Getting the Most out of Air Source Heat Pumps in our Cold Climate

Enabling Contractor Success

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COMMERCE DEPARTMENT

This training was developed by The Minnesota Air Source Heat Pump (MN ASHP) Collaborative

The MN ASHP Collaborative is a statewide initiative dedicated to advancing the adoption of energy-efficient air source heat pumps.

Leading the Charge –

Why Minnesota is **transforming the HVAC market** with air source heat pumps

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Why are utilities focused on heat pump technology?

Utilities and the state want energy savings for their goals.

Heat pump technology offers a strong solution

- Enormous energy saving potential
- Demonstrated cold-climate performance
- Valuable customer benefits
- Dual fuel applications reduce peak demand

Our focus is on dual fuel applications

- Benefits for natural gas customers
  - Fuel choice flexibility

- Benefits for delivered fuel customers
  - Operational cost savings

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What is the trend in the market?

- Over half of surveyed HVAC contractors saw an increase in ducted heat pump sales in the last few years.

- Over 70% of surveyed HVAC contractors expected ducted heat pump sales to increase over the next 5 years.

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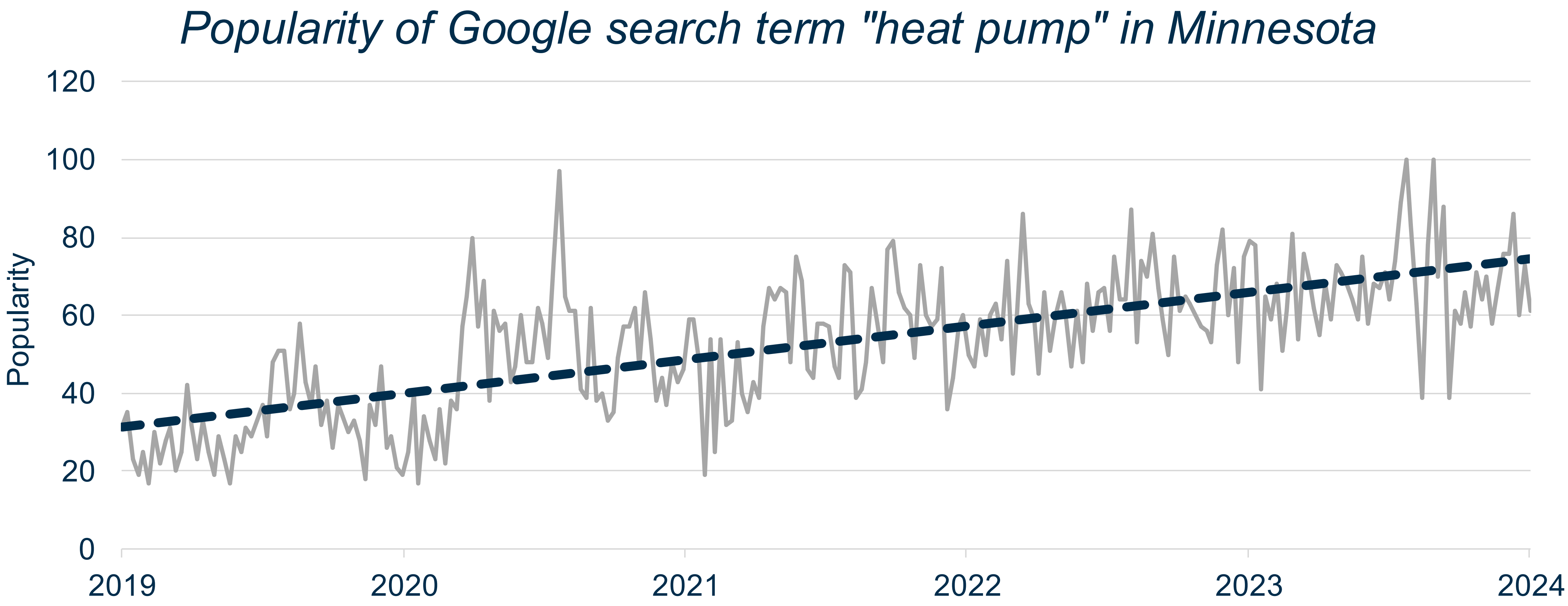
Heat pumps are already trending



Source: https://trends.google.com/trends/explore?date=today%205-y&geo=US-MN&q=heat%20pump

Stay on the leading edge!

Near term value:

- Practical tips to properly design and configure equipment to meet customer expectations
- Differentiation for your business

Longer term value:

- Higher margins for heat pump installs
- Happier, more comfortable customers

This training is better with you! Share your expertise and ask questions for everyone to get the best experience.

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What is the value for your customers?

- **Highly efficient** technology for home heating and cooling
- Stackable rebates and financing options to **offset installation costs**
- Favorable electric rates to **reduce operational costs**
- **Fully replaces the air conditioner** and pairable with auxiliary heat for year-round comfort

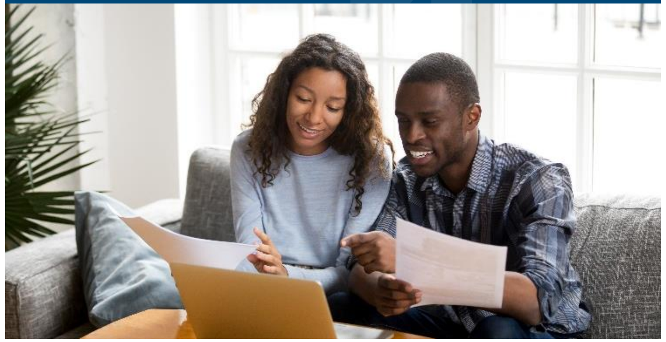



Getting ready for a future with more heat pumps

Dual fuel air source heat pumps are **the future of HVAC in Minnesota**

Year-round comfort for customers

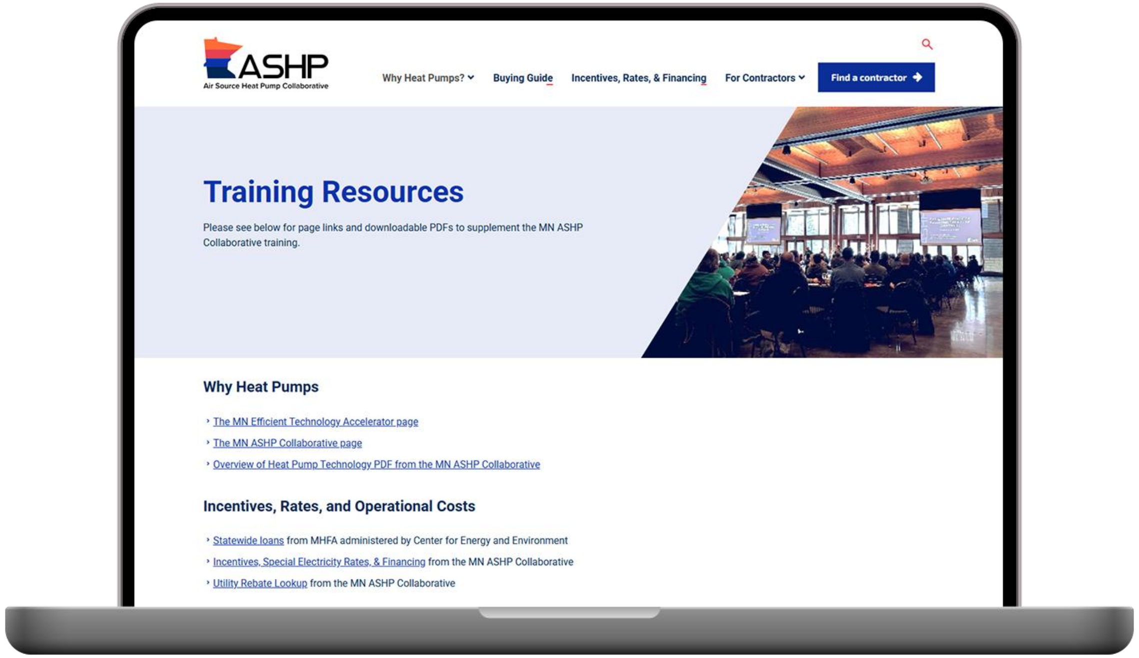
Economic solutions for homes with delivered fuels



Practical upgrade for homes with natural gas

All links and resources from this training are stored in the Training Resources page.

Scan the QR code to visit!



www.mnashp.org/trainingresources

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Incentive Sources & Minimizing Operational Costs

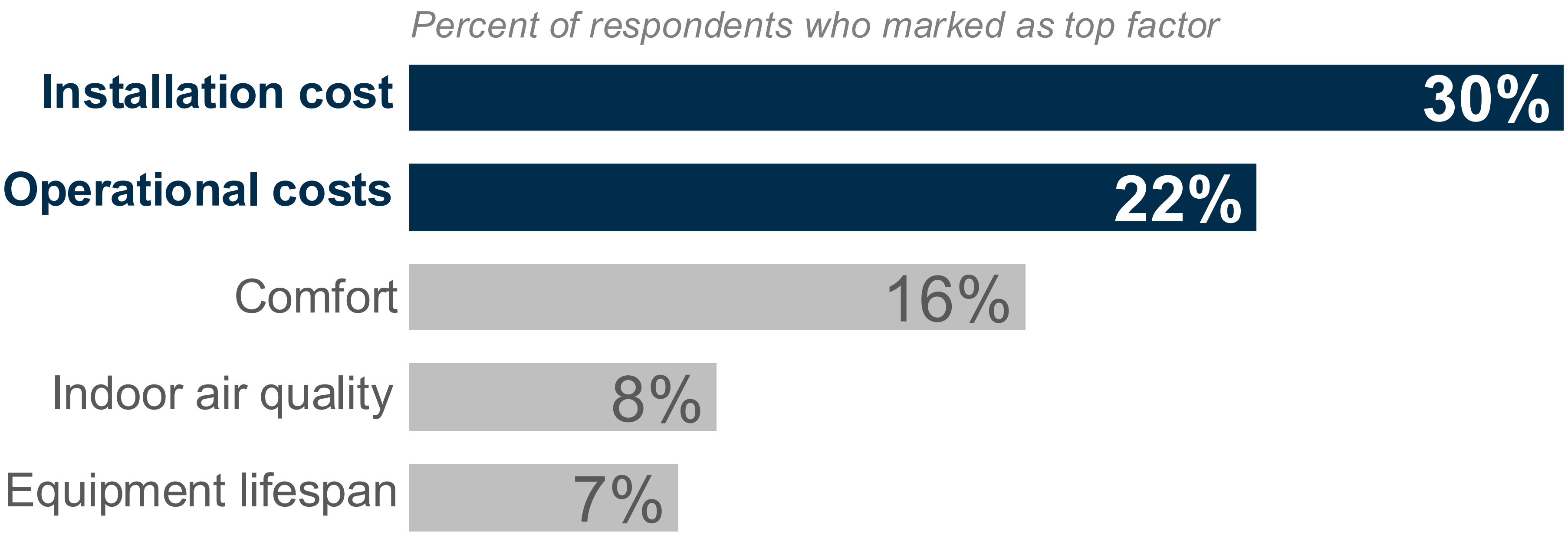
Learning objectives

By the end of the module, you will be able to:

- Summarize available utility rebates and rates, local programs, and financing for customers
- Refer customers to information about state and federal incentives
- Use tools to estimate annual energy costs and runtime of different heat pump applications
- Describe how customers can access and stack available incentives

Costs are the most important factor for Minnesota homeowners

The top 5 factors for homeowners when choosing a new heating system, according to thousands of Minnesotans and Midwesterners:



CEE, Behavioral Insights Team (2024). *Messaging strategies to drive heat pump adoption in Minnesota*

What incentives are available?

Available for most Minnesotans:

- Utility rebates
- Utility special electric rates
- Federal tax credits
- Financing

Available in specific cities:

- Local rebate match programs

Available later:

- State rebates
- Federal rebates

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Statewide loans through the Minnesota Housing Finance Agency

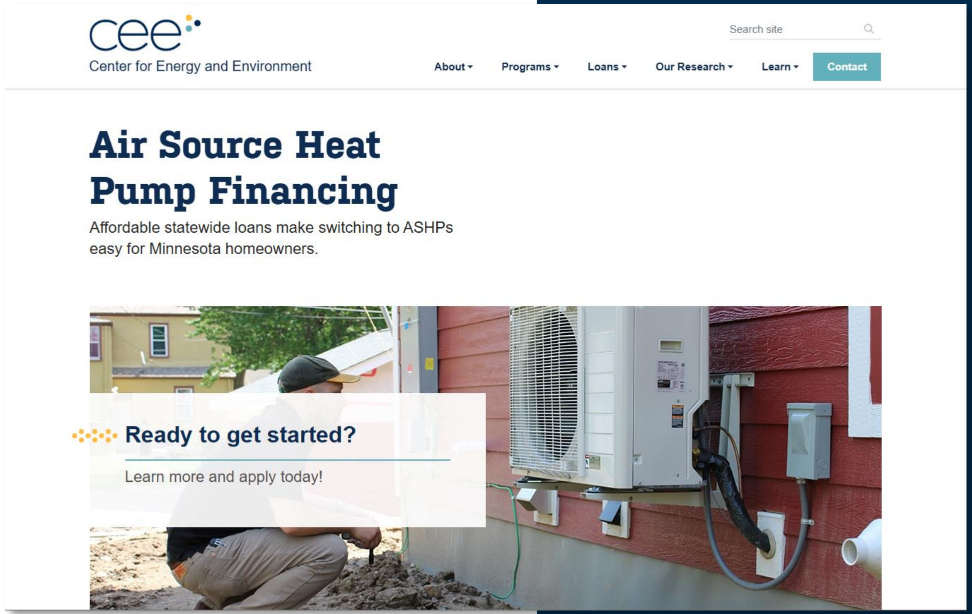
Loans administered by CEE

Home Energy Loans- Tailored loans for energy efficiency upgrades like heat pumps

Fix Up Fund- Flexible financing for home improvements, including heat pumps

https://www.mncee.org/ashp

This link is also stored in the **Training Resources** page.



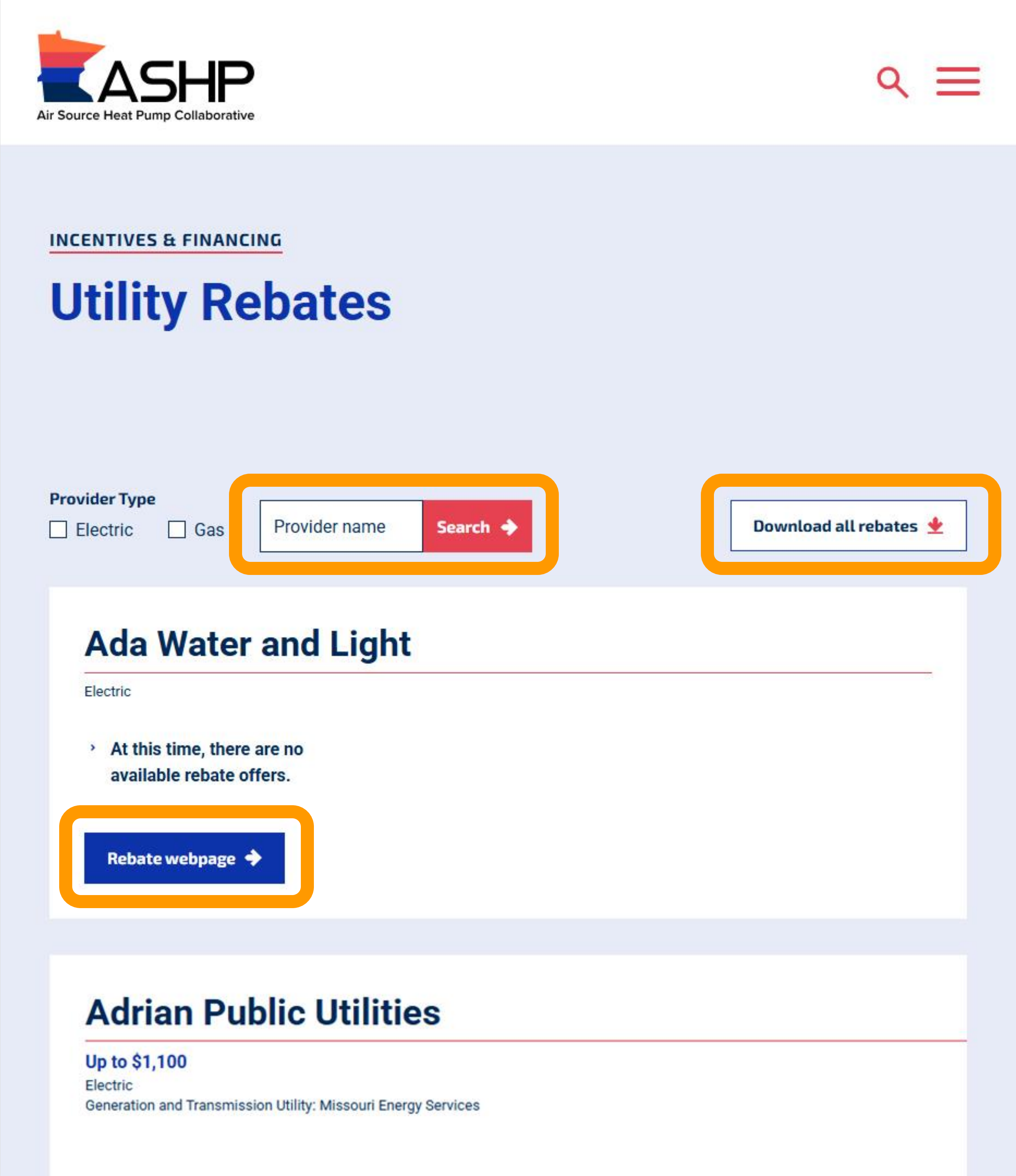
Find utility rebates through the utility rebate tool

Includes:

- Rebates by application type
- Minimum efficiency specs.
- Link to utility rebate page

Searchable by:

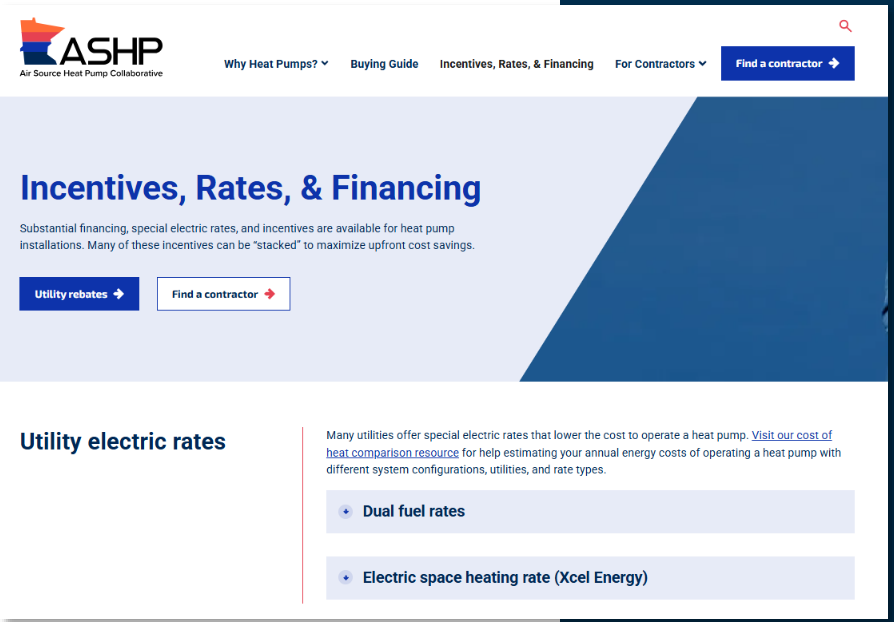
- Alphabetical list
- Search field by name
- Downloadable spreadsheet



Incentives and financing information is available on our website.

ashp.org/incentives-financing

This link is also stored in the **Training Resources** page.



Use the Cost of Heat Comparison to compare relative differences between applications

Customizable by:

- Utility
- Fuel type
- Electric rate

Scenarios:

- Baseline
- Dual fuel
- All-electric

Annual heat energy costs

The following chart can help contractors and homeowners predict annual energy costs with a cold-climate air source heat pump (ccASHP). The chart compares two ccASHP system types commonly used in Minnesota with a baseline furnace and air conditioner (AC):

- **Baseline System** – Furnace provides all heating and AC provides all cooling.
- **Dual Fuel / Hybrid System** – ccASHP provides all cooling and all heating down to the specified switchover temperature, at which point the natural gas/propane furnace is used for heating.
- **All-Electric System –** ccASHP provides all cooling and heating, with electric resistance heat used to meet any remaining heating load.

This tool models an ASHP archetype intended to represent an average cold climate air source heat pump (ccASHP) qualifying for the 2024 25C Energy Efficient Home Improvement federal tax credit.

Electric Utility/Region	Fuel Type	Electric Rate
Xcel Energy (CenterPoint Energy gas)	Natural Gas	Standard

View on Tableau Public   Share

Using the Chart

Get started by selecting the electric utility/region, fuel type, and electric rate that apply to the home's location and system type. Details on rates, energy use, and energy savings can be viewed by hovering a cursor over the orange heating or blue cooling portion of each bar.

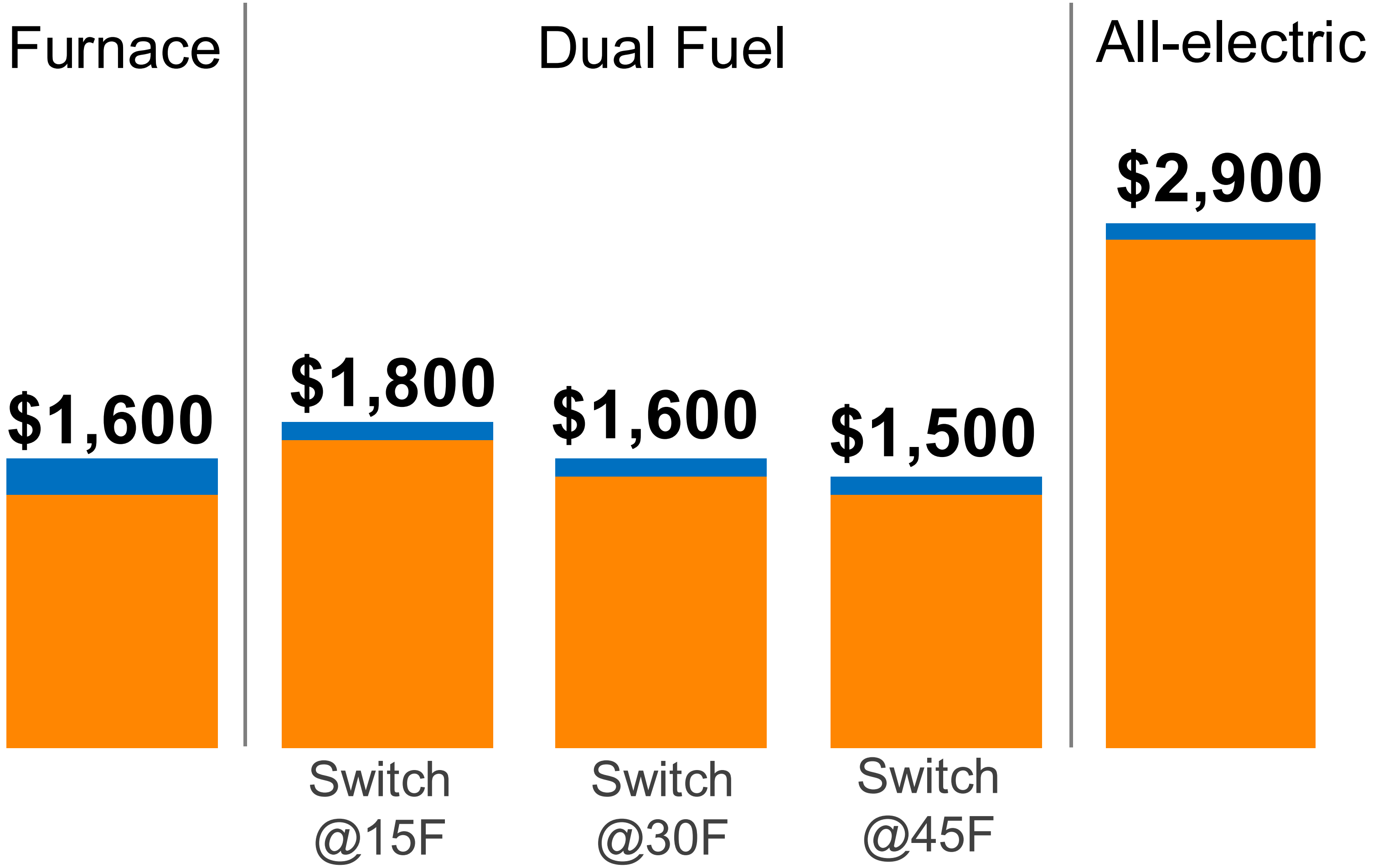
This chart is updated annually. The current rates shown were last updated November 2024. .

Disclaimer

The potential savings values listed here are estimates for an example home. These estimates are generalized results from field research and are intended to provide relative performance information to help rank options and make high-level decisions. These estimates should only be used when comparing scenarios for planning

Annual heating & cooling cost comparison

(natural gas, standard electric rate)



For natural gas customers:

- Most economical to **size for cooling load**
- ASHP allows future utility bill flexibility

Values rounded for easier comparison. Rates used last updated November 2024.

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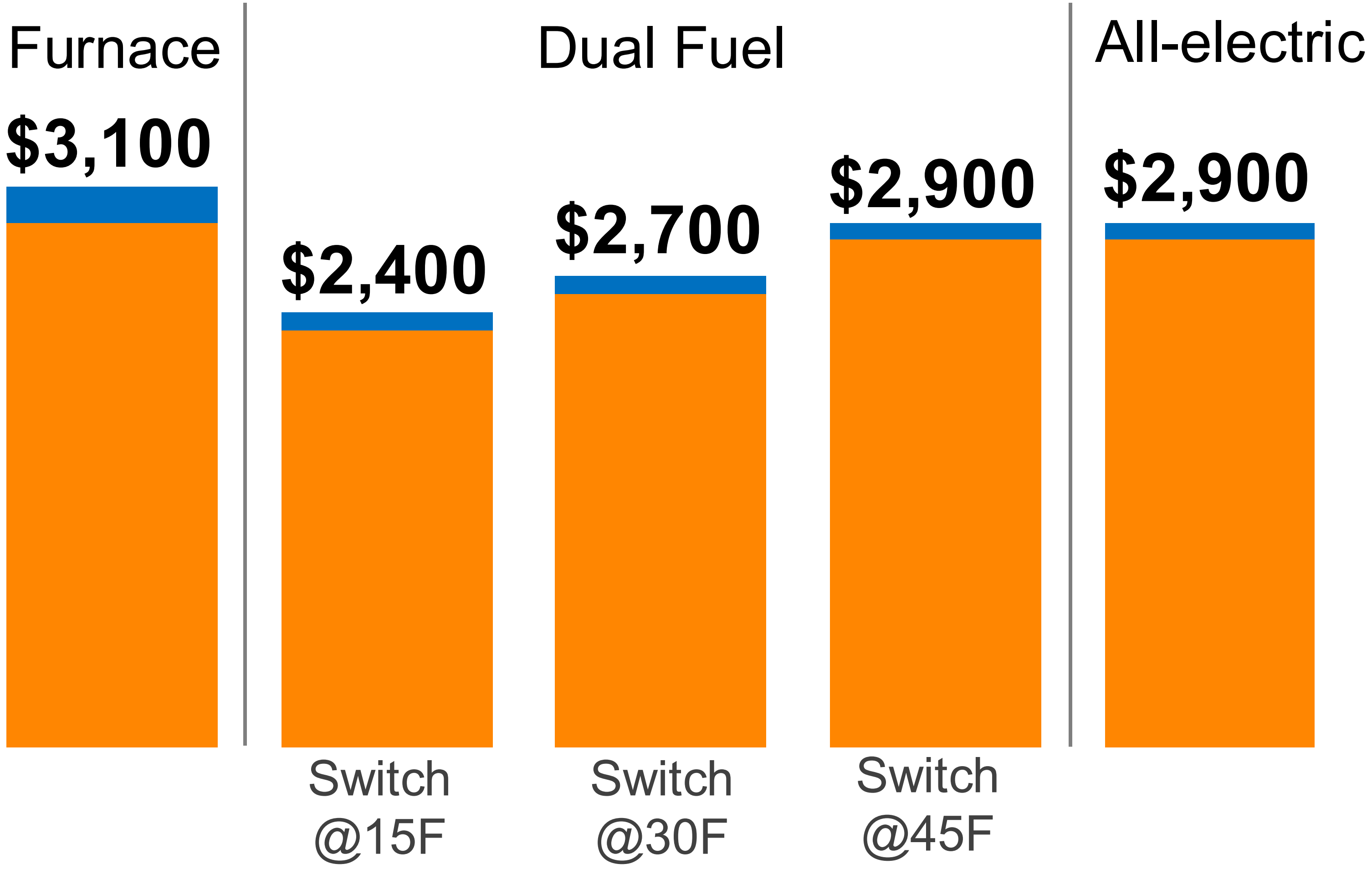
Annual heating & cooling cost comparison

(propane, standard electric rate)



For propane customers:

- Most economical to **size for heating load**
- Choose a variable-capacity system
- All-electric systems more viable

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Want the details? Check out the Additional notes just below the chart

heating or blue cooling portion of each bar.

This chart is updated annually. The current rates shown were last updated November 2024. .

Disclaimer

The potential savings values listed here are estimates for an example home. These estimates are generalized results from field research and are intended to provide relative performance information to help rank options and make high-level decisions. These estimates should only be used when comparing scenarios for planning purposes. In general, hybrid-heat systems offer the lowest operational costs for both propane and natural gas customers, while all-electric systems may increase bills for natural gas customers. Dual fuel or off-peak electric rate options, where available, can decrease costs even further for systems with both propane and natural gas secondary heat.

Additional notes

- Rate and utility assumptions
- Technical assumptions

Heat pump operating hours

The chart below estimates the number of operating hours for a heat pump in both heating and cooling mode. The number above each bar shows the number of hours in the specified temperature range, and the table below the chart summarizes the results. The two left columns show the number and percentage of operating hours during the heating season, split between the heat pump and the furnace. The right column shows the number of operating hours for a heat pump in cooling mode. As the chart indicates, 100% of cooling hours can be served by a heat pump.

Location: Minneapolis

User Defined Switchover Tempera...: 30

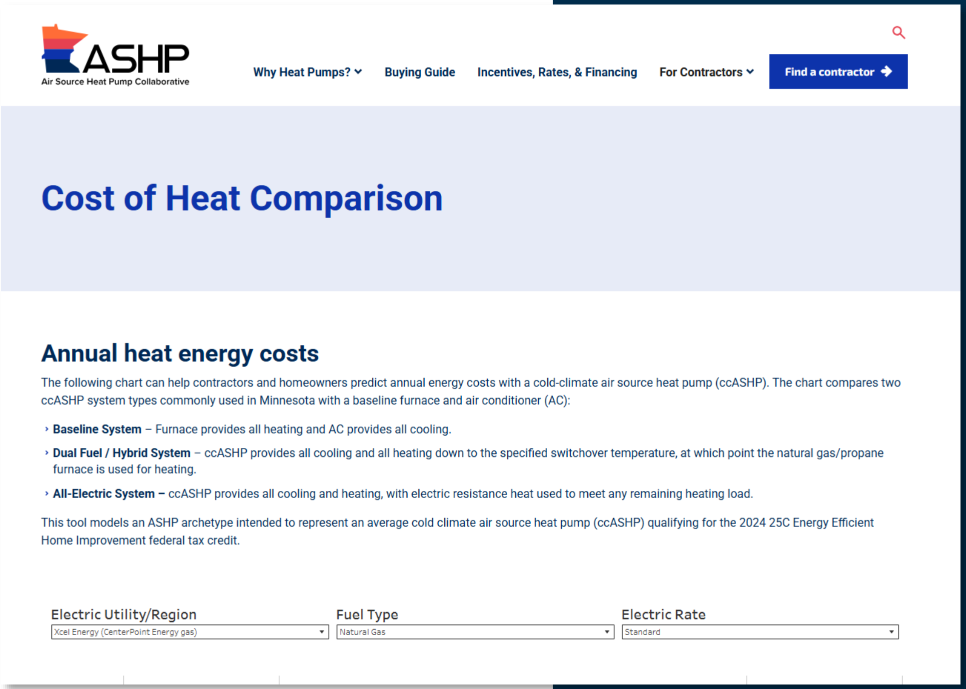
- Furnace Heating Hours
- ASHP Heating Hours
- ASHP Cooling Hours

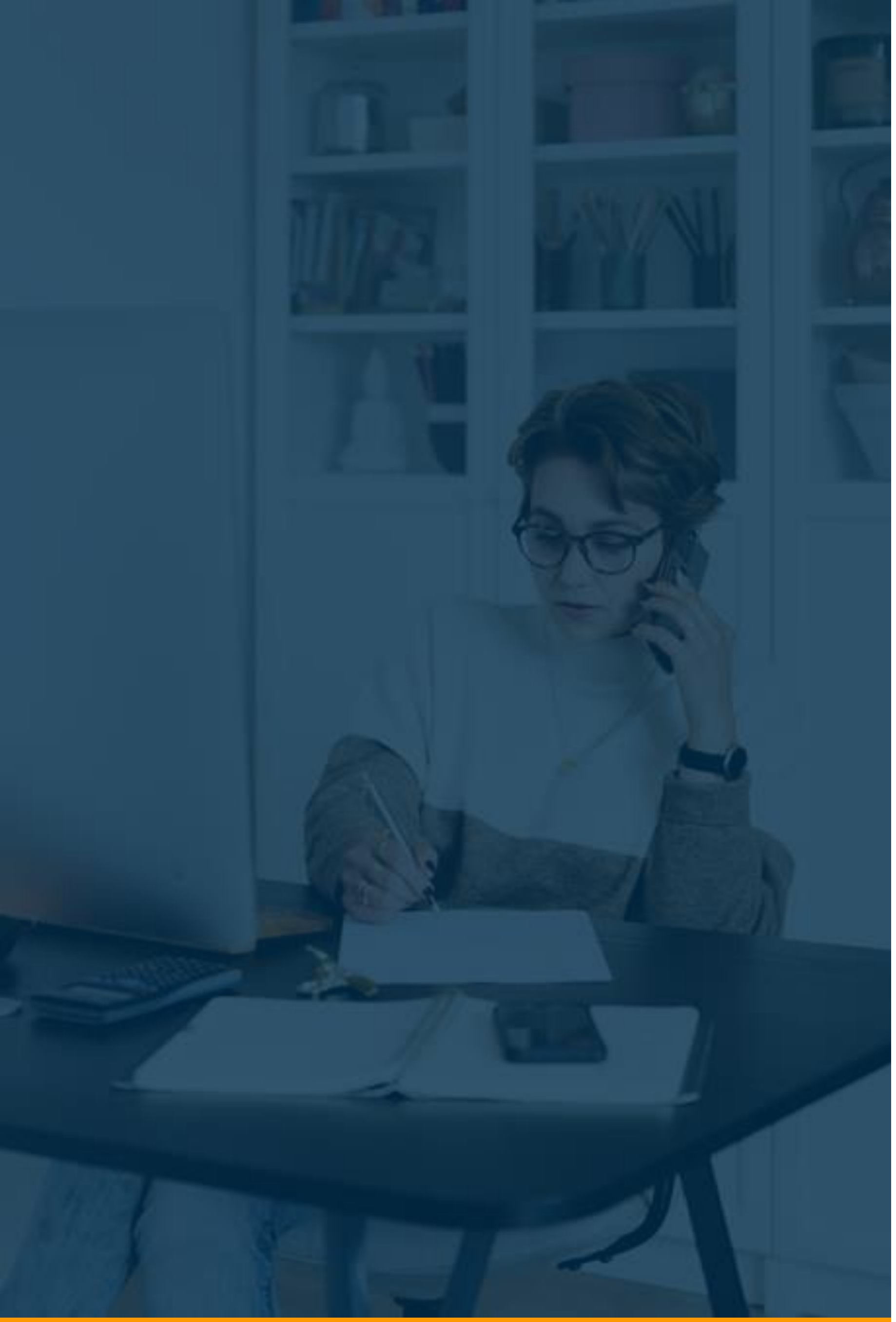
Temperature (°F)

The link to the Cost of Heat Comparison

mnashp.org/cost-heat-comparison

This link is also stored in the **Training Resources** page.





Are there special rates available? Make sure your customers know about them!

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The impact of rates

AC & Natural Gas Furnace*	**standard rates** ($0.14/kWh)	**$1,600**

Cold climate ASHP & Natural Gas Furnace (15°F switchover)	**standard rates** ($0.14/kWh)	**$1,800**
	dual fuel rate ($0.07/kWh)	**$1,200**

*$1.06/therm

Specifications are for standard AC, high-efficiency furnace, and mid-level ccASHP.
Values rounded for easier comparison. Rates used last updated November 2024.

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The impact of rates

AC & Propane Furnace*	**standard rates** ($0.14/kWh)	**$3,100**
Cold climate ASHP & Propane Furnace (15°F switchover)	**standard rates** ($0.14/kWh)	**$2,400**
	dual fuel rate ($0.07/kWh)	**$1,900**

*$2.03/gal

Specifications are for standard AC, high-efficiency furnace, and mid-level ccASHP.
Values rounded for easier comparison. Rates used last updated November 2024.

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Access dual fuel rates with load management compatible units

Refer to our Compatible Product List for ASHP models verified to respond to radio-controlled utility load control programs.*

Listed equipment can be:

- Connected to interrupt class 1 (line voltage) wiring**
- Operated through third party wiring controls kits
- Communicating equipment with wiring instructions for two-wire relay-based load management

***Disclaimer:** This information is provided for general informational purposes only and should not be considered as professional electrical advice. Electrical wiring can be dangerous and should only be performed by qualified and licensed electricians. Improper wiring can lead to fire, electric shock, and other serious hazards. Always consult with a qualified electrician before undertaking any electrical work. The author and publisher assume no responsibility for any injuries, damages, or losses resulting from the use or misuse of this information.

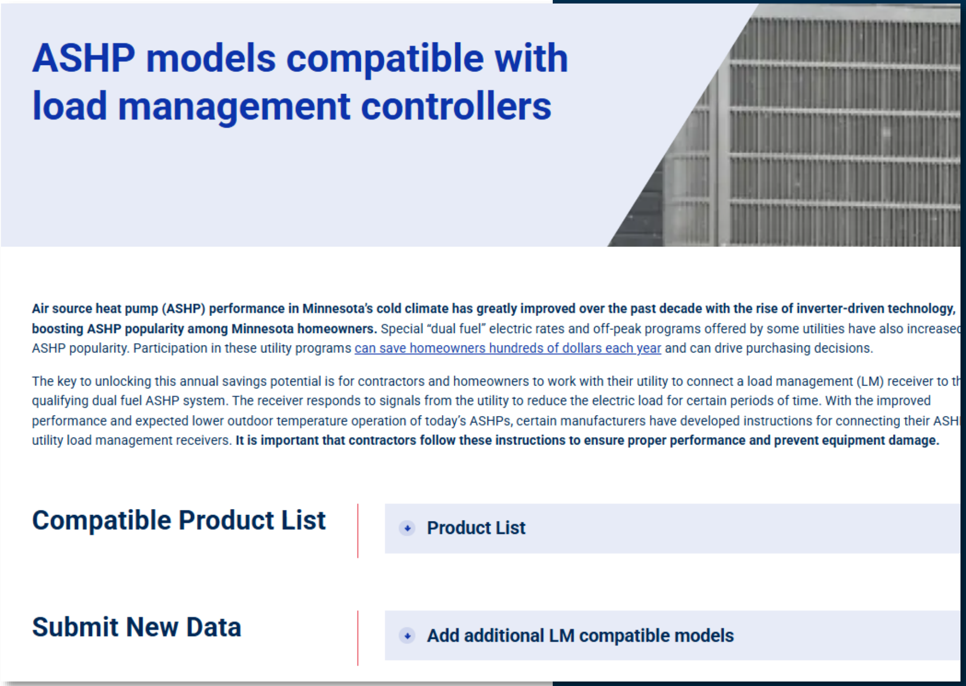
**Refer to manufacturer for approved control method, not all units can be controlled with line (Class 1) and/or low voltage (Class 2) control interruption

INSERT YOUR LOGO

Find the Compatible Product Lists and wiring resources online

mnashp.org/ashp-models-compatible-load-management-controllers

This link is also stored in the **Training Resources** page.

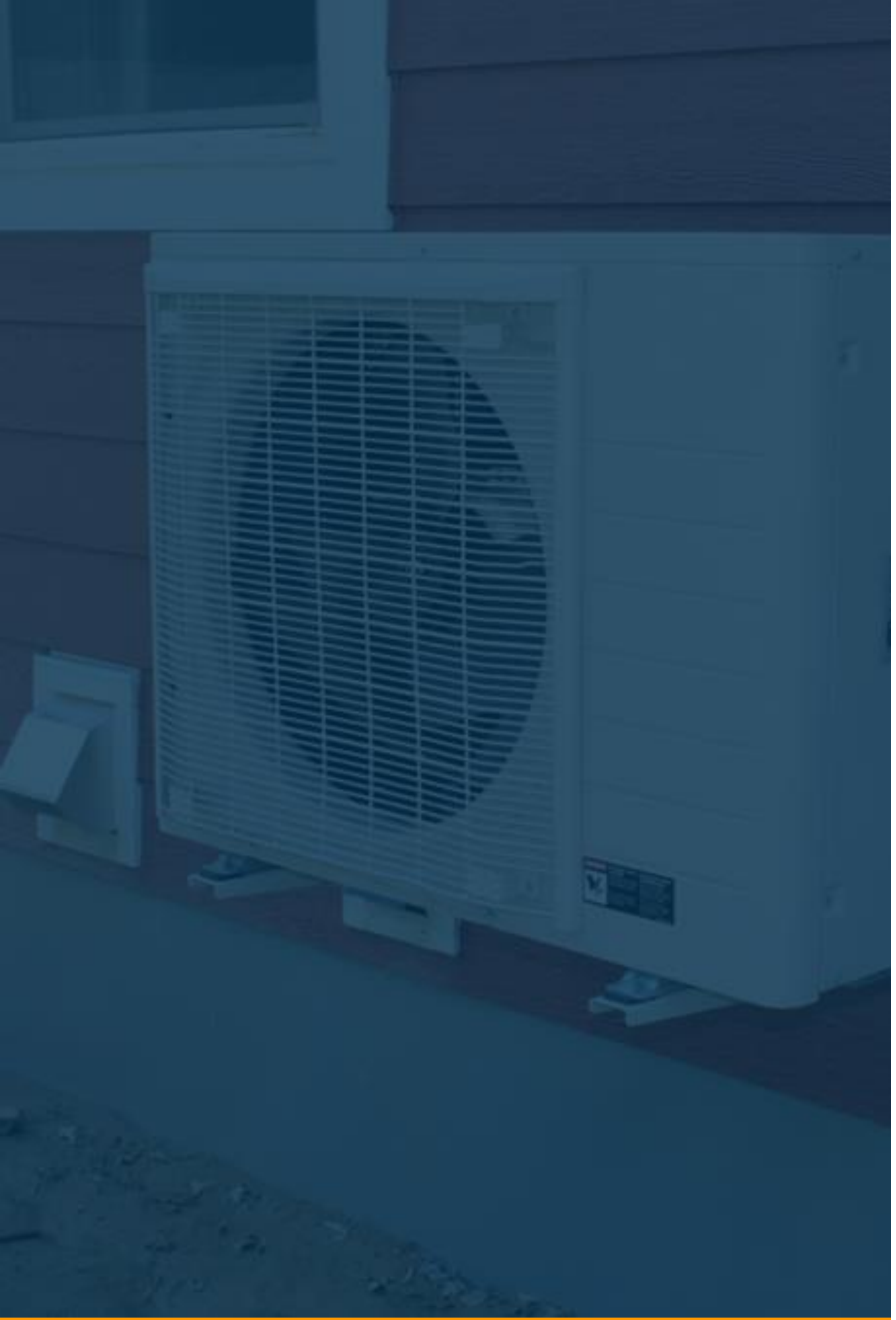

ASHP models compatible with load management controllers

Air source heat pump (ASHP) performance in Minnesota's cold climate has greatly improved over the past decade with the rise of inverter-driven technology, boosting ASHP popularity among Minnesota homeowners. Special "dual fuel" electric rates and off-peak programs offered by some utilities have also increased ASHP popularity. Participation in these utility programs can save homeowners hundreds of dollars each year and can drive purchasing decisions.

The key to unlocking this annual savings potential is for contractors and homeowners to work with their utility to connect a load management (LM) receiver to th qualifying dual fuel ASHP system. The receiver responds to signals from the utility to reduce the electric load for certain periods of time. With the improved performance and expected lower outdoor temperature operation of today's ASHPs, certain manufacturers have developed instructions for connecting their ASH utility load management receivers. **It is important that contractors follow these instructions to ensure proper performance and prevent equipment damage.**

Compatible Product List — Product List

Submit New Data — Add additional LM compatible models



Charts of heat pump operating hours

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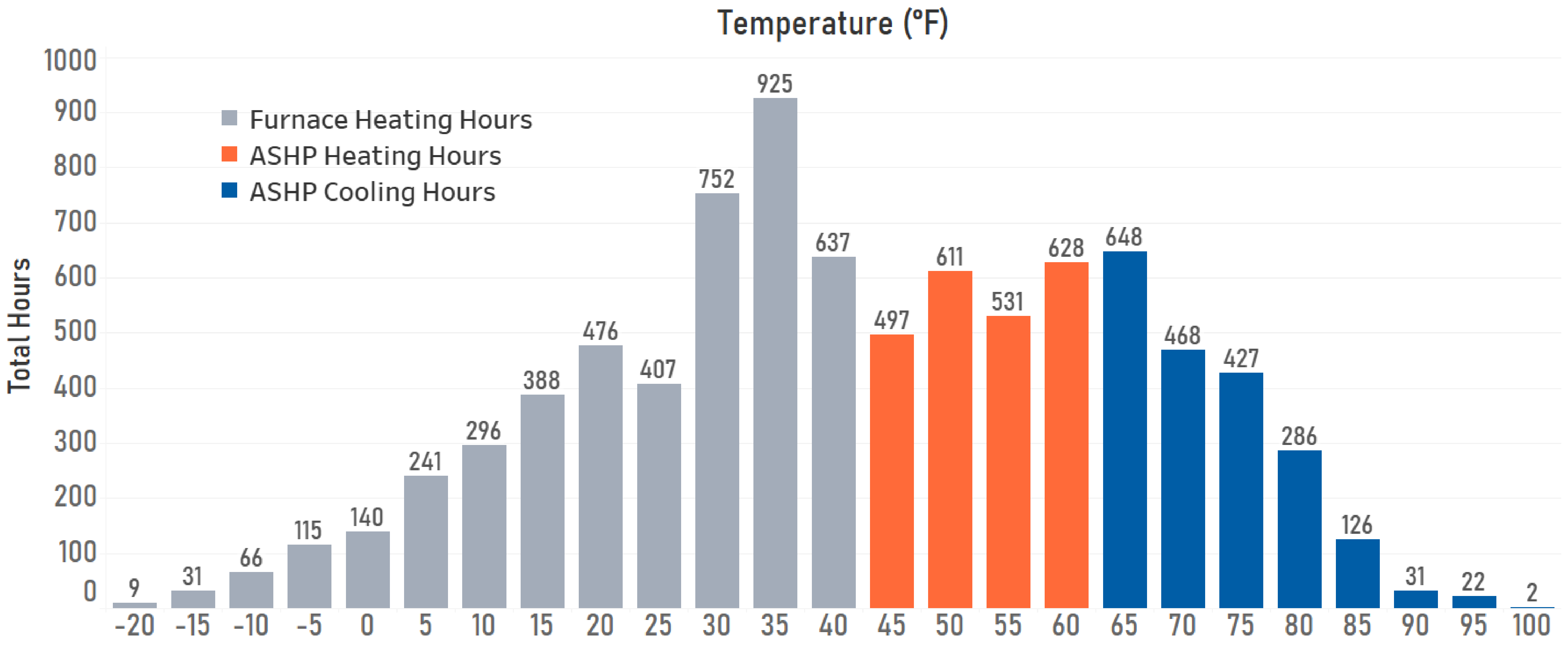
Fergus Falls – Switchover at 45°

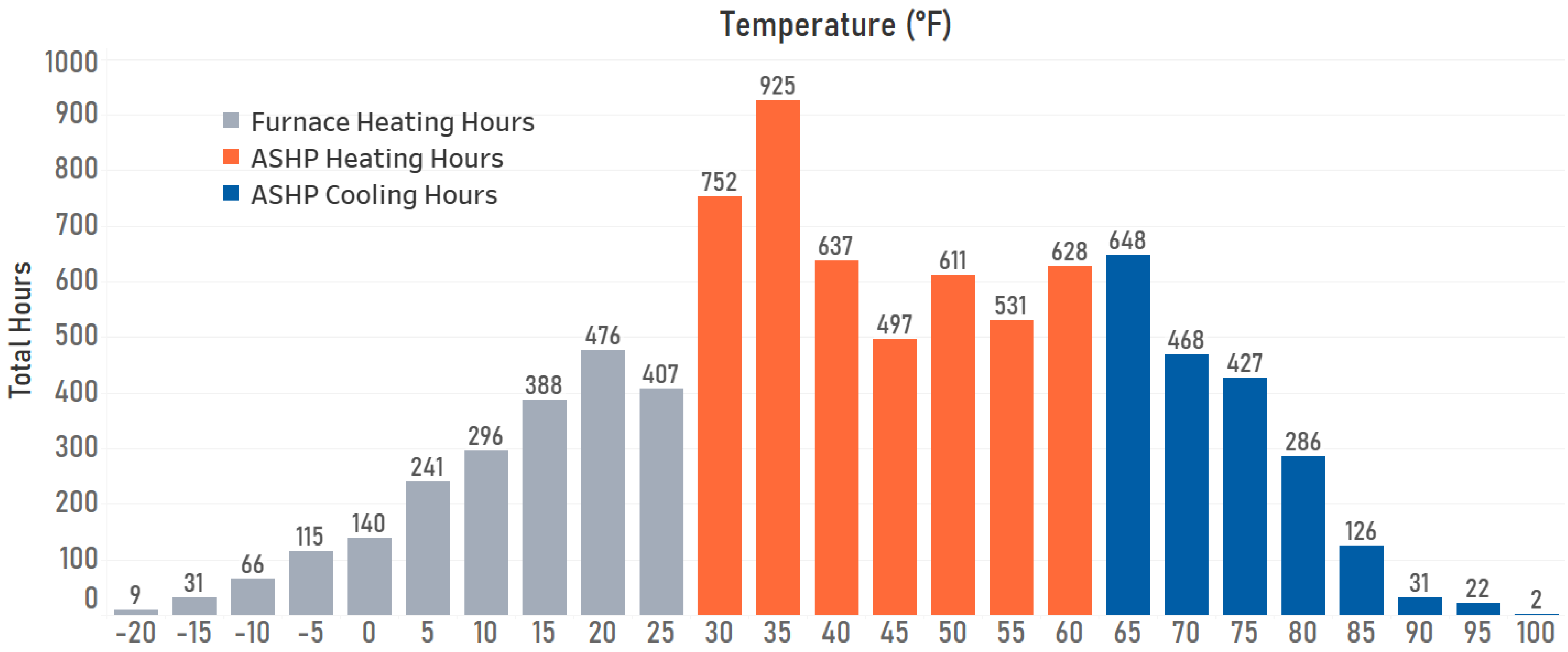


Furnace Heating Hours
4,483 - 66%

ASHP Heating Hours
2,267 - 34%

ASHP Cooling Hours
2,010 - 100%

Fergus Falls – Switchover at 30°

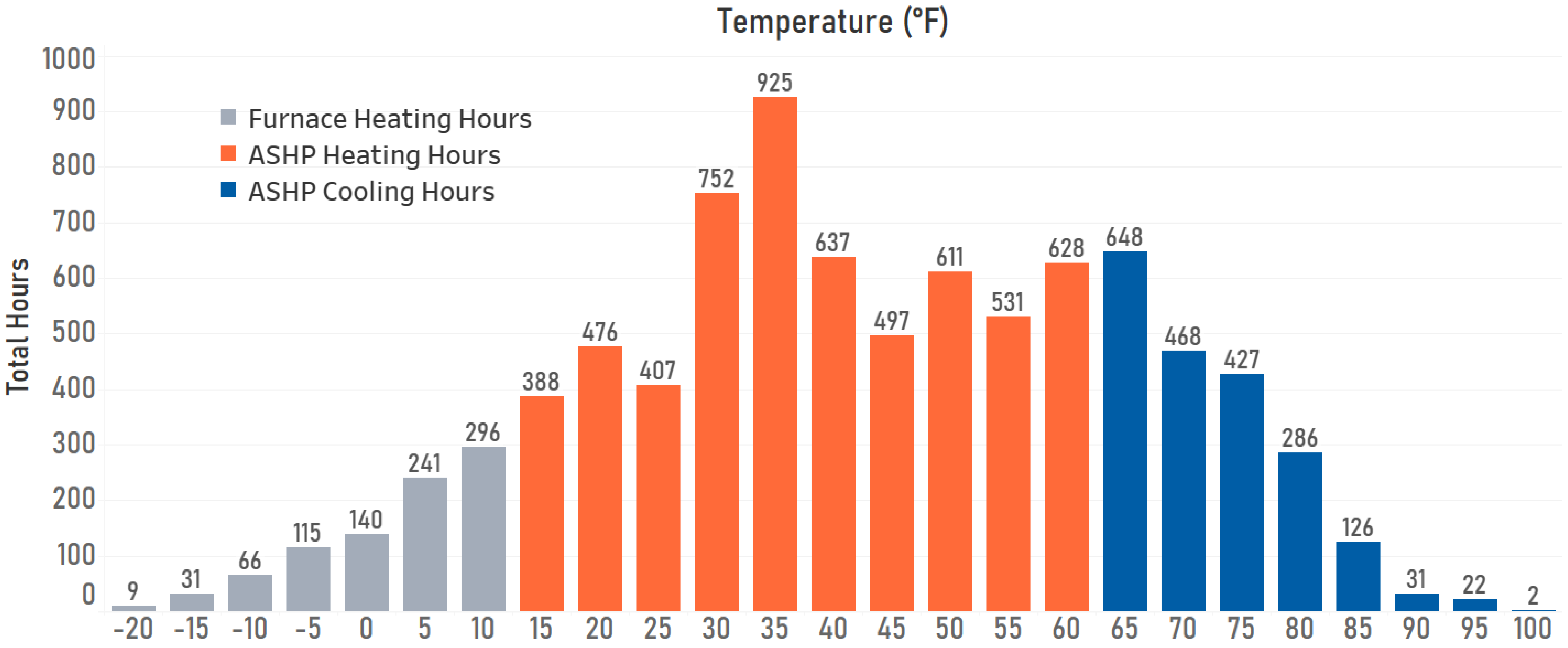


Furnace Heating Hours
2,169 - 32%

ASHP Heating Hours
4,581 - 68%

ASHP Cooling Hours
2,010 - 100%

Fergus Falls – Switchover at 15°



Furnace Heating Hours
898 - 13%

ASHP Heating Hours
5,852 - 87%

ASHP Cooling Hours
2,010 - 100%

What we covered:

- Available utility rebates and rates, local programs, and financing for customers
- Information customers can refer to about state and federal incentives
- Tools to estimate annual energy costs and runtime of different heat pump applications
- How customers can access and stack available incentives

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Homeowner Education

Learning objectives

By the end of the module, you will be able to:

- Recognize different customer perceptions and priorities
- Use survey data and messaging guides to build customer confidence in heat pumps
- Build trust in your expertise by addressing key items throughout the sales and installation process
- Give your customers valuable education so they become comfortable and satisfied heat pump owners

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What do customers want from their new HVAC system?

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2024 market survey of Minnesotans and Midwesterners

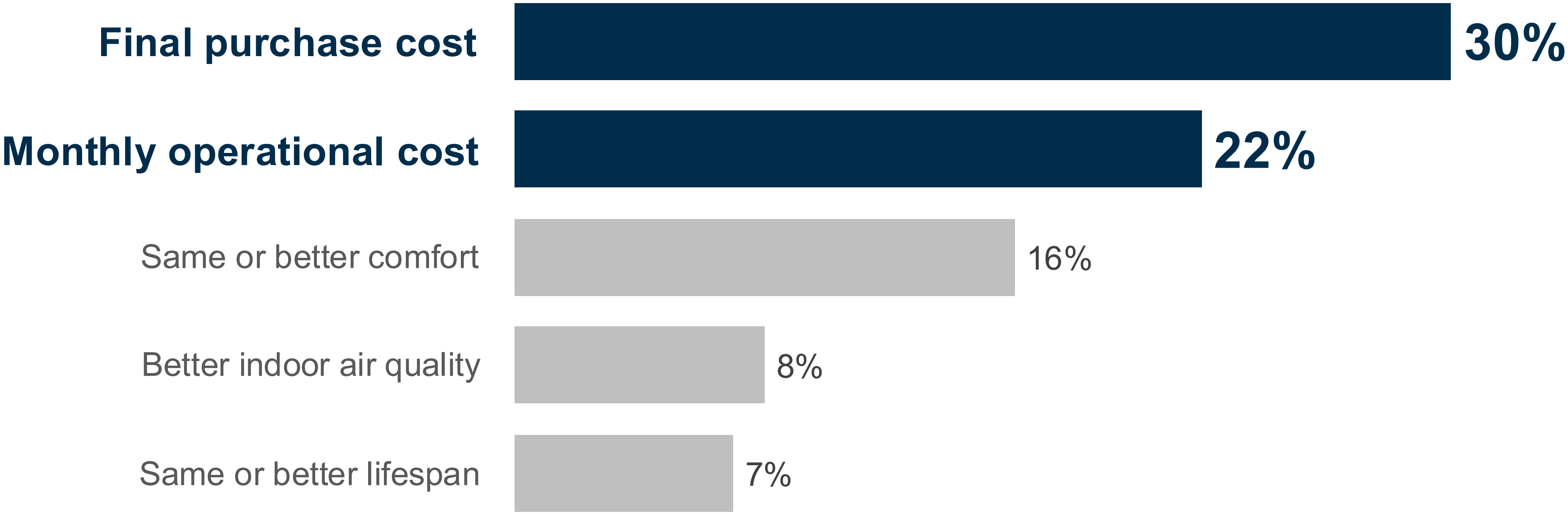
The research goal was to better understand customer awareness and perceptions of heat pump technology.

- **30 Minnesotan homeowners** participated in focus groups
- **Over 1,700 Minnesotans and 2,300 Midwesterners** completed online surveys and message tests

Research completed by Behavioural Insights Team and commissioned by Center for Energy and Environment

Costs are the top two priorities

Top-five ranked factors for home heat and cooling decisions to Minnesotans (n=1,733)



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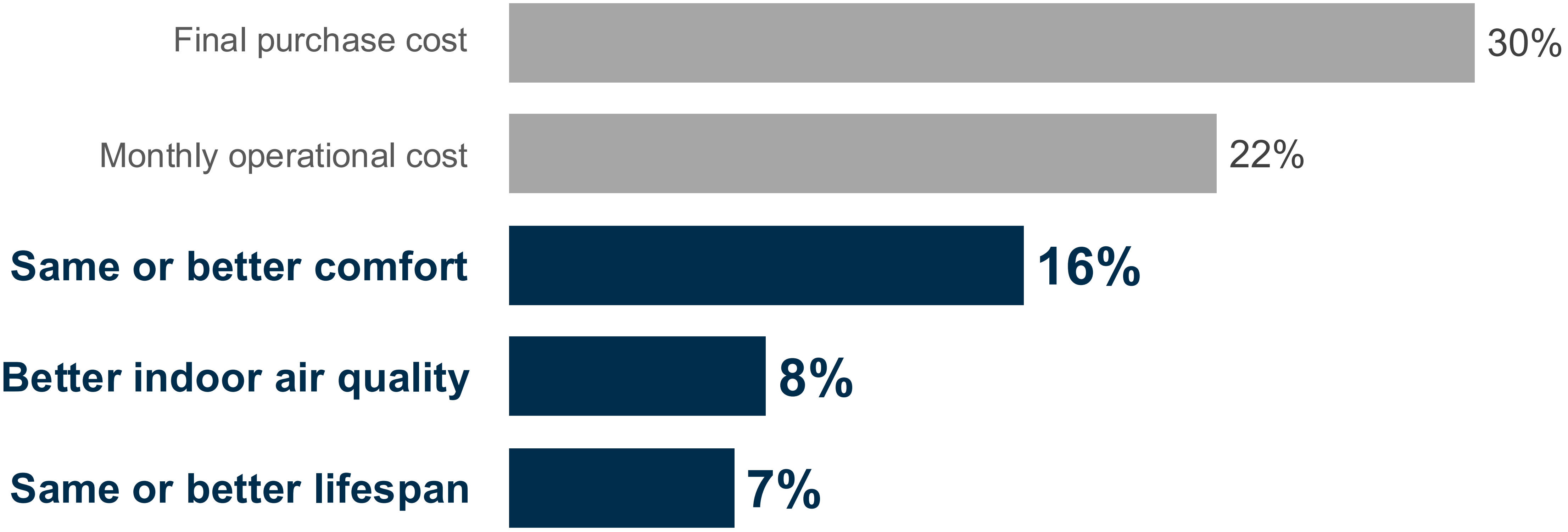
Items related to system quality are the rest of the top-five priorities

Top-five ranked factors for home heat and cooling decisions to Minnesotans (n=1,733)



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A summary of customer priorities for new HVAC

Economical solutions

- Competitive upfront costs
- Taking advantage of incentives and financing
- Competitive operational costs

Quality equipment

- Temperature consistency and balance around home
- Less fluctuation around set point
- Better indoor air quality
- System reliability and durability

How can you make simple modifications to your sales process to sell heat pumps?

How can you solve common customer needs with a heat pump solution?

What survey data and messaging guidance is there to build customer confidence in heat pumps?

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Messaging guides and resources are available from the MN ASHP Collaborative

- Research-backed messaging to build awareness of heat pumps
- White-label templates for email, blog, social media, and more
- Other customer education materials

mnashp.org/marketing-resources

This link is also stored in the **Training Resources** page.

For more, contact marketing@mnashp.org

How can you be a trusted source of information and increase your customer's confidence in your expertise?

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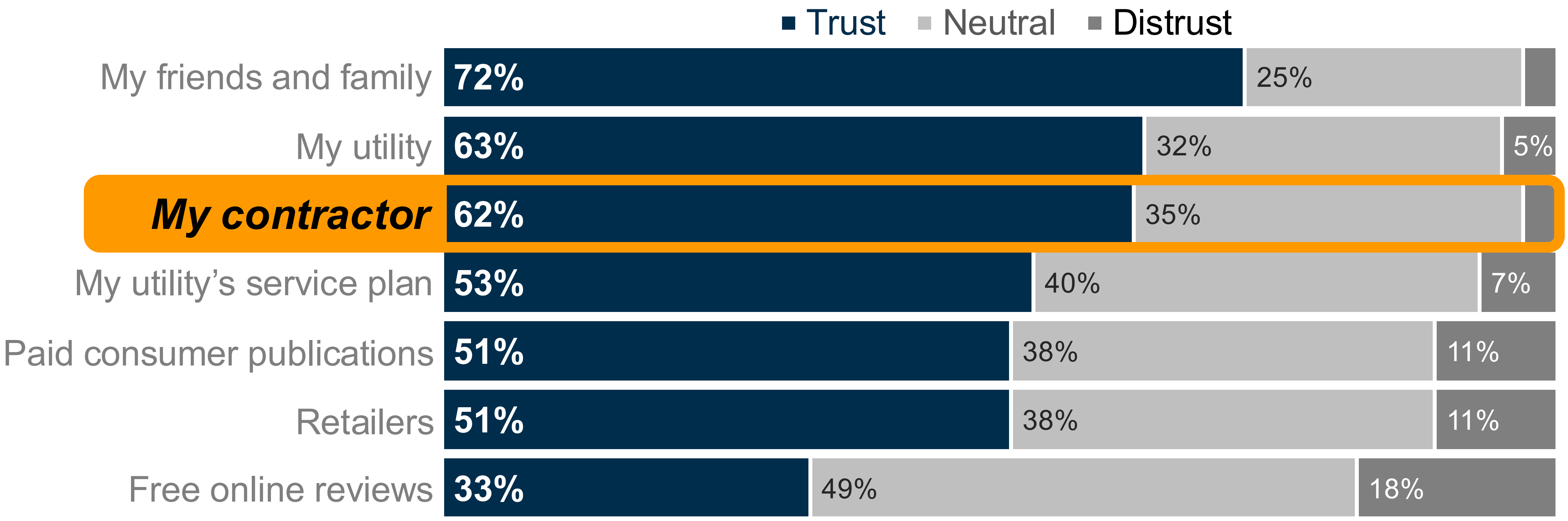
Your voice is important! Contractors are a trusted resource for homeowners

Source of information that participants trust in the Midwest sample (n=4,007)



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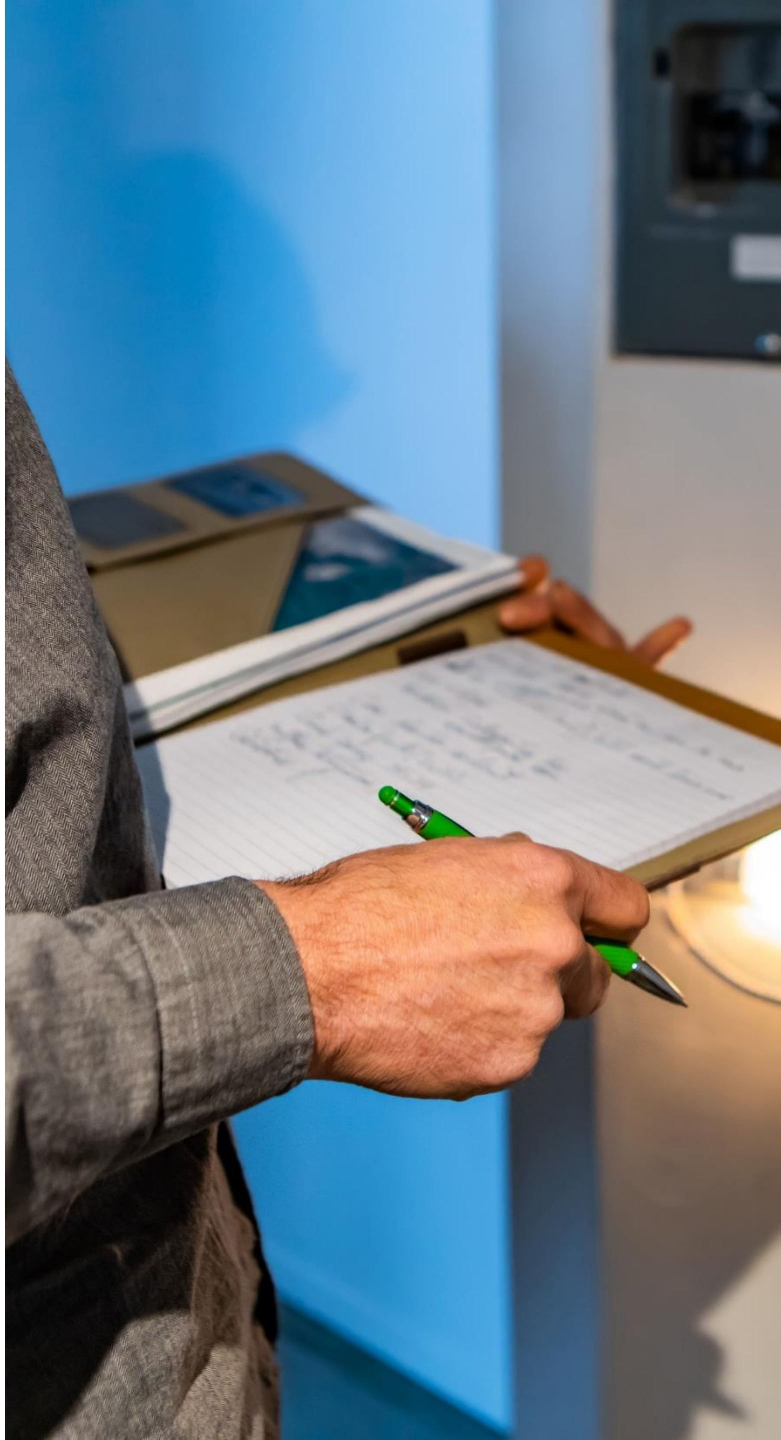
Be a knowledgeable source on incentives to address cost concerns

- Be familiar with your incentive landscape
- Be familiar with dual fuel or electric space heating rates from your utility and how to sign up for them
- Be able to communicate to your customers how the incentives can address cost barriers

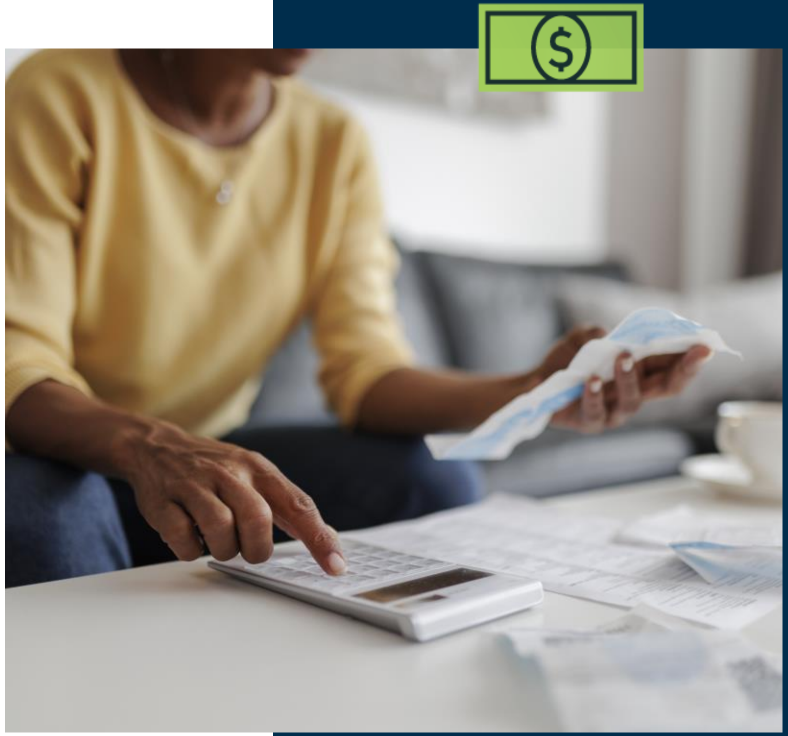


Talking points for the tax credit

The current tax credit is likely to apply to installations this tax year

- No historical precedent for a new tax law to apply to the current tax year

Installations in tax year 2026 may be subject to new laws



Engage your customers throughout the process

Initial conversation

Bid lineup proposal

Installation

The initial conversation

Initial conversation

- What incentives and financing can help with the upfront costs?
- What rates can help with operational costs?
- What are the pain points with the current system?
- How will a heat pump solution address the customer’s priorities?

The bid lineup proposal

Initial conversation

Bid lineup proposal

- What are the tradeoffs?
- Where would the equipment be located?
- Why advantages does the heat pump solution have over an AC?

The installation

Initial conversation

Bid lineup proposal

Installation

- Is the equipment location agreed upon?
- What should the customer expect from their controls?
- How should the customer control their heat pump and auxiliary heat?
- What work did you complete?

Educate your customers on what to expect from their heat pump and how to use it

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What is different about living with a heat pump?

- Longer runtimes
- Lower supply air temperatures
- Defrost cycles
- Reduced setbacks

How should they control their system?

- Thermostat features
- Navigating setbacks
  - “Set it and forget it” or minimal setbacks

How will the heat pump and auxiliary heat interact?

- The switchover temperature
- Staggered controls for homes with ductless ASHPs & hydronic heat

Photo credit: Thomas Klepl

How can they maintain their heat pump?

- Snow removal
- Filter replacement
- Service scheduling

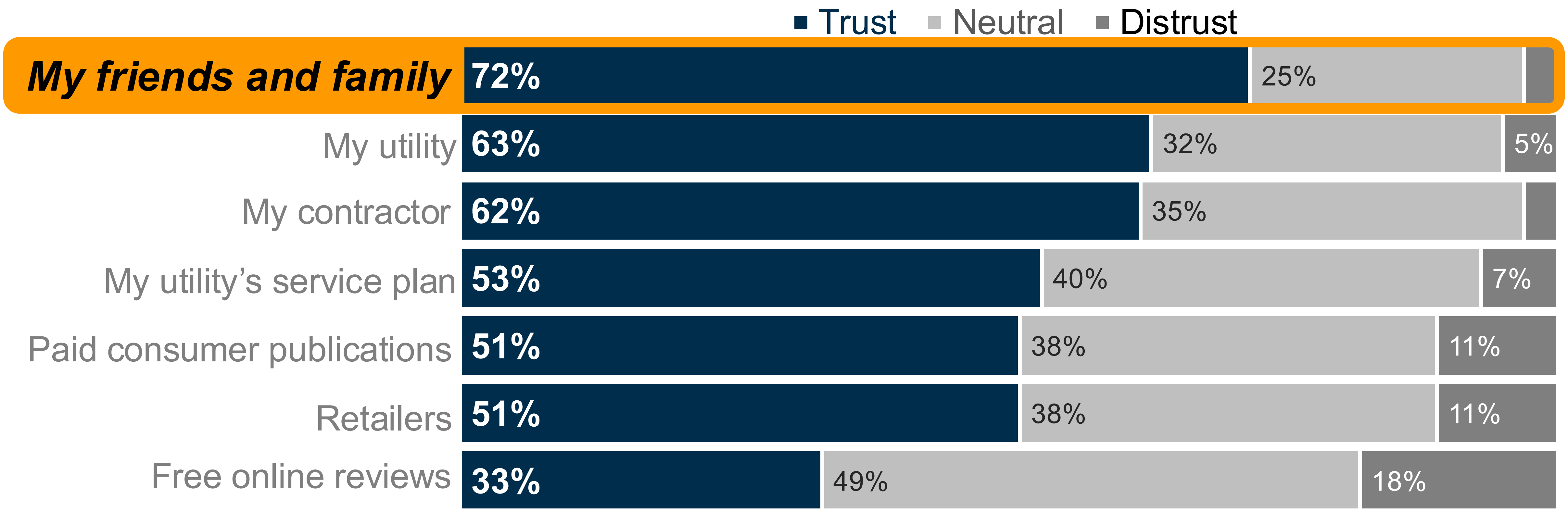
Image courtesy of Jeff Curtes

What utility bill changes can they expect?

- Increased electric bills
- Decreased gas bills

Happy, well-educated homeowners are the best salespeople!

Source of information that participants trust in the Midwest sample (n=4,007)



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What we covered

- The different customer perceptions and priorities
- The key messages to support your customers throughout the sales and installation process
- Key items to cover in the sales and installation process to build trust in your expertise
- Customer education to ensure comfort and satisfaction with their new heat pumps

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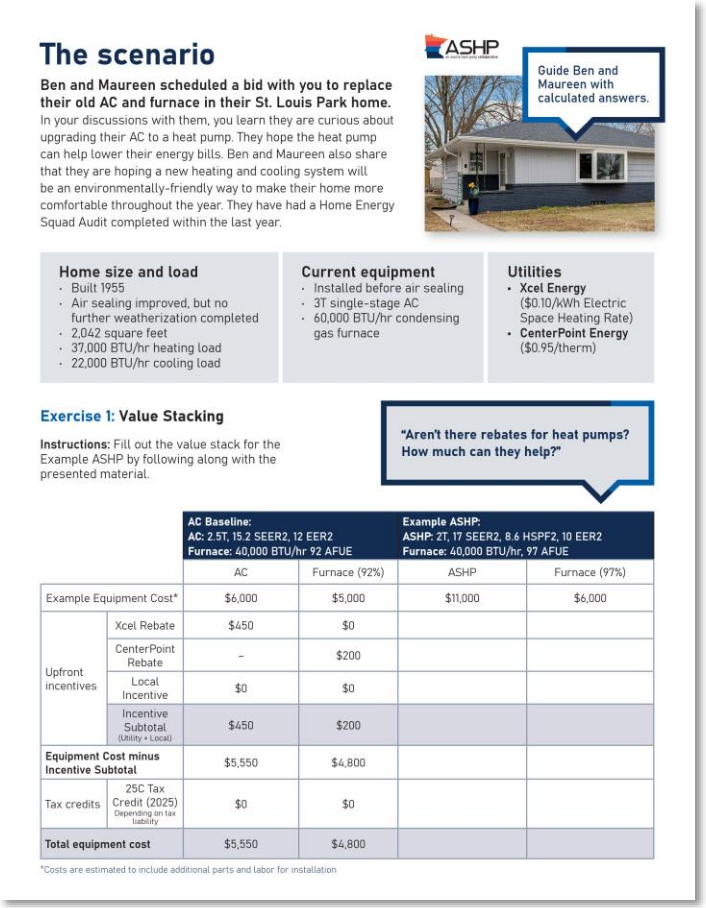
Exercise 1: Value Stacking

We will fill out a value stack together using sample data for Wadena, MN.

Needed to follow along:

- **Worksheet**



The scenario

Ben and Maureen scheduled a bid with you to replace their old AC and furnace in their St. Louis Park home. In your discussions with them, you learn they are curious about upgrading their AC to a heat pump. They hope the heat pump can help lower their energy bills. Ben and Maureen also share that they are hoping a new heating and cooling system will be an environmentally-friendly way to make their home more comfortable throughout the year. They have had a Home Energy Squad Audit completed within the last year.

ASHP

Guide Ben and Maureen with calculated answers.

Home size and load
- Built 1955
- Air sealing improved, but no further weatherization completed
- 2,042 square feet
- 37,000 BTU/hr heating load
- 22,000 BTU/hr cooling load

Current equipment
- Installed before air sealing
- 3T single-stage AC
- 60,000 BTU/hr condensing gas furnace

Utilities
- **Xcel Energy** ($0.10/kWh Electric Space Heating Rate)
- **CenterPoint Energy** ($0.95/therm)

Exercise 1: Value Stacking

Instructions: Fill out the value stack for the Example ASHP by following along with the presented material.

"Aren't there rebates for heat pumps? How much can they help?"

		AC Baseline: AC: 2.5T, 15.2 SEER2, 12 EER2 Furnace: 40,000 BTU/hr 92 AFUE		Example ASHP: ASHP: 2T, 17 SEER2, 8.6 HSPF2, 10 EER2 Furnace: 40,000 BTU/hr, 97 AFUE	
		AC	Furnace (92%)	ASHP	Furnace (97%)
Example Equipment Cost*		$6,000	$5,000	$11,000	$6,000
Upfront incentives	Xcel Rebate	$450	$0		
	CenterPoint Rebate	–	$200		
	Local Incentive	$0	$0		
	Incentive Subtotal (Utility + Local)	$450	$200		
Equipment Cost minus Incentive Subtotal		$5,550	$4,800		
Tax credits	25C Tax Credit (2025) Depending on tax liability	$0	$0		
Total equipment cost		$5,550	$4,800		

*Costs are estimated to include additional parts and labor for installation

We will compare two fictional bids

	Basic AC & Furnace **AC:** 2.5T, 15.2 SEER2, 12 EER2 **Furnace:** 40,000 BTU/hr 95 AFUE		**High Efficiency ASHP & Furnace** **ASHP:** 2T, 17 SEER2, 8.6 HSPF2, 10 EER2 **Furnace:** 40,000 BTU/hr, 97 AFUE	
	AC	Furnace (95%)	ASHP	Furnace (97%)
Example Cost*	$6,000	$5,000	$11,000	$6,000

*Costs are estimated to include additional parts and labor for installation

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First we consider utility rebates

		Basic AC & Furnace		High Efficiency ASHP & Furnace	
		AC	Furnace (95%)	ASHP	Furnace (97%)
Example Cost*		$6,000	$5,000	$11,000	$6,000
Upfront incentives	Todd-Wadena				
	MERC				

*Costs are estimated to include additional parts and labor for installation

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The Todd-Wadena Electric Utility rebate

Up to $700

Electric

Generation and Transmission Utility: Great River Energy

Ducted Air Source Heat Pump

Rebate range

$500 -$700

Minimum efficiency

SEER2: 14.3

HSPF2: 7.5

SEER2: 16

HSPF2: 8

Ductless Air Source Heat Pump, ≤1 ton

Rebate range

$150 - $250

Minimum efficiency

SEER2: 14.3

HSPF2: 7.5

SEER2: 16

HSPF2: 8

Ductless Air Source Heat Pump, >1 ton

Rebate range

$500 - $700

Minimum efficiency

SEER2: 14.3

HSPF2: 7.5

SEER2: 16

HSPF2: 8

Source: MN ASHP Collaborative’s Utility Rebate Lookup website

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Todd-Wadena Rebate Specs

Rebate Minimum Specs	Example ASHP specs
16 SEER2	17 SEER2
8 HSPF2	8.6 HSPF2

Example ASHP qualifies for the rebate!

The bottom line for a customer at bid

		Basic AC & Furnace		High Efficiency ASHP & Furnace	
		AC	Furnace (95%)	ASHP	Furnace (97%)
Example Cost*		$6,000	$5,000	$11,000	$6,000
Upfront incentives	Todd-Wadena	-	-	$700	-
	MERC	-	$350	-	$500
Bottom line at bid		**$6,000**	**$4,650**	**$10,300**	**$5,500**

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Next is the federal tax credit

ENERGY STAR V6.1	✓
ENERGY STAR V6.1 Cold Climate	✓
ENERGY STAR V5.0	
Federal Tax Credit Eligibility North	✓

Source: NEEP Information Tables for the Example ASHP

Equipment Spec Sheet: Page 1

Data sourced from NEEP's Cold Climate Air Source Heat Pump List. Only values most relevant for the training exercises are represented in this resource.

Size: 2T

- Maximum Heating Capacity (Btu/h) @5°F: **16,100**
- Rated Heating Capacity (Btu/h) @47°F*: **23,000**
- Rated Cooling Capacity (Btu/h) @95°F*: **23,000**

Paired Furnace: 40,000 BTU/hr, 97% AFUE

Sizing for Heating Tool Inputs	
Zip Code	56482
Weather Station	Chandler Field
Heating Design Temp	-13°F
Cooling Design Temp	85°F
Heating Design Load	37,000 BTU/hr
Cooling Design Load	22,000 BTU/hr

Information Tables	
EER2	10
SEER2	17
HSPF2 (Region IV)	8.6
ENERGY STAR V6.1 Cold Climate	Yes
CEE Tier 1 Path A (2025)	Yes
Variable Capacity	Yes
Capacity Maintenance (Max 5°F/Rated 47°F)	70%

Performance Specs

Heating/ Cooling	Outdoor Dry Bulb	Indoor Dry Bulb	Unit	Min	Rated	Max
Cooling	95°F	80°F	BTU/h	6,600	23,000	23,000
			COP	3.28	3.18	3.18
Cooling	82°F	80°F	BTU/h	5,700	-	25,200
			COP	4.77	-	3.97
Heating	47°F	70°F	BTU/h	5,700	23,000	23,000
			COP	4.77	3.37	3.37
Heating	17°F	70°F	BTU/h	9,100	16,000	19,400
			COP	2.78	2.65	2
Heating	5°F	70°F	BTU/h	6,700	16,100	16,100
			COP	2.21	2	2

Example ASHP gets the tax credit!
(and 97% furnace gets the tax credit!)

The tax credit applied to the project costs after upfront incentives

		Basic AC & Furnace		High Efficiency ASHP & Furnace	
		AC	Furnace (95%)	ASHP	Furnace (97%)
Bottom line at bid		$6,000	$4,650	$10,300	$5,500
Tax credits	25C Tax Credit (2025) Depending on tax liability	$0	$0		

Tax credit = 30% of project costs (ASHP max is $2,000)

Tax credit = 30% of project costs (Furnace max is $600)

The tax credit amount

		Basic AC & Furnace		High Efficiency ASHP & Furnace	
		AC	Furnace (95%)	ASHP	Furnace (97%)
Bottom line at bid		$6,000	$4,650	$10,300	$5,500
Tax credits	25C Tax Credit (2025) Depending on tax liability	$0	$0	**$2,000**	**$600**

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The final equipment and bid costs

	Basic AC & Furnace		High Efficiency ASHP & Furnace	
	AC	Furnace (95%)	ASHP	Furnace (97%)
Example Cost	$6,000	$5,000	$11,000	$6,000
Minus all the incentives	*– $0*	*– $350*	*– $2,700*	*– $1,100*
Final equipment cost	$6,000	$4,650	$8,300	$4,900
Final bid cost	**$10,650**		**$13,200**	

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Best Practices for Sizing & Load Calculations

Learning objectives

By the end of the module, you will be able to:

- Identify sizing methods to complete accurate load calculations
- Recognize the risks of oversizing and low-quality load calculations
- Recognize the value of high-quality load calculations and tools to do so
- Determine when to size for heating or cooling

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Low quality methods

- Duplicating existing equipment size
- A rule of thumb
- The Heating Load Estimator

For rough estimations, training, and gut checks

Heating Load Estimator (Btuh/sq.ft.)

	Climate winter design temp (°F)			
Home Envelope	**Below -10**	**-10 to 5**	**5 to 20**	**Above 20**
No wall insulation	44	38	32	28
2x4 construction with insulation	23	20	17	15
2x6 construction with insulation	16	13	11	10
Newer construction (after 2012)	15	13	11	8

Original estimator created by the Northwest Energy Efficiency Alliance and updated for variable capacity heat pumps by Dan Wildenhaus

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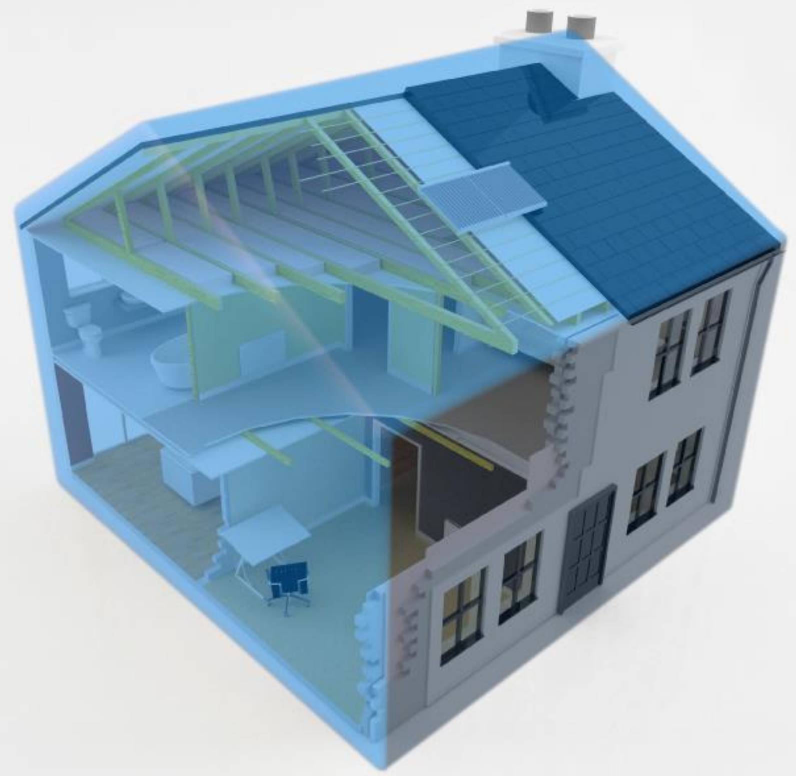
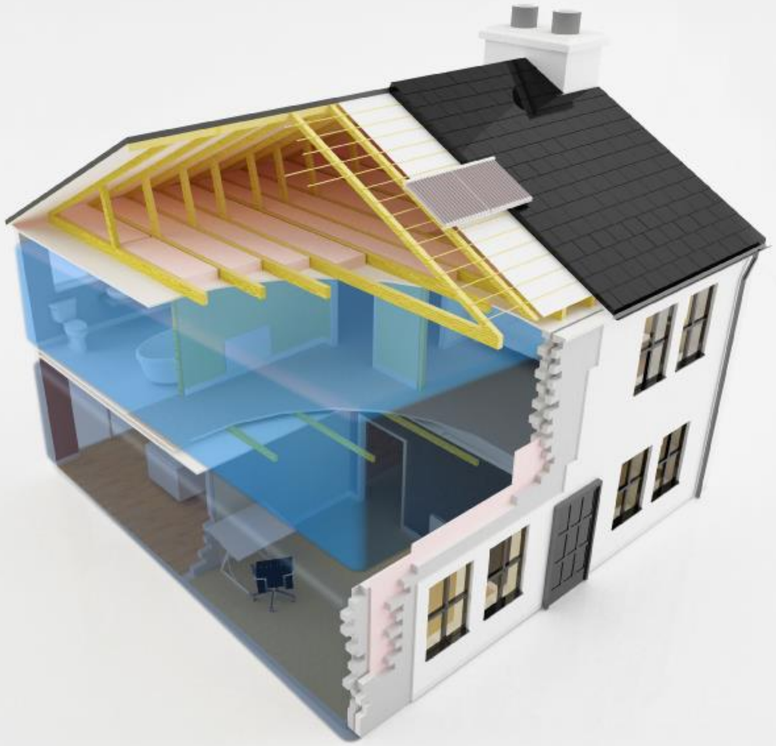
Medium quality methods

- Comfort consultation
- Block load calculation (Manual J or equivalent)
- Account for detailed building envelope information
- Factor in design temperatures



High quality methods

- Comfort consultation
- Room-by-room Manual J or equivalent
- Account for detailed building envelope information
- Factor in design temperatures
- Factoring in existing equipment’s run time or customer’s utility bills



Design temperatures

There are multiple design temp values depending on the source!

- For example, ASHRAE, Manual J, NEEP Sizing for Heating tool, etc.

Best practice is to use the MN Mechanical Code consistently across different tools and calculation methods.

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Using ASHRAE look up for most accurate design temps

MINNEAPOLIS-ST PAUL, MN, USA (WMO: 726580)

...266 StdP: 98.17 Time zone:-6.00 (NAC) Period:94-19 WBAN:14922 Climate zone:6A

Heating DB	
99.6%	99%
-23.6	-21.1

...ign Conditions

Humidification DP/MCDB and HR					Coldest month WS/MCDB				MCWS/PCWD to 99.6% DB		WSF
...%	99%				0.4%		1%				
MCDB	DP	HR	MCDB		WS	MCDB	WS	MCDB	MCWS	PCWD	
-23.0	-25.9	0.4	-20.3		11.3	-9.0	10.2	-8.7	3.6	310	0.586

...ign Conditions

Cooling DB/MCWB					
0.4%		1%		2%	
DB	MCWB	DB	MCWB	DB	MCWB
32.7	23.0	31.1	22.2	29.5	21.3

Hottest Month	Hot... Mo... DB R...
7	9...

Evaporation WB/MCDB					MCWS/PCWD to 0.4% DB	
...	1%		2%			
WB	MCDB	WB	MCDB		MCWS	PCWD
23.8	29.0	22.8	27.8		5.6	180

https://ashrae-meteo.info/v2.0/index.php?lat=39.833&lng=-104.658&place=%27%27&wmo=725650

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ACCA approved solutions to make high high quality calculations easier

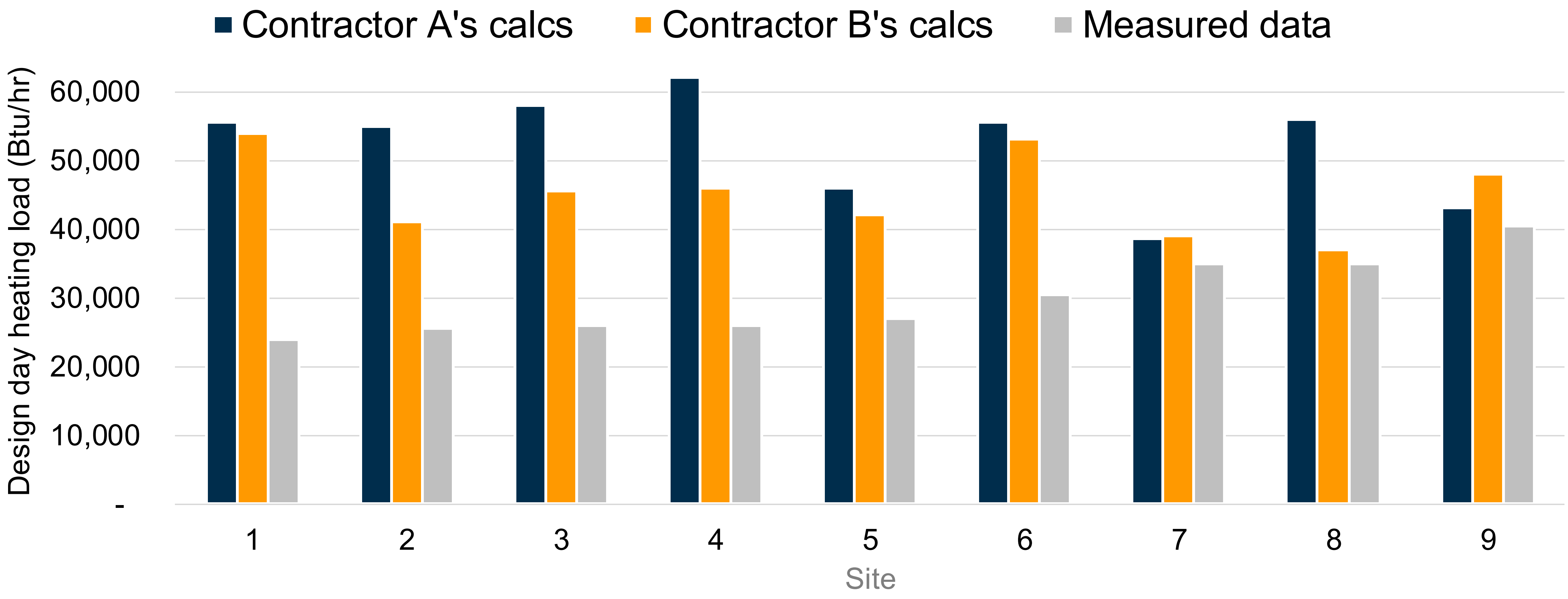
- CoolCalc Manual J
- MiTek Wrightsoft
- Elite Software
- EnergyGauge
- **Amply**
- **Conduit Tech**

] Room-scanning software for tablets (LiDAR)

This link is also stored in the **Training Resources** page.

Manual J has many built-in conservative assumptions- no weights needed!

Comparison of two Manual J's versus measured data



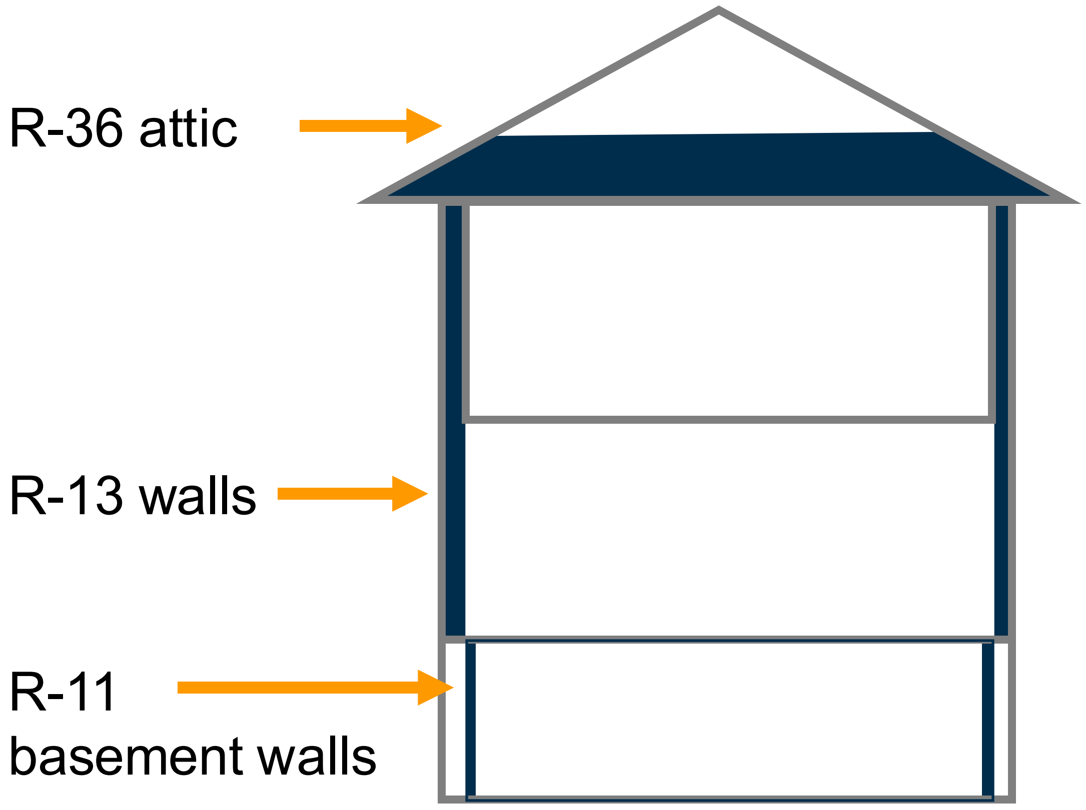
Example house to compare Manual J versus Rule of Thumb

Home specifications and observations

- 2-stories over a conditioned basement
- 2,250 sq ft
- Built early 1970's
- Ductwork is metal, appears small, and is mostly in the attic and basement

Homeowner feedback

- Lived in home two years
- AC does not keep up
- Upstairs is uncomfortable year-round



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Better Built NW Tool for Sizing

HVAC
SIZING TOOL

Building

Conditioned Floor Area	2250	Floors Above Grade	2
Average Wall Height	8.5	Bedrooms	4

Default Insulation Level: 2x6 insulated w/vinyl windows
Foundation Type: Conditioned Basement
Duct Location: Custom (enter details below)

Custom Duct Location

Attic %: 35
Unconditioned Basement or Crawl Space %: 0
Conditioned Area %: 65

Direction Front Door (House Orientation): West
Year Built: 1970

St Cloud Example House

Site ID:	20991	Heating:	51,600 BTU/hr
Area:	2,250 ft^2	Cooling:	16,200 BTU/hr
Climate:	St. Cloud AP	Latent:	2,000 BTU/hr

4.3 Tons

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What is the result?

Rule of Thumb:

- 1 ton per 400 sq ft
- 2,250 sq ft / 400 = **5.6 tons**

Manual J: **4.3 tons**

The Rule of Thumb oversized the system by over a ton!

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What are the benefits of accurate sizing?

Accurately sized equipment has longer run times,
and longer run times are better!

Longer run times improve:

- filtration
- dehumidification
- destratification
- temperature consistency
- energy efficiency

Oversized equipment loses out on these benefits!

What are the risks from oversizing?

Oversizing in HVAC installations contributes to these risks:

- struggles with existing ductwork
- shorter runtimes
- short cycling
- more noise
- reduced dehumidification
- needing larger electrical circuits

Start with accurate load calculations to mitigate risks!

Is the homeowner planning to have any weatherization work done?

Why this is a valuable question to ask before installation:

- Future weatherization will change the home loads
- Weatherization contractors can be a valuable partner in your design process

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Possible responses to plans around weatherization

Is the homeowner considering future weatherization?	How could you respond?
Yes	Recommend installing a heat pump at the same time or after the weatherization project occurs
No	Recommend installing a heat pump that is flexible for lower loads in the future
Not sure	Introduce the homeowner to a weatherization service!

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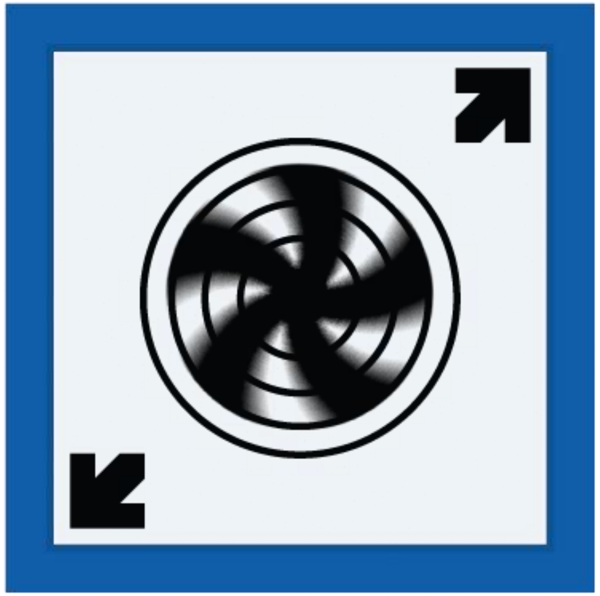
When to size to the cooling load

Size to cooling load when auxiliary heat is less expensive



Applicable for:

- Natural gas customers (dual fuel)

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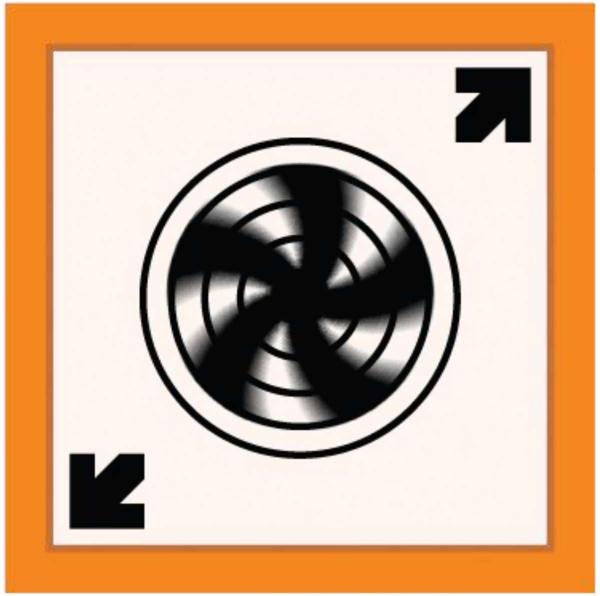
When to size to the heating load?

Size to heating load to displace an expensive auxiliary heat



Applicable for:

- Propane customers (dual fuel)
- Customers with electric resistance heat
- All-electric system

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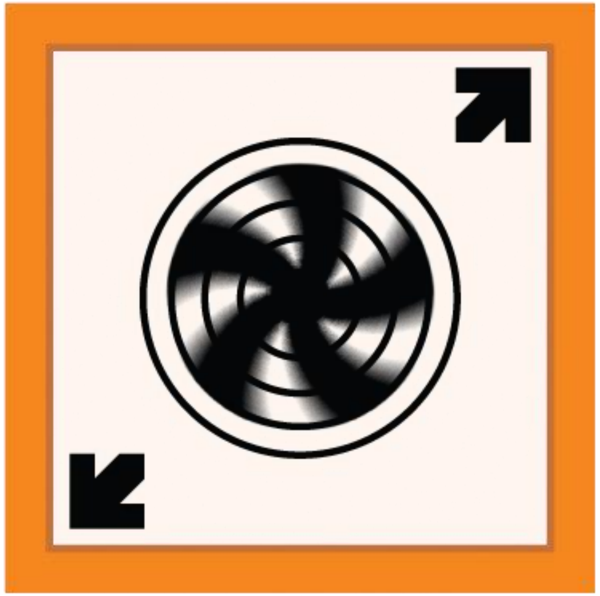
Important notes when sizing to the heating load

- Ensure the system is not oversized for the cooling load
- Variable speed systems are recommended for these scenarios
- Consider supplemental dehumidification depending on latent cooling load



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What we covered

- Sizing methods to complete accurate load calculations
- The risks of oversizing and low-quality load calculations
- The value of high-quality load calculations and tools to do so
- When to size for heating or cooling

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Ductwork & Airflow

Learning objectives

By the end of the module, you will be able to:

- Recognize the importance of a ductwork assessment
- Assess the ductwork in three steps: Compare airflow requirements, interview the homeowner, and evaluate
- Diagnose any ductwork issues and resolve through feasible modifications or replacement

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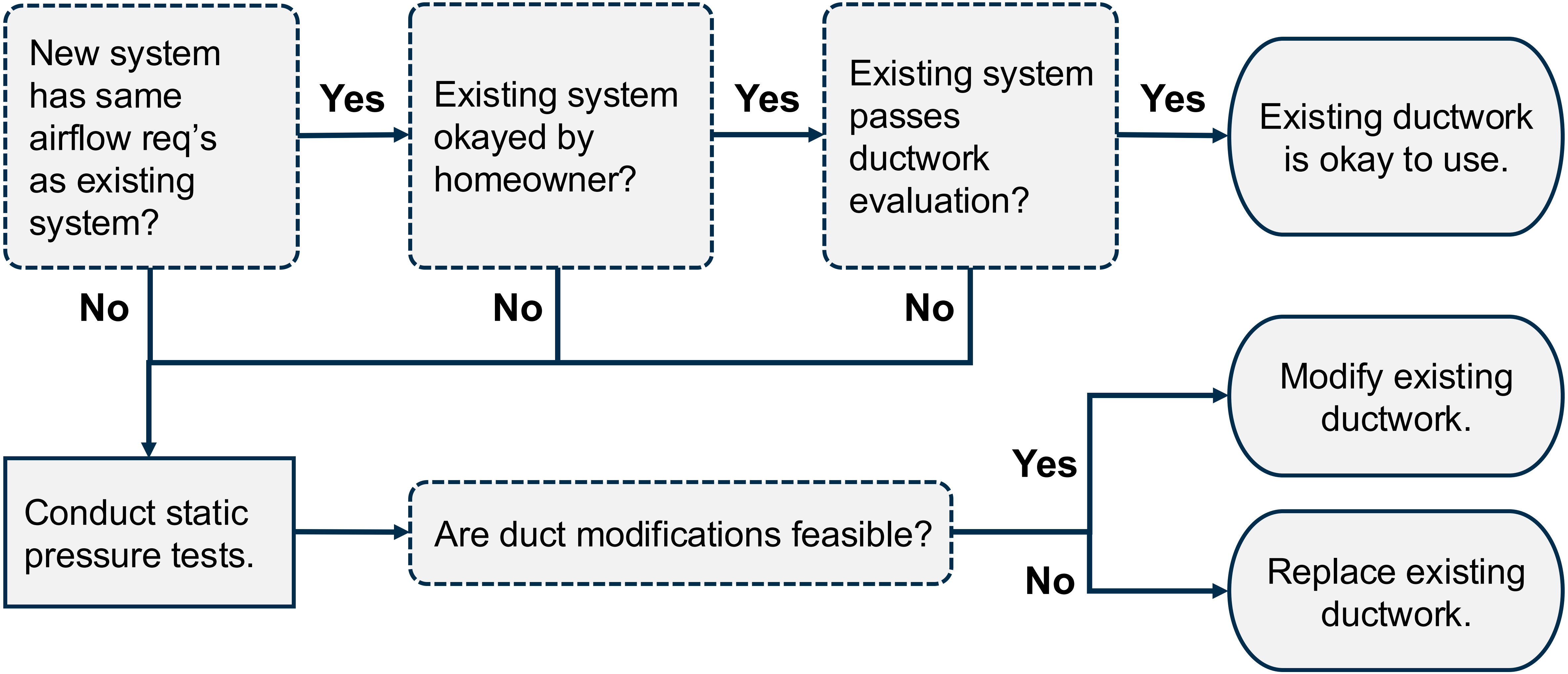
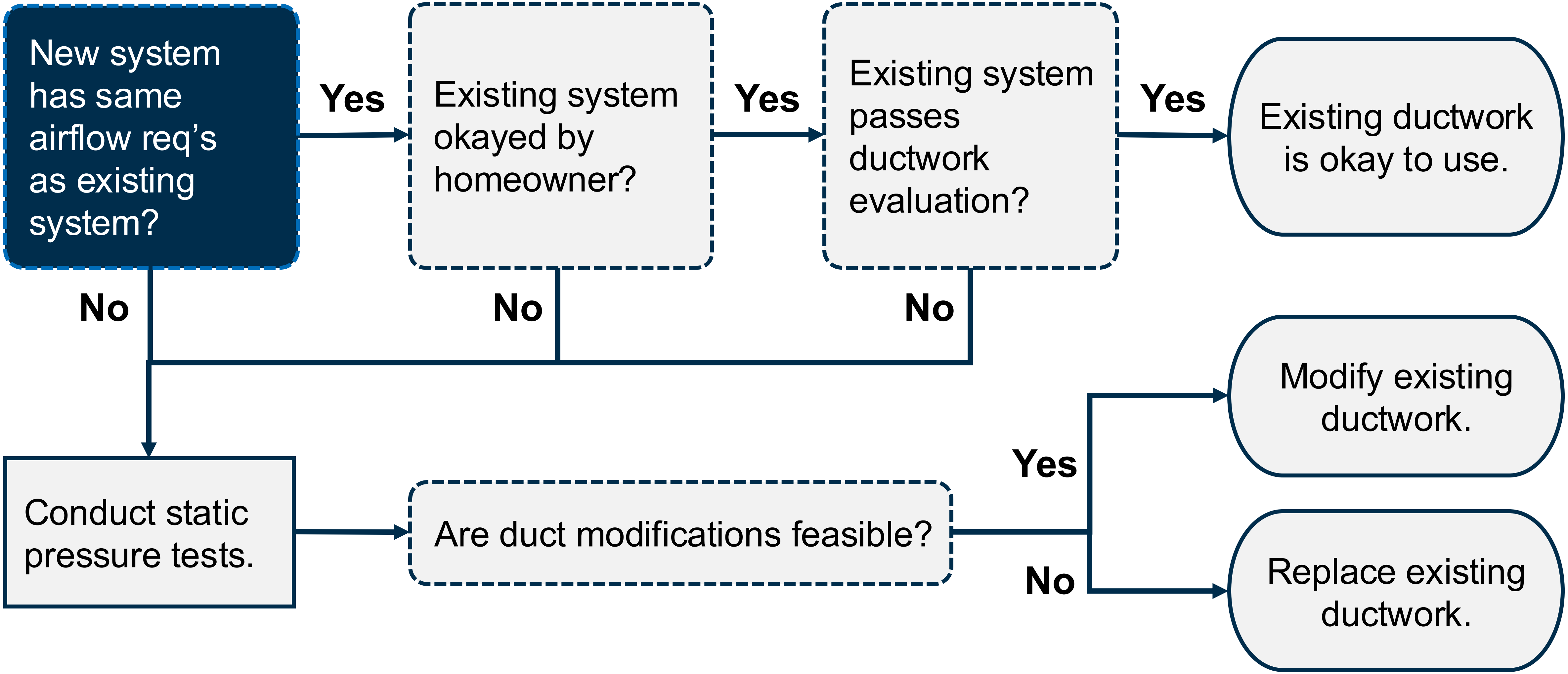
Why is assessing the ductwork important?

- Heat pumps may need more airflow than traditional systems
- Existing homes commonly have poor ductwork
- Even a great heat pump will struggle in poor ductwork!

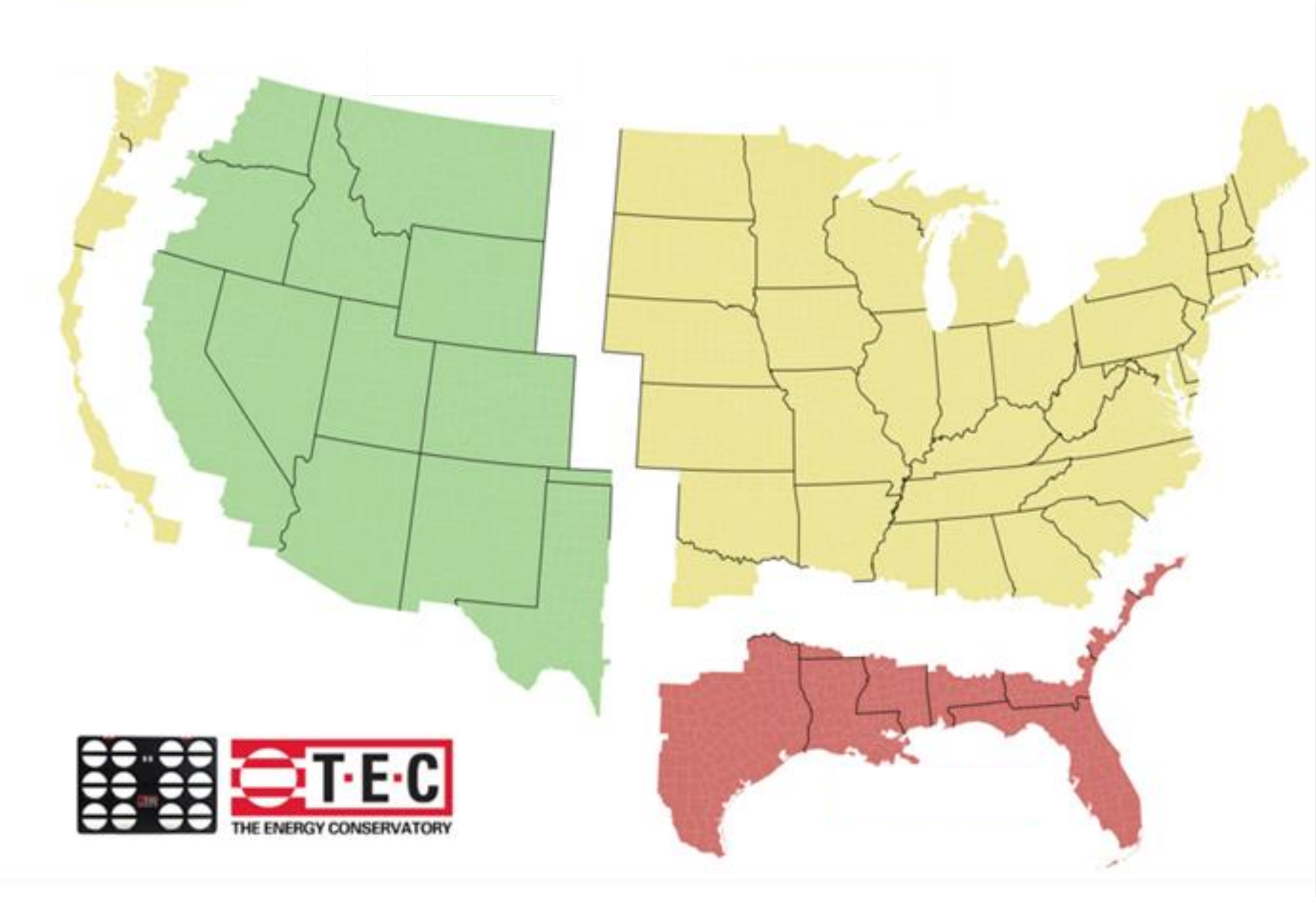
Decision tree for existing ductwork



Step 1: Compare airflow requirements



Regional CFM/ton assumptions for our example walkthough



450 CFM/ton

400 CFM/ton

350 CFM/ton

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Does the heat pump require the same airflow as the existing equipment?

Existing equipment

- 60,000 BTU/hr condensing gas furnace
- 3-ton single-stage AC

New equipment

- 2-ton variable-capacity ASHP

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Find the air flow of the existing gas furnace

- 60,000 BTU/hr condensing gas furnace
- 150 CFM per 10,000 BTU of rated BTU input

150 CFM x Rated BTU input / 10,000 = Furnace Air Flow

150 x 60,000 / 10,000 = 900 CFM

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Find the air flow of the existing AC

- 3-ton single-stage AC
- 400 CFM per ton

400 CFM x Tonnage = AC Air Flow

400 x 3 = 1,200 CFM

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Find the air flow of the new ASHP

- 2-ton variable-capacity ASHP
- 375 – 400 CFM per ton

400 CFM x Tonnage = ASHP Air Flow

400 x 2 = 800 CFM

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So, does the heat pump require the same airflow as the existing equipment?

Existing equipment

- Furnace needs **900 CFM**
- AC needs **1,200 CFM**

New equipment

- ASHP needs ~ **800 CFM**

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What if the scenario was a bit different?

Existing equipment

- Furnace needs **900 CFM**
- ***2-ton AC needs 800 CFM***

New equipment

- ***3-ton ASHP needs ~ 1,200 CFM***

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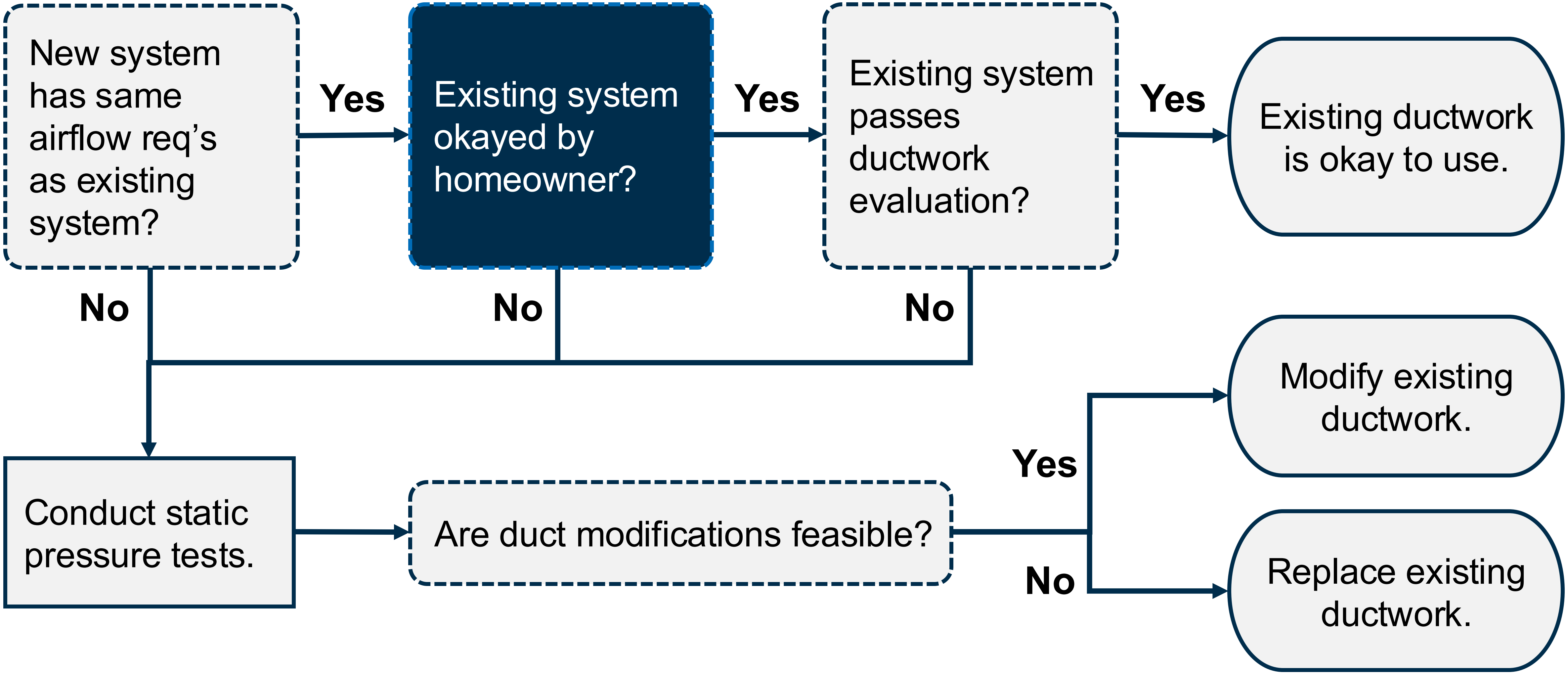
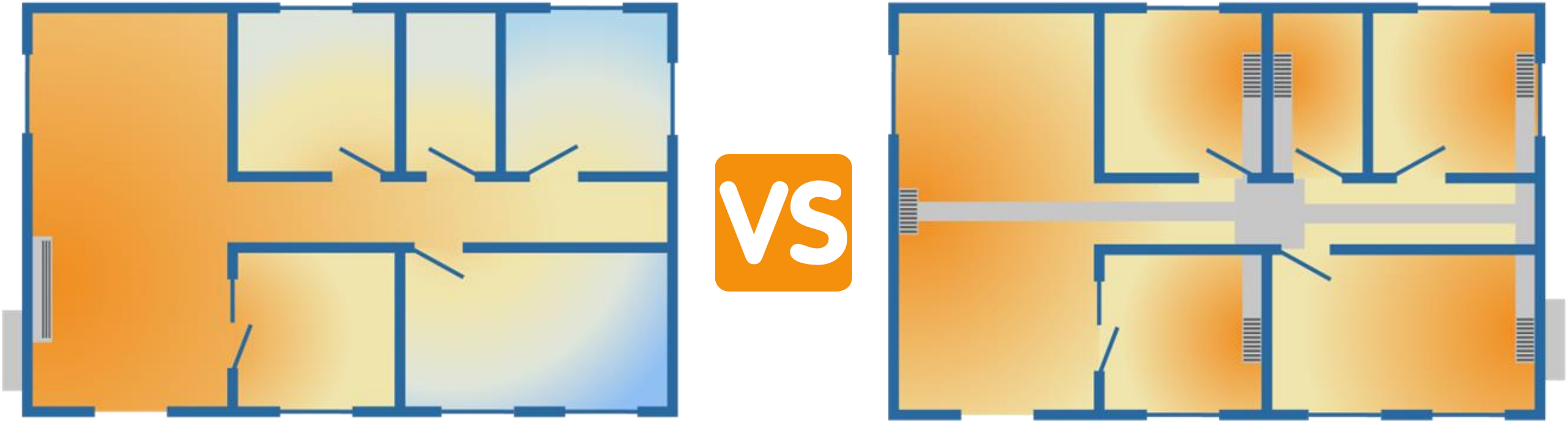
Step 2: Get the homeowner's assessment

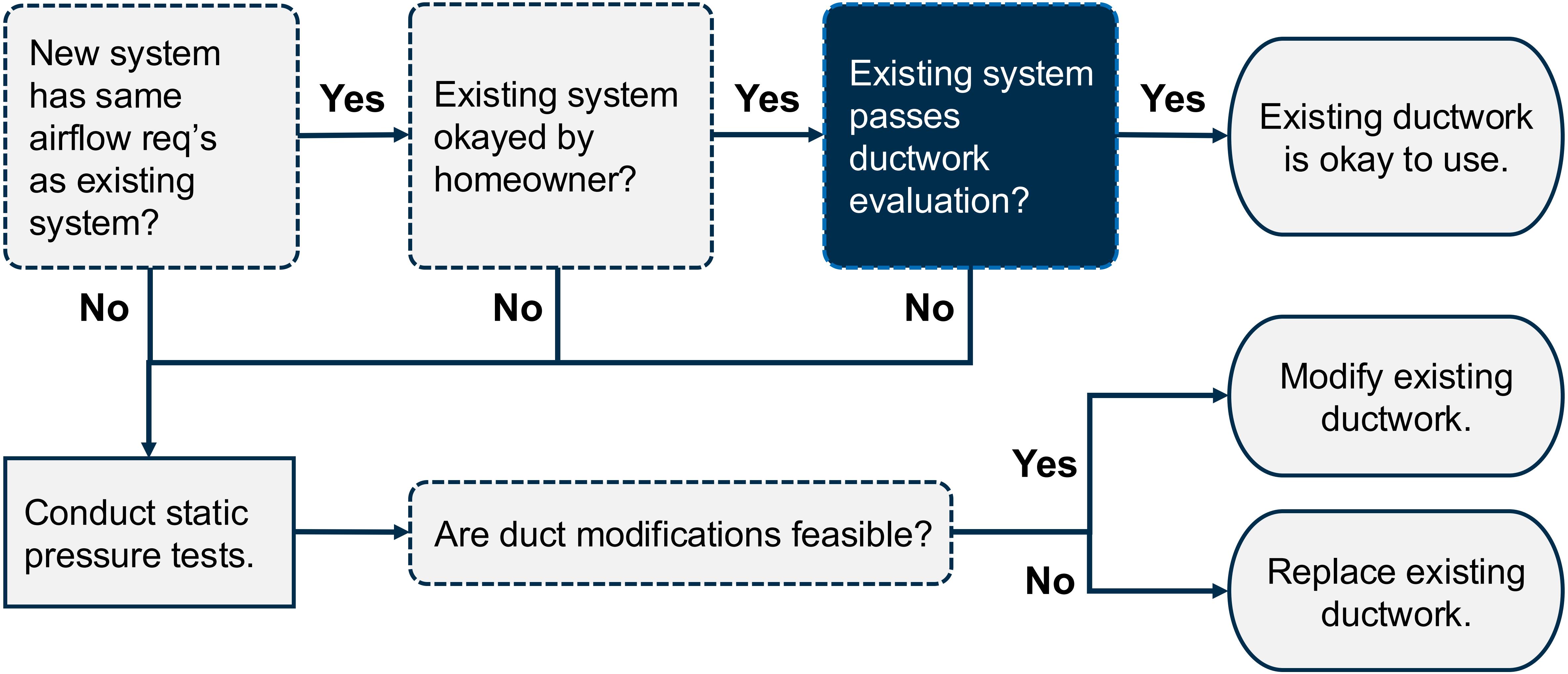


Questions to learn how the system is working for the homeowner now

- How well is hot or cold air delivered to all rooms?
- Where are they most comfortable in the home?
- Are there indoor air quality issues in the home?

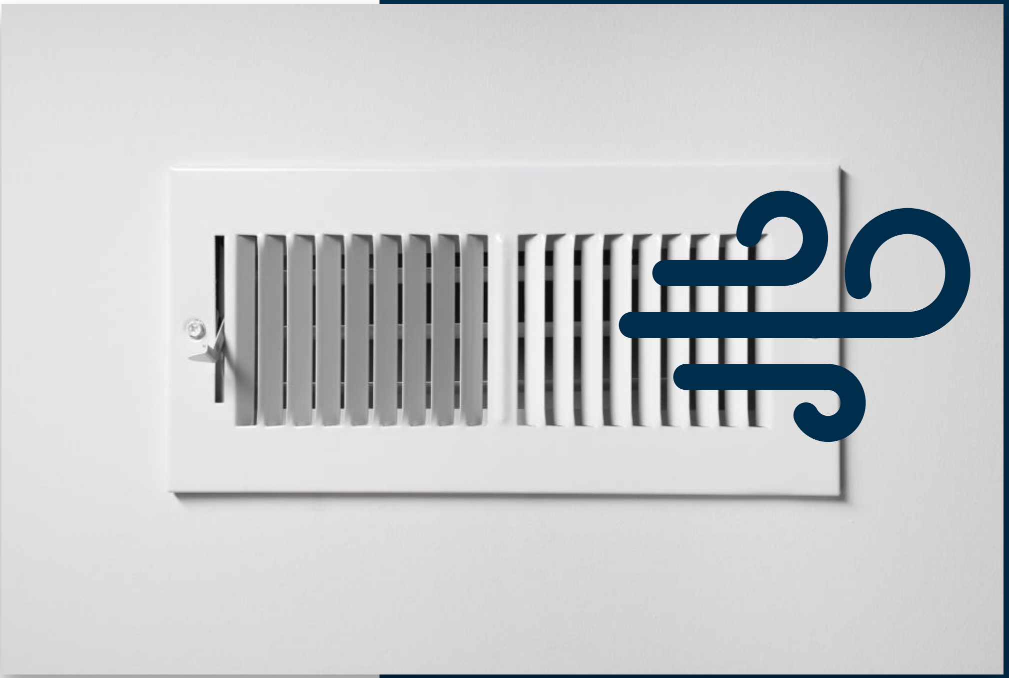


Step 3: Evaluate the ductwork



Check the airflow

- Turn the HVAC system on and the fan to high
- Check if air is flowing from all registers



No air movement?

The duct may be crushed, blocked, or disconnected!

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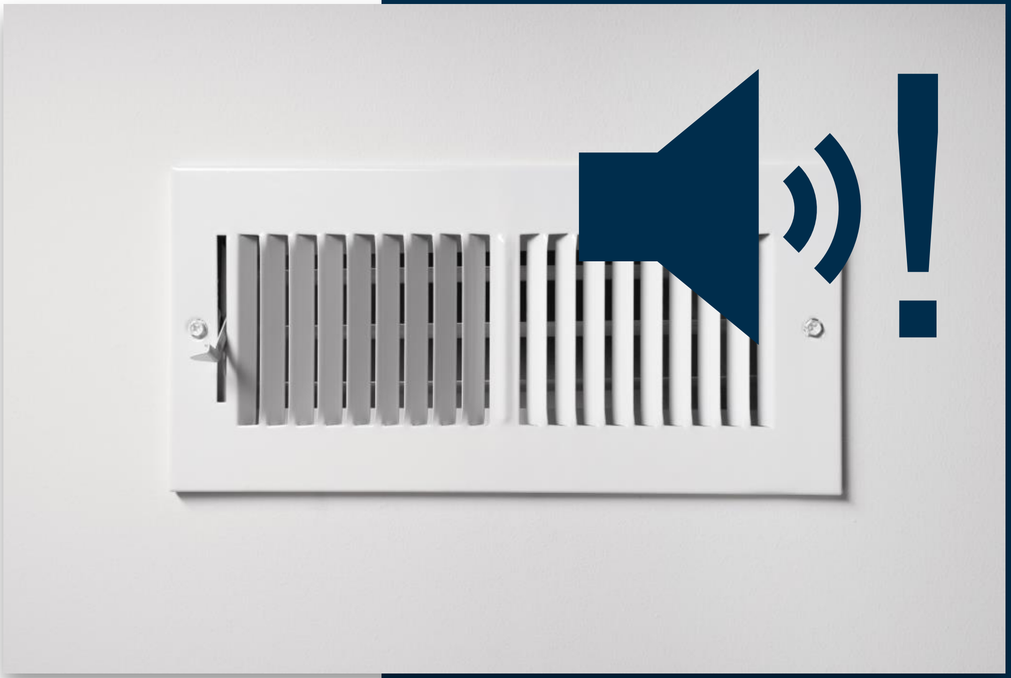
Check for noise and vibration

Noise and vibration? This can mean deterioration within the ductwork, incorrect sizing, or inadequate securing.



Is there ductwork in an unconditioned basement?

Used with permission from Reddit:
https://www.reddit.com/r/hvacadvice/s/Sxi34NVENG

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Is there visible damage or leaks in the ducts?

INSERT YOUR LOGO

Are the ducts properly insulated?

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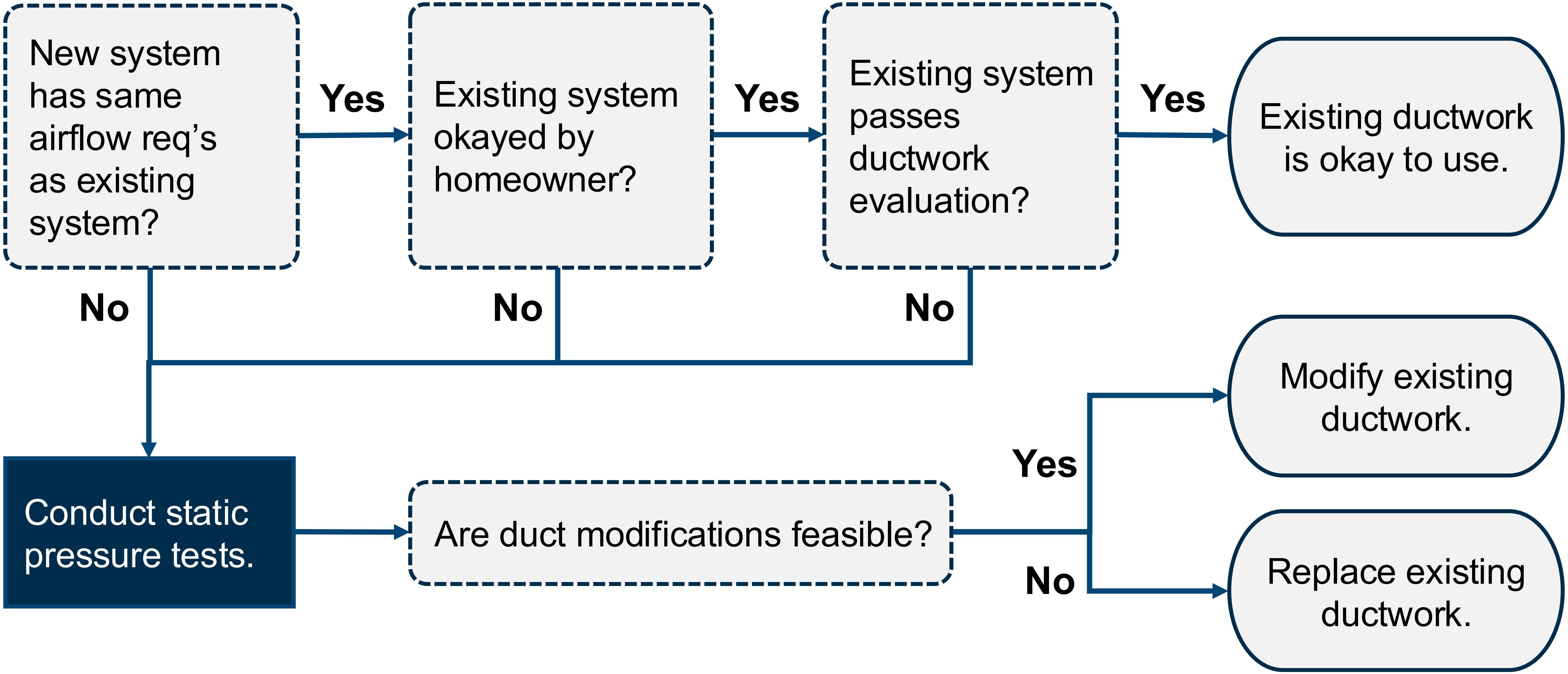
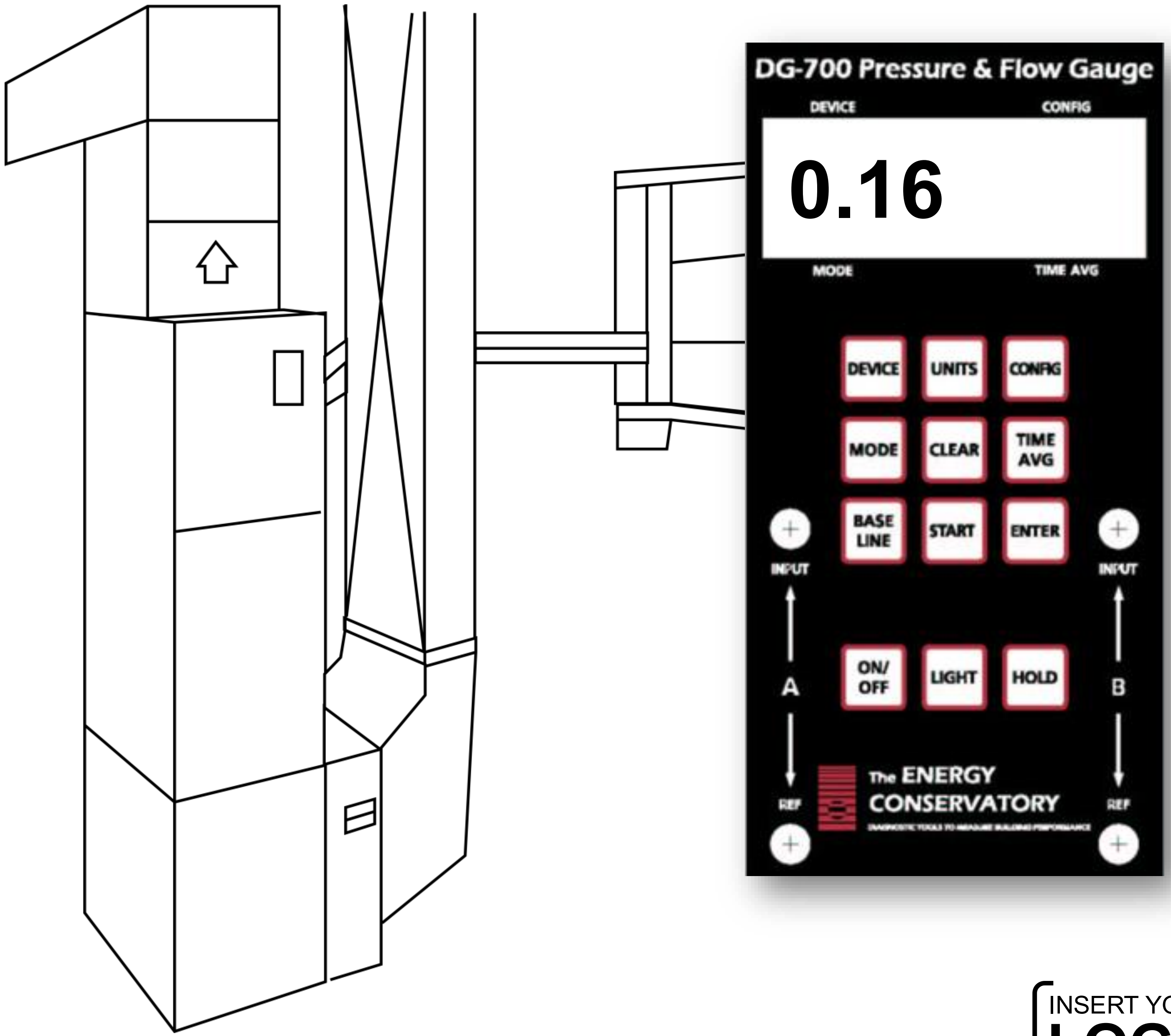
Issue so far? Conduct a static pressure test



Perform static pressure tests to measure TESP and filter pressure

TESP = Total External Static Pressure



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Analyze the results

- Check the manufacturer recommended TESP for the model installed
- Compare this value against the measured TESP

Remember! Variable speed ASHPs will seldomly be on maximum air flow

Graph represents general rules and does not represent one manufacturer or model

Single-stage	Variable capacity
0.1	0.1
0.2	0.2
0.3	0.3
0.4	0.4
0.5	0.5
0.6	0.6
0.7	0.7
0.8	0.8
0.9	0.9
1.0	1.0
1.1	1.1
1.2	1.2

Inches of water column
Total External Static Pressure

High TESP? Check the filter first

The most common cause of high TEST is a dirty or incorrectly situated filter.

Measure the filter pressure to help diagnose this issue.

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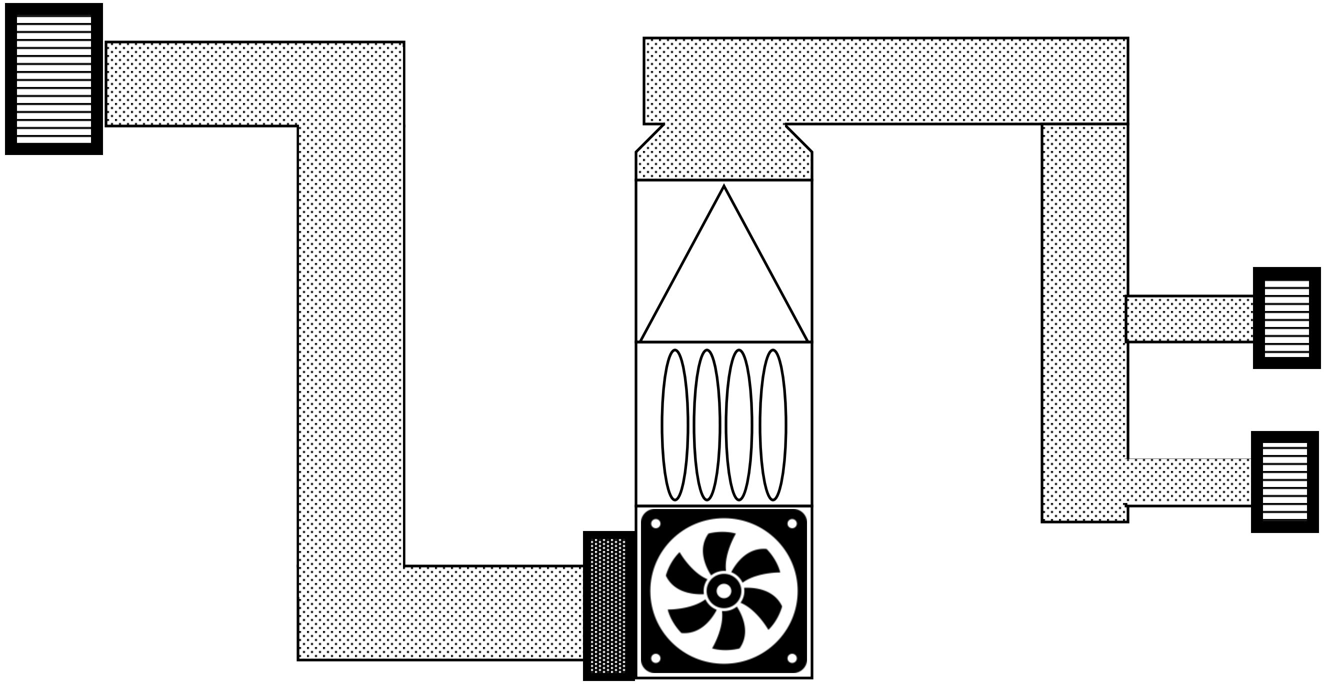
Identify other components that add to TESP

This helps identify the ductwork modifications that minimize work and maximize impact.



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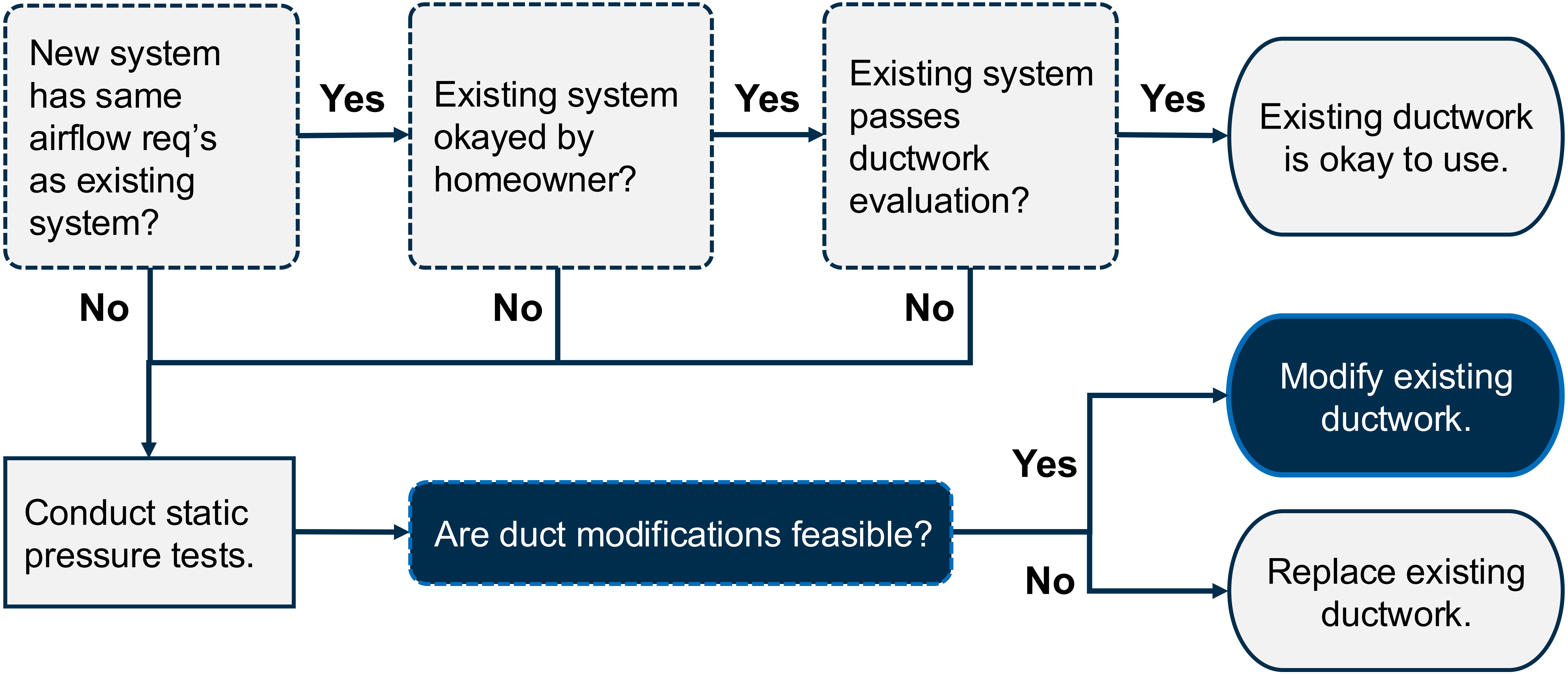
When ductwork modifications are feasible



Consider these modification options

1. Size for the cooling load
2. Upsize return duct size
3. Upgrade base cans and major plenum connections
4. Split house loads addressed by central ducted system + a ductless heat pump
5. Add additional runs
6. Increase the duct size to the registers
7. Size for the maximum airflow

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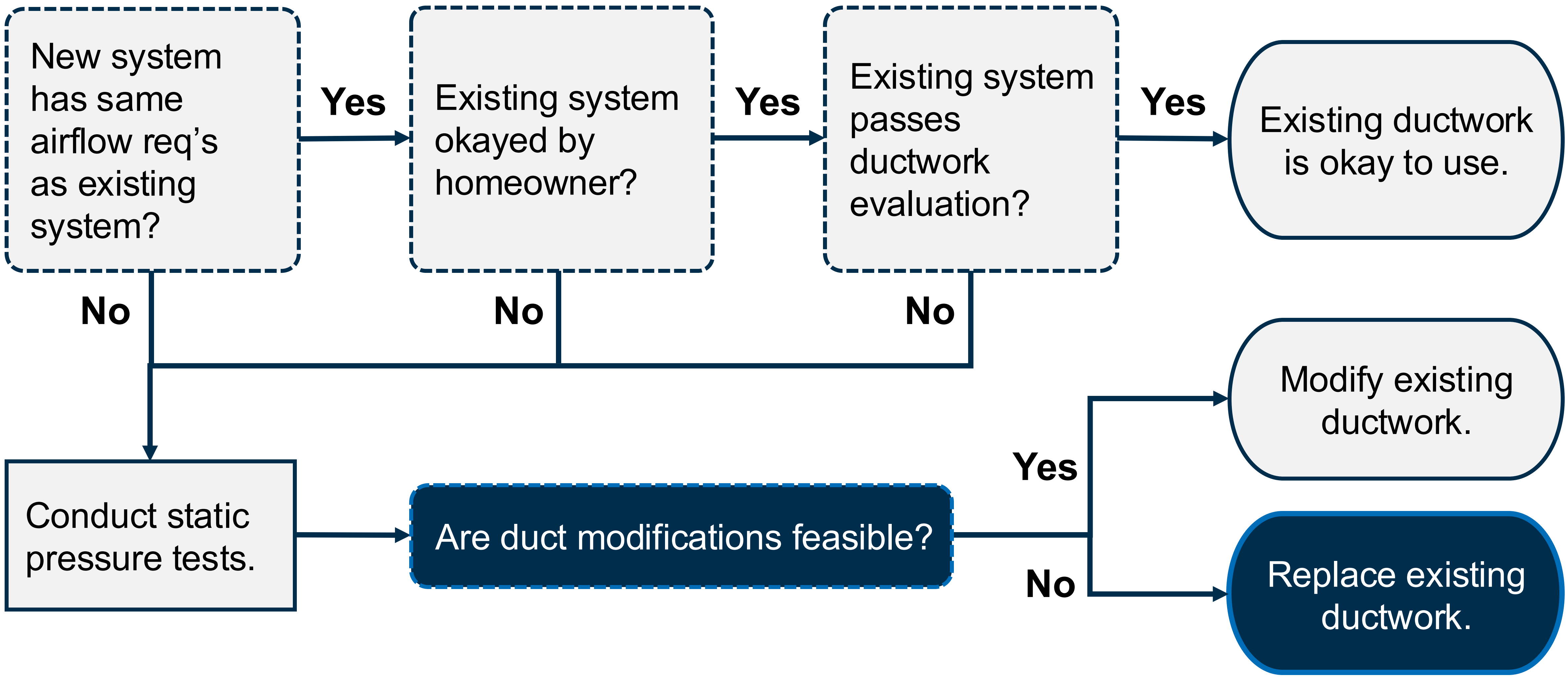
Consider replacing ductwork if modifications are not possible



What we covered and what other methods are available

Minimum Practice

- ✓ Interview the homeowner
- ✓ Visually evaluate the ducts
- ✓ Non-diagnostic commissioning

Better Practice

- ✓ **Perform static pressure test**
- ❑ Verify duct balancing
- ❑ Measure airflow at registers with flow-hood

Professional Grade

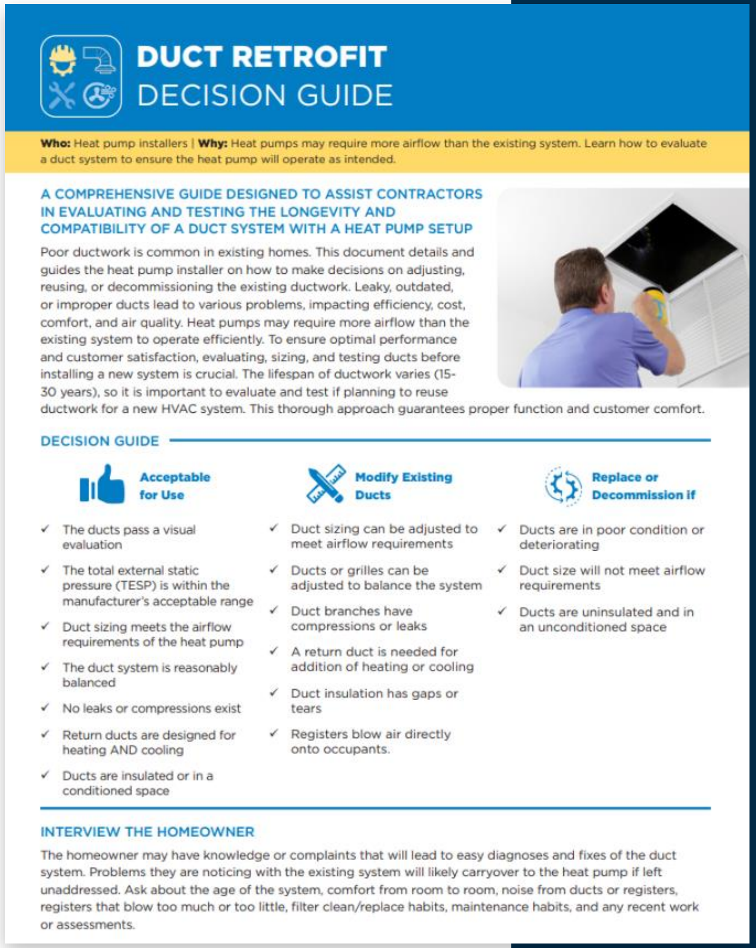
- ❑ Assess duct leakage with duct-blaster or blower door and pressure pan
- ❑ Complete a Manual D and compare to existing ducts

Duct Retrofit Decision Guide

Includes:

- Minimum Practice for sales staff
- Better Practice for selling technicians
- Professional Grade for home performance contractors, addressing severe comfort tand IAQ issues

This link is also stored in the **Training Resources** page.



DUCT RETROFIT
DECISION GUIDE

Who: Heat pump installers | **Why:** Heat pumps may require more airflow than the existing system. Learn how to evaluate a duct system to ensure the heat pump will operate as intended.

A COMPREHENSIVE GUIDE DESIGNED TO ASSIST CONTRACTORS IN EVALUATING AND TESTING THE LONGEVITY AND COMPATIBILITY OF A DUCT SYSTEM WITH A HEAT PUMP SETUP

Poor ductwork is common in existing homes. This document details and guides the heat pump installer on how to make decisions on adjusting, reusing, or decommissioning the existing ductwork. Leaky, outdated, or improper ducts lead to various problems, impacting efficiency, cost, comfort, and air quality. Heat pumps may require more airflow than the existing system to operate efficiently. To ensure optimal performance and customer satisfaction, evaluating, sizing, and testing ducts before installing a new system is crucial. The lifespan of ductwork varies (15-30 years), so it is important to evaluate and test if planning to reuse ductwork for a new HVAC system. This thorough approach guarantees proper function and customer comfort.

DECISION GUIDE

Acceptable for Use

- ✓ The ducts pass a visual evaluation
- ✓ The total external static pressure (TESP) is within the manufacturer's acceptable range
- ✓ Duct sizing meets the airflow requirements of the heat pump
- ✓ The duct system is reasonably balanced
- ✓ No leaks or compressions exist
- ✓ Return ducts are designed for heating AND cooling
- ✓ Ducts are insulated or in a conditioned space

Modify Existing Ducts

- ✓ Duct sizing can be adjusted to meet airflow requirements
- ✓ Ducts or grilles can be adjusted to balance the system
- ✓ Duct branches have compressions or leaks
- ✓ A return duct is needed for addition of heating or cooling
- ✓ Duct insulation has gaps or tears
- ✓ Registers blow air directly onto occupants.

Replace or Decommission if

- ✓ Ducts are in poor condition or deteriorating
- ✓ Duct size will not meet airflow requirements
- ✓ Ducts are uninsulated and in an unconditioned space

INTERVIEW THE HOMEOWNER

The homeowner may have knowledge or complaints that will lead to easy diagnoses and fixes of the duct system. Problems they are noticing with the existing system will likely carryover to the heat pump if left unaddressed. Ask about the age of the system, comfort from room to room, noise from ducts or registers, registers that blow too much or too little, filter clean/replace habits, maintenance habits, and any recent work or assessments.

What we covered

- Recognize the importance of a ductwork assessment
- Three steps to assess the ductwork: Compare airflow requirements, interview the homeowner, and evaluate
- Ductwork issues and resolutions through feasible modifications or replacement

INSERT YOUR LOGO

Control Strategies

Learning objectives

By the end of the module, you will be able to:

- Summarize best practices for selecting thermostats- especially for dual fuel systems
- Describe how to identify balance points and select switchover temperatures
- Apply additional control strategies for auxiliary heat

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Selecting the proper thermostat is critical

This is especially important when replacing an AC.

Heat pumps should be controlled with a **dual fuel compatible thermostat.**

Caution:

- Not all thermostats are dual fuel compatible!
- Even some heat pump compatible thermostats do not work with auxiliary heat!

What should you look for in a thermostat for AC replacements?

- **4+ wires or wireless** to control the reversing valve
- **Dual fuel control software** to control auxiliary heat
- **Outdoor air temperature monitor** to set switchover and condenser lockout temp
  - E.g., a hardwired sensor, wireless sensor, or Wi-Fi connection to check the weather
  - An alternative is a supply air temperature sensor
- **(optional) Multi-stage heating controls** for more flexibility and comfort

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Proprietary versus 3rd-party thermostats

	Proprietary Thermostats	Third-Party Thermostats
Non-communicating systems	✓	✓
Communicating systems	✓ ✓	✗

Always ask your distributor or manufacturer's rep for guidance- especially if the customer demands a third-party thermostat.

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How do you factor in your customers' preferences?

Scenario: Your customer cares most about improving her comfort. She also is expecting operational cost savings. She like her current ecobee.

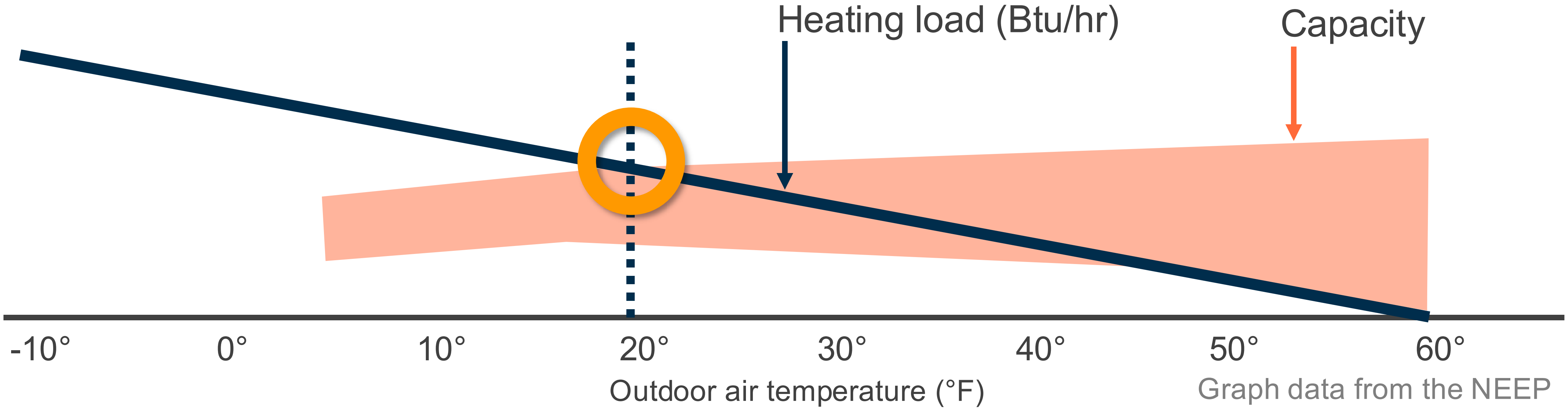
How do you approach this conversation?

The capacity (or thermal) balance point

The lowest outdoor temp that the heat pump **can meet the heating load.**

Depends on:

- Equipment capacity
- Home heating load



Graph data from the NEEP Cold-climate heat pump list

The economic balance point

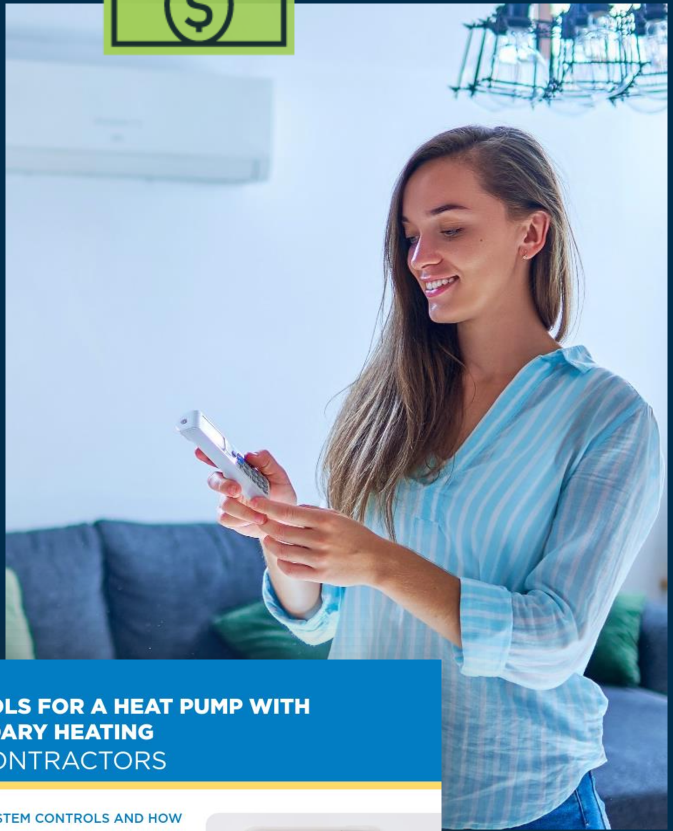
The lowest outdoor temperature that the heat pump **costs the same or less to run than the auxiliary heat**

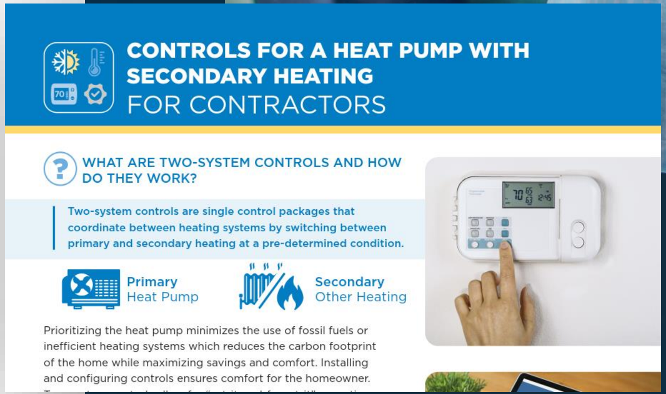
Depends on:

- Equipment efficiency
- Electric rates
- Natural gas/propane rates

Download a controls guide PDF from our website.

This link is also stored in the **Training Resources** page.





CONTROLS FOR A HEAT PUMP WITH SECONDARY HEATING FOR CONTRACTORS

WHAT ARE TWO-SYSTEM CONTROLS AND HOW DO THEY WORK?

Two-system controls are single control packages that coordinate between heating systems by switching between primary and secondary heating at a pre-determined condition.

Primary Heat Pump

Secondary Other Heating

Prioritizing the heat pump minimizes the use of fossil fuels or inefficient heating systems which reduces the carbon footprint of the home while maximizing savings and comfort. Installing and configuring controls ensures comfort for the homeowner.

Economic Balance Point Calculation – Natural Gas, standard electric rate

BeCOP = Breakeven Coefficient of Performance

$$BeCOP = \frac{(E \times C \times Ef)}{G}$$

E = $/kWh

C = kWh/therm **(constant)**

Ef = Efficiency of furnace

G = $/therm

1 gal propane = 27 kWh
1 therm natural gas = 29.3 kWh

Example House Calculation

E = $0.14/kWh

C = 29.3 kWh/therm

Ef = 0.97 (97% AFUE)

G = $1.06/therm

$$BeCOP = \frac{(0.14 \times 29.3 \times 0.97)}{1.06}$$

BeCOP = 3.75

Use the Performance Specs chart and BeCOP to estimate the economic balance point

BeCOP = 3.75

- Find the **Rated COP** at different temps
- Depending on where the **BeCOP** falls, estimate the **economic balance point**

Our estimate: ~45-55°F

Heating/ Cooling	Outdoor Dry Bulb	Unit	Min	Rated	Max
Heating	47°F	Btu/h	11,500	27,400	35,000
		kW	0.91	2.47	3.73
		COP	3.7	**3.25**	2.75
Heating	17°F	Btu/h	6,400	19,400	25,500
		kW	0.82	2.23	3.31
		COP	2.25	**2.55**	2.26
Heating	5°F	Btu/h	5,400	20,800	20,800
		kW	0.83	3.1	3.1
		COP	1.91	**1.97**	1.97
Heating	-3°F	Btu/h	5,400	-	18,800
		kW	0.93	-	2.85
		COP	1.7	-	1.93

Economic Balance Point Calculation – Natural Gas, dual fuel rate

BeCOP = Breakeven Coefficient of Performance

$$BeCOP = \frac{(E \times C \times Ef)}{G}$$

E = $/kWh

C = kWh/therm **(constant)**

Ef = Efficiency of furnace

G = $/therm

1 gal propane = 27 kWh
1 therm natural gas = 29.3 kWh

Example House Calculation

E = $0.07/kWh

C = 29.3 kWh/therm

Ef = 0.97 (97% AFUE)

G = $1.06/therm

$$BeCOP = \frac{(0.07 \times 29.3 \times 0.97)}{1.06}$$

BeCOP = 1.88

Use the Performance Specs chart and BeCOP to estimate the economic balance point

BeCOP = 1.88

- Find the **Rated COP** at different temps
- Depending on where the **BeCOP** falls, estimate the **economic balance point**

Our estimate: <5°F

Heating/ Cooling	Outdoor Dry Bulb	Unit	Min	Rated	Max
Heating	47°F	Btu/h	11,500	27,400	35,000
		kW	0.91	2.47	3.73
		COP	3.7	**3.25**	2.75
Heating	17°F	Btu/h	6,400	19,400	25,500
		kW	0.82	2.23	3.31
		COP	2.25	**2.55**	2.26
Heating	5°F	Btu/h	5,400	20,800	20,800
		kW	0.83	3.1	3.1
		COP	1.91	**1.97**	1.97
Heating	-3°F	Btu/h	5,400	-	18,800
		kW	0.93	-	2.85
		COP	1.7	-	1.93

Economic Balance Point Calculation – Propane, standard electric rate

BeCOP = Breakeven Coefficient of Performance

$$BeCOP = \frac{(E \times C \times Ef)}{G}$$

E = $/kWh

C = kWh/gal **(constant)**

Ef = Efficiency of furnace

G = $/gal propane

1 gal propane = 27 kWh
1 therm natural gas = 29.3 kWh

Example House Calculation

E = $0.14/kWh

C = 27 kWh/gal propane

Ef = 0.97 (97% AFUE)

G = $2.03/gal

$$BeCOP = \frac{(0.14 \times 27 \times 0.97)}{2.03}$$

BeCOP = 1.81

What if the customer has propane?

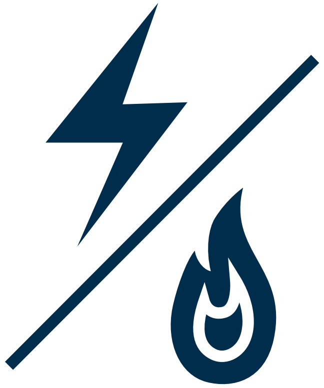
BeCOP = 1.81

- Find the **Rated COP** at different temps
- Depending on where the **BeCOP** falls, estimate the **economic balance point**

Our estimate: <5°F

Heating/ Cooling	Outdoor Dry Bulb	Unit	Min	Rated	Max
Heating	47°F	Btu/h	11,500	27,400	35,000
		kW	0.91	2.47	3.73
		COP	3.7	**3.25**	2.75
Heating	17°F	Btu/h	6,400	19,400	25,500
		kW	0.82	2.23	3.31
		COP	2.25	**2.55**	2.26
Heating	5°F	Btu/h	5,400	20,800	20,800
		kW	0.83	3.1	3.1
		COP	1.91	**1.97**	1.97
Heating	-3°F	Btu/h	5,400	-	18,800
		kW	0.93	-	2.85
		COP	1.7	-	1.93

Auxiliary heat control methods



Ducted Dual-Fuel

- Set or confirm a switchover temp
- Set or confirm a droop temp

Ducted All-Electric

- Set or confirm a lockout temp
- If droop not an option: Use supplemental heat upstage timer

Set a switchover temp using a Supply Air Temperature Sensor.
Always check default settings when setting up control methods!

What is a droop temperature setting?

Droop sets the maximum allowable temperature drop before the auxiliary heat engages

Droop can fully engage or upstage the auxiliary heat

Indoor temp setpoint:	70°F
Droop setting:	2°F
Aux. heat engages:	**<68°F**

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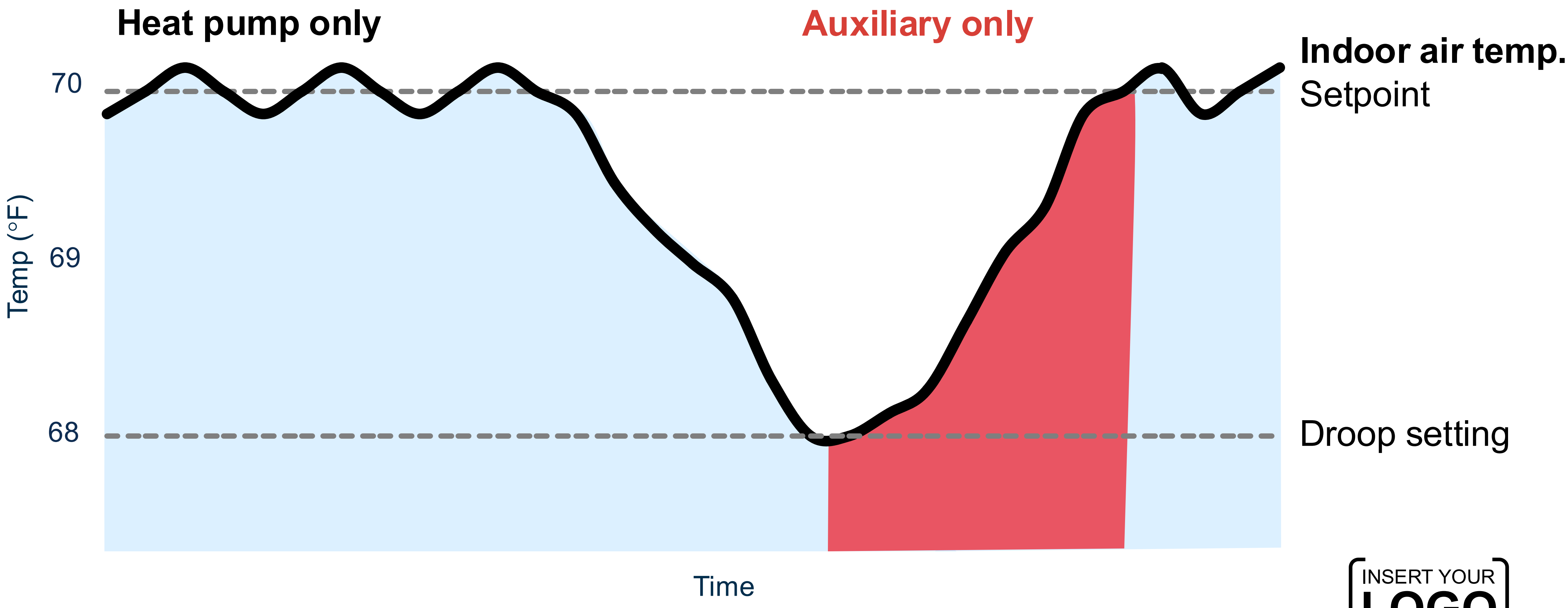
Droop method for a ducted dual fuel system



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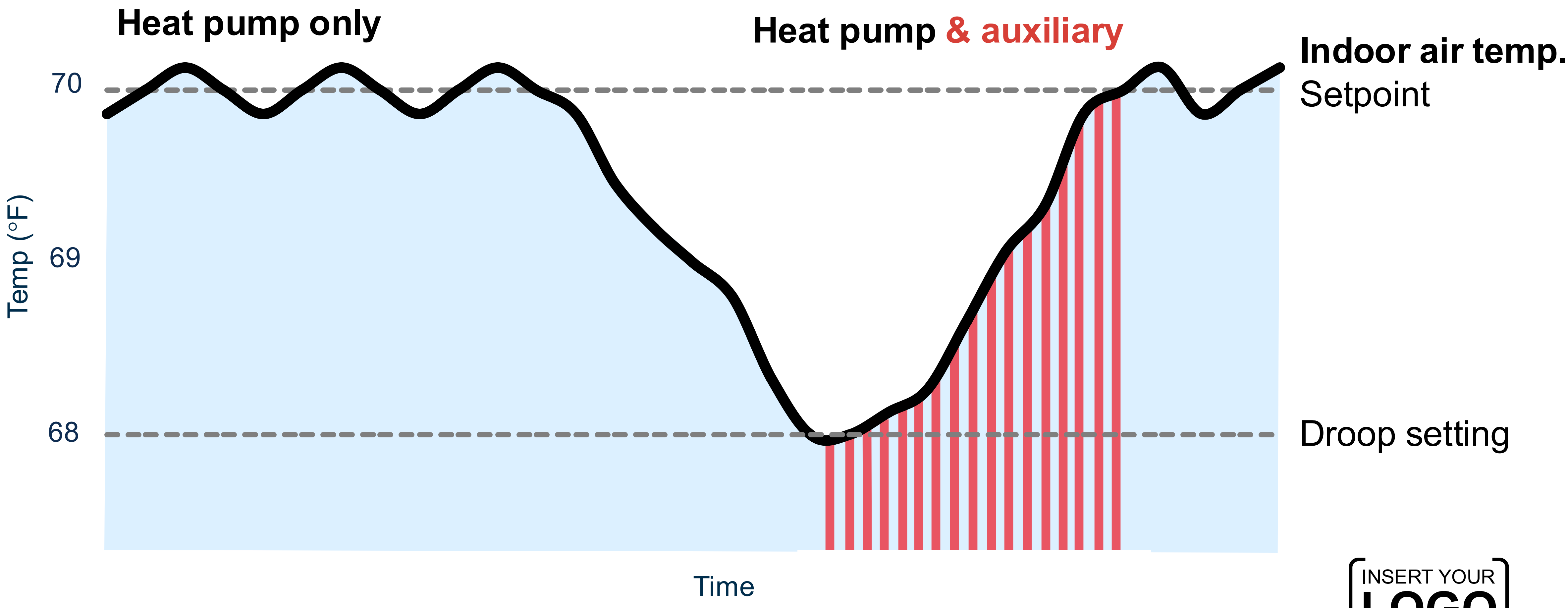
Droop method for a ducted all-electric & ductless systems



What we covered

- Best practices for selecting thermostats- especially for dual fuel systems
- How to identify balance points and select switchover temperatures
- Additional control strategies for auxiliary heat

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Equipment Selection

What's important in Sizing and Selection?

- Understanding the basics of Manual S
  - Size limits
  - Latent load
- Other critical components
  - Turndown ratio
  - Addressing homes with heating loads 1.5x cooling loads
  - Where to find expanded performance data
  - Using the NEEP tool for data visualization and selection
  - Rolling up recommendations into a checklist

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Learning objectives

By the end of the module, you will be able to:

- Recognize equipment selection challenges and how to overcome them
- Utilize available equipment selection tools to support the accuracy of your work and increase customer confidence

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What are challenges and considerations when selecting equipment?

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Challenges and considerations we covered previously

- When to size for heating or cooling
- Whether the system would work with the existing ductwork
- What ductwork retrofit options may improve airflow
- Where to place outdoor units
- How to factor in future weatherization work

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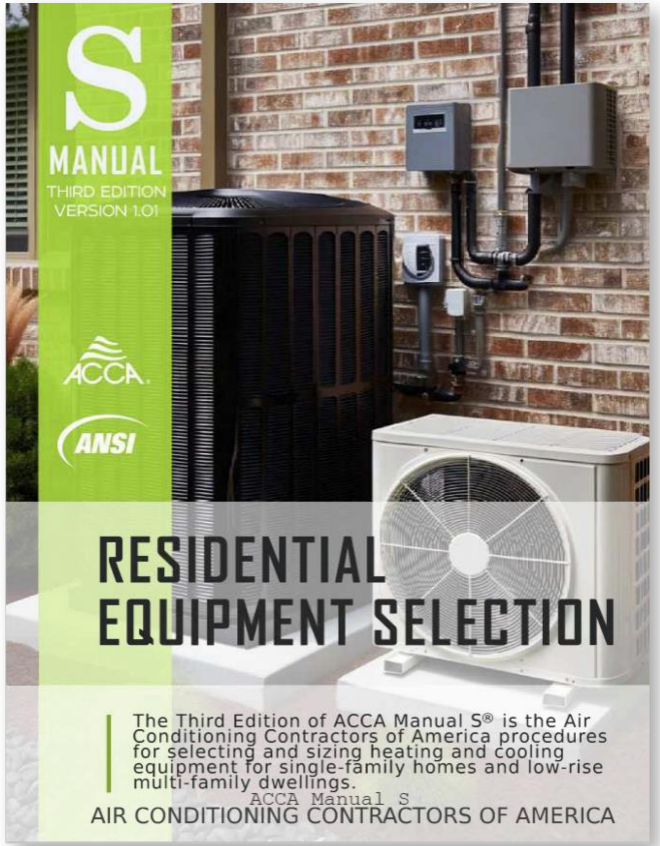
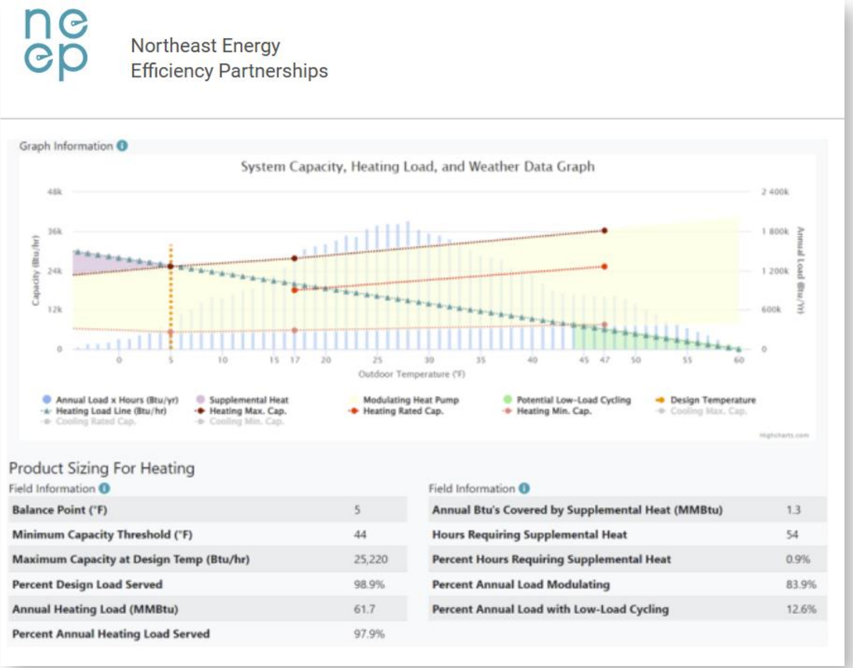
Manual S and NEEP





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Updated Manual S sizing guidance

Equipment Type	Heating Size Limit*	Cooling Size Limit*
Single-stage AC	NA	120%
Two-stage AC	NA	125%
Single- and two-stage ASHP	120%	120%
Combustion system	140%	NA
Variable-capacity ASHP	150%	130%
Auxiliary electric resistance	175%	NA

* Limits reference design loads

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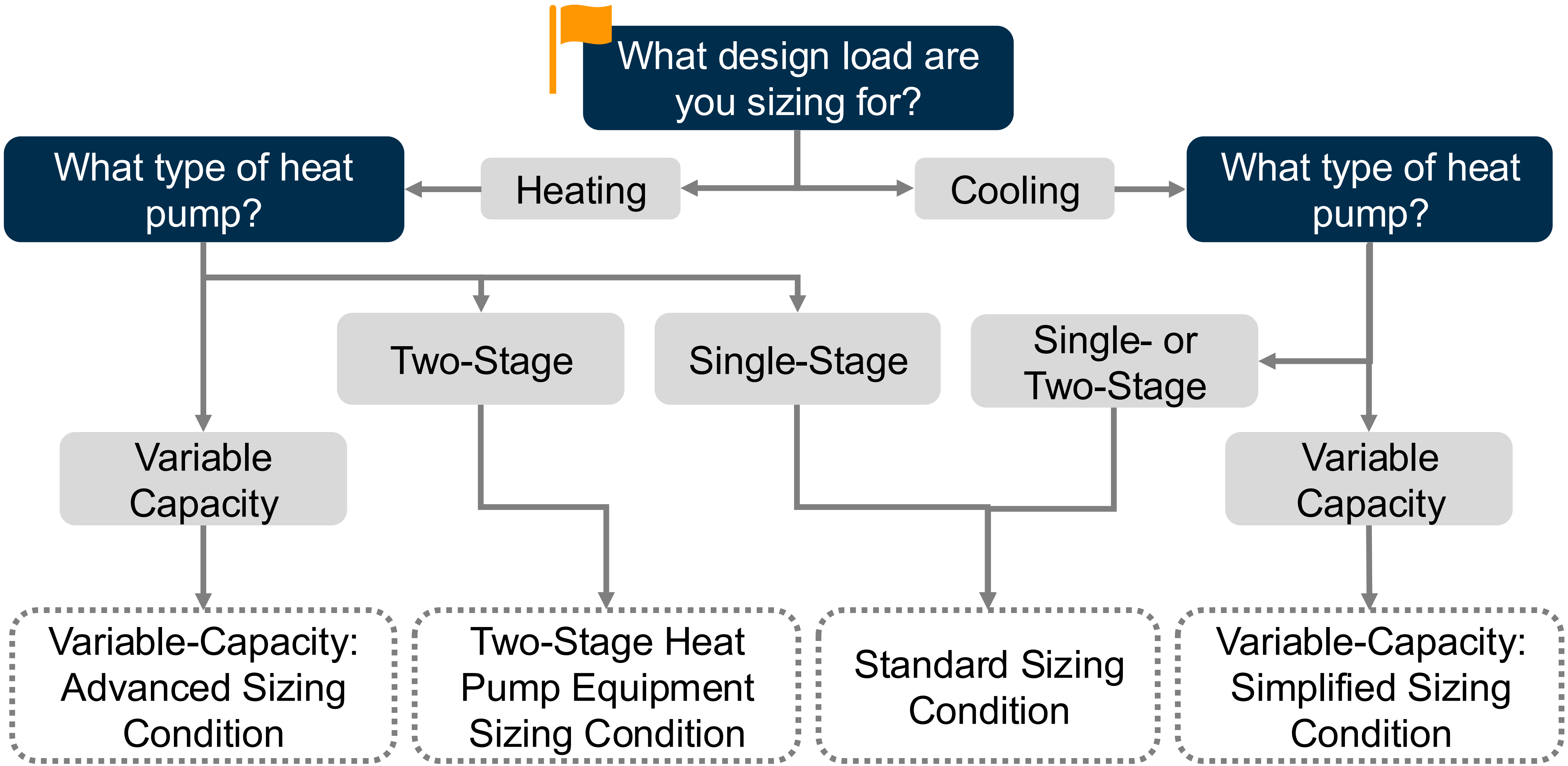
Manual S: Determining the heat pump sizing condition



Manual S: Equipment selection & sizing procedure

1. **Produce a load calculation.**
2. **When heat pump equipment is used, determine the heat pump sizing condition.**
3. Procure OEM performance data.
4. For forced-air systems, determine the entering air condition for cooling and heating.
5. Determine blower airflow in CFM for cooling and heating.
6. Extract capacity values from performance data. As needed, interpolate OEM capacity values for the operating conditions that apply.
7. **Ensure that the selected equipment conforms to the size limits that apply to the project.**
8. Product a project file that documents the design decisions.

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Key considerations

Manual S is complicated – what are the key areas we can focus on to ensure we’re incorporating the most important principles?

- Heating to cooling design load ratios
- How to best use capacity tables
- Sensible vs latent load and “right sizing”

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Heating to cooling design load ratio

Example: 2000 sq ft home in Minneapolis

Outdoor Design Conditions (MN Code)	
Location	Minneapolis
Summer Db	88°
Summer Wb	72°
Winter Db	-15°

Heating/Cooling Loads	
Heating Load	40,000 BTU/hr
Cooling Load	22,000 BTU/hr
Sensible Load	20,000 BTU/hr
Latent Load	2,000 BTU/hr

$$Heating\ to\ cooling\ design\ load\ ratio = \frac{Heating\ design\ load}{Cooling\ design\ load}$$

$$\frac{40{,}000\ BTU/hr}{22{,}000\ BTU/hr} = 1.8$$

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What do you need to consider when the heating load is >1.5x higher than the cooling load?

Consideration	Notes
Sizing for variable-capacity units	Use a balanced approach for dual fuel sizing (don't oversize for cooling)
Capacity maintenance	Look for high capacity maintenance (70% of capacity @ 5°F / 47°F)
Weatherization and ventilation	Discuss options with the homeowner
Mix-and-match heat pump solutions	Zone the house and install systems per zone
Short-cycling	Short-cycling should occur less than 30% of annual hours in both heating and cooling

Know where to find capacity tables for selected equipment

The issue: AHRI data simulates a small geographic area.

A solution: Use manufacturer extended performance data.

- More detailed
- Wider variety of results

For easier selection: Narrow down available product lines as you find “best” solutions.

			Outdoor Ambient Temperature															
			65°F				75°F				85°F				95°F			
			Entering Indoor Wet Bulb Temperature															
IDB*	Airflow		59	63	67	71	59	63	67	71	59	63	67	71	59	63	67	71
		MBh	25.1	25.5	26.2	27.4	24.7	25.0	25.8	26.9	23.8	24.2	24.9	26.0	22.5	22.8	23.6	24.7
		S/T	1.00	0.81	0.67	0.52	1.00	0.82	0.67	0.52	1.00	0.84	0.70	0.55	1.00	0.86	0.72	0.57
		ΔT	28	26	23	19	28	26	22	19	27	26	22	19	26	25	22	18
	770	kW	1.26	1.26	1.26	1.27	1.47	1.47	1.46	1.47	1.70	1.70	1.70	1.71	1.97	1.96	1.96	1.98
		Amps	6.0	6.0	5.9	6.0	6.7	6.7	6.7	6.7	7.5	7.5	7.5	7.6	8.4	8.4	8.4	8.4
		Hi PR	219	220	222	225	258	259	260	264	299	300	302	306	345	346	348	352
		Lo PR	130	134	141	152	134	138	145	156	136	140	148	159	138	142	[illegible]	160
		MBh	25.5	25.9	26.6	27.7	25.1	25.4	26.1	27.3	24.2	24.5	25.3	26.4	22.9	23.2	**24.0**	25.1
		S/T	1.00	0.89	0.75	0.60	1.00	0.90	0.75	0.60	1.00	0.92	0.78	0.63	1.00	0.94	**0.80**	0.65
		ΔT	27	25	22	18	26	24	21	18	26	24	21	17	25	23	**20**	17
80	900	kW	1.27	1.27	1.27	1.28	1.48	1.48	1.47	1.48	1.71	1.71	1.71	1.72	1.98	1.98	**1.97**	2.01
		Amps	6.0	6.0	6.0	6.1	6.8	6.8	6.7	6.8	7.6	7.6	7.6	7.6	8.4	8.4	**8.4**	8.5
		Hi PR	221	222	224	228	260	261	263	267	302	303	304	308	348	349	**350**	354
		Lo PR	132	136	143	155	136	140	147	159	139	143	150	161	140	144	**151**	162
		MBh	26.0	26.3	27.1	28.2	25.5	25.9	26.6	27.8	24.7	25.0	25.7	26.9	23.3	23.7	[illegible]	25.5
		S/T	1.00	0.94	0.79	0.64	1.00	0.94	0.79	0.64	1.00	0.96	0.82	0.67	1.00	1.00	0.84	0.69
		ΔT	26	24	20	17	25	23	20	17	25	23	20	16	24	22	19	16
	1040	kW	1.28	1.28	1.28	1.29	1.48	1.48	1.48	1.49	1.72	1.72	1.72	1.73	1.99	1.98	2.01	2.02
		Amps	6.1	6.0	6.0	6.1	6.8	6.8	6.8	6.8	7.6	7.6	7.6	7.6	8.5	8.5	8.5	8.5
		Hi PR	224	224	226	230	262	263	265	269	304	305	307	311	350	351	352	356
		Lo PR	135	139	146	158	139	143	150	162	141	145	152	164	142	146	153	165

AHRI only uses the highlighted section!
It is important to find the correct section for equipment in our specific climate.

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Sensible Heat Fraction (SHF)

Sensible Heat Fraction is the capability of selected equipment

- Acronyms include CSHR or S/T
- Ratio of cooling system sensible heat to total heat removal
- Manufacturer data shows equipment sensible heat fraction as a decimal (S/T) and listed with a total capacity (MBh or TC, depending on the manufacturer)

75°F	**MBh**	**25.8**	**26.5**	**26.7**
	S/T	**0.83**	**0.69**	**0.54**
	ΔT	19	16	13
	kW	1.72	1.72	1.73
	Amps	7.6	7.6	7.6

INSERT YOUR LOGO

Finding the Sensible Cooling Capacity

This system was “Rated” as a 24,000 BTU/hr cooling heat pump

Total Capacity x Sensible Heat Fraction = Sensible Cooling Capacity

75°F	**MBh**	**25.8**	**26.5**	**26.7**
	S/T	**0.83**	**0.69**	**0.54**
	ΔT	19	16	13
	kW	1.72	1.72	1.73
	Amps	7.6	7.6	7.6

*Total Capacity **(25,800 BTU/hr)** x SHF **(0.83)** = Sensible Cooling Capacity **(21,414 BTU)***

INSERT YOUR LOGO

Sensible Heat Ratio (JSHR)

The ratio of sensible load to total cooling load from the Manual J load calculation.

Heating/Cooling Loads	
Heating Load	40,000 BTU/hr
Cooling Load	22,000 BTU/hr
Sensible Load	20,000 BTU/hr
Latent Load	2,000 BTU/hr

$$JSHR = \frac{Sensible\ Load\ (\frac{BTU}{hr})}{Cooling\ Load\ (\frac{BTU}{hr})}$$

$$JSHR = \frac{20{,}000}{22{,}000} = 0.91$$

INSERT YOUR LOGO

Sensible Heat Fraction vs Sensible Heat Ratio

Sensible Heat Fraction (SHF) = **0.83**

Sensible Heat Ratio (SHR) = **0.91**

Heating/Cooling Loads	
Heating Load	40,000 BTU/hr
Cooling Load	22,000 BTU/hr
Sensible Load	20,000 BTU/hr
Latent Load	2,000 BTU/hr

SHF should be *lower* than the SHR ✓

If SHR if higher than SHR,
dehumidification should be considered

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Quick design guidance

Metric	Upper Midwest Goals
Sensible Heat Fraction (SHF)	At or lower than Sensible Heat Ratio (SHR)
Weatherization recommended	Yes, particularly for propane and all-electric systems+
Low-load short cycling	Watch for cooling low-load short cycling
Dehumidification solution or dry mode	Only if SHF is the same or slightly higher than SHR

+ Weatherization is always recommended if heating load to cooling load is 1.5 or more, unless multiple systems are being designed to handle the home

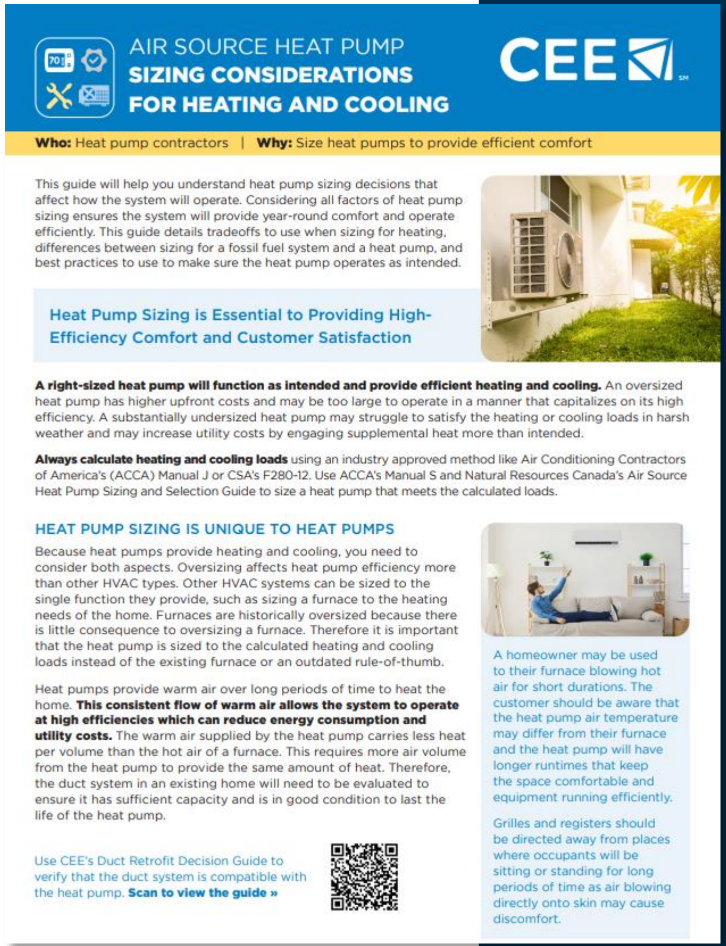
INSERT YOUR LOGO

Refer to CEE's Sizing Considerations for Heating and Cooling resource

Includes:

- Sizing methods
- Flow chart to determine ACCA sizing condition to use
- Sizing tips and tricks

This link is also stored in the **Training Resources** page.



AIR SOURCE HEAT PUMP
SIZING CONSIDERATIONS FOR HEATING AND COOLING

CEE

Who: Heat pump contractors | **Why:** Size heat pumps to provide efficient comfort

This guide will help you understand heat pump sizing decisions that affect how the system will operate. Considering all factors of heat pump sizing ensures the system will provide year-round comfort and operate efficiently. This guide details tradeoffs to use when sizing for heating, differences between sizing for a fossil fuel system and a heat pump, and best practices to use to make sure the heat pump operates as intended.

Heat Pump Sizing is Essential to Providing High-Efficiency Comfort and Customer Satisfaction

A right-sized heat pump will function as intended and provide efficient heating and cooling. An oversized heat pump has higher upfront costs and may be too large to operate in a manner that capitalizes on its high efficiency. A substantially undersized heat pump may struggle to satisfy the heating or cooling loads in harsh weather and may increase utility costs by engaging supplemental heat more than intended.

Always calculate heating and cooling loads using an industry approved method like Air Conditioning Contractors of America's (ACCA) Manual J or CSA's F280-12. Use ACCA's Manual S and Natural Resources Canada's Air Source Heat Pump Sizing and Selection Guide to size a heat pump that meets the calculated loads.

HEAT PUMP SIZING IS UNIQUE TO HEAT PUMPS

Because heat pumps provide heating and cooling, you need to consider both aspects. Oversizing affects heat pump efficiency more than other HVAC types. Other HVAC systems can be sized to the single function they provide, such as sizing a furnace to the heating needs of the home. Furnaces are historically oversized because there is little consequence to oversizing a furnace. Therefore it is important that the heat pump is sized to the calculated heating and cooling loads instead of the existing furnace or an outdated rule-of-thumb.

Heat pumps provide warm air over long periods of time to heat the home. **This consistent flow of warm air allows the system to operate at high efficiencies which can reduce energy consumption and utility costs.** The warm air supplied by the heat pump carries less heat per volume than the hot air of a furnace. This requires more air volume from the heat pump to provide the same amount of heat. Therefore, the duct system in an existing home will need to be evaluated to ensure it has sufficient capacity and is in good condition to last the life of the heat pump.

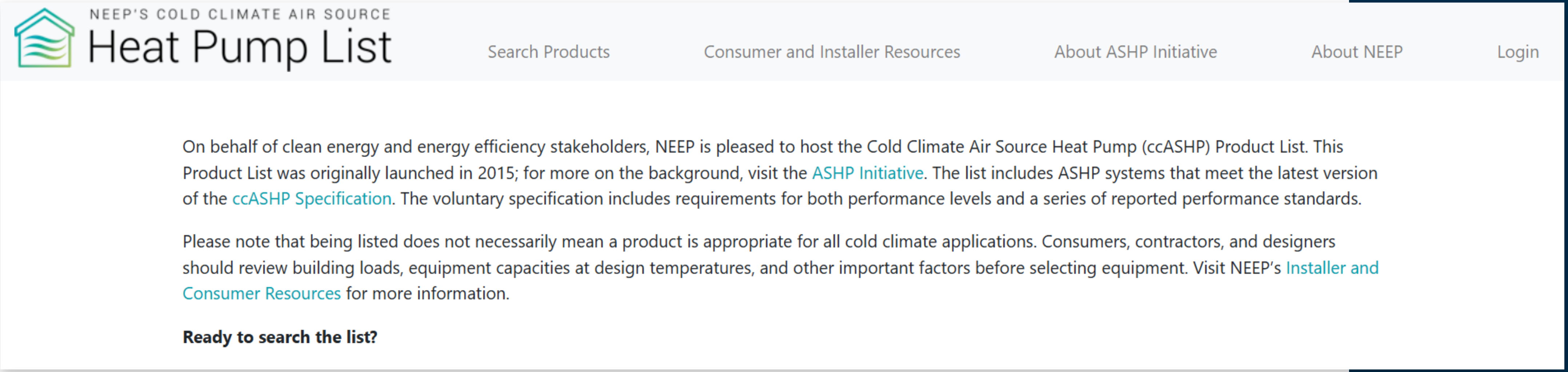
Use CEE's Duct Retrofit Decision Guide to verify that the duct system is compatible with the heat pump. **Scan to view the guide »**

A homeowner may be used to their furnace blowing hot air for short durations. The customer should be aware that the heat pump air temperature may differ from their furnace and the heat pump will have longer runtimes that keep the space comfortable and equipment running efficiently.

Grilles and registers should be directed away from places where occupants will be sitting or standing for long periods of time as air blowing directly onto skin may cause discomfort.

A walkthrough of the NEEP Sizing for Heating tool

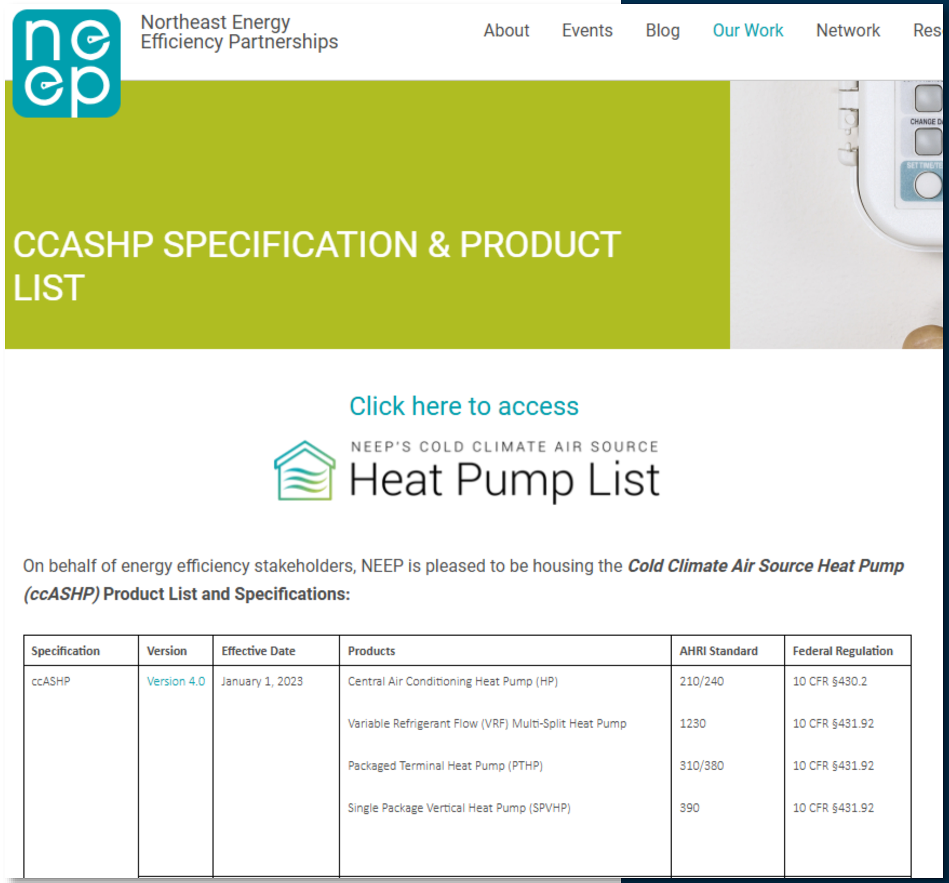
ashp.neep.org/#!/product_list/



This link is also stored in the **Training Resources** page.

A walkthrough of the NEEP Advanced Sizing for Heating tool

Note: This is a selection tool and NOT a true sizing tool.



On behalf of energy efficiency stakeholders, NEEP is pleased to be housing the ***Cold Climate Air Source Heat Pump (ccASHP)*** **Product List and Specifications:**

Specification	Version	Effective Date	Products	AHRI Standard	Federal Regulation
ccASHP	Version 4.0	January 1, 2023	Central Air Conditioning Heat Pump (HP)	210/240	10 CFR §430.2
			Variable Refrigerant Flow (VRF) Multi-Split Heat Pump	1230	10 CFR §431.92
			Packaged Terminal Heat Pump (PTHP)	310/380	10 CFR §431.92
			Single Package Vertical Heat Pump (SPVHP)	390	10 CFR §431.92

ashp.neep.org/#!/product_list/

This link is also stored in the **Training Resources** page.

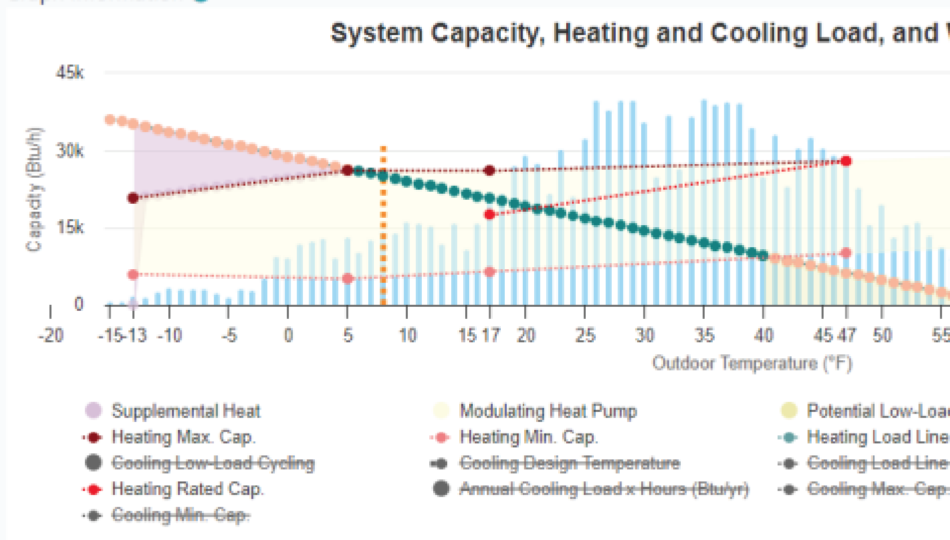
What is the value of the NEEP tool?

- Compares equipment options for a home application
- Accounts for design temps
- Identifies capacity balance points

NEEP'S COLD CLIMAT
Heat Pum

Figure 2: ***Product View Results Example***

Graph Information



Product Sizing For Heating

View Oversizing Effects

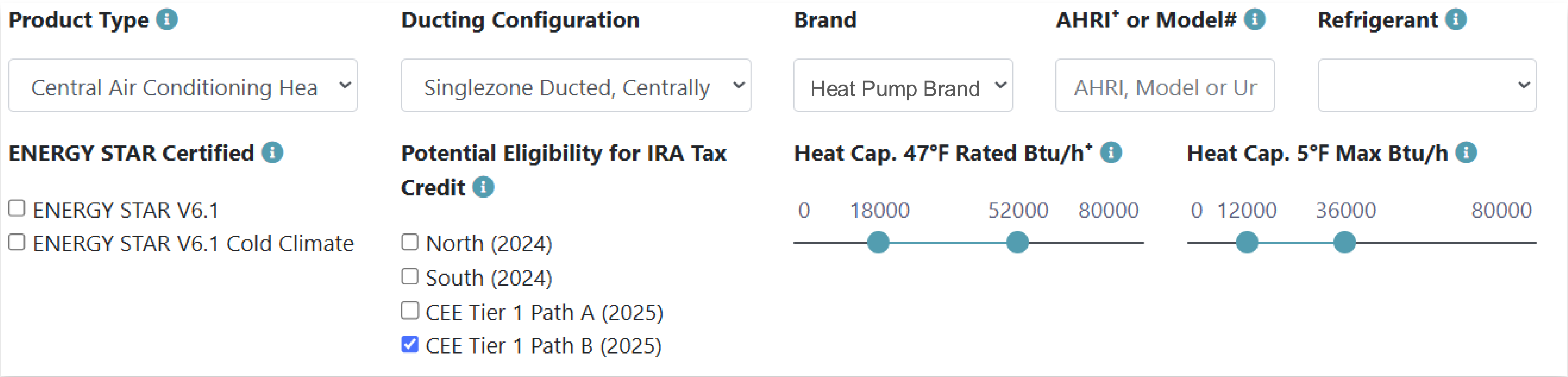
Definition/Use Cases

Capacity Balance Point (°F)	6
Minimum Capacity Threshold (°F)	40
Maximum Capacity at Design Temp (Btu/h)	26,000
Percent Design Load Served	104.0%
Annual Heating Load (MMBtu)	55.8
Percent Annual Heating Load Served	93.0%

Definition/Use Ca

Annual Btu's Co
Hours Requiring
Percent Hours F
Percent Annual
Percent Annual

The first input screen



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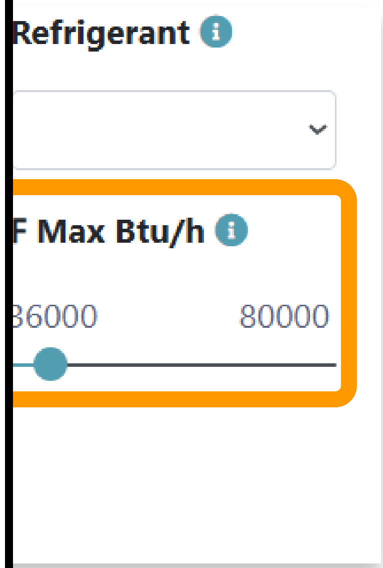
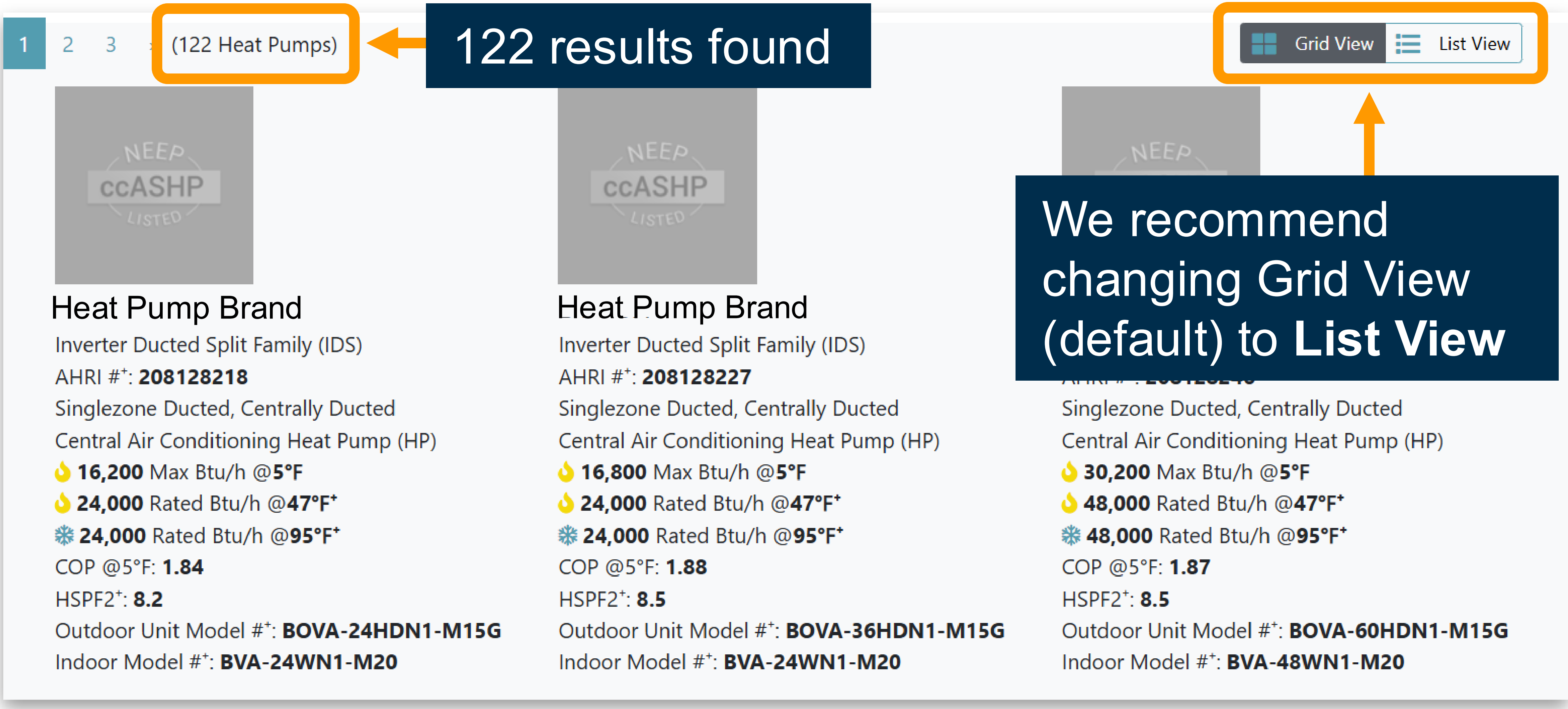
Our example inputs

Summary:

- **Type:** Central Air Conditioning Heat Pump
- **Ducting Configuration:** Singlezone Ducted, Centrally Ducted
- **Brand:** Heat Pump Brand
- **AHRI, Model, Unit #:** (none entered)
- **Rated Heating Capacity @47F:** 18,000 – 52,000 Btu/h
- **Max Heating Capacity @ 5F:** 12,000 – 36,000 Btu/h
- **Potential Eligibility for Tax Credit:** CEE Tier 1 Path B (2025)



The search results- Grid view



The search results- List view

‹ 1 2 3 4 5 6 7 8 9 10 › (5445 Heat Pumps)

Grid View | List View

Download Product List

View.	Brand Name	AHRI Reference #	Ducting Config	Outdoor Unit Model #	Indoor Model(s)	Furnace Unit #	SEER2	HSPF2 (Region IV)	COP at Max Capacity @5°	Max Capacity @5°F	Rated Capacity @47°F	Rated Capacity @95°F
	MOOVAIR	216623468	Singlezone Duc...	MSHMA30R2AN1	MCHI				1.9		36000	36000
	BRYANT HEATING AN...	213770284	Singlezone Duc...	284ANV048*0**B*	CAP**				2.36		46000	44500
	CAPELLA	216623798	Singlezone Duc...	CCB1-H36A-O	CACB				1.9		36000	36000
	CanAir	216621492	Singlezone Duc...	4CDH2036C21	CEB-3				1.9		36000	36000
	LENNOX	207436598	Singlezone Duc...	SL25XPV-048-230...	CX35-				1.76		44000	45000
	LENNOX	207436597	Singlezone Duc...	SL25XPV-048-230...	CX35-				1.76		44000	45500
	MIDEA	216623526	Singlezone Duc...	MO1SE-H36B-2A	MAAHE-H36B-CA		15.8	9.4	1.9	36000	36000	36000
	COMFORT-AIRE	216623771	Singlezone Duc...	A-VXP36TA-1	MXP30/36C1A		15.8	9.4	1.9	36000	36000	36000
	COMFORT-AIRE	216623770	Singlezone Duc...	A-VXP36TA-1	MXP30/36B1A		15.8	9.4	1.9	36000	36000	36000
	Panasonic	216621501	Singlezone Duc...	CU-HM36BAHU	CS-HM36BAAU2		15.8	9.4	1.9	36000	36000	36000
	LENNOX	207436586	Singlezone Duc...	SL25XPV-048-230...	CX35-49C+TDR	EL296UH090XV...	20	8.9	1.76	36000	44000	45000
	LENNOX	214626240	Singlezone Duc...	SL25XPV-048-230...	CK40CT-49C-0*+...	EL297UH110XV...	20	8.9	1.76	36000	44000	45500
	ELIOS	216760016	Singlezone Duc...	ESHMB36R2AN1	GUHMA36RCAS1		15.8	9.4	1.9	36000	38000	36000
	BRYANT HEATING AN...	206790588	Singlezone Duc...	284ANV048*0**B*	FE4AN(B,F)005L+UI		22	9.5	2.32	36000	46000	45000
	DIRECT AIR	216623493	Singlezone Duc...	DIRM4-36MAGIC...	DIRM4-4821MAG...		15.8	9.4	1.9	36000	36000	36000
	LENNOX	207436599	Singlezone Duc...	SL25XPV-048-230...	CX35-49C+TDR	SLP99UH090XV...	20	8.9	1.78	36000	44000	45500
	ELIOS	216760015	Singlezone Duc...	ESHMB36R2AN1	GUHMA36RBAS1		15.8	9.4	1.9	36000	38000	36000

Sort Ascending
Sort Descending
Remove Sort
Hide Column

Columns allow sorting and hiding

INSERT YOUR LOGO

Download product list is available to NEEP members

‹ 1 2 3 4 5 6 7 8 9 10 › (5445 Heat Pumps)

Download product list

Download Product List

View.	Brand Name	AHRI Reference #*	Ducting Config*..	Outdoor Unit Model #*	Indoor Model(s)*...	Furnace Unit #*..	SEER2*	HSPF2 (Region IV)*	COP at Max Capacity @5°F	Max Capacity @5°F	Rated Capacity @47°F*	Rated Capacity @95°F*
	MOOVAIR	216623468	Singlezone Duc...	MSHMA30R2AN1	MCHMA36RCAS1		15.8	9.4	1.9		36000	36000
	BRYANT HEATING AN...	213770284	Singlezone Duc...	284ANV048*0**B*	CAP**6024AL*+UI	88*TB60090C21...	21.5	9.5	2.36		46000	44500
	CAPELLA	216623798	Singlezone Duc...	CCB1-H36A-O	CACB1-H36A2124-I		15.8	9.4	1.9		36000	36000
	CanAir	216621492	Singlezone Duc...	4CDH2036C21	CEB-36MX1721		15.8	9.4	1.9		36000	36000
	LENNOX	207436598	Singlezone Duc...	SL25XPV-048-230...	CX35-49C+TDR	SLP99UH090XV...	20	8.9	1.76		44000	45000
	LENNOX	207436597	Singlezone Duc...	SL25XPV-048-230...	CX35-49C+TDR	SL297UH080NV...	20	8.9	1.76	36000	44000	45500
	MIDEA	216623526	Singlezone Duc...	MO1SE-H36B-2A	MAAHE-H36B-CA		15.8	9.4	1.9	36000	36000	36000
	COMFORT-AIRE	216623771	Singlezone Duc...	A-VXP36TA-1	MXP30/36C1A		15.8	9.4	1.9	36000	36000	36000
	COMFORT-AIRE	216623770	Singlezone Duc...	A-VXP36TA-1	MXP30/36B1A		15.8	9.4	1.9	36000	36000	36000
	Panasonic	216621501	Singlezone Duc...	CU-HM36BAHU	CS-HM36BAAU2		15.8	9.4	1.9	36000	36000	36000
	LENNOX	207436586	Singlezone Duc...	SL25XPV-048-230...	CX35-49C+TDR	EL296UH090XV...	20	8.9	1.76	36000	44000	45000
	LENNOX	214626240	Singlezone Duc...	SL25XPV-048-230...	CK40CT-49C-0*+...	EL297UH110XV...	20	8.9	1.76	36000	44000	45500
	ELIOS	216760016	Singlezone Duc...	ESHMB36R2AN1	GUHMA36RCAS1		15.8	9.4	1.9	36000	38000	36000
	BRYANT HEATING AN...	206790588	Singlezone Duc...	284ANV048*0**B*	FE4AN(B,F)005L+UI		22	9.5	2.32	36000	46000	45000
	DIRECT AIR	216623493	Singlezone Duc...	DIRM4-36MAGIC...	DIRM4-4821MAG...		15.8	9.4	1.9	36000	36000	36000
	LENNOX	207436599	Singlezone Duc...	SL25XPV-048-230...	CX35-49C+TDR	SLP99UH090XV...	20	8.9	1.78	36000	44000	45500
	ELIOS	216760015	Singlezone Duc...	ESHMB36R2AN1	GUHMA36RBAS1		15.8	9.4	1.9	36000	38000	36000

Sort Ascending
Sort Descending
Remove Sort
Hide Column

INSERT YOUR LOGO

Viewing an equipment page

Central Air Conditioning Heat Pump (HP)
Singlezone Ducted, Centrally Ducted
AHRI Cert #*:
Outdoor Unit Model #*
Indoor Model #*
Maximum Heating Capacity (Btu/h) @5°F: **36,000**
Rated Heating Capacity (Btu/h) @47°F*: **36,000**
Rated Cooling Capacity (Btu/h) @95°F*: **36,000**

Information Tables

Brand	
Series	
Ducting Configuration	Singlezone Ducted, Centrally Ducted

Performance Specs

Heating / Cooling	Outdoor Dry Bulb	Indoor Dry Bulb	Unit	Min	Rated	Max
Cooling	95°F	80°F	Btu/h	11,000	23,400	31,000
			kW	0.72	2.36	4.04
			COP	4.48	2.91	2.25
Cooling	82°F	80°F	Btu/h	12,200	-	34,000
			kW	0.67	-	3.76
			COP	5.34	-	2.65
Heating	47°F	70°F	Btu/h	11,500	27,400	35,000
			kW	0.91	2.47	3.73
			COP	3.7	3.25	2.75
Heating	17°F	70°F	Btu/h	6,400	19,400	25,500
			kW	0.82	2.23	3.31
			COP	2.29	2.55	2.26
Heating	5°F	70°F	Btu/h	5,400	20,800	20,800
			kW	0.83	3.1	3.1
			COP	1.91	1.97	1.97
Heating	-3°F	70°F	Btu/h	5,400	-	18,800

Information Page:

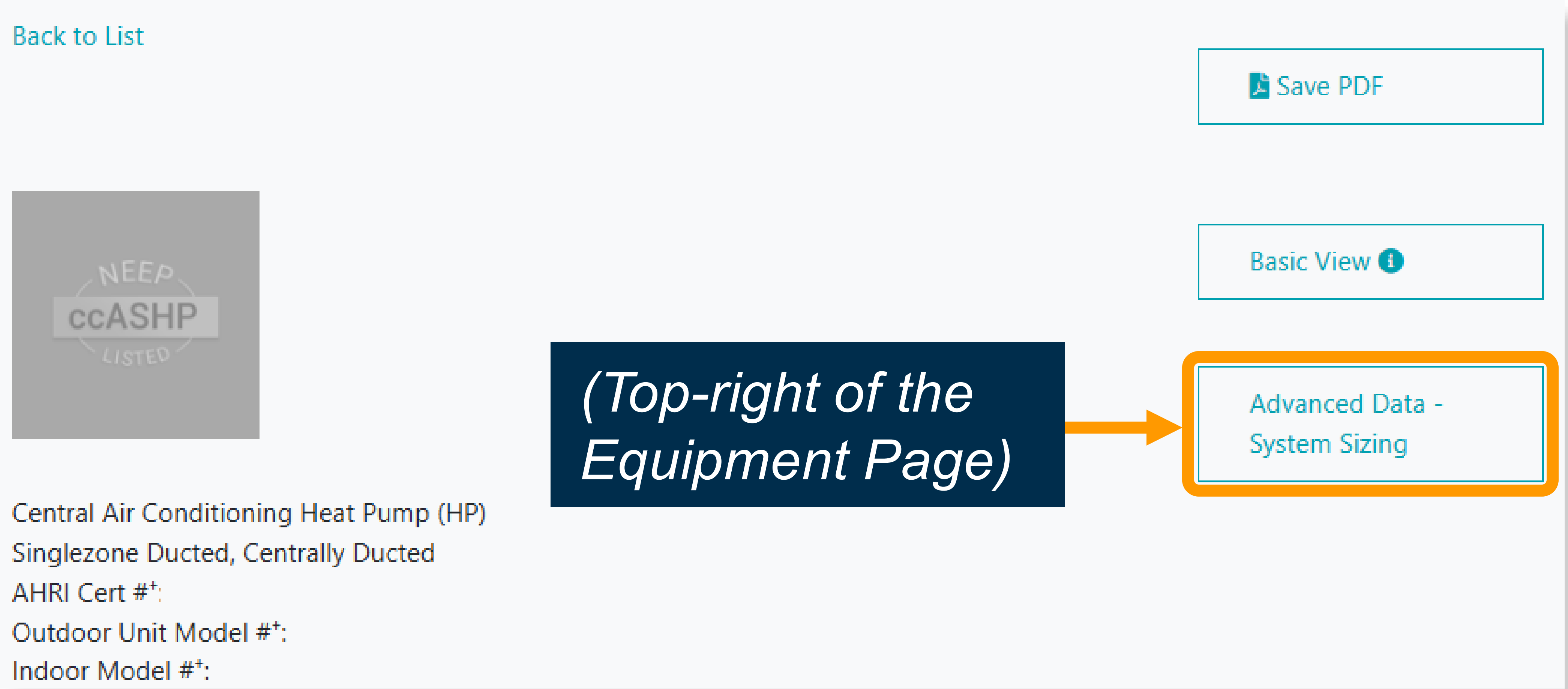
- Efficient ratings
- ENERGY STAR
- Potential IRA tax credit eligibility
- Capacity maintenance
- …and more

Performance Specs:

- Minimum and maximum rated capacities

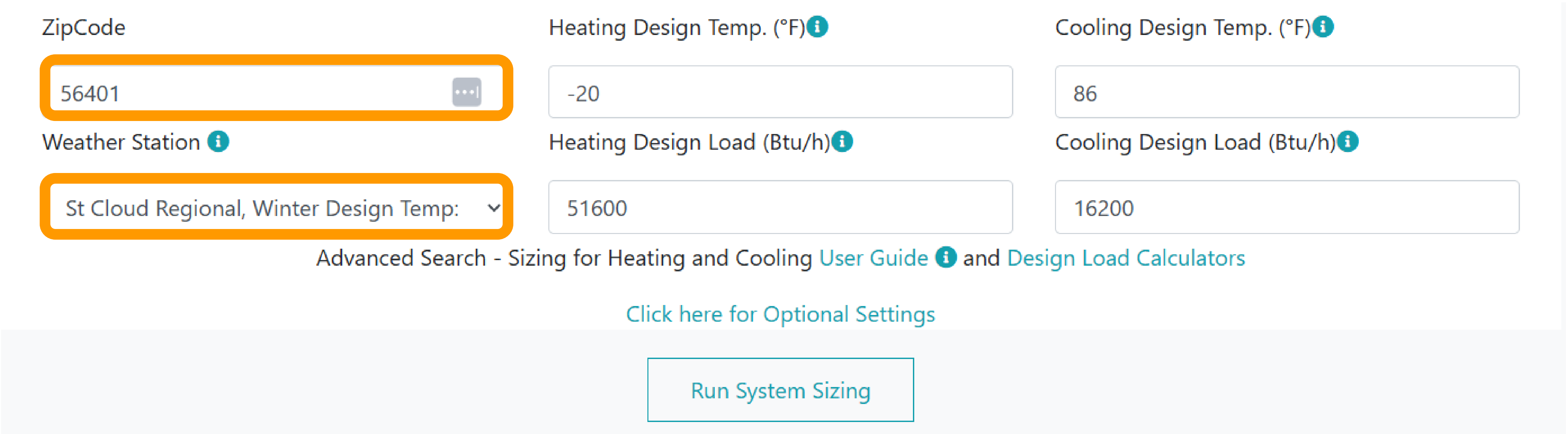
INSERT YOUR LOGO

Using Advanced Data – System Sizing



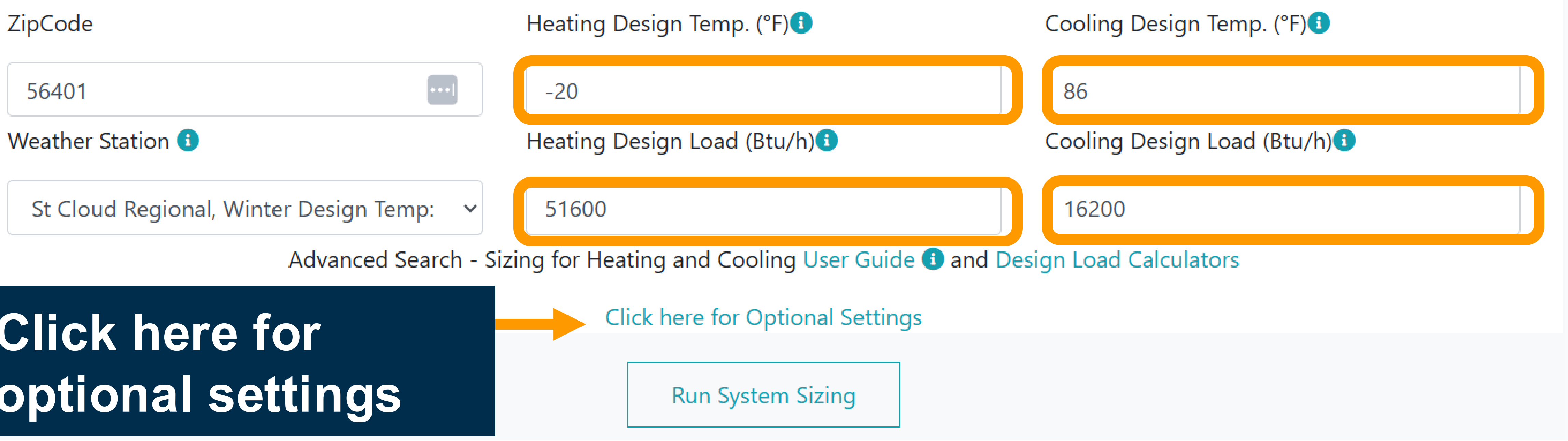
INSERT YOUR LOGO

In the NEEP Sizing for Heating Tool, enter the zip code and weather station



INSERT YOUR LOGO

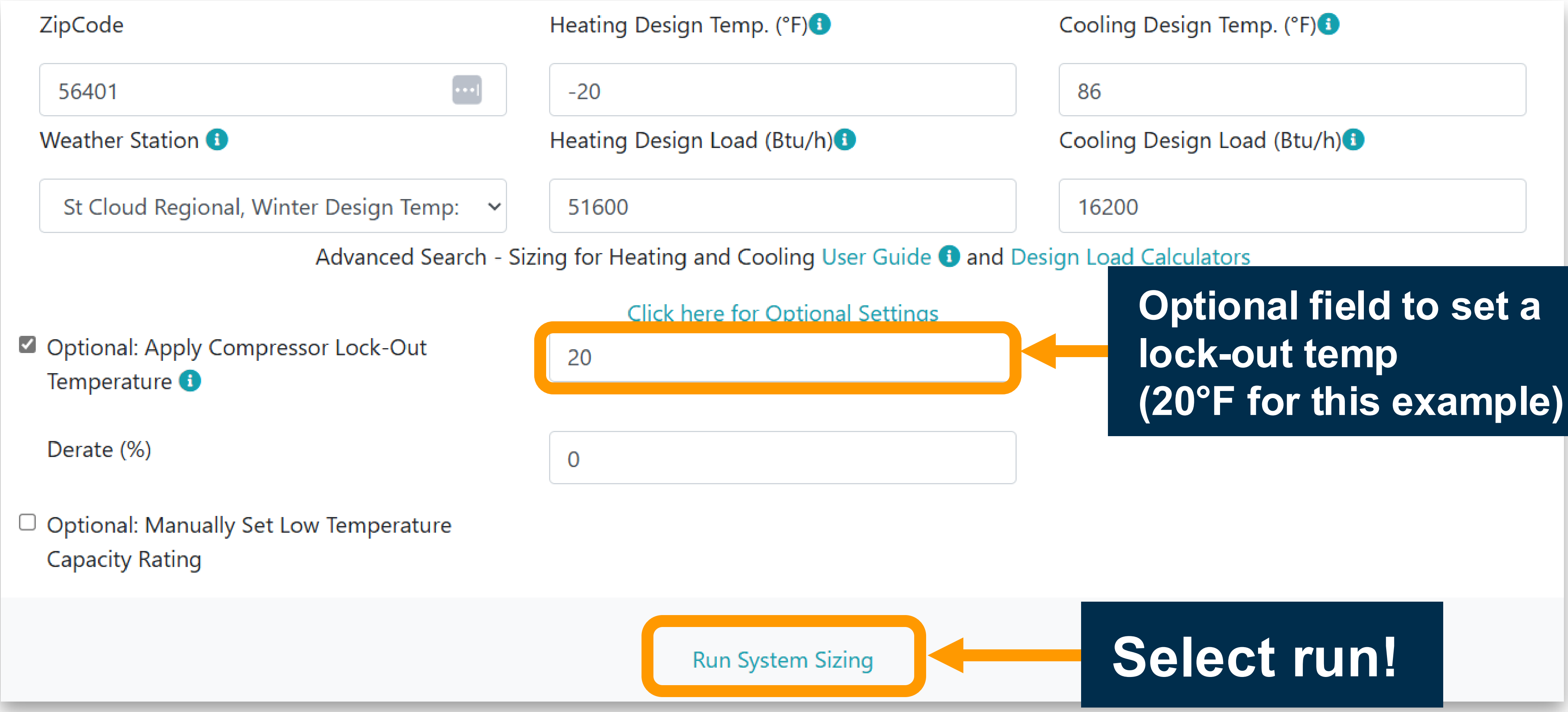
Enter heating and cooling design temps and loads (from your load calculations)



Click here for optional settings

INSERT YOUR LOGO

Select and enter optional settings as needed

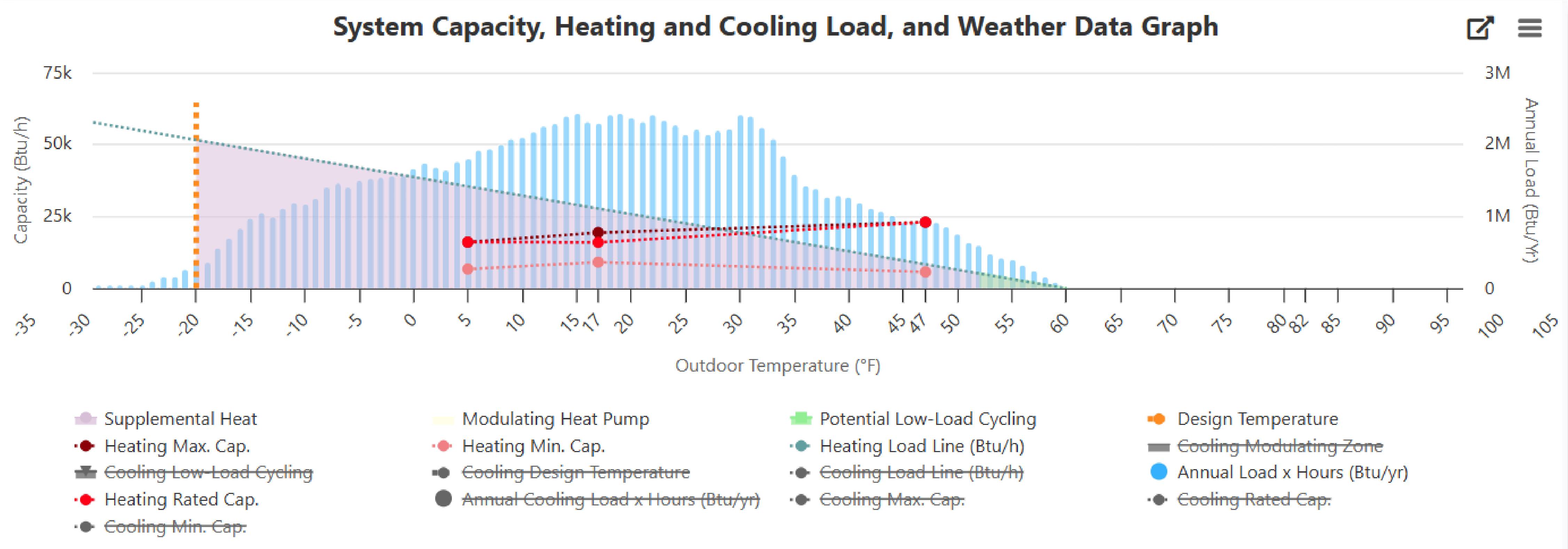


Optional field to set a lock-out temp (20°F for this example)

Select run!

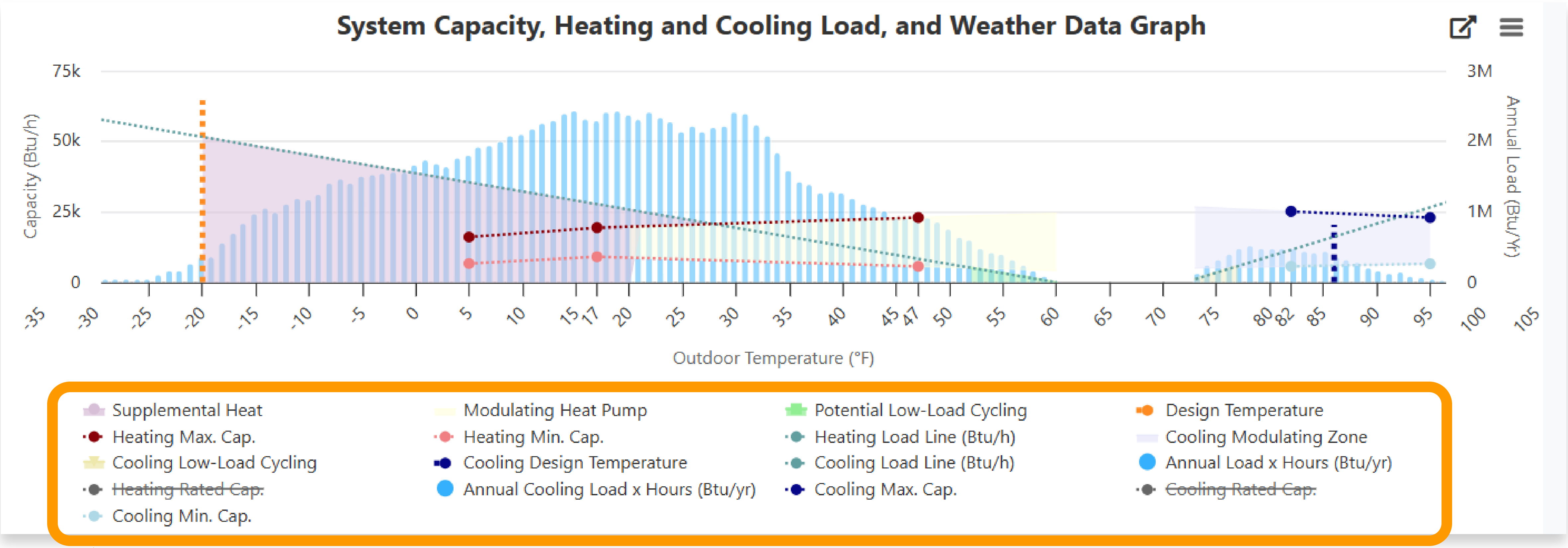
INSERT YOUR LOGO

The resulting graph with the default settings



INSERT YOUR LOGO

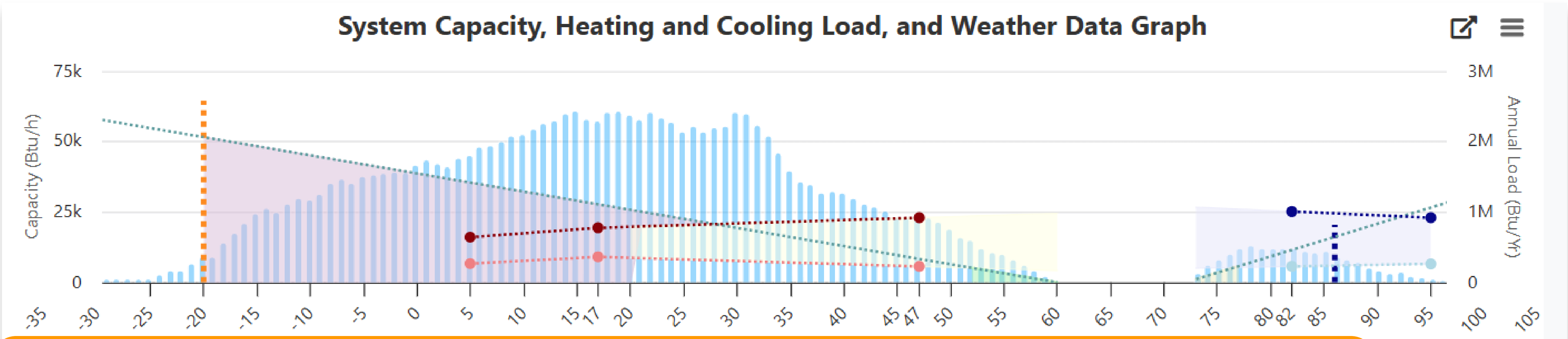
Toggle the data lines on or off to modify what the graph shows



Cooling inputs turned on,
Heating and cooling rated cap turned off

INSERT YOUR LOGO

Find additional values in tables below the graph



Product Sizing For Heating

View Oversizing Effects

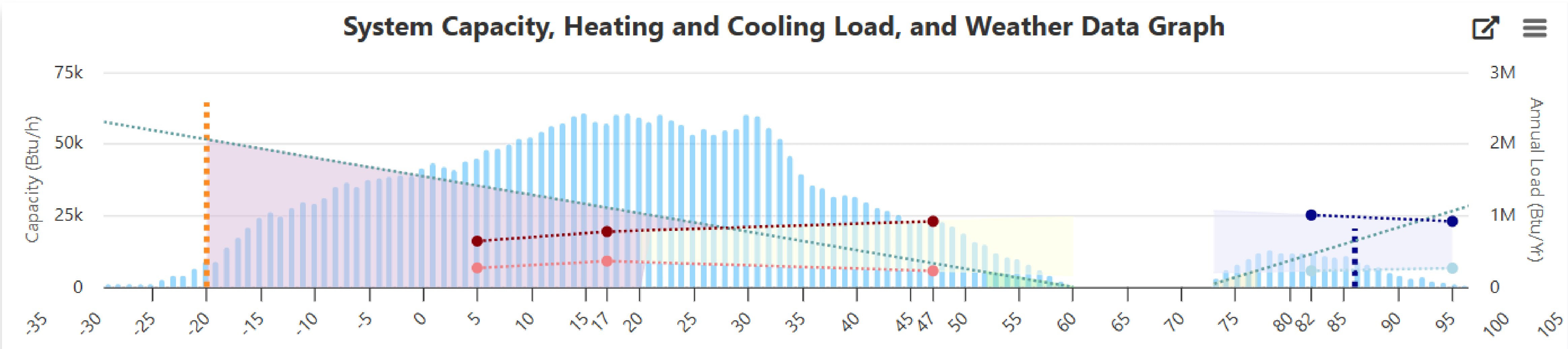
Definition/Use Cases

Capacity Balance Point (°F)	28
Minimum Capacity Threshold (°F)	52
Maximum Capacity at Design Temp (Btu/h)	No capacity at design Temperature
Percent Design Load Served	No capacity at design Temperature
Annual Heating Load (MMBtu)	119.9
Percent Annual Heating Load Served	32.8%

Definition/Use Cases

Annual Btu's Covered by Supplemental Heat (MMBtu)	80.6
Hours Requiring Supplemental Heat	2,614
Percent Hours Requiring Supplemental Heat	41.5%
Percent Annual Load Modulating	57.9%
Percent Annual Load with Low-Load Cycling	1.8%

The capacity balance point



Product Sizing For Heating

View Oversizing Effects

Definition/Use Cases

Capacity Balance Point (°F)	28
Minimum Capacity Threshold (°F)	52
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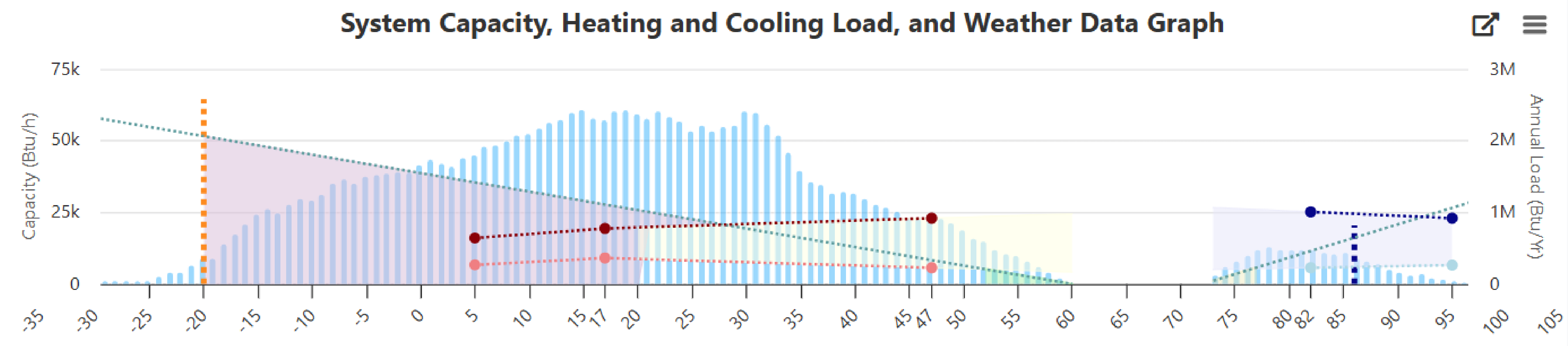
Percent Design Load Served	No capacity at design Temperature
Annual Heating Load (MMBtu)	119.9
Percent Annual Heating Load Served	32.8%

28

Definition/Use Cases

Annual Btu's Covered by Supplemental Heat (MMBtu)	80.6
Hours Requiring Supplemental Heat	2,614
Percent Hours Requiring Supplemental Heat	41.5%
Percent Annual Load Modulating	57.9%
Percent Annual Load with Low-Load Cycling	1.8%

The percent annual heating load served



Product Sizing For Heating

View Oversizing Effects

Definition/Use Cases

Capacity Balance Point (°F)	28
Minimum Capacity Threshold (°F)	52
Maximum Capacity at Design Temp (Btu/h)	No capacity at design Temperature
Percent Design Load Served	No capacity at design Temperature
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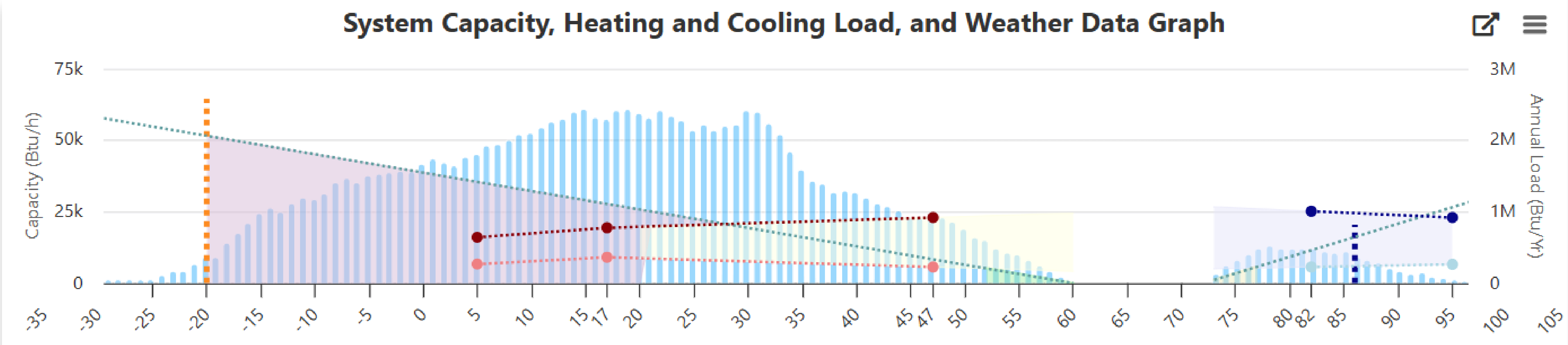
Definition/Use Cases

Annual Btu's Covered by Supplemental Heat (MMBtu)	80.6
Hours Requiring Supplemental Heat	2,614
Percent Hours Requiring Supplemental Heat	41.5%
Percent Annual Load Modulating	57.9%
Percent Annual Load with Low-Load Cycling	1.8%

r)

32.8%

The hours requiring supplemental heat



Product Sizing For Heating

View Oversizing Effects

Definition/Use Cases

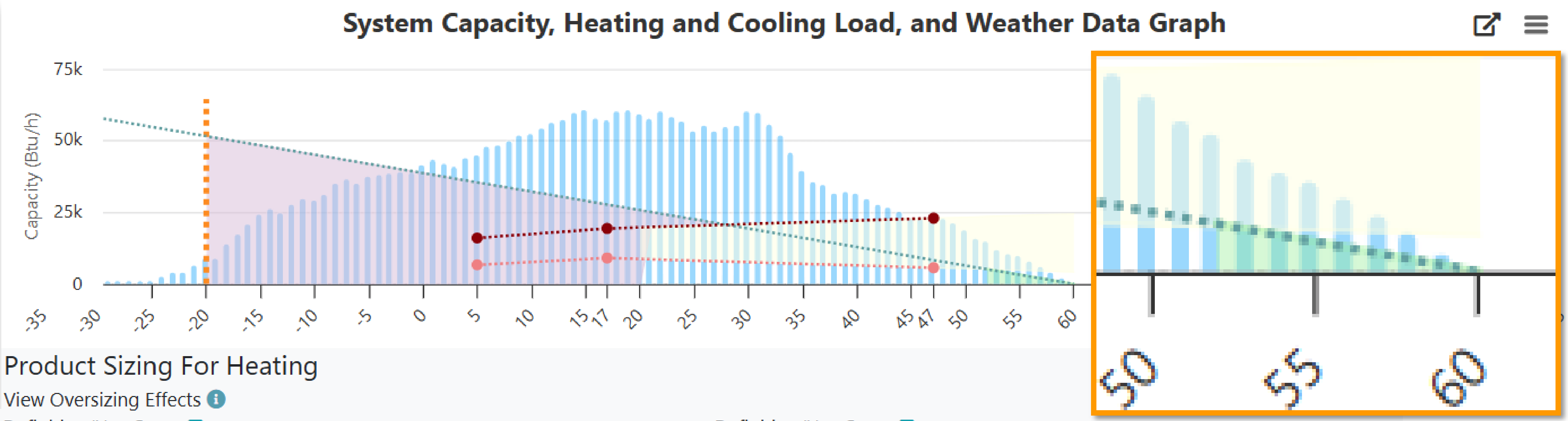
Capacity Balance Point (°F)	28
Minimum Capacity Threshold (°F)	52
Maximum Capacity at Design Temp (Btu/h)	No capacity at design Temperature
Percent Design Load Served	No capacity at design Temperature
Annual Heating Load (MMBtu)	119.9
Percent Annual Heating Load Served	32.8%

Definition/Use Cases

Annual Btu's Covered by Supplemental Heat (MMBtu)	80.6
Hours Requiring Supplemental Heat	2,614
Percent Hours Requiring Supplemental Heat	41.5%
Percent Annual Load Modulating	57.9%
Percent Annual Load with Low-Load Cycling	1.8%

2,614

The percent annual heating load with low-load cycling



Product Sizing For Heating

View Oversizing Effects

Definition/Use Cases

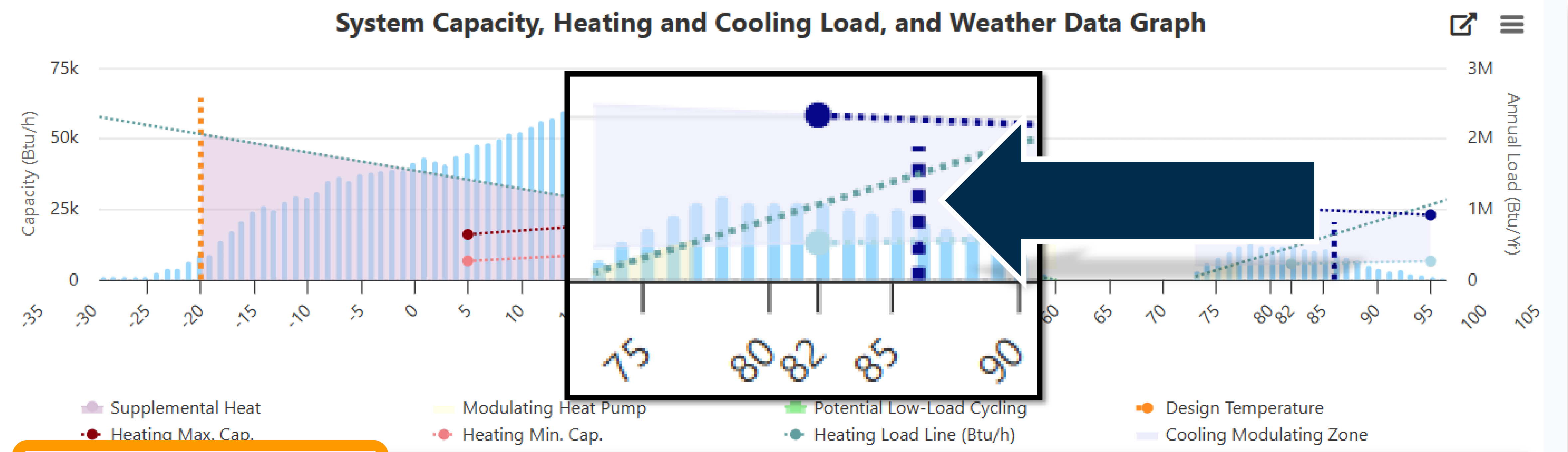
Capacity Balance Point (°F)	28
Minimum Capacity Threshold (°F)	52
Maximum Capacity at Design Temp (Btu/h)	No capacity at design Temperature
Percent Design Load Served	No capacity at design Temperature
Annual Heating Load (MMBtu)	119.9
Percent Annual Heating Load Served	32.8%

Definition/Use Cases

Annual Btu's Covered by Supplemental Heat (MMBtu)	80.6
Hours Requiring Supplemental Heat	2,614
Percent Hours Requiring Supplemental Heat	41.5%
Percent Annual Load Modulating	57.9%
Percent Annual Load with Low-Load Cycling	1.8%

1.8%

Reference cooling information to ensure the cooling load falls between the min and max capacities



Product Sizing For Cooling

View Oversizing Effects

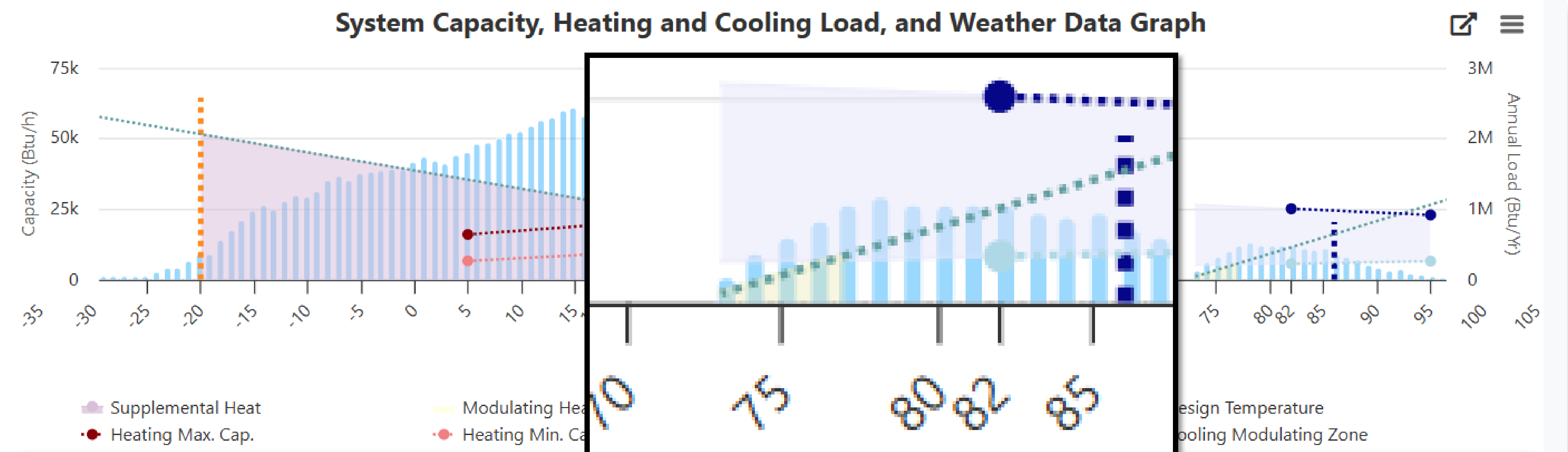
Definition/Use Cases

Minimum Capacity Threshold (°F)	77
Maximum Capacity at Design Temp (Btu/h)	24,523
Percent Design Load Served	151.4%
Annual Cooling Load (MMBtu)	7.2

Definitions/Use Cases

Percent Annual Cooling Load Served	94.9%
Percent Annual Load Modulating	73.0%
Percent Annual Load with Low-Load Cycling	21.8%

The percent annual cooling load with low-load cycling



Product Sizing For Cooling

View Oversizing Effects

Definition/Use Cases

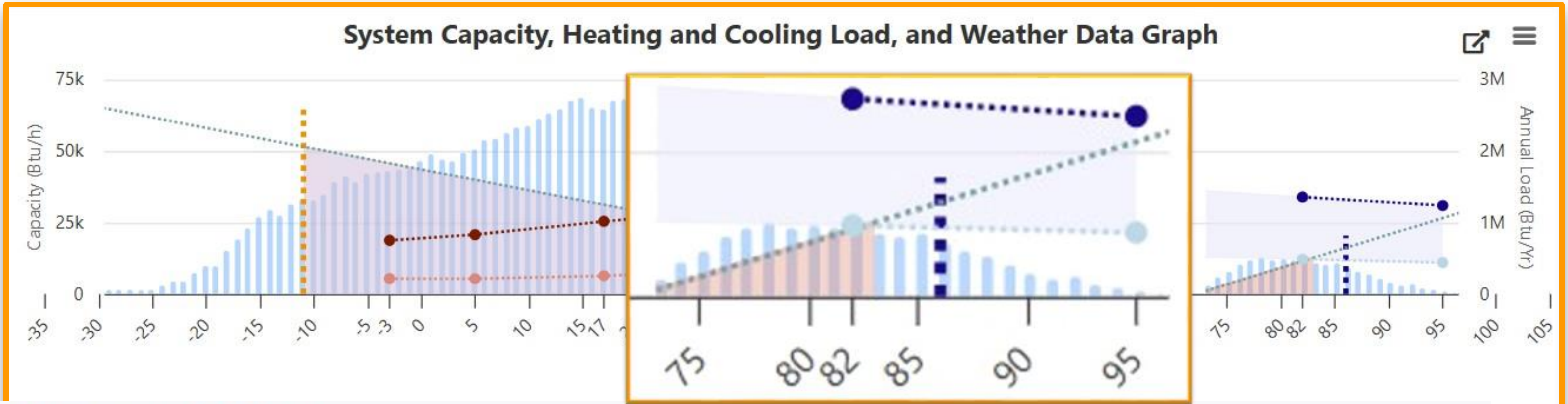
Minimum Capacity Threshold (°F)	77
Maximum Capacity at Design Temp (Btu/h)	24,523
Percent Design Load Served	
Annual Cooling Load (MMBtu)	7.2

Definitions/Use Cases

Percent Annual Cooling Load Served	94.9%
Percent Annual Load Modulating	73.0%
Percent Annual Load with Low-Load Cycling	21.8%

21.8%

What does low-load cycling look like with a different piece of equipment?



Product Sizing For Cooling

View Oversizing Effects

Definition/Use Cases

Minimum Capacity Threshold (°F)	83
Maximum Capacity at Design Temp (Btu/h)	33,077
Percent Design Load Served	
Annual Cooling Load (MMBtu)	7.2

61.9%

Definitions/Use Cases

Percent Annual Cooling Load Served	100.0%
Percent Annual Load Modulating	37.7%
Percent Annual Load with Low-Load Cycling	61.9%

LOGO

What we covered

- Equipment selection challenges and how to overcome them
- Available equipment selection tools to support the accuracy of your work and increase customer confidence

INSERT YOUR LOGO

Installation Best Practices

Learning objectives

By the end of the module, you will be able to:

- Implement best practices for outdoor unit placement
- Implement best practices for line set routing and insulation
- Recognize the value of surge protection

INSERT YOUR LOGO

Next segment: What's the issue here?

INSERT YOUR LOGO

What’s the issue here?

Image courtesy of Reddit user:
https://www.reddit.com/r/heatpumps/s/14hdgTf8et

INSERT YOUR LOGO

Best practice- Place outdoor unit away from walkways

INSERT YOUR LOGO

What may have caused this?

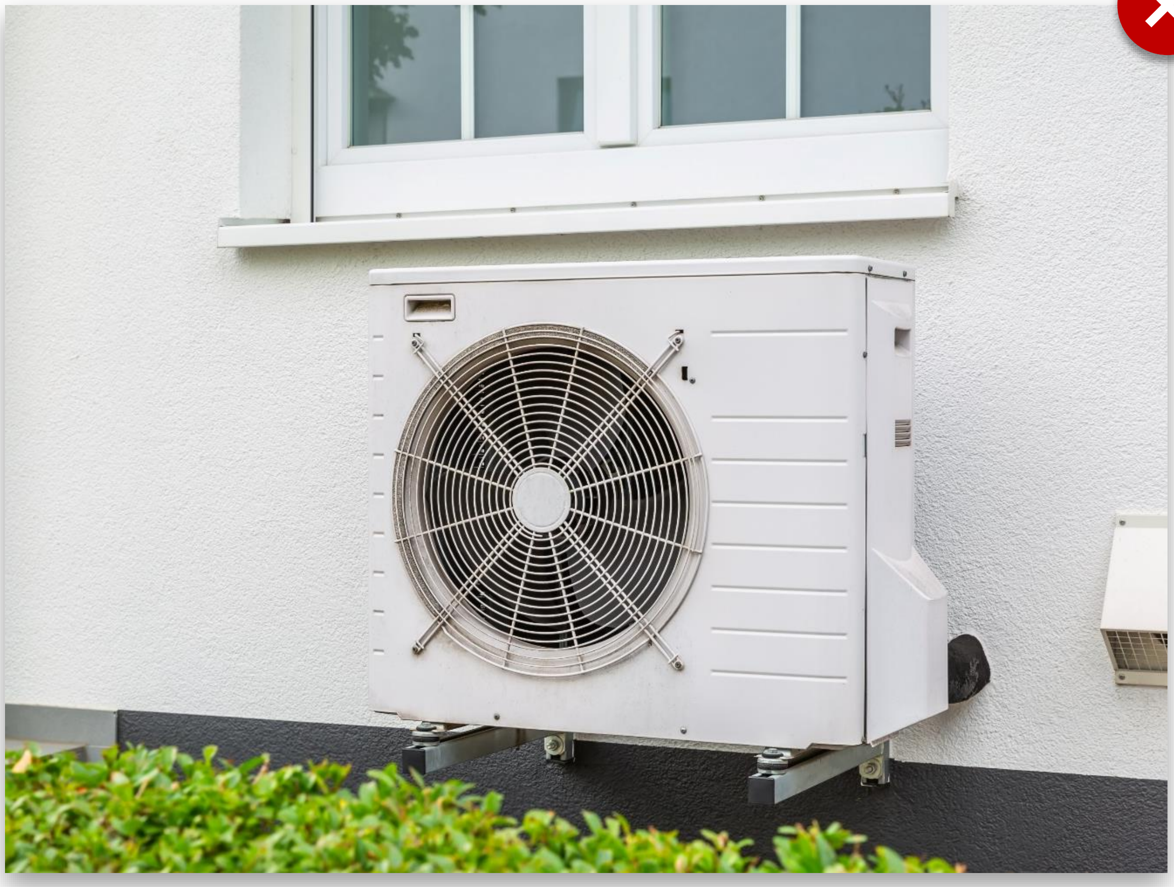
Image courtesy of Reddit user: https://www.reddit.com/r/heatpumps/s/HZDZgzCj11

INSERT YOUR LOGO

Best practice- Place outdoor unit away from driplines

INSERT YOUR LOGO

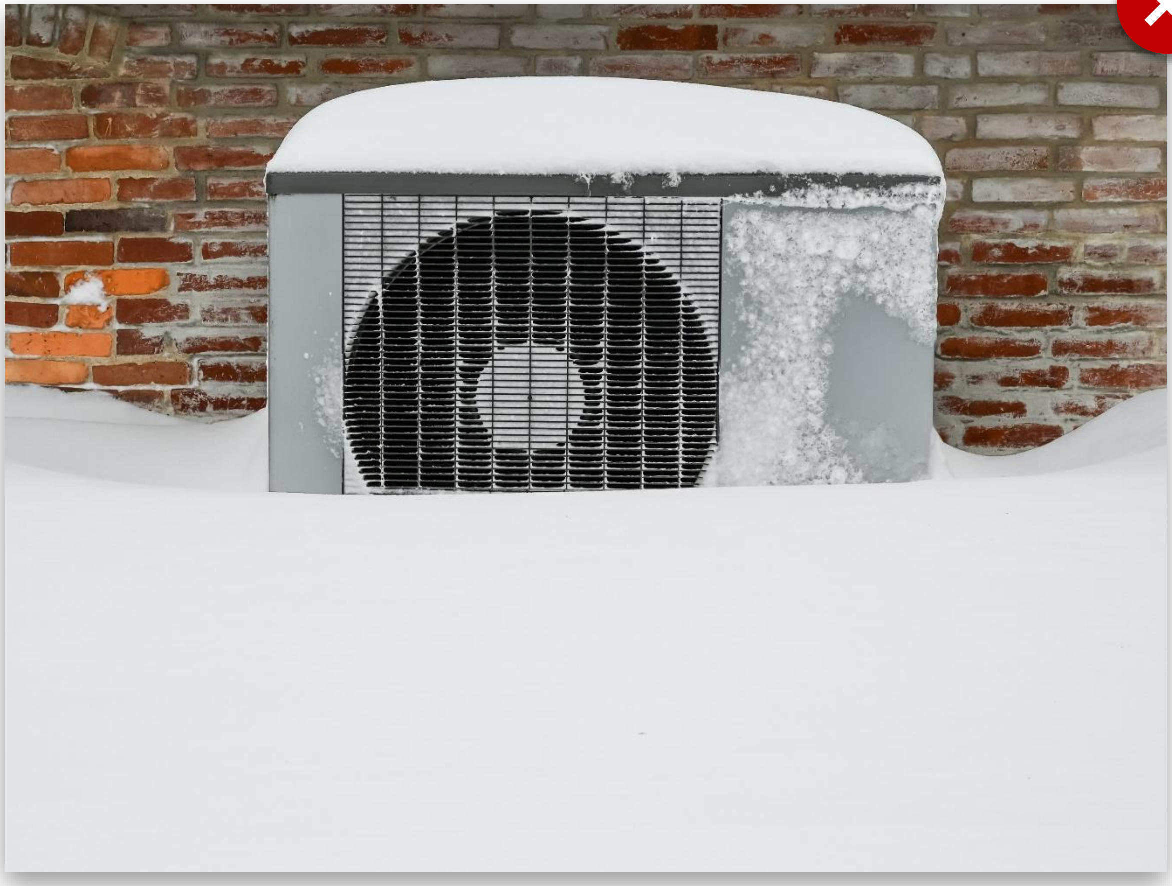
What's a factor to consider with this placement?



Best practice- Place outdoor units where they are less likely to bother occupants with noise

INSERT YOUR LOGO

What may have avoided this?



INSERT YOUR LOGO

Best practice-
Use a stand to raise outdoor unit above snowline, educate customer about snow removal

INSERT YOUR LOGO

What's a factor to consider with this placement?

INSERT YOUR LOGO

Best practice- Avoid locations that face the dominant wind

Consider a wind baffle if the only available location would get strong, direct wind

Image source: Energy Smart Colorado /https://energysmartcolorado.org/

INSERT YOUR LOGO

What's wrong with this line set?

Image source: Excel Air Systems. "Fixing a Kinked Copper Line". https://www.youtube.com/watch?v=6vN1SyJRI78

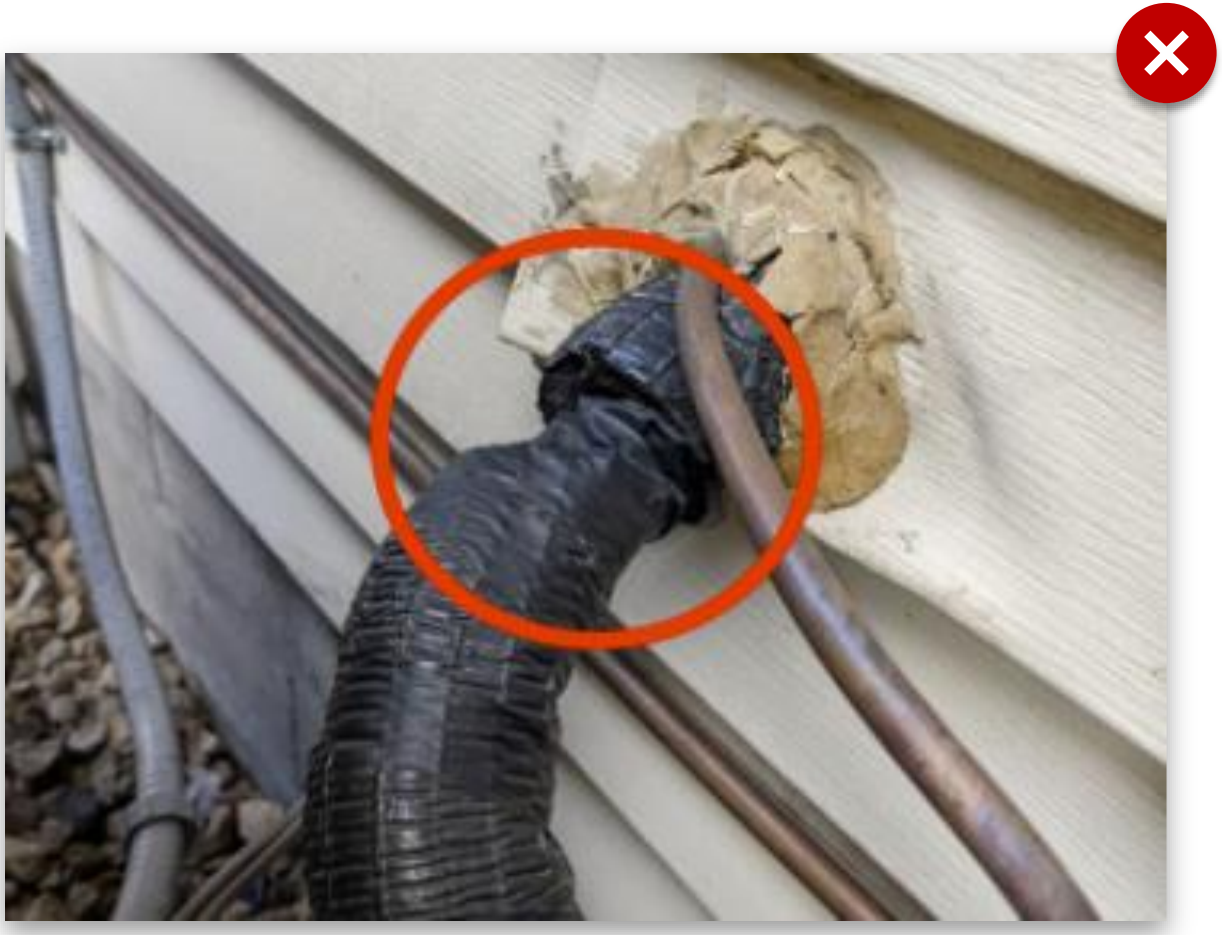
INSERT YOUR LOGO

Best practice- Avoid kinks and partial kinks

Image source: stuzman52. “Mini-Split Heat Pump: Line-Set Installation, Detailed”. https://www.youtube.com/watch?v=MfseMtg_YPg

INSERT YOUR LOGO

What's wrong with this line set?



INSERT YOUR LOGO

Best practice- Insulate the entire line set

INSERT YOUR LOGO

Other installation best practices

INSERT YOUR LOGO

Surge protection is a low-cost solution to protect expensive equipment

Surge protection is particularly valuable for units with microprocessor components

Units with microprocessors include:

- All variable speed units
- Many single and two-stage units

INSERT YOUR LOGO

Refer to the supplemental resources on installation best practices online

Electrical service & panel evaluation

Sample questions include:

- Is the amperage delivered to the home sufficient to power the new appliances?
- Is there enough room for new single- or double-pole breakers to be attached to the main bus bars?

Filter selection

Sample questions include:

- What are the static pressure impacts of filter types and sizes?
- Where should filters be located?

INSERT YOUR LOGO

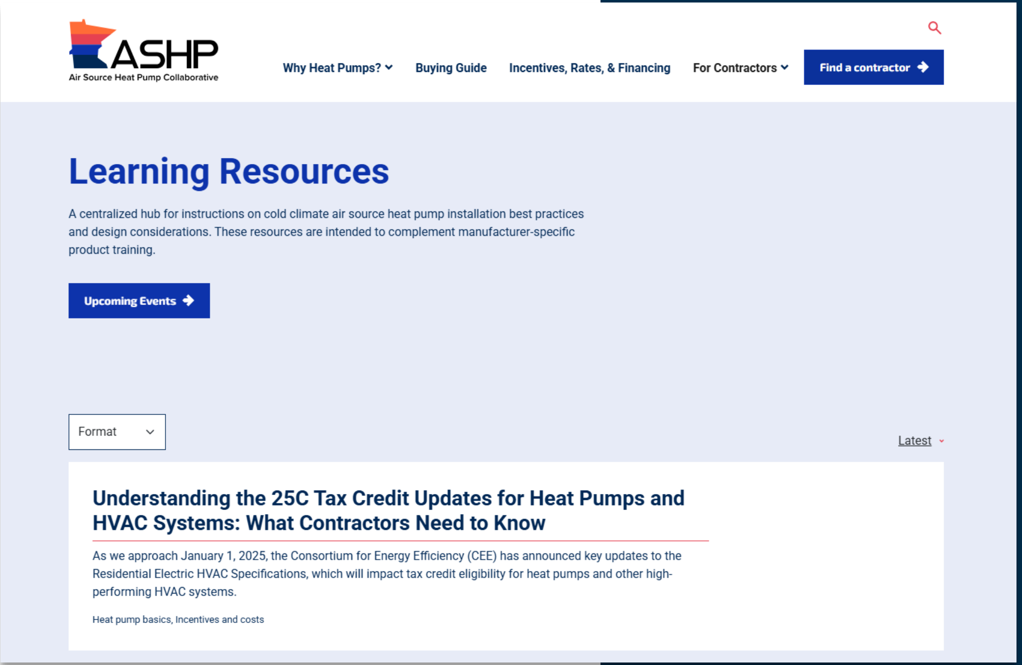
Refer to the Best Practices Installation Guide for this content and more

The *Preferred Contractor Network* site verification process follows the steps in the guide.

Content:

- Line sets
- Refrigerant charging and tubing
- Condensate drains
- Outdoor unit installation
- Homeowner education
- Additional resources

www.mnashp.org/learning-resources



This link is also stored in the **Training Resources** page.

What we covered

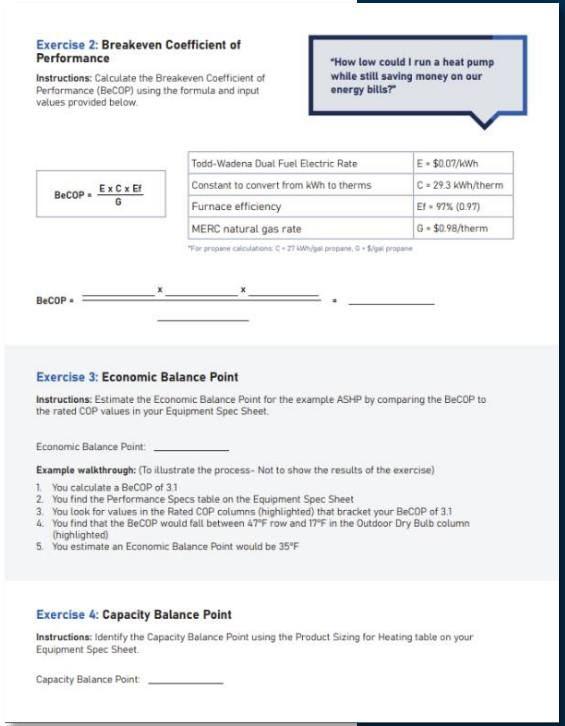
- Best practices for outdoor unit placement
- Best practices for line set routing and insulation
- The value of surge protection

Exercise 2: Breakeven Coefficient of Performance (BeCOP)

We will walk through calculating a BeCOP.

Needed to follow along:

- **Worksheet: Page 2**



Exercise 2: Breakeven Coefficient of Performance

Instructions: Calculate the Breakeven Coefficient of Performance (BeCOP) using the formula and input values provided below.

"How low could I run a heat pump while still saving money on our energy bills?"

$$BeCOP = \frac{E \times C \times Ef}{G}$$

Todd-Wadena Dual Fuel Electric Rate	E = $0.07/kWh
Constant to convert from kWh to therms	C = 29.3 kWh/therm
Furnace efficiency	Ef = 97% (0.97)
MERC natural gas rate	G = $0.98/therm

*For propane calculations: C = 27 kWh/gal propane, G = $/gal propane

BeCOP = ______ x ______ x ______ / ______ = ______

Exercise 3: Economic Balance Point

Instructions: Estimate the Economic Balance Point for the example ASHP by comparing the BeCOP to the rated COP values in your Equipment Spec Sheet.

Economic Balance Point: ______

Example walkthrough: (To illustrate the process- Not to show the results of the exercise)

1. You calculate a BeCOP of 3.1
2. You find the Performance Specs table on the Equipment Spec Sheet
3. You look for values in the Rated COP columns (highlighted) that bracket your BeCOP of 3.1
4. You find that the BeCOP would fall between 47°F row and 17°F in the Outdoor Dry Bulb column (highlighted)
5. You estimate an Economic Balance Point would be 35°F

Exercise 4: Capacity Balance Point

Instructions: Identify the Capacity Balance Point using the Product Sizing for Heating table on your Equipment Spec Sheet.

Capacity Balance Point: ______

The BeCOP formula

$$BeCOP = \frac{E \times C \times Ef}{G}$$

$$BeCOP = \frac{0.07 \times 29.3 \times 0.97}{0.98}$$

Todd-Wadena Dual Fuel Electric Rate	E = $0.07/kWh
Constant to convert from kWh to therms	C = 29.3 kWh/therm
Furnace efficiency	Ef = 97% (0.97)
MERC natural gas rate	G = $0.98/therm

INSERT YOUR LOGO

The BeCOP for our example is 2.03

$$\text{BeCOP} = \frac{0.07 \times 29.3 \times 0.97}{0.98}$$

= 2.03

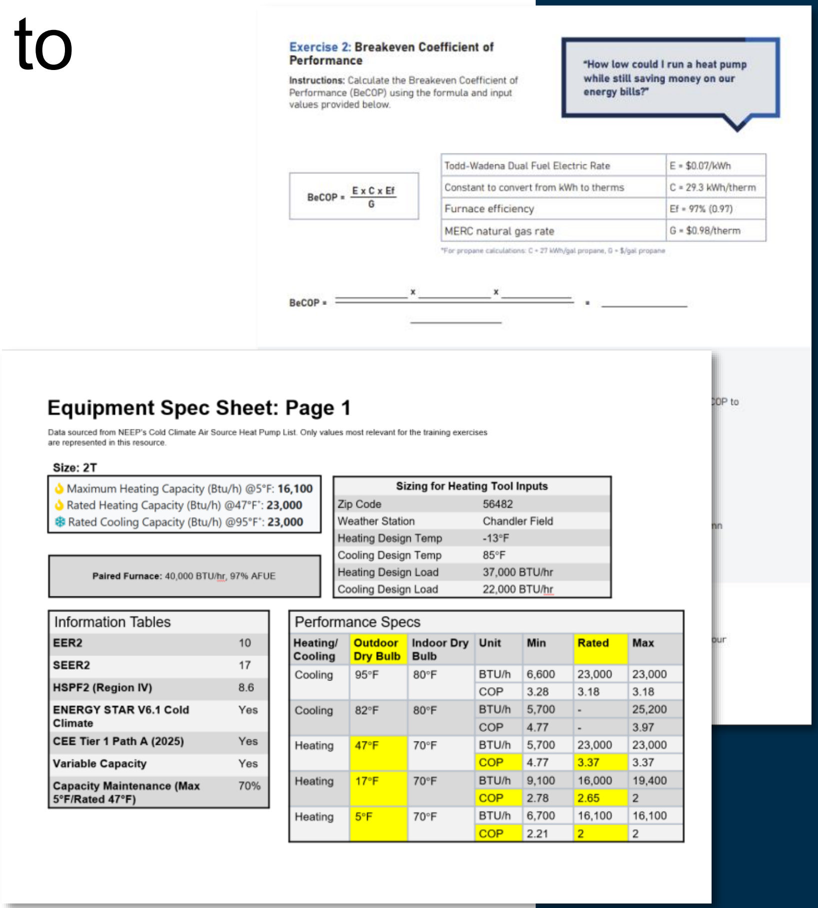
INSERT YOUR LOGO

Exercise 3: Economic Balance Point

We will walk through using the BeCOP to estimate the Economic Balance Point.

Needed to follow along:

- **Worksheet: Page 2**
- **Equipment Spec Sheet: Page 1**



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Furnace efficiency	Ef = 97% (0.97)
MERC natural gas rate	G = $0.98/therm

*For propane calculations: C = 27 kWh/gal propane, G = $/gal propane

BeCOP = ______ x ______ x ______ / ______ = ______

Equipment Spec Sheet: Page 1

Data sourced from NEEP's Cold Climate Air Source Heat Pump List. Only values most relevant for the training exercises are represented in this resource.

Size: 2T

- Maximum Heating Capacity (Btu/h) @5°F: **16,100**
- Rated Heating Capacity (Btu/h) @47°F: **23,000**
- Rated Cooling Capacity (Btu/h) @95°F: **23,000**

Paired Furnace: 40,000 BTU/hr, 97% AFUE

Sizing for Heating Tool Inputs	
Zip Code	56482
Weather Station	Chandler Field
Heating Design Temp	-13°F
Cooling Design Temp	85°F
Heating Design Load	37,000 BTU/hr
Cooling Design Load	22,000 BTU/hr

Information Tables	
EER2	10
SEER2	17
HSPF2 (Region IV)	8.6
ENERGY STAR V6.1 Cold Climate	Yes
CEE Tier 1 Path A (2025)	Yes
Variable Capacity	Yes
Capacity Maintenance (Max 5°F/Rated 47°F)	70%

Performance Specs

Heating/ Cooling	Outdoor Dry Bulb	Indoor Dry Bulb	Unit	Min	Rated	Max
Cooling	95°F	80°F	BTU/h	6,600	23,000	23,000
			COP	3.28	3.18	3.18
Cooling	82°F	80°F	BTU/h	5,700	-	25,200
			COP	4.77	-	3.97
Heating	47°F	70°F	BTU/h	5,700	23,000	23,000
			COP	4.77	3.37	3.37
Heating	17°F	70°F	BTU/h	9,100	16,000	19,400
			COP	2.78	2.65	2
Heating	5°F	70°F	BTU/h	6,700	16,100	16,100
			COP	2.21	2	2

A note about BeCOPs

- COP curves aren't linear!
- This exercise will give you an estimation- not an exact number

INSERT YOUR LOGO

Find where a BeCOP of 2.03 would fall in the Rated COP column

Heating/ Cooling	Outdoor Dry Bulb	Indoor Dry Bulb	Unit	Min	Rated	Max
Heating	47°F	70°F	Btu/h	5,700	-	25,200
			COP	4.77	3.37	3.37
Heating	17°F	70°F	Btu/h	9,100	16,000	19,400
			COP	2.78	2.65	2
Heating	5°F	70°F	Btu/h	6,700	16,100	16,100
			COP	2.21	2	2

INSERT YOUR LOGO

Find the temperature the BeCOP would fall in the Outdoor Dry Bulb column

Heating/ Cooling	Outdoor Dry Bulb	Indoor Dry Bulb	Unit	Min	Rated	Max
Heating	47°F	70°F	Btu/h	5,700	-	25,200
			COP	4.77	3.37	3.37
Heating	17°F	70°F	Btu/h	9,100	16,000	19,400
			COP	2.78	2.65	2
Heating	5°F	70°F	Btu/h	6,700	16,100	16,100
			COP	2.21	2	2

INSERT YOUR LOGO

Estimate the Economic Balance Point based on where the BeCOP would fall

Heating/ Cooling	Outdoor Dry Bulb	Indoor Dry Bulb	Unit	Min	Rated	Max
Heating	47°F	70°F	Btu/h	5,700	-	25,200
			COP	4.77	3.37	3.37
Heating	17°F	70°F	Btu/h	9,100	16,000	19,400
			COP	2.78	2.65	2
Heating	5°F	70°F	Btu/h	6,700	16,100	16,100
			COP	2.21	2	2

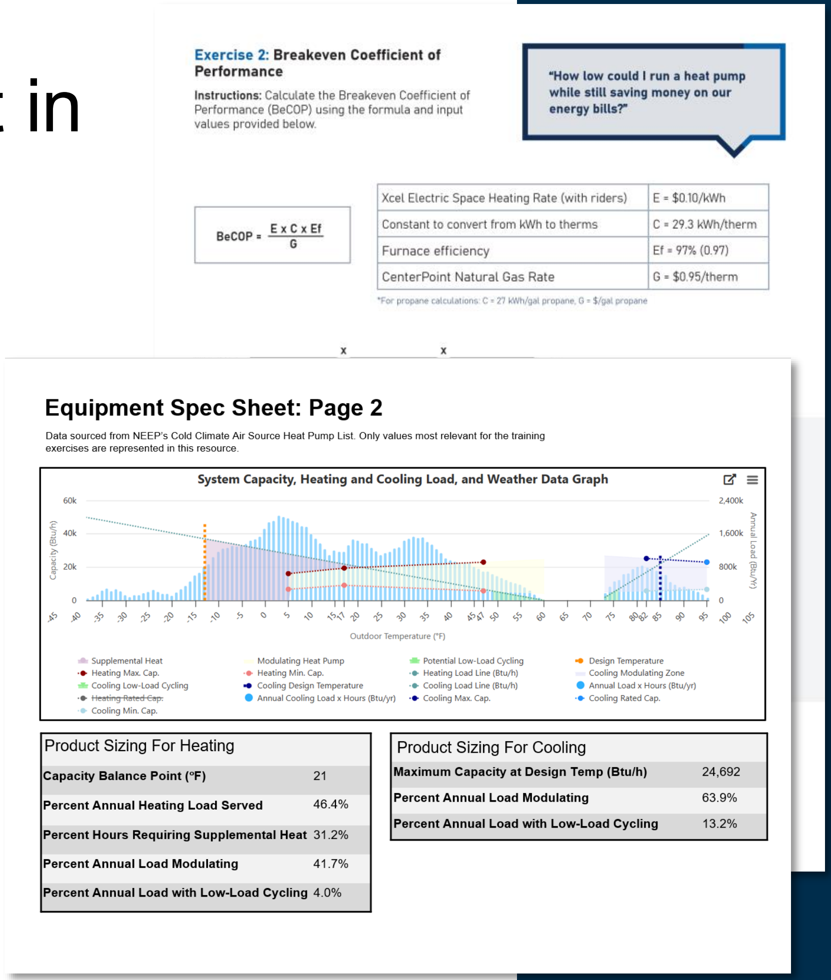
INSERT YOUR LOGO

Exercise 4: Capacity Balance Point

We can find the Capacity Balance Point in the Equipment Spec Sheet from NEEP.

Needed to follow along:

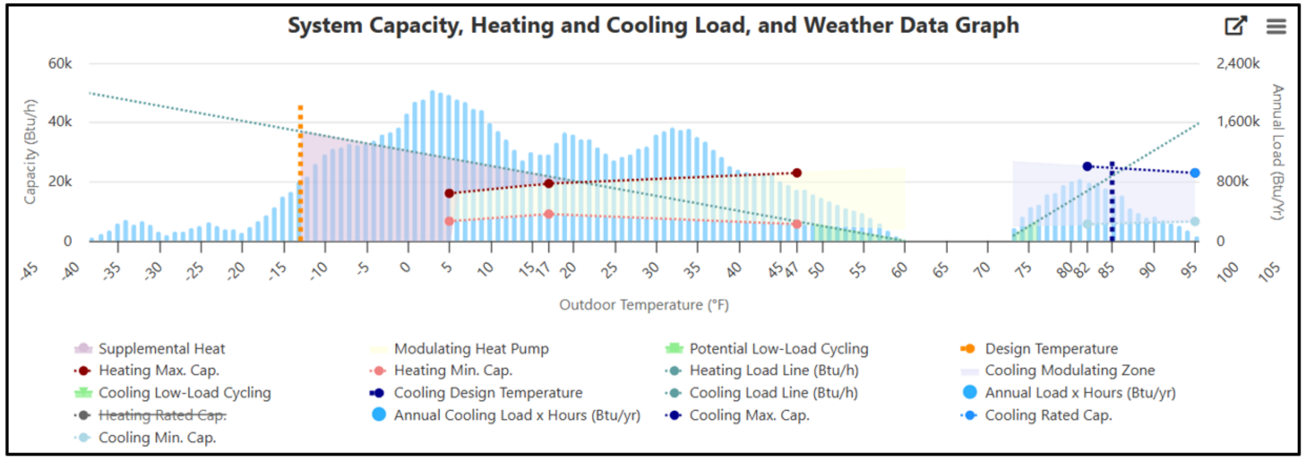
- **Worksheet**
- **Equipment Spec Sheet: Page 2**



Find the Capacity Balance Point on the Product Sizing for Heating table

Equipment Spec Sheet: Page 2

Data sourced from NEEP's Cold Climate Air Source Heat Pump List. Only values most relevant for the training exercises are represented in this resource.



Product Sizing For Heating	
Capacity Balance Point (°F)	21
Percent Annual Heating Load Served	46.4%
Percent Hours Requiring Supplemental Heat	31.2%
Percent Annual Load Modulating	41.7%
Percent Annual Load with Low-Load Cycling	4.0%

Product Sizing For Cooling	
Maximum Capacity at Design Temp (Btu/h)	24,692
Percent Annual Load Modulating	63.9%
Percent Annual Load with Low-Load Cycling	13.2%

Summary & Closing

Next Steps for Contractors

- Practice installations at employee homes to gain experience with the technology
- Leverage and stack financial incentives and lending products
- Attend ongoing distributor and manufacturer trainings
- Stay engaged with your utilities on rates and programs

INSERT YOUR LOGO

Thank you!