study.

The 51 homes in the study were, on average, 60 years old and were built in an era when Michigan did not have energy-efficient building codes. The cost of the average retrofit package recommended by the energy-audit contractor was $7,628.

On top of that, efficient cold-weather residential heat pumps typically cost between $5,000 and $10,000 for the hardware, and installation costs can double the total price tag.

"The upfront costs of weatherization and heat-pump installation can be very high," said study senior author Parth Vaishnav of the School for Environment and Sustainability. "Our findings clearly demonstrate the challenges associated with heat pump adoption in cold climates."

In the study, the lowest-income households had the least energy-efficient homes and also used the lowest amount of energy. That finding suggests that low-income households are likely not using enough energy to meet their health, safety and comfort needs, McKenna said.

Given that households below median income currently have a 6%

median energy burden on their existing natural gas heating systems, the transition to electric heat pumps "would severely worsen existing energy insecurity," the study authors wrote.

"That, in turn, could increase coping behaviors like trading off paying utility bills for paying for rent or food, or the underconsumption of energy in households that struggle to pay their bills. This could have huge ramifications for health," said study co-author Carina Gronlund, an environmental epidemiologist at the U-M Institute for Social Research and the School of Public Health.

The researchers identified three ways that policymakers can help lower heat pump costs for low-income households in cold climates. First, government-sponsored initiatives to advance more energy-efficient heat-pump technology are essential.

Second, state regulators should exercise "a more robust scrutiny" of utility company returns and create more opportunities to improve customer outcomes in the rate-making process. Most households in the U-M study were DTE customers, with a few supplied by Consumers Energy.

Third, states should consider implementing "percentage of income payment plans," known as PIPPs, which place a cap on energy expenditures relative to household income. Such programs can be paired with federal- and state-funded retrofit programs to simultaneously improve the building stock and mitigate energy poverty, according to the study authors.

"The economics of electrification are adverse for the existing housing stock in cold climates," the authors concluded. "Policy action is needed to make heating electrification viable."

More information: Claire McKenna et al, Heating with justice: Barriers and solutions to a just energy transition in cold climates, *Resources, Conservation and Recycling* (2024). DOI: 10.1016/j.resconrec.2024.107699