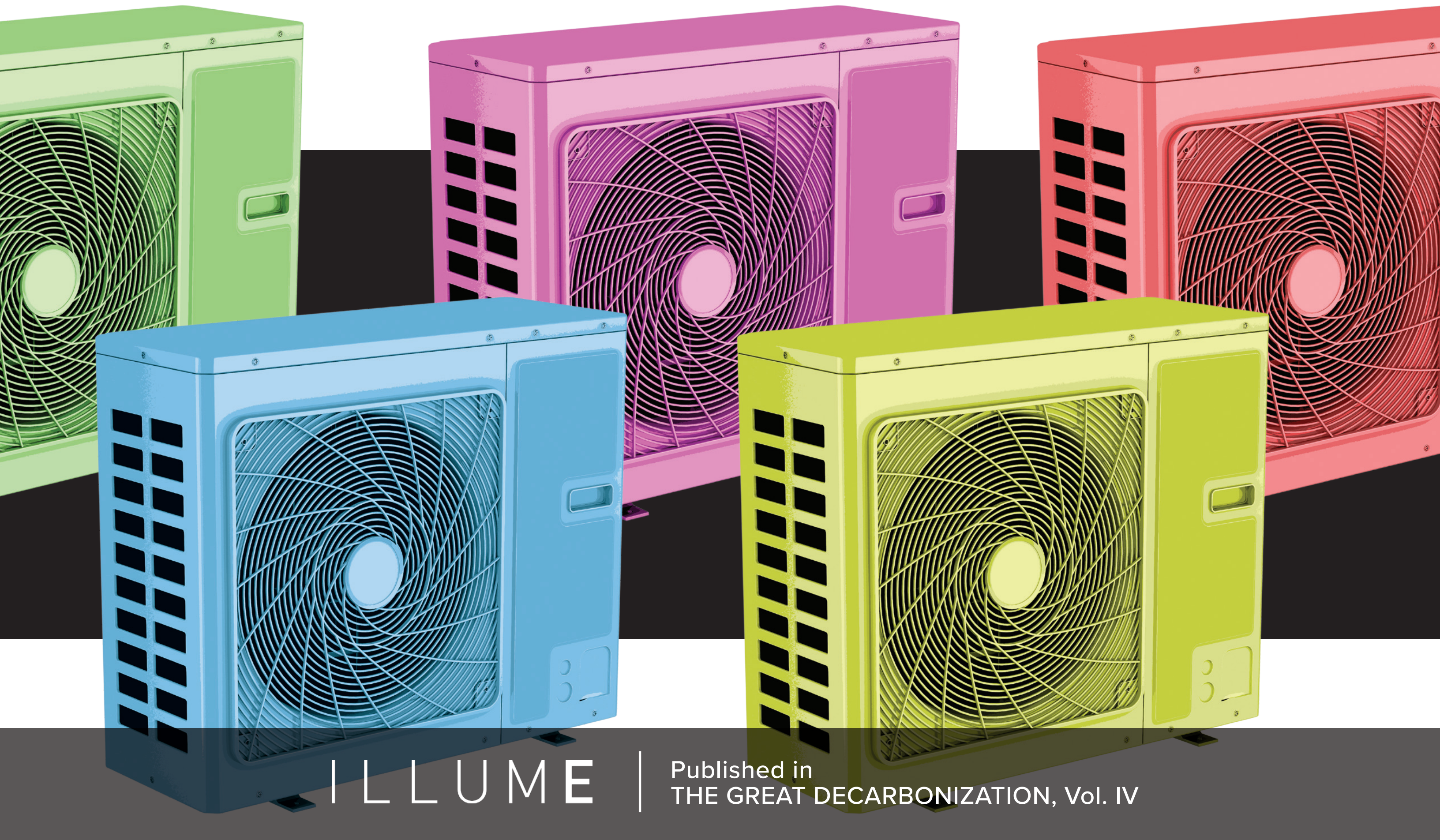
heat pumps take center stage

As today's most economical way to electrify space heating in the U.S., heat pumps represent both the opportunities and challenges central to beneficial electrification efforts.

How can heat pumps push the energy industry toward a greater and more equitable decarbonization strategy?



ILLUME | Published in
THE GREAT DECARBONIZATION, Vol. IV

Environmental advocates talk a lot about electrification because unlike natural gas, propane, and gasoline, electric power can largely be provided at scale through cost-competitive, zero-emission sources. In their push toward electrification, advocates frequently cite space heating and transportation as easy entry points because electric powered versions of these technologies are readily available in retail markets at cost-competitive prices.

However, transforming the space heating and transportation markets isn't easy or straightforward, and there is not a clear playbook for successful beneficial electrification (BE) strategies. Heat pumps, however, are providing organizations with an opportunity to make progress on electrification and learn critical lessons along the way. As we tackle this new frontier, the frameworks, and decisions we make today for electrifying space heating have the potential to influence future efforts in industries with more nascent electric powered technology, such as manufacturing. So what electrification playbooks are heat pumps writing?

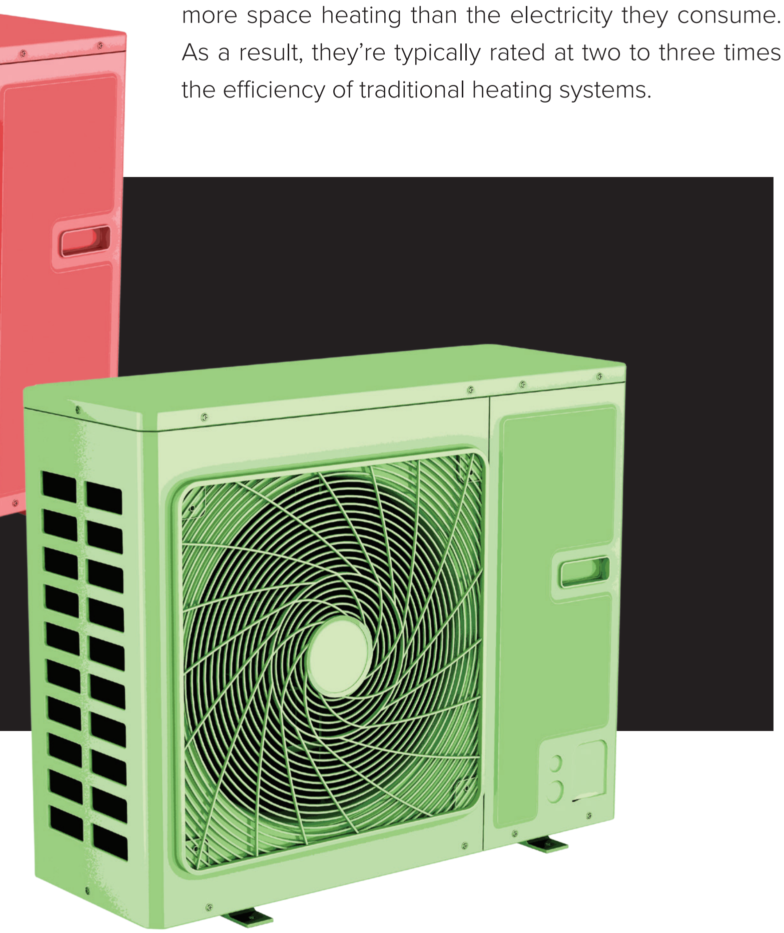
Electrification refers to converting end uses to electricity from an earlier power source such as natural gas, gasoline, propane, or oil. Beneficial electrification (BE) is electrification that meets one of the following conditions, without negatively affecting the other two.

- Saves consumers money or time
- Enables better grid management
- Reduces negative environmental and human health impacts

Why heat pumps?

In addition to providing an electrified alternative to space and water heating, heat pumps offer:

Two to three times the efficiency of traditional heating systems. Heat pumps leverage available heat in the outdoor air (even at low temperatures) to provide more space heating than the electricity they consume. As a result, they're typically rated at two to three times the efficiency of traditional heating systems.



Many applications for ubiquitous end use, providing a large market potential. Top contenders currently include air source heat pumps (ASHP) used for space heating and cooling and heat pump water heaters (HPWH) used for domestic hot water.

An established market, including several major manufacturers, vendors, and distributors that provide this technology.

Lower operating costs in some regions, particularly for high efficiency units going into applications with oil or propane baselines.

In addition to the things heat pumps already have going for them, there are emerging trends creating yet more opportunity for heat pumps. These include a growing demand for space cooling in what have traditionally been heating-dominated climates, like the Pacific Northwest, and the rapidly accelerating demand for affordable housing and accessory dwelling units (ADU) or granny flats sweeping the nation – for which ductless heat pumps (DHP), a type of ASHP, have become the go to heating and cooling system.

But there are challenges too.

A couple key issues have limited the momentum for heat pump adoption, including:

Limited customer demand. While installations have increased, many customers remain unaware of heat pump technology. Customers with existing electric resistance heat may pose a distinct challenge, as electric resistance heating systems tend to have a long operating life which makes the opportunity for replace-on-failure upgrades less common.

Confusion in the market. In some regions, contractors are actively promoting heat pumps (notably ASHPs) to customers while other contractors are actively discouraging their adoption. This appears to stem from contractors' lack of familiarity with heat pumps or misinformation being spread in the market by competitors to heat pump appliances.

Heat pump performance in extreme cold. While extended capacity (or cold climate) heat pumps are becoming increasingly available, heat pumps struggle to effectively meet heating loads in some climates as the sole heating system.

Thinking revolution rather than evolution: While EE programs tend to work on the customer side of the meter, decarbonization is much more sweeping. For example, some statewide programs like those that exist in Oregon, Maine, Vermont, and Wisconsin, could consider decarbonization initiatives, measures, or offerings far outside our current paradigm. These might include working with construction crews to reduce natural gas leaks or working with local agriculture or forestry groups to change practices to provide decarbonization and carbon sequestration.

Lack of sufficient training for how to optimize ASHP performance in homes with supplemental heating systems. Contractors who are not familiar with sizing, controls, lockouts, and switch over temperature setpoints can create installations that negatively impact both energy savings and comfort.

The environmental impact of some commonly used refrigerants. Refrigerants are key to heat pump technology. We know refrigerants can impact the environment via decomposing in the atmosphere and some eventually contaminate the ground and water. While some low global warming potential (GWP) refrigerants exist and progress is being made on yet more emerging versions, refrigerants continue to have a detrimental environmental impact.

For more information on **Emerging Refrigerant Tech**, see page 60.

Increased operating costs and economic conditions in some regions, particularly where natural gas prices are sufficiently low compared to electricity prices, make the payback from electrifying space heating unrealistically long, even with an incentive.

And there are additional longer-term challenges that still exist. First, large-scale electrification of heating may dramatically increase winter peak demands on the electric grid and introduce new grid demand management challenges. Second, we do not have a clear way to identify and prioritize potential decarbonization measures through our traditional program funding mechanisms. And finally—but importantly—within our traditional DSM framework, there might be places where other decarbonization strategies (i.e., strategies other than electrification) are more cost-effective in the near term. This is especially so when we consider the total potential infrastructure costs of making buildings ready for the electrification of new end uses. For example, potentially lower cost decarbonization strategies might include approaches like using hydrogen power for certain industrial needs, and although currently limited in potential, using renewable natural gas.

Integrating BE into EE

EE programs may be well suited to administer BE directives as EE programs and program staff have the infrastructure and market knowledge to prioritize technologies, affect adoption rates, and monitor their progress. Some states, such as Massachusetts, Vermont, and Maine, are opening their energy efficiency programs to support initiatives beyond EE, including beneficial electrification. For example, Wisconsin's Focus on Energy policy manual allows fuel switching in cases where it is cost-effective from a total resource and customer perspective. The Illinois Technical Reference Manual (IL TRM) currently lists measures that explicitly allow fuel switching (both from natural gas to electric and from electric to natural gas), including both electric and gas heat pump measures, as well as a gas combined heat pump measure.

However, in many regions policies regarding EE and BE, and how utilities are allowed or not allowed to promote or get credit for BE, are mostly lacking. There are so few statewide policies in place right now that most utilities lack a viable means to fund BE actions within EE programs. The few operational policies that do exist in the U.S. are relatively young yet to demonstrate long-term success. At this point, it remains to be seen whether these policies will continue as they currently exist or undergo meaningful and disruptive changes.

Fuel Switching, also referred to as fuel substitution, refers to switching from one fuel source to another. While the definitions and terms of which fuels are included vary by state, fuel switching is generally a movement toward the lowest-carbon fuel choice. Emerging policies are attempting to create additional criteria including accounting for the full greenhouse gas (GHG) and fuel-savings benefits that fuel switching yields.

The horizon

The next generation of products, including ducted ASHPs that can integrate with existing furnaces, a residential-sized variable refrigerant flow (VRF) heat pump, and products that can use emerging types of more environmentally friendly refrigerants, show promise in overcoming some remaining barriers to adoption.

There are also emerging heat pump applications, including heat pump clothes dryers, and the potential to value stack by using heat pump appliances, such as HPWHs, to provide demand flexibility by shifting load to off-peak times.

New rate designs may also increase the appeal of heat pumps in some applications.

And innovation in codes and standard work include ideas such as a requirement that residential central air conditioners be capable of refrigerant-based heating. Finally, as EE programs and market actors become more familiar with heat pumps, we can expect to see innovative marketing strategies, program designs, and trade ally support for this technology.

In short, all signs suggest that we'll be hearing about heat pumps for a long time.

Getting Started

Here are some initial steps to consider:

Foundational research. Foundational research might take different shapes depending on the context of your region. This research might include understanding common BE measures, common heating fuels in the region, regional context for counting savings from or evaluating BE or BE-adjacent measures, customer and contractor sentiment and awareness of high-profile BE measures, as well as potential barriers and drivers. This research can also help to find the appropriate balance between efforts to increase heat pump adoption compared to efforts to further improve the efficiency of heat pump technologies. At this stage, it can be helpful to share your findings within your organization to begin developing a common language across the relevant teams.

Strategic identification of measures. Identify entry points for heat pumps, or heat pump applications and products to strategically pursue. Ideally these measures can contribute to program savings immediately (e.g., with a current practice or time-of-sale baseline) while also providing learning opportunities and creating some degree of market momentum (e.g., by increasing customer and contractor awareness).

Identify areas of influence. Whether intending to increase heat pump adoption or drive further heat pump efficiency improvements, it can be beneficial to identify the actions your organization can take to affect change. For example, you may be able to adjust incentive levels, marketing strategies, or host contractor trainings to affect market adoption.

Demonstration projects. Consider field tests or demonstration projects to test your most promising entry points and areas of influence. These tests can be designed to determine the viability of strategies and to learn lessons from new heat pump products and measures. For example, your organization might consider piloting a HPWH measure to understand comfort impacts, bill impacts, and user experience. Such a study could also identify lessons learned from the field, including insights regarding installation, contractor experience, and potential program implementation. Where the demonstration projects are successful, the team can move forward scaling the strategy, developing recommendations to modify technical references, or pursuing regulatory changes as appropriate.

A decarbonization success story

Buoyed by supporting policies, Efficiency Maine Trust's heat pump program appears to have proven that the scalable, market-based electrification of heating can work.

Since 2012, more than 75,000 high-performance ASHPs have been installed across the state's 800,000 homes and businesses. With over 1,000-plus currently registered Maine heat pump contractors, the state saw 20,000 heat pumps installed in the past year putting Maine on track to hit a goal of installing another 100,000 heat pumps in the next five years.[1]

Maine's program includes online tools that allow customers to compare annual home heating costs across fuel types and heat systems. The tool also helps customers find registered heat pump vendors and customer education such as user tips, installation considerations, and FAQs.

Trade allies in the program have access to training scholarships, sales tools (brochures, case studies), and an e-newsletter with best practice tips and notices of upcoming exhibiting opportunities.

Much of this momentum is driven by Maine's statutory carbon reduction targets and related policies, including policies directly addressing the advancement of beneficial electrification.

For example, state law requires Efficiency Maine to use revenue from the region's forward capacity market to fund the installation of high-efficiency heat pumps.

Public Law ch. 476 established in 2019 required that the state develop an action plan to achieve Greenhouse Gas (GHG) targets. In the Climate Action Plan delivered to the Governor in December 2020, the state set a target of installing whole house heat pumps in 115,000 homes and heat pumps providing supplemental heating in an additional 130,000 homes by 2030.

1. Michael Stoddard, Efficiency Maine Trust, "Maine's Keys to Successful Heat Pump Programs," (AESP) (July 2021).