Heat pumps seem ready for prime time, so what’s the holdup?

How comfortable and clean heating could be just around the corner for everyone
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Heat pumps used to be something you’d only hear your tech-savvy neighbor talk about. But in the last two years, it seems like manufacturers have been announcing a newer, more capable, more appealing model every month. Many claim that their cold-climate heat pump models can heat homes with full capacity at temperatures as low as 5° Fahrenheit (F) (–15° Celsius [C]). And a number make that claim at even colder temperatures. On paper, heat pumps are ready for prime time. So what’s holding everyone back?

I recently returned from the American Council for an Energy-Efficient Economy ACEEE Hot Air Forum in Atlanta, where I presented E Source research on advanced heat pump controls and how to get heat pumps onto Main Street. What I learned in Atlanta reinforces my perspective. Here’s what I observed.

Stay ahead of the heat pump evolution

Fill out this short form to start a conversation about your needs and how we can help.

We need more field data, *not* lab data

The US Department of Energy’s Residential Cold Climate Heat Pump Challenge now has one season’s worth of complete field data from 22 models. The field data shows that while each model met the challenge requirements—efficiently operating down to –15°F (–26°C) at full capacity with an efficiency greater than 210%—each model approached the cold-climate challenge differently. Some drew power fairly consistently while others had a spikey load curve. Some can modulate based on grid need while others can’t. Some defrost coils on demand while others did so on a regular schedule. You catch my drift.

A lot of the variation stems from design and operational strategies, like when to run defrost cycles and how to ramp up compressors. But don't let me get lost in the details. The point is that, on paper, each compressor achieves the same goal, but different behaviors mean different and unpredictable loads on the grid.

Utilities must target AC users for heat pump programs. Not because the small incremental cost is easier to cover with an incentive, but because the utility and customer values align and happen to be more than twice that of average AC users.

When it comes to field data, public records are important! California's statewide [TECH Clean California] program is a great (and growing) source for field data. Public sources like this one track the type of systems in various homes and their performance.

Digging into the TECH program field data, the program's implementer found that savings are exponentially higher for *super coolers* (people who use their air conditioning [AC] more than the average user). Lesson learned? Utilities must target AC users for heat pump programs. Not because the small incremental cost is easier to cover with an incentive, but because the utility and customer values align and happen to be more than twice that of average AC users.

And if you're an engineer reading this, let me put it this way: It's not because ACs are inherently less efficient. It's because most people don't install the most efficient AC. But heat pumps use the latest and greatest components and, as a result, are more efficient.

Check out the TECH Project Data Visualizations and public records from the Massachusetts Clean Energy Center for more field data and inspiration to launch your own resource.

Demand flexibility is critical

Heating and fleet electrification may have a bigger impact on the grid than passenger EVs. If we want to electrify a significant chunk of building heating, heat pump electric demand needs to be flexible.

Two pilots in the UK—HeatFlex and EQUINOX—show that residential demand flexibility using heat pumps is possible. Pilot participants reduced their load by an average of 1.5 kilowatt-hours during each two-hour event.

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Customers participating in these pilots were asked to identify their comfort window and allowed to preheat their homes before the event. The idea of heating demand response isn't entirely new, but we'll need more pilots in the US and Canada to determine scalability and assess costs and benefits. For now, these two projects illustrate an opportunity that utilities need to take seriously.

Are ground-source heat pumps a diamond in the rough?

Hydro-Québec is effectively giving away ground-source heat pumps. The higher incentive is well worth the system benefit the utility earns from these systems.

Compared to air-source heat pumps, ground-source systems are more consistently efficient, especially during extreme cold and hot weather events. This reduces system cost and, therefore, utility bills.

Interoperability of legacy and new equipment is still lacking

Third-party integrated controls like [Flair Puck Pro] are a great option for coordinating mini split heat pump controls with existing central air and heating systems. But what about coordinating centralized heating with newer, inverter-based heat pumps?

In cold climates, customers can buy an expensive, cold-climate model and completely remove their existing furnace, or they can install a standard model and hope the systems can talk to each other.

Want more control? Many manufacturers lock customers into their own ecosystem, like we see with the [Mitsubishi kumo cloud.] It’s dependable, but proprietary and expensive.

Smarter thermostats that can coordinate the controls for different types of heating equipment can also help customer reduce their bills—especially when they sign up for time-varying pricing.

Our research shows that time-varying rates are more effective when paired with technology that responds to price signals and learns from customer behavior.

Free heat pumps might not be enough

Even with incentives, heat pumps run on electricity, and that, depending on where you live, can be expensive. Like how utilities are experimenting with new EV-specific rates to charge customers a flat monthly rate if they charge their vehicles during specific times, customers might now be able to pay a lower rate for heating their homes during off-peak hours or dialing back their setpoint during peak hours.

In some cases, customers might not even need to change their heating and cooling behaviors: heat pumps get a special rate, but other uses are more expensive or subject to time-varying price signals.

Our research shows that time-varying rates are more effective when paired with technology that responds to price signals and learns from customer behavior. Maybe it’s just me, but I want to see more pilots or technology demonstrations that validate this claim for North American heat pumps.

Are clean heat standards the path forward?

Full electrification of space heating in buildings might not make sense everywhere. In some cases, hybrid technology that coordinates gas and electric fuels might make more sense from both a cost and carbon emissions perspective. In some cases, networked geothermal systems might work well. In others, combined heat and power or waste heat recovery systems might make more sense.

I think carbon-emission standards are the reliable path forward to more clean heat. But to roll them out well, everyone has to be at the table—utilities, regulators, government, customer focus groups, and more.

Whatever the flavor, one policy option that might sway customers and contractors to pick the right strategy is a clean heat standard that specifies the carbon emissions, *not* the technology itself. While many states are considering these standards, some jurisdictions are currently working on them, including:

- Colorado
- Vermont
- Massachusetts
- Maryland

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