Welcome

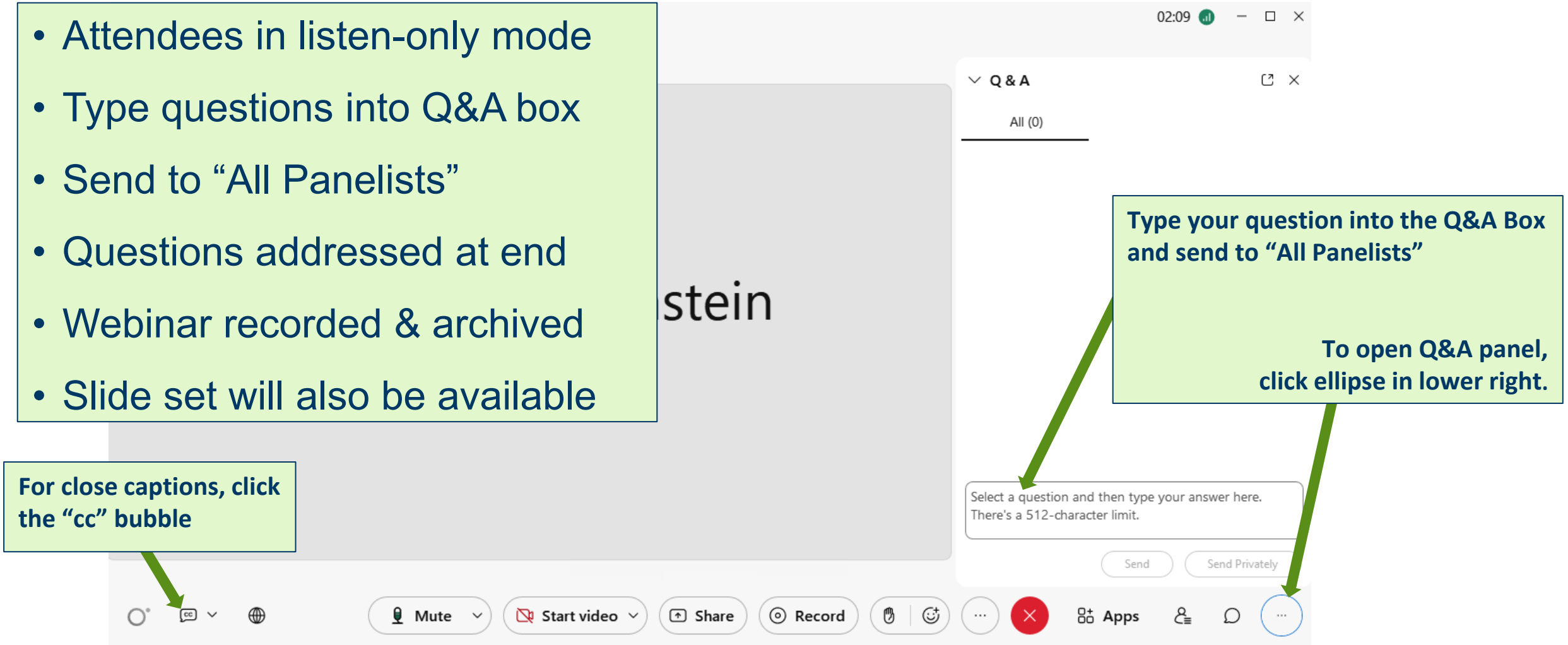
Conservation Applied Research & Development (CARD) Webinar

August 4, 2022

It’s the End of Traditional AC as We Know It – and I Feel Fine

Webinar Basics

- Attendees in listen-only mode
- Type questions into Q&A box
- Send to “All Panelists”
- Questions addressed at end
- Webinar recorded & archived
- Slide set will also be available



It’s the End of Traditional AC as We Know It – and I Feel Fine

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Project Team Introductions

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Minnesota Applied Research & Development Fund

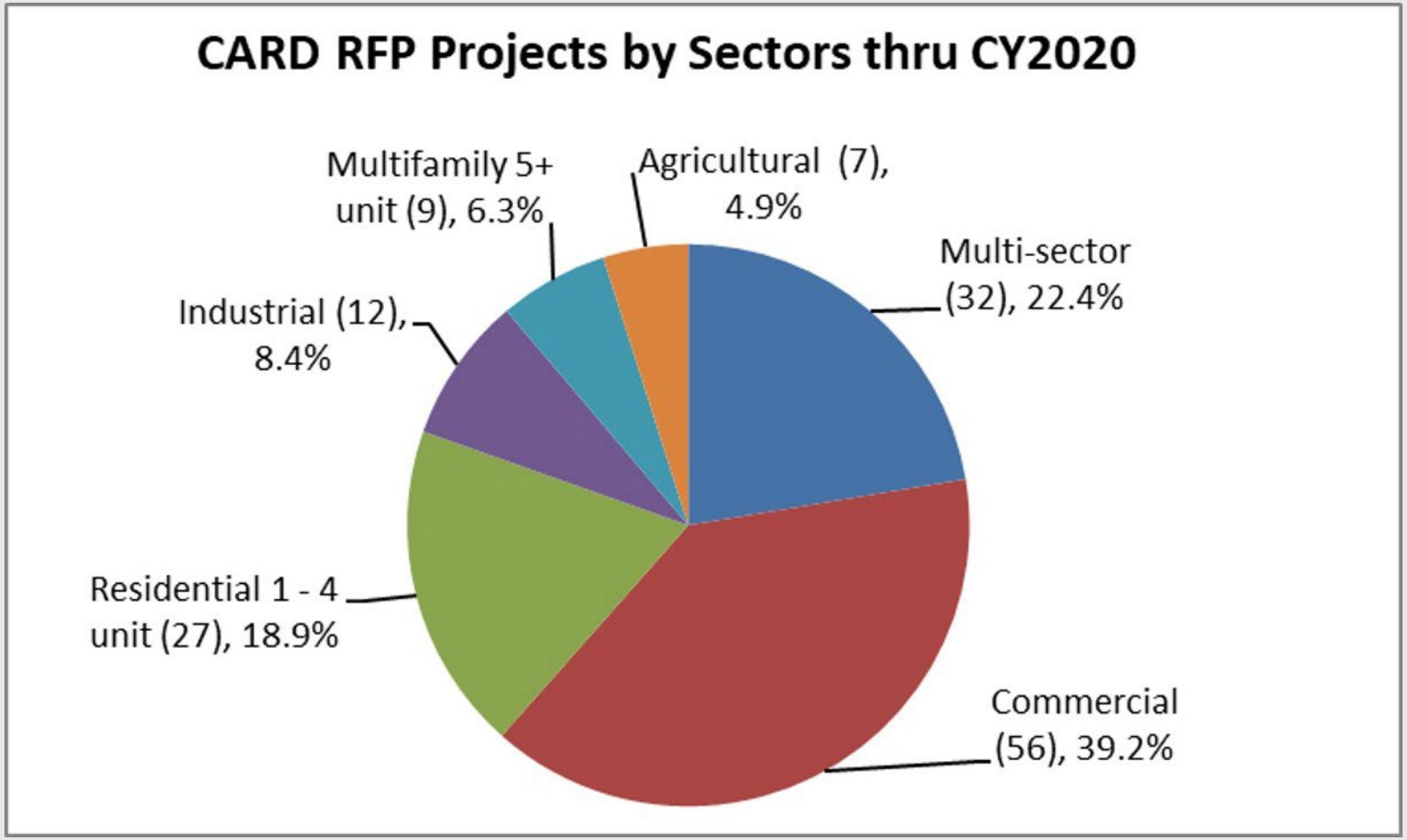
- **Purpose to help Minnesota utilities achieve 1.5% energy savings goal by:**
  - ***Identifying new technologies or strategies to maximize energy savings;***
  - ***Improving effectiveness of energy conservation programs;***
  - ***Documenting CO_2 reductions from energy conservation programs.***

Minnesota Statutes §216B.241, Subd. 1e

- **Utility may reach its energy savings goal**
  - **Directly through its Conservation Improvement Program (CIP)**
  - **Indirectly through energy codes, appliance standards, behavior, and other market transformation programs**

State Capitol Image: Courtesy Minnesota Department of Administration

CARD RFP Spending by Sector thru FY2020



RFP Summary

- 12 Funding Cycles
- 513 proposals
- 143 projects funded
- $31.2 million in research

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IT'S THE END OF TRADITIONAL AC AS WE KNOW IT - AND I FEEL FINE

**Chidinma Emenike, Ranal Tudawe,
Emily McPherson, Josh Quinnell**

Center for Energy and Environment

Agenda

- Introduction
- Market research findings
- Performance and cost model findings
- Conclusions
- Q&A

Big Picture

- Space heating is the biggest end use, by a factor of 10, in MN homes
  - Decarbonization of space heating via electrification on a clean grid is among the best climate mitigation opportunities for buildings
  - On top of that, they are an incredible energy efficiency technology, up to 600% better than standard gas furnaces
  - But all-electric ASHP systems are prohibitively expensive to buy and also to operate compared to natural gas furnaces

- Let's start small?
  - ASHPs also cool better than code minimum central air conditioners (CACs)
  - Can we advance the ASHP market by installing ASHP as cooling measures?
  - **How close can ASHPs as CAC replacements get us to our residential space heating decarbonization goals?**

MN Market Characteristics

Existing HVAC	ASHP Options	Market Size
AC replacement – with ductwork	Ducted ASHP	1,200,000 homes
Big Opportunity – 1,200,000 homes		
Electric baseboard	Cold-climate ducted HP	270,000 homes
Propane furnace	Ducted dual fuel ccASHP	250,000 homes
Electric furnace	Ducted ccASHP	87,000 homes

Product Definition – For this Study

WHAT IT IS	WHAT IT ISNT
✓ Centrally ducted	✗ Mini-split / Multi-split / Mini-ducted
✓ Natural gas furnace backup (dual fuel or hybrid heat)	✗ All-electric or propane backup
✓ Sized for cooling	✗ Sized for heating
✓ Single speed air source heat pump (ssASHP)	
✓ Variable speed ASHP (vsASHP)	
✓ Cold climate ASHP (ccASHP)	
✓ Interoperable or non-interoperable with existing furnace	

Key Research Questions

- What are the market barriers and opportunities for ASHP technology as a CAC replacement ?
- What are the sensitivities governing energy and cost saving potential?
- What are the promising avenues to customer cost and energy savings?

Market Research Findings

Market Research Interviews

- 438 Minnesota Households – Online survey

- Supplemental Info (not presented)
  - 30 Installers – In-depth Interviews
  - 3 Distributors – In-depth Interviews
  - 5 Manufacturers – In-depth Interviews

Customer Survey Overview

- Method
  - Online surveys
  - Leede Research carried out survey work and analysis
- Target Audience
  - Homeowners with furnace and AC
  - Segmented recent purchasers and intenders
- Timing
  - Information from this study reflects the current environment at the time of the gathering**. It will generally be good for 18 months to 2 years, unless something significantly impacts the target market for these products.**

Key Takeaways – Customers

Most homeowners are happy with existing HVAC but are interested in upgrading for cost or comfort benefits

Most customers are replacing AC at the time of failure or malfunction which limits the time for decision making

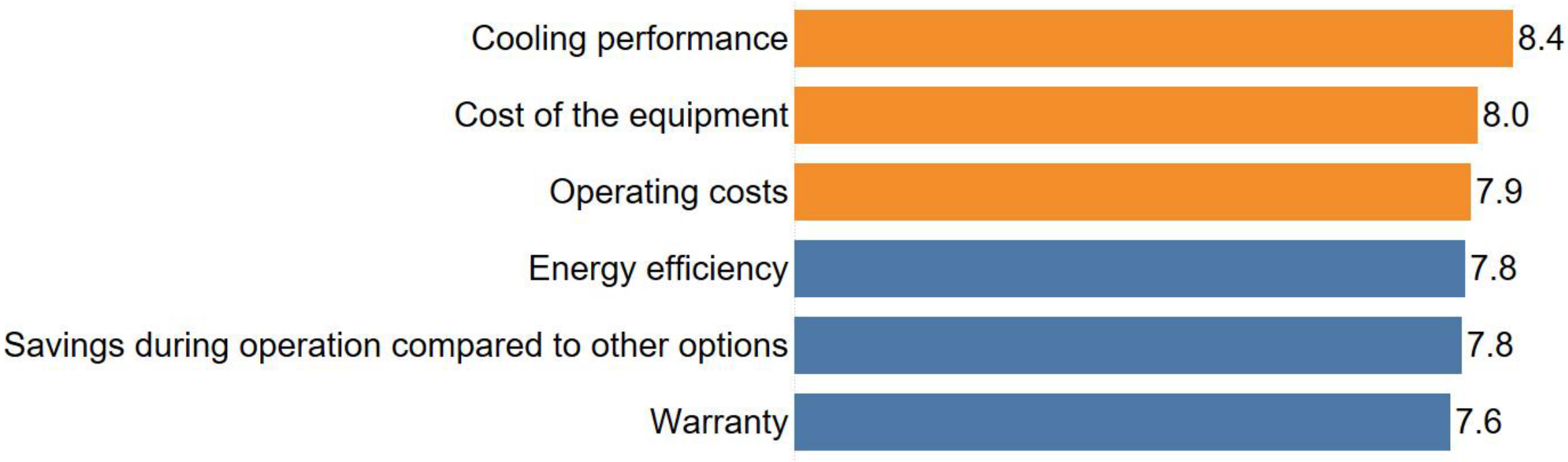
Customers want options at the point of replacement

Customers are willing to pay more upfront to lower their operating costs; a 6-year payback is attractive

Majority of customers prefer to replace both their furnace and AC at the same time

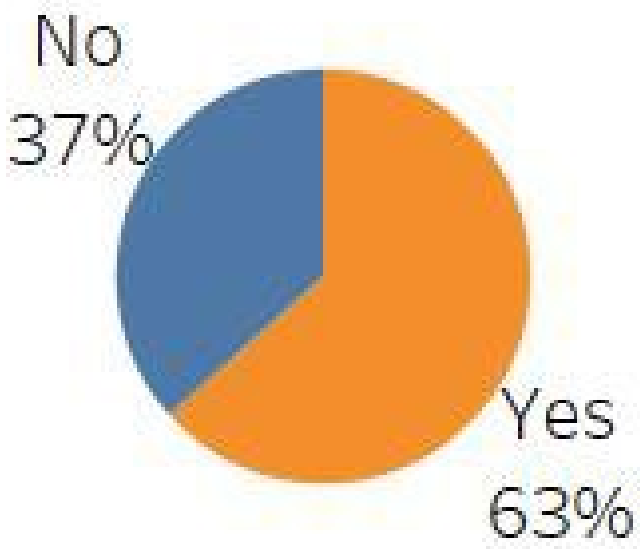
General awareness is needed, as well as an education-based sales process

Attribute Importance – Recent Purchasers



System Replacement Trends – Recent Purchasers

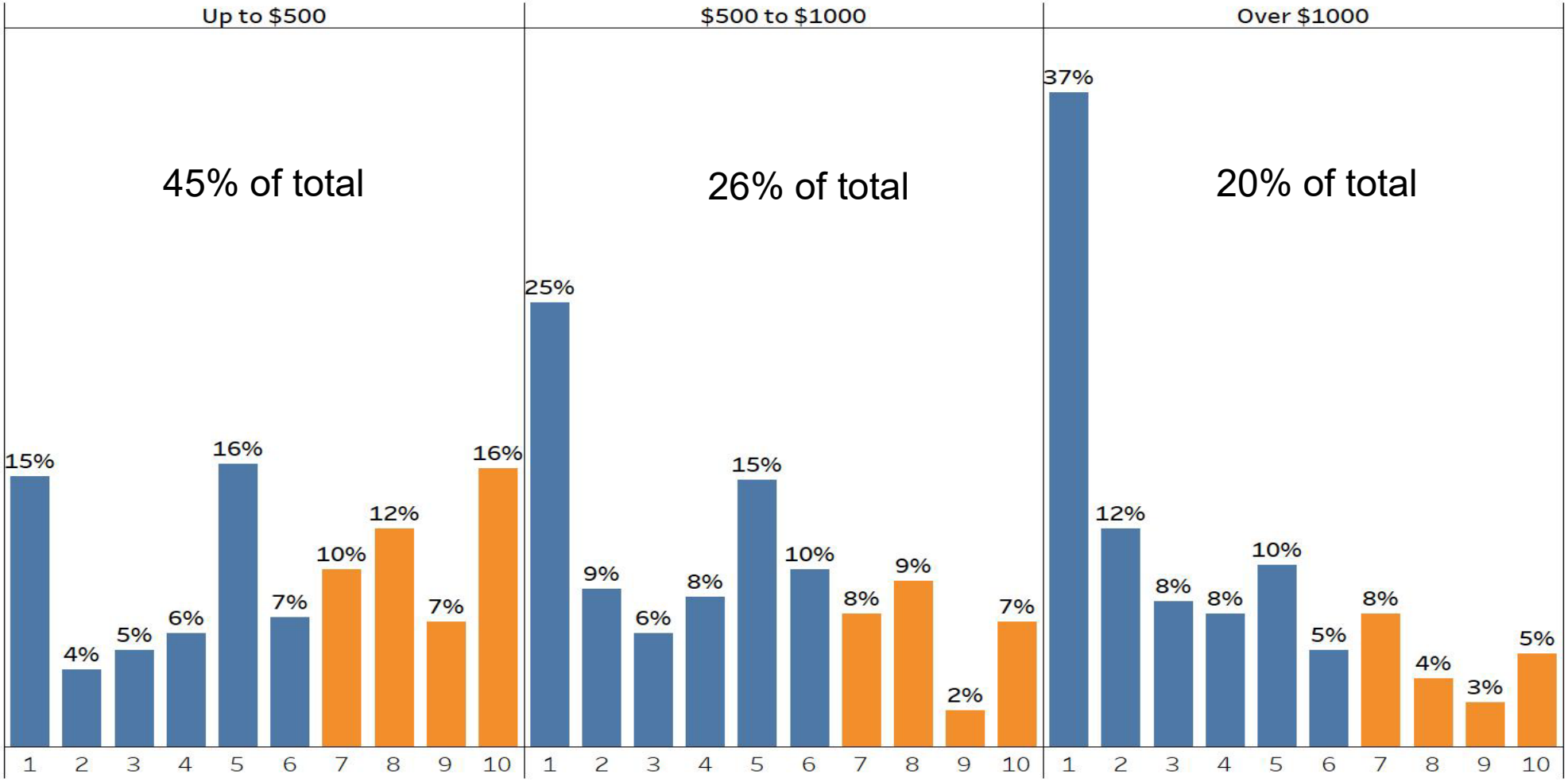
In the installation process did you replace your heating system at the same time?



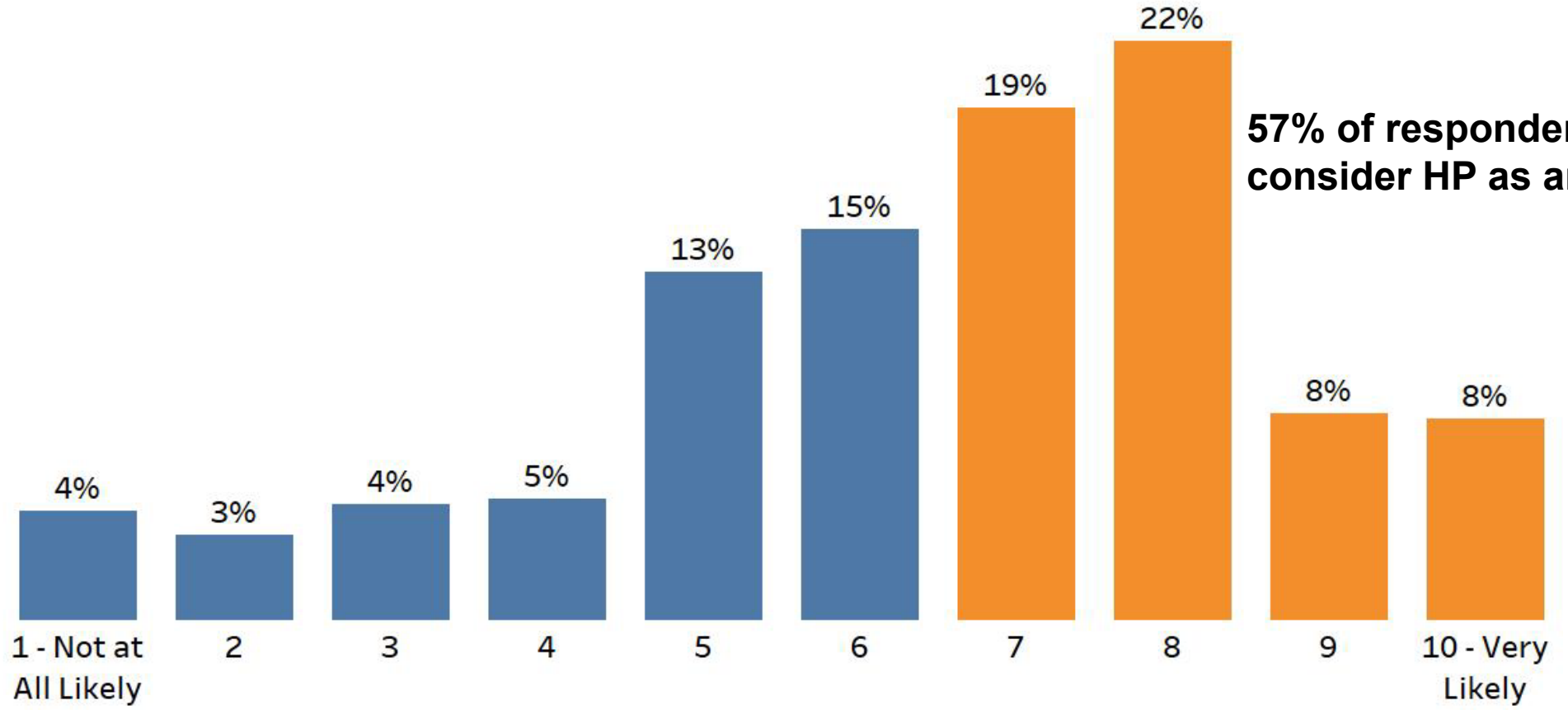
Customers replace heating systems together with ACs at a ratio of 2:1

Spending Trends – Energy Costs

How likely would you be to spend the following amounts to reduce the energy costs of your heating and AC systems in the next two years?



Consider vs. Traditional Central Air



57% of respondents are likely to consider HP as an AC alternative

How likely would you be to consider this technology as an alternative to AC?

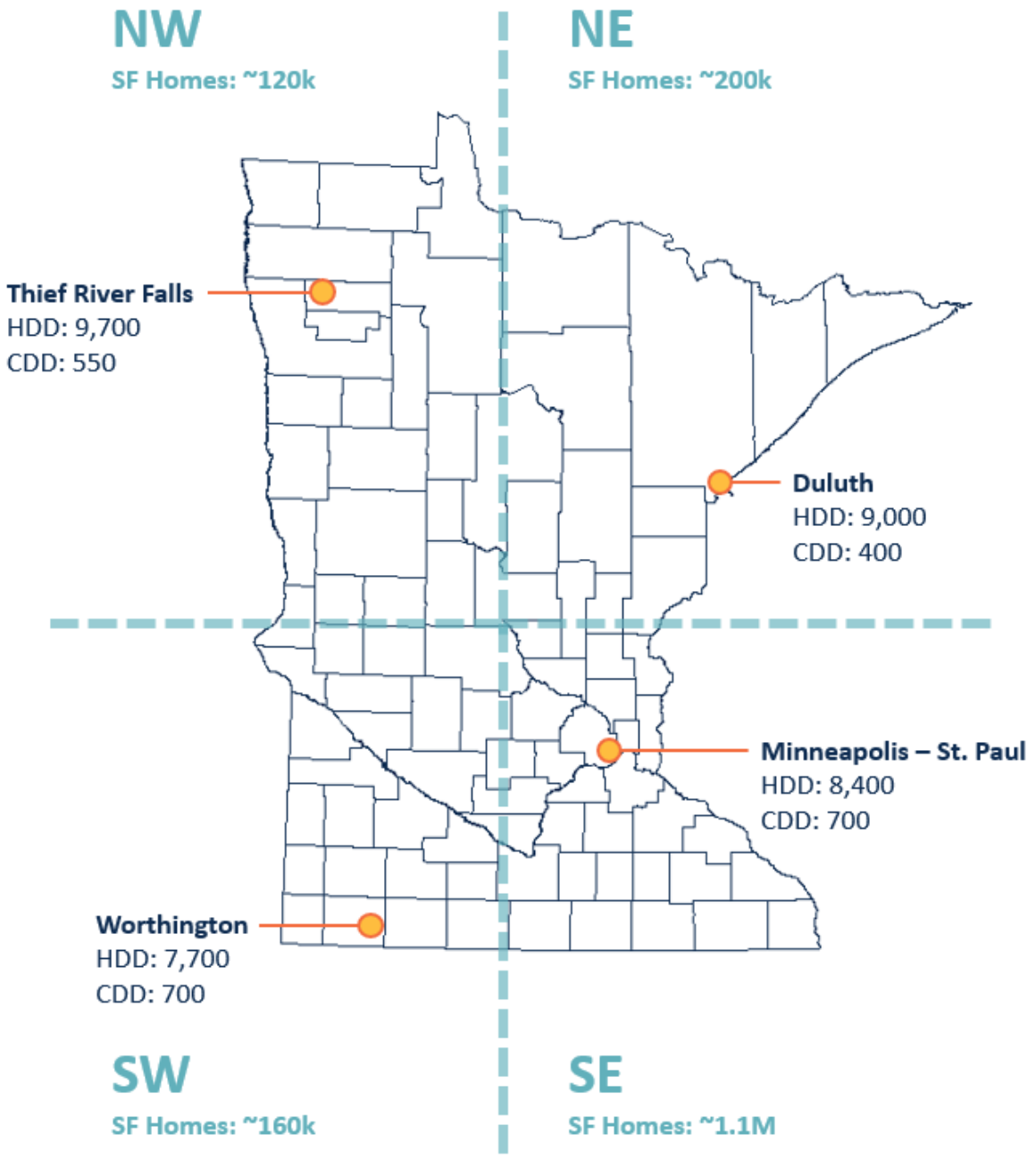
Key Takeaways – Supply Chain

- **Contractors:**
  - Demand for ASHPs as an AC replacement is low
  - Education is needed to make the sale
  - Sentiment that ASHP business will increase in the future
  - Rebates are a key driver
- **Distributors:**
  - Most current sales are mini-split
  - Demand for centrally ducted heat pumps replacing AC comes from the utility and efficiency industry **but not from customers**
  - Contractors are receptive but not yet actively pushing
  - ~10% of customers always pick the top option presented — this would apply if heat pumps were offered over AC
- **Manufacturers:**
  - All manufacturers acknowledged the market is transitioning from fossil fuels to heat pumps
  - Generally agreed that HP as AC replacement products will be helpful in transition to all-electric

ASHP for CAC Performance and Cost Modeling

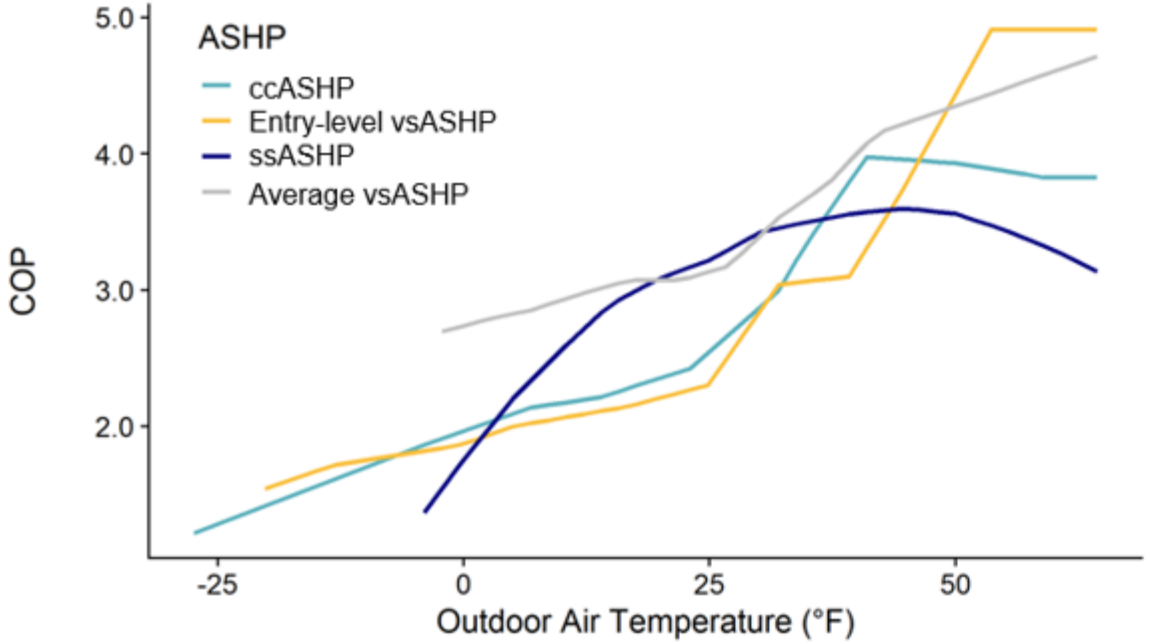
Methodology – Model

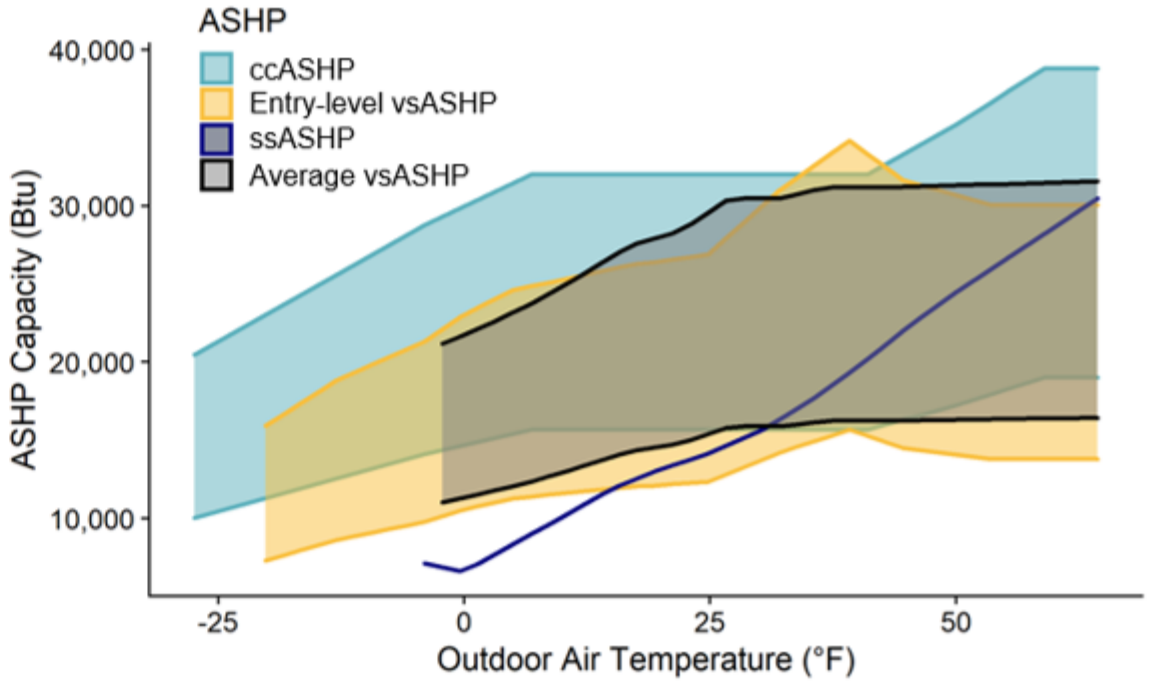
- Hourly building energy model
- A representative building
  - Broadly consistent with a 1950s Minneapolis home
  - Gas furnace and a failed CAC
- Iterated across a variety of variables
  - ASHP
  - Baseline furnace
  - Gas and electric rates
  - CAC or full replacement
  - Switchover temperature
  - Location (weather)
- Over 1.3 million scenarios



Methodology – ASHP Archetypes

ASHP Archetype	Rated Capacity	SEER	HSPF
Single Speed (ssASHP)	2 ton	14	9
Entry-level Variable Speed (vsASHP)	2 ton	20	13
Average (vsASHP)	3 ton	20	10.5
Cold Climate (ccASHP)	2.5 ton	18	10





Methodology – Variables of Interest

Variable	Details
Baseline Furnace	• 9 furnace + fan combinations • 80%–95% efficiency furnaces • Low efficiency (PSC) and high efficiency (ECM) fans • Fixed speed, two-stage heat, two-stage heat + cool
Gas/Electric Rates	• Represent potential present and future rate scenarios • Include dual-fuel electric rates
Replacement Type	• CAC only or furnace + CAC (full) replacement • Full replacement allows for fan energy savings and gas heating savings
Switchover Temperature	• Temperature at which ASHP switches to backup furnace • Between -15°F and 65°F • Capacity-limited switchover typically above -15°F

Incremental Costs

	Wholesale-Based		Average Project Bids	
ASHP	CAC-Only	Full*	CAC-Only	Full
ssASHP	$ 700	$ 1,000	$ 2,000	$ 4,300
Entry-level vsASHP**	$ 2,100	$ 3,000	$ 5,000	$ 6,100
Average vsASHP**	$ 3,500	$ 4,900	$ 8,300	$ 8,800
ccASHP**	$ 4,620	$ 7,300	$ 11,100	$ 10,300

40% margin added to wholesale cost-based estimates

*+$1000 for sealed vent (where applicable)

**+$500 for wiring (for multi-stage wiring)

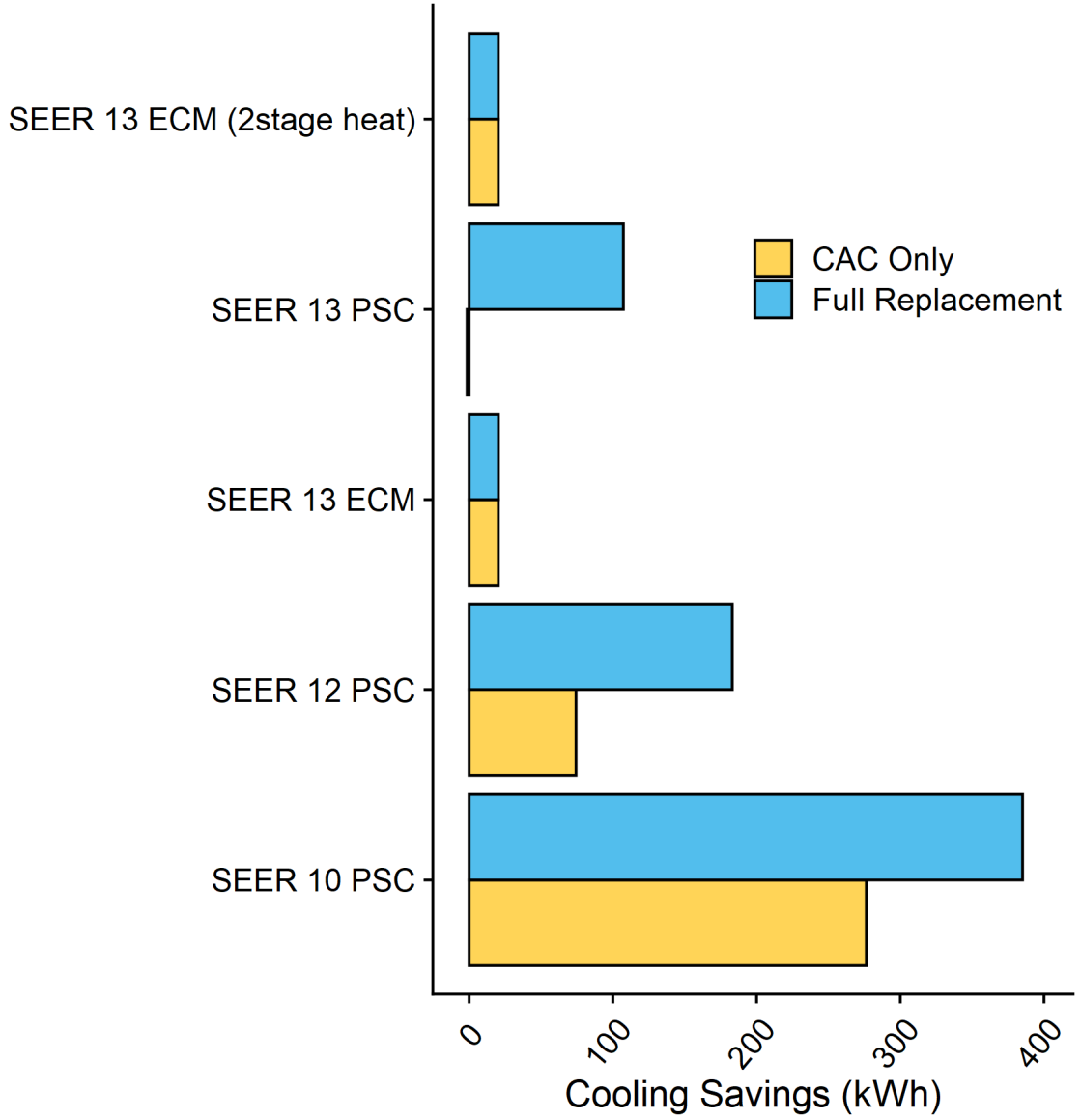
Today's Rebates

	ASHP (Ducted)		AC	
Utility	**Rebate Amount**	**System Specification**	**Rebate Available?**	**Centrally ducted units?**
Minnesota Power	$400 (ASHP) $1000 (ccASHP)	ASHP: ENERGY STAR, SEER 15+, HSPF 8.5+ ccASHP: SEER 15+, HSPF 9+, 1.75+ COP at 5°F	No	N/A
Otter Tail Power	$600-$700 per ton	HSPF 9+ & variable speed Higher rebate for ENERGY STAR or SEER 15+	No	N/A
Xcel Energy	N/A	N/A	Yes ($150 - $450)	Yes and heat pumps

Results

Cooling Savings – ssASHP

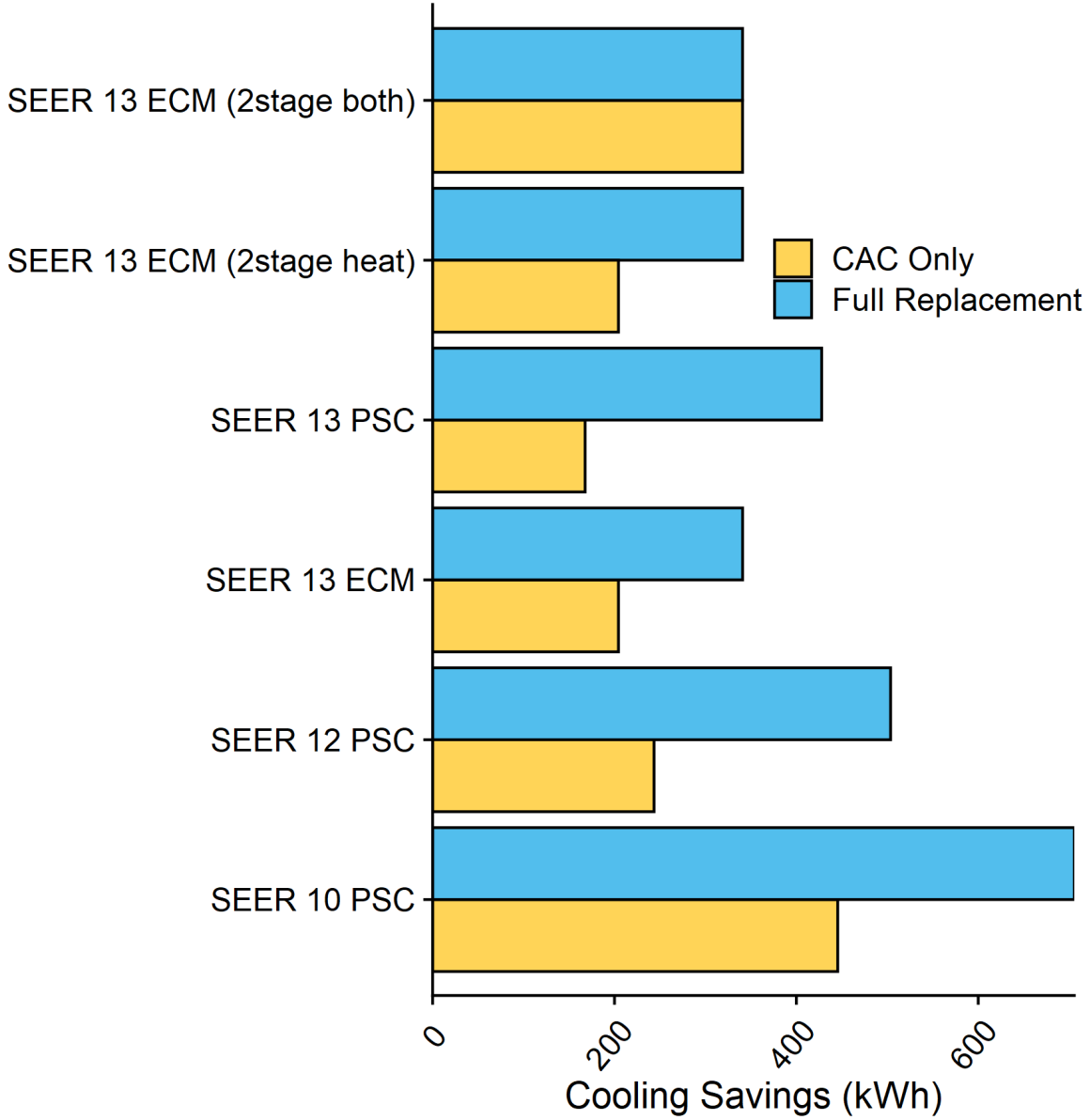
- Potential cooling savings between 0 kWh and nearly 400 kWh per year
- Lower efficiency CAC units offer the highest potential savings
- Furnace replacements increase cooling savings through fan improvements
- Every ASHP produces increased cooling comfort compared to existing CACs



SEER 14 Single-Speed ASHP

Cooling Savings – vsASHP

- The vsASHP yields between nearly 200 kWh and 700 kWh in cooling savings
- Inefficient fans penalize variable speed and lower capacity ASHPs with longer runtimes
- Furnace replacements increase cooling savings through fan efficiency



SEER 20 Variable Speed ASHP

Heating Savings

- Heat pumps sized for cooling can typically meet most of the heating load
- A 2-ton ssASHP can still electrify nearly half the annual heating load
- Furnace replacements can provide an additional 40 to 150 therms in gas savings
- Across all four climates, there is a 20% difference in total max space heating savings

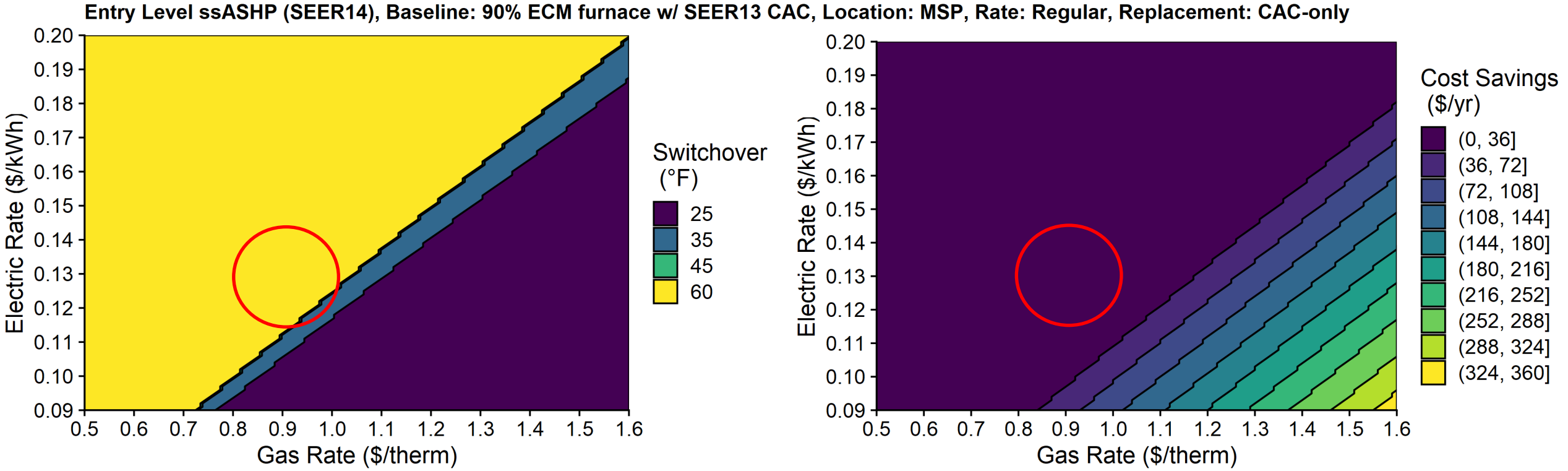
Location	ASHP Archetype	Capacity Switchover (°F)	Heating Load Met by ASHP
MPLS 700 CDD 8,400 HDD	ssASHP	25	47%
	Entry-level vsASHP	0	85%
	Average vsASHP	5	78%
	ccASHP	-5	91%

Cost Savings and Cost-Effectiveness

- All combinations of location, baseline, ASHP, and replacement type have cost-effective outcomes
- ASHP operational cost savings (cost-effectiveness) exhibit extreme sensitivity to electric and gas rates

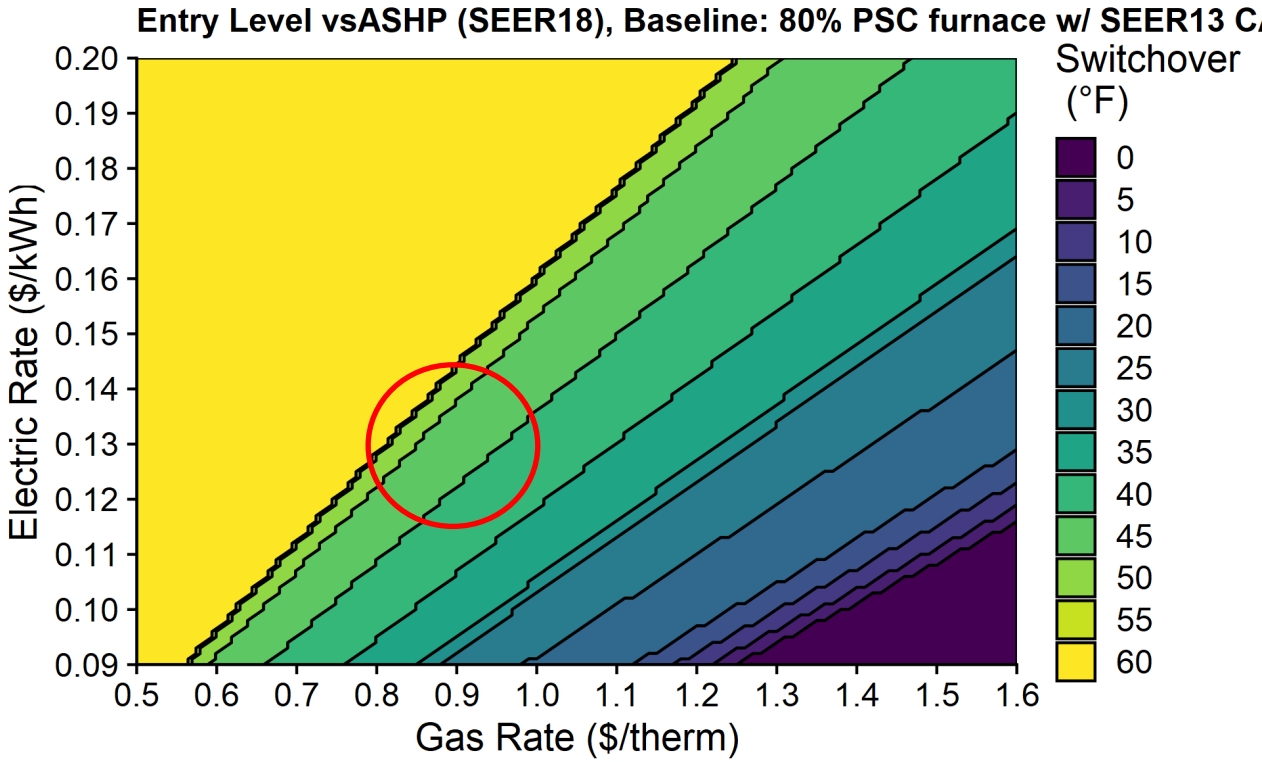
Scenario 1	Scenario 2	Scenario 3
• ssASHP paired with a newer furnace • CAC-only replacement	• Entry-level vsASHP • Full replacement of older furnace	• Entry-level vsASHP • Full replacement of older furnace • Dual fuel space heating rates

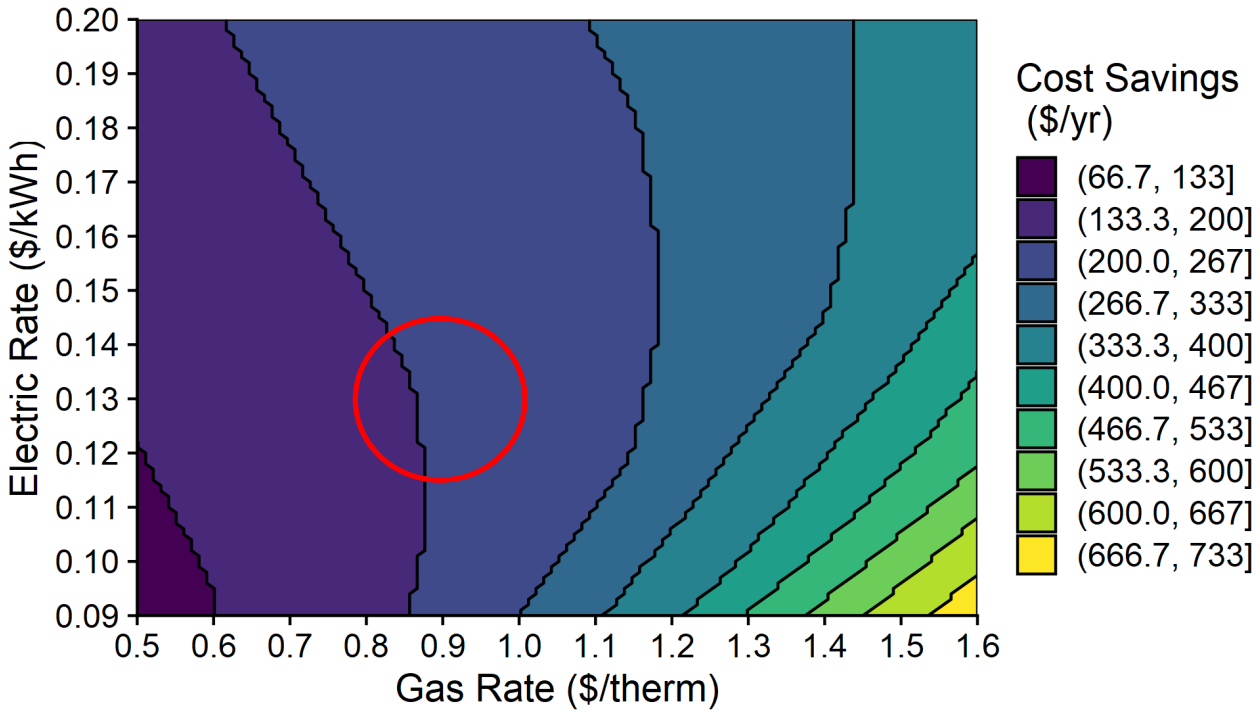
Scenario 1 – Newish existing furnace with entry ssASHP



Scenario 2 – Older existing furnace alongside failed CAC with entry-level vsASHP

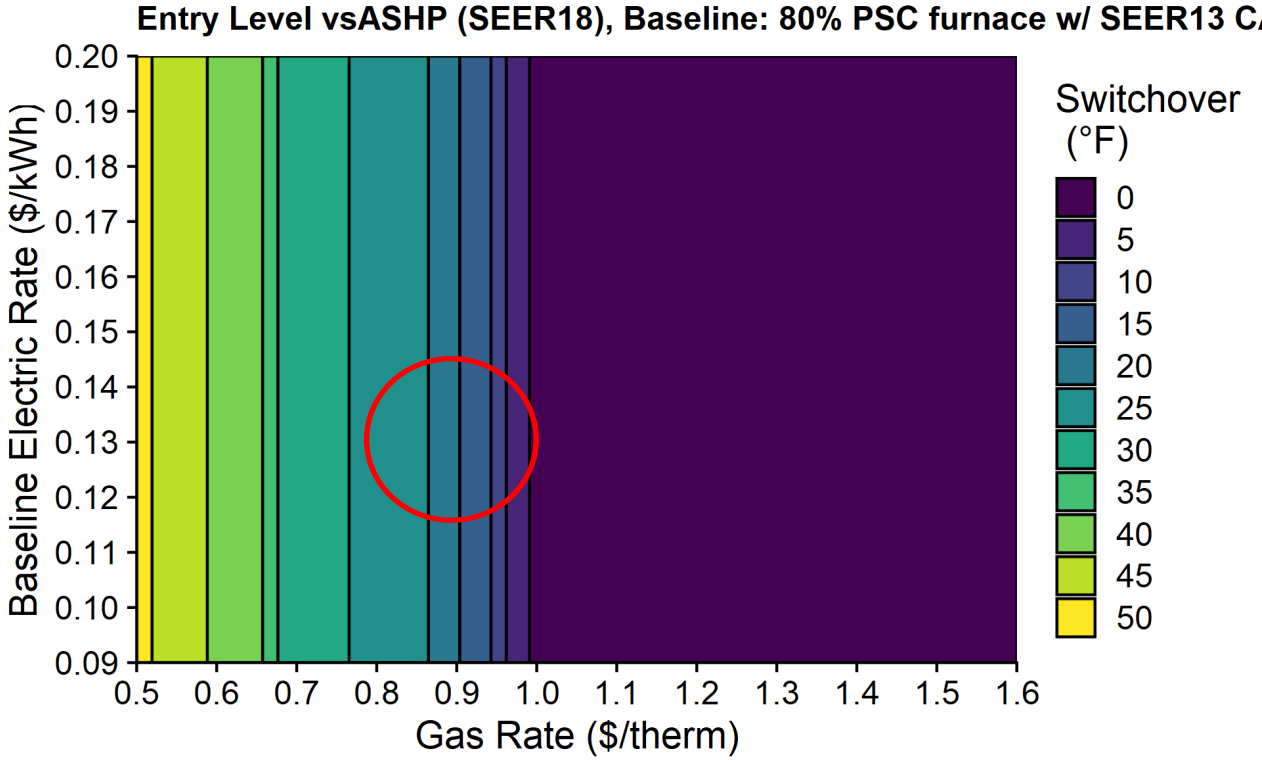
Older existing furnace alongside failed CAC with entry-level vsASHP

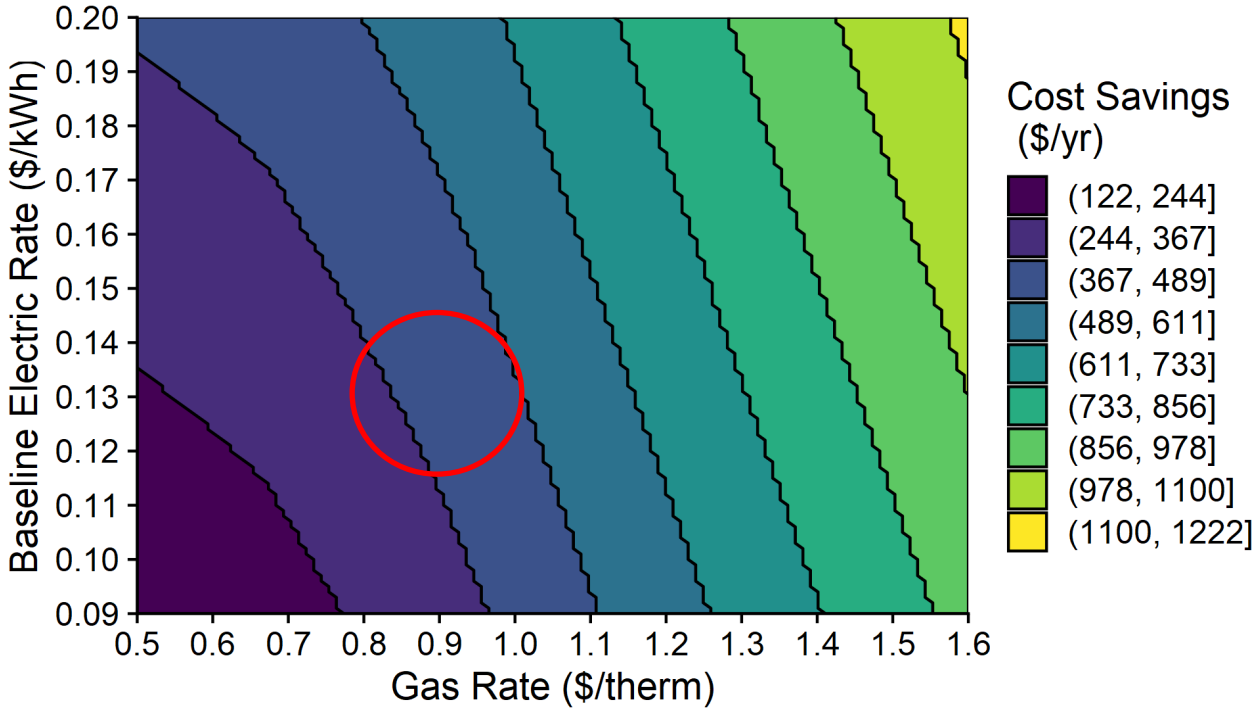




Scenario 3 – Older existing furnace alongside failed CAC with entry-level vsASHP with dual fuel rate

Older existing furnace alongside failed CAC with entry-level vsASHP with dual fuel rate





Conclusions and Recommendations

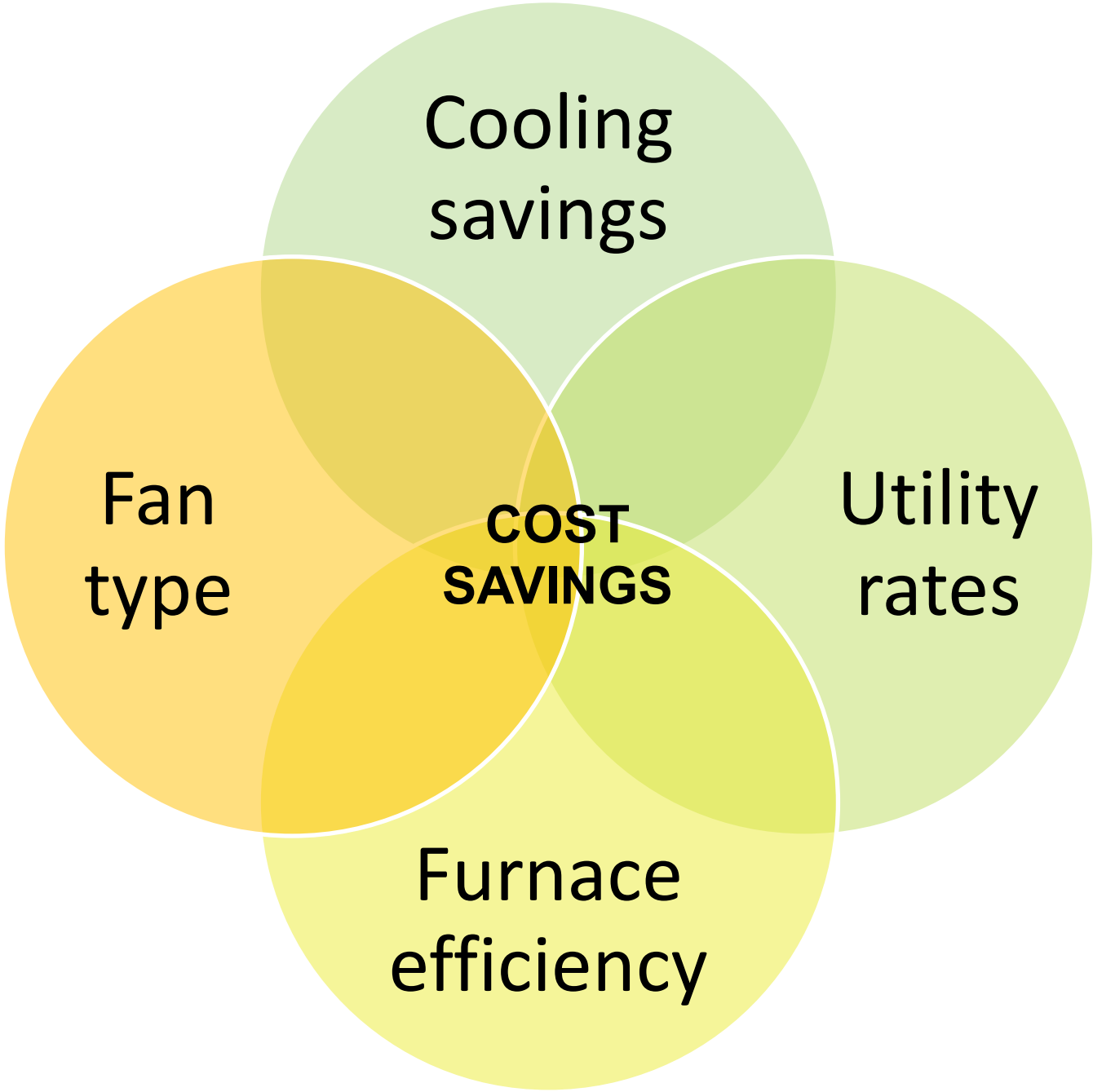
Conclusions – Market Readiness

Existing ASHP products offer a broad range of system types and designs to meet customer needs

Market conditions are positive for transformational change

Conclusions – Savings

- Stacking efficiency benefits by bundling fan, furnace, and cooling efficiency increase net savings
- ASHP savings depend on many factors, but remain highly sensitive to utility rates



Conclusions – Potential

- ***ASHPs as CAC replacements provide most of the potential of full ASHP electrification***

- ***This is the opportunity to end traditional CAC as we know it and advance the baseline***

Questions?

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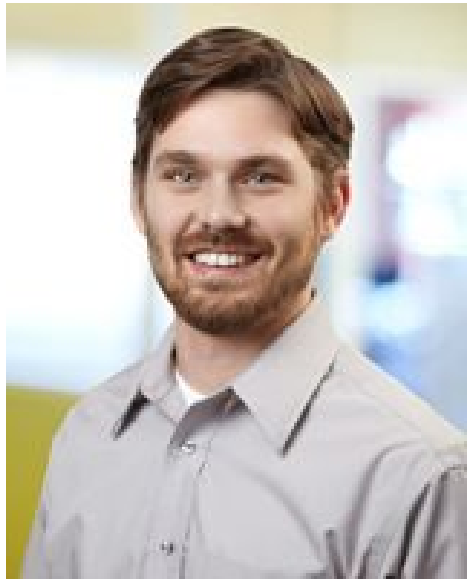

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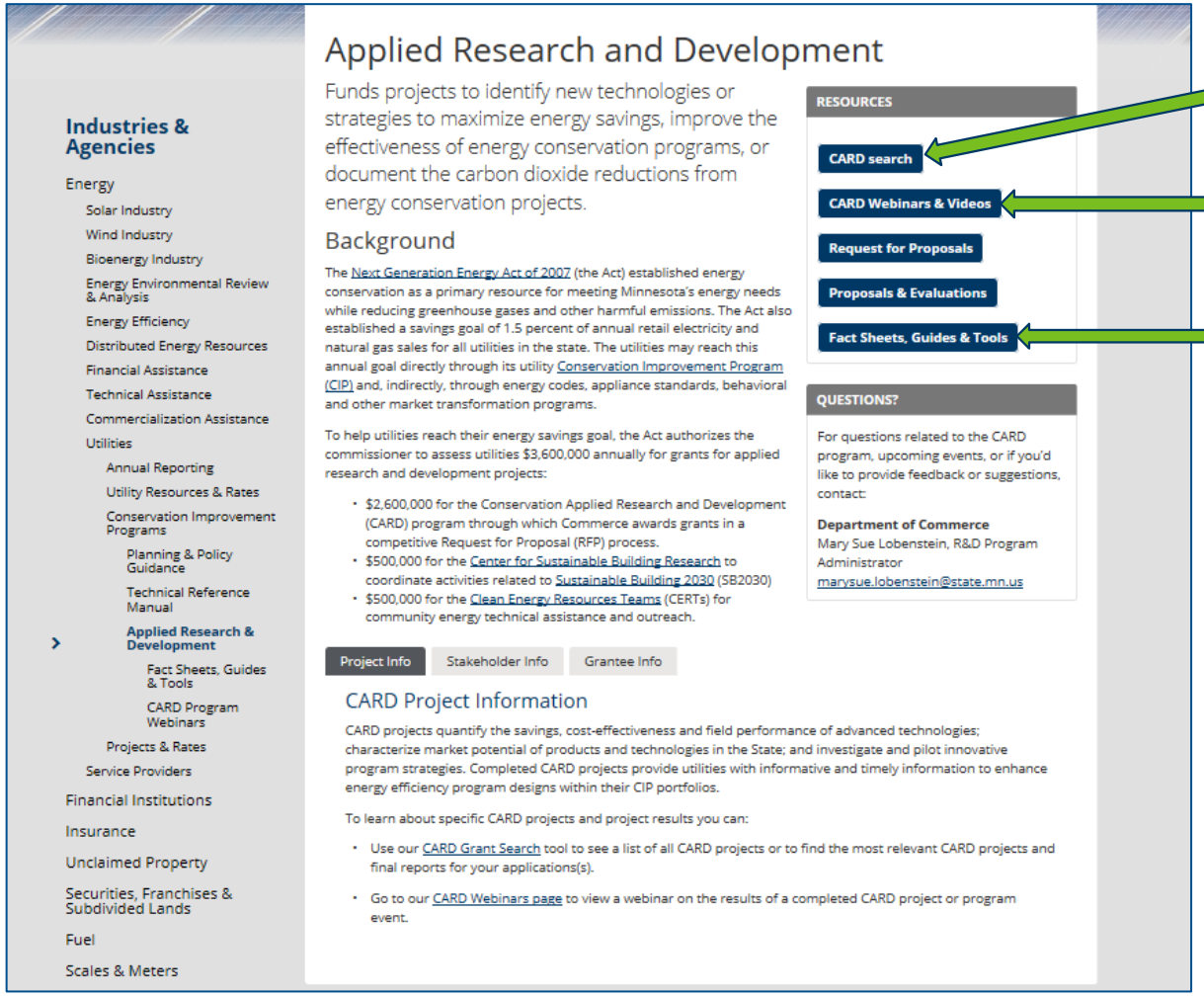
Send us your questions using the Q&A panel

CARD Project Resources



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Webinar Recording & Final Report available in couple months

[R&D Web Page](https://mn.gov/commerce/industries/energy/utilities/cip/applied-research-development/) (https://mn.gov/commerce/industries/energy/utilities/cip/applied-research-development/)

Thanks for Participating!

Upcoming CARD Webinars:

- **August 18, 2022:** Slipstream – Opportunities for CIP to Support Tribal Food Sovereignty
- **October 12, 2022:** Michaels Energy – Energy Efficiency Potential of Nanofluids

Commerce Division of Energy Resources e-mail list sign-up

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