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BUILDING ELECTRIFICATION
Helps Illinois Achieve Climate Goals

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Key Insights

- **Illinois needs to phase fossil fuels out of buildings to meet its commitment to the Paris Climate Agreement:** Direct fossil fuel combustion in buildings accounts for 18% of Illinois' energy-related carbon emissions.

- **Electrification saves emissions:** Recent improvements in the electric grid and heat pump technology make heat pumps an emissions-savings intervention over their lifetime even with conservative assumptions about the future growth of renewable energy in the state.

- **Pursuing 100% clean electricity will significantly increase emissions savings related to building electrification:** Achieving 100% renewable energy on the grid by 2050 would result in 46% more emissions savings in the buildings sector than a lower renewable energy scenario.

Introduction

Like much of the United States, Illinois is experiencing a rapidly evolving electricity landscape. Thanks to a combination of state policies and declining renewable energy costs, the electric grid is cleaner than ever, opening the door for policymakers to use this growing supply of clean energy to decarbonize stubborn sectors like buildings. A new analysis by Rocky Mountain Institute (RMI) and Elevate Energy finds that electrifying single-family homes in Illinois, and thus eliminating appliances powered by gas or propane, reduces carbon emissions today.

The emissions benefits of electrifying homes have improved over time. This analysis updates the findings of the 2018 RMI report ***The Economics of Electrifying Buildings*** with both changes in the Illinois energy landscape and an improved methodology.

Since the study period for the report, the Future Energy Jobs Act (FEJA) came into effect in Illinois, requiring Illinois' investor-owned electric utilities to achieve 25% renewable energy by 2030. Utility renewable generation has increased by more than 13%,[i] at least **four coal plants have closed**, and electrification policies have become part of mainstream policy and program conversation. And although COVID-19 has created new uncertainty about the electricity market, initial expectations are that it will increase the **speed of coal plant retirement**.

[i] Based on net generation for electric power from the US Energy Information Administration.

The pace of renewable energy growth is also expected to increase, either via existing market forces or in response to a more aggressive renewable portfolio standard, such as the proposed Clean Energy Jobs Act (CEJA) standard of 100% renewables by 2050.[ii]

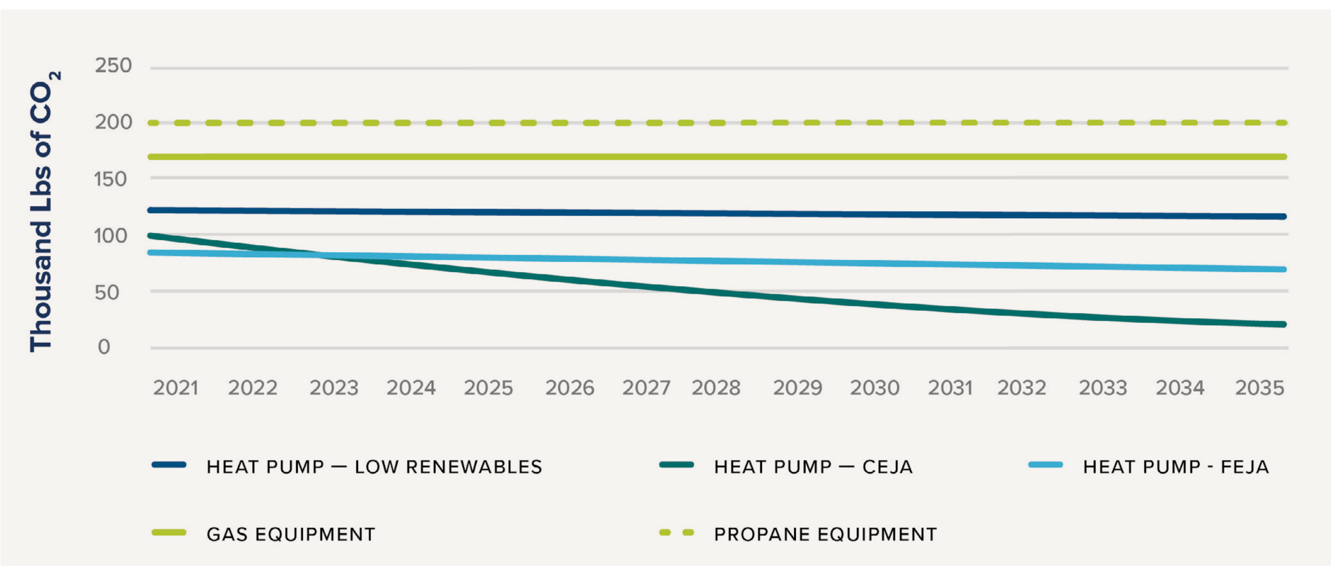
Accounting for these long-term changes, RMI and Elevate Energy's updated analysis finds that for single-family homes in Illinois, electrifying space and water heating and cooling through installation of air source heat pumps reduces carbon emissions compared with installing high-efficiency gas furnaces and gas hot water heaters or propane systems. These results are true across several scenarios and even without accounting for methane leaks in gas systems.

The emissions reductions are greater as Illinois commits to more aggressive clean energy goals but persist even in the lowest renewable energy scenario modeled. For example, if 500,000 homes were to install electric heat pumps for space and water heating and cooling, total carbon emissions by 2050 would be reduced by 28 million metric tons in a scenario with CEJA-level renewables. This is 81% lower carbon emissions than a scenario in which those homes installed a new high-efficiency furnace and water heater. Even in a scenario with much lower renewable energy levels, those homes would emit 35% less carbon.

These emissions reductions don't require waiting for additional renewable energy to come online; given a heat pump's 15-year lifetime and the rate of grid changes, installing a heat pump today is an emissions-saving intervention. As seen in Exhibit 1, electrifying a home in any year after 2020 has significant emissions savings over the heat pump's lifetime.

EXHIBIT 1

CO_2 Emissions over 15-Year Lifetime by Installation Year



[ii] The Clean Energy Jobs Act (CEJA), which would put Illinois on a path to 100% renewables by 2050, was introduced to the legislature in 2020 (voting was delayed due to COVID-19).

Exhibit 1 shows the lifetime emissions of each equipment type by year installed. For example, a heat pump space and water heater installation in 2021 in the FEJA scenario will emit approximately 93,000 pounds of CO_2 over its lifetime, while installation of the same equipment in 2030 in the same grid scenario emits approximately 75,000 pounds over its lifetime. Gas and propane equipment has the same lifetime emissions regardless of the year installed because its emissions come from direct combustion rather than the emissions of the changing grid. These numbers are for a single home but were derived from the electrification of 500,000 homes by 2050.

Addressing emissions from the buildings sector is critical to meeting Illinois' climate goals. In 2017, direct emissions from burning fossil fuels in buildings accounted for **18% of energy-related emissions in Illinois**. Gas and propane furnaces have a lifetime of approximately 20 years, meaning that fossil fuel-burning appliances installed now will continue to generate carbon emissions well past 2030 regardless of how clean the electric grid becomes.

Illinois will not be able to stay on track with climate goals, such as its commitment to **Paris Agreement targets**, unless it sharply reduces the direct use of fossil fuels in buildings in parallel with increasing renewable energy generation. As this analysis illustrates, building electrification represents a critical pathway for addressing these emissions.

Approach

This analysis takes a forward-looking approach to identify lifetime and marginal carbon dioxide emissions from electrification, taking into account expected grid changes between now and 2050. Our results reflect the decreased reliance on coal for generation in Illinois, and the expectation that future load increases can be met by renewables and gas. The analysis covers single-family homes served by the three Illinois investor-owned electric utilities (ComEd, Ameren, and MidAmerican) installing an air source heat pump for space heating and cooling and a heat pump water heater.

To account for the uncertainty of the rate of electrification, this model was built by selecting a number of homes to electrify over time. The analysis discussed here reflects electrifying 500,000 homes (representing about 15% of the single-family homes in Illinois' investor-owned utilities service territories, or about 10% of the total customers) between 2021 and 2050. We also tested several sensitivities with different numbers of electrified homes (see the Technical Volume for sensitivities).

In all scenarios and sensitivities, electrification resulted in a reduction of carbon emissions compared with a gas-powered home and even greater reductions for a propane-powered home.

In order to reflect the uncertainty of the future fuel mix for the grid, we explored three scenarios:

1. The **CEJA scenario** reflects the grid if the CEJA standard of 100% renewables by 2050 is achieved.
2. The **FEJA scenario** reflects the current renewable portfolio standard of 25% renewables by 2030 followed by continued but slower renewable energy growth through 2050.
3. The third scenario reflects a **lower renewables scenario** than either of the policy-based scenarios, acknowledging that the state is not currently on track to meet FEJA goals but that renewables have been increasing. This scenario continues the current **6.8% annual growth rate** of the renewable energy share.

We determined the baseline (without electrification) fuel mix through 2050 for each of these scenarios assuming a flat load growth rate.[iii] The mix was modeled at the generator level for coal and nuclear, with renewable percentage determined by policy as stated above and gas making up the remaining energy supply.

The models reflect a phaseout of coal by 2030 in the CEJA scenario and a slower decrease in the other scenarios based on **estimates from the National Renewable Energy Laboratory** (NREL) and on nuclear plants continuing at current capacity up to their license expiration dates. For the FEJA scenario, renewable growth after 2030 was also based on the **NREL study** (for a full list of assumptions, see the Technical Volume).

We then added the projected additional demand from the 500,000 homes electrified by 2050 starting with 10,000 homes in 2021. We used average annual increase in electric usage across the territory for a home with heat pump heating and cooling and heat pump domestic hot water (DHW) compared with electric cooling but high-efficiency gas or propane furnace and DHW.[iv] We also used a constant technology efficiency over time for all technologies. This total annual load increase of 8,333 additional kWh per home multiplied by the number of electric homes per year was added to the baseline electricity load.

[iii] Utility short-term projections are from annual reports and longer-term projections are from Illinois Power Agency procurement planning.

[iv] Energy consumption in each modeled home was provided by Energy Futures Group. Its analysis is based on knowledge of buildings and efficiency programs in Illinois and utility market studies on current percentage of gas and propane heat.

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Exhibits 2 to 4 below show how the model accounted for the additional generation needed to fulfill this added load. Coal does supply some of the additional load in every scenario, but only a small portion—in the FEJA and CEJA scenarios most of the additional load is supplied by more renewables, while in the low-renewables scenario it is mostly provided by additional gas generation.

EXHIBIT 2

Generation Mix of Incremental Supply for Electrification Load: CEJA Scenario

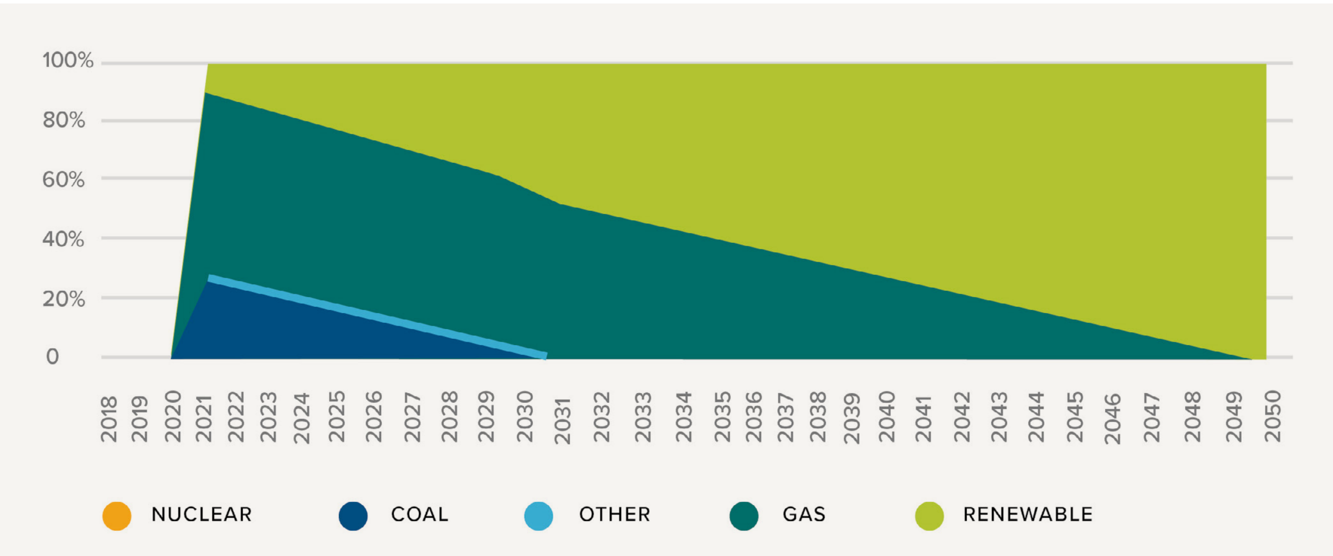


EXHIBIT 3

Generation Mix of Incremental Supply for Electrification Load: FEJA Scenario

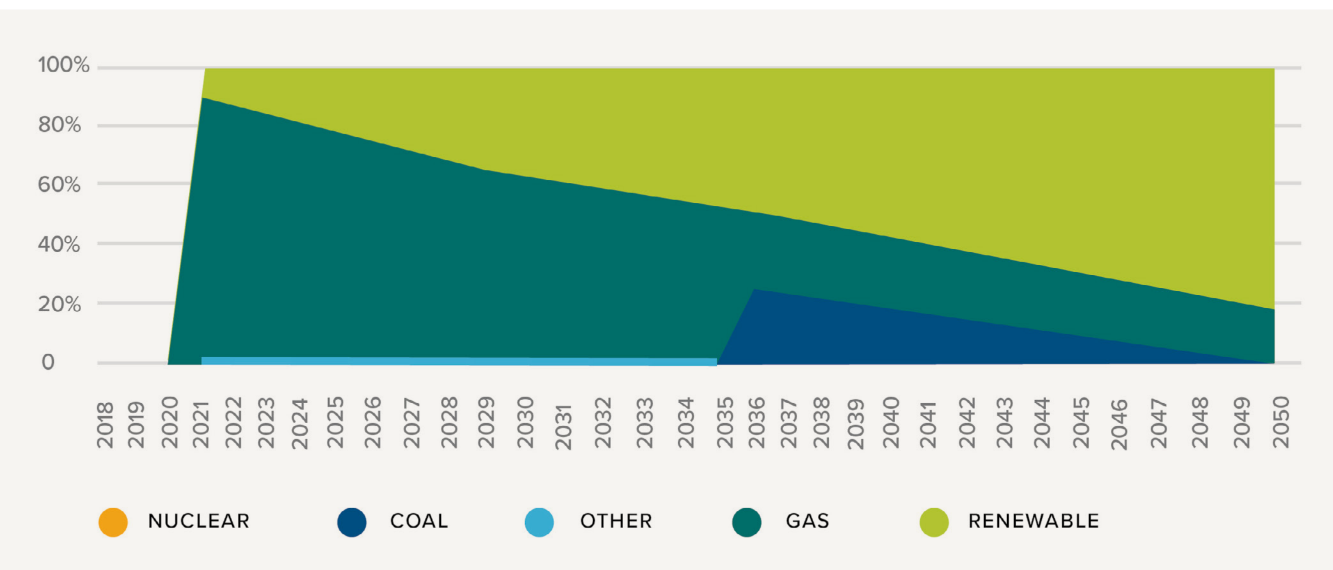
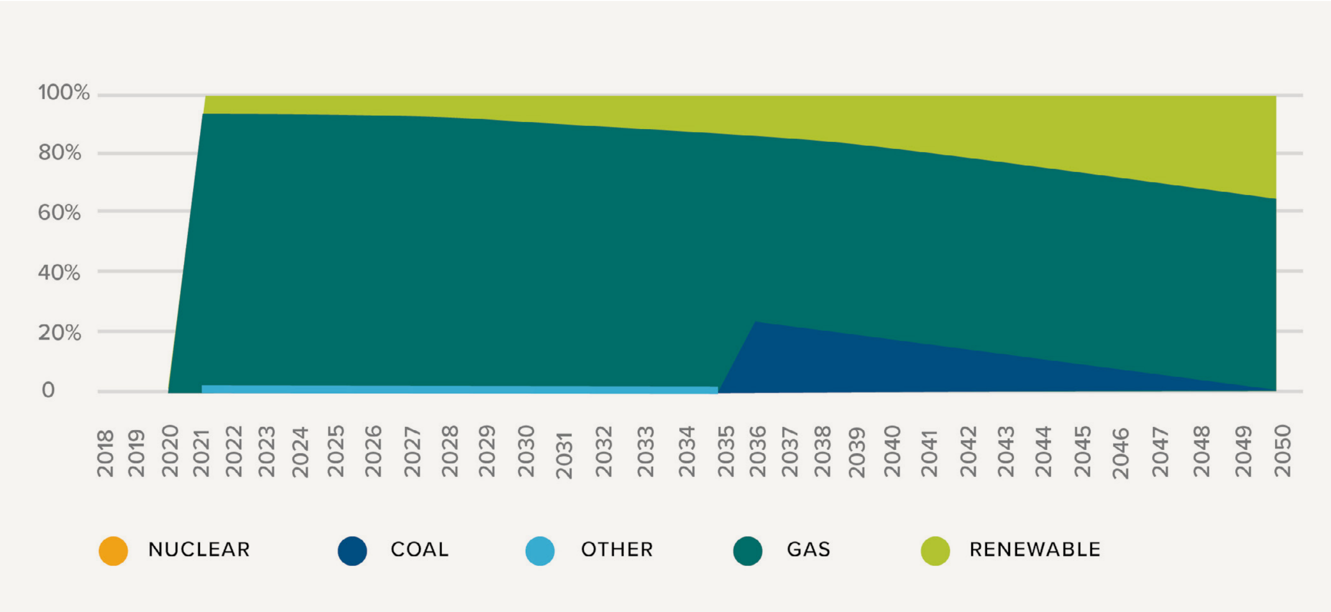


EXHIBIT 4

Generation Mix of Incremental Supply for Electrification Load: Low-Renewables Scenario



In order to compare emissions, we used the current carbon dioxide emissions factors for each electric generation source to calculate the total emissions each year of the added generation.[v] We compared these emissions with the calculated emissions of fossil fuel combustion if those same homes were not electrified but rather retrofitted with a traditional gas (or propane) furnace and DHW system.

An electrified home uses 8,333 more kWh annually than a gas (or propane) home but displaces 96 million BTU of fossil fuel use. This estimate is based on a weighted average of propane and gas heated homes (see the Technical Volume for details on propane share and equipment efficiencies).

[v] The electricity emissions factors per fuel type and emissions factors from direct combustion of propane and gas are from the Energy Information Administration.

Results

Exhibits 5 and 6 show the lifetime added emissions corresponding to electrification alone, and then the net emissions savings (electric emissions minus fossil fuel emissions) for the 500,000 homes. The higher the percentage of renewables in a scenario, the lower the initial increased emissions and therefore the greater the emissions reductions.

While the low-renewables scenario does still see emissions reductions, the climate impact is greatly improved with more aggressive renewable energy targets (or more homes electrified, as reflected in the sensitivities analyses shown in the Technical Volume). In the CEJA scenario, electrifying 500,000 homes avoids 28 million metric tons of carbon emissions, equivalent to removing one year of emissions from more than seven coal plants. Even in the low-renewables scenario, the same amount of electrification would eliminate 12 million metric tons of carbon emissions, equivalent to the annual emissions of three coal plants.

EXHIBIT 5

Increased Electricity Emissions Due to Electrification of 500,000 Single-Family Homes

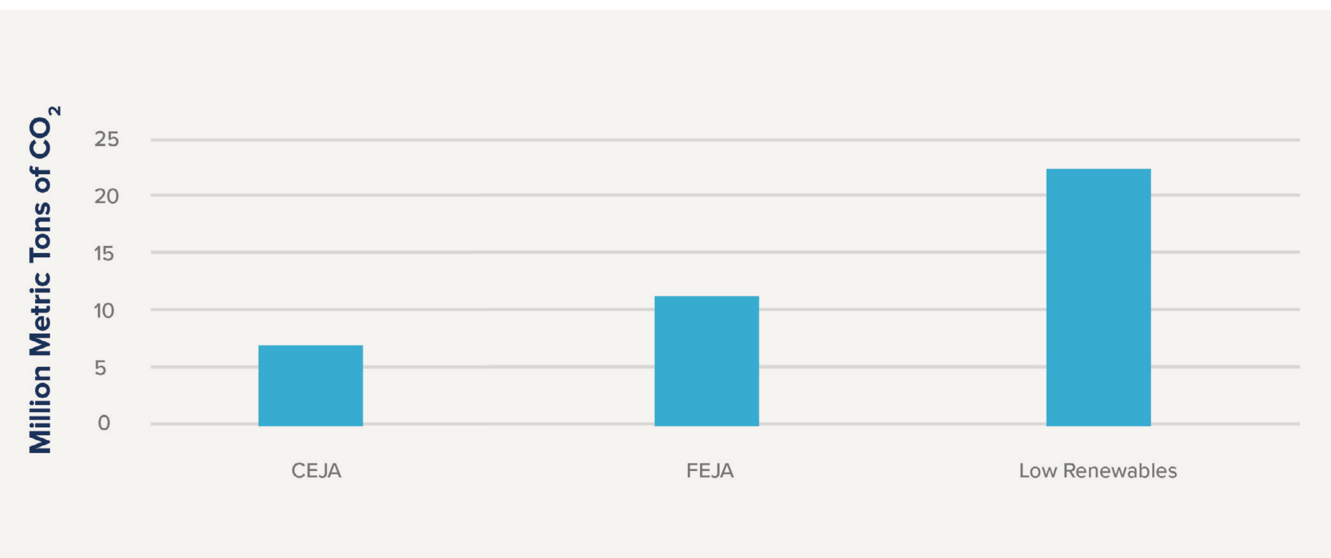
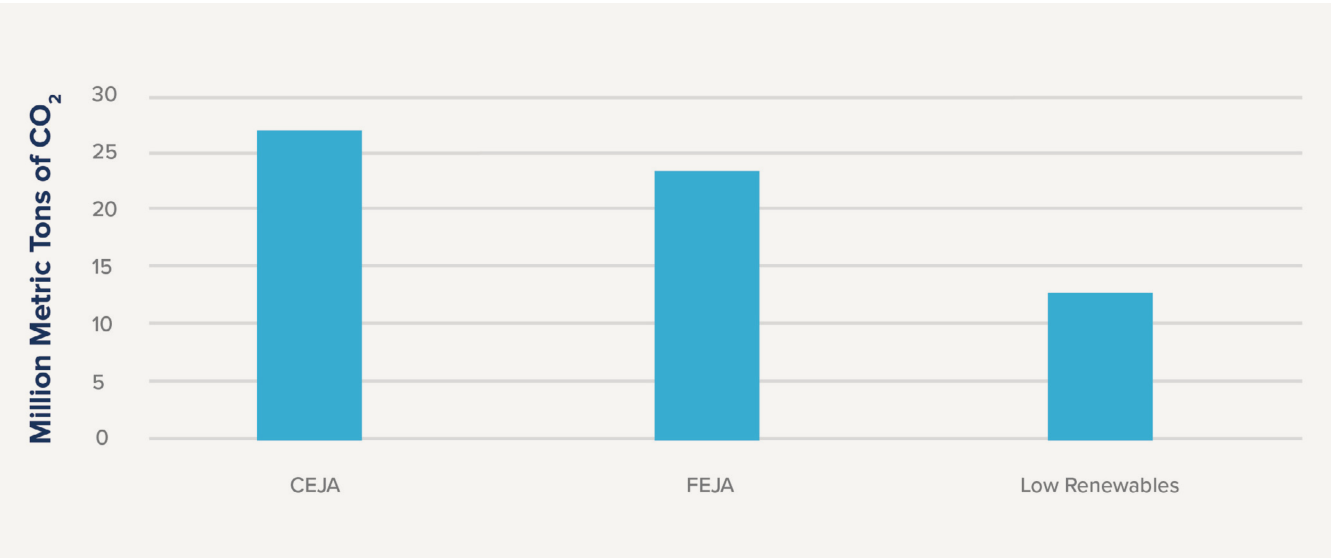


EXHIBIT 6

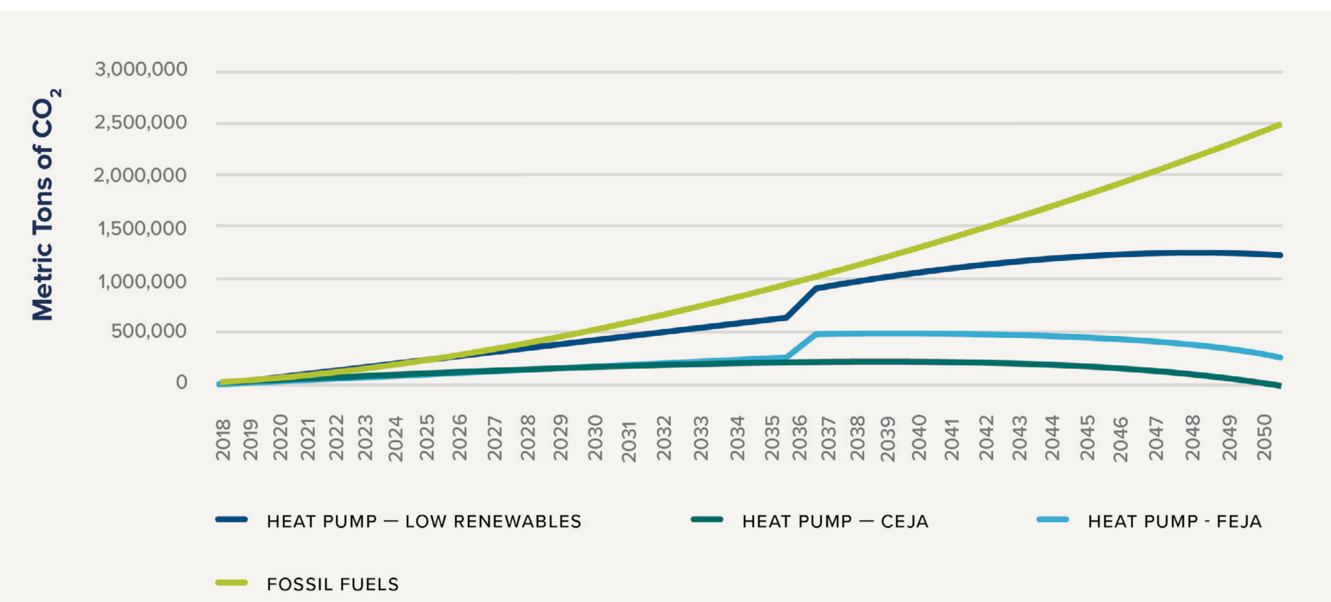
Net Emissions Savings of Electrification of 500,000 Single-Family Homes



The emissions benefit of installing electric heat pumps begins with heat pumps installed today and continues over time as more homes are electrified and the grid continues to become cleaner, as seen in Exhibit 7.

EXHIBIT 7

Annual Emissions over Time



Future Research

As with all modeling, particularly long-term, future-facing modeling, we made simplifying assumptions that are good topics for future research. Cost impacts represent an important topic for future study, which could also incorporate stoves and dryer demands, include multifamily buildings, account for differing carbon and pollution emissions across different coal plants, and explore health impacts of reduced indoor fuel combustion.

Future research could also further explore the emissions implications of consuming energy at different times of day as well as the impact on seasonal variations in renewable supply, the emissions impact of methane leakage for gas equipment, and the added emissions benefit of behind-the-meter distributed solar. Additionally, it could incorporate other energy efficiency retrofits and reflect technology improvement over time. We hope future studies are able to expand and incorporate some of these items.

Conclusion

This analysis confirms that there is no reason to delay building electrification. Illinois has already moved toward a grid less reliant on coal and ready for more renewables. Even more aggressive renewable energy policies, paired with policies and programs to support building electrification, can maximize the benefits of a cleaner grid and help Illinois achieve its climate goals. To maximize the benefits of building electrification, Illinois should:

- Pair or sequence legislation to increase renewable energy with complementary policy to support building electrification;

- Adopt state-wide building codes that incentivize, require, or promote all-electric buildings in both existing buildings and new construction;

- Make it easier for homeowners and affordable housing providers to electrify (for example: use both carrots [incentives] and sticks [requirements at time-of-sale], allow energy efficiency rebates to be used for building electrification, encourage flexible financing); and/or

- Scrutinize further gas investment.

These actions, along with movement toward a fully renewable electric grid, will ensure Illinois contributes to a carbon-free world.

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