



# FOCUS EERD ASHP RESEARCH FINAL REPORT PRESENTATION

**Center for Energy & Environment and Elevate Energy**

**September 21, 2021**

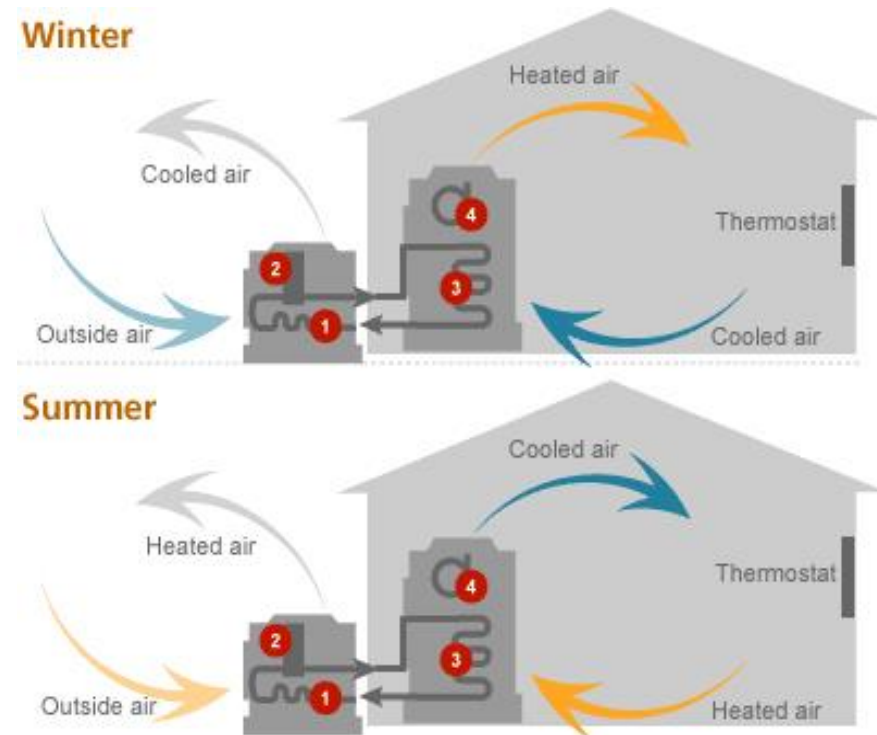
# •• Agenda

- ✓ About ASHPs
- ✓ EERD research purpose
- ✓ Methodology
- ✓ Findings
- ✓ Recommendations
- ✓ Discussion

# Air Source Heat Pumps

# ASHPs provide heating and cooling

- Use a refrigerant system involving a compressor, condenser, and evaporator to absorb heat at one place and release it at another.
- Deliver both heating and cooling via forced air distribution
- New generation systems can operate as low as  $-25^{\circ}\text{F}$

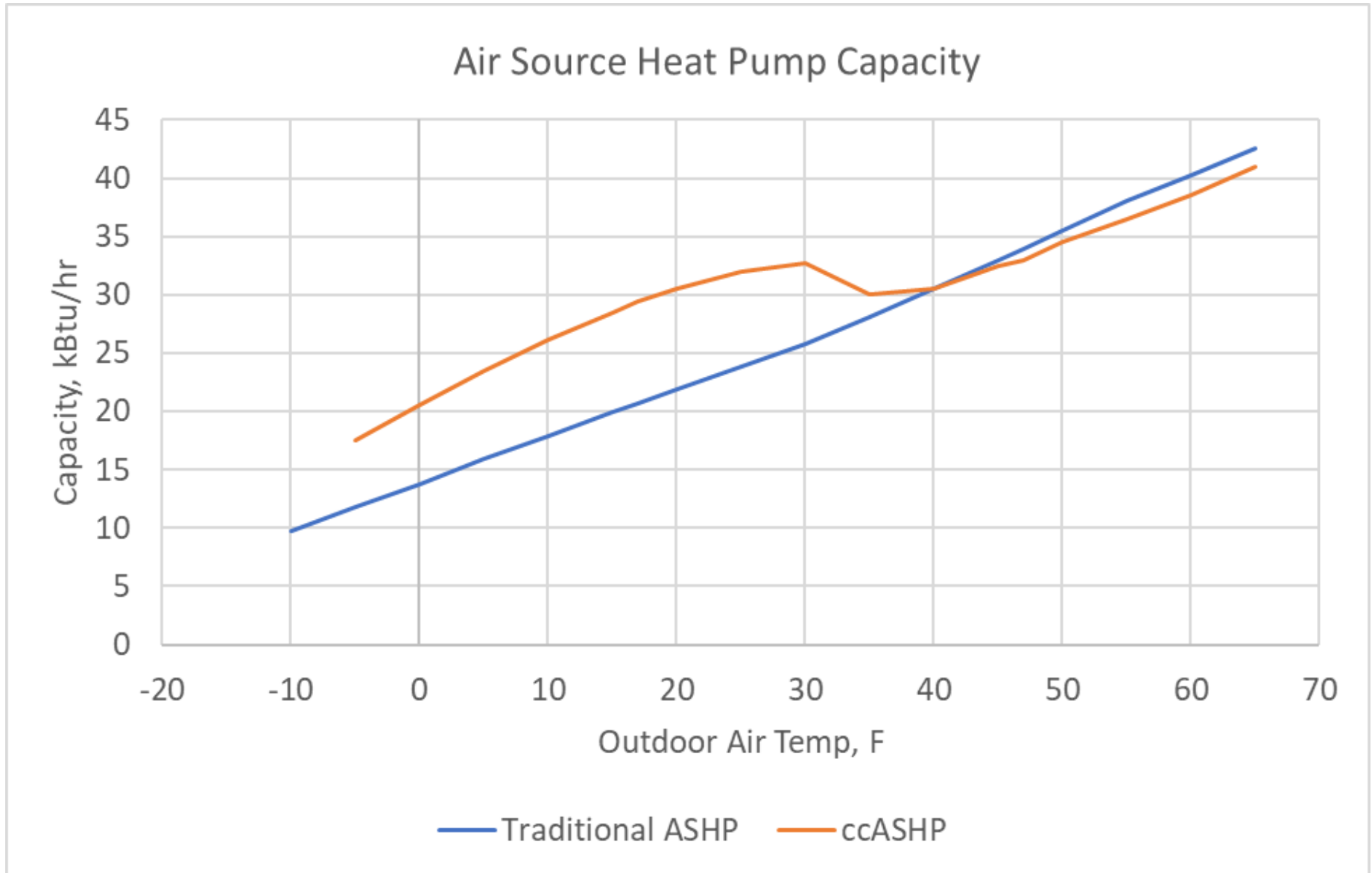




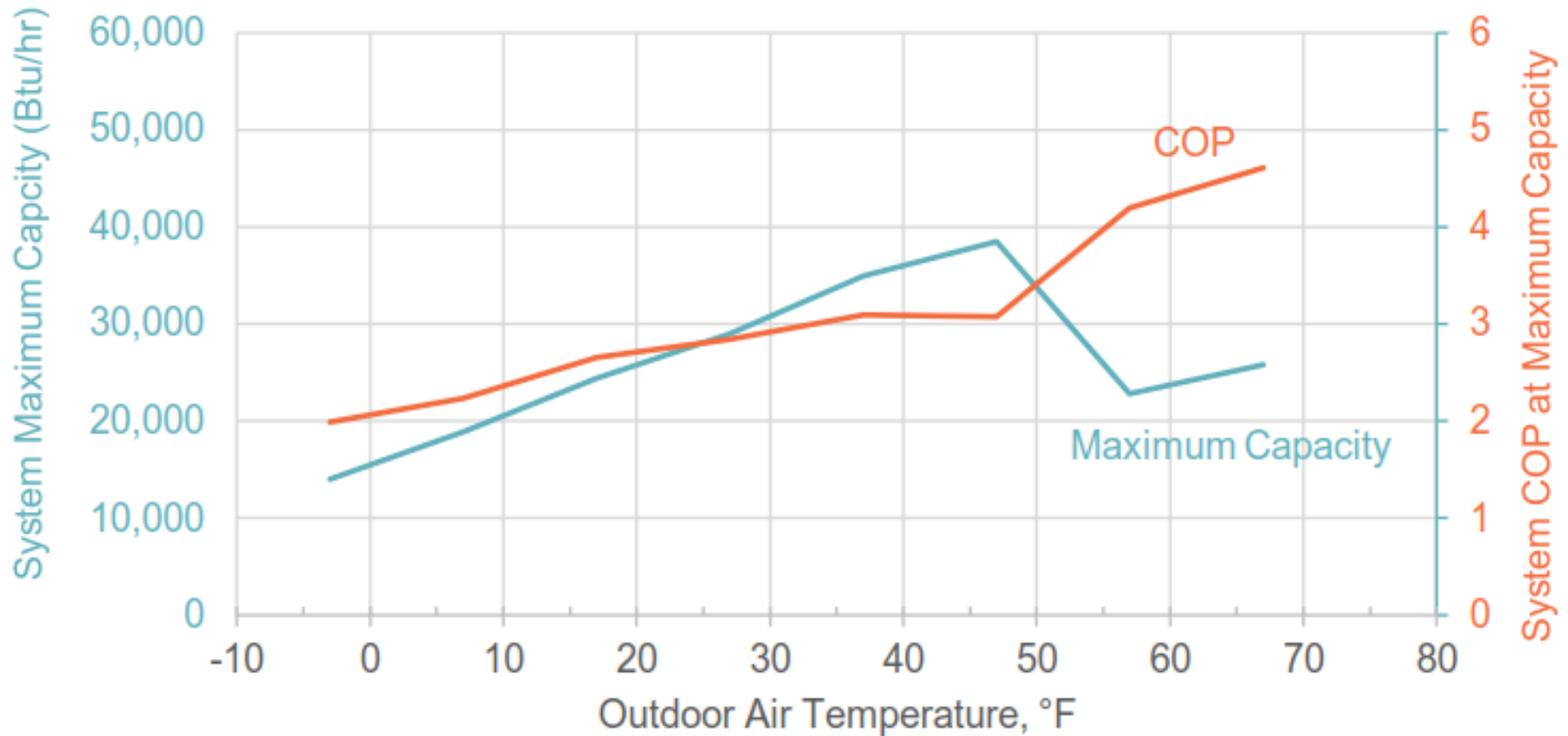
## •• Really... in cold climates?

- Typically, ASHP heat transfer performance of reduces as outdoor temps drop
- However, variable capacity advancements have greatly expanded cold climate performance
- Development of a cold climate performance spec
- Now, manufacturers claim performance below -20F
- CEE has documented systems delivering heat as cold as -25 F

# ❖ ASHP capacity by outdoor temperature



# • ASHP performance by temperature



## •• Ducted/whole-home ASHP – dual fuel





## • Ducted/whole-home ASHP – all-electric



# •• Ductless minisplit heat pump

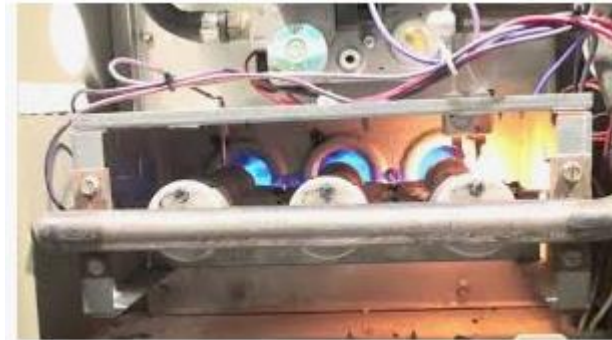


# • Sizing, control, and design considerations

Control and Operation



Integration with backup



Sizing



# •• Modes of ASHP system operation

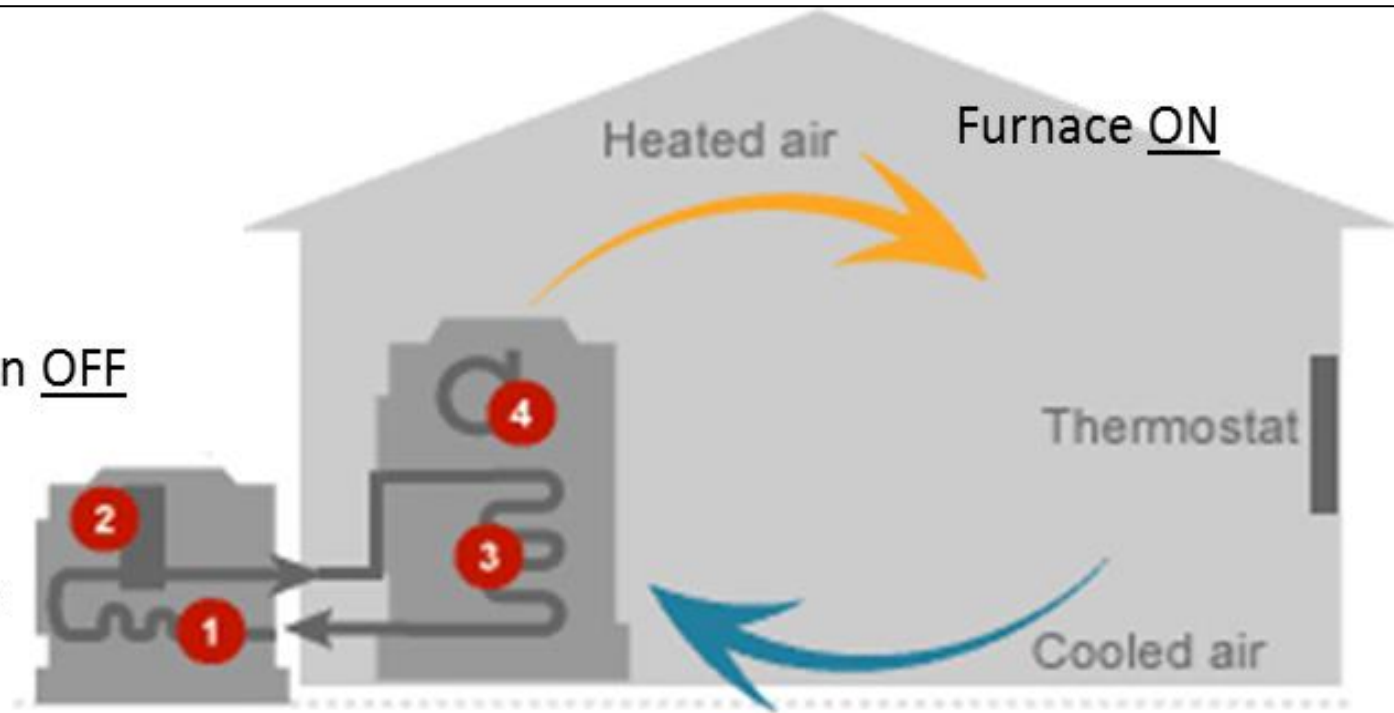
Heating system has 3 modes of operation

- ASHP heating
- Back up heating
- Defrost

## Defrost Mode

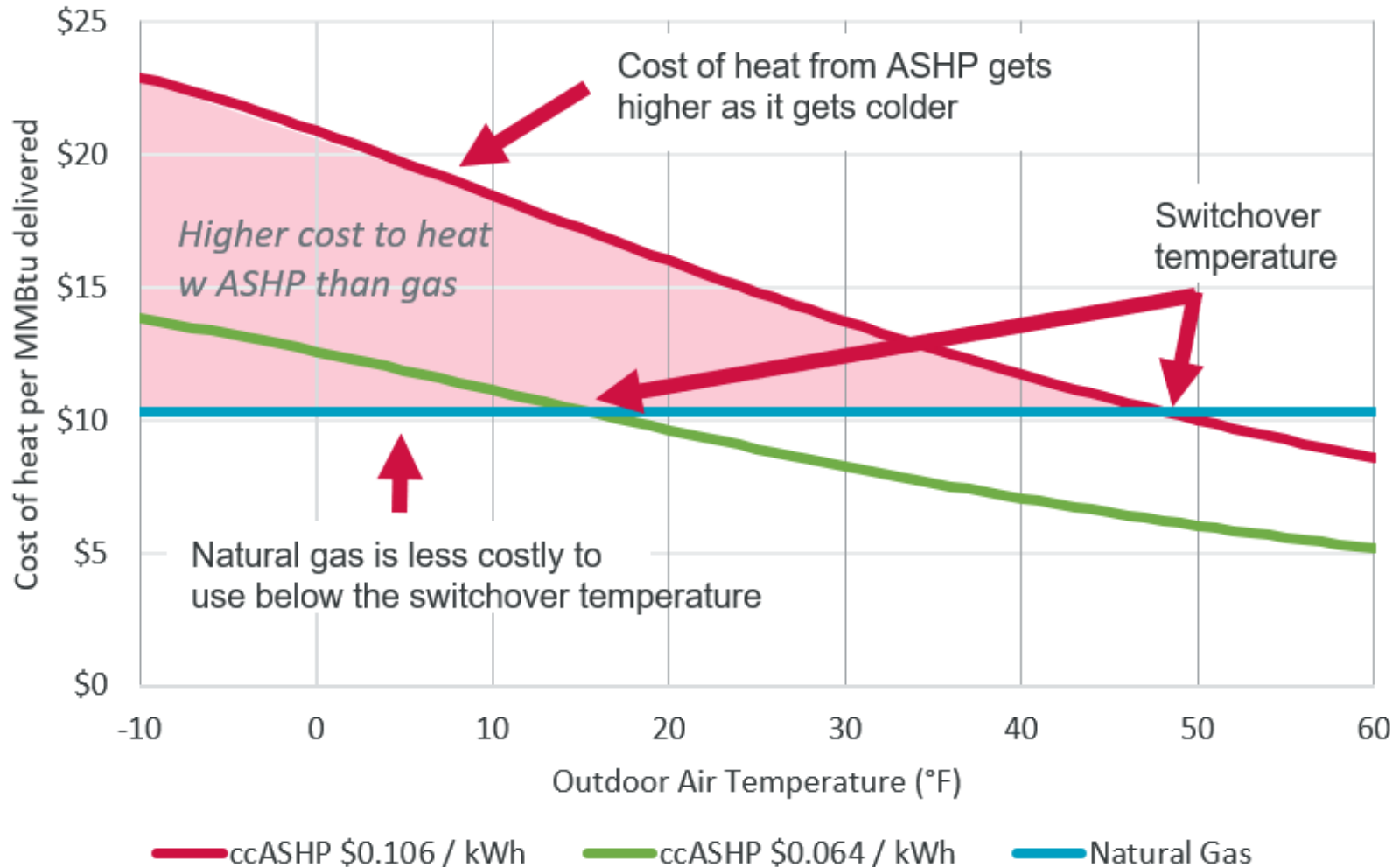
Outdoor Fan OFF

Refrigerant in reverse





# • Dual fuel switchover temp economics



# EERD ASHP Research

## ❖ EERD research purpose

**Purpose:** Help Focus maximize residential sector energy savings, and explore other benefits from ASHPs – now and into future quadrennials

*How can Focus achieve greater residential savings by focusing on heat pumps? What does Focus' heat pump savings potential look like?*

**Looked at:** Single-family and multifamily sectors

**Not included:** New construction and commercial

# •• Methodology

- I. Economics and Wisconsin market potential analysis – where does the highest potential lie?
- II. CEE's electric heating analysis to target that application – can we target this high savings segment?
- III. HVAC contractor interviews and focus group – what's the contractor perspective on heat pumps?
- IV. Multifamily owner/manager interviews and focus groups
- V. Review heat pump program best practices
- VI. Review Focus heat pump offerings and TRM measures
- VII. Develop heat pump program recommendations



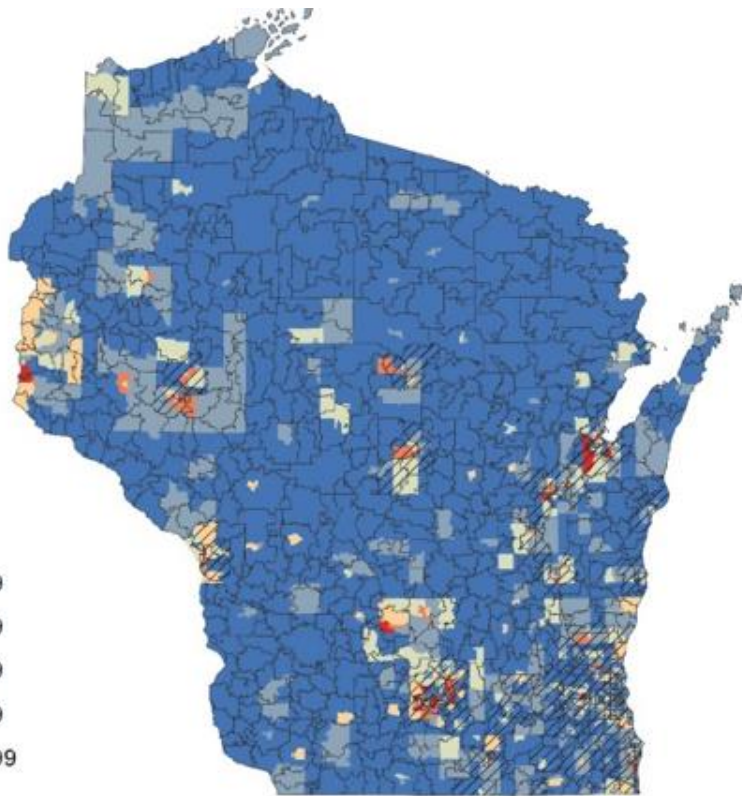
# Research findings

## • Heat pump market size by fuel type

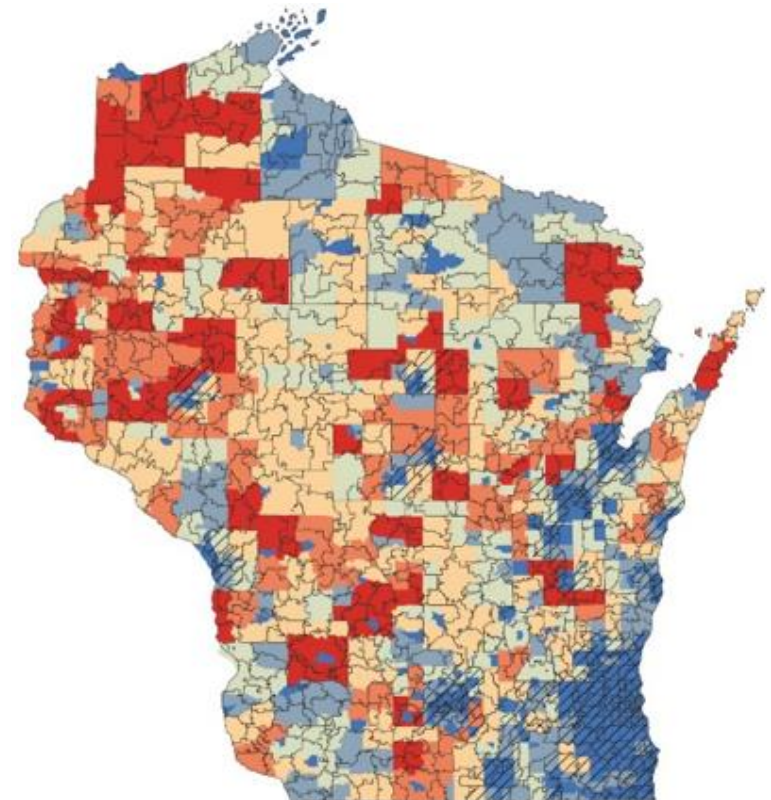
Existing fuel type	Single family units (% income eligible)	Multifamily units (% income eligible)	Type of HP – SF/MF
Electric resistance	157,210 (42%)	221,138 (67%)	Minisplit / Minisplit
Propane	247,274 (37%)	5,572 (73%)	Ducted / Minisplit
Natural gas total	1,276,125 (36%)	224,557 (63%)	NA
Natural gas – forced air	1,046,422	121,261	Ducted / Minisplit
Natural gas – boiler	38,283	53,894	Minisplit / Minisplit

# •• Electric and propane heating maps

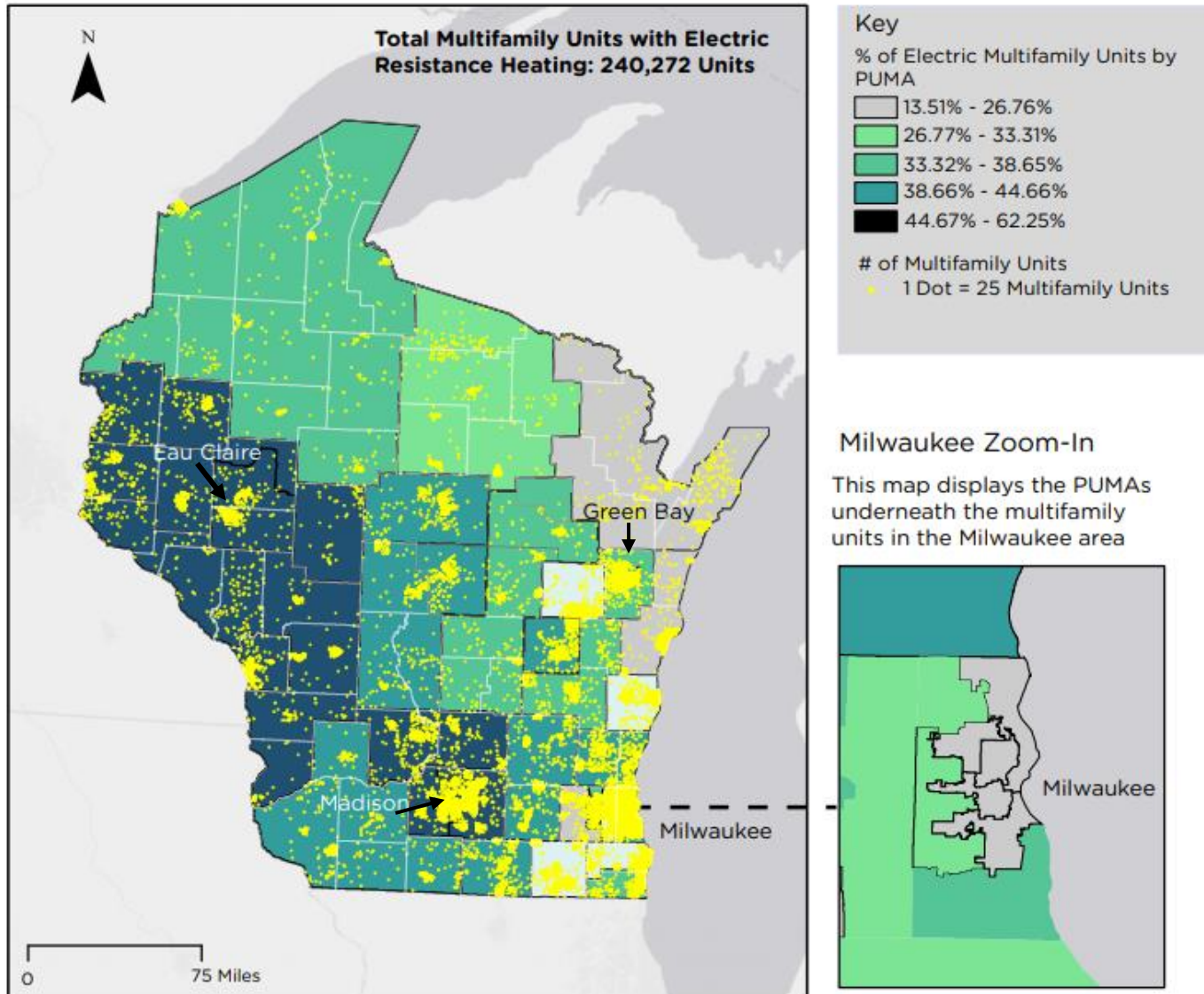
Electric heating in Wisconsin



Propane heating in Wisconsin



# Electric heating and multifamily housing



## • Electric heat is ideal application type for savings

- Existing heating fuel type is the most significant indicator of energy savings potential and customer economics
- Best per-unit customer economics: single-family and multifamily heated with electric resistance

Application	Annual kWh reduction	% heating met by ASHP	Annual savings
Single-Family Electric Resistance Displacement	6,612 kWh/yr	67%	\$ 705
Multifamily Electric Resistance Displacement	3,915 kWh/yr/unit	75%	\$ 417

## • Propane application also shows savings

Inputs:

- Ave. WI \$/kWh: \$.1066
- Lower \$/kWh: \$.07
- Cost of propane: \$1.83/gal
- 90% AFUE furnace
- Savings calculated compared to gas and kWh baseline

Application	Annual LP reduction (MMBtu/yr)	Annual savings for ave. kWh rate	Annual savings for low kWh rate	% Heating load met by ASHP
Dual fuel 5°F switchover	58	\$ 531	\$ 755	81%
Dual fuel 25°F switchover	38	\$ 381	\$ 514	53%
Dual fuel 45°F switchover	9	\$ 114	\$ 139	13%

## • For NG: ASHPs economically provide partial heat

Inputs:

- Ave. WI \$/kWh: \$.1066
- Lower \$/kWh: \$.07
- Cost of NG: \$0.81/therm
- 90% AFUE furnace
- Savings calculated compared to gas and kWh baseline

Application	Annual gas reduction (MMBtu/yr)	Annual savings for ave. kWh rate	Annual savings for low kWh rate	% Heating load met by ASHP
Dual fuel 5°F switchover	58	\$ (155)	\$ 70	81%
Dual fuel 25°F switchover	38	\$ (66)	\$ 67	53%
Dual fuel 45°F switchover	9	\$ 5	\$ 30	13%



## •• CEE's work to target electric heating



In partnership with WPPI Energy and Madison Gas and Electric, CEE analyzed billing data to identify electrically heated customers.



Overall, across urban and rural areas, CEE found a range of 6%–24% electric heating.

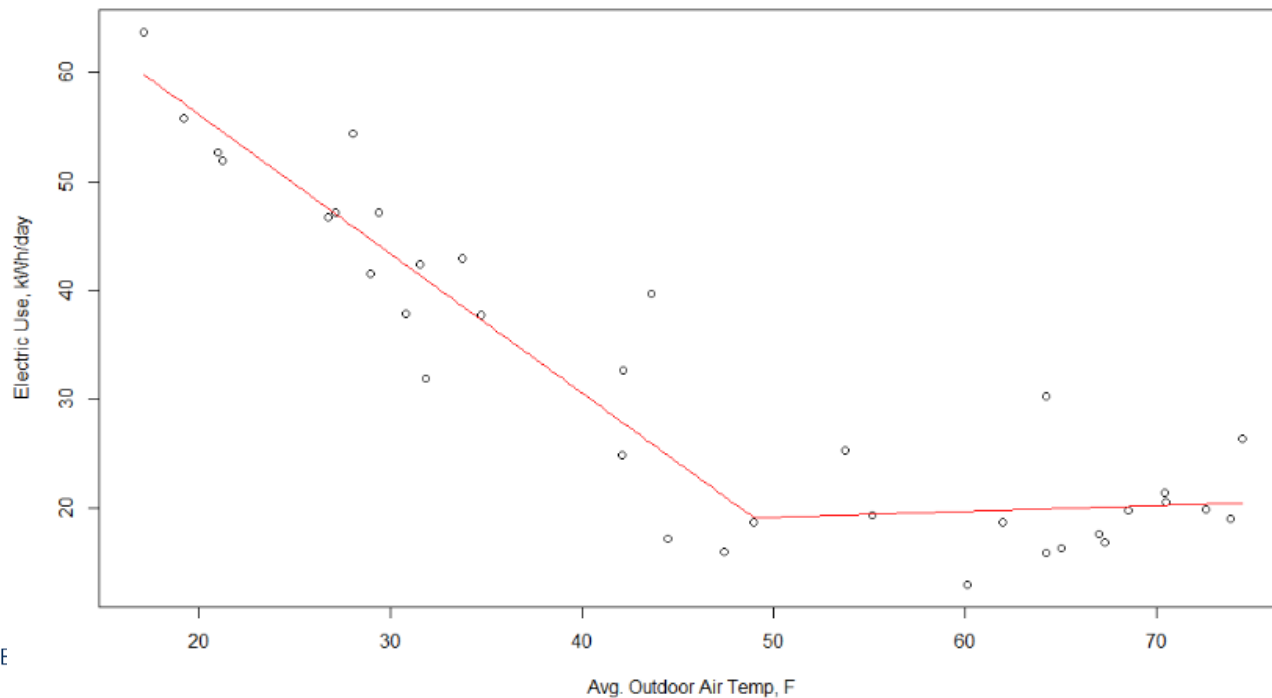


Helps target customers with significant electric heating loads. It may have excluded some electrically heated housing if the load was small.

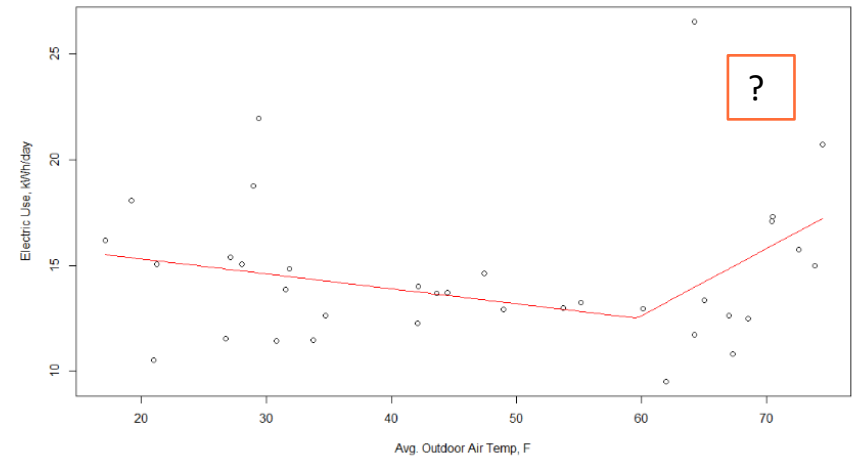
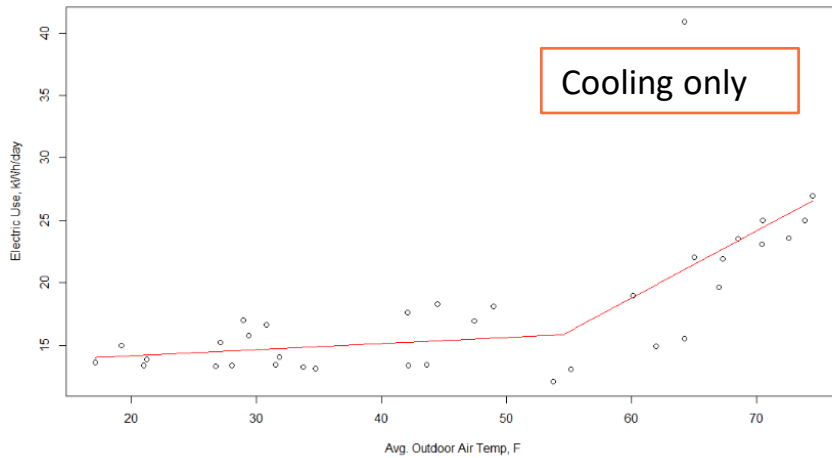
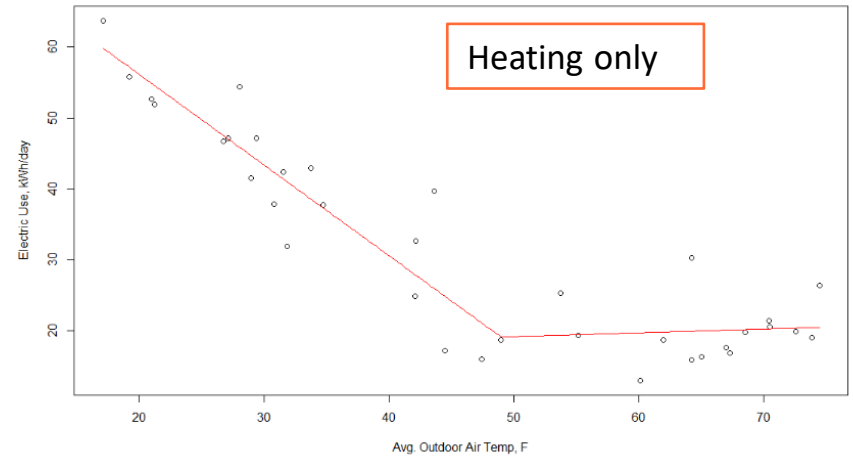
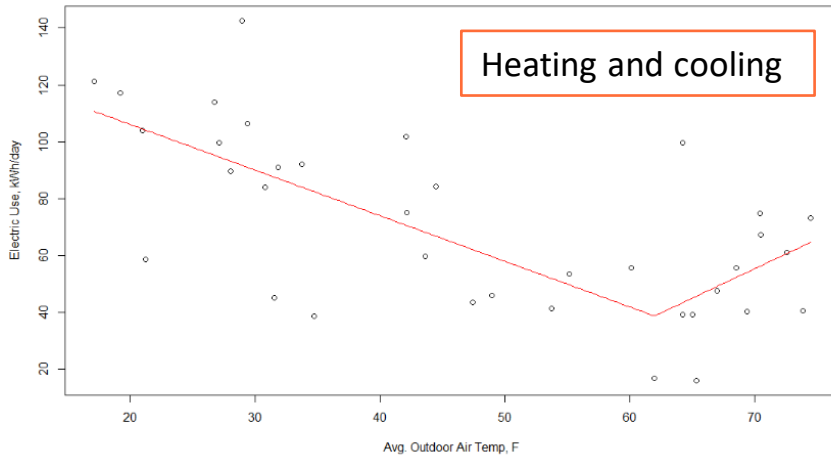


# •• Conducting bill analysis to find electric heat

- Use calculation
  - Bill analysis: Use vs OAT
  - Typical weather data from nearby weather station
- Results
  - Annual heating kWh usage



# Bill analysis graphs – how we identify



## Comparison with Census data

- Census microdata regions are aggregated. However, they can point to trends
- Percentages do not necessarily indicate high total number – can be a small city
- For Dane/Dodge/Jefferson: majority is mid-size multifamily

Census microdata region	% electric heating (Census)	Corresponding municipal and % electric heating
Dane, Dodge, and Jefferson Counties ("Madison aggregate area")	21%	Sun Prairie Utilities – 12% Mt. Horeb Utilities – 15% Stoughton Utilities – 13%
Eau Claire and St. Croix (aggregate)	14.6%	River Falls Municipal Utilities – 16%
Grant, Green, Iowa, Richland & Lafayette Counties	10%	New Glarus Utilities – 12%
West Central (LaCrosse) (aggregate)	16.4%	Whitehall Electric Utility – 24% Black River Falls – 20%
Marinette, Oconto, Door, Florence, Manitowoc & Kewaunee Counties	6.3%	Sturgeon Bay Utilities – 14% Algoma Utilities – 6%
Washington, Sheboygan, & Ozaukee Counties	15%	New Holstein Utilities – 13% Plymouth Utilities – 12%

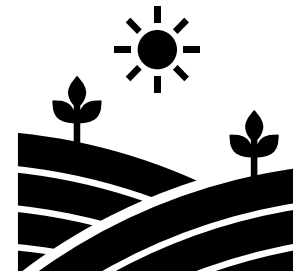
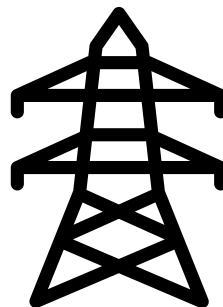
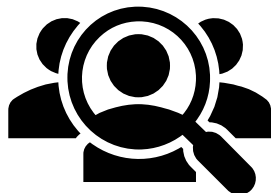
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## •• What to do with that info?

- Clearer picture of proportion of electric heating (validate Census)
- Target marketing to ASHP application types with greatest savings potential
- Assess savings potential more broadly for the utility (i.e., look at sum heating load)



# HVAC contractor findings

# • HVAC contractors engaged for research

- Total engaged: 30
- Contractors surveyed = orange
- Focus group participants = green
- Both survey and focus group = indigo



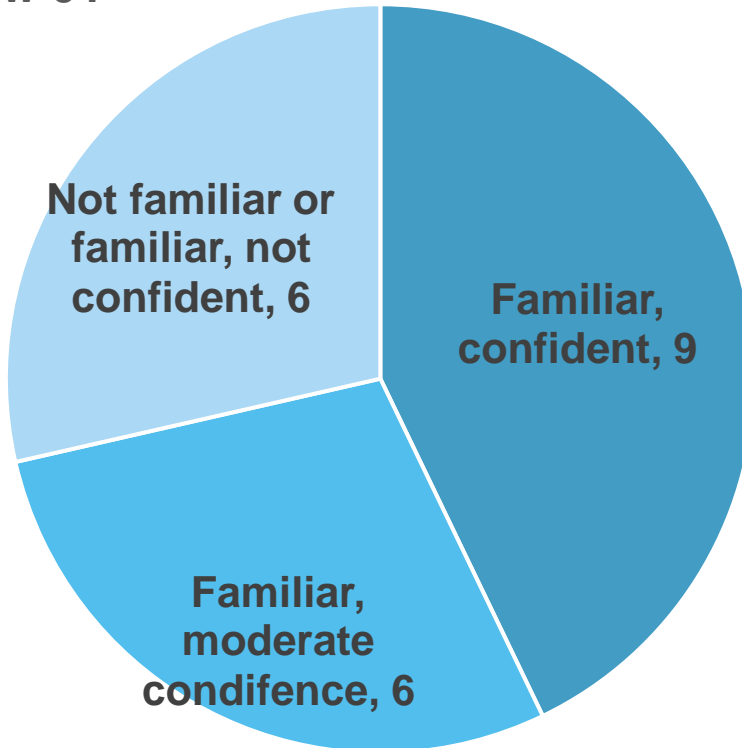
# • HVAC contractor research findings

- Cost is a big factor – the low cost of natural gas can make heat pumps a less attractive heating solution, and rebates don't necessarily help.
- Contractors are not fully comfortable with ASHP systems with back-up heat.
- Lack of customer knowledge of heat pump operation and benefits is a sales barrier.



# Contractors are not effectively educated about benefits / applications of heat pumps.

How familiar are you with cold climate heat pumps, and how confident are you in their performance down to temps below 0?



What are some barriers to increasing heat pump sales?

“ *Not being able to use HPs as a primary heating source.* ”

# Contractors are not effectively educated about benefits / applications of heat pumps.

Technology going in a good direction; however, seems like the unitary system technology is not improving much anymore.

I have not fully dived into heat pumps. In Milwaukee, there are a lot of furnaces and A/Cs. I'm mainly working in bonus rooms for heat pumps, so I have to diversify my knowledge in them.

If the technology were to allow it to be the only system the customer needs, I could sell more. I can sell it, but I have to maintain this other system. [Many agreed with this comment].

# Multifamily findings

# • Multifamily customers engaged

- Unique customers engaged in interviews or focus groups: 12
- Tens of thousands of units represented by owners/managers Elevate engaged

Multifamily company name	Multifamily type	Property locations	Engagement
Wisconsin Management Company	Large for-profit property management company	Northeast, Southwest, South Central, and Central Wisconsin, Milwaukee/Greater Milwaukee, and Northern IL	One-on-One
Housing Initiatives, Inc.	Medium-Large non-profit developer	Madison, Wisconsin	One-on-One
AK Development	Small real estate developer	Milwaukee, Wisconsin	One-on-One
Wangard Partners, Inc	Commercial real estate investment company	Primarily in Southeast Wisconsin	One-on-One
West CAP—West Central Wisconsin Community Action Agency, Inc.	Medium non-profit affordable housing developer	Northwestern Wisconsin	One-on-One
HoChunk Nation	Nonprofit affordable housing developer	Northwest and Central Wisconsin	One-on-One
The Morgan Partners	Small, for-profit development company	Oshkosh, Wisconsin	One-on-One
KM3 Management	Small, for-profit development company	Madison, Appleton, and Milwaukee, Wisconsin	One-on-One
FORE Investment Group	Small for-profit management company	Appleton, WI	Focus Group
New Year Investments	Medium for-profit management company	Madison, WI	Focus Group
Lincoln Avenue Capital	Large for-profit affordable housing developer	Operates across 15 states and based in Madison, WI	Focus Group
Wisconsin Housing Preservation Corp	Large non-profit developer (largest owner of affordable housing in WI)	58/72 counties in Wisconsin	One-on-One & Focus Group

## •• Confirmed: cost and rebates are challenging

- Cost and payback period is a significant, but there is opportunity to improve this in buildings heated with electric resistance.
- Owners and managers consider efficiency in retrofits/design but Focus rebates may not be top-of-mind.

"If 50% of the cost was covered, we would jump on it!"

"The more generous the incentive is, the more units we can do!"

## •• Heat pump knowledge gap is a barrier

- Lack of knowledge about heat pump operation and maintenance leads managers and owners to stay away from heat pumps
- Ability of heat pumps to keep tenants warm below zero degrees is a concern
- Not very good experiences with knowledgeable contractors

## • Unique, tailored approach is needed

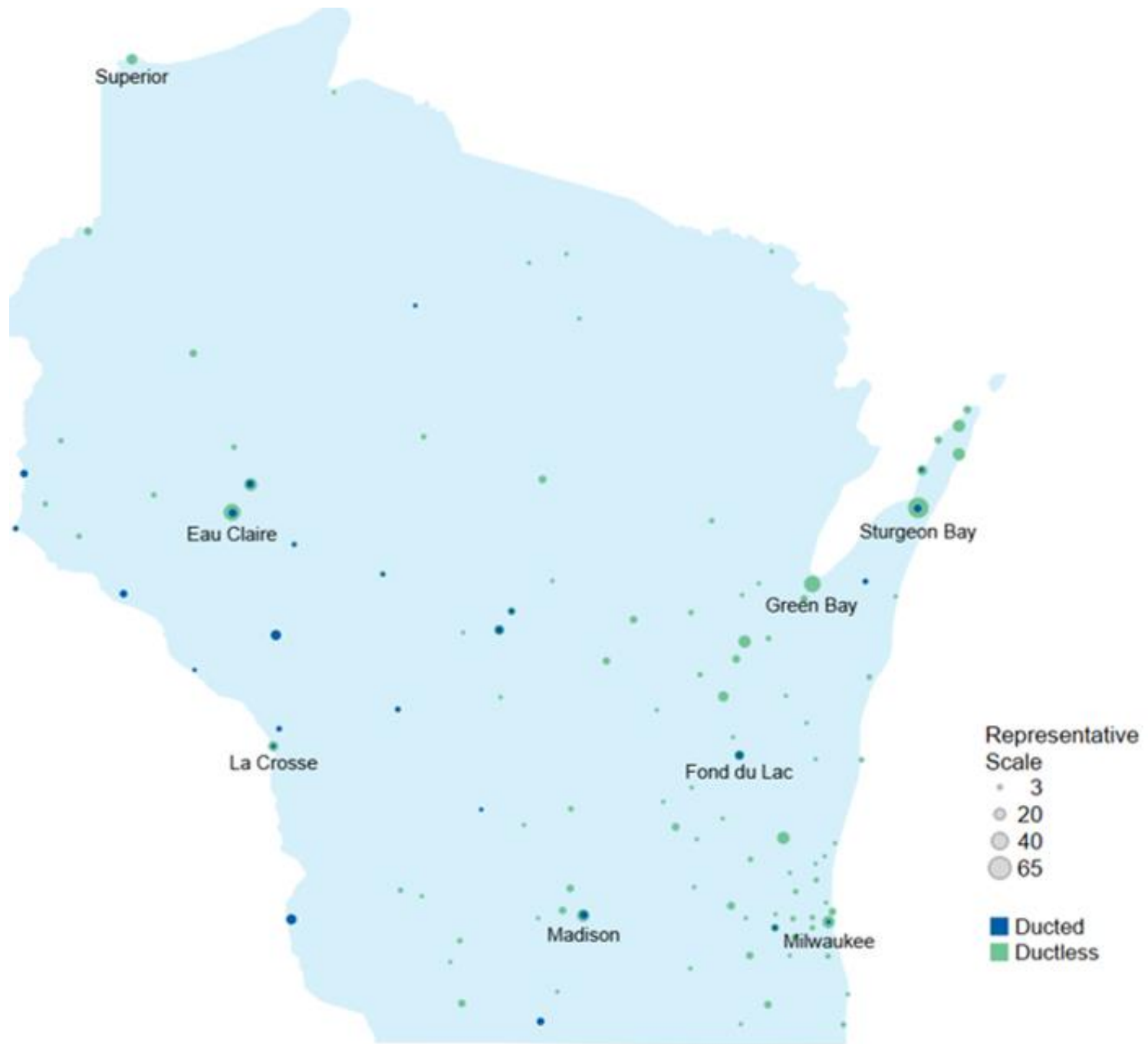
- Nonprofit-owned affordable multifamily housing developers face unique challenges and require a tailored approach.
- The design-build nature of multifamily new construction poses a challenge.

# Focus heat pump offerings & TRM



# •• Review of Focus heat pump offerings

- Ducted and ductless measures are capturing a small amount of the potential market
- Small number of contractors conduct the majority of installs
  - Installs are not occurring where there is the greatest potential for savings.
- Allowing natural gas and propane is a good thing!



## •• TRM review findings

- Focus TRM assumes that heat pumps are sized for the load and will meet full heating load hours — this is not realistic for many applications.
- Focus TRM does not count efficiency gains from modulating-speed heat pumps.
- Overall, on par with other TRMs across the U.S.
- TRMs tend to miss the dual fuel savings opportunity.

# Recommendations

## • Consider tiered ASHP rebates (examples below)

### Ducted ASHP rebates

	SEER	HSPF	Cold Climate?	Rebate \$	IE Bonus
Standard efficiency tier	15+	8.5+	N	\$750	\$250
High efficiency tier	18+	9.5+	Y	\$1,250	\$250

### Ductless minisplit rebates

	SEER	HSPF	Cold Climate?	Rebate \$	ER Bonus	IE Bonus
Standard efficiency tier	16+	8+	N	\$500	--	\$250
High efficiency tier	19+	10.5+	Y	\$750	\$250	\$250


## •• Develop “heat pump for A/C” initiative

- All customers replacing their A/C *should replace with an ASHP*
- “Heat pumps for A/C” promotional initiative (ductless minisplits and ducted ASHPs) can spur heat pump program growth for cooling
- HVAC equipment installed now is the equipment we will have 15 years from now – will want it to be ready for broader electrification



# •• Develop education/marketing materials

- Develop materials and targeted campaigns to support contractors
- Educational materials help contractors feel supported in more active promotion
- Materials that are clear on energy/cost savings would be helpful
- **Additionally: target marketing at customers with electric heat**



## For Customers

### Basics and Customer Experience

1. Why choose a heat pump?
  - a. A heat pump provides multiple benefits in one heating and cooling system. It can provide cooling at twice the efficiency of common window unit air conditioners and can save between 30% and 55% on heating costs compared to other electric and propane heating types. This provides better energy savings, more comfort, and lower carbon emissions.
2. How does it work?
  - a. A heat pump works by gathering and transferring heat energy from the outside air. Like an air conditioner or a refrigerator, heat pumps use electricity to move heat from one place to another. Heat pumps are special because they can provide heating, in addition to cooling, by running in reverse.
  - b. There are two general types of heat pumps: "centrally ducted" and "ductless," (or "mini-splits"). A ducted system uses the existing ductwork in your home to move heated and cooled air. For homes that do not have ductwork, ductless/mini-split systems can heat a portion or all of your home, with options to provide zonal control for both heating and cooling.
3. How does it work in our climate? How low can it deliver heat in cold weather?
  - a. Even on the most frigid Minnesota days, heat is still present in the outside air. This means a heat pump with cold-climate specifications can efficiently extract heat from the outside even when the air temperature is as cold as 5°F. Cold-climate heat pumps can still extract heat from the outside air all the way down to -13°F, though efficiency decreases at lower temperatures.
4. What does it look like? Sound like?





### 7. How do I find a contractor?

a. Connect with your utility for a list of qualified contractors in your area. The ASHP Collaborative has also worked with a number of contractors for research projects—the following contractors would be familiar with utilizing ASHP technology:

**Angell Aire**  
952-746-5200  
angellaire@angellaire.com  
Greater Twin Cities Metro

**Lofgren Heating**  
952-431-5811  
lofgrenhtg@lofgrenheating-ac.com  
Twin Cities Metro

**Centraire**  
952-941-1044  
btiwari@centraire.com  
Greater Twin Cities Metro

**Metro Heating and Cooling**  
651-294-7798  
Greater Twin Cities area

**Residential Heating & Air Conditioning**  
612-440-4260  
Greater Twin Cities area

**Eclipse**  
eclipseeands@gmail.com  
218-879-8802  
MN statewide

**Naylor Heating and Refrigeration**  
218-444-4328  
office@naylorhvac.com  
Bemidji area

**Town & Country Heating & AC**  
218-483-1225  
jim@tchtg.com  
Northwestern MN area

**MSP Heating and Cooling**  
612-963-9691  
NickJBender@mac.com  
Twin Cities Metro

## Cold-Climate ASHP in Kenyon, MN

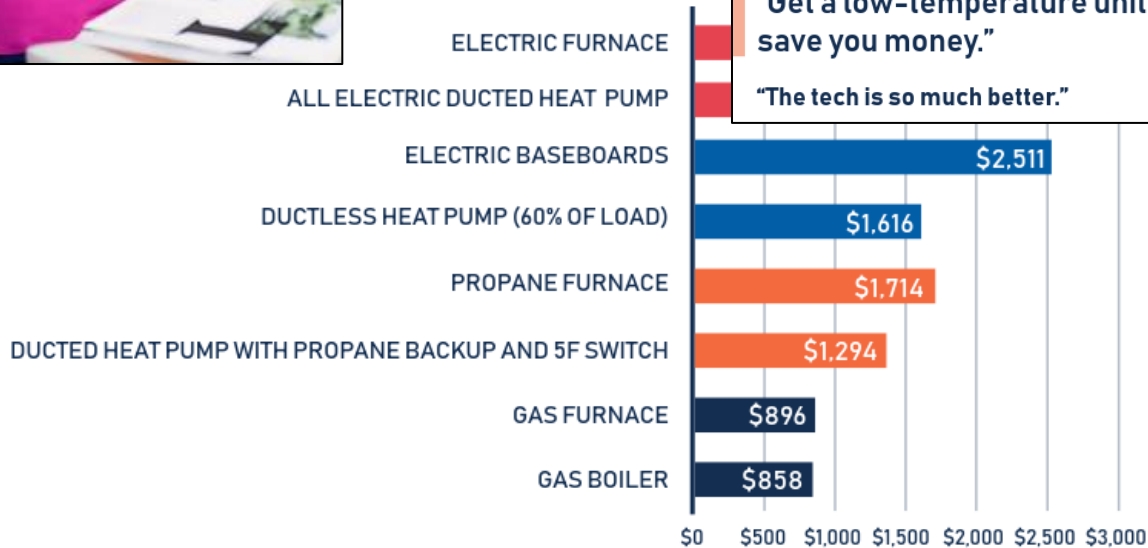


Gene Bang is someone who keeps careful track of his expenses. Over the 2020–2021 winter, he noticed his propane prices had nearly tripled. However, what normally might have been a concerning jump didn't bother Bang.

This season, Bang had another option for heating his Kenyon, MN, home — a high-efficiency air source heat pump. Unlike propane prices, his electricity rates were reduced over the winter. Bang also took advantage of the off-peak usage pricing offered by his electric cooperative, Goodhue County Co-Op, resulting in even lower electricity rates. "I use a lot less propane now!" says Bang.

**"Get a low-temperature unit," Bang says. "It's going to save you money."**

**"The tech is so much better."**

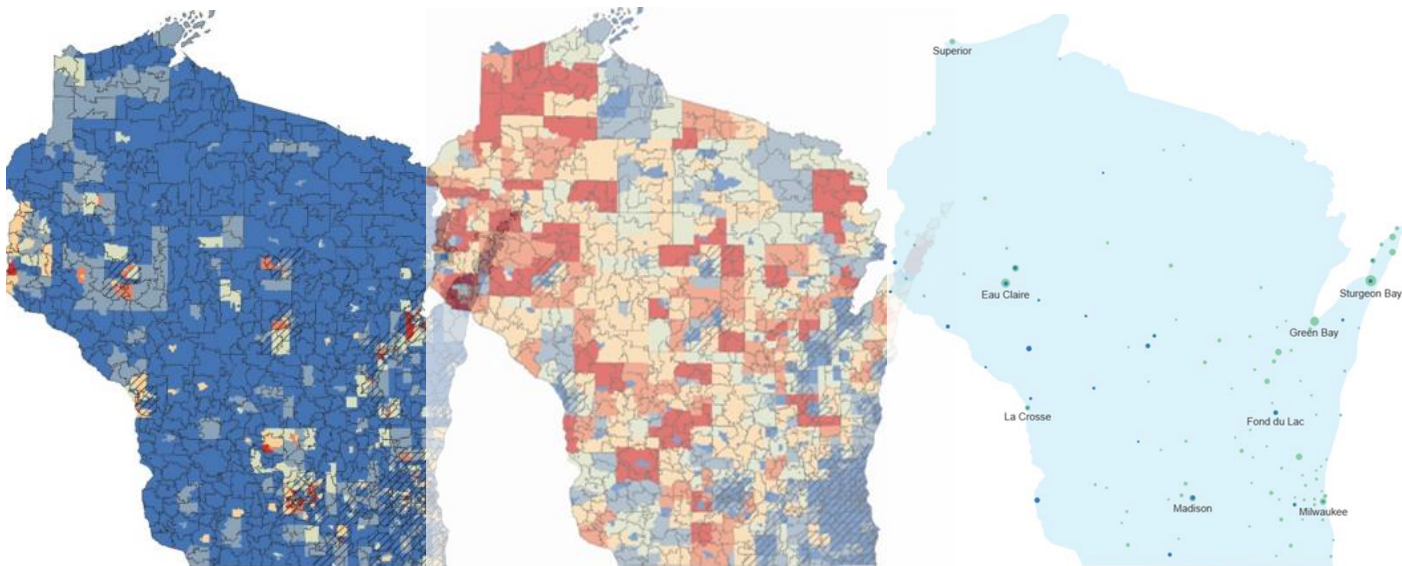


### 8. Are rebates, financing, and tax

# • Explore utility partnerships for statewide growth

Rural / statewide collaboration would result in:

- More widespread HVAC contractor training and outreach
- Broader distributor/manufacturer engagement to discuss stocking practices and coordinate promotions/marketing
- Further developing a quality installer list to provide customers
- Ultimately greater participation heat pump programs (overlapping contractor territories)



# ❖ Create a multifamily-specific offering

- Unique challenges that call for specific approach
- Majority of multifamily is income eligible, and large portion electric heat

## Comprehensive multifamily offering

Ensure Focus' energy advisors assist with the following:

Assist with completing rebate paperwork

Facilitate learning between the contractor and O&M staff

Coordinate building envelope improvements to optimize ASHP performance

Promote/coordinate other financing mechanisms, such as PACE

Engage customers more — introduce incentives; meetings around critical decision points, etc.

Develop ASHP O&M educational materials for building/facility personnel

Coordinate with building operator programs for ASHP training and certification – could be integrated with the Building Operator Certification (BOC) program

Incorporate a design incentive for a 20% complete design drawing

Provide a higher rebate for ccASHPs, as well as for electric resistance applications



# DISCUSSION

Comments / Questions?



# THANK YOU!

**Contact:**

Carl Nelson – [cnelson@mncee.org](mailto:cnelson@mncee.org)

Isaac Smith – [ismith@mncee.org](mailto:ismith@mncee.org)

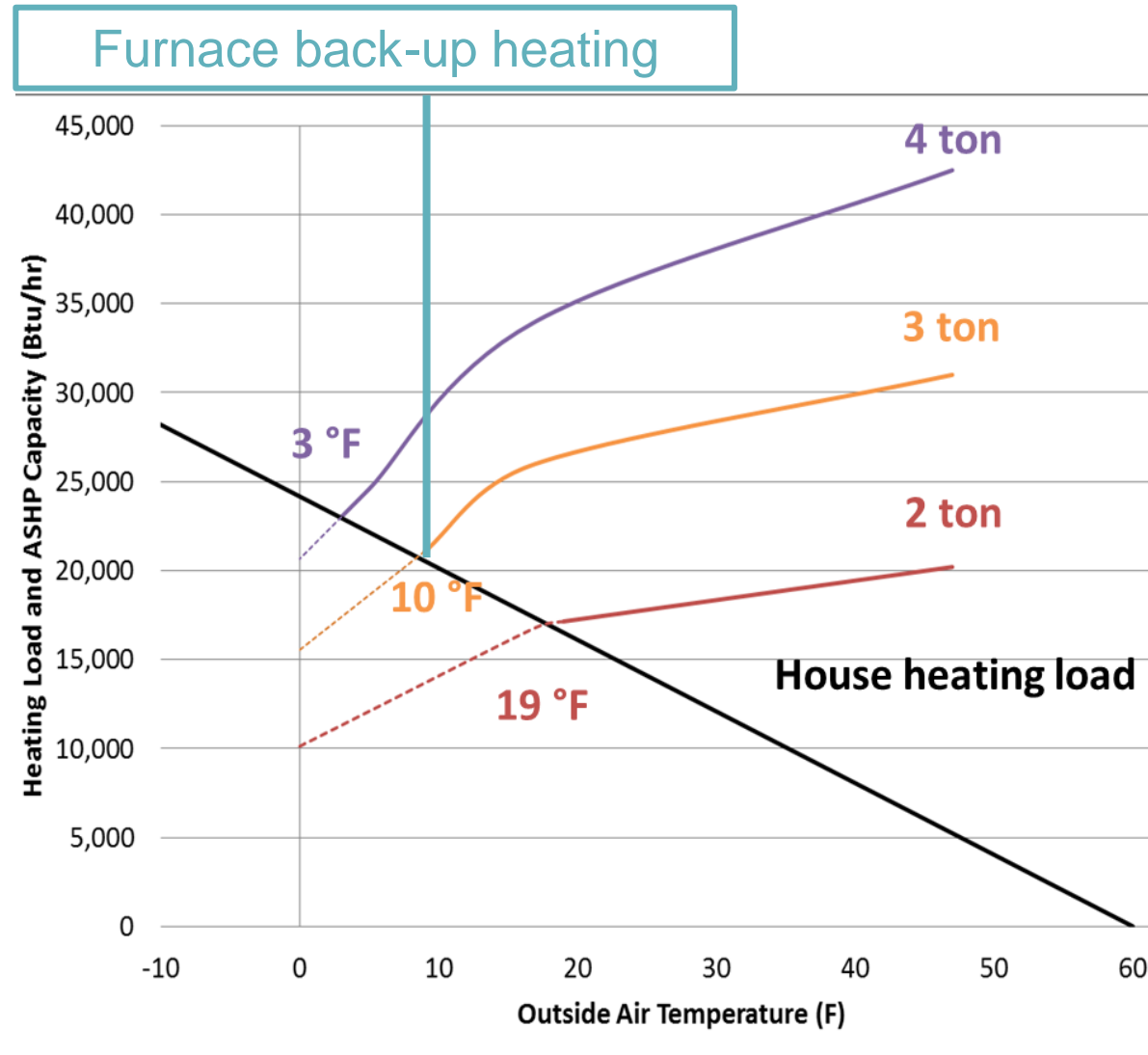


Center for Energy and Environment

# Appendices

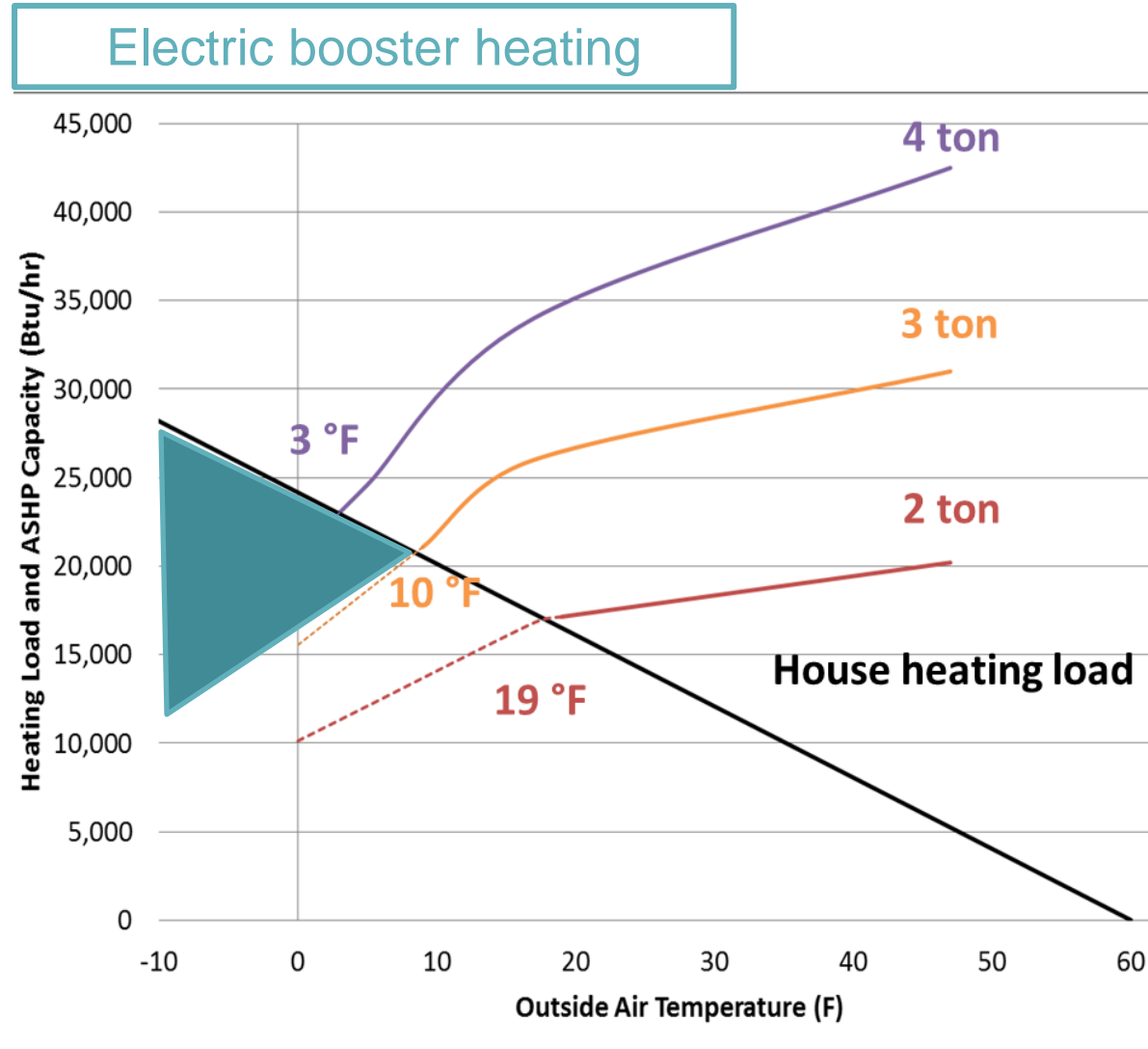
# • Design & sizing for ducted systems

- Trade-offs between HP size and fraction of heating load meet
- Rule of thumb: Sizing for heating increases HP size by 1-ton over sizing for cooling
- Percent heating load met by ASHP:
  - 4 ton ~ 86%**
  - 3 ton ~ 77%**
  - 2 ton ~ 60%**



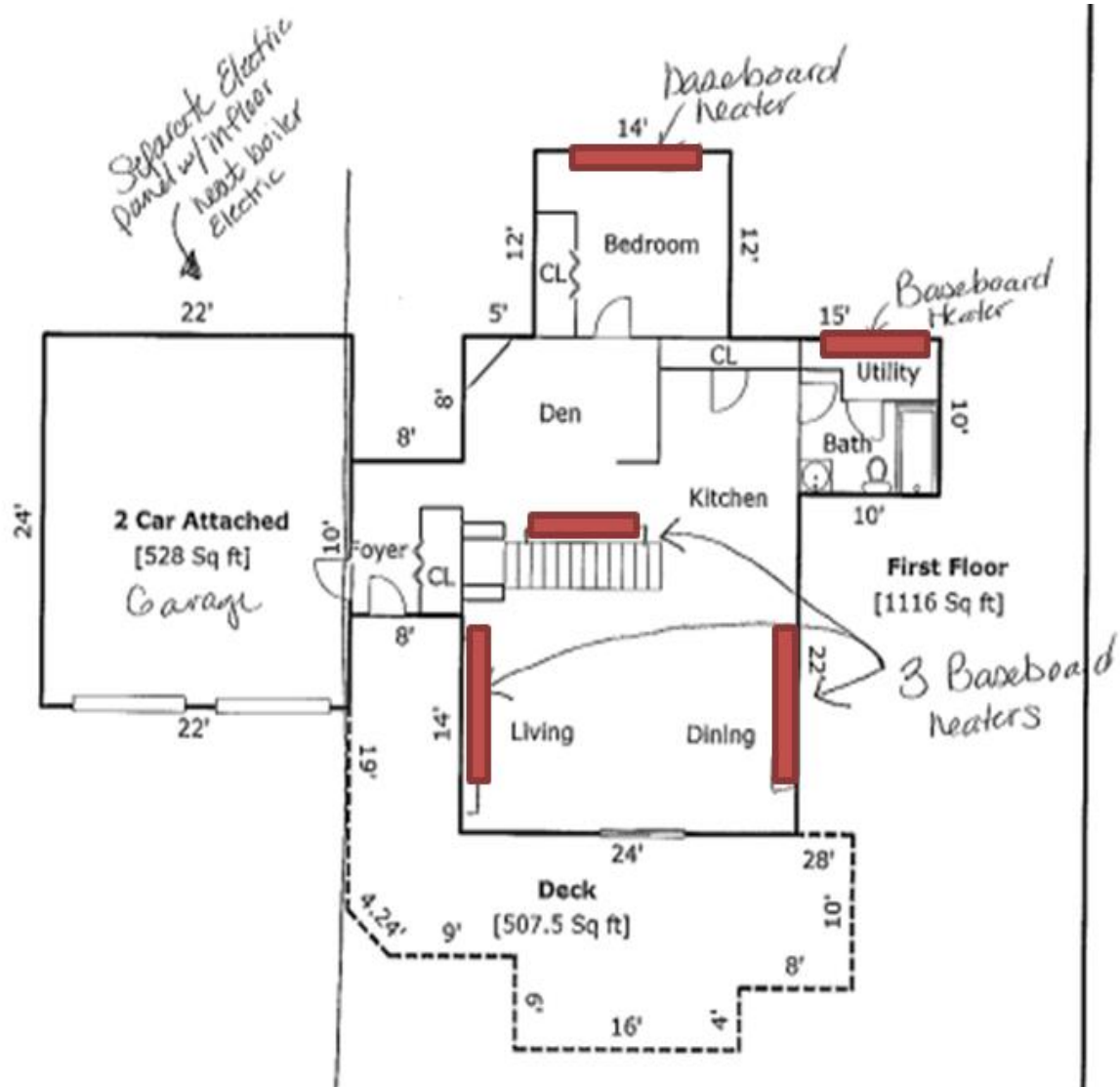
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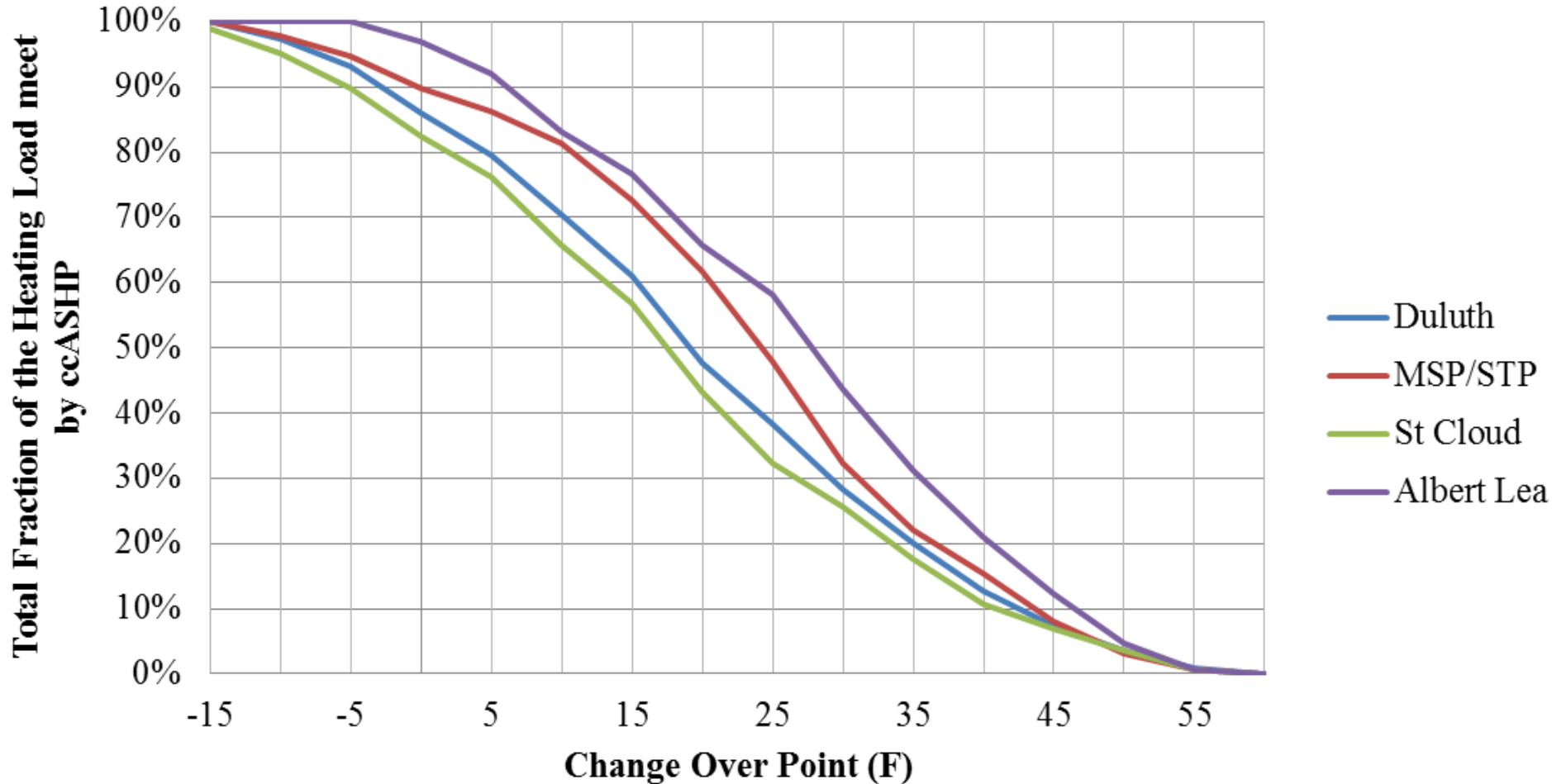




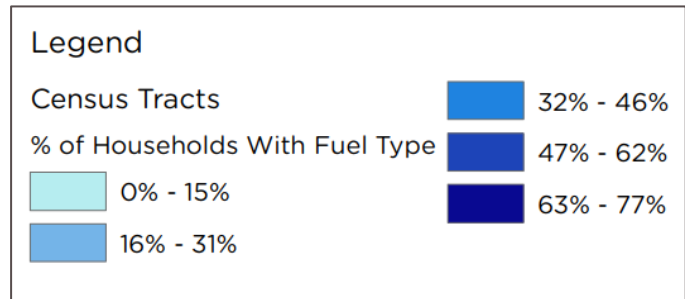
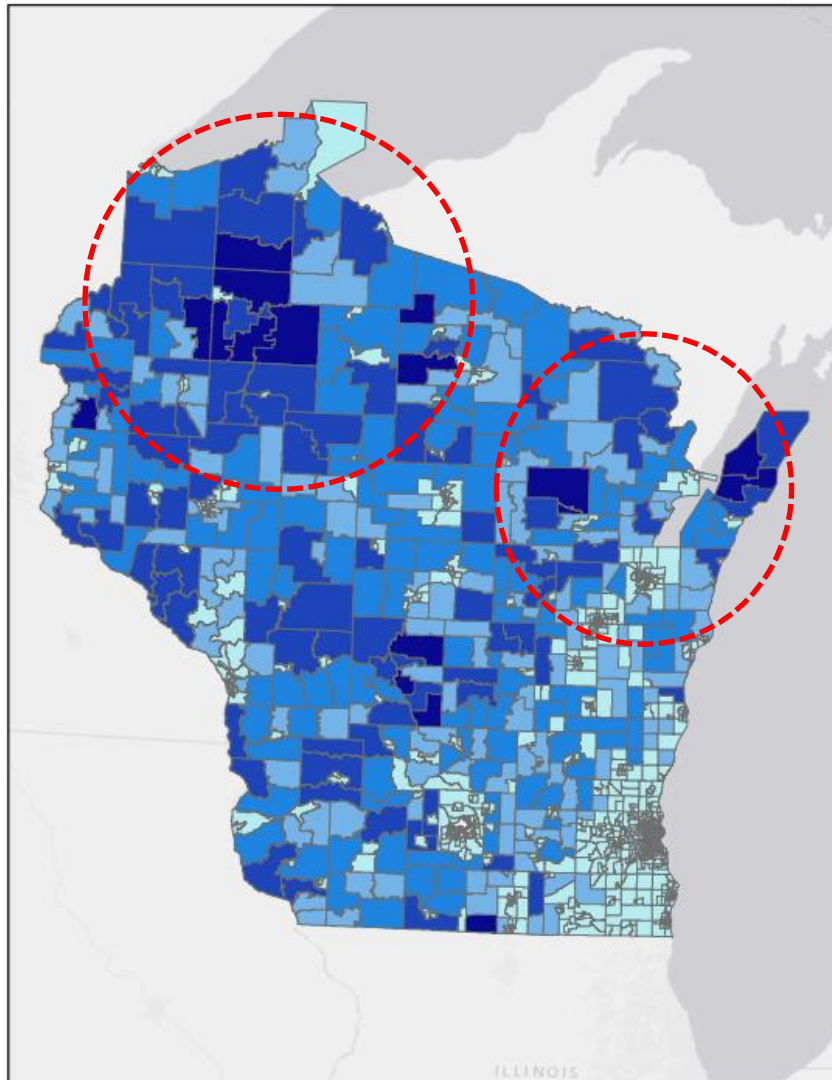
# •• Ductless: install locations



# Impact of switchover temperature



# Market research – propane heat in Wisconsin



## •• **Electric heating criteria**

- Number of records: total & heating
- Goodness of fit
- Change over point and intercepts
- Usage criteria
  - Design heating load,
  - Annual use,
  - Relative use (heating vs. shoulder vs. cooling peaks)

# •• Contractor survey – scope

## Contractors Surveyed

23 surveys total

11 online survey  
12 phone call

## Locations Represented

4 in/near  
Milwaukee and 1  
in Madison

La Crosse and Eau  
Claire represented

2 in Northwest /  
Lake Superior & 1  
by Lake Michigan

Beloit, Sheboygan,  
SE and SW

## Employee titles represented

11 Presidents /  
Owners

9 Sales /  
Heating  
Specialists

3 Office  
Managers

# •• Contractor and customer research

- **HVAC contractors**

- Lists from Midstream and Residential TAS
- Contractor interviews – 23 contractors
- Contractor focus group – 10 contractors

- **Multifamily customers**

- Lists from industry contacts
- Property and management types
- Interviews – number?
- Two focus groups

## •• Contractor survey findings – details

**Finding:** many contractors not actively promoting heat pumps for the broader applications they can fit

- Most contractors are installing heat pumps into “bonus rooms,” garages, singular rooms with electric heat, no A/C
- Almost exclusively installing ductless heat pumps
- Many think that the rebates do not have a big impact

**Finding:** Many noted electric prices as compared with affordable natural gas and sometimes affordable propane as a main barrier

- Perception of ROI on equipment price is a deterrent