

**AMERICAN
ECONOMIC
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Lessons From the Heat Pump Market:

Why Market Structure Analysis Matters for Effective Industrial Policy Design and Implementation

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EXECUTIVE SUMMARY

The Inflation Reduction Act (IRA) is the centerpiece of the Biden administration's climate policy, with a key focus on decarbonizing the nation's 123 million homes by subsidizing the adoption of low-carbon infrastructure and technologies. The IRA includes \$369 billion in climate spending for many forms of renewable technologies, including solar and nuclear energy, electric vehicle subsidies, advanced manufacturing, and climate-smart agriculture. In concert with adjacent industrial policies passed under the Biden administration, the IRA breaks from decades of labor-hostile neoliberal policymaking and inaction with respect to climate change, and it represents a new, activist role for public governance over markets.

The goals of the IRA are the adoption of new climate technologies, the reshoring of key manufacturing segments, and the creation of good, stable jobs. Parallel competition concerns are central to ensuring these goals are met. Only with open, decentralized, and competitive markets will these new technologies and new industries be able to grow at the scale and quality that is needed.

This report focuses on the market for residential heat pumps, one of the key energy-saving technologies supported by the IRA. Like many other technologies supported by the IRA, supports for the heat pump market come in the form of demand-side subsidies, which pay for part of the cost to a final buyer in purchasing the technology. As a result, the policy itself does not incorporate a detailed examination of the market structure for the manufacturing and installation of heat pumps, including a supply chain from global manufacturers all the way down to local heating, ventilation, and air conditioning (HVAC) installers. Each step in that supply chain presents unique difficulties with respect to competition and industrial policy implementation.

We find several concerning trends in the market for heat pumps that industrial policy implementation should take into consideration. First, heat pump manufacturers continue to pour enormous amounts of their financial resources into investor compensation in the form of dividends and stock buybacks, rather than making larger investments in expanding capacity. Second, acquisition activity among these manufacturers appears to be speeding up in the wake of the IRA's passage, with a few multibillion-dollar deals already announced or recently consummated. Third, there are concerning signs that consolidation at the local level of installation and distribution may lead to price increases down the line, with manufacturers acquiring regional distributors and private equity firms acquiring HVAC installers at a concerning rate. With the price of heat pumps continuing to rise, the risk is that the increased demand from IRA subsidies may simply be captured by consolidating interests in the heat pump

supply chain, meaning that final consumers and buyers will not benefit directly from the IRA's subsidies. This indicates that the Biden administration's industrial policy and competition priorities should be more integrated with one another.

This report is also relevant to markets beyond heat pumps. Many of the dynamics of demand-side industrial policy highlighted in this report will likely also apply to other market segments and industries where a similar policy design is applied. For instance, adjacent policies, such as the CHIPS Act for semiconductor production and the Infrastructure Investment and Jobs Act for infrastructure spending, are implemented with varying degrees of attention to the underlying market structure in semiconductor chip fabrication and infrastructure, respectively. Yet, without detailed attention to market segments and structure, any subsidy's effectiveness in increasing production and lowering consumer prices may be blunted by problems of limited competition and investors' remarkably high expectations for financial returns.

The following recommendations are intended to promote competition throughout the residential heat pump market and put downward pressure on total installed costs:

- Shareholder compensation should be limited and investments in productive capacity should be promoted.
- The \$250 million Defense Production Act procurement should be highly targeted to individual components, such as inverters or interoperable controls, and should benefit all domestic manufacturers.
- The government should support entrepreneurs who are reimagining heat pumps to reduce installation labor inputs.
- A government office charged with industrial policy management should collect and analyze market data for all industries targeted by the IRA, including data on market structure, regional coverage, and pricing. Such an office should collect standardized heat pump cost data across the country to guide policymaking through 2030, as well as track labor and supply chain resiliency.
- Federal agencies should coordinate in planning for significant growth in the HVAC labor market.
- Interoperability between heat pumps and thermostats should be mandated to avoid lock-in and promote innovation.

INTRODUCTION

The Inflation Reduction Act (IRA) was passed on August 16, 2022, after weeks of legislative debate. Despite numerous compromises, the IRA represents almost \$400 billion in federal spending to expand the markets and infrastructure to mitigate climate change. With the scale of investments in electric vehicles, residential heating and energy efficiency, renewable energy sources like wind and solar, and climate-smart agriculture, the federal government is putting its weight behind a large-scale green transition to mitigate the looming threat of climate change. With the IRA's prevailing wage and apprenticeship provisions, it is also a success for labor advocates, with the government supporting requirements that the newly created jobs offer stable and well-compensated employment. Lastly, in turning the page away from a generation of neoliberal, hands-off economic policymaking, and in conjunction with other industrial policies like the CHIPS Act and the Bipartisan Infrastructure law, the IRA is a huge step forward for progressive policy.

The IRA disburses funding using different methods depending on the specific program, but one of the most common ways is through tax credits, which subsidize a portion of the final buyer's costs of purchasing the technology in question. While the IRA does include domestic content requirements or bonuses to guarantee or encourage the re-shoring of manufacturing, in many cases these subsidies are being disbursed with limited attention to the market structure in the targeted sector. Without such attention, key bottlenecks, acquisitions, or dominant actors in that market segment might be able to capture the IRA subsidies just by raising their prices, a potential outcome that should concern any supporters of the Biden administration's policies.

This is precisely what we are seeing in the market for heat pumps, one of the technologies targeted for adoption by the IRA's subsidies. Heat pumps are a mechanism for heating and cooling homes that significantly reduces carbon emissions as compared with fossil-fueled heating systems. Currently, only about 15% of American homes (19 million) have heat pumps as their primary method for space heating.¹ The IRA allocates up to \$9.05 billion for heat pumps through funds to be administered by the states, and it provides an additional tax credit of up to \$2,000 per year for heat pumps. It is difficult to predict the total number of homes that are likely to be retrofitted with heat pumps as a result of the IRA, but one estimate is 7.2 million from the federal tax credits alone.² Substantial demand growth for heat pumps is necessary to achieve

1 Energy Information Administration, Residential Energy Consumption Survey (RECS) 2020, Table HC6.1, <https://www.eia.gov/consumption/residential/data/2020/hc/pdf/HC%206.1.pdf>.

2 David Smedick, Rachel Golden, and Alisa Petersen, "The Inflation Reduction Act Could Transform the US Buildings Sector," RMI, August 31, 2022, <https://rmi.org/the-inflation-reduction-act-could-transform-the-us-buildings-sector/>.

the Biden administration's climate goal of a 50%-52% reduction of emissions from household fossil-fuel combustion by 2030.³ Meeting the climate goal will require installation growth rates of 10%-15% or more per year for the next decade (and beyond). Despite the opportunity to cut carbon emissions, replacing gas, propane, and oil furnaces in approximately 70 million American homes⁴ is a daunting challenge. Heat pumps need to be produced and deployed en masse, requiring advanced skills and custom installations.

The IRA takes its effect only by increasing the consumer's willingness to pay in proportion to the amount of the subsidy. If the market for heat pumps were competitive, this would mean that heat pumps would become effectively cheaper for consumers, manufacturers would increase their output, and the IRA's goals would be achieved. Following conventional wisdom whereby cost for new technologies consistently decreases over time as companies "learn by doing," expanding the market in this way would be expected to make heat pumps cheaper over time. However, that effect is not seen in practice: the price of heat pumps is rapidly increasing rather than falling.

At the level of manufacturers, among our key findings is that, on an annualized basis, the IRA's heat pump subsidies are dwarfed by the current magnitude of shareholder compensation among the 10 publicly traded manufacturers we analyzed (Bosch, Carrier, Daikin, Emerson, Haier, Lennox, LG, Mitsubishi/Trane, Panasonic, and Samsung). We estimate that the combination of dividends and share buybacks from these manufacturers equals \$16.9 billion in the past year, as compared with the IRA's \$0.9 billion in subsidies (annualized) – a factor of 18.7 to 1. Even excluding the diversified conglomerates (companies that only make many unrelated products such as Bosch, Haier, LG, Mitsubishi/Trane, Panasonic, and Samsung), the four "pure play" manufacturers (those such as Carrier, Daikin, Emerson, and Lennox that only manufacture HVAC systems) have compensated shareholders \$5.2 billion in the past year, exceeding the IRA's annual subsidy by a factor of 5.8 to 1.

While heat pump manufacturers operate in a global market, distribution and installation of heat pumps is a distinctly local market and accounts for over half of the final cost of heat pumps. Accordingly, serial acquisitions of smaller, local businesses could result in regional monopolies on the installation of HVAC systems, including heat pumps. Even prior to the IRA, private equity firms were buying up independent HVAC companies at a breakneck speed, and the shortage of trained HVAC technicians in the United States bodes poorly for the possibility of new entrants. This is likely to lead to bottlenecks throughout the supply chain, to be exploited for the benefit of private equity shareholders, who famously demand outsized premiums.

³ Brad Plumer and Nadja Popovich, "The U.S. Has a New Climate Goal. How Does It Stack Up Globally?," New York Times, April 22, 2021, <https://www.nytimes.com/interactive/2021/04/22/climate/new-climate-pledge.html>.

⁴ U.S. Energy Information Administration, Residential Energy Consumption Survey, 2020, Table HC1.1, <https://www.eia.gov/consumption/residential/data/2020/hc/pdf/HC%201.1.pdf>.

Lastly, acquisitions by heat pump manufacturers could undermine the IRA's success by undermining competition and diverting financial resources that would be better directed towards productive investment. In the market for heat pumps, private equity giant Blackstone just finalized a \$14 billion acquisition, announced after the IRA's passage, of Emerson Technology's environmental sciences division, which focuses on HVAC equipment.⁵ Carrier, one of the leading HVAC manufacturers, recently announced a planned \$13 billion acquisition of Viessmann Group's boiler and heat pumps unit.⁶ And as detailed in this report, several heat pump manufacturers are making vertical acquisitions of distributors, raising the risk of exclusive dealing in order to reduce competition between manufacturers in a given region.

In order for industrial policies to reach their full potential in implementation, subsidies should be targeted with a set of clear rules to ensure competition by the implementing agency, paired with interagency coordination to ensure that the policies work as intended. For example, the large-scale subsidies for heat pumps may have induced some of the merger and acquisition activity that we see today in the heat pump market, and this consolidation should be thoroughly scrutinized by the antitrust agencies, even if the IRA itself does not assign them a clear implementation role. Correspondingly, the implementing agencies (the Energy and Treasury Departments) should add regulations as guardrails against runaway cost increases from consolidation, it should do so.

In this report, we first outline basic trends in the price of heat pumps in recent years, highlighting the rapidly exploding costs of heat pumps and the large degree of investor compensation, in the form of stock buybacks and dividends, that heat pump manufacturers have pursued. Second, we challenge conventional narratives around new climate technologies and industrial policy, namely that prices will invariably continue to fall as the market for the new technology grows. Third, we explore the organizational features of the heat pump market that indicate a mixed picture of relatively dispersed manufacturing, potentially very concentrated local markets for installation, and a large projected labor shortage in the coming decade. Lastly, we provide a series of recommendations for industrial policy implementation for heat pumps, with lessons for other, similar markets targeted by the IRA.

⁵ Blackstone Newsroom, "Blackstone Completes Acquisition of Majority Stake of Copeland, Formerly Emerson Climate Technologies," May 31, 2023, <https://www.blackstone.com/news/press/blackstone-completes-acquisition-of-majority-stake-of-copeland-formerly-emerson-climate-technologies/>.

⁶ Reuters, "Carrier to buy German firm Viessmann's unit in \$13.17 bln deal," April 25, 2023, <https://www.reuters.com/markets/deals/carrier-buy-german-firm-viessmanns-unit-1317-blm-deal-2023-04-25/>.

Summary of the Inflation Reduction Act’s Heat Pumps Subsidies

There are three major provisions of the IRA that pertain to heat pumps: (1) tax credits under Section 50121, entitled Home Energy Performance-Based, Whole-House Rebates (HOMES); (2) electrification tax credits under Section 50122, entitled High-Efficiency Electric Home Rebate Program (HEEHRP); and (3) President Biden’s use of the Defense Production Act (DPA) to promote domestic clean energy manufacturing, including heat pumps. Together, these three provisions provide up to \$9.05 billion to deploy heat pumps.⁷ Finally, a \$2,000 tax credit is available (uncapped), but it is not known how many taxpayers will utilize it.

(1) HOMES (\$4.3 billion). Since HOMES rebates are determined by estimates of energy savings as a result of any type of improvement, not necessarily heat pumps, calculating the applicable rebate is somewhat complex. At a minimum, households can claim a tax credit for 30% of the cost of a heat pump, up to \$2,000. However, state programs will offer low- and moderate-income (LMI) households rebates for heat pumps at the point of sale of up to 80% of the project cost or up to \$8,000.⁸

(2) HEEHRP (\$4.5 billion). The means-tested rebates for heat pumps are given below.

Tier	Amount	Payment Mechanism
Lower-income households (below 80% area median income)	100% of heat pump cost up to \$8,000	Point-of-sale discount
Medium-income households (80%-150% area median income)	50% of heat pump cost up to \$8,000	Point-of-sale discount
Higher-income households (above 150% area median income)	30% of heat pump cost up to \$2,000	Tax credit claimed when filing annual tax return

(3) DPA (\$250 million). Section 30001 of the IRA appropriated \$500 million in DPA funding to spend on manufacturing in solar, transformers and grid components, heat pumps, insulation, electrolyzers, and other technologies. The Biden administration has allocated \$250 million for heat pumps. The Department of Energy has released a request for information (RFI) asking how the funds should be allocated, but as of this writing, no further determinations have been made.

(4) 25C Residential Energy Efficiency tax credit (uncapped). Heat pumps are eligible for a tax credit of up to \$2,000 per year beginning in the 2023 tax year, with another \$600 tax credit for electrical panel upgrades if they are installed in conjunction with a heat pump. As of this writing, there is no official estimate of the number of taxpayers that are expected to claim this tax credit.

⁷ Note that a basket of home energy technologies are eligible for HEEHRP and HOMES rebates, including heat pumps, electric panel upgrades, insulation, and many others. Thus, the percent allocation of HEEHRP and HOMES for heat pumps specifically is not knowable at this time.

⁸ For a helpful summary of the HOMES rebates, see Kara Saul-Rinaldi and Skip Wiltshire-Gordon, “The HOMES Rebate Program: Efficiency for Everyone,” AnnDyl Policy Group, <https://www.anndyl.com/the-homes-rebate-program-efficiency-for-everyone/>.

FINANCIAL TRENDS

INTRODUCTION TO HEAT PUMP PRICING

The total cost of an installed heat pump can range widely, from \$3,000 to \$69,882, according to a California database of approximately 9,000 installations in 2021-2022.⁹ Unfortunately, in most cases, heat pumps are significantly more expensive to install than traditional gas-fired furnaces and air conditioners. Making matters worse, manufacturers have recently raised their prices by 10%-30% or more, and rising wages for installation labor have put strong upward pressure on the total installed price for homeowners. These price increases are eating away at any potential cost benefits to consumers from the IRA tax credits.

There is no national data set on heat pump prices, so it is difficult to identify key statistics such as regional cost differences or the percentage of total cost allocated to hardware vs. installation labor. Nevertheless, anecdotal reports indicate that some customers are already seeing total price increases well in excess of the \$2,000 tax credit from the IRA. Manufacturers have reported record revenues and profits even as they raise prices and cite inflationary pressures. At a moment when climate experts are calling for a “wartime mobilization” of industry in order to cut carbon emissions 50% by 2030, capital should be allocated to productive capacity, not shareholder compensation.

Many proponents cite the advantage of heat pumps’ lower operational costs relative to natural gas or oil, arguing that higher upfront costs can be managed with financing schemes in a manner similar to the rooftop solar industry. While heat pumps do have lower operational costs in many locations,¹⁰ this paper focuses not on cost comparisons with fossil fuel alternatives but rather on the inflationary threat to heat pump adoption. If the policy objective is to achieve a durable and decisive economic advantage for heat pumps over fossil fuel alternatives on a lifecycle basis, we cannot ignore the root causes of the price increases that are undermining that effort.

⁹ TECH Clean California. Data set updated October 20, 2022. See “Total Project Cost per Unit (\$).” <https://techcleanca.com/public-data/download-data/>.

¹⁰ It is not guaranteed that all American homes will have lower operating costs with heat pumps as compared to alternatives. We recommend site-specific analyses and are skeptical of broad claims. For instance, one recent California study found that 30% of homes would see their energy bills rise after switching to heat pumps due to the relatively high cost of electricity and other factors. Recurve, “Finding Customers Who Will Save With a Heat Pump,” October 11, 2022, <https://www.recurve.com/blog/how-to-use-meter-data-to-identify-good-and-bad-candidates-for-heat-pumps>. Policy support beyond the IRA’s upfront subsidies will be necessary if heat pumps are operationally more expensive.

PROFITS AND INCREASED SHAREHOLDER COMPENSATION

We identified 11 major manufacturers of residential heat pumps that are widely accessible to homeowners in many geographic locations.¹¹ Ten are publicly traded. Of these, six are industrial conglomerates (Bosch, Haier, LG, Mitsubishi/Trane, Panasonic, and Samsung). Among these firms, it is very difficult to identify profits from heat pumps compared to other, unrelated lines of business. However, four major “pure-play” heat pump and heating, ventilation, and air conditioning (HVAC) manufacturers – Carrier, Daikin, Emerson, and Lennox – all recently announced record revenues and profits.

- **Carrier** announced in December 2022 a 23% increase in its shareholder dividend.¹² During the third quarter of 2022, Carrier repurchased \$247 million of its common stock and approved another \$2 billion in future repurchases.¹³
- **Daikin** reported record revenues and profits at the global level.¹⁴ The company has paid out approximately \$450 million in shareholder dividends in the past year.
- **Emerson** announced in October 2022 that its full-year sales in the Americas were up 12% year-over-year and earnings per share were up 42%, an all-time record. The profit margin of the “climate technologies” division was 21%. The company announced its intent to compensate shareholders with \$1.2 billion in dividends and \$2 billion in share repurchases in 2023.¹⁵
- **Lennox** announced in October 2022 that revenue had increased by 17% and profits by 12%, both quarterly records. For the residential division, profits reached a record \$154 million, up 7% compared to a year earlier.¹⁶

Total shareholder compensation in the past year was calculated by adding dividend payments and share repurchases. Results are shown below, separating the “pure-play” manufacturers from the conglomerates.

¹¹ Manufacturers considered include Bosch Thermotechnology, Carrier, Daikin/Goodman/Amana, Emerson, GE/Haier, Lennox, LG HVAC, Mitsubishi/Trane/American Standard, Panasonic, W, and Samsung HVAC. We excluded several manufacturers: Johnson Controls/Hitachi because they focus on cooling only; AAOON because they focus on commercial buildings; and Water Furnace because they focus on ground-source heat pumps.

¹² Carrier, “Carrier Board of Directors Increases Quarterly Dividend by 23%,” December 7, 2022, https://www.corporate.carrier.com/news/news-articles/202212_carrier-board-directors-increases-quarterly-dividend-23.html.

¹³ Carrier Global Corporation Form 8-K, October 22, 2022, <https://ir.carrier.com/static-files/d2846881-1d2c-4136-87b2-375d50f16947>.

¹⁴ Daikin Global Financial Data, <https://www.daikin.com/investor/financial> (last accessed January 25, 2023).

¹⁵ Emerson, “Emerson Reports Fourth Quarter and Full Year 2022 Results; Provides Initial 2023 Outlook,” October 31, 2022, <https://www.emerson.com/en-us/news/corporate/emerson-fourth-quarter-2022-results>.

¹⁶ Lennox International, “Lennox International Reports Record Third Quarter Results,” October 27, 2022, <https://lennoxinternational.gcs-web.com/node/26176/pdf>.

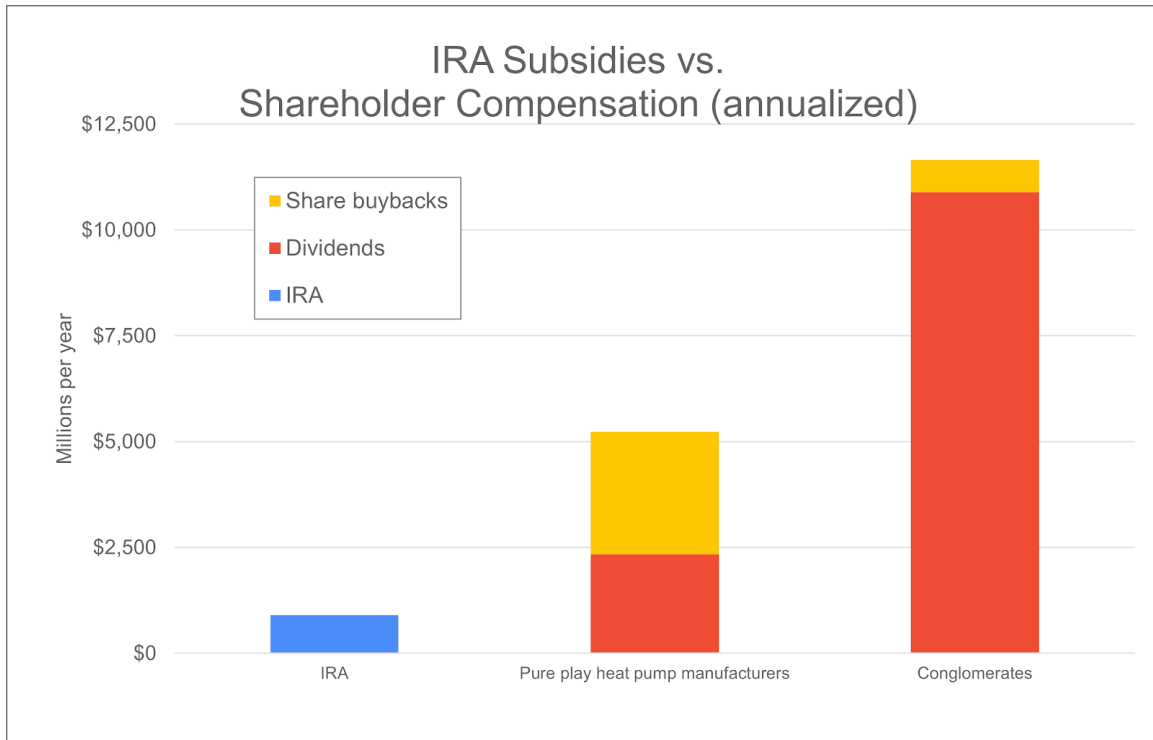


Figure 1: Comparing the magnitude of the IRA's spending on heat pumps (annualized) to the past year of shareholder compensation for four “pure-play” heat pump manufacturers and six conglomerates. Source: Manufacturers’ financial statements, Q4 2021 through Q3 2022.

Simply put, the IRA’s spending on heat pumps is dwarfed by the shareholder compensation of the major manufacturers. Unless policymakers can facilitate investments in production and labor training and promote robust price rivalry among manufacturers, wholesalers, and installers, we are likely to see inadequate investments in productive capacity. Redirecting the river of cash from shareholder compensation to increases in production and labor productivity would have a significant multiplier effect on the IRA’s goal of reducing carbon emissions from homes.

PRICE INCREASES

Overall, the HVAC and commercial refrigeration industry has seen price increases of more than 7.8% per year since September 2021. For much of 2022, prices rose more than 20%.

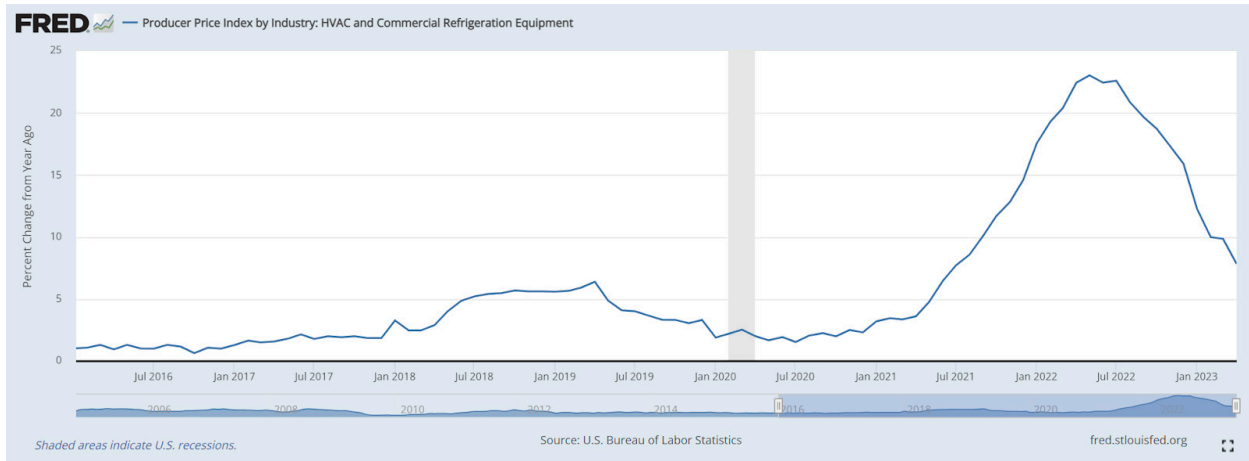


Figure 2: Producer Price Index for HVAC and Commercial Refrigeration Equipment

For residential heat pumps specifically, publicly available cost data sets are limited. But manufacturers have announced numerous price increases over the past 18 months. For example, Mitsubishi/Trane announced a 12% price increase in November 2021,¹⁷ a 9% increase on March 31, 2022,¹⁸ and an up-to-18% price increase on May 16, 2022.¹⁹ According to one HVAC installer in Arkansas and Missouri, Lennox increased its prices between 3% and 6% on January 1, 2021; between 6% and 9% on June 1, 2021; and then by 9% on May 2, 2022.²⁰ Despite an apparent diversity of manufacturers, manufacturers have increased their prices virtually in unison, according to several installers.

While manufacturers’ price increases and investor compensation practices are concerning, hardware is only one component of the total cost to consumers. According to heat pump installers and experts we spoke with, the cost of the heat pump hardware is only about 25% to 50% of the total installed cost, depending on various factors. This is both good and bad news. On one hand, manufacturers’ price hikes may not precipitate a crisis of affordability, because they represent less than half of the total installed cost. But on the other hand, total installed costs are very sensitive to installation labor costs, which are also growing.

In the words of one heat pump installer, “Everybody is 100% employed in HVAC right now.” Estimates of the average age of an HVAC technician range from 54 to 62, and installers frequently complain about the lack of qualified young people entering the profession. One installer expressed concern about using unskilled technicians to design heat pumps due to

¹⁷ Contracting Business, “Trane Technologies Announces Price Hikes for 2022,” November 15, 2021, <https://www.contractingbusiness.com/residential-hvac/article/21182162/trane-technologies-announces-price-hikes-for-2022>.

¹⁸ Contracting Business, “Trane Technologies Price Increase,” March 31, 2022, <https://www.contractingbusiness.com/product-news/article/21237887/trane-technologies-price-increase>.

¹⁹ Paschal, “HVAC Prices in 2023: What You Should Know About Price Increases This Year,” <https://gopaschal.com/hvac-pricing-2023/>.

²⁰ Ibid.

the risk of improper sizing or misapprehending duct capacities. The consequences of poor installation include customer complaints about thermal problems or mold formation, as well as a potential backlash against heat pumps altogether. As an unfortunate reality, conventional gas furnaces require less expertise to function reasonably well, putting additional pressure on installation labor markets for heat pumps.

Aside from manufacturers’ announced price hikes, there are very few sources on the total installed cost of heat pumps. What little cost data are available indicate very high dispersion (i.e., large standard deviations) and appear to suffer from data quality problems such as erroneously low or high values. Table 1 below lists publicly available data sources.

Data Source	Cost Range	Notes
Tech Clean California ²¹	\$3,000 to \$69,882 (median=\$16,997, SD=\$8,801)	10,000 cost records as of October 2022, but only heat pumps that received a rebate are included.
Massachusetts Clean Energy Center’s air source heat pump rebate database ²²	\$925 to \$120,070 (median=\$8,300, SD=\$5,804)	20,000 records from 2015-2019. Only heat pumps that received a rebate are included. Data quality problems include extremely low and high values.
Cadmus data provided to Consumer Reports ²³	\$8,700 to \$32,000	Range for cold-climate heat pumps.

ECONOMIC NARRATIVES AND INDUSTRIAL POLICY

There are a number of economic and media narratives around the costs of heat pumps and why they may be rising. As a starting point, although the observation is often dismissed by proponents, as it currently stands, heat pumps are objectively more expensive than alternatives. If the dream of climate advocates is for the IRA to make the economics of heat pumps so compelling that homeowners rush to have them installed (ideally without first waiting for their gas furnace to fail), one installer and heat pump proponent we spoke with threw cold water on that idea: “The IRA is not enough of an incentive for people to rip out a perfectly functional gas furnace.” In the words of another installer and heat pump proponent, “Heat pumps just cost more than a regular air conditioner and gas furnace. Period.” Several installers told us that the IRA incentives are being negated by increases in equipment prices and labor costs. The IRA’s rebates and tax credits are fixed dollar amounts, which decrease over time as a percentage of the total heat pump installation cost as equipment and labor costs rise.

21 TECH Clean California, Public Data, <https://techcleanca.com/public-data/>.

22 Massachusetts Clean Energy Center, “Installer Resources - Air-Source Heat Pumps” <https://www.masscec.com/resources/installer-resources-air-source-heat-pumps>.

23 Liam McCabe, “4 Reasons You Might Consider a Heat Pump (Plus a Few Caveats),” Consumer Reports, July 19, 2022, <https://www.consumerreports.org/heat-pumps/reasons-to-consider-a-heat-pump-for-your-home-a6507162057/>.

Apples-to-apples comparisons of total installed costs of heat pumps versus conventional systems are very difficult to develop, owing to many factors; there are wide variations in existing home HVAC systems, such as ducting, local labor costs, installer profit, etc. One expert told us she received price quotes from two installers, and despite quoting the same equipment and system design, the total prices were \$5,000 apart. Both proponents and detractors of heat pumps cite their higher cost relative to traditional systems. In opposing the Washington state building code requiring heat pumps in single-family residential buildings, the Building Industry Association claimed that heat pumps increase the cost per home by at least \$8,300.²⁴ Although this estimate is disputed by many heat pump proponents, it is notable that it exceeds the IRA's maximum heat-pump subsidy to lower-income households of \$8,000.

RISING DEMAND AND CONSTRAINED SUPPLY

The second economic narrative, expressed by manufacturers and heat pump proponents, will be familiar to anyone who has read the news over the past year: Supply chain problems and generalized inflation are the cause of higher prices. While there is certainly some merit to this narrative – for example, a Daikin executive said his company was dependent upon a single Ukrainian metals supplier and working to reduce concentration risk after the Russian invasion – it elides price increases in excess of costs, the record profitability of firms, and increases in shareholder compensation. Nonetheless, the IRA's demand subsidies are likely to exacerbate these cost problems more than stimulate output.

Demand for heat pumps has been rising considerably over the past decade, whether due to climate-friendly building codes, changing consumer preferences, state incentives, or other factors, and output has barely been able to keep pace. According to the Energy Information Administration, the number of homes with heat pumps as the primary heat source has increased from 9.8 million in 2009 to 18.9 million in 2020.

²⁴ News Release, "State Building Code Council ignores cost concerns, passes heat pump mandate," Building Industry Association of Washington, November 7, 2022, <https://www.biaw.com/heat-pump-mandate/>.

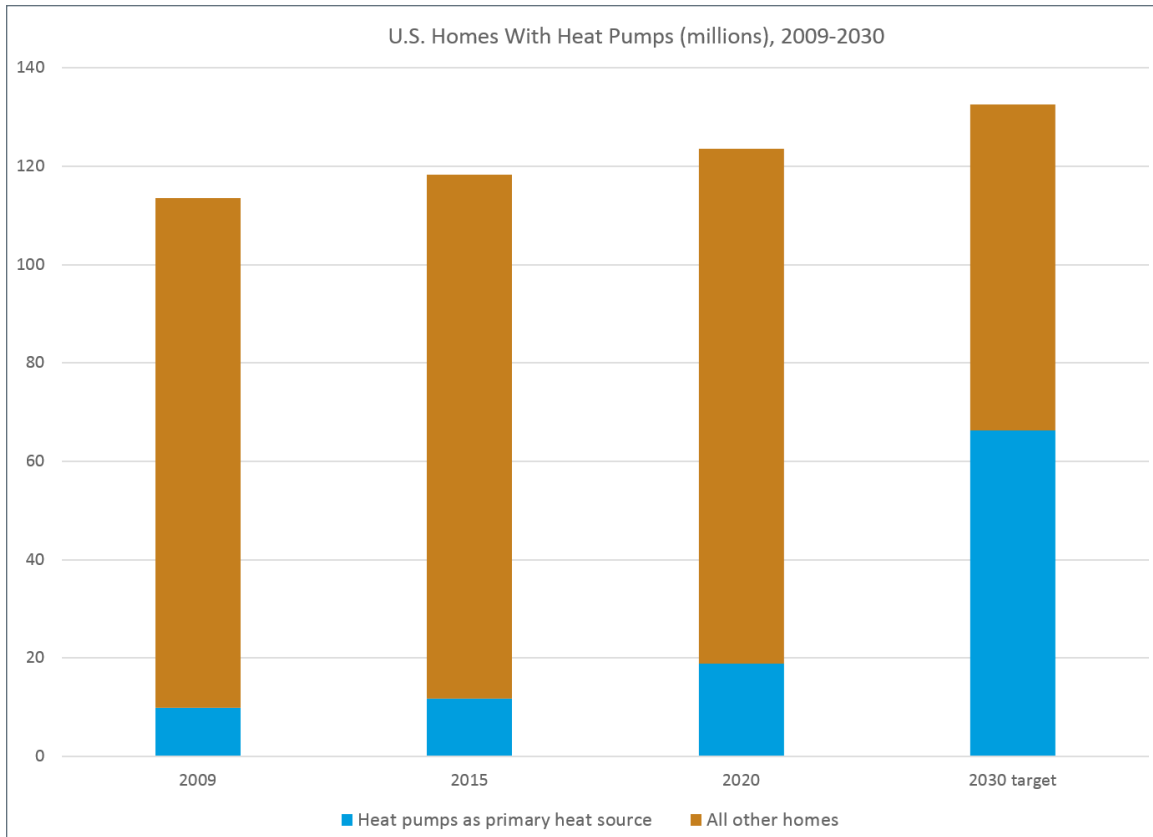


Figure 3: Past Prevalence of Heat Pumps and Future Targets

More recently, pandemic-induced work-from-home policies sparked widespread home renovations beginning in 2021, many of which included heat pump installations. While publicly available statistics pertaining specifically to residential heat pumps are relatively scarce – for example, the Energy Information Administration’s survey data on American homes are on a five-year cadence, last collected in 2020, and no cost data are available – various sources indicate an upward demand trajectory. U.S. shipments of air-source heat pumps for commercial and residential applications combined increased 19.5% in October 2022 compared to the prior year, to 363,830 units, according to one source.²⁵ Assuming that the total number of homes in 2030 will be 132 million (due to population growth) and assuming a 50% reduction in greenhouse gas emissions from residential heating, an order-of-magnitude estimate of necessary residential heat pump installation growth is 13% per year through 2030.

²⁵ Air Conditioning, Heating and Refrigeration Institute (AHRI), October 2022 U.S. Heating and Cooling Equipment Shipment Data, <https://www.ahrinet.org/sites/default/files/2022-12/October2022StatisticalRelease.pdf>. Interestingly, shipments of air conditioners were down 18.6% compared to the prior year, suggesting that, for ducted systems, homeowners are opting to use heat pumps for heating rather than gas furnaces or electric resistance baseboard heaters.

Achieving a 50% emissions reduction by 2030 is partly being met by state policy. Many states have committed to significant heat pump deployments by 2030, including California (6 million),²⁶ Maine (100,000),²⁷ Massachusetts (1 million), and New York (2 million). Some states, such as Washington, are modifying building codes to require heat pumps in new homes and major renovations.²⁸

By subsidizing the final buyer's cost for heat pumps, the IRA will primarily exacerbate inflationary pressure. In a setting where many geopolitical and economic forces have increased the demand for heat pumps already, there are limits to increasing output by further stimulating demand - particularly as certain market segments, such as wholesalers, become more concentrated. Prices and demand are already high enough to encourage increased output.

Despite recent demand growth, the gap between current trends and what climate action requires is humbling. For example, Massachusetts decarbonization policy calls for 100,000 heat pump installations per year, but in 2021, only 461 were completed.²⁹ One analysis indicated that as many as 48 million households across the U.S. may need to have their electrical panel upgraded to accommodate heat pumps (and electric vehicle charging) at a cost of over \$100 billion.³⁰ Cost containment of heat pumps (and associated electrical upgrades) is thus the first and most important task for rapid decarbonization in homes.

UNDERSTATED COSTS

Many climate advocates highlight a second set of narratives that either understate the real costs of heat pumps or consider future cost reductions to be automatic and inevitable. First, many claim that heat pumps are a simple technology: just an air conditioner that is bidirectional. In one sense this is true, and homes with central air conditioning (such as in the South) are best suited to replacing central air conditioning with a heat pump.

However, this obscures many of the complexities surrounding the sizing and installation of heat pumps. Despite being a relatively mature technology, installers told us that portraying heat pumps as mass-produced widgets that can be easily substituted for existing HVAC systems in any home overlooks the considerable skill needed to design, install, and maintain them. Rather, heat pumps are complex machines that need to be sized appropriately and must be installed and

²⁶ Office of the Governor, "Governor Newsom Calls for Bold Actions to Move Faster Toward Climate Goals," July 22, 2022, <https://www.gov.ca.gov/2022/07/22/governor-newsom-calls-for-bold-actions-to-move-faster-toward-climate-goals/>.

²⁷ 2025 target of 100,000 heat pumps established by L.D. 1766, "An Act to Transform Maine's Heat Pump Market To Advance Economic Security and Climate Objectives," <https://www.maine.gov/governor/mills/news/governor-mills-signs-bill-promoting-energy-efficient-heat-pumps-maine-2019-06-14>.

²⁸ Nicholas Turner, "WA building council votes to require heat pumps in new homes and apartments," *The Seattle Times*, November 8, 2022, <https://www.seattletimes.com/seattle-news/environment/wa-building-council-votes-to-require-heat-pumps-in-new-homes-and-apartments/>.

²⁹ Sabrina Shankman, "Massachusetts should be converting 100,000 homes a year to electric heat. The actual number: 461," *The Boston Globe*, August 21, 2022, <https://www.bostonglobe.com/2021/08/21/science/massachusetts-should-be-converting-100000-homes-year-electric-heat-actual-number-461/>.

³⁰ Pecan Street, "Addressing an Electrification Roadblock: Residential Electric Panel Capacity," August 2021, <https://www.pecanstreet.org/publications/addressing-an-electrification-roadblock-residential-electric-panel-capacity/>.

maintained by a skilled professional. Discounting the importance of labor in public messaging could backfire for several reasons. According to one installer, many consumers are led to believe (incorrectly) that installation is trivial, leading to “sticker shock” and fears of price gouging when labor accounts for more than 50% of the total cost – even if the labor input is necessary and reasonably priced. Moreover, a poorly designed system can lead to indoor air quality problems such as mold, potentially fueling a consumer backlash against the technology and setting back emissions mitigation efforts. The emphasis on public discourse on heat pump manufacturing costs over labor leads to false impressions and discounts the need for skilled labor in the minds of homeowners.

Similarly, many advocates suggest that the costs of producing and installing heat pumps will decline almost automatically with time, as manufacturers and installers gain more experience building and working at scale. In this view, heat pumps have reached a “tipping point” in which mass production begets lower prices, and lower prices induce greater demand, creating a virtuous cycle. This view was recently articulated by Dr. Leah Stokes, a professor at the University of California Santa Barbara:

As the world manufactures more solar panels, electric vehicles and heat pumps, it will also learn how to make them more cheaply. That innovation cannot easily be undone. As clean technology falls in price, more consumers and businesses around the world will choose it rather than fossil fuels. Think about how widely cellphones were adopted over landlines after they were more affordable.³¹

This narrative could be described as the “inevitability thesis”: The simple economics of mass production guarantee that low-carbon solutions will prevail over their fossil-fuel competitors. Another articulation of this narrative comes from Bloomberg, which recently identified “tipping points” for 10 clean energy technologies, including heat pumps: “Once the tough investments in manufacturing have been made and consumer preferences start to shift, the first wave of adoption sets the conditions to go much bigger.”³²

To be fair, there is empirical evidence for this claim in the solar, wind power, and battery manufacturing sectors, where we have seen per-unit cost decreases on the order of 10%-20% per year.³³ These are compelling figures. However, it is incorrect to make similar projections for the heat pump market simply on the basis that they are all clean energy technologies, particularly when the evidence suggests that unit prices for heat pumps are currently *increasing*.

³¹ Leah C. Stokes, “This Year Was the Beginning of a Green Transition,” *New York Times*, December 25, 2022, <https://www.nytimes.com/2022/12/25/opinion/gas-prices-crisis-climate-change.html>.

³² Tom Randall, “Clean Energy Has a Tipping Point, and 87 Countries Have Reached It,” *Bloomberg*, October 18, 2022, <https://www.bloomberg.com/graphics/2022-clean-energy-electric-cars-tipping-points/>.

³³ See, e.g., Rupert Way et al., “Empirically grounded technology forecasts and the energy transition,” *Institute for New Economic Thinking Working Paper*, September 14, 2021, https://www.inet.ox.ac.uk/files/energy_transition_paper-INET-working-paper.pdf.

It should be noted as well that there is recent evidence of cost increases for electric vehicle batteries and wind turbines for the first time in decades.³⁴ A more accurate assessment is that heat pumps are both design-intensive and customized for each home which are countervailing forces that work against the “learning rate.”

The obvious weakness of the inevitability thesis is that when the boundaries of analysis are limited to the factory’s output, the total cost to the final consumer is overlooked. We have observed a similar circumstance in the rooftop solar industry. While solar panels have gotten remarkably less expensive over time, the total installed cost of rooftop solar has remained stubbornly high because of labor, “soft costs,” and custom installation work for each home. This same dynamic applies to heat pumps. In contesting the notion that heat pumps will inevitably get cheaper over time, one heat pump installer told us simply, “That’s magical thinking!”

These narratives create a tendency for climate advocates to understate the costs of heat pumps. Rewiring America, a prominent nonprofit advocating for electrification policies, states that a heat pump costs only \$7,500 for a 1,500-square-foot home. Exasperated, one installer said, “The equipment alone costs more than that!”³⁵ To some extent, the higher upfront costs of heat pumps compared to alternatives can be addressed with state and utility financing schemes, so long as the operating costs of heat pumps are lower. However, without a clear-eyed and data-driven assessment of actual costs, consumers may lose trust in heat pumps when they experience the discrepancy between what they’ve been told and what’s on their price quote, even after subsidies from the IRA.

In our view, heat pumps are, and will likely continue to be, considerably more expensive than conventional gas furnaces and air conditioners – both in terms of manufacturing and installation. The goal of industrial policies should be to actively intervene in the heat pump market in order to avoid bottlenecks throughout different market segments, whether they are caused by material and labor shortages or an absence of competition. Without a holistic approach, the subsidies expended on industrial policies can be easily captured by private firms. By primarily depending on demand stimulation, industrial policy is left relying on wishful thinking for how costs will come down with time. At the moment, rather than falling prices and decreased labor inputs, we have the worst of both worlds: Equipment prices are surging, in part due to record profits and excess investor compensation, and the labor inputs of heat pump installation are higher than for conventional alternatives. Reckoning with these facts is a necessary first step, and doing that requires in-depth understanding of and engagement with the market structure of the industry.

34 See, e.g., Colin McKerracher, “Rising Battery Prices Threaten to Derail the Arrival of Affordable EVs,” Bloomberg, December 6, 2022, <https://www.bloomberg.com/news/articles/2022-12-06/rising-battery-prices-threaten-to-derail-the-arrival-of-affordable-evs>; Will Mathis and Akshat Rathi, “The Wind Industry’s Success Has Become Its Biggest Threat,” Bloomberg, January 19, 2023, <https://www.bloomberg.com/news/articles/2023-01-19/the-wind-industry-s-success-has-become-its-biggest-threat>.

35 See Twitter post, January 4, 2023, <https://twitter.com/energysmartwv/status/1610854706531688448>.

MARKET STRUCTURE

The key players in the residential heat pump market are **manufacturers, wholesalers, and installers.**



Manufacturer: Unlike in European or Asian markets, manufacturers must design their products for ducted as well as ductless installations in the U.S., given that much of the U.S. housing stock has ductwork for distributing hot or cold air. Ducted heat pumps typically replace gas furnaces or central air conditioners. Although functionally similar to ductless systems, ducted heat pumps must be separately engineered to accommodate existing ductwork and a range of air pressures and flow rates.

While the most visible outputs from residential heat pump manufacturers are heat exchangers and register units, they perform many other functions. Manufacturers produce necessary supplies such as refrigerant lines, electronic controls, and thermostats, and they are responsible for testing the energy efficiency of their products in various scenarios and outdoor air temperatures according to the U.S. Department of Energy’s Seasonal Energy Efficiency Rating (SEER) for labeling purposes. Given concerns about the global warming potential (GWP) of refrigerants, manufacturers are also responsible for phasing out certain high-GWP refrigerants pursuant to national and international agreements, such as the Kigali Amendment to the Montreal Protocol. In addition, manufacturers typically provide design software to wholesalers and installers in order to calculate the appropriate size of the system given the customer’s climate, square footage, and other design considerations. Manufacturers must invest in research and development activities, including multiple rounds of the SEER testing regime under different refrigerants, compressor characteristics, and heat transfer specifications, in order to produce a marketable product. Finally, manufacturers provide warranty support to both wholesalers and installers.

Wholesaler: Wholesalers are regional businesses that provide shipping and logistics for installers. Wholesalers typically sell product lines from multiple manufacturers – for example, Daikin, Emerson, Mitsubishi/Trane, etc. Wholesalers also provide design and technical support to installers. If an installer cannot fix a technical issue, the wholesaler is often the first line of support, followed by the manufacturer.

Installer: Paid by consumers to install heat pumps, installers provide design, deployment, billing, and maintenance services. Heat pumps typically need annual inspection to ensure that refrigerant pressures are appropriate, and this is done by installers.

It should be noted that competitive pressures are working in some respects. Among manufacturers, warranties have improved from 5 years to 12 years without policy intervention; air-source heat pumps suitable for colder climates have been developed; and, thanks to government intervention at the state and federal level, manufacturers are offering increasingly energy-efficient heat pumps while simultaneously moving away from high-global warming potential (GWP) refrigerants such as 410a and toward lower-GWP refrigerants such as R-32.³⁶

However, this does not imply an absence of problems in the market as a whole. According to interviews with installers, U.S.-based manufacturing of high-efficiency heat pumps (which are prioritized in the IRA) is very limited. Moreover, geographic effects are significant: In some areas – particularly low-income rural areas – only one or two installers are available, and regional market concentration among wholesalers and installers appears to be worsening. There are also real risks of concentration from acquisition activity at the local level, and several private equity firms have been aggressively acquiring and combining HVAC installation businesses. Without competition, the combined installation firms could raise prices significantly.

CONCENTRATION CONCERNS AND VERTICAL ACQUISITIONS

Of course, the above segmentation between different parts of the supply chain is not always universal or clear-cut in practice. There are varying degrees of vertical integration, blurring the lines between traditional roles. For example, some manufacturers are vertically integrating by acquiring wholesalers. Since 2020, Daikin has purchased at least three regional wholesalers in the Midwest, Pacific Northwest, and New England.³⁷ In this case, the obvious concern with manufacturer ownership of wholesalers is whether the new owner will continue providing support for competing manufacturers' products at the same price or quality, which would potentially stifle competing manufacturers' attempts to lower prices. By vertically integrating with regional businesses and dealing exclusively in their own products or raising barriers to competing products, manufacturers could avoid competition on the merits in certain markets, despite the total number of manufacturers appearing to be adequate.

There is also considerable variation in the number of competing installers and wholesalers across different geographic areas. Anecdotal evidence is that rural areas have fewer installers

³⁶ Low-GWP refrigerants are generally defined as having a global warming potential of under 750 times that of carbon dioxide.

³⁷ Contracting Business, "Daikin Acquires Two Northwest HVAC Distributors," December 13, 2021, <https://www.contractingbusiness.com/hvacrdb/article/21182762/daikin-acquires-two-northwest-hvac-distributors>.

than urban areas, in part due to increased travel time to reach a customer's home.³⁸ The actual number of installers or wholesalers for a given population or geographic area is unknown because no state or federal agency collects this data.

As a potential threat to the success of the IRA and similar industrial policies, there is also some evidence of increasing concentration among wholesalers and installers. Both publicly traded firms³⁹ and private equity have been making significant acquisitions in the space since 2021.⁴⁰ Growth through acquisition may give wholesalers greater negotiating power with manufacturers, but it is an open question whether such price negotiations are merely taken as profit by the wholesaler or whether they are passed on to installers and customers. Likewise, should private equity operationally combine local and regional HVAC installers, those merged companies would have a great deal of pricing power over customers in that region. This would further increase costs, funnel resources away from their intended purpose, and undermine the goals of the IRA. This problem is further exacerbated by existing shortages in qualified HVAC personnel, whereby there would be no labor pool from which any potential competing installer would be able to hire.

Ultimately, while the market for heat pump manufacturing appears to be dispersed among a number of competing firms, this does not mean the overall market is sufficiently competitive, whether at the manufacturer, wholesale, or installation segment. The government collects very little, if any, information about the makeup, prices, ownership, or geographic coverage of wholesalers and installers. The only way to evaluate competition holistically is to increase the scale and frequency of data collection.

LABOR NEEDS FOR HVAC

One conspicuous shortfall of the federal government's industrial policymaking around heat pumps and residential upgrades is a series of inaccurate projections for the labor needs across the HVAC industry. The U.S. Department of Labor's Bureau of Labor Statistics (BLS) forecasts only 5% total growth in HVAC installers by 2031 (not 5% per year, but 5% total in a decade).⁴¹ This needs to be increased at least tenfold: One source cites an 8.6% increase in heat pump shipments in August 2022 as compared to a single year earlier.⁴²

³⁸ This is particularly disappointing because, according to one installer, rural customers are more open to heat pumps than urban customers because rural areas are not served by natural gas networks. Common alternatives for rural home heating are fuel oil and propane, both of which are subject to significant price volatility.

³⁹ See, e.g., Ferguson's acquisition of Airefco, a Pacific Northwest wholesaler. Ferguson Corporate News, "Ferguson Acquires HVAC Distributor Airefco, Inc.," December 2, 2022, <https://www.fergusonpressroom.com/ferguson-acquires-hvac-distributor-airefco-inc>.

⁴⁰ See, e.g., Ted Craig, "Private Equity Firms Continue to Acquire HVAC Firms at Rapid Clip," The ACHR News, May 5, 2022, <https://www.achrnews.com/articles/146517-private-equity-firms-continue-to-acquire-hvac-firms-at-rapid-clip>; Andy Jones, "Private Equity Investments in HVAC Companies," Private Equity Info, May 12, 2022, <https://blog.privateequityinfo.com/index.php/2022/05/12/private-equity-investments-in-hvac-companies/>.

⁴¹ Bureau of Labor Statistics, Occupational Outlook Handbook, Heating, Air Conditioning, and Refrigeration Mechanics and Installers, <https://www.bls.gov/ooh/installation-maintenance-and-repair/heating-air-conditioning-and-refrigeration-mechanics-and-installers.htm#tab-6> (last accessed January 25, 2023).

⁴² The ACHR News, "Facts + Figures: AHRI Shipment Data for August 2022," <https://www.achrnews.com/articles/147209-facts-figures-ahri-shipment-data-for-august-2022>.

The Biden administration stated that, “As the world transitions to a clean energy economy, global demand for these essential products and components is set to skyrocket by 400-600% over the next several decades.”⁴³ Labor costs are already a majority of total heat pump costs, but BLS is woefully underestimating job growth in the installation segment. As for heat pump manufacturing, BLS actually forecasts a 10% decline in HVAC manufacturing jobs by 2031,⁴⁴ despite attempts to bring heat pump manufacturing to the U.S., such as through DPA procurement.

In addition to overlooking a significant need for training in both manufacturing and non-manufacturing blue-collar jobs associated with heat pumps, there is also the “silver tsunami” – a coming wave of retirements. With the majority of heat pump costs to consumers coming from labor, the government should be investing much more heavily in training and labor productivity tools such as remote diagnostics.

RECOMMENDATIONS

Subsidies for heat pumps cannot indefinitely keep pace with inflation if costs continue to rise. Even under today’s economics, a \$2,000 tax credit makes a dent in the cost of a heat pump but does not make it cheaper than conventional, high-carbon alternatives. Investing in near-shoring and multi-source supply chains coupled with price relief in semiconductors, metals, and shipping will make the biggest impact on equipment costs. However, a key risk is that cost decreases are captured by shareholders instead of passed through to consumers. The following recommendations are aimed at increasing competition, decreasing component costs, increasing the labor productivity of installers, and making the upfront costs of heat pumps more competitive with their conventional fossil-fuel competitors.

Limit shareholder compensation. Federal law should leverage the IRA’s funding to increase productive capacity rather than permit the tax credits to be siphoned off by shareholders. The Biden administration or Congress could establish rules prohibiting share repurchases or excess dividends by heat pump manufacturers for some period of time. Some concerning acquisitions in the industry, such as private equity firm Blackstone’s acquisition of Emerson’s heat pump business, indicate that private equity investors are looking to profit from the subsidies.⁴⁵ Taxpayer subsidies could be made available only to those manufacturers and installers that commit to keep shareholder compensation within specific limits.

43 Department of Energy, “President Biden Invokes Defense Production Act to Accelerate Domestic Manufacturing of Clean Energy,” June 6, 2022, <https://www.energy.gov/articles/president-biden-invokes-defense-production-act-accelerate-domestic-manufacturing-clean>.

44 U.S. Bureau of Labor Statistics Employment Projections 2021-2031, Table 2.11, line 79, <https://www.bls.gov/emp/industry-employment/industry.xlsx>.

45 Laura Cooper and Miriam Gottfried, “Blackstone, Emerson Electric Strike \$14 Billion Buyout Deal,” Wall Street Journal, October 31, 2022, <https://www.wsj.com/articles/blackstone-emerson-electric-strike-14-billion-buyout-deal-11667188861>.

The Defense Production Act procurement should be highly targeted to individual components such as inverters and should benefit all domestic manufacturers. The reality is that \$250 million for heat pumps is not enough money to build significant new heat pump manufacturing capacity in the U.S. Rather than focusing on a broad range of investments, the DPA procurement should be narrowly targeted on a few modular components – or even one – with the widest possible use by a variety of manufacturers. For example, inverters, which are predominantly made in Asia and are essential to high-efficiency heat pumps, deserve special attention.

Support entrepreneurs focused on reducing the cost structure. Unlike established firms, new entrants can avoid the costs of legacy refrigerant management and maintenance. Gradient, for example, has redesigned and simplified the heat pump into a single, beautiful window unit that is sealed, uses a low-GWP refrigerant, requires much less maintenance, and does not need a professional installer, in part because it runs on a 120-volt plug rather than requiring a 240-volt outlet. Federal support should target key bottlenecks such as energy efficiency testing, which is costly and labor intensive. Funding bulk procurements, such as NYSERDA’s “Clean Heat for All Challenge,” in which New York is purchasing 30,000 heat pumps for New York City Public Housing facilities, is one mechanism to overcome the fixed costs associated with producing a marketable product.⁴⁶ Federal grants through the Department of Energy should support software tools for remote diagnostics, predictive maintenance, and workforce automation so that the limited labor pool is used as efficiently as possible.

Collect standardized cost data. Neither state agencies nor the federal government have adequate data about either the manufactured costs or installed costs of residential heat pumps. The Department of Energy and Internal Revenue Service have an opportunity to mandate standardized reporting of installed costs, which would provide critical inputs to DOE through 2030, particularly with regard to DOE’s use of the Defense Production Act. Because the IRA’s tax credits and rebates are based on the total installed cost of heat pumps, DOE and the IRS are well positioned to collect cost data. DOE is expected to release a request for information (RFI) regarding the IRA’s Section 50121, Home Energy Performance-Based, Whole-House Rebates (HOMES), in early 2023. The Biden administration should require standardized cost reporting, using the TECH Clean California database as a model.

Coordinate federal agencies in planning for growth across the HVAC manufacturing and installation markets. One government office or agency should be charged with industrial policy management of the industries targeted by the IRA, including collecting data on market

⁴⁶ New York State Energy Research and Development Authority, “Governor Hochul and Mayor Adams Announce \$70 Million Initial Investment to Decarbonize NYCHA Buildings as Part of Clean Heat for All Challenge,” August 2, 2022, <https://www.nyserda.ny.gov/About/Newsroom/2022-Announcements/2022-08-02-Governor-Hochul-and-Mayor-Adams-Announce-Clean-Heat-for-All>.

structure, regional coverage, supply bottlenecks, and pricing. Highlighting this need, the U.S. Departments of Labor and Energy are not synchronized at all with regard to heat pump projections. As one example, the Bureau of Labor Statistics forecasts only 5% total growth in HVAC installers by 2031 (not 5% per year, but 5% total over the decade).⁴⁷ This needs to be increased at least tenfold; 2021 alone saw an 8.6% increase in heat pump sales.⁴⁸ While the Biden administration stated that, “As the world transitions to a clean energy economy, global demand for these essential products and components is set to skyrocket by 400-600% over the next several decades,”⁴⁹ BLS is woefully underestimating job growth in the installation sector. Moreover, BLS actually forecasts a 10% decline in HVAC manufacturing jobs by 2031,⁵⁰ despite attempts to bring heat pump manufacturing to the U.S., such as the DPA procurement, which Rewiring America estimates would serve 25% of annual U.S. heat pump sales.⁵¹ The Department of Labor is overlooking a significant need for training in this critical area of both manufacturing and non-manufacturing blue-collar jobs. As for the Department of Energy, the DPA may be useful in stimulating domestic heat pump manufacturing, but given that the majority of the total cost of heat pumps to consumers is installation labor and not equipment, the federal government’s efforts may be better spent supporting workforce development, apprenticeships, and labor productivity enhancements.

Mandate interoperability between heat pumps and thermostats to promote innovation and avoid lock-in. One way for consumers to offset the costs of heat pump installation is to allow their electric utility, or an “aggregator” of grid services, to control their heat pump at times of congestion on the power grid. Providing “flexible” electricity demand can earn consumers anywhere from \$25 to \$100 per year or more, depending on electric utility programs and state and local rules. However, consumers are often “locked in” to a thermostat that comes with their heat pump, which has a lifespan of 15 years or more. A manufacturer that makes a great heat pump does not necessarily make a thermostat with the most options for consumers to monetize flexible load. States and the federal government should mandate interoperability of heat pump controls, either through direct legislation, standard-setting (e.g., Department of Energy’s appliance standards), or making subsidies contingent on independently tested and verified thermostat interoperability. This recommendation aligns with the International Energy Agency’s recommendation to harmonize data communication protocols for heat pumps in order to support grid flexibility.⁵²

47 Bureau of Labor Statistics, Occupational Outlook Handbook, Heating, Air Conditioning, and Refrigeration Mechanics and Installers, <https://www.bls.gov/ooh/installation-maintenance-and-repair/heating-air-conditioning-and-refrigeration-mechanics-and-installers.htm#tab-6>.

48 The ACHR News, “Facts + Figures: AHRI Shipment Data for August 2022,” <https://www.achrnews.com/articles/147209-facts-figures-ahri-shipment-data-for-august-2022>.

49 Department of Energy, “President Biden Invokes Defense Production Act to Accelerate Domestic Manufacturing of Clean Energy,” June 6, 2022, <https://www.energy.gov/articles/president-biden-invokes-defense-production-act-accelerate-domestic-manufacturing-clean>.

50 U.S. Bureau of Labor Statistics Employment Projections 2021-2031, Table 2.11, line 79, <https://www.bls.gov/emp/industry-employment/industry.xlsx>.

51 Rewiring America, DPA Implementation Plan, October 19, 2022, https://assets.ctfassets.net/v4qx5q5o44nj/2Ct99mCoJGkTi9L5pXpqev/19ec15ac5ed1bf38879054a40b3a274a/DPA_Implementation_Brief.pdf.

52 International Energy Agency, “Heat Pumps,” September 2022, <https://www.iea.org/reports/heat-pumps>.

APPENDIX: TERMS

Heat pumps are like bidirectional air conditioners that can provide both heating and cooling. Heat pumps are also referred to as “split systems” or “mini-splits” because, unlike a traditional window air conditioner, which is a single unit, a heat pump is usually “split” into two components: the heat exchanger (which is typically outdoors), also called a “condenser,” and the indoor fan unit.

Ducted vs. ductless: Unlike in Europe, a majority of American homes are heated or cooled by circulating air through ductwork. For homes with central, ducted air conditioning (such as those in the South), a heat pump can replace the air conditioner and provide both heating and cooling. In contrast, ductless systems have indoor fan units, also known as “heads” or “registers,” in multiple locations throughout a home. The heads are connected to a heat exchanger (typically outdoors) via a refrigerant loop. The decision to use a ducted or ductless heat pump (or even a combination of the two) depends on multiple factors, such as the size of the home, the size and quality of existing ductwork, and the thermal comfort preferences of residents.

Air source vs. ground source: Air-source heat pumps, which are most common, mean the heat exchanger is placed outdoors. In contrast, ground-source heat pumps (sometimes called “geothermal”) use an underground loop of water. With underground temperatures at a relatively constant -54 degrees Fahrenheit, ground-source heat pumps are well suited to particularly cold climates, such as the Upper Midwest; however, ground-source heat pumps are considerably more expensive to install due to trenching and/or drilling costs.

Single stage vs. variable speed: A “single-stage” air conditioner or heat pump only operates in the “on” or “off” position. A variable-speed heat pump provides heating or cooling along a slope of output (say, from 20% to 100% of total capacity).

Inverters: Inverters control heat pump compressor motors at a continuously variable rate. Instead of binary “on/off” use, adjusting the power input to the compressor along a gradient allows for energy efficiency gains that are not possible with single-stage heat pumps. Inverters also allow for more comfortable and consistent indoor temperatures.

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