

A person wearing a blue long-sleeved shirt is sitting on a couch, using a silver laptop. The laptop screen displays the Ameren website, which includes a navigation bar, a "My Account" section, and several service cards. The person's hands are on the keyboard.

# Believe in the Math Behind Air Source Heat Pumps

2022 Morning Brief Series: April

# Agenda



- COVID-19 Health & Safety Reminder
- Believe in the Math Behind Air Source Heat Pumps
- Q & A

# COVID-19 Health & Safety Reminder



- Filed health and safety plans should continued to be followed until a new plan is submitted and approved by the Program
- Contact your Field Energy Specialist (FES) if you have questions



**John Carroll**  
Residential  
Program Manager

# Today's Speaker



**Paul Svoboda**  
Crescent Parts & Equipment  
Service and Support Manager



# BELIEVE IN THE MATH!

HEATING SOURCES AND FUEL PRICES –  
ECONOMICS OF BEST OPTIONS



**Air Source Heat Pumps  
Answers for Today's World!**

# SOME BASIC CONVERSIONS.

- $EER = SEER \times .875$
- $SEER = EER / .875$
- $HSPF / 3.414 = COP$
- $EER / 3.414 = COP$
- $KWH = 3414 \text{ BTU}$
- What does COP 3.0 mean?
  - $1kWh = 3413 \text{ Btu}$
  - $1kWh \times 3.0 \text{ COP} = 10,239 \text{ Btu/kWh}$

# WHAT NEEDS TO BE CONSIDERED?

- Cost of installation
- Cost of operation
- Comfort
- Integration with cooling and ventilation systems
- Multiple zones with different heat delivery mechanism
- Always compare apples to apples

# DISCUSS AND PRIORITIZE WITH THE CUSTOMER

- What is the installed cost?
  - How does cost fit with the budget/mortgage?
- What fits the customer's lifestyle?
- Are there environmental concerns and what are they?
- What fuel types are available?
- What are the rates in your area?
  - Today and in the future?



# WHAT IS DIFFICULT TO VERIFY?

- Future rates for fuel
- Efficiency of delivery system
  - Duct leakage
  - Duct runs outside thermal envelope
- Heating load
  - Thermal envelope impact easier to verify
  - Occupant behavior impact tough to verify

# WHAT IS NEARLY IMPOSSIBLE TO VERIFY?

- Radiant vs. forced air comfort
- Economic benefits of modulating systems
- Non-comfort benefits
  - Allergies
  - Aesthetics
- Environmental concerns
- Customer fears

# WHAT IS EASY TO VERIFY?

- Efficiency of the unit producing the heat
- The current cost of the fuel
- The Btu content of the fuel

# DEFINITIONS AND STANDARDS

- BTU (British Thermal Unit) - The amount of energy required to raise 1 pound of water 1° Fahrenheit

<b>Electricity</b>	<b>1 kwh = 3413 BTU</b>
<b>Natural Gas</b>	<b>1 Therm = 100,000 Btu</b>
<b>Liquid Propane</b>	<b>1 Gallon = 91,600 Btu</b>
<b>Fuel Oil</b>	<b>1 Gallon = 139,600 Btu</b>
<b>Wood</b>	<b>1 Cord = 22,500,000 Btu</b>
<b>Wood</b>	<b>1 Ton Pellets = 16,500,000 Btu</b>
<b>Corn</b>	<b>1 Pound Shelled = 6,970 Btu</b> <b>1 Bushel Shelled = 390,320 Btu*</b>

\* Assumes a moisture content of 15.5%

# CALCULATION FOR COMPARING APPLES TO ORANGES

Heat content per unit of fuel

÷ Cost per unit of fuel

= Btu available per \$1

Btu available per \$1

X Efficiency of heater

= Btu available for each \$1 spent

# ELECTRIC RESISTANCE

Heat content per kWh of electricity

3,413 Btu

Price per kWh of electricity

÷ \$0.115

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Btu available for each \$1 spent

29,678 Btu/kWh of Electricity

Efficiency of boiler or furnace

29,678 Btu/\$

x 99% Efficiency (.99)

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Actual Btu usable in the home

29,381 Btu Delivered/\$

## EXAMPLE - NATURAL GAS

Heat content per therm of nat gas

100,000 Btu

Price per therm of natural gas

÷ \$1.30 (US Bureau of Labor Stats)

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Btu available for each \$1 spent

76,923 Btu/Therm Nat Gas

83,333 Btu/\$

Efficiency of boiler or furnace

x 93% Efficiency (.93)

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Actual Btu usable in the home

71,538 Btu Delivered/\$

## EXAMPLE - PROPANE

Heat content per gallon of propane

91,600 Btu

Price per gallon of propane

÷ \$3.00 p/gal

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Btu available for each \$1 spent

30,533 Btu/Gal of Propane

Efficiency of boiler or furnace

30,533 Btu/\$

x 93% Efficiency (.93)

---

Actual Btu usable in the home

28,396 Btu Delivered/\$



# AIR SOURCE HEAT PUMPS

- Rated in COP (Coefficient of Performance) (HSPF / 3.414)
- What does COP 3.0 mean?
  - 1kWh = 3413 Btu
  - 1kWh x 3.0 COP = 10,239 Btu/kWh
- 3 times the heat for the same amount of energy!

# EXAMPLE - AIR SOURCE HEAT PUMP

Heat content per kWh of electricity	3413 Btu
Price per kWh of electricity	÷ \$0.115
Btu available for each \$1 spent	29,678 Btu/kWh
	29,678 Btu/\$
Efficiency of Air Source HP	x 2.93 COP (10 HSPF / 3.413)
Actual Btu usable in the home	86,957 Btu Delivered/\$

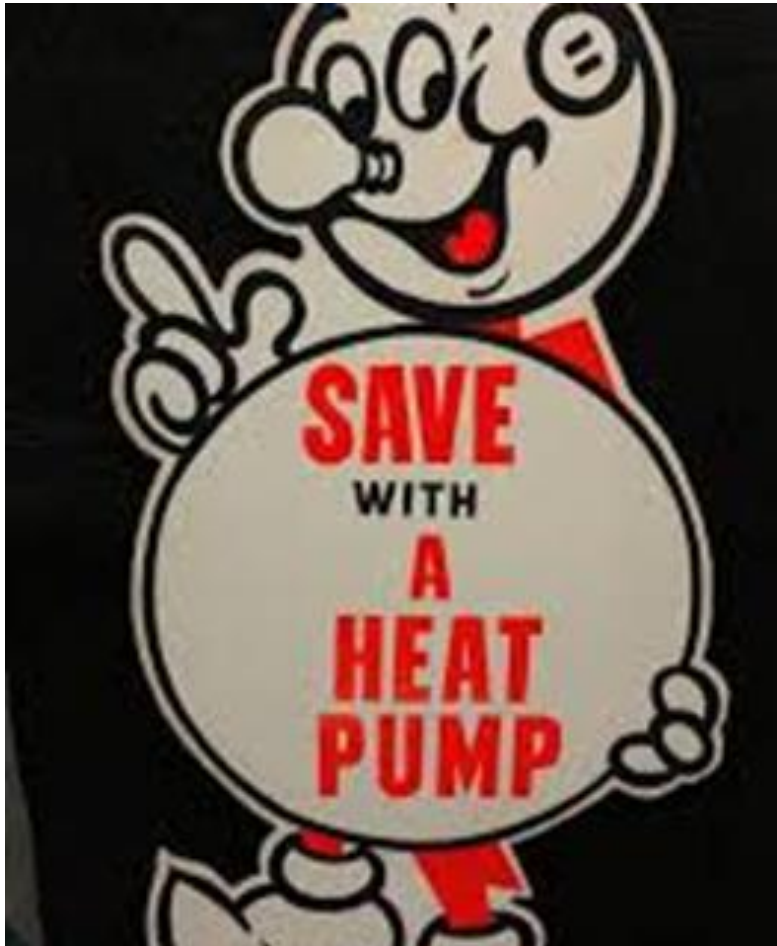
## EXAMPLE – DUCTLESS HEAT PUMP

Heat content per kWh of electricity	3413 Btu
Price per kWh of electricity	÷ \$0.115
Btu available for each \$1 spent	29,678 Btu/kWh
	29,678 Btu/\$
Efficiency of Air Source Heat Pump	x 3.95 COP (13.5 HSPF / 3.413)
Actual Btu usable in the home	117,376 Btu Delivered/\$

## HOW DO THEY STACK UP?

- Natural gas ..... 71,538 Btu per dollar
- Propane gas (L.P.) ..... 28,396 Btu per dollar
- Fuel oil ..... 34,987 Btu per dollar (\$3.99 p/gal)
- Electric resistance ..... 29,678 Btu per dollar
- Wood (corded) ..... 60,237 Btu per dollar (\$375 p/cord)
- Wood pellets ..... 66,000 Btu per dollar (\$250 p/ton)
- Corn (shelled) ..... 60,234 Btu per dollar (\$6.48 p/bushel)
- Heat Pump (Air Source) .. 86,857 Btu per dollar
- Ductless Heat Pump (Air Source) 117,376 Btu per dollar

# NOT YOUR GRANDFATHERS HEAT PUMP.....



- Auxiliary Heating
- Timed Defrost
- Cap tube metering
- Recip compressors
- Fan motors
- Refrigerant flow
- Sizing theory (sizing for non dominate load)

# HEAT PUMP DEVELOPMENTS: 1960-2020

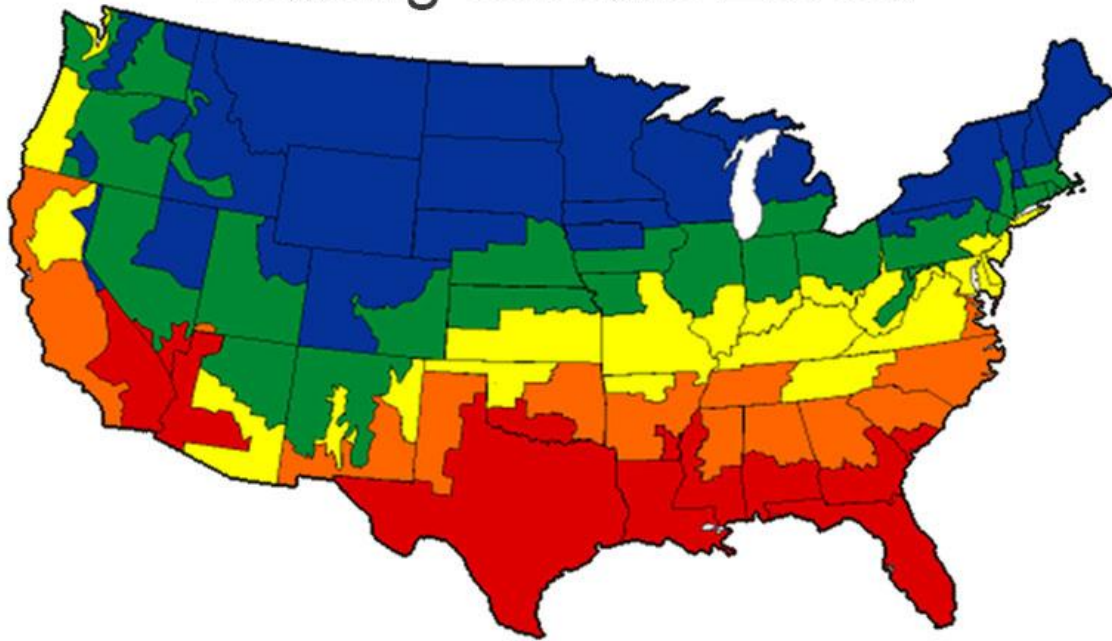
Issue	Old School	Sort of New School	New School
Auxiliary Heat Control	Thermostat	Outdoor Lockout	Discharge Air Temp
Defrost Control	Timed	On Demand	On Demand / No Auxiliary
Refrigerant Metering	Capillary Tube	Fixed / TXV	EEV
Compressor Efficiency	Hermetic / Piston	Scroll / Two Stage	Inverter
Fan Motors	Belt Driven	Direct Drive / Shaded Pole	ECM *(with good duct design, or ductless)
Refrigerant Flow	fixed flow	Digital / Unloading	Enhanced Vapor Injection Technology

# COMPONENTS OF A GOOD INSTALLATION

- 1. Manual J heating load calculation
- 2. A good duct design ( Manual D ) if applicable
- 3. Size your equipment by Thermal Balance Point

# NO!!!

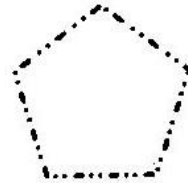
## Heating Climate Zones



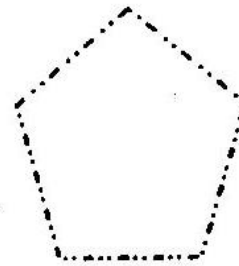
Zone 1	Zone 2	Zone 3	Zone 4	Zone 5
30-35 BTUs per sq ft	35-40 BTUs per sq ft	40-45 BTUs per sq ft	45-50 BTUs per sq ft	50-60 BTUs per sq ft

## Air Conditioner or Heat Pump SIZING CHART

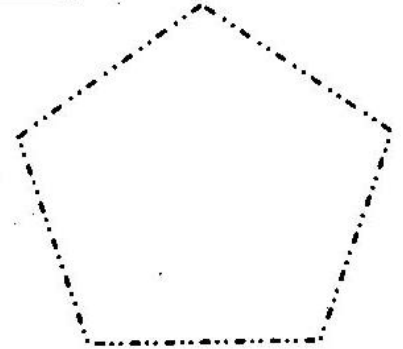
**TRIM OUT HOLES VERY CAREFULLY, CUTTING ON THE DOTTED LINES, THEN FOLLOW INSTRUCTIONS SHOWN BELOW**



1 1/2 TO 2  
TON



2-1/2 TO  
3-1/2 TON



4 TO 5  
TON

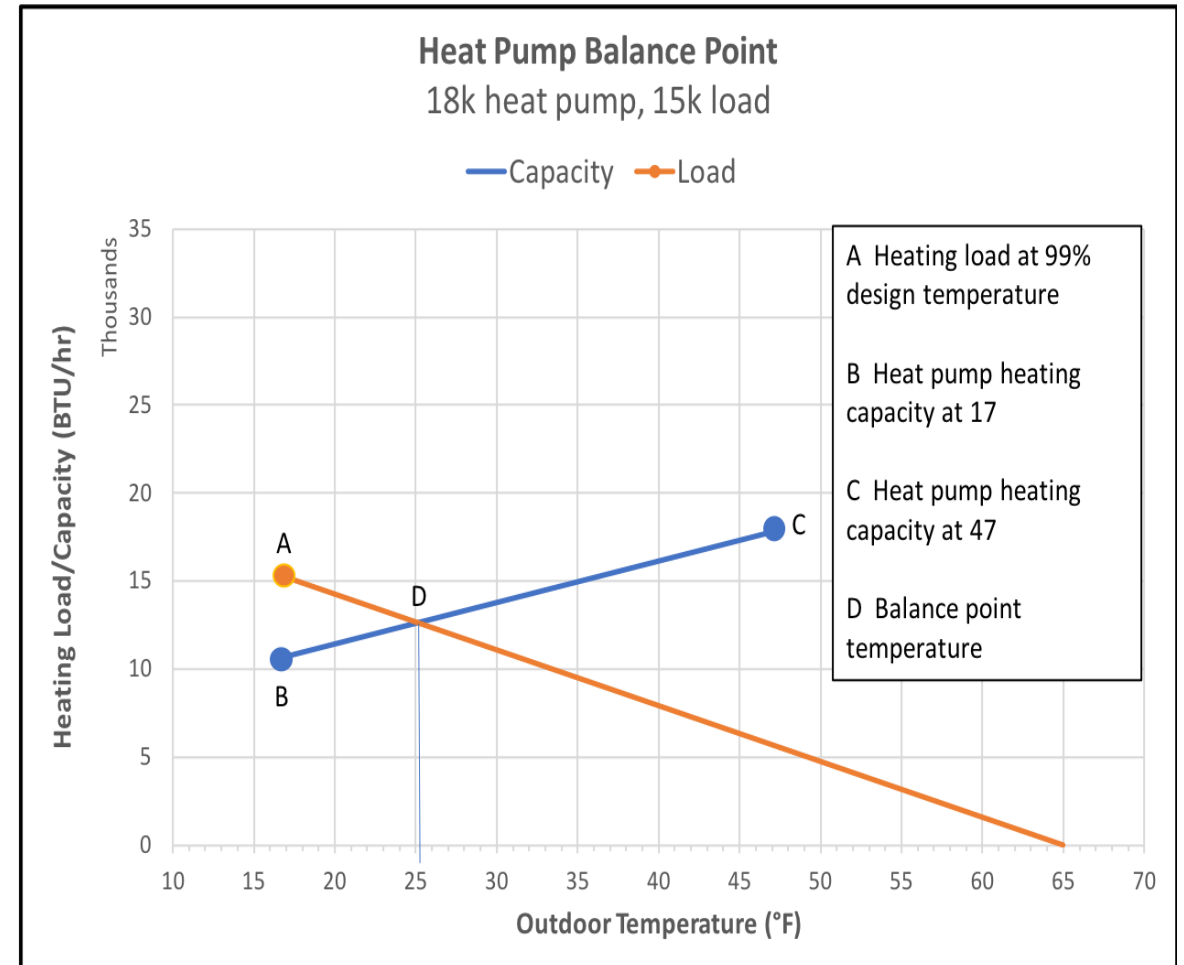
**INSTRUCTIONS:** Stand on the curb\* Hold Sizing Chart approximately one foot from your face and look at the house thru each hole. If the house fits in a hole, that's the size unit to use.

*\*If curb is not available – ask the homeowner where a curb would be if there was one.*



# YES!!!

- Sizing single and two stage heat pumps up to %125 of air conditioning capacity.
- Sizing inverter heat pumps. Size for dominant load with dehumidification and balance point considered
- Many ductless systems have full heating capacity at 5 degrees outdoor temperature



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- You've carefully thought out all the angles
  - You've done it a thousand times
  - It comes naturally to you
  - You know what you're doing, it's what you've been trained to do your whole life
  - Nothing could possibly go wrong, right?

Think Again.





**Thank you for your  
time!**

*Saving Energy Today & Tomorrow*

*By B. Paul Svoboda*

Service and Support Manager / Crescent Parts and Equipment

# Q & A