Tip of the Spear: *How Efficiency Programs Supporting Cold Climate Heat Pumps in Low Income Multi-Family Buildings Could Help Lay the Foundation for Building Decarbonization in Michigan and Illinois*

Laura Goldberg, Valeria Rincon, & Samantha Williams – Natural Resources Defense Council
Chris Neme, Energy Futures Group

ABSTRACT

Equitably electrifying the majority of space heating is essential to decarbonize the building sector and meet climate goals. However, heat pump sales are extremely low in many northern states due to several interrelated factors: outdated misperceptions regarding their efficiency and cold weather capabilities; limited numbers of HVAC contractors selling products; high prices often associated with niche products; and low natural gas prices. Utility energy efficiency programs can play an important role in breaking down some of these barriers by educating of customers about recent advances in heat pump technology, creating enough demand to increase contractor interest and drive down heat pump prices, targeting heat pumps to low-income multi-family buildings, and helping ensure this technology is prioritized and built out in under-resourced communities.

NRDC is working with Michigan and Illinois utilities on programs promoting cold climate heat pumps as an electric efficiency measure, displacing inefficient electric resistance heat. Though there is little electric heat in single family homes, 30% of Michigan and Illinois multifamily apartments – and an even higher percentage of low-income buildings – have electric resistance heat. Thus, programs have focused primarily on low-income multi-family buildings, simultaneously addressing efficiency, electrification, and equity objectives, and bringing this key technology to communities that have been historically underserved by utility efficiency.

This paper summarizes the results of initial pilot programs – average heating savings of 25-45%, ability to provide sufficient heat even during polar vortex conditions, and high customer satisfaction. It also discusses why savings have not been quite as large as expected and program design considerations for increasing future savings and addressing inequities. Finally, it discusses how the utilities are transitioning from pilots to full scale programs and other emerging opportunities, with a continued focus on affordable housing.

Introduction & Background

Level-Setting: State of Midwest

Buildings are fossil fuel guzzlers that emit massive amounts of greenhouse gas (GHGs) and health-harming air pollution. Scientists agree that if we do not act quickly to reduce GHG emissions, we are unlikely to avert the worst consequences of the climate crisis (IPCC 2022). Replacing fossil fuel equipment with high efficiency electric appliances—notably, electric air-source heat pumps—and running them in energy efficient homes with clean, renewable electricity are necessary parts of the strategy to fight the climate crisis. The leading

decarbonization studies show that the electrification of buildings will play a major role in decarbonizing the sector (e.g., Larson et al. 2021; Orvis and Mahajan 2021; NRDC 2021). In the Midwest, emissions associated with on-site fossil fuel combustion in buildings have been stubbornly consistent for several decades, accounting for 15-20% of total energy-related carbon dioxide emissions depending on the state, largely attributed to home heating needs (EIA 2022a; EIA 2022b).[1] This is not surprising when you consider the fact that Midwest states rely more heavily on fossil fuels for home heating than the national average (Census Bureau 2019). More than 80% of homes use either gas or propane for space heating in Illinois and Michigan (Id). This unfortunate status quo of pollution from buildings is in stark contrast to electric power production; CO2 emissions from power plants have declined by nearly half in the last decade, as coal plants retire, and more renewable power comes online—declines that are expected to continue in the wake of new climate policies and utility commitments (EIA 2022c). In fact, it is beneficial from a GHG perspective to switch *today* from a gas-fired furnace in the Midwest to an electric heat pump, especially when considering the life of a heat pump and the rate of grid changes (McKenna, Shah, and Silberg 2021; Sharrow et al. 2020).

Continued fossil fuel reliance in buildings is also contributing to growing public health concerns. A Harvard TH Chan School of Public Health study finds that burning gas is now more polluting to outdoor air quality than coal-fired power plants, largely because of gas use in residential homes and in industry (Buonocore et al. 2021). These data do not account for the toxic indoor air quality impacts of burning gas indoors, particularly from gas stoves, of which peer-reviewed research continues to accumulate (RMI 2022).

Proactive policy to remove barriers and spur the market for electric heat pumps in both existing and new homes, with a focus on low-income homes and buildings, will be essential to building a foundation for electrification. Unfortunately, significant challenges exist across the region that are preventing access to the latest electric alternatives to traditional gas-fired (and propane) heating. These challenges are keeping high efficiency electric air source heat pump sales extremely low, particularly in the colder climates of the Northern Midwest. Perceptions of heat pumps are often based on experience with products from decades ago; there is a profound lack of awareness—among policymakers/regulators, HVAC contractors, building owners and consumers—of the incredible evolution of technology that now allows cold climate heat pumps to function relatively efficiently even at temperatures below zero. This lack of awareness is further exacerbated by the lack of heat pumps offered by HVAC installers and contractors, who have limited or no experience in installing and servicing them. Policy barriers at the state and local level also prevent progress on retrofitting single-family homes and multifamily buildings with high efficiency electric heat pumps.

Focus on Heat Pumps in Low-Income Multifamily Buildings

[1] Includes total energy-related CO2 emissions resulting from residential and commercial sectors as of 2018. These totals do not include emissions associated with on-site methane leaks from gas appliances, or methane emissions in the process of transporting gas from along the supply chain to the distribution system that serves home.

Retrofitting electrically heated housing with electric heat pumps can potentially provide substantial electric energy savings, especially when paired with air sealing and insulation. While electric heat is currently uncommon in single family homes, it is quite common in multi-family buildings. Tables 1 and 2 show that approximately 40% of multifamily buildings (5+ units) in Illinois and 33% of multifamily buildings (5+ units) in Michigan are electrically heated. In most cases, these buildings rely primarily on inefficient electric resistance heat (baseboard heat). The portion of low-income apartments with electric resistance heat is likely even higher.[2]

Table 1: Illinois Heating Fuels by Building Type

Fuel	One-family house	2-4 Apartments	5-9 Apartments	10-19 Apartments	20-49 Apartments	50 or More Apartments	Boat, RV, van, etc.	Total
Natural Gas	2,740,363	442,301	197,214	99,522	93,313	162,055	905	3,735,673
Propane	185,858	7,450	4,176	2,869	3,017	5,265	153	208,788
Electricity	338,148	88,543	92,343	70,495	70,273	176,741	753	837,296
Other	38,817	5,780	6,866	6,185	8,986	17,202	421	84,257
Total	3,303,186	544,074	300,599	179,071	175,589	361,263	2,232	4,866,014
Electric %	**10%**	**16%**	**31%**	**39%**	**40%**	**49%**	**34%**	**17%**

Source: Census Bureau 2019

Table 2: Michigan Heating Fuels by Building Type

Fuel	One-family house	2-4 Apartments	5-9 Apartments	10-19 Apartments	20-49 Apartments	50 or More Apartments	Boat, RV, van, etc.	Total
Natural Gas	2,548,849	139,147	119,648	95,956	47,164	72,417	631	3,023,812
Propane	325,942	3,278	1,827	2,639	845	1,006	385	335,922
Electricity	200,397	36,264	51,465	38,064	33,581	48,986	51	408,808
Other	177,627	4,087	4,580	4,059	3,682	7,019	294	201,348
Total	3,252,815	182,776	177,520	140,718	85,272	129,428	1,361	3,969,890
Electric %	**6%**	**20%**	**29%**	**27%**	**39%**	**38%**	**4%**	**10%**

Source: Census Bureau 2019

Low-income multifamily households also have the potential to see affordability benefits from energy efficiency measures, including heat pumps - as low-income multifamily residents have some of the highest energy burdens, meaning they spend high percentages[3] of household income on their energy bills. Nationally, low-income multifamily households have energy burdens that are 81% higher than the average household (Drehobl, Ross, and Ayala 2020). This is also true in the Midwest. For example, in Detroit and Chicago low-income, low-income multifamily, and Black households face the highest energy burdens, with low-income multifamily households having a median energy burden that is 2.3-2.4 times higher than other multifamily households (ACEEE 2020). Yet, national research shows untargeted utility-administered energy efficiency programs fail to effectively reach communities of color and low-income communities—particularly those living in multifamily buildings (Samarripas and York 2019).

[2] The average annual income of households in electrically-heated multi-family buildings (5+ units) is substantially lower – 16% lower in Illinois and 12% lower in Michigan – than the average annual income of households in gas-heated multi-family buildings (Census Bureau 2019).

[3] A high energy burden is considered to be at or above 6% of household income spent on energy bills.

Energy efficiency programs are an essential tool for addressing energy burden and achieving energy affordability, especially when targeted at the communities most in need. Installing only light touch efficiency measures, such as lighting, faucet aerators, and minor improvements – will not be enough to reach the full potential for energy efficiency in low-income multifamily properties.[4] High impact efficiency measures such as heat pumps paired with whole building improvements including air sealing, insulation, and other building envelope measures will be key for achieving optimal energy savings for low-income multifamily buildings and continuing to help grow the heat pump market.

Midwest Models

In this paper, NRDC and Energy Futures Group present case studies on heat pump pilots from two utilities in Illinois and Michigan that demonstrate the value of high efficiency electric air-source heat pumps in a cold climate. While these early models focus on electric-to-electric retrofits, they can serve as a proving ground for the fuel-switching that will need to occur in order to scale electrification and deeply reduce GHGs from homes and other buildings. They demonstrate the value and efficacy of building electrification in the Midwest; that, even in a cold climate, electric heat pumps can keep people comfortable in their homes and maintain bill affordability. These pilots also provide opportunities for installers and contractors in the Midwest to become familiar with electric heat pumps, how to install and maintain, demonstrate efficacy, grow consumer appeal, and correct misconceptions about performance in cold climates.

As more consumers, building owners, developers, utilities, installers, and contractors become familiar with this technology and seek it out, a market for heat pumps in the Midwest will emerge, creating economies of scale that should bring equipment costs down and make them increasingly competitive with traditional fossil fuel furnaces—not unlike the precipitous cost declines in solar panels over the last decade (Lazard 2021, 2, 9). Building the market for electric air source heat pumps in the Midwest in this way, especially for low-income multifamily households, will be key for realizing climate goals and ensuring safe, affordable, healthy homes.

Illinois and Michigan Heat Pump Pilots

Overview

Over the past several years, several different Illinois and Michigan utilities have begun supporting the installation of heat pumps as efficiency measures in income qualified, electric resistance-heated, multifamily buildings. In most cases these initiatives were launched following settlement agreements with NRDC and other advocacy organizations. That includes both Ameren Illinois and Commonwealth Edison (ComEd) in Illinois and DTE, Consumers Energy and the Upper Peninsula Power Company (UPPCO) in Michigan. Two of those initiatives – pilot programs run by ComEd and DTE – have been analyzed in extensive detail by independent evaluators. This section focuses primarily on those two pilot programs.

[4] Energy efficiency programs in low-income multifamily buildings have the potential to cut electricity usage by as much as 32% (Mosenthal and Socks 2015).

ComEd Pilot Program

Program design. ComEd launched its pilot program in the Fall of 2018. Within three months, the program installed 80 cold climate ductless mini-split heat pumps[5] in low-income multifamily buildings with electric resistance baseboard heat. The electric resistance heat was left in place to provide back-up heating if needed. Tenants were educated on how to optimize the operation of the two systems together. All of the heat pumps were Mitsubishi products with an average capacity of 12,000 Btu/hour for single head units and 19,000 Btu/hour for the multi-head systems. HSPF ratings ranged from 11 to 12.5; SEER ratings ranged from 21 to 33. All were installed by the same local HVAC contractor who was a Mitsubishi Diamond dealer. They were all installed with Ecobee smart thermostats and eGauge submeters.[6]

To create a sample that was diverse enough to be representative of buildings in ComEd's service territory, installations were spread across seven different buildings of different sizes and in different parts of the company's Chicago-area service territory. Installations were focused on low rise (two to three story) buildings, which represent a large fraction of the area's multifamily buildings. A mixture of one-bedroom, two-bedroom and some three-bedroom apartments were treated.

To test the efficacy of different heat pump configurations, the pilot included a mix of single-head (65 units across six buildings) and multi-head heat pumps (15 units across three buildings). Transfer grills – e.g., between the living room and bedroom, or between two bedrooms – were frequently installed to enable the heat pumps to serve as much of the living space as possible. Apartment sizes varied but averaged only 549 square feet.

To test different potential future program approaches, outdoor temperature lockouts were installed in 20 of the apartments across three buildings. The lockouts prevented the electric resistance baseboard heat from being turned on unless the outdoor] temperature dropped below 15 degrees. The program also performed air sealing and added insulation to one eight-unit building that had a very inefficient building envelope prior to treatment. Table 3 below provides a summary of the characteristics of the apartment buildings treated.

Table 3. Characteristics of buildings in ComEd heat pump pilot

[5] Air source heat pumps with an outdoor compressor connected by refrigerant lines to one or more indoor air handler – commonly called a "head" – that are mounted on walls, floors or ceilings. Air from a room is pulled through the "head" to transfer heat (in winter) or cooling (in summer) and then exhausted back into the room. Mini-splits are different from centrally-ducted air source heat pumps in that they heat and cool only the portions of a building (whereas centrally-ducted air source heat pumps can heat and cool an entire home or apartment)

[6] eGauge is a company that produce meters which can measure electricity consumption on individual electric circuits using sensors called current transformers.

Site	Location	Units at Site	Units Treated	Shell Efficiency Before Treatment	Average Unit Size (square feet)	% with Multi-Head Heat Pumps	% with Insulation Upgrade	% with Outdoor Temp. Lock-out
1-A	Waukegan, IL	8	8	Average	507	50%		
1-B	Waukegan, IL	8	8	Poor	600		100%	100%
1-C	Gurnee, IL	8	8	Good	550	100%		
1-C	Harvey, IL	8	8	Average	400			
2-A	Chicago, IL	30	15	Poor	707	20%		53%
2-B	Chicago, IL	17	17	Average	622			24%
2-C	Zion, IL	32	16	Average	400			
All		**111**	**80**		**549**	**19%**	**10%**	**25%**

Source: CMC 2020.

CMC Energy Services, the contractor hired by ComEd to implement the pilot, worked closely with Navigant Consulting (ComEd's independent evaluator at the time) to evaluate the results of the pilot. That included extensive analysis of ComEd's AMI metering data as well as sub-metering of heat pump and electric resistance strip heat data. It also included both pre- and post-treatment interviews with both the tenants living in the apartments and the building owners. Twenty-two tenants and two building owners participated in those interviews.

Results – meeting heating needs. The heat pumps appeared to perform remarkably well in meeting tenants' heating needs. Indeed, there were no tenant complaints, even during the polar vortex in late January 2019 when temperatures dropped in Chicago to the -20s. Moreover, 64% of the tenants who responded to surveys indicated that they felt their apartments were *more comfortable* after the heat pumps were installed; only 4% said less comfortable (CMC 2020). Overall, 90% of tenants who responded to surveys – as well as both property managers who responded – stated that they would recommend their ductless mini-split heat pumps (Id).

Results – heat pump efficiency. The operating efficiency of the heat pumps differed considerably between single-head and multi-head systems. Single-head systems had an average seasonal coefficient of performance (COP) of 2.63, generally consistent with their rated efficiency. In contrast, multi-head systems had a COP of just 1.47 which was significantly lower than their rated efficiency (Id). This is consistent with anecdotal information from some northeastern states. It suggests that programs promoting ductless mini-split heat pumps can be confident in the performance of single heat head systems but should explore and address issues affecting the performance of multi-head systems – ideally with manufacturers.

Results – energy savings. As shown in Table 4, the heat pumps reduced heating energy use by a weather-normalized average of 1637 kWh per year – a 25% savings. A combination of factors likely led to this lower-than-expected level of savings. First, as noted above, the multi-head systems did not operate nearly as efficiently as either their ratings suggest or as the single-head systems did. Second, many customers did not appear to optimize the operation of their heat pump in conjunction with their electric resistance baseboard heat. For example, in a number of cases tenants were using electric resistance "strip heat" – as well as their heat pump – at

temperatures at which the heat pump would have been able to meet the entire heating need (and much more efficiently). That included running strip heat even when temperatures were in the 40s and 50s. In contrast, the 20 tenants identified as having operated their system optimally realized 48% savings – nearly double the program average. Sites with outdoor temperature lockouts also achieved higher savings (34% compared to 22% for those without lockouts). Put simply, building owner and tenant education on how to optimize operation of two systems did not work as well as desired. A high rate of occupant turnover (35% during the program) likely contributed to this problem. Third, the severity of the polar vortex also appeared to reduce savings.

Table 4. Summary of heating savings from ComEd pilot 2020[7]

Site	Units Treated and Analyzed	Average Size (square feet)	% with Lock-out	% with Multi-Head Heat Pumps	Pre-Treatment Heating (kWh)	Average Heating Savings (kWh)	Average Heating Savings (%)
1-A	8	507		50%	7,673	1,429	19%
1-B	8	600	100%		3,470	724	21%
1-C	8	550		100%	5,706	814	14%
1-C	8	400			5,032	1,925	38%
2-A	15	707	53%	20%	10,399	2,476	24%
2-B	15	622	24%		8,137	1,812	22%
2-C	16	400			4,171	1,514	36%
All	**78**	**549**	**25%**	**19%**	**6,664**	**1,637**	**25%**

Source: CMC 2020.

Recommendations. The pilot program report offered several recommendations for increasing savings in the future. They include (1) targeting apartments that had annual heating energy consumption of at least 4000 kWh; (2) weatherizing buildings before or immediately after heat pumps are installed; (3) considering use of outdoor ambient temperature lock-outs to eliminate the potential for electric resistance heating usage when it is not needed; (4) limiting use of multi-head systems – at least until there is reason to believe any performance issues have been remedied; (5) increasing on-site instruction on how to operate the heat pumps; and (6) creating "leave-behind" materials for building managers – including instructional videos and product tags – so that they can more effectively educate new tenants (Id).

The report also offered a range of additional recommendations to improve program delivery and cost-effectiveness. They include: (1) focusing delivery, to the extent possible, on shoulder seasons when HVAC contractors have more capacity; (2) pre-qualifying buildings in which heat pumps installations will be relatively straight forward – and/or pre-treating buildings that create challenges for heat pump installations such as those needing electric panel upgrades, pre-existing code violations, etc.; (3) using a bulk purchase bidding process to minimize per unit costs and ensure product availability; (4) selecting two or three highly qualified HVAC contractors; (5) developing a database of potential building participants, leveraging data collected from more than a decade of multi-family efficiency program delivery; and (6) focusing customer acquisition

[7] Two pilot sites were excluded from the analysis because of inadequate pre-treatment AMI data.

efforts on building managers (not tenants) - emphasizing the potential for reducing tenant turnover as a result of lower energy bills.

DTE Pilot Program[8]

Program design. DTE launched its pilot in 2020. The program installed 44 two-head Mitsubishi cold climate ductless mini-split heat pumps, each with a rated heating capacity of 22,000 Btu/hour, an HSPF rating of 9.8 and a SEER rating of 17 (Guidehouse 2022). The installations were in several buildings in one low-income multi-family complex in Melvindale, Michigan, just west of the city of Detroit. Twenty-eight of the apartments were one-bedroom units with an average of 600 square feet of living space. The remaining 16 units had two bedrooms and an average of 750 square feet of living space. In the two-bedroom units, transfer grills were installed between the living room and second bedroom to enable heat to reach the second bedroom. The program required the installation contractor to perform Manual J load calculations to ensure that the heating capacity of the heat pumps would be adequate to meet heating needs. As a result, the program was able to require the contractor disable all electric resistance strip heat at the electrical panel, except for strip heat in bathrooms that might not be reached by the heat pumps. All apartments were also supplied with a new programmable thermostat.

Results – meeting heating needs. Attempts to obtain customer feedback were not very successful, with only three tenants responding to survey questions about heating season performance of the heat pumps. That said, there were no complaints from tenants or the building owner. Furthermore, survey responses from fourteen participants in a parallel low-income single-family pilot which used the same heat pump products installed by the same HVAC contractor, combined with the three multi-family responses, suggested customers generally liked the heat pumps. For example, 76% of the 17 total respondents rated their satisfaction with heating season performance as either a 9 or 10 (average score of 8.76) on a scale of 1 to 10. Scores for heating season comfort were even higher, with 82% rating their comfort as either a 9 or 10.

Results – heat pump efficiency. DTE's pilot only deployed six eGauge end use data loggers to provide a reality check on their analysis of billing data. Thus, their evaluation did not collect enough data necessary to estimate the average seasonal efficiency of the heat pumps.

Results – energy savings. As Table 5 shows, Guidehouse, DTE's independent evaluator, estimated that the average heat pump reduced weather-normalized heating energy consumption by 1613 kWh per year, or 36% of pre-treatment heating use. Savings were lower for 1-bedroom units (32%) and higher for two-bedroom units (41%). These savings levels are substantial, but somewhat lower than expected. Several factors may have contributed to that result. First, it is possible that the analytical method used by Guidehouse led to a modest understatement of savings. For example, Guidehouse noted that the change in total electricity consumption per apartment was 17% higher than their estimated change in heating consumption. However, that difference was not statistically significant. If actual kWh savings were 17% greater, that would

[8] DTE's pilot included single family homes as well. However, since the focus of this paper is on low-income multi-family buildings, we do not address the single family component.

equate to average savings of 42% (instead of the reported 36%). Second, Covid-19 may have impacted savings. The heat pump consumption was measured for the winter of 2020/21, the first winter after the pandemic hit. Pre-heat pump consumption was measured for the winter of 2019/20, before the pandemic. If tenants were home more hours of the day during the pandemic, and therefore kept thermostat settings higher, savings would look artificially lower. Third, though the program intended to disconnect all electric resistance baseboard heat (other than in bathrooms), Guidehouse found significant baseboard heating in one of the six apartments in which data loggers were installed, leading to lower savings in that unit. Though this problem was discovered in only one apartment, it was possible that not all electric resistance baseboard heating was disconnected in other apartments in which data loggers were not installed. Fourth, it is also possible that tenants increased the thermostat setting to increase comfort, leading to reduced savings. Finally, all the heat pumps were two-head systems, which have been found in some other studies (including the ComEd pilot) to be less efficient than single-head products.

Table 5. Summary of heating savings from DTE pilot (Guidehouse 2022)

BRs	Units	Avg Size (square feet)	Pre-Treatment Heating (kWh)	Average Savings (kWh)	Average Savings (%)
1-BR	28	600	4,137	1,342	32%
2-BR	16	750	5,137	2,088	41%
Total	44	655	4,500	1,613	36%

Source: Guidehouse 2022

Recommendations. The pilot program report offered several recommendations for increasing savings in the future. They include (1) ensuring electric resistance baseboard heat is disabled at the main electric panel; (2) developing additional customer education material on the use of heat pumps, including short videos; (3) mailing reminders of how to operate heat pumps at the beginning of heating and cooling seasons, as well as at the time of tenant turnover; (4) consideration of requirements for weatherization to "ensure optimal heat pump efficiency and accurate sizing"; (5) testing single-head heat pumps; and (6) working with manufacturers to better understand the performance of multi-head heat pumps. The report also recommended increased education and training of HVAC contractors.

What is Next in Illinois and Michigan

Heat Pumps as Electric Efficiency Measures in Low Income Multi-Family Buildings

Illinois. As part of their 2022 to 2025 efficiency program plan filings, both ComEd and Ameren Illinois have committed to transitioning from piloting heat pumps as efficiency measures (displacing electric resistance heat) to making them core components of their full-scale low-income multifamily efficiency programs. In ComEd's case, the Company has committed to spending at least $10.7 million retrofitting heat pumps into electric resistance heated low-income multifamily buildings. That reflects a ramp up to at least $4.3 million to retrofit at least 1000

apartments in 2025 (ComEd 2022). That $4.3 million represents about 15% of the Company's total planned budget for its 2025 income qualified multifamily program (Id). Similarly, Ameren Illinois has committed to spending $10.9 million retrofitting heat pumps into electric resistance heated low-income multifamily buildings (Ameren 2022). That reflects a ramp-up to $4.0 million in 2025. Though ComEd has more than three times as many residential customers as Ameren, the saturation of electric heat in low-income multifamily buildings is much higher in Ameren's service territory than in ComEd's.

Michigan. In 2020, Consumers Energy retrofitted cold climate heat pumps to displace electric resistance heat in 312 apartments through its low-income multi-family program. As part of a settlement agreement with NRDC and other stakeholders, the company plans to increase such heat pump retrofits by 50% or more in 2022. It has also agreed to establish a performance metric tied to the number of heat pumps, heat pump water heaters and building envelope measures in low-income housing (Consumers 2022). DTE is planning to transition from its pilot program to making heat pump retrofits – also just to displace in efficient electric resistance heat – a core component of its 2022-2023 low-income multifamily program. Indeed, as part of a settlement agreement with NRDC and other stakeholders, the Company has agreed to "maximize adoption of all applicable major electric measures (cold climate heat pumps, heat pump water heaters, air sealing and insulation upgrades) in electrically heated multifamily buildings." Like Consumers Energy, DTE has also made the installation of such major electric measures one of its three performance metrics, with 12.5% of its potential shareholder earnings attached to it.[9] The Company's shareholders can earn their maximum incentive on this metric if they install at least 400 such measures in 2022 and as many as 700 measures in 2023 (DTE 2021).[10] DTE, Consumers Energy and the Upper Peninsula Power Company are also planning to work together on a new initiative to educate HVAC contractors and customers about cold climate heat pumps.

Illinois Expanding into Electrification as Energy Efficiency Through the Clean Energy Jobs Act

Beginning in 2022, the focus on heat pumps in Illinois can now be expanded beyond electric efficiency improvements in electric resistance heated buildings to also include efficient electrification of buildings heated with gas, propane, and other fossil fuels. This change stems from the passage, in September 2021, of the Climate and Equitable Jobs Act (CEJA 2021). CEJA is focused on a range of clean energy issues (e.g., phasing out fossil fuel-fired electric generation, increasing renewable energy, promoting electric vehicles, increasing jobs in disadvantaged communities, etc.), including several changes to electric utility efficiency programs (Id). One of the most notable is a provision that allows electric utilities to count efficient electrification (in MWh-equivalents) towards their annual savings goals, starting with the following limited amounts: 5% per year for each year from 2022 through 2025, 10% per year for each year from 2026 through 2029, and 15% per year for 2030 and all subsequent years.

[9] The main metric, with 80% weight, is lifetime energy savings from its total program portfolio. The other performance metric is low-income spending.
[10] The 2023 metric is the higher of 600 measures or two times the 2022 measure volume, but with a maximum of 700 measures.

To prioritize low-income communities in the implementation of these electrification measures, CEJA's efficient electrification provision requires that at least 25% of the total electrification savings come from low-income housing (Id).

Passage of the new law required ComEd and Ameren to re-open their 2022-2025 energy efficiency plans and settlement agreements to make relevant modifications. This led to negotiations between the Companies and a group of stakeholders on how to interpret the law, including extensive discussions around implementation of the new electrification requirements.

ComEd's Revised Plan and Settlement was filed on March 1, 2022 (ComEd 2022). The settlement includes a commitment for ComEd to spend an average of $10 million per year on low-income electrification, alongside detailed program design commitments. In addition, it requires that any low-income electrification work must lead to bill savings.[11] The Plan also includes details on electrification in other sectors, including residential and business electrification planned budgets.

Ameren's Revised Plan and Settlement was filed in April 2022 (Ameren 2022). Its settlement also includes specific commitments to low-income electrification, with a focus on propane-heated customers. Ameren is a dual-fuel utility and has a lot more propane heating in its service territory than ComEd. The Plan includes additional commitments to broader residential and business electrification as well.[12]

Trends and other Emerging Opportunities

DOE Cold-Climate Heat Pump Challenge and Midwest Participation.

To further support state-level efforts, the Biden Administration launched the Cold Climate Heat Pump Technology (CCHPT) challenge in May of 2021, as part of a broader initiative for better Energy, Emissions, and Equity (E3).[13] The challenge is a public-private partnership between federal agencies (DOE, US EPA, and Canada Natural Resources) manufacturers, utilities, and state agencies that aims to develop next generation heat pumps with improved performance in cold weather climates (DOE EERE 2021). The challenge currently focuses on residential, centrally ducted, electric air source heat pumps that optimize for two different temperature thresholds: –5 degrees Fahrenheit or –15 degrees Fahrenheit with a commercialization target of 2024. Participating partners to date have included leading manufacturers (e.g., Johnson Controls, Mitsubishi Electric, LG, Daikin); Midwest utilities and cooperatives: DTE and UPPCO in Michigan, Great River Energy and Xcel Energy in Minnesota, and Focus on Energy in Wisconsin; and state agencies including the Michigan Department of Environment, Great Lakes, and Energy, the Minnesota Department of Commerce, and the Public Service Commission of Wisconsin (DOE EERE 2021). Participating partners are tasked with sharing quarterly updates, developing customer incentives and pilot programs, developing

[11] "Prior to installing an electrification measure, the utility shall provide a customer with an estimate of the impact of the new measure on the customer's average monthly electric bill and total annual energy expenses" (CEJA 2021)

[12] Ameren's Revised Plan and Settlement have not been filed yet, and therefore are not public documents. The revised filing is expected in mid-April. This paragraph will be updated accordingly in the second draft.

[13] The purpose of this initiative is to focus on advancing the deployment of clean heating and cooling technologies.

education and outreach campaigns, and supporting the development of customer incentive programs where applicable.

The Weatherization Assistance Program and Heat Pumps/Fuel-Switching

The Department of Energy's (DOE) Weatherization Assistance Program (WAP) has served approximately seven million households with weatherization retrofits and home energy upgrades since it began in 1976. It focuses on reducing energy costs for low-income households. DOE recently announced new WAP Enhancement and Innovation funding. In Fiscal Year 2021 $18.6 million new dollars are available (DOE 2021). The new funding is designed to support goals related to carbon pollution-free electricity by 2035 and net zero GHG emissions by 2050 (DOE 2022). The funding is also focused on deep retrofits through place-based initiatives, multifamily housing, single family and manufactured housing, and workforce development. Making homes electrification-ready is a new area of focus for WAP. Guidance for the Enhancement and Innovation funding explicitly includes fuel-switching incentives and heat pumps, noting funds can be used for "performing necessary updates and panel replacements to incentivize fuel switching, and to enable the safe installation of clean energy technologies such as heat pumps and solar PVs." The guidance also describes that the electrification-ready work should be paired with goals for reducing energy burden in low-income households. The Enhancement and Innovation funding has the opportunity to continue, at up to $25 million in subsequent years through 2025.

Additional Changing Policies on Electrification as Energy Efficiency

Like Illinois, Minnesota now allows public and consumer-owned utilities to count efficient fuel-switching retrofits towards a portion of annual energy conservation goals. Under the Energy Savings and Optimization Act, utilities may spend a certain percentage per year of gross annual retail energy sales (0.55 percent for consumer-owned utilities and 0.35 percent for public utilities) on efficient fuel-switching retrofits (ECO Act 2021). These measures can count only if they prove efficient, climate-aligned (i.e., result in a net reduction in GHG emissions over the lifetime of the measure) and ensure energy savings for the consumer on a holistic basis. The benefit of expanding the scope of energy efficiency portfolios to include electrification measures is that it provides greater energy savings and CO2 reductions. Electrification measures yield significant health and comfort co-benefits for consumers, reducing exposure to toxic indoor air pollutants such as PM 2.5 released by the burning of fossil fuels in homes and adding *cooling* functions for consumers that previously did not have access to an electric A/C unit. These co-benefits are especially beneficial to low-income households.

Housing Finance Agencies and Electrification

Increasing the energy and water efficiency of Low-Income Housing Tax Credit (LIHTC) properties has been a priority and best practice policy for many State Housing Finance Agencies (HFAs) within their competitive Qualified Allocation Plan (QAP) process for 9% tax credits (Bartolomei 2017). QAPs are important for incorporating energy efficiency, clean energy, energy conservation, and energy equity considerations in affordable housing new construction and

rehabilitation projects. Several state HFAs[14] that have recently added LIHTC QAP criteria related to pre-electrification or electrification work (including heat pumps). In Illinois, the latest 2022-2023 QAP incentivizes energy efficiency and some pre-electrification, partial electrification, and full electrification through a mix of mandatory and optional points for meeting third party green certifications, several which have an electrification related pathway, with a range of 3-10 points associated with the various certifications (IHDA 2021). There are also 3 additional points available for buildings that pursue net zero certifications. Every project must at a minimum comply with 2020 Enterprise Green Communities mandatory items, which includes a base level of energy efficiency.

Codes And Electrification/Heat Pumps

Ensuring an energy-efficient, future building stock in the Midwest can most effectively be addressed through the implementation of updated energy codes and stretch codes. Several states across the Midwest have adopted some type of statewide code with a few states such as Missouri and Kansas having a home rule but no specific statewide code. States such as Illinois and Michigan have gone one step further by committing to or expressing support for adopting the IECC 2021 model code. States can also take leadership in promoting the creation of a stretch code that local municipalities can voluntarily adopt. Traditionally baseline state building codes have been focused on reducing energy consumption but stretch codes can help overlay on these existing codes and explicitly address the operational carbon, methane, and accompany polluting emissions (PM 2.5, nitrous oxides, etc.) buildings produce. This is important given that in cities and counties buildings emissions account for more than 50% of energy-related emissions (Borgeson 2019), including cities across the Midwest such as Chicago, Detroit, and Ann Arbor. In Illinois, CEJA has kicked off a process to create a statewide “stretch” building code with the potential to incorporate all-electric ready standards.

Conclusion

The Illinois and Michigan case studies discussed in this paper provide an important window into the value of switching to cold climate electric air-source heat pumps for affordable multi-family housing. As the market for heat pumps is developed in this part of the country, it will be important to continue to emphasize this often-underserved market segment and to ensure that forthcoming building electrification policies and programs direct a proportionate level of focus and funding to income-qualified residents. Other regions, and programs at the federal level, provide useful models for the Midwest to follow (and improve upon) as we continue down this path. Building the market for electric air source heat pumps in the Midwest, especially for low-income multi-family households, will pay dividends for the ambitious levels of building electrification that will be necessary in this region to realize our climate goals and ensure safe, affordable, healthy homes for all.

[14] Includes HFAs in CO, CT, IL, and NV.

References

ACEEE (American Council for an Energy Efficient Economy). 2020. *Energy Burdens in Detroit and Energy Burdens in Chicago.* Washington DC: American Cities Energy Efficient Economy. www.aceee.org/sites/default/files/pdfs/aceee-01_energy_burden_-_detroit.pdf. www.aceee.org/sites/default/files/pdfs/aceee-01_energy_burden_-_chicago.pdf.

Ameren Illinois (Ameren), 2022. *Modified Ameren Illinois Company Electric and Gas Energy Efficiency and Demand Response Plan 2022-2025*, April 14, 2022., filed in ICC Docket No. 21-0158 as Ameren Exhibit 1.1RO and Appendix J. https://www.icc.illinois.gov/docket/P2021-0158/documents

Bartolomei, D. 2017. *State Strategies to Increase Energy Efficiency in Low Income Housing Tax Credit Properties.* Energy Efficiency for All. www.energyefficiencyforall.org/resources/state-strategies-to-increase-energy-efficiency-in-low-income-housing-tax-credit-properties/.

BED (Burlington Electric Department). 2022. *Heat Pumps*. www.burlingtonelectric.com/heatpumps.

Borgeson, M. Natural Resources Defense Council (NRDC). *Global effort to decarbonize buildings is accelerating.* 2019. https://www.nrdc.org/experts/merrian-borgeson/global-effort-decarbonize-buildings-accelerating accessed (Mar 12, 2022).

Buonocore, J, Salimifard P., Michanowicz, D., and Allen, J. 2021. *A decade of the U.S. energy mix transitioning away from coal: historical reconstruction of the reductions in the public health burden of energy.* Harvard TH Chan School of Public Health. Environmental Research Letters. DOI: 10.1088/1748-9326/abe74c.

Census Bureau. 2019. *American Community Survey*. https://data.census.gov/mdat/#/

ComEd (Commonwealth Edison). 2022. *Revised 2022-2025 Energy Efficiency and Demand Response Plan and Stipulation Agreement*, filed in ICC Docket No. 21-0155 as ComEd Exhibits 1.01R and 1.02R, March 1, 2022. https://www.icc.illinois.gov/docket/P2021-0155/documents

CEJA (Climate and Equitable Jobs Act), Public Act 102-0662. 220 ILCS 5/8-103B. (2021). www.ilga.gov/legislation/102/SB/PDF/10200SB2408enr.pdf

CMC (CMC Energy Services). 2020. *ComEd Cold Climate Ductless Heat Pump Pilot Final Report*, May 7, 2020.

Consumers Energy, 2022-2025 Energy Waste Reduction Plan, filed as Exhibit A-2 (SQM-2) in Michigan Public Service Commission Case No. U-20875.

DOE (Department of Energy). 2021. *DOE Announces $18.6 Million to Expand the Weatherization Assistance Program.* Washington DC: DOE. www.energy.gov/articles/doe-

announces-186-million-expand-weatherization-assistance-program.

DOE (Department of Energy). 2022. *WAP Enhancement & Innovation Funding Opportunity Announcement Memo.* Washington DC: DOE. www.energy.gov/sites/default/files/2022-01/wap-memo-086-revised.pdf.

DOE (Department of Energy: EERE (Office of Energy, Efficiency, and Renewable Energy). 2021. *Residential Cold Climate Heat Pump Challenge*. www.energy.gov/eere/buildings/residential-cold-climate-heat-pump-challenge

Drehobl, A., L. Ross, and R. Ayala. 2020. *How High are Household Energy Burdens?* Washington, DC: American Council for an Energy-Efficient Economy. www.aceee.org/research-report/u2006.

DTE (DTE 2016), 2016 Residential Customer Appliance Saturation Study.

DTE (DTE 2021), 2022-2023 *Energy Waste Reduction Plan Stipulation and Settlement Agreement*, filed in MPSC Case U-20876, December 21, 2021.

ECO Act (Energy Conservation and Optimization Act) 2021, H.F.No. 164, Sec. 2. Minnesota 92nd Legislature, passed (August 01, 2021)

EIA (U.S. Energy Information Administration). 2022a. *Illinois State Dashboard.* www.eia.gov/beta/states/states/il/data/dashboard/environment .

EIA (U.S. Energy Information Administration). 2022b. *Data Sets, Residential Carbon Dioxide Emissions, All fuels, Illinois.* www.eia.gov/opendata/qb.php?sdid=EMISS.CO2-TOTV-RC-TO-IL.A.

EIA (U.S. Energy Information Administration). 2022c. *Electric Power Annual 2020*. www.eia.gov/electricity/annual/pdf/epa.pdf.

Guidehouse (Guidehouse 2022), DTE Income Qualified Residential and Multifamily Whole-Home Mini-Split Cold Climate Heat Pump Pilot, Final Report, February 15, 2022.

IHDA (Illinois Housing Development Authority). 2021. *2022-2023 Low-Income Housing Tax Credits Qualified Allocation Plan.* Chicago IL. www.ihda.org/developers/qap/.

Intergovernmental Panel on Climate Change (IPCC). 2022. *Sixth Assessment Report, Climate Change 2022: Mitigation of Climate Change*. https://www.ipcc.ch/report/ar6/wg3/

Larson, E., Greig, C., Jenkins, J., Mayfield, E., Pascale, A., Zhang, C., Drossman, J., Williams, R., Pacala, S., Socolow, R., Baik, EJ, Birdsey, R., Duke, R., Jones, R., Haley, B., Leslie, E.,

Paustian, K., and Swan, A. 2021. *Net-Zero America: Potential Pathways, Infrastructure, and Impacts, Final Report Summary*. Princeton University. netzeroamerica.princeton.edu/img/Princeton%20NZA%20FINAL%20REPORT%20SUMMARY%20(29Oct2021).pdf.

Lazard. 2021. *Levelized Cost of Energy Analysis (LCOE) 15.0*. https://www.lazard.com/media/451905/lazards-levelized-cost-of-energy-version-150-vf.pdf.

McKenna, C., Shah, A., and Silberg, M. 2021. *It's Time to Incentivize Residential Heat Pumps*. RMI. rmi.org/its-time-to-incentivize-residential-heat-pumps/

Mosenthal, P., and Socks, M. 2015. *Potential for Energy Savings in Affordable Multifamily Housing.* Energy Efficiency for All. www.energyefficiencyforall.org/resources/potential-for-energy-savings-in-affordable-multifamily-housing.

NRDC (Natural Resources Defense Council). 2021. *Issue Brief: Biden Administration Must Swiftly Commit to Cutting Climate Pollution at Least 50 Percent By 2030.* www.nrdc.org/sites/default/files/2030-biden-climate-pollution-ib.pdf.

NYSERDA (New York State Energy Research and Development Authority). 2021. *Multi-Family Buildings of Excellence*. www.nyserda.ny.gov/All-Programs/Multifamily-Buildings-of-Excellence.

Orvis, R., and Mahajan, M. 2021. A 1.5°C NDC for Climate Leadership by the United States. Energy Innovation. energyinnovation.org/wp-content/uploads/2021/04/A-1.5-C-Pathway-to-Climate-Leadership-for-The-United-States_NDC-update.pdf.

RMI. 2022. *Fact Sheet: Gas Appliance Pollution Inequitably Impacts Health: Who Would Gain the Most from Electrification*. rmi.org/wp-content/uploads/2022/02/gas_appliance_equity_factsheet.pdf.

Samarripas, S. and York, D. 2019. *Closing the Gap in Energy Efficiency Programs for Affordable Multifamily Housing*. Washington, DC: ACEEE. www.aceee.org/research-report/u1903.

Sharrow, L., Mifsud, A., Henchen, M., and Garascia, M. 2020. *Building Electrification Helps Illinois Achieve Climate Goals*. Elevate, RMI. www.elevatenp.org/wp-content/uploads/llinois-Electrification-Analysis-final.pdf.