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Not At This Rate!

Why Enhanced Rate Structures are Both Justified and Necessary for Hybrid Air Source Heat Pumps (ASHPs) in the Midwest

Ranal Tudawe – Research Engineer

Agenda

- What are regional rates?
- Why do lower rates make sense for hybrid ASHPs?
- What do rates need to be?

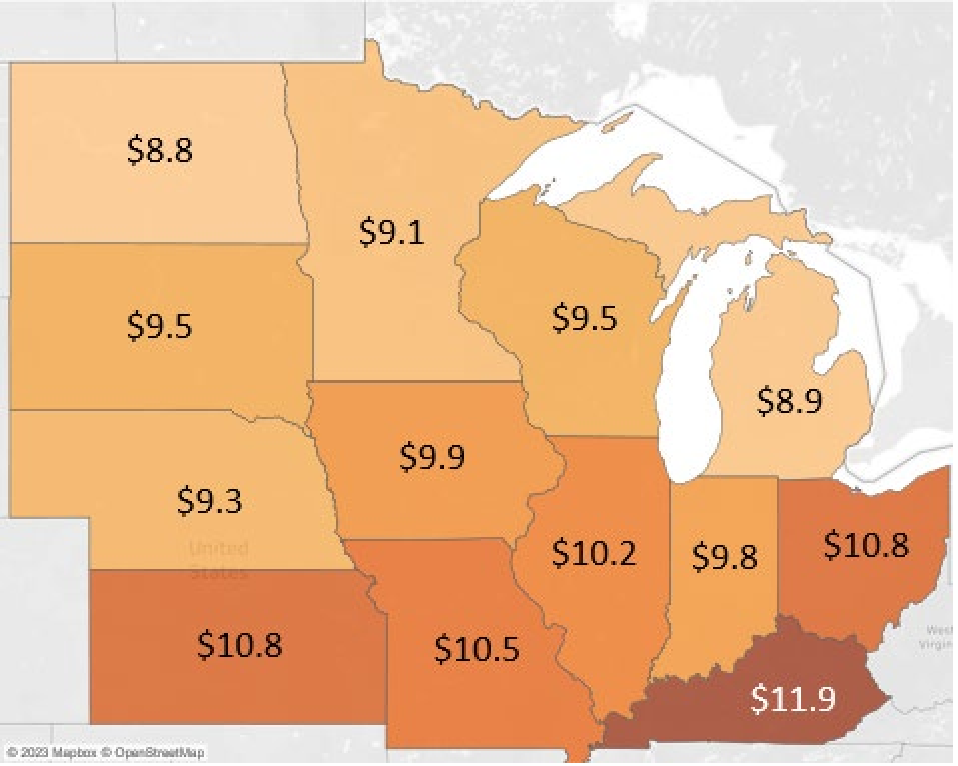
What Are Regional Rates?

Rates are important to achieve electrification goals

- Developing and utilizing the right electric rates for ASHPs, particularly hybrid systems, will be essential to reach the full potential of the technology
- It is also important for equity
  - Avoid unintended consequences of increased energy burden on low-income populations
- More engagement is needed
  - Energy efficiency/electrification teams are often siloed from public utilities commission and utility rate making.
- Current rates will increase energy costs with heating electrification
  - High-volume electric heating customers overpay on rate components derived from fixed costs
  - Modeling shows dual fuel systems can produce grid benefits that justify special rates

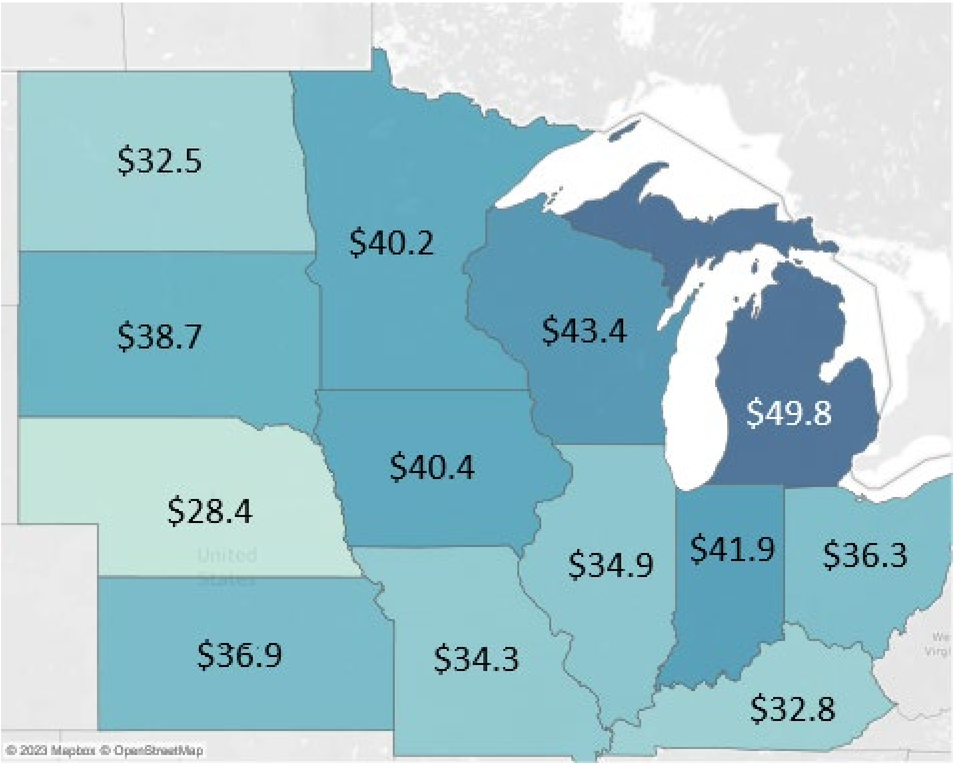
Electric and Gas Prices

Gas Prices (8.8–11.9 $/MMBtu)



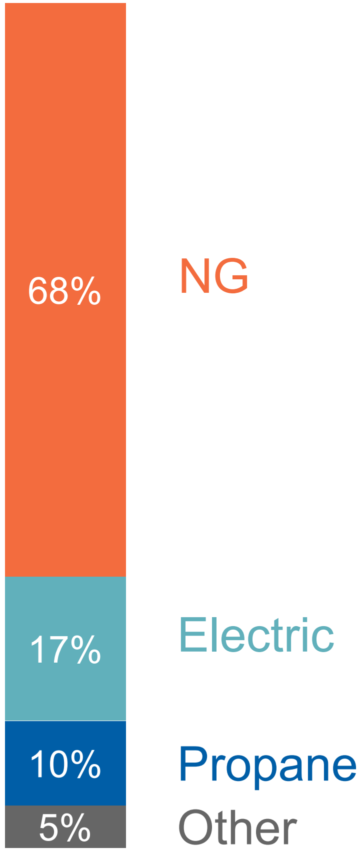
[EIA 2021]

Electric Rates (28.4–49.8 $/MMBtu)



[EIA 2021]

Midwest S.F. Heating Fuel



[NREL ResStock 2024]

Full electrification will likely result in bill increases for most customers.

Why Do Special Rates Make Sense?

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Residential Rate Components

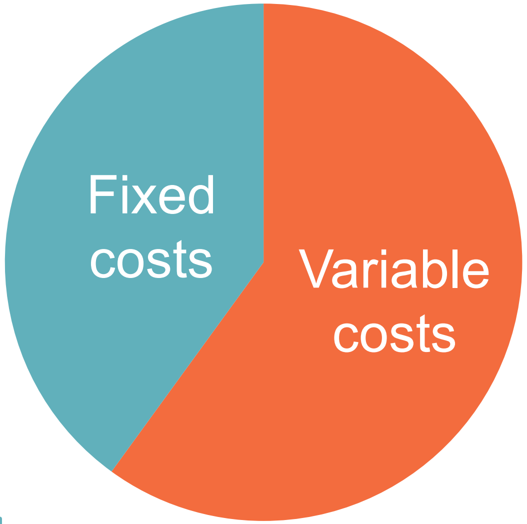
- Rates seek to recover costs for variable and fixed costs to serve the customer

- Hybrid 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

Typical Customers



- Transmission
- Distribution
- Capacity (kW)
- Customer billing

- Generation (kWh)

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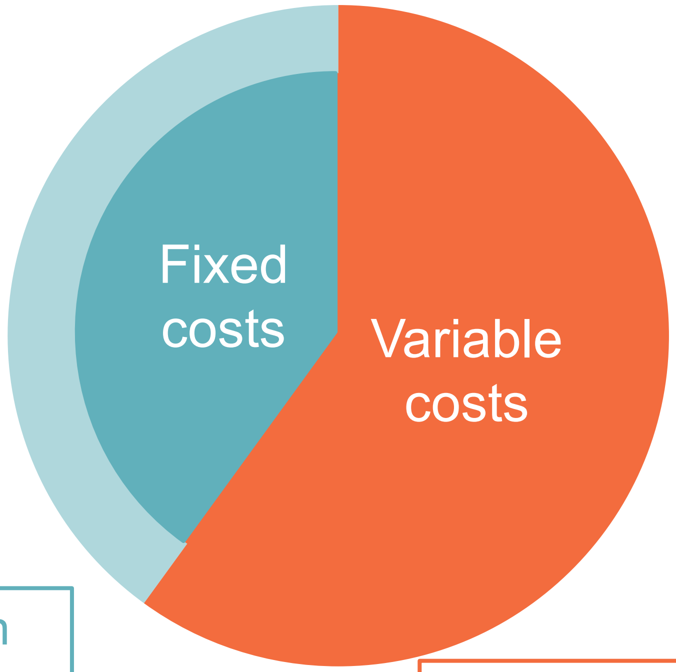
Electric Heating Customers



- Transmission
- Distribution
- Capacity (kW)
- Customer billing

- Generation (kWh)

Dual Fuel ASHPs Help the Grid By…

Reducing Summer Peaks

- Increased cooling efficiency shaves summertime peak consumption

Increasing Winter Consumption

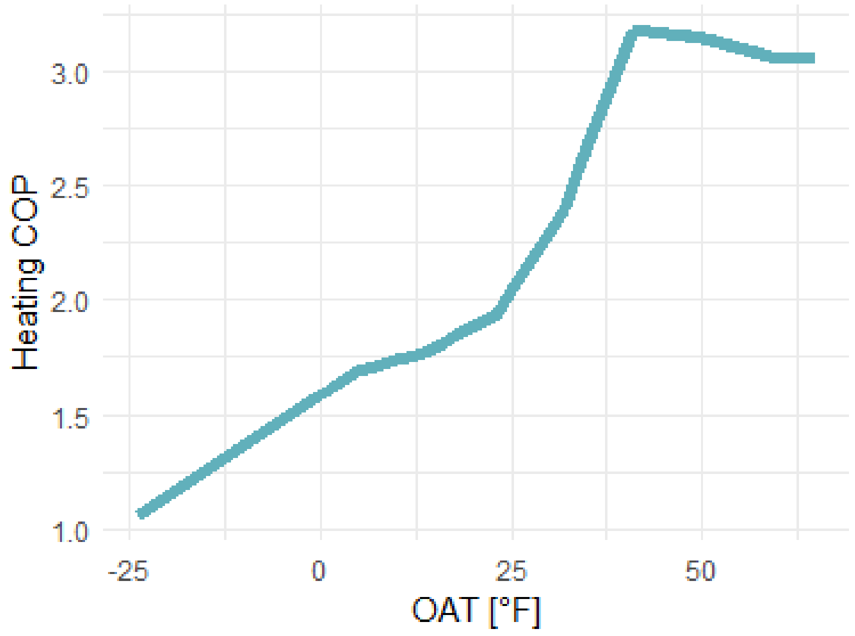
- Partially electrifying the heating season allows for increased electricity sales in off-peak season

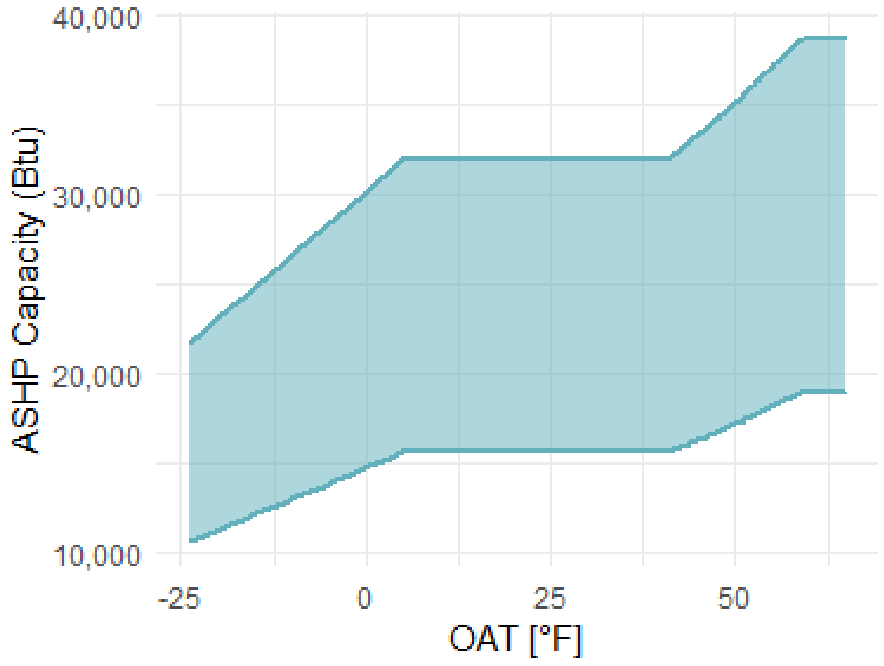
Allowing for Wintertime Flexibility

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

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

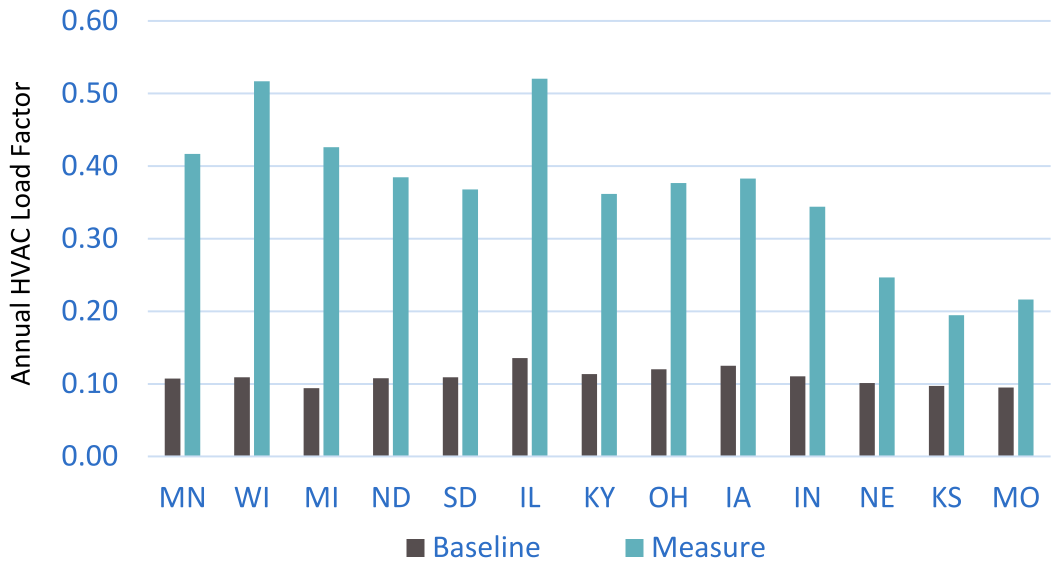




Grid Impacts

- The load factor is calculated using peak summertime HVAC electricity use
- A higher load factor indicates that the peak hourly consumption is similar to the average hourly consumption throughout 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.

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

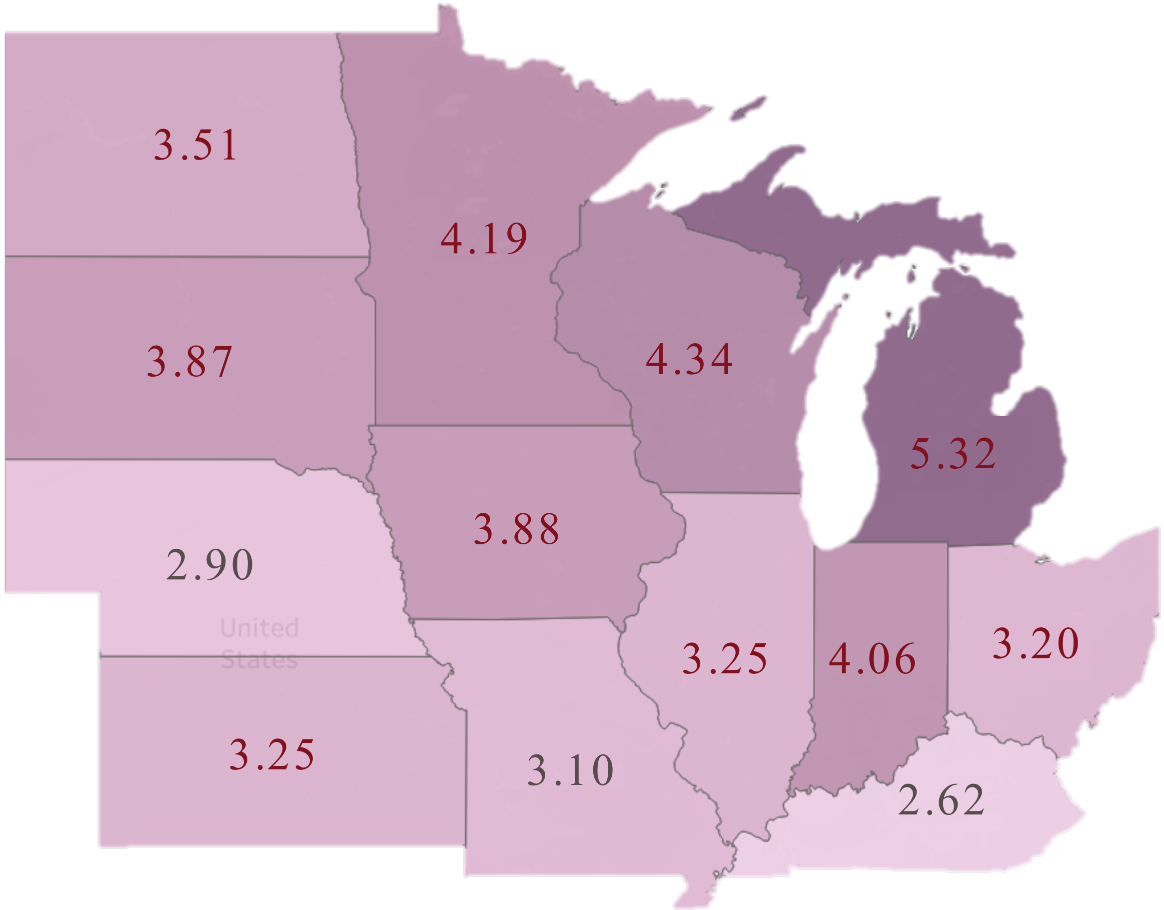


What Do Rates Need to Be?

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 more recent gas costs.

Seasonal COP Needed for Cost Parity Using 2021 EIA Estimates



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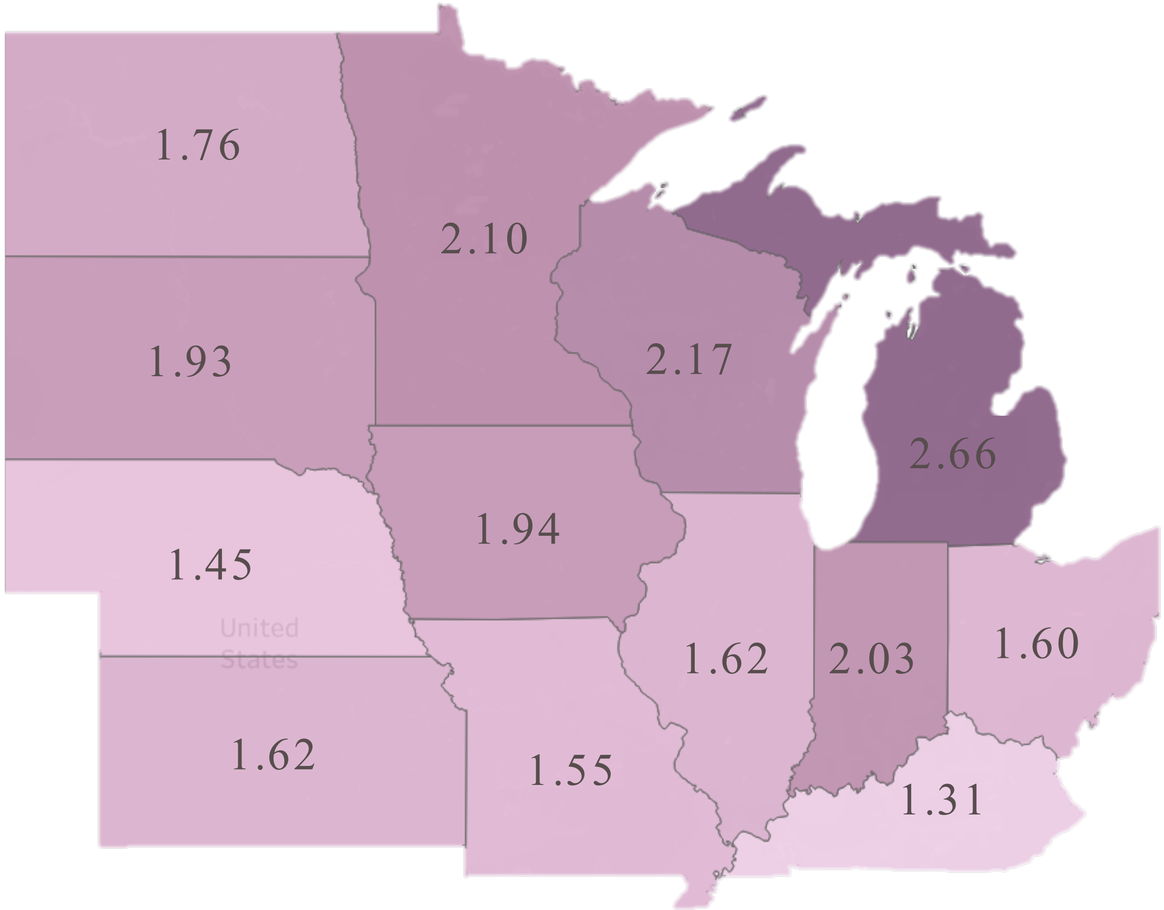
Special Rate Scenarios

- Adjusting for more 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

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

- 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 greatest 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**

		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

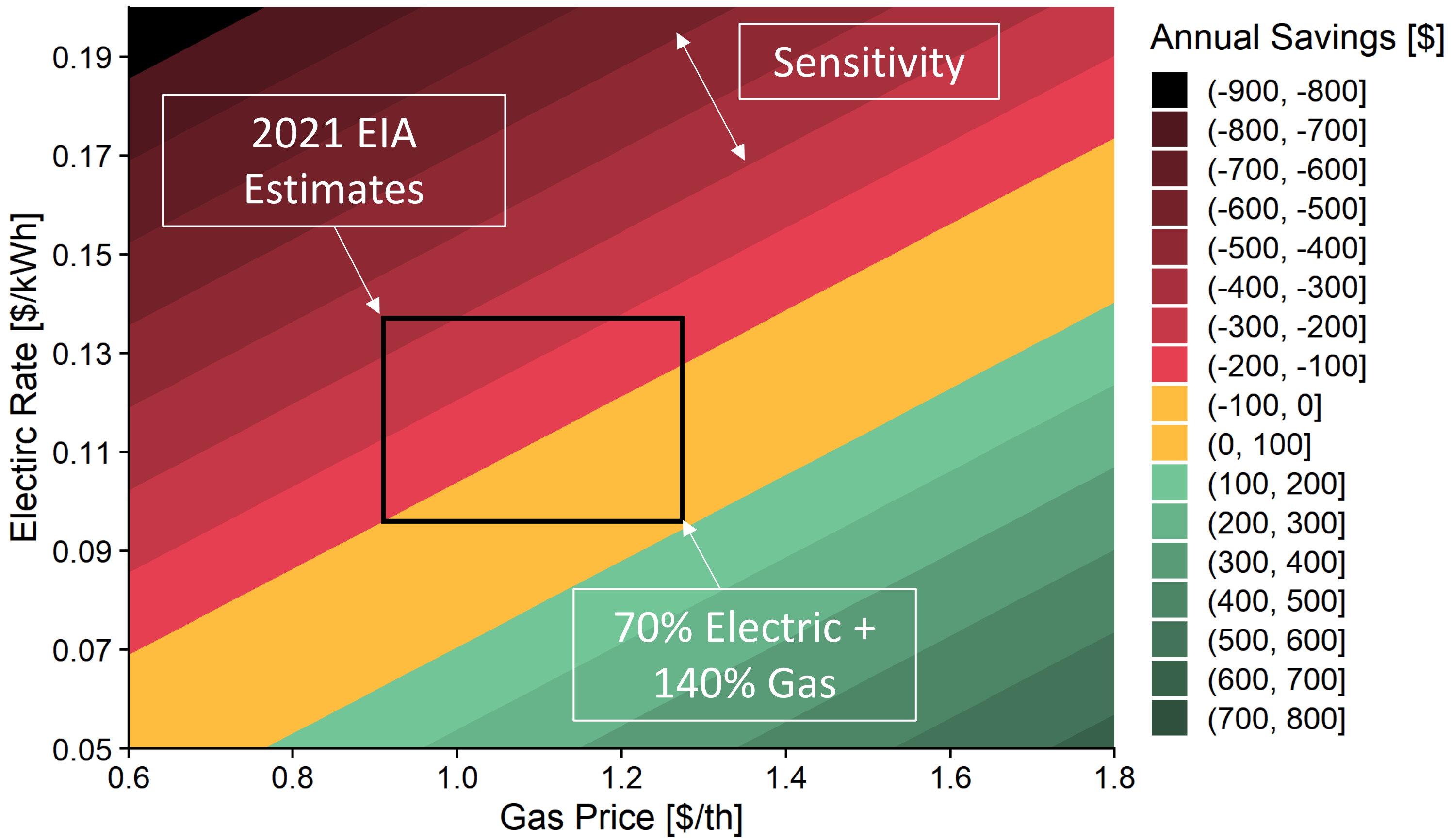
🟢 Significant Bill Savings

Results for all 13 states are available in our report

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

Annual savings outcomes for all 13 states are in our report



How have rates changed since 2021?

- Regionally, utility bundled **electric prices are up 11%** as of data available from 2023, weighed between states by MWh sales. **Gas prices are up 10%** in 2023 vs 2021, or 15% in 2024 vs 2021.
- Electric rates rising at a similar rate to gas prices is unlikely to change outcomes at a regional level.
- Some states have changed much more than others. Referring to the contour plots is a quick way to see where economics stand for these systems with different rates.
- ASHP performance assumptions may be different now as new field data become available.

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THANK YOU

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Link to Full Report

Appendix

Model Inputs

Variables

Electric Rates

Gas Rates

Location & Weather

Assumptions

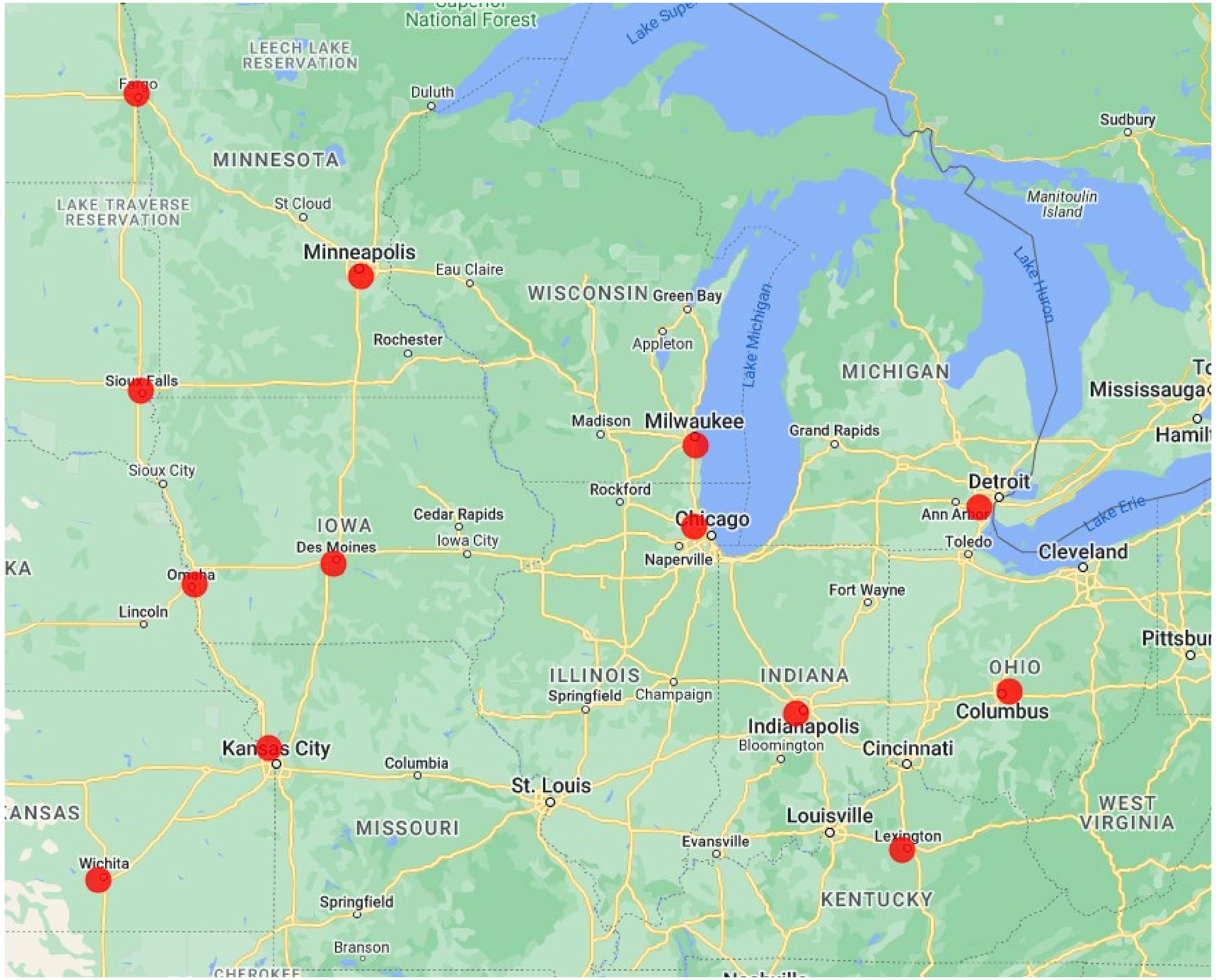
Home Type

Baseline System

Measure System

Heat Pump Use

Non-HVAC Electricity Use



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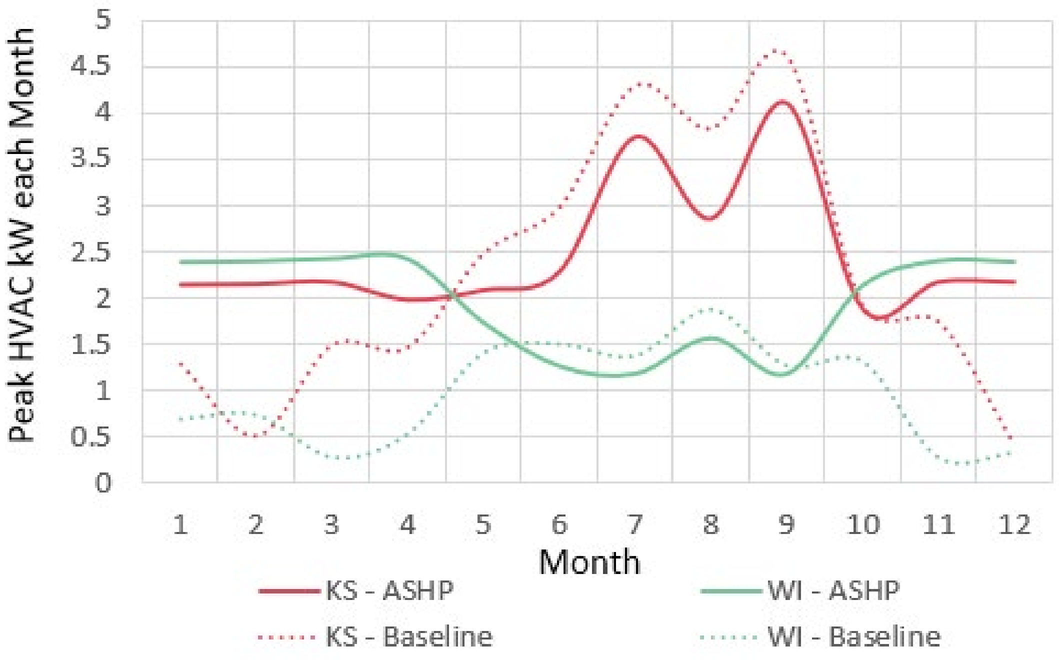
Grid Impacts

- **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

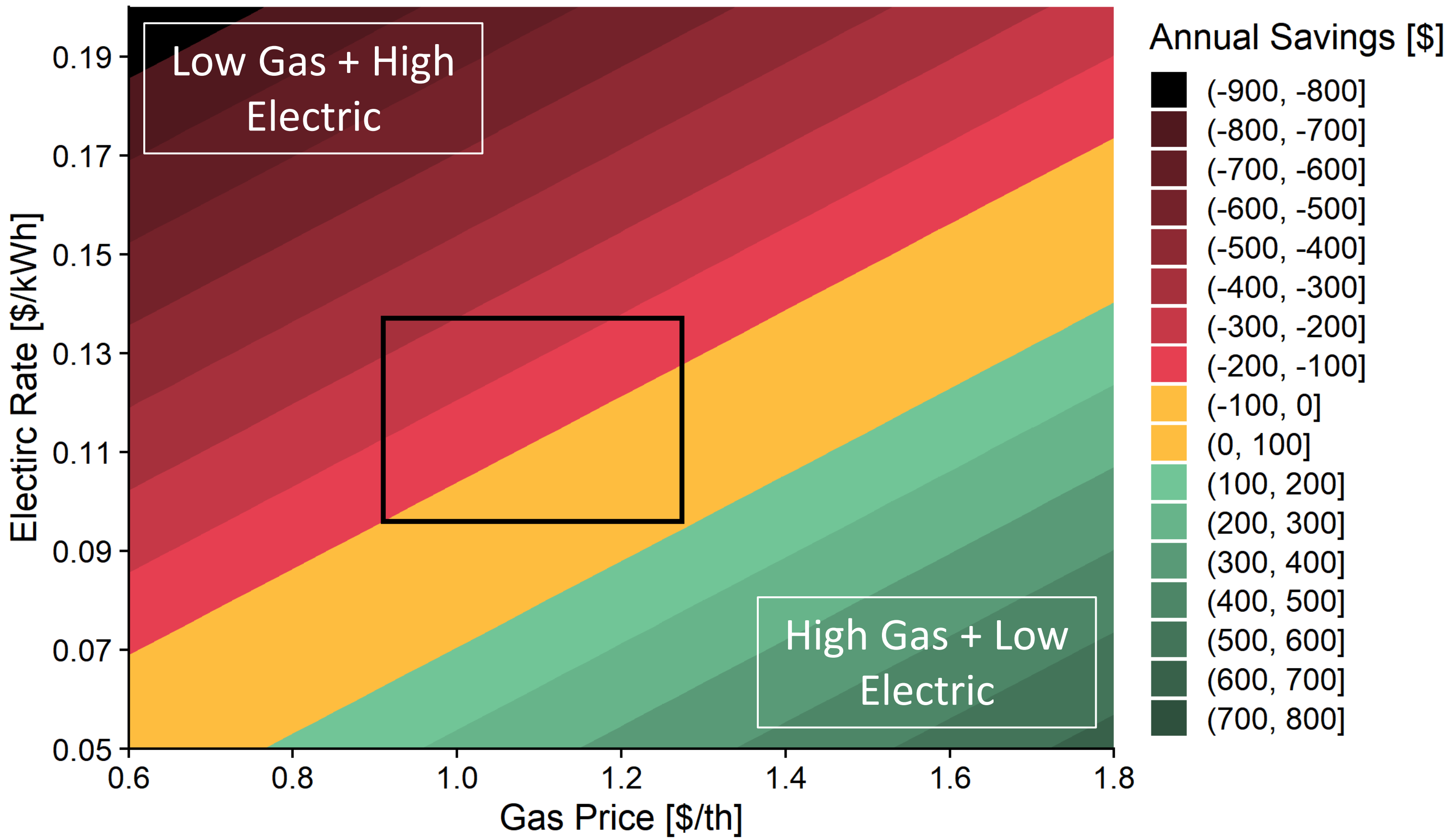


But how does this affect customer economics?

Rate Sensitivi

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

Annual savings outcomes for [all 13 states are in our report]



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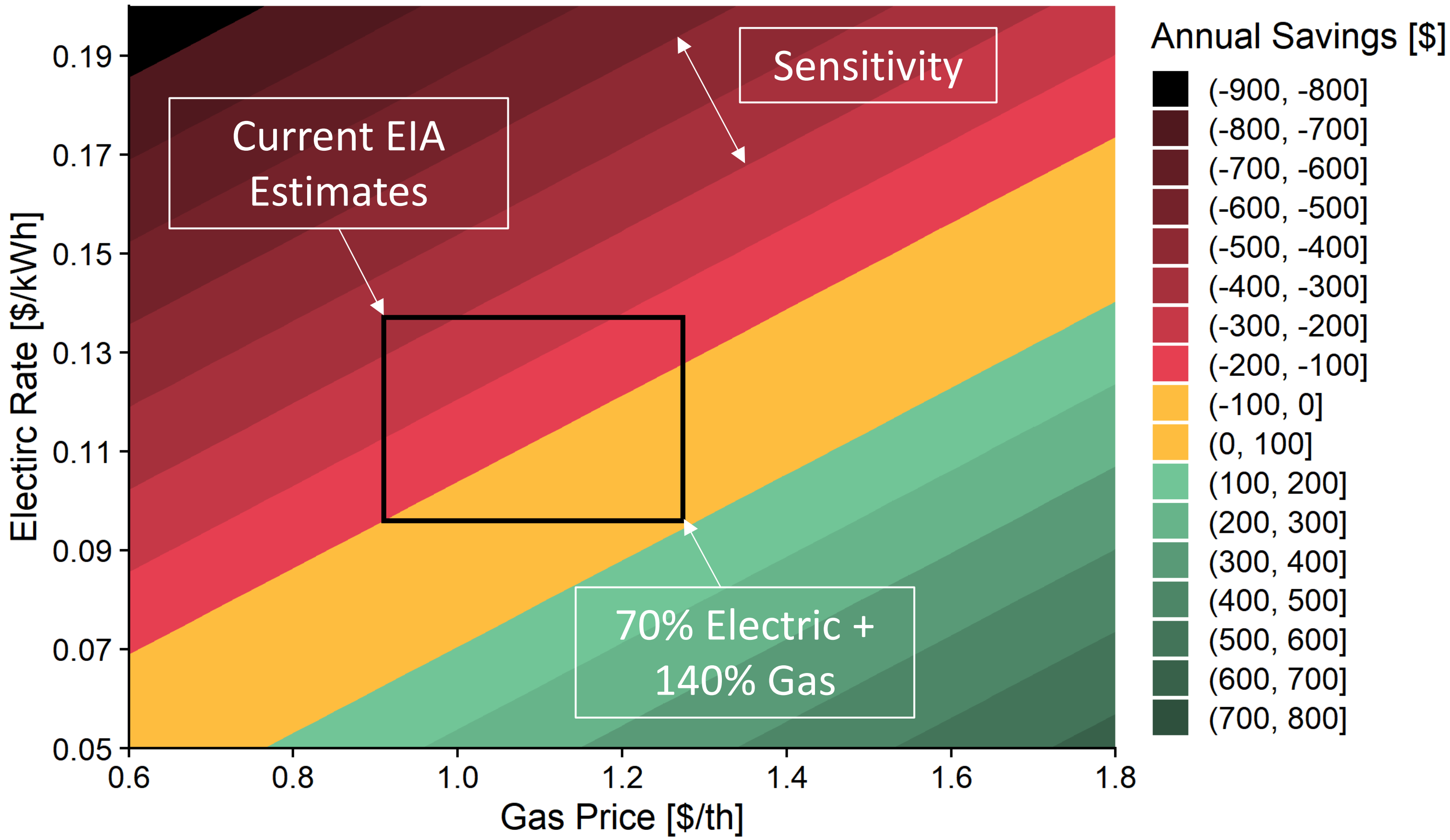
Rate Sensitivity

- Where do opportunities lie outside the rate scenarios we've seen?

- What do outcomes look like across a broader range of rates?

Annual savings outcomes for all 13 states are in our report



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Rate Sensitivity – Colder Climate (Minneapolis, MN)

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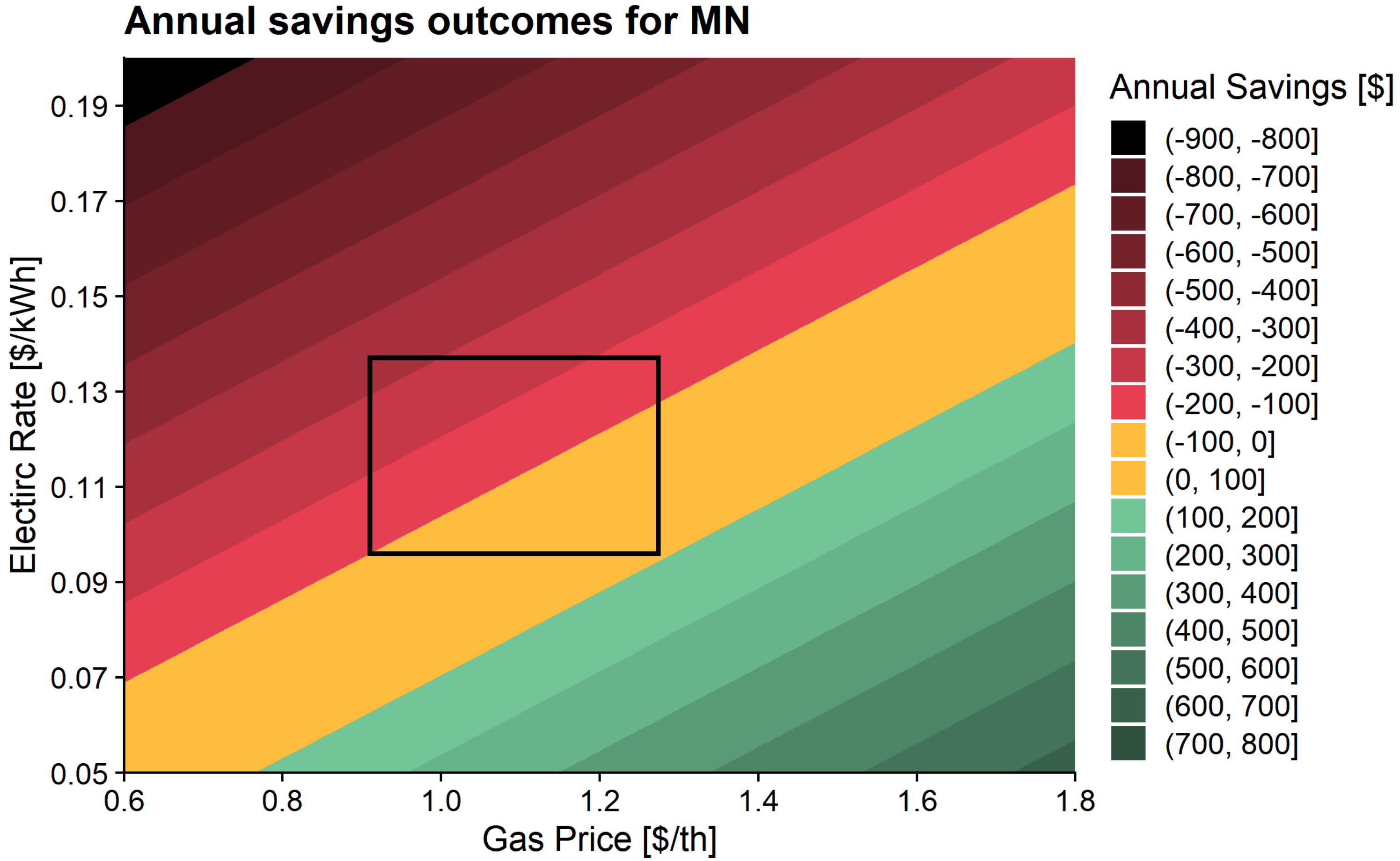

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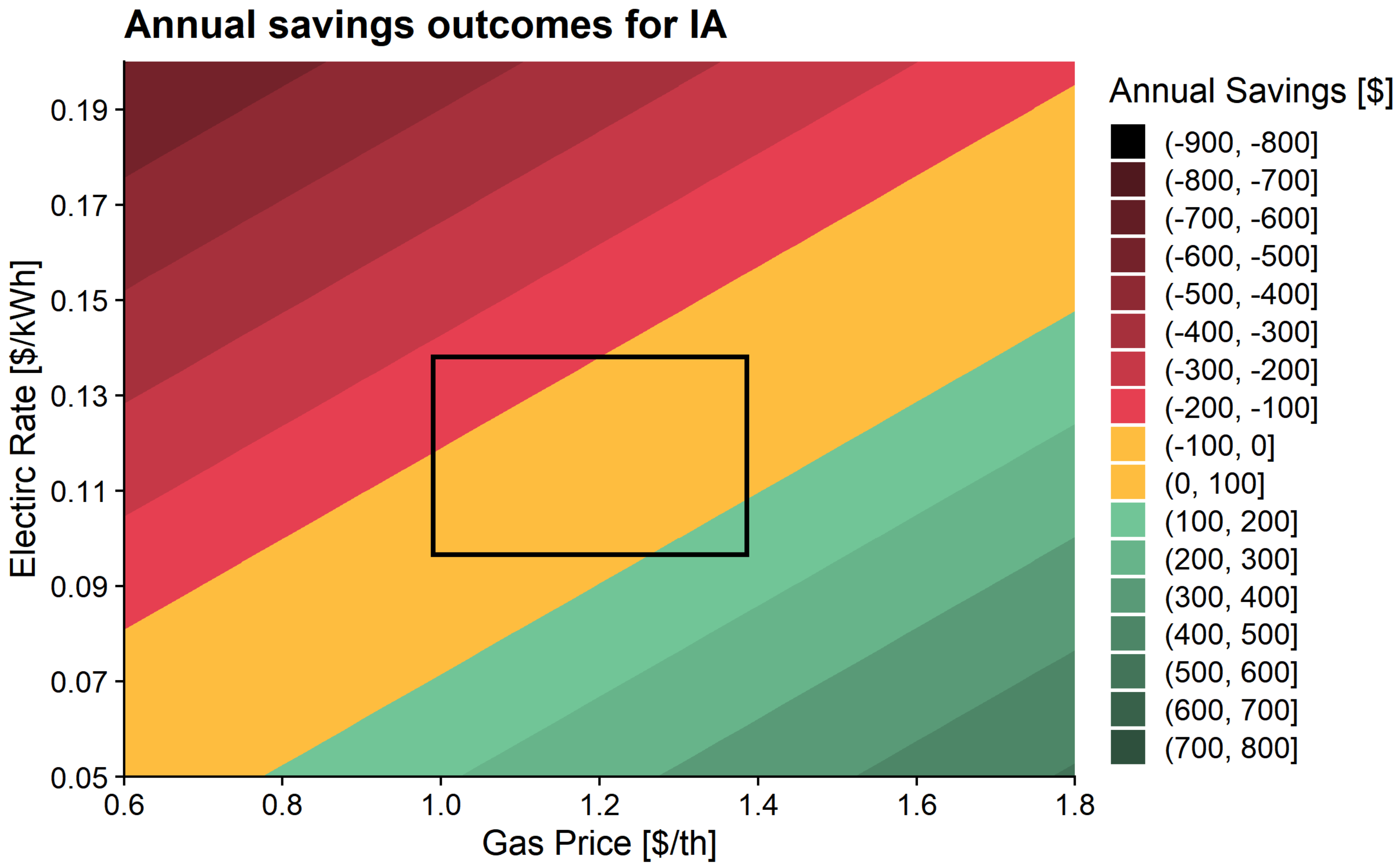
Rate Sensitivity – Moderate Climate (Des Moines, IA)

- Moderate temperatures and unfavorable rates significantly increase 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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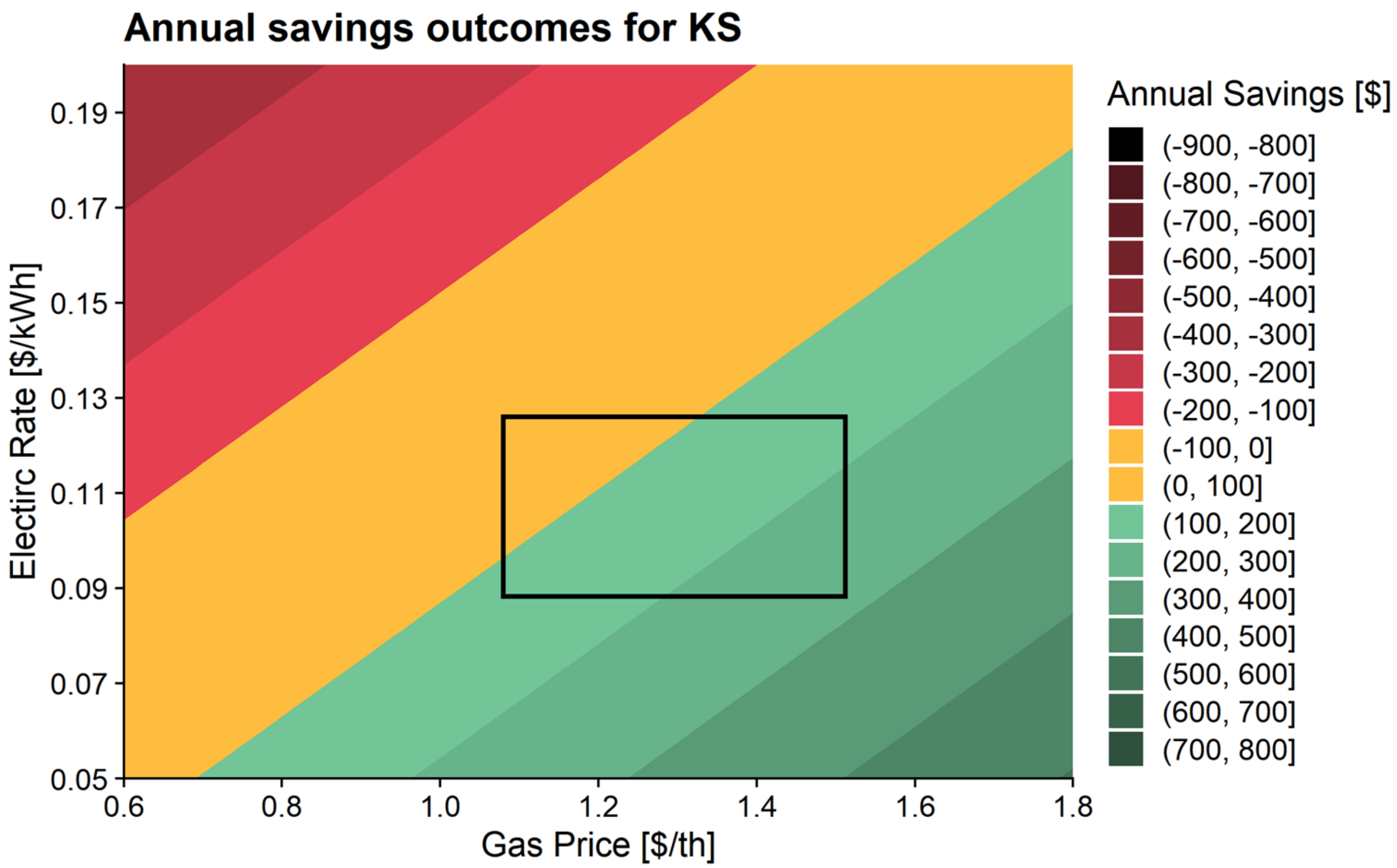
Rate Sensitivity – Warmer Climate (Wichita, KS)

- 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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Modeling Conclusions

- Electrification with these 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 present the greatest challenge, the most crucial need, and the greatest 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