Electric Rates for Hybrid Air Source Heat Pumps in the Midwest

Midwest Air Source Heat Pump Collaborative

June 1, 2023

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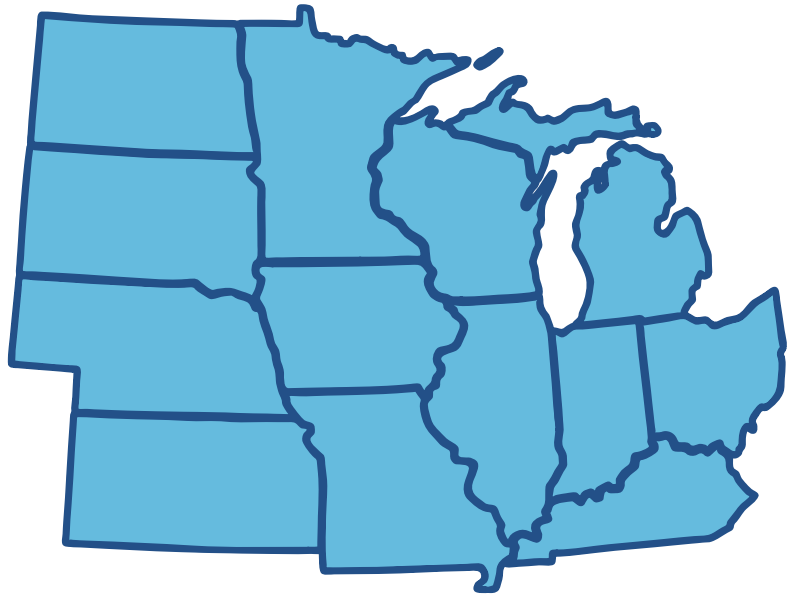
Housekeeping

- This webinar is being recorded, and MEEA will be sending a link to view it along with the slide deck
- If you have any questions for the presenters, please put them in the Question box, not the chat, to make sure we see them
  - We have saved time at the end for discussion
- Feel free to provide input using the chat functionality

Midwest Energy Efficiency Alliance

The Midwest Energy Efficiency Alliance (MEEA) is a collaborative network, promoting energy efficiency to optimize energy generation, reduce consumption, create jobs and decrease carbon emissions in all Midwest communities.



MEEA is a non-profit membership organization with 150+ members, including:

Energy service companies & contractors

State & local governments

Academic & Research institutions

Electric & gas utilities

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Speakers

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Midwest Energy Efficiency Alliance

Moderator

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Center for Energy and Environment

Molly Garcia
Center for Energy and Environment

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Agenda

- Introduction
- Making the Case for Special Electrification Rates
- Exploring Potential Electrification Rates
- Modeling Conclusions
- Expanding Engagement
- Discussion

Goals for today

01

Absorb why rates are important for equitable electrification

02

Understand modeling for potential electrification rates

03

Drive further discussion and interest

Introduction

Molly Garcia

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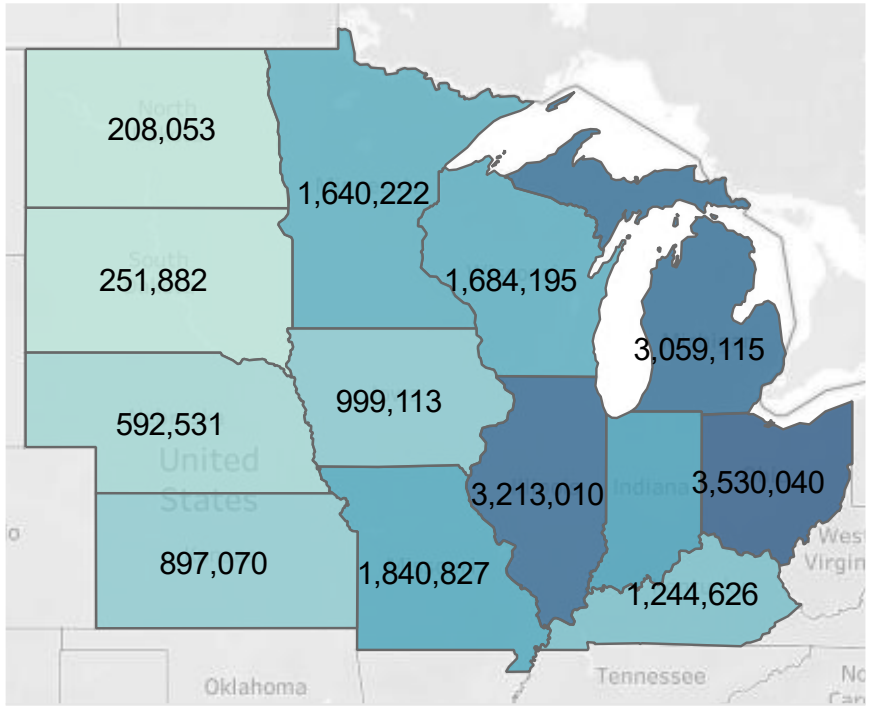
Midwest ASHP Collaborative

Accelerating ASHP adoption faster and better, together

- Delivered by **CEE** and **Slipstream**
  - In partnership with Midwest Energy Efficiency Alliance (**MEEA)** and **Elevate**
- 2022-2023 Objectives:
  - Cross pollinating program best practices
  - Rate design for heat pumps
  - Equitable workforce development
  - Regional market transformation strategy



Number of SFH per state

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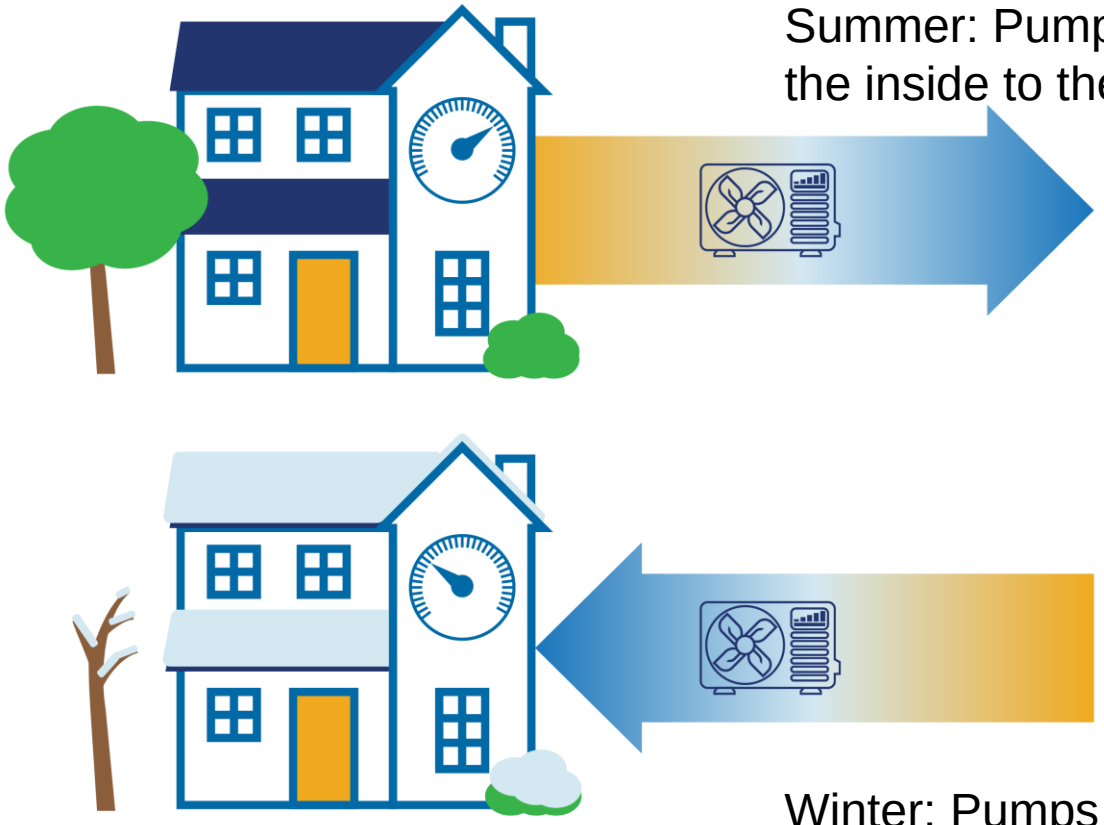
Why do we need to act now?

“The mission of DOE’s Office of Energy Efficiency and Renewable Energy is to accelerate the research, development, demonstration, and deployment of technologies and solutions to equitably **transition America to net zero greenhouse gas emissions economy-wide by no later than 2050**”

Vision: The Future of Home Heating is Heat Pumps

By 2030 air source heat pumps (ASHPs) are the first choice for contractors and homeowners replacing heating systems or air conditioners, optimized to provide heating as well as cooling.

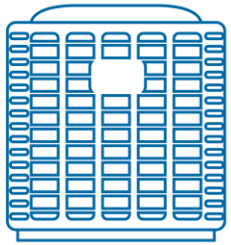
What is a Heat Pump?



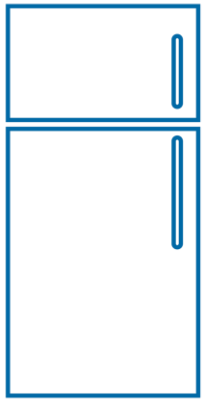
Summer: Pumps heat from the inside to the outside

Winter: Pumps heat from the outside to the inside

Same technology as:



Air Conditioner



Refrigerator

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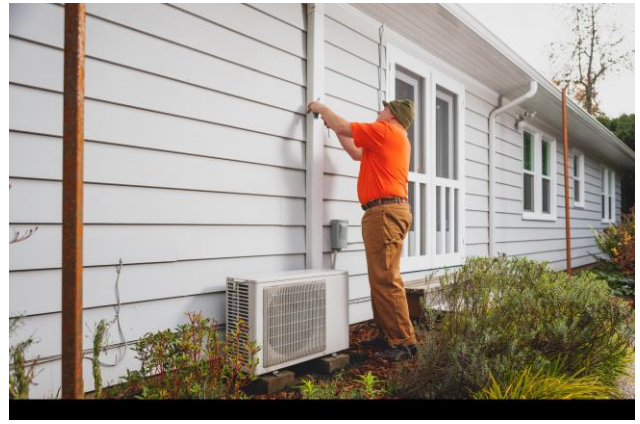
In focus for the Midwest ASHP Collaborative

- **Residential Heat Pumps**
  - **Minisplit heat pumps**
  - **Centrally ducted heat pumps**
  - **Dual-fuel heat pumps**
  - Air-to-water heat pumps
  - Ground source heat pumps
  - Gas fired heat pumps
- Commercial Heat Pumps
  - VRF heat pumps
  - RTU heat pumps
- Industrial heat pumps



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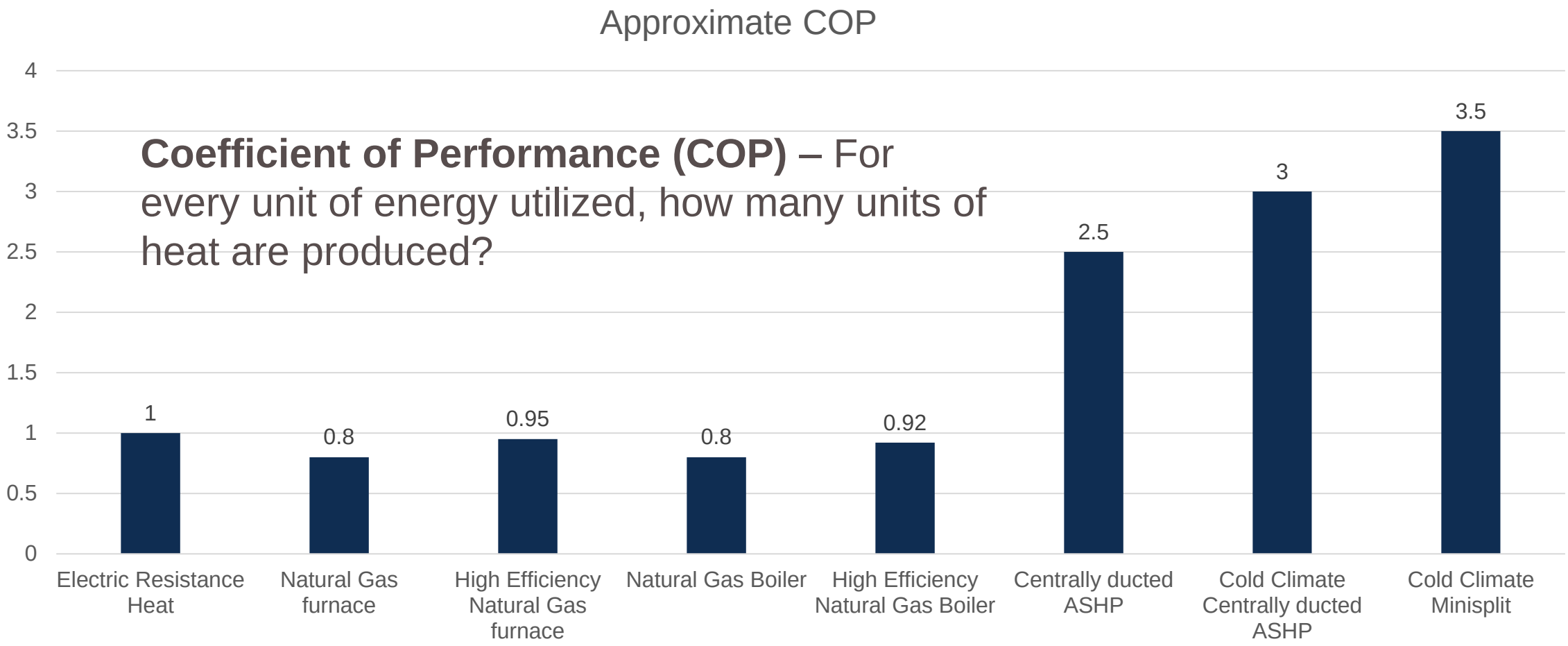
Why ASHPs?

Immense fuel efficiency and carbon reduction



Coefficient of Performance (COP) – For every unit of energy utilized, how many units of heat are produced?

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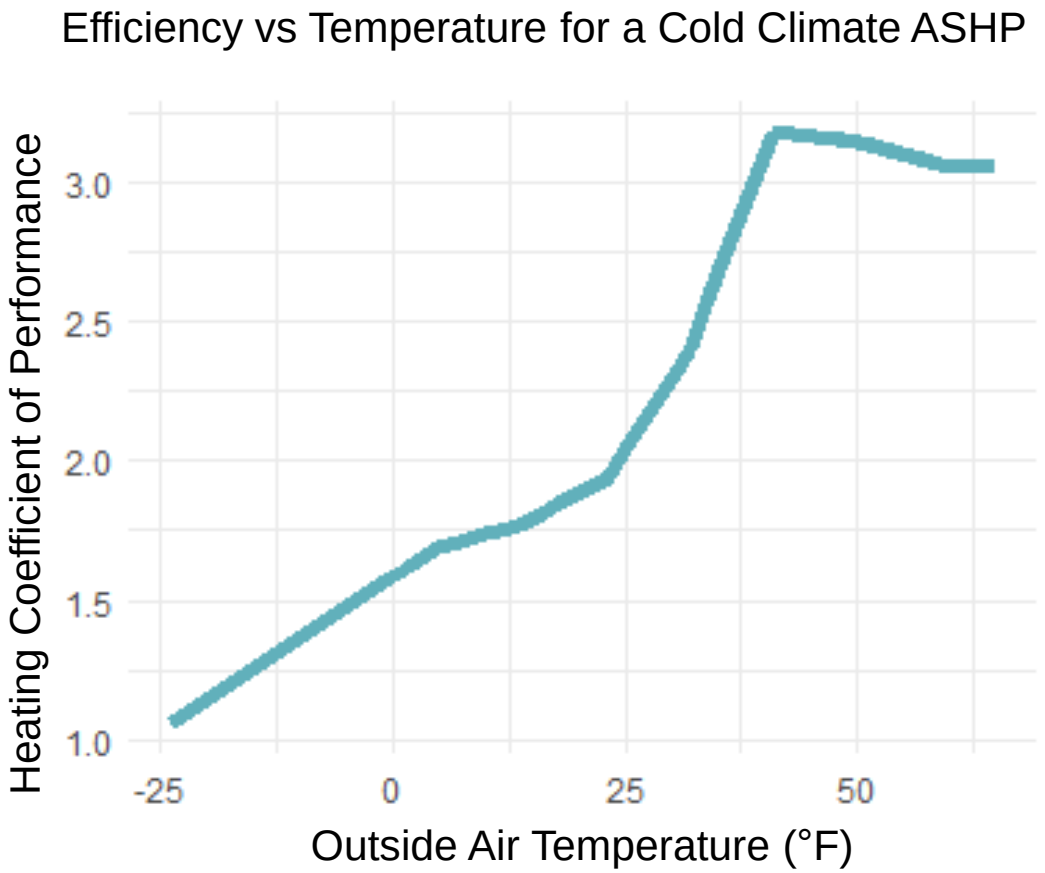
ASHPs in cold and very cold climates

- ccASHPs offer promise for large site energy savings and emissions reductions
- Many models do work at these very cold design temperatures
- But they still have significant capacity limitations compared to space heating needs



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Low hanging fruit opportunities

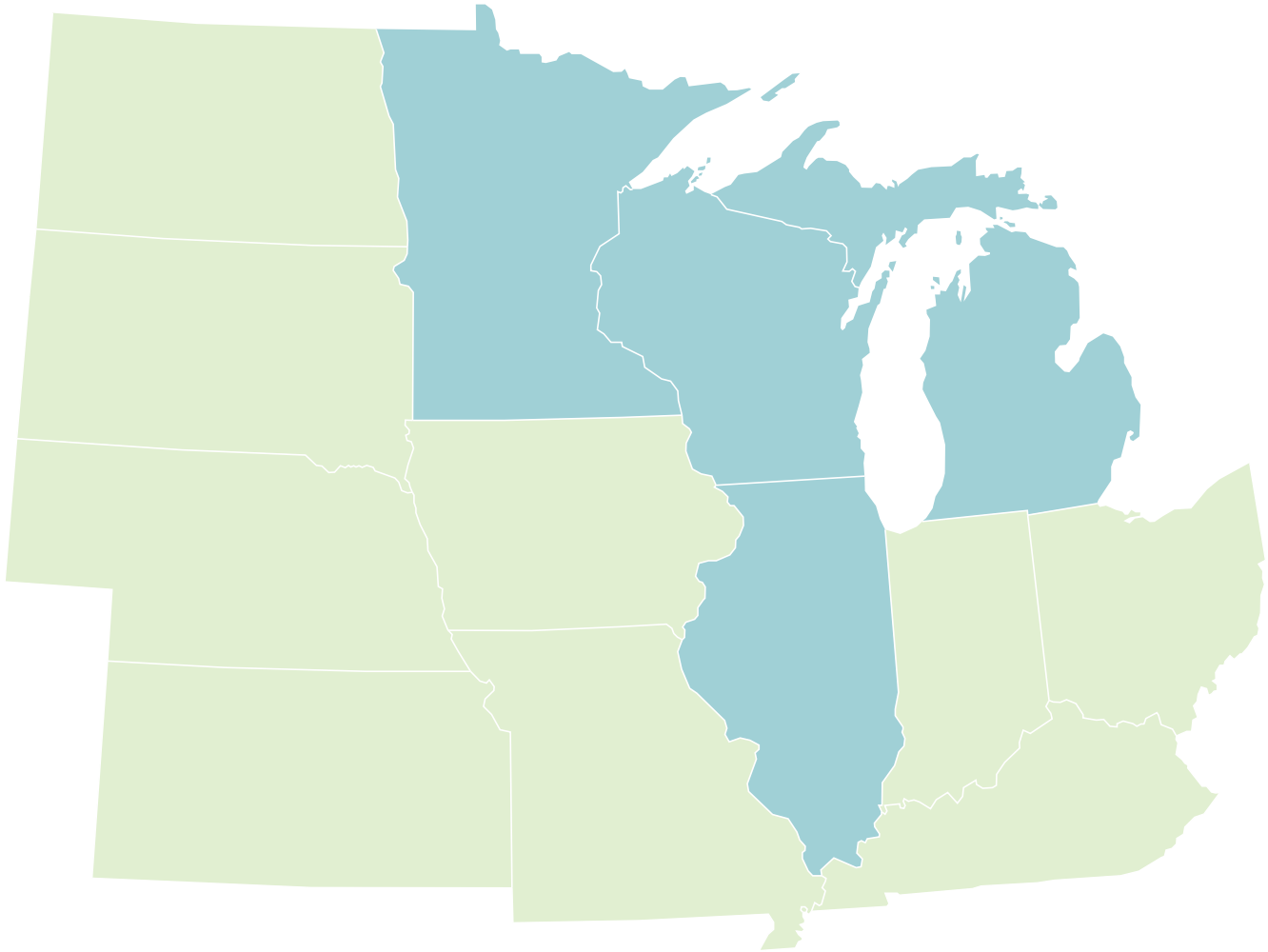
Electric resistance heated homes

- 2X - 3X customer bill reduction and emissions reductions
- Addresses customer comfort issues

Propane heated homes

- ~40% customer bill reduction and ~35% - 70% emissions reductions
- Addresses customer comfort issues
- Hedges against fuel price volatility

Align States and Activate States



Align State

Activate State

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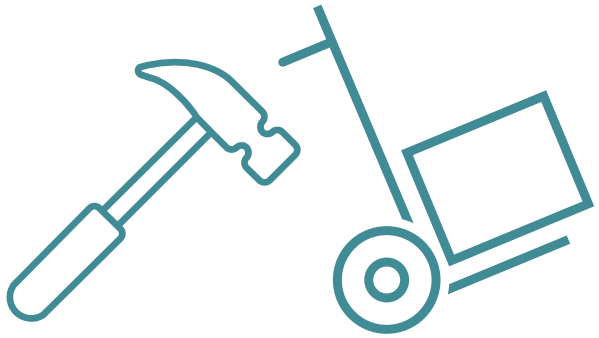
Initial key audiences of the Collaborative

Utilities

State energy offices and regulators



ASHP Manufacturers and Distributors

Making the Case for Special Electrification Rates

Carl Nelson

Center for Energy and Environment

Why should we care about electric rates for ASHPs?

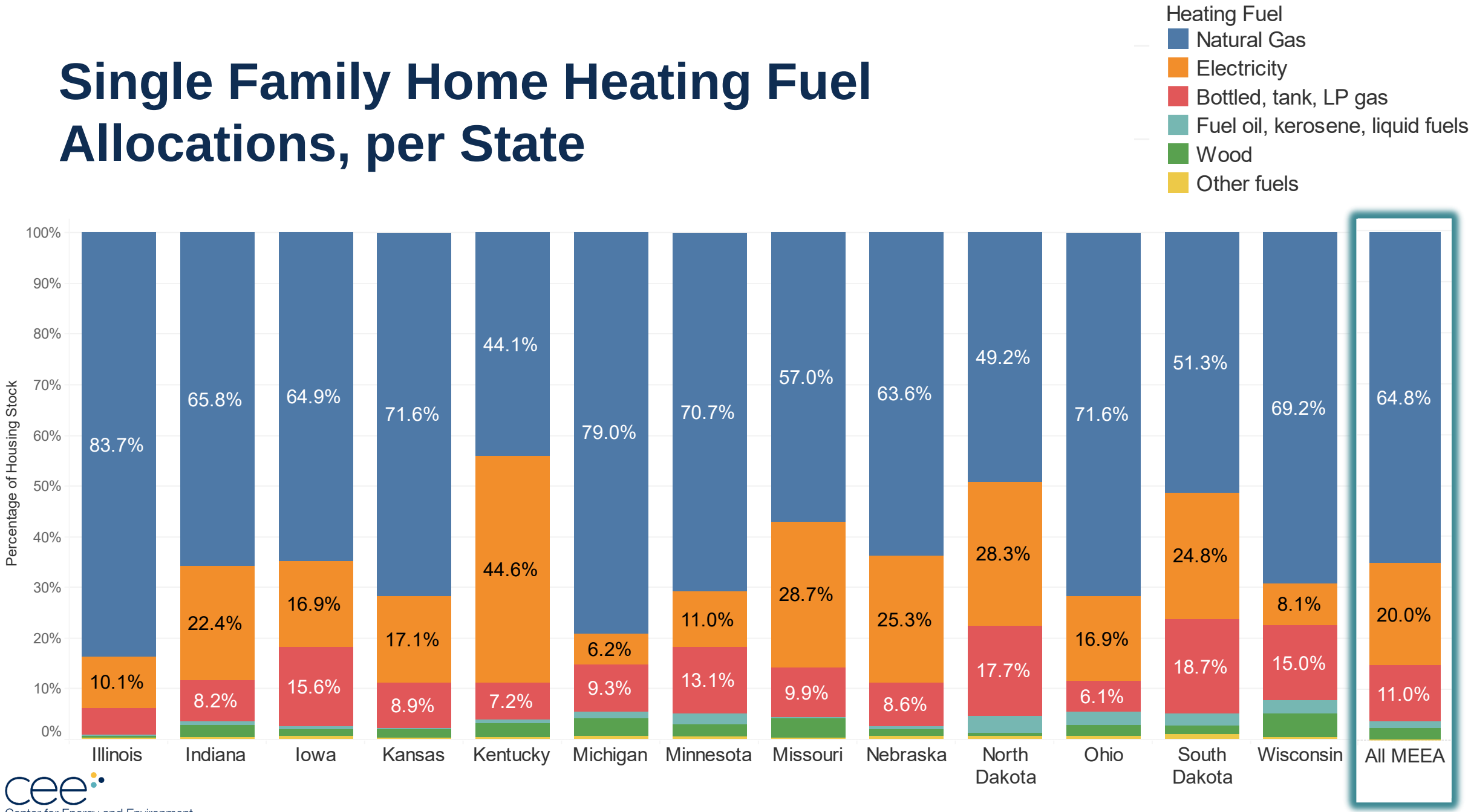
Very little electrification is economic for the customer at current electric rates

Yet, lower electric rates are justified, particularly for hybrid systems

This is because standard rates typically overcharge ASHP customers

Solving this issue is important for achieving equitable electrification

Single Family Home Heating Fuel Allocations, per State



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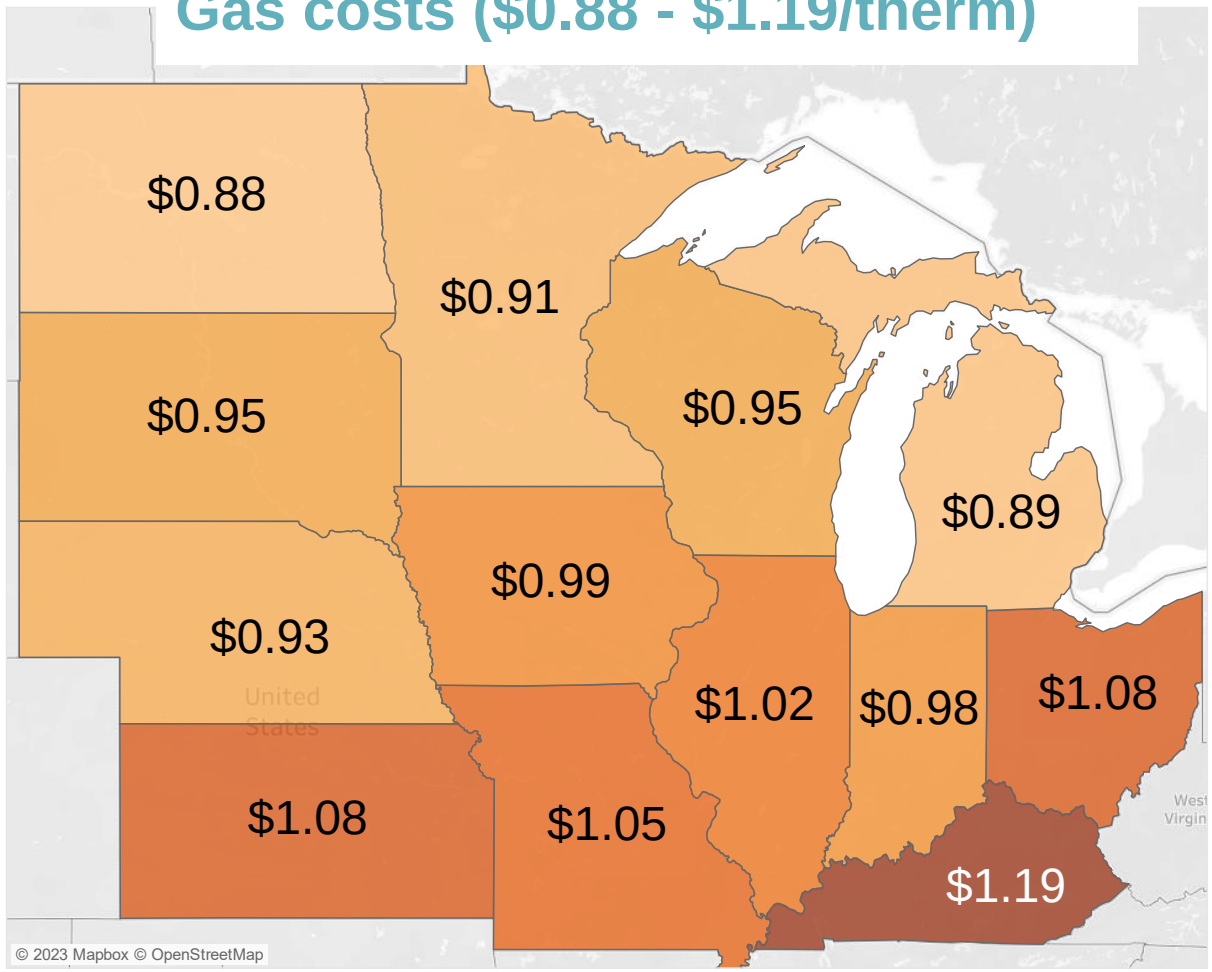
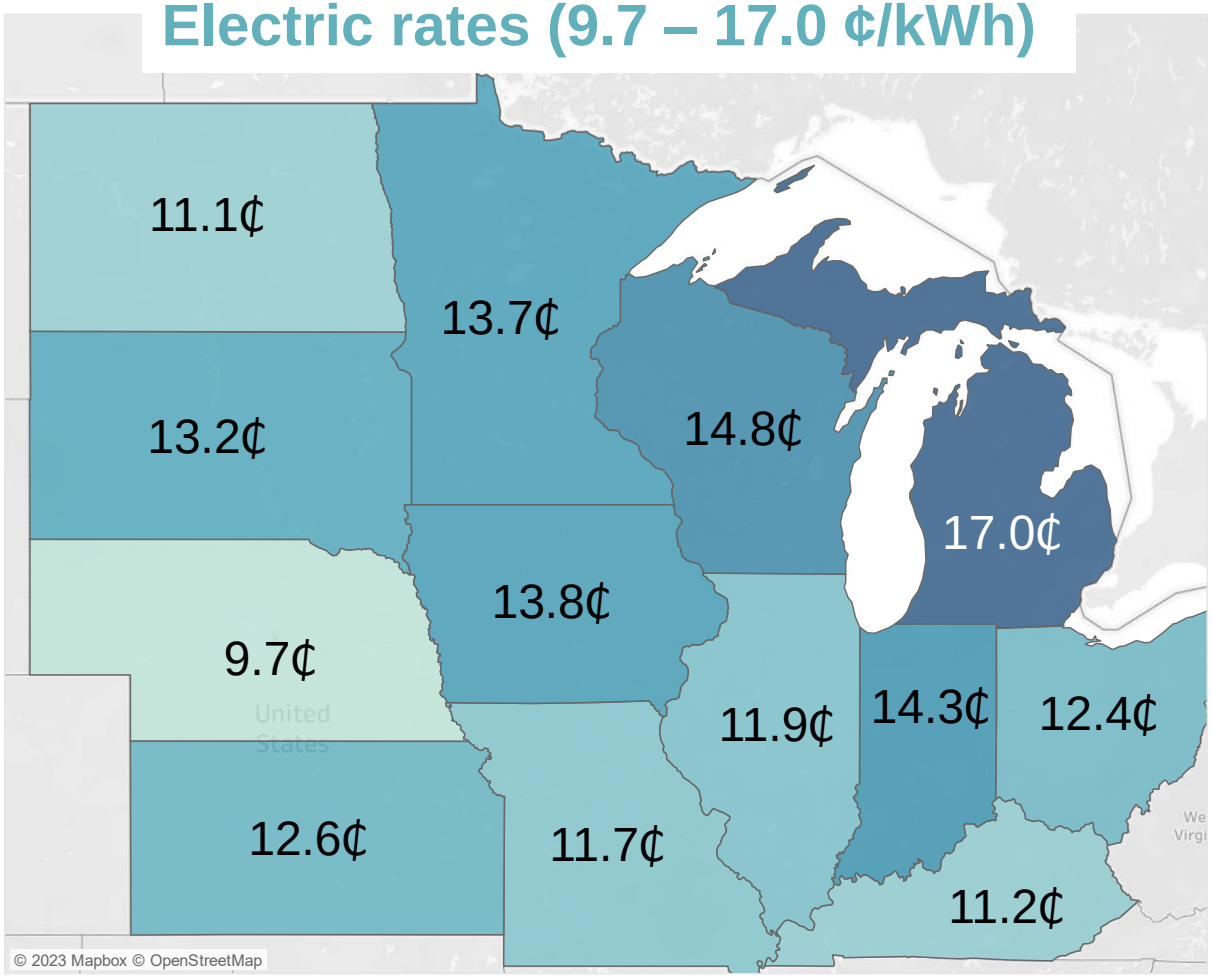
Natural gas remains affordable fuel in Midwest

Gas costs ($0.88 - $1.19/therm)



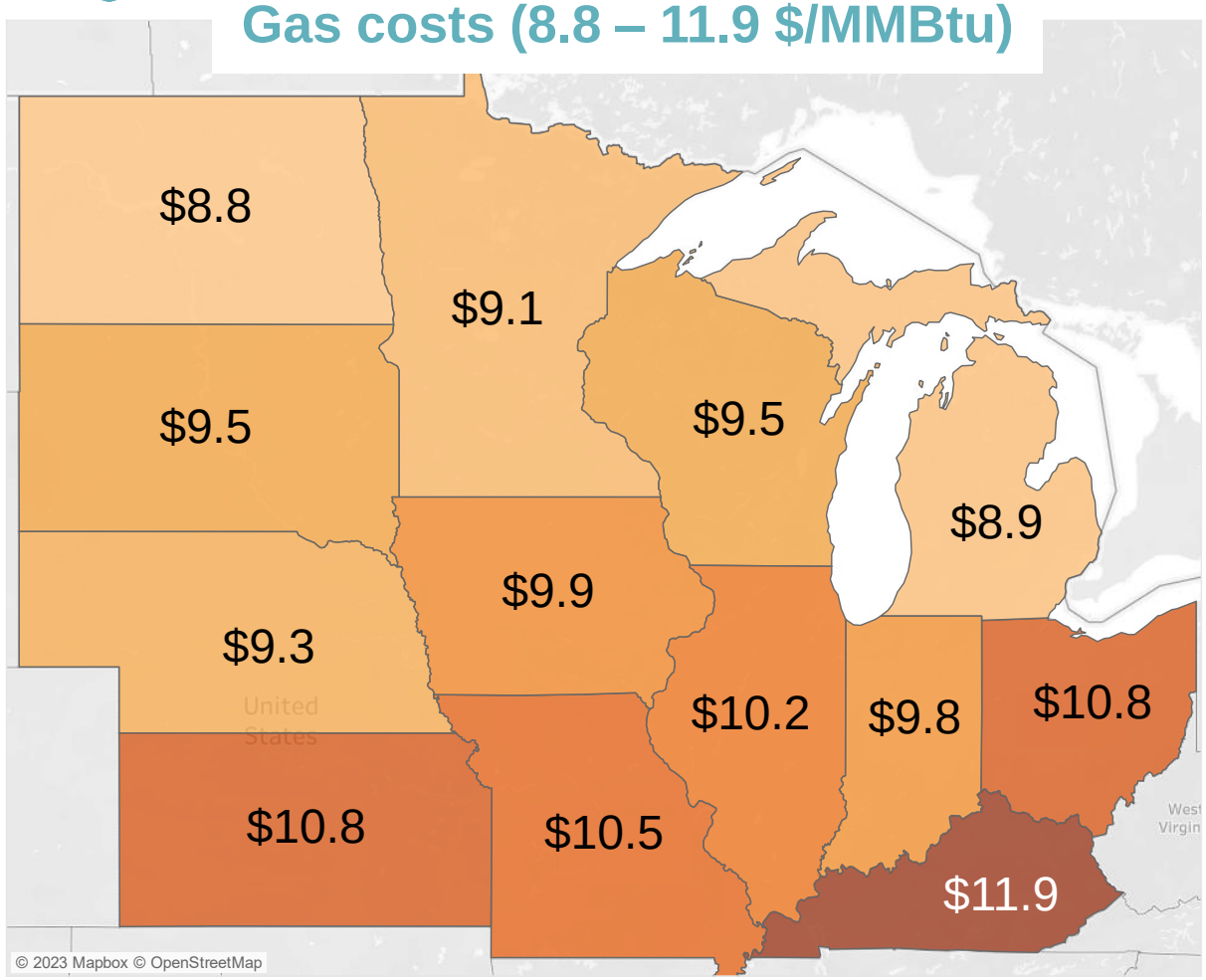
Electric rates (9.7 – 17.0 ¢/kWh)



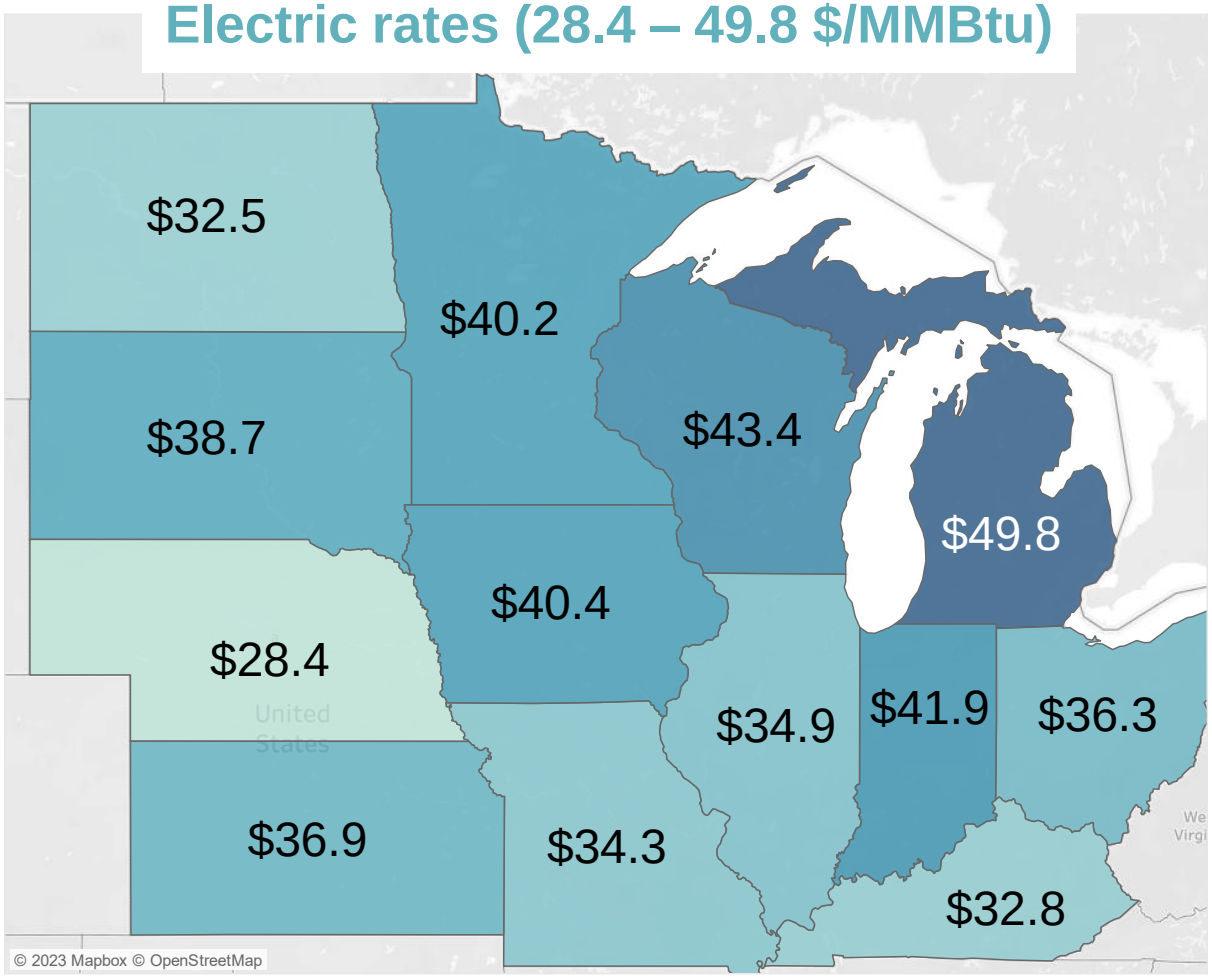
Full electrification will result in bill increases for the vast majority of customers

Electric and gas costs on MMBtu basis

Gas costs (8.8 – 11.9 $/MMBtu)

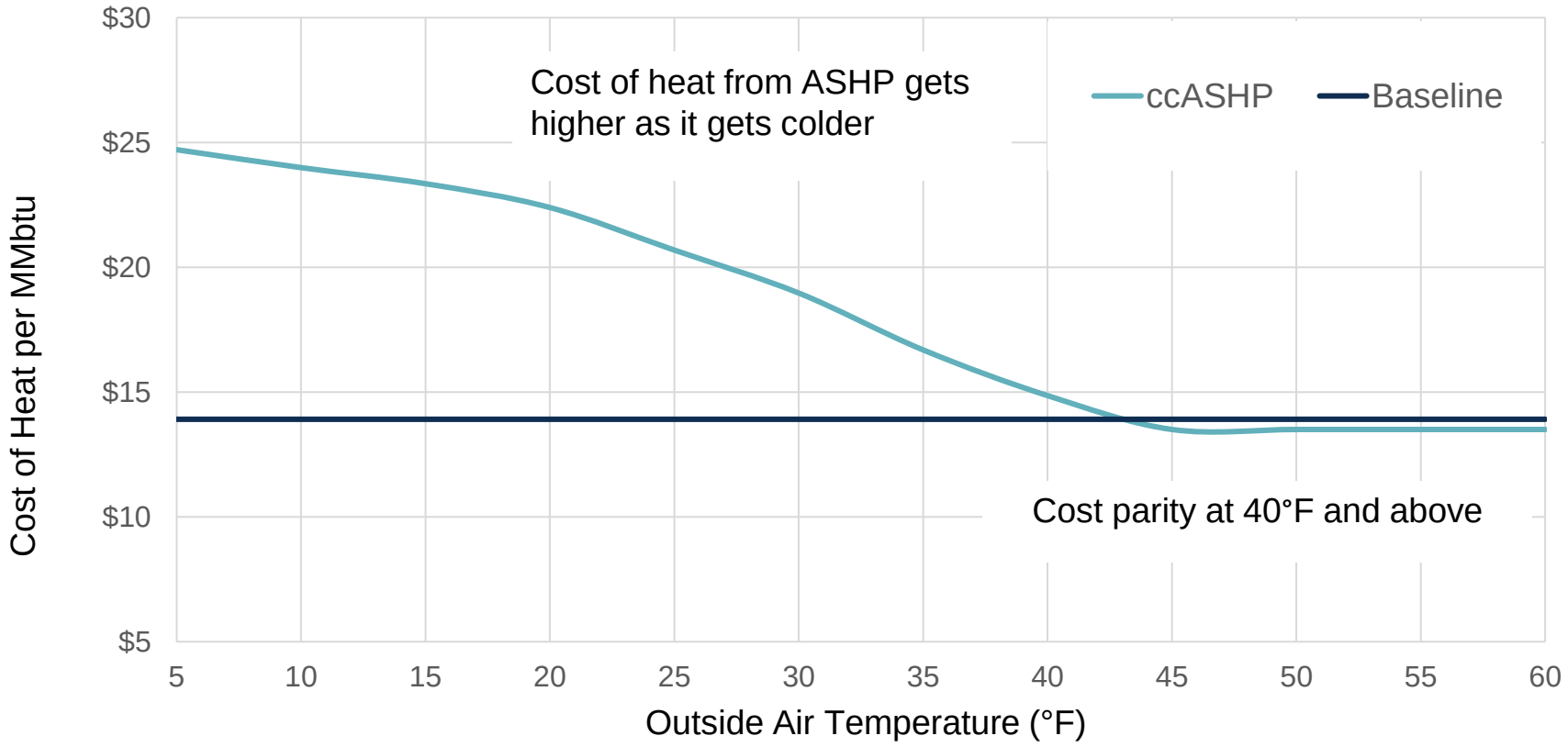


Electric rates (28.4 – 49.8 $/MMBtu)



Full electrification will result in bill increases for the vast majority of customers

Even at high gas prices, electrification is only cost-effective at moderate temps at current rates



- Elec - $0.137/kWh
- **Gas - $1.23/therm**

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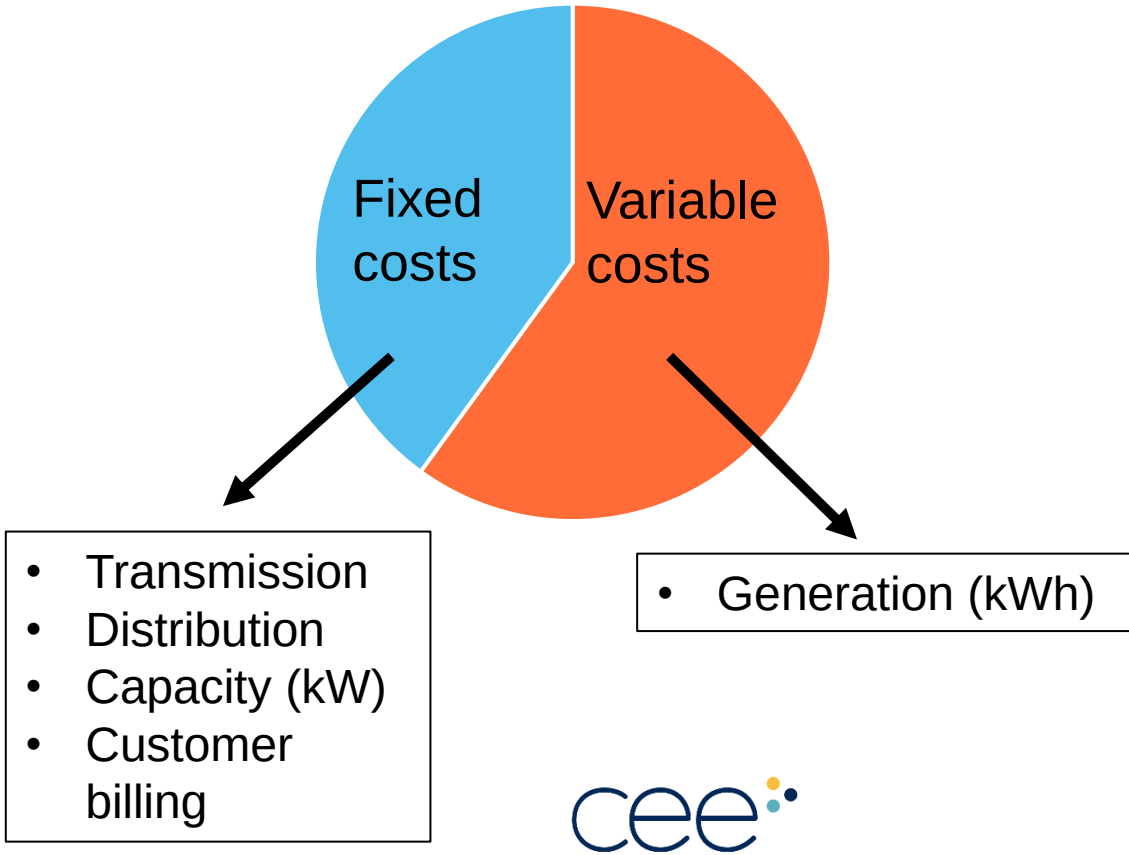
Residential rates composed of fixed and variable costs

- Rates seek to recover costs for variable and fixed costs to serve the customer
- ASHPs do not increase (or only moderately increase) fixed costs on the system
- Only variable costs increase, compared to typical residential customer

Cost components of residential electric rates



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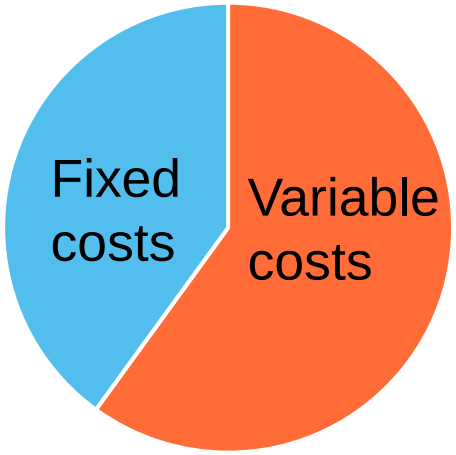
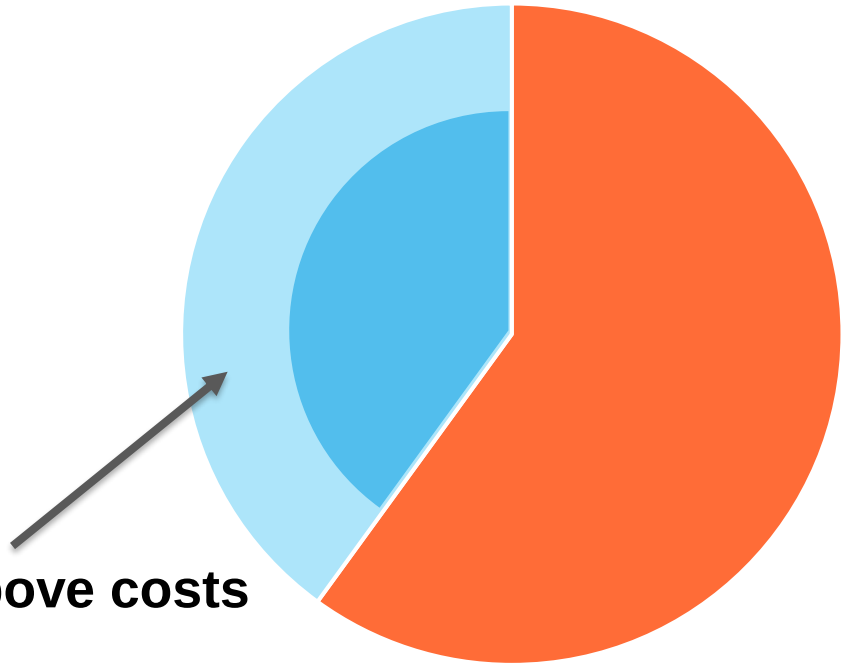
ASHP customers overpay at standard rates

Average residential customer
10,000 kWh usage
$1370 annual bill



ASHP customer
20,000 kWh usage
$2740 annual bill



Excess payment above costs
$548/yr

Figure is illustrative only of magnitude of costs based on a 60/40 split between variable and fixed costs; not based on actual rate analysis or ASHP performance

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Rates are important to achieve electrification goals

- Developing and utilizing the right electric rates for ASHPs, particularly hybrid systems, will be essential to reaching full potential of the technology
- It is also important for equity
  - Avoid un-intended consequences of increased energy burden on low-income populations
- Generally, energy-efficiency/electrification folks are siloed from public utilities commission and utility rates folks
  - More engagement is needed
- CEE white paper expands on this
  - https://www.mncee.org/developing-electric-rates-hybrid-air-source-heat-pumps-midwest

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Exploring Potential Rates

Ranal Tudawe

Center for Energy and Environment

Model Inputs

Variables

Electric Rates

Gas Rates

Location & Weather

Assumptions

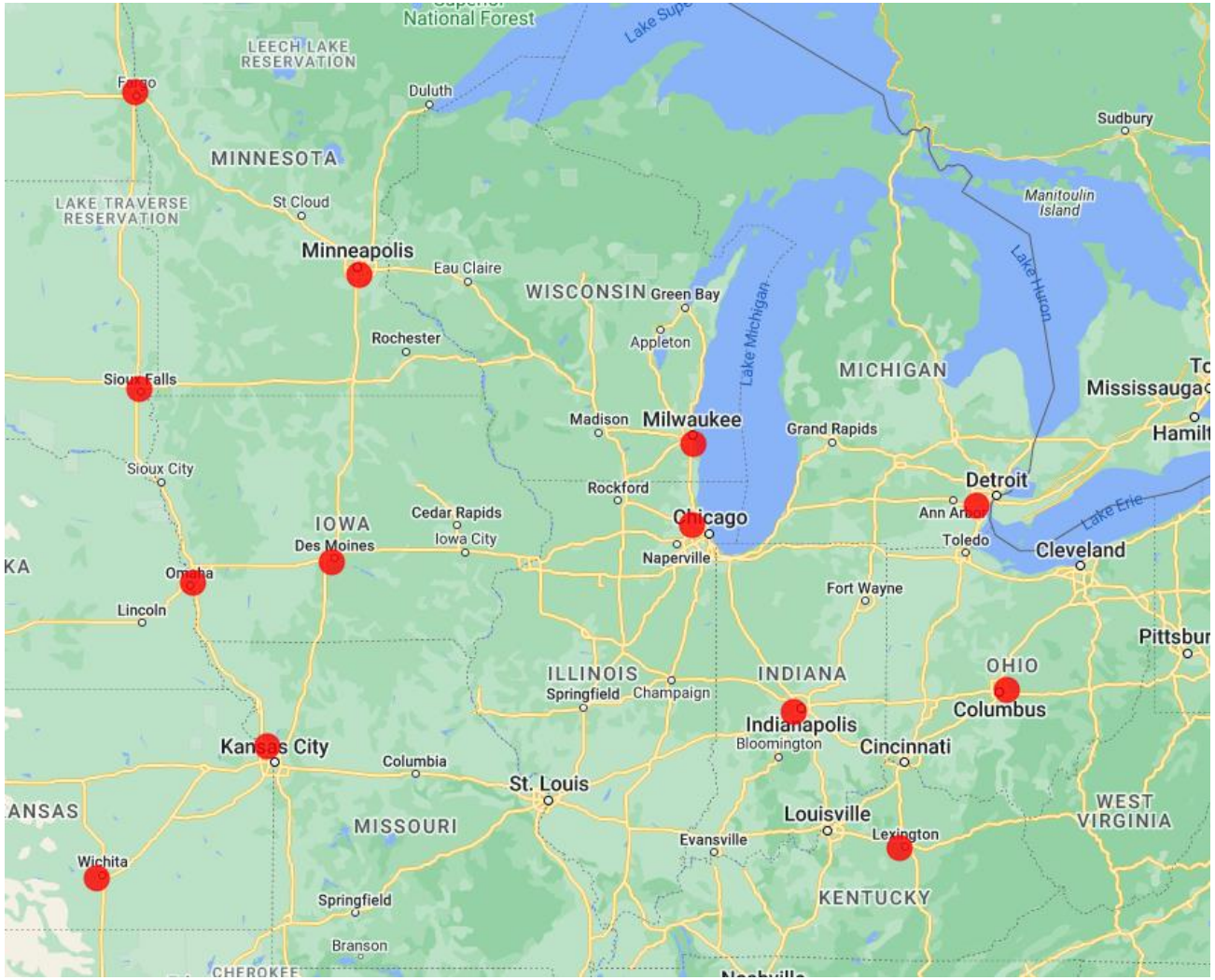
Home Type

Baseline System

Measure System

Heat Pump Usage

Non-HVAC Electricity Usage



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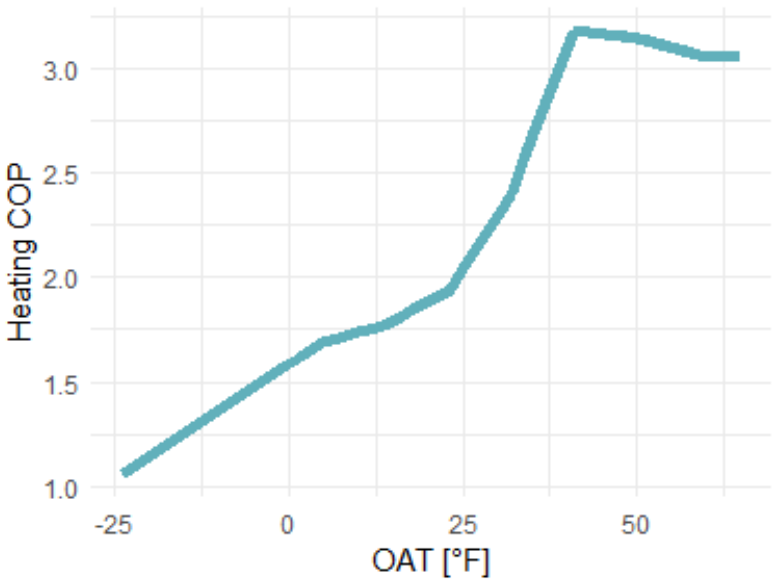
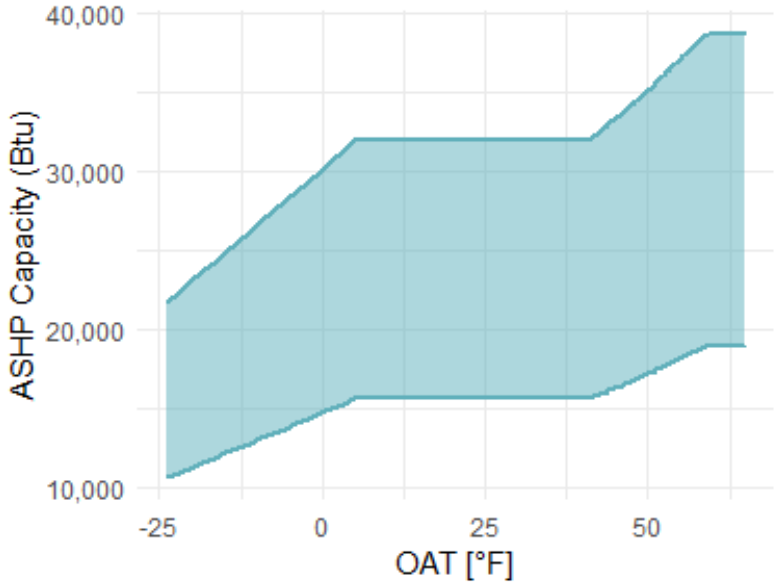
Energy Model

- Hourly building energy model built in R
- 2,100 square foot single-family detached home constructed in the 1970s
- Compares dual fuel cold climate heat pump system to counterfactual 95% baseline furnace + SEER 14 central AC
- Heat pump operates above the switchover temperature to electrify at least 50% of the heating load
- The measure and baseline address the same heating and cooling loads

Heat Pump Performance





- The modeled heat pump emulates a cold-climate vsASHP.
- Both COP and capacity decrease at lower outdoor temperatures.

- The switchover temperature is selected for each location based on the nearest temperature in 5°F increments that electrifies at least 50% of the annual heating load
- This is typically at 20 ° F – 30 ° F.

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Dual Fuel ASHPs Help the Grid By…

Reducing Summer Peaks

- Increased cooling efficiency shaves summertime peak consumption

Increasing Winter Consumption

- Partially electrifying the heating season allows for increased electricity sales in off-peak season

Allowing for Wintertime Flexibility

- A dual fuel system offers peak shaving flexibility in a winter peaking scenario

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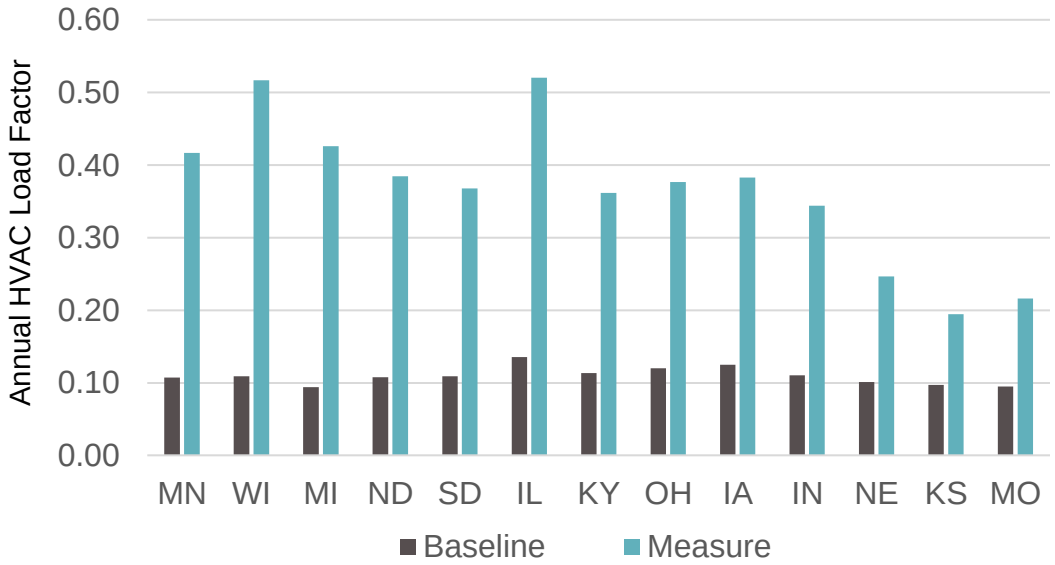
Grid Impacts

- The load factor is calculated using peak summertime HVAC electricity usage

$$Load\ Factor = \frac{Total\ kWh\ consumed\ per\ year}{Summer\ Peak\ kW\ \cdot 8760\ hours\ per\ year}$$

- A higher load factor indicates that the peak hourly consumption is similar to the average hourly consumption through the year
- Increasing load factors mean that grid resources can be used more efficiently, especially if the peak stays the same or reduces
- **Measure** load factors increase to 200% – 470% of the **baseline** value, with colder states seeing larger benefits.



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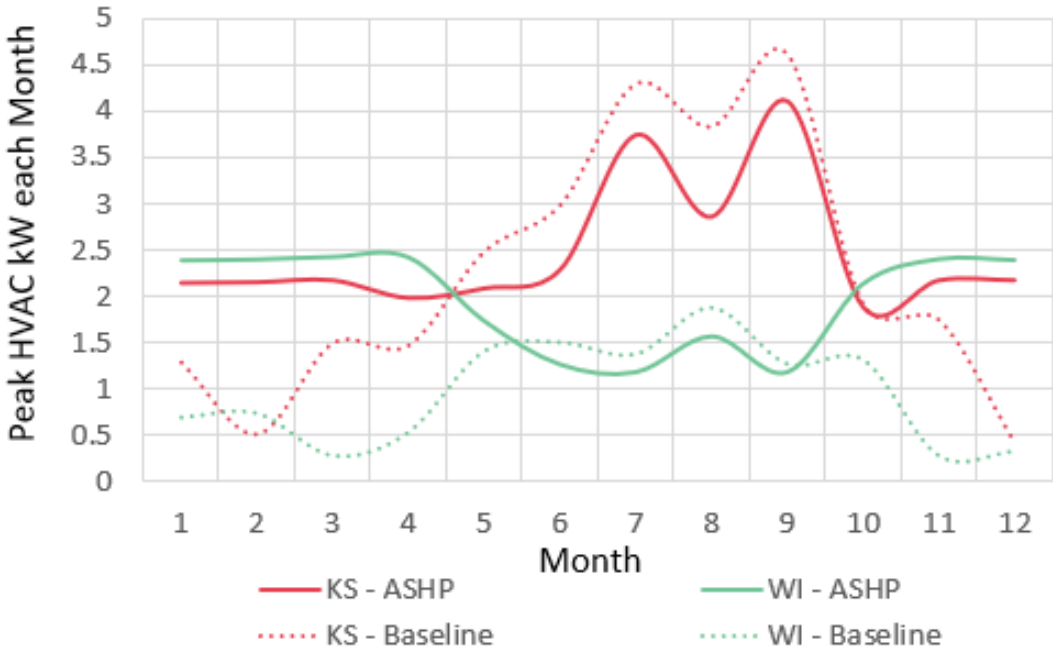
Grid Impacts

- **Warmer climates** see sizeable peak shaving in cooling season, with electricity consumption rising in the heating season.
  - The new system does not approach the summer peak in heating season.
- **Colder climates** see smaller peak shaving in cooling season, with heating season consumption rising significantly.
  - Large heating loads and milder summers cause winter peak consumption to surpass current summer peaks.
- Dual fuel systems in winter peaking grid scenarios offer the added benefit of load shaving compared to all-electric options



But how does this affect customer economics?

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Cost, Rates, and Efficiency

Special Rates

Warmer Climate

$$\frac{\left(\frac{Electric\ Rate}{Gas\ Rate}\right)}{\left(\frac{Electric\ Heating\ Efficiency}{Gas\ Heating\ Efficiency}\right)} =$$

Assuming equal load

1	Cost Neutral with Gas
< 1	**Savings**
> 1	**Increased costs**

- Applies to the heating load above the switchover temperature
- Lower electric rates allow for lower ASHP efficiency without increasing costs
- Better ASHP efficiency (better performance or warmer climate) allows for economic electrification with higher electric rates
- We can “buy down” further electrification with cooling savings and weatherization

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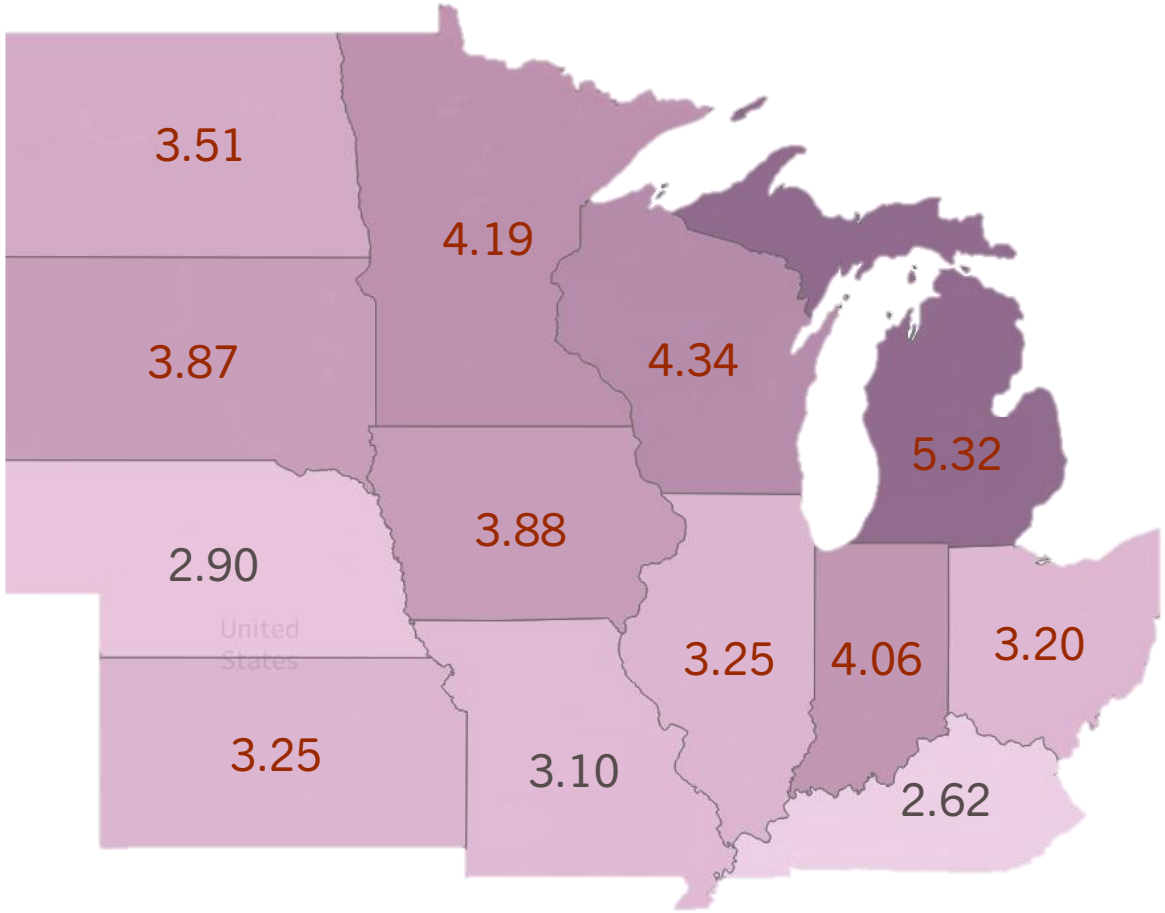
Rate Scenarios

- EIA estimates for all-inclusive (fixed and volumetric) ¢/kWh and $/therm.
- Most states require an average seasonal heating efficiency **higher than the modeled ASHP can achieve at any temperature**.
- Additional rate scenario at 70% of EIA rates to emulate a special dual-fuel rate based on existing special rates.
- Additional gas scenario uses 140% prices to adjust for recent gas costs.

<u>Seasonal</u> COP Needed for Cost Parity Using EIA Estimates



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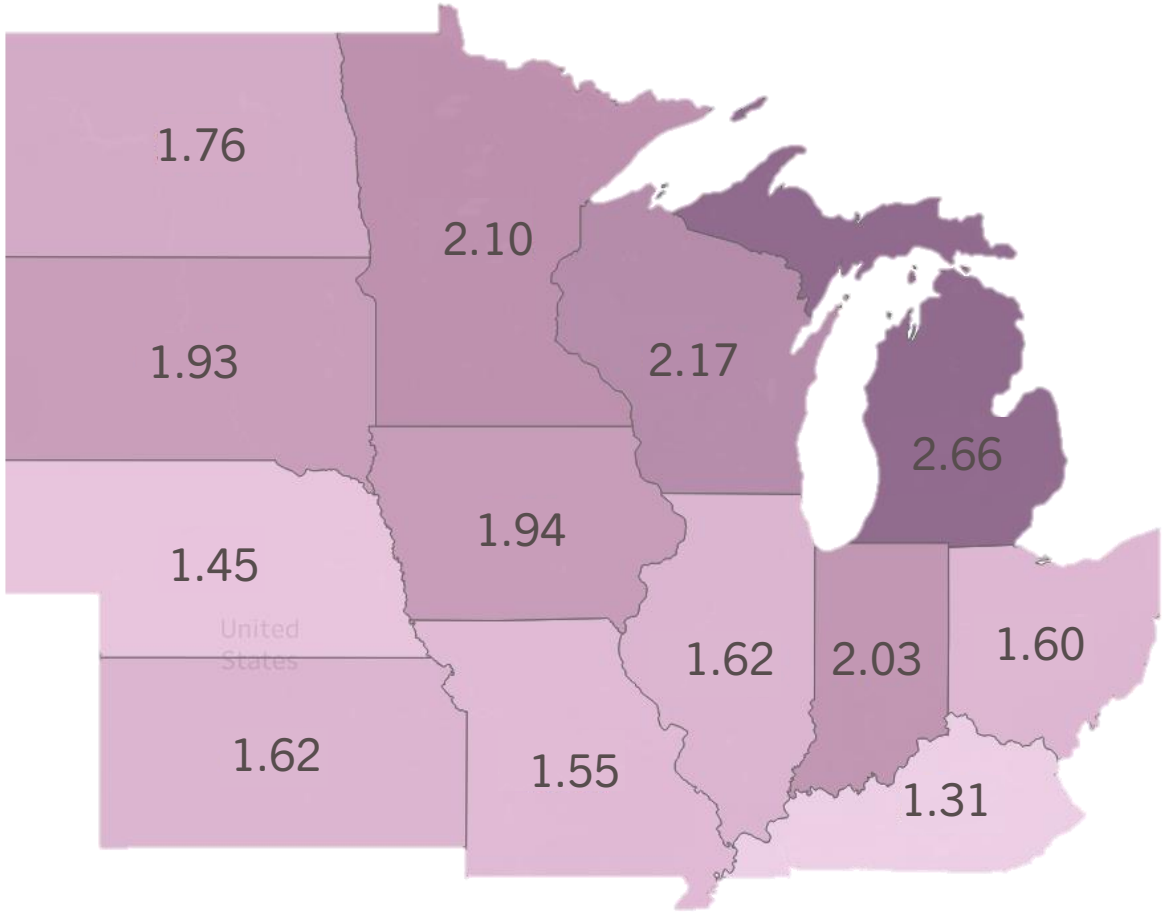
Rate Scenarios

- Adjusting for recent gas prices and 70% special electric rates, the seasonal COP required for cost parity is **50% lower**.
- Required COP can be further decreased when considering other operational savings:
  - Cooling
  - Weatherization
  - Electric bill savings from other end uses

Seasonal COP Needed for Cost Parity Using Special Rates



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Economic outcomes

- Most states see cost increases with current price estimates.
- Colder states present a greater challenge compared to warmer climates due to both climate and energy prices
- They also present the largest environmental benefit from electrifying large space heating loads
- Special rates are necessary to maintain or improve energy costs in these states
- **Even a free heat pump can be unfeasible for customers with high energy burdens**

Climate Type	Typical HDDs
Colder	> 7,300
Moderate	6,100–7,300
Warmer	< 6,100

		100% Electric Price		70% Electric Price HVAC only		70% Electric Price Whole Home	
State	Climate	100% NG Price	140% NG Price	100% NG Price	140% NG Price	100% NG Price	140% NG Price
MN	Colder	🔴	🔴	🔴	🟡	🟡	🟢
ND	Colder	🔴	🟡	🟡	🟢	🟢	🟢
IA	Moderate	🔴	🟡	🟡	🟢	🟢	🟢
OH	Warmer	🟡	🟡	🟡	🟢	🟢	🟢
KS	Warmer	🟡	🟢	🟢	🟢	🟢	🟢

🔴 Significant Bill Increase

🟡 Cost Parity

🟢 Significant Bill Savings

Results for all 13 states are available in our report

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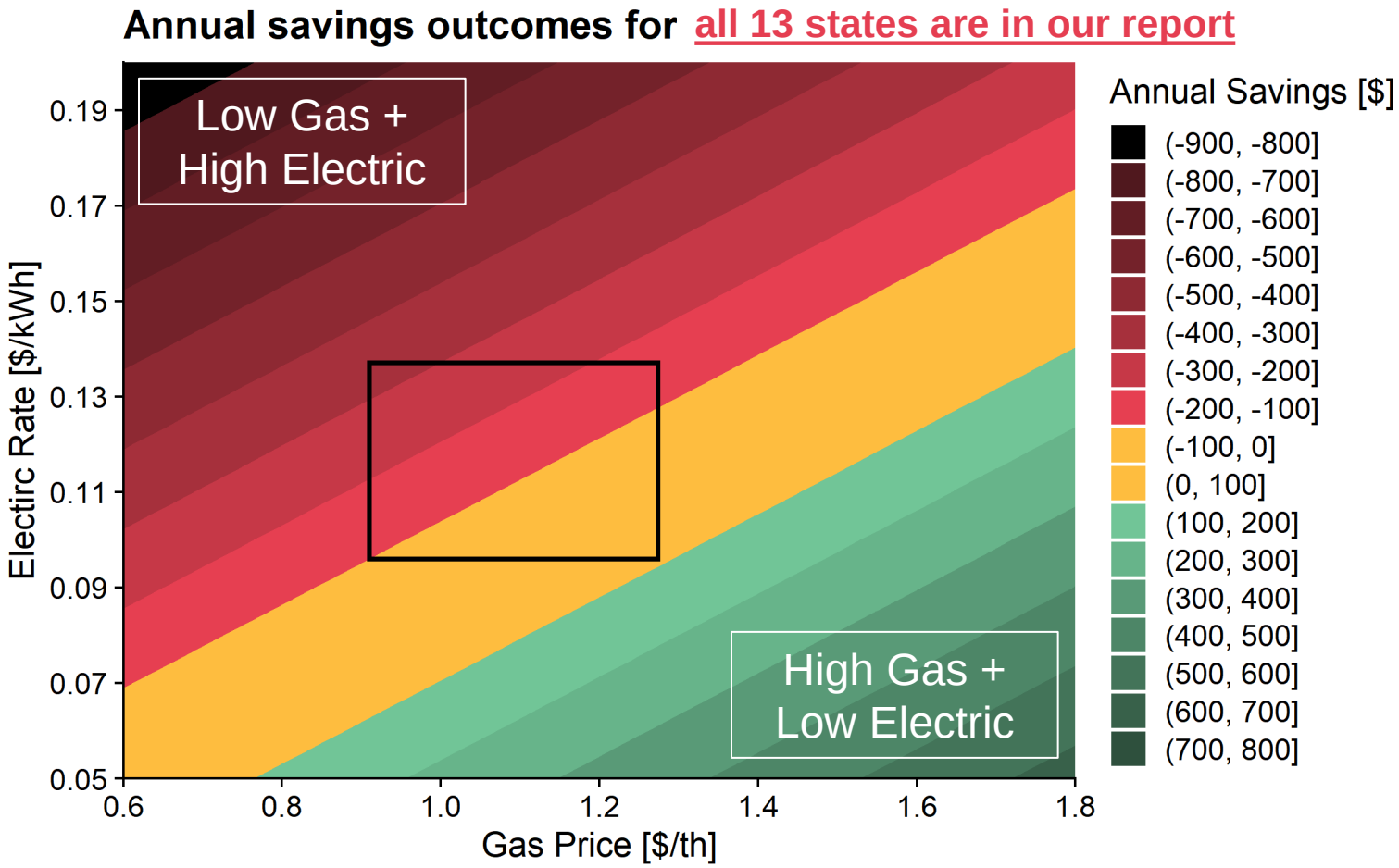
Rate Sensitivity

- What do outcomes look like across a broader range of rates?
- How sensitive are these outcomes?



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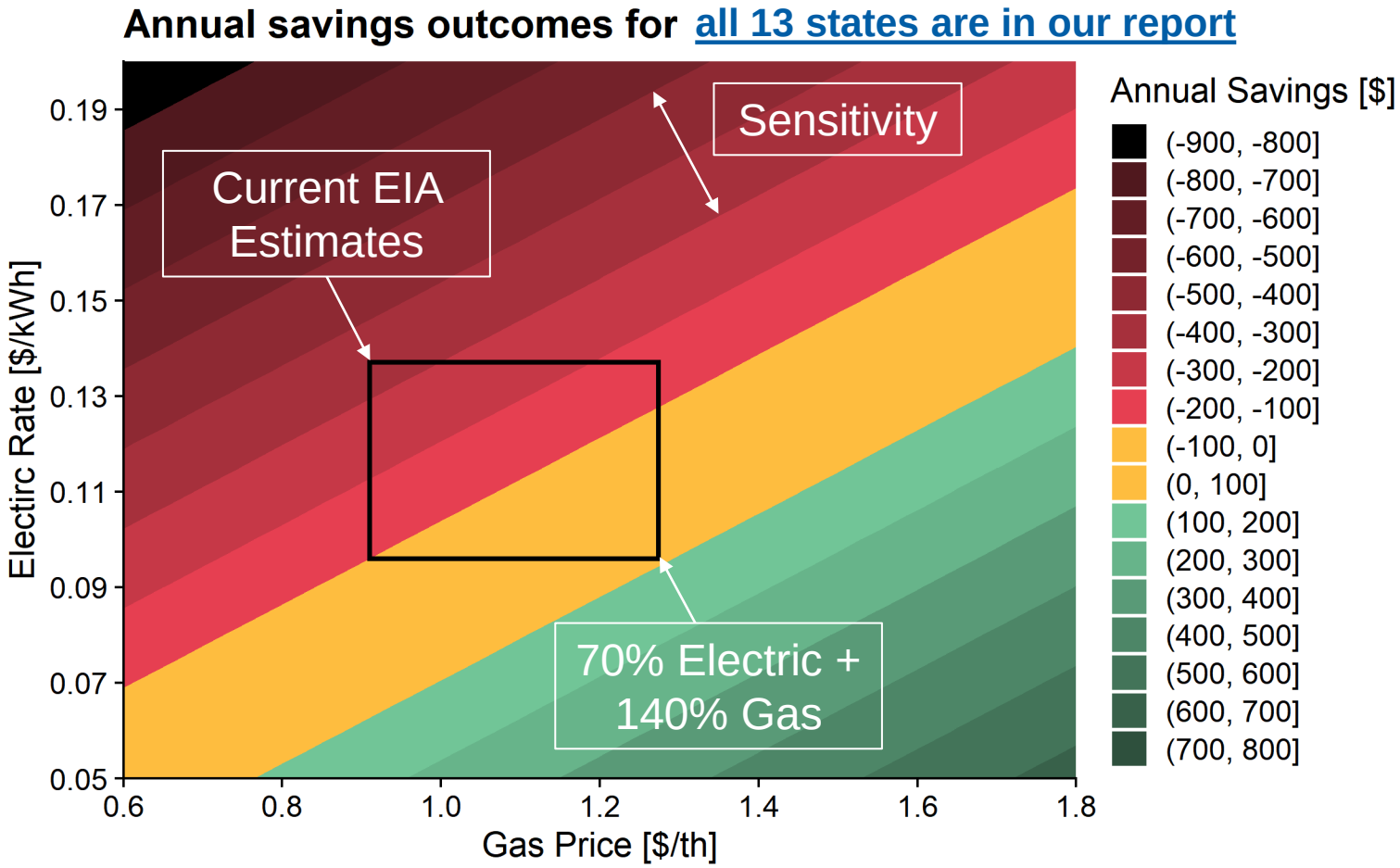
Rate Sensitivity

- Where do opportunities lie outside the rate scenarios we've seen?
- What do outcomes look like across a broader range of rates?



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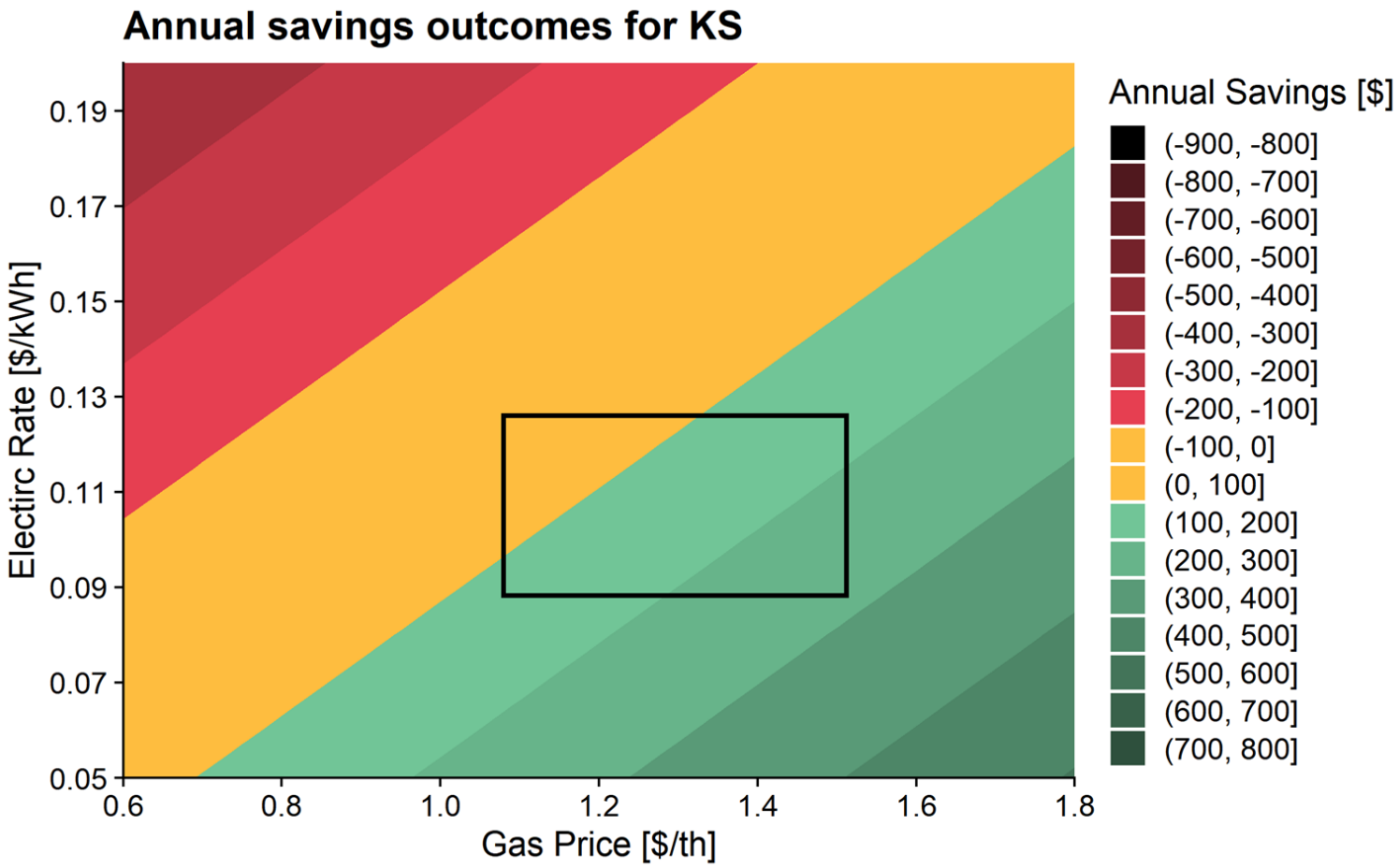
Rate Sensitivity – Warmer Climate (Wichita, KS)

- Warmer temperatures and favorable rate scenarios = higher savings
- Smaller heating load = low sensitivity
  - Savings outcomes don't change much with price fluctuation



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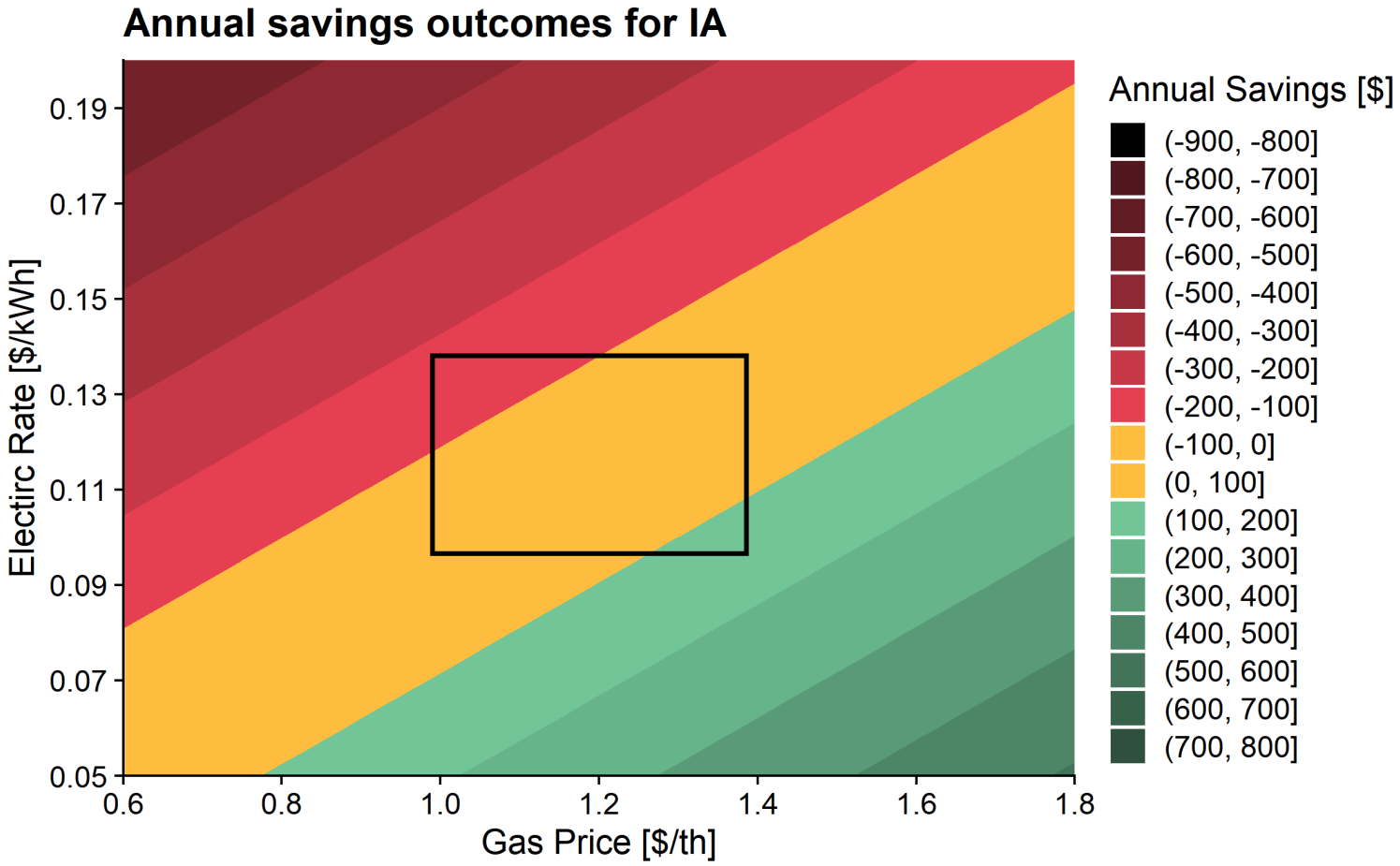
Rate Sensitivity – Moderate Climate (Des Moines, IA)

- Moderate temperatures and unfavorable rates give significantly increased costs with EIA rate estimates
- Heating dominated climate produces a greater sensitivity to rates
- Special rates can be the difference maker in electrification program eligibility



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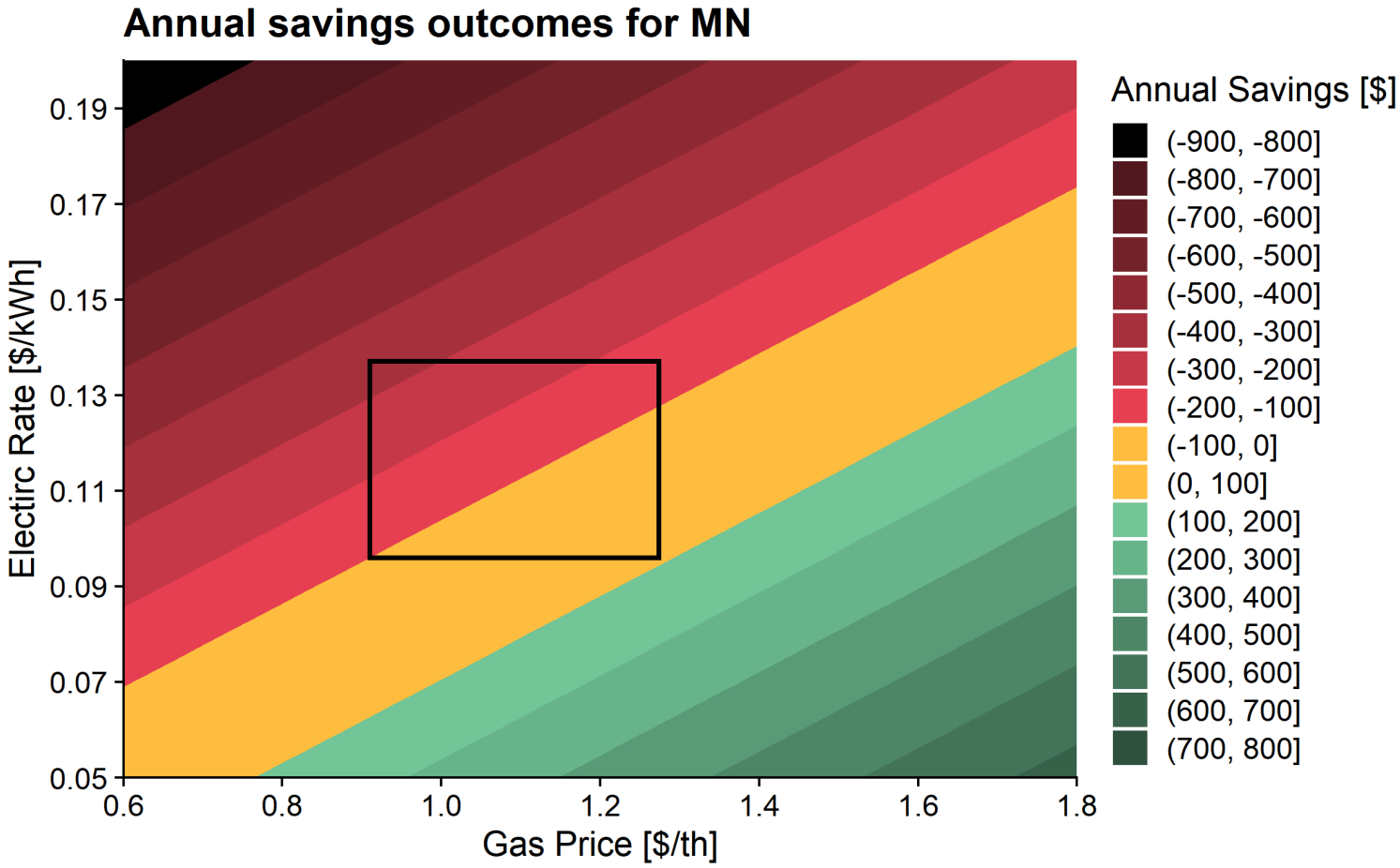
Rate Sensitivity – Colder Climate (Minneapolis, MN)

- High heating loads, colder temperatures, and unfavorable rates make this a challenging scenario that can cost customers hundreds per year
- High sensitivity means that cost parity may not be enough
- Special rates are both more crucial and easier to justify, given greater grid and environmental benefits



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Modeling Conclusions

- Electrification with current rates is not economic in most of the Midwest
- While electric space heating rates exist, they typically do not apply to dual-fuel systems
- Lower electric rates for dual-fuel ASHPs are justified and should be pursued
- Colder-climate regions provide the greatest challenge, the most crucial need, and the largest potential for environmental and grid benefits
- Utilities and regulators should investigate appropriate rate structures for ASHPs while considering economic implications for customers with unique needs

Expanding Engagement

Molly Garcia

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Stakeholder Engagement

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Close and Discussion

Molly Garcia
Joe Ricchiuto

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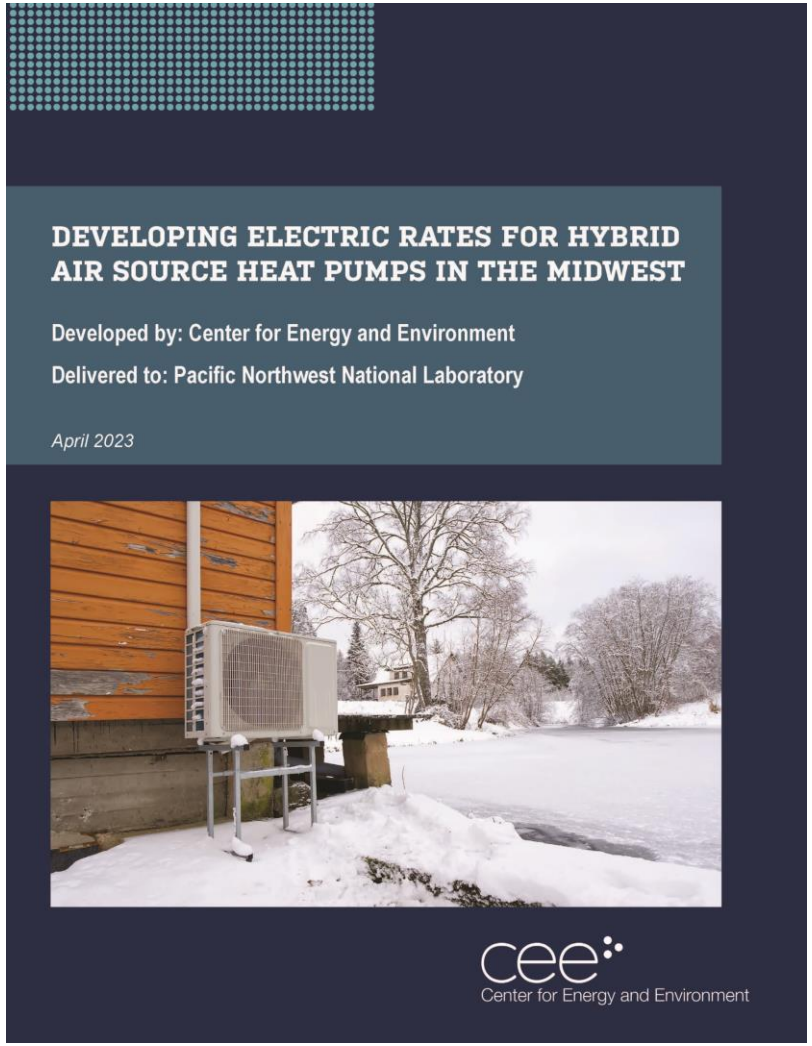

Download the full report

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Stay up to date with the Collaborative

Join us for upcoming Collaborative webinars showcasing our work to date

- July 20 | Equitable Workforce Development
- August/September | Best Practices Website Launch

Sign up for emails from the Collaborative

Center for Energy and Environment

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Discussion

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THANK YOU!

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