



2026 Colorado Heat Pump Webinar Series

Best Practices for Selecting and Installing Heat Pumps in *Existing* Colorado Homes

All Electric Cold Climate Heat Pump Systems



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Introduction

- Colorado Climate Zones
- Heat Pump Types

System Sizing

Electrical Requirements for Heat Pumps

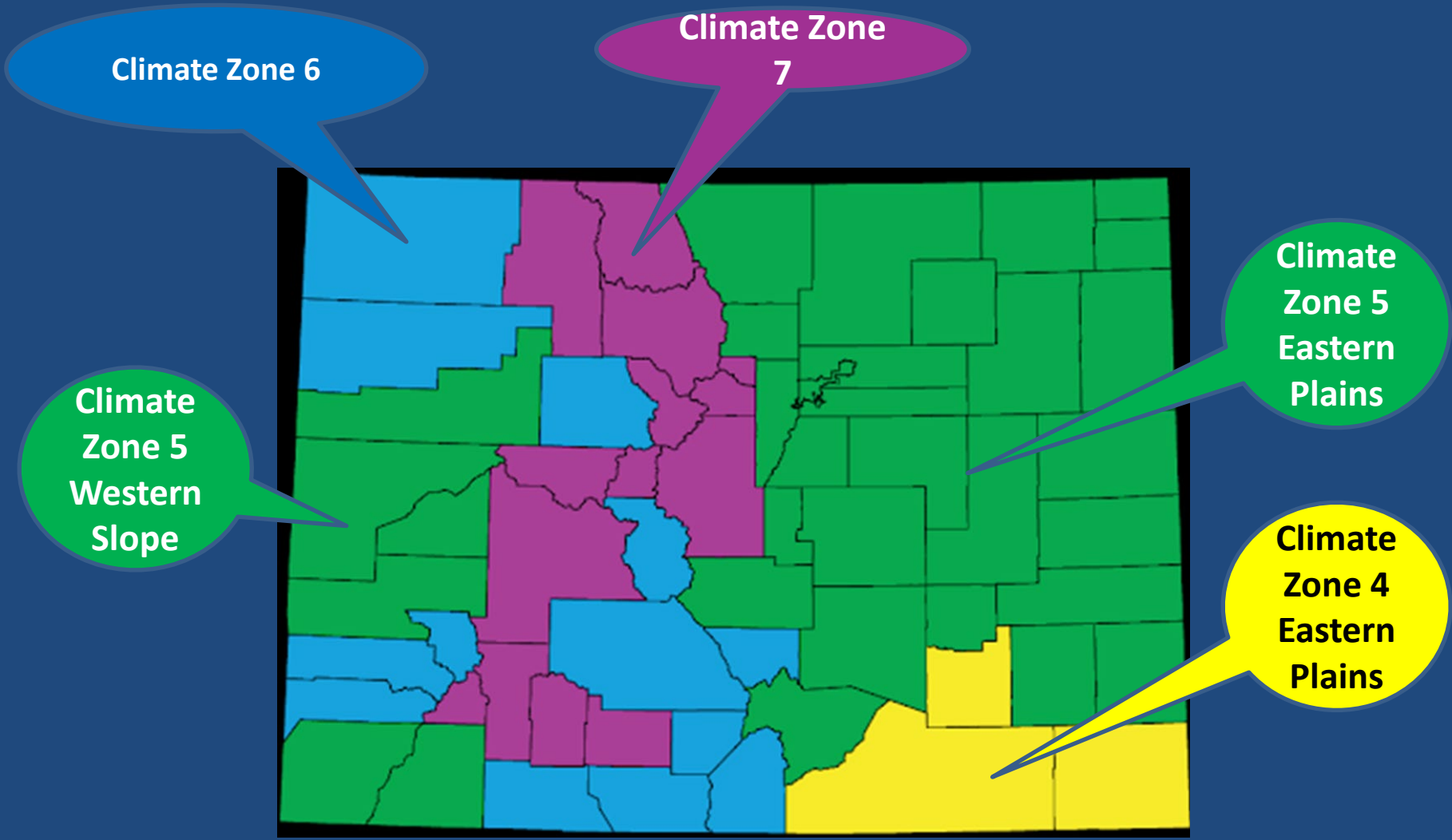
Ducting Requirements for Heat Pumps

Airflow Requirements and Testing

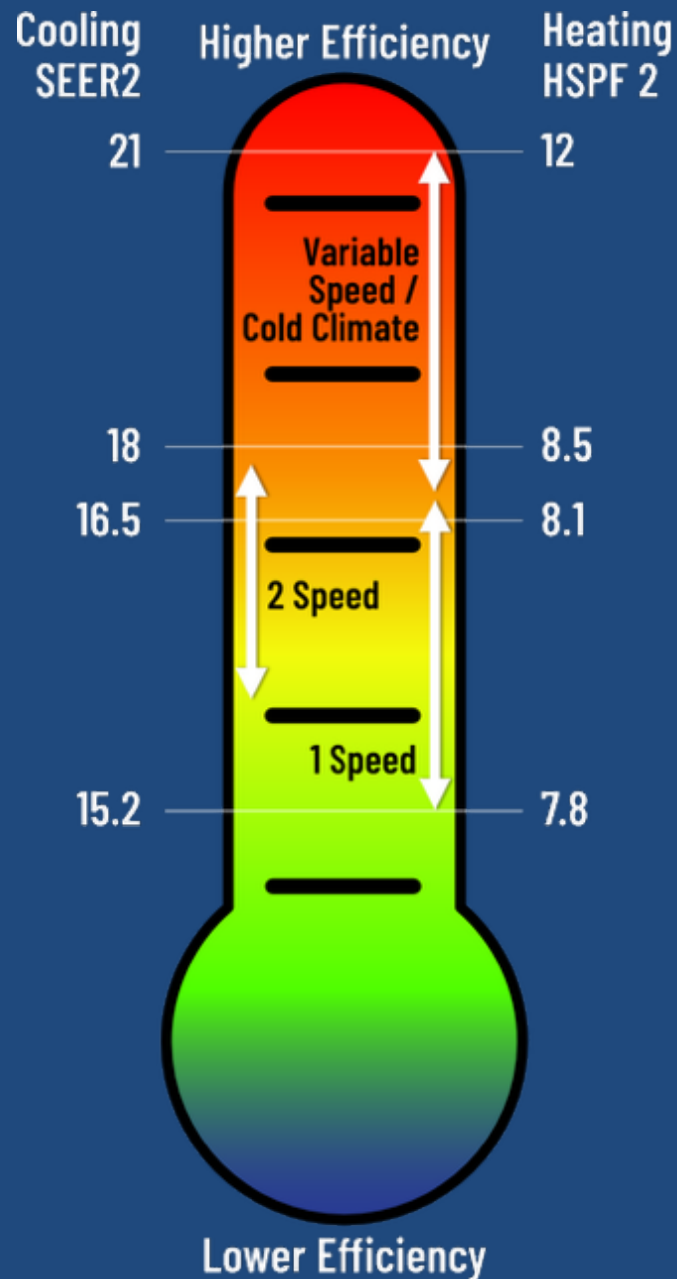
Installation Best Practices

Colorado Climate Zone Map

Zone	Elevation
5	Up to 7000'
5a	7000 to 8000'
6	7000 to 8000'
6a	Above 8000'



Air Source Heat Pump Levels



Cold Climate Variable Speed/Capacity (inverter systems)

- Good for all electric or dual fuel heating in CO → Climate Zones 5, 6, 7
- Hold Capacity at low outdoor temperature → 5°F capacity is 70%+ of 47°F
- Heat down to -13°F; often lower in specific cases
- Meet requirements for Colorado Utility & Govt Cold Climate System rebates

Note: On manufacturers websites some heat pumps are labeled as *cold climate* and other units are labeled only as *inverter/variable speed* or *high efficiency* even though their specifications do meet Colorado cold climate rebate requirements

Multi-stage/speed (2 or 3 speed) / Single speed

- **Not practical for all electric heat pump system**
- Good heat pump/furnace dual fuel option
- Simple installation, commissioning and setup
- Compatible with some older furnaces
- Good option to overcome electrical and ducting constraints

Installation

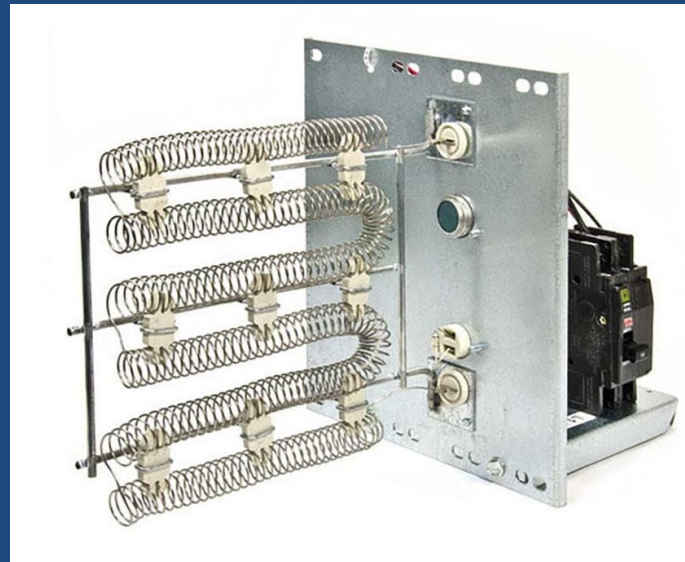


All Electric System Configurations

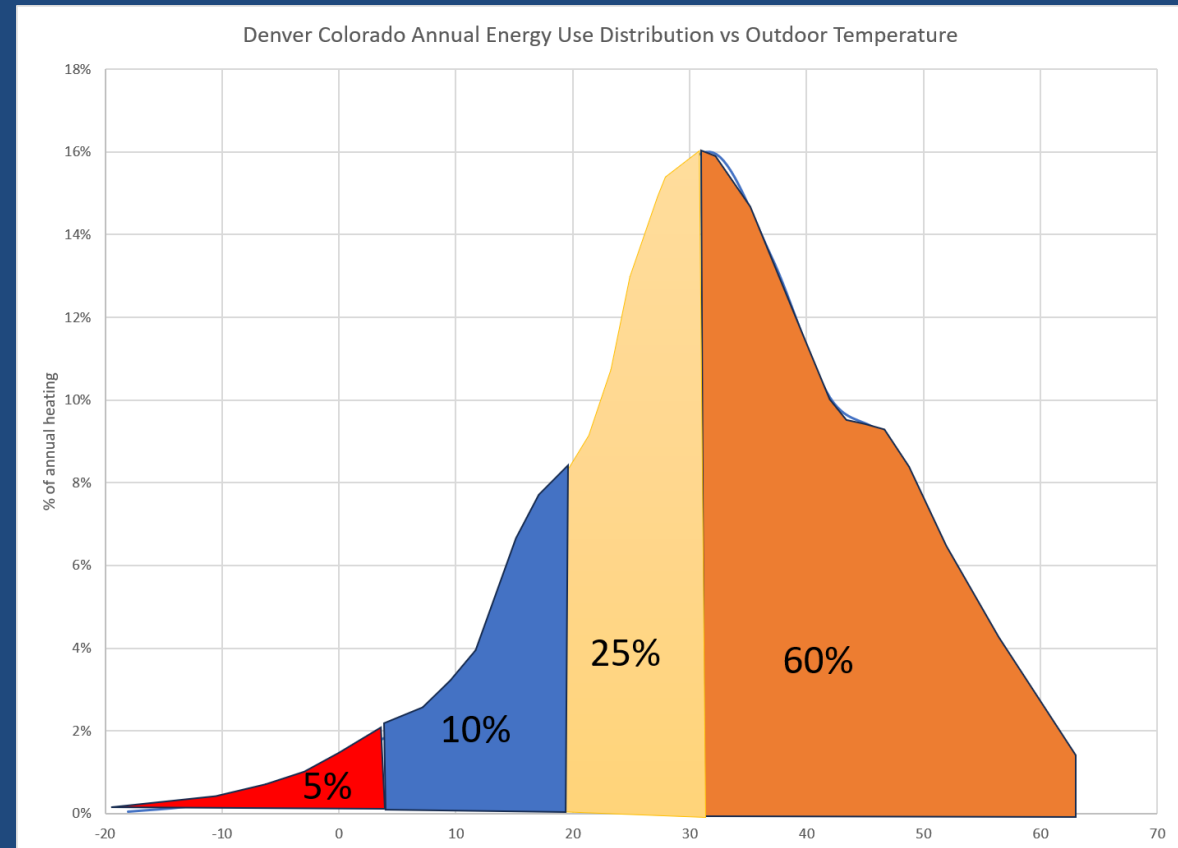
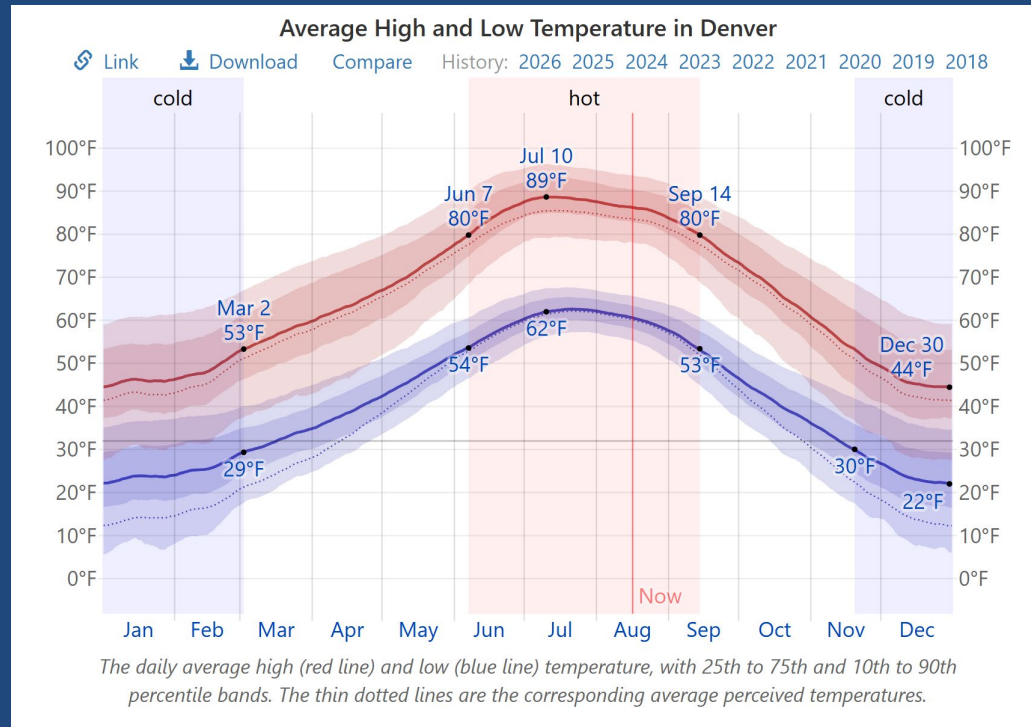
Heat Pump System with Electric Resistance Strip Heaters in the Air Handler for auxiliary/backup heating

Heat Pump System in home with existing fireplace/wood stove for auxiliary/backup

Stand-alone heat pump system



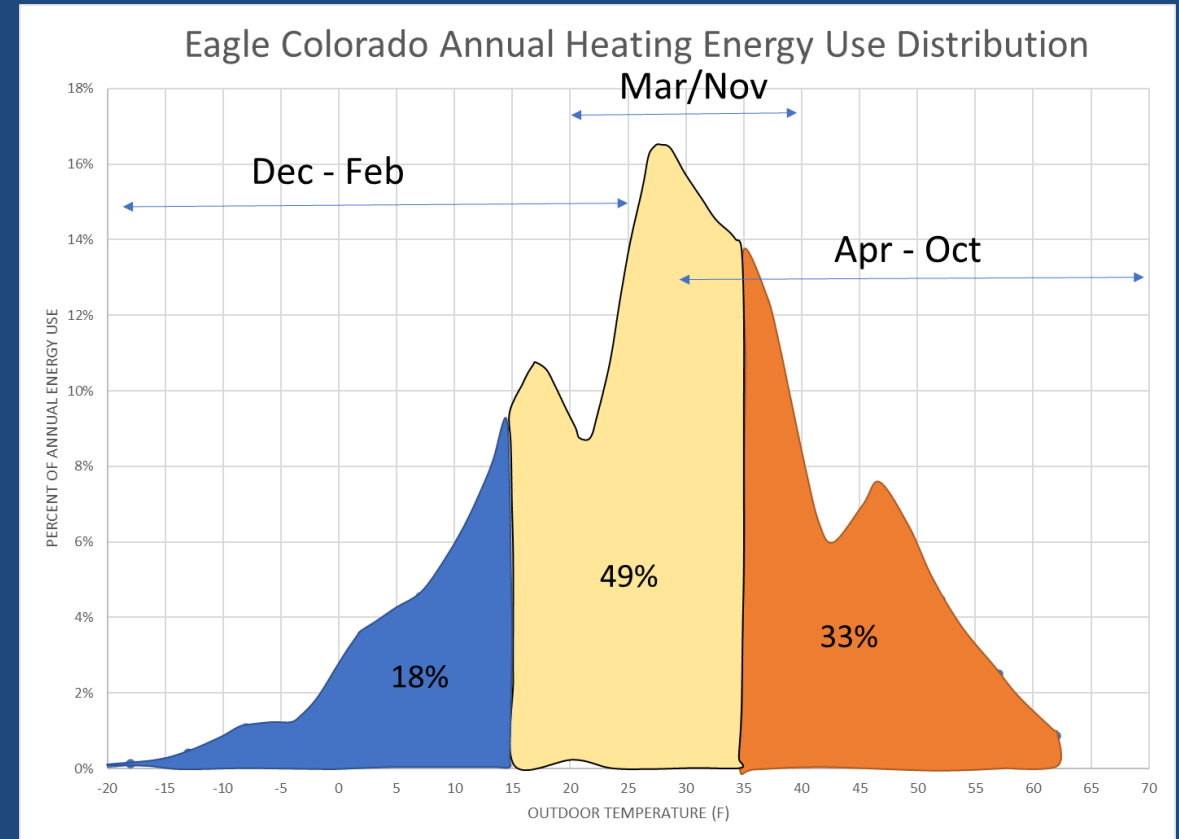
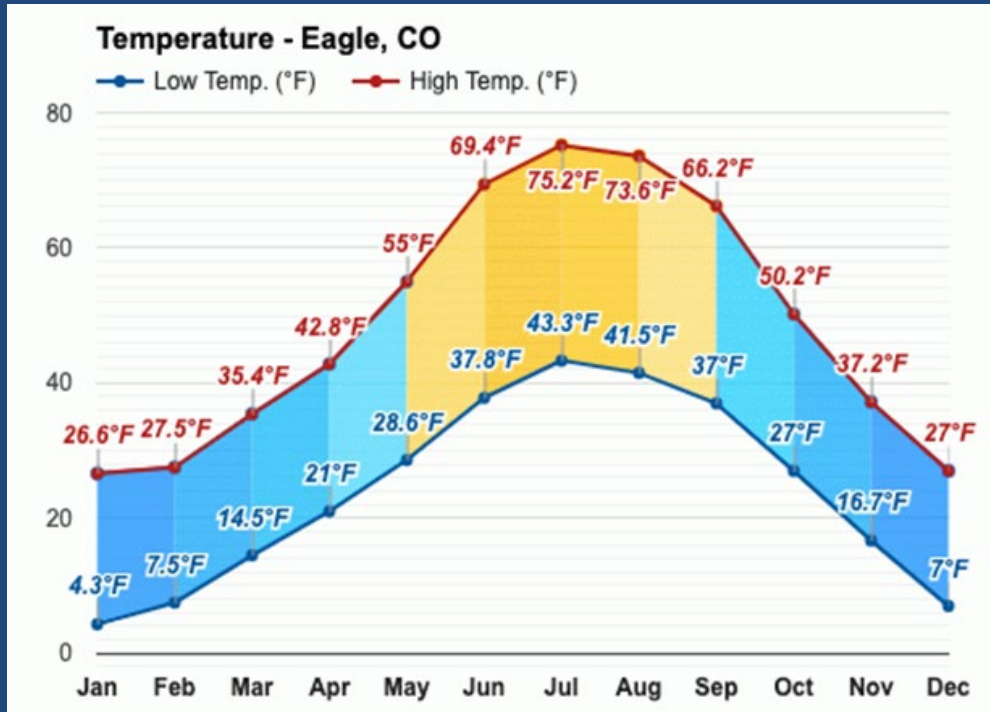
Denver Heat Pumps → Heating Comparisons



HP&Auxiliary

Cold Climate HP

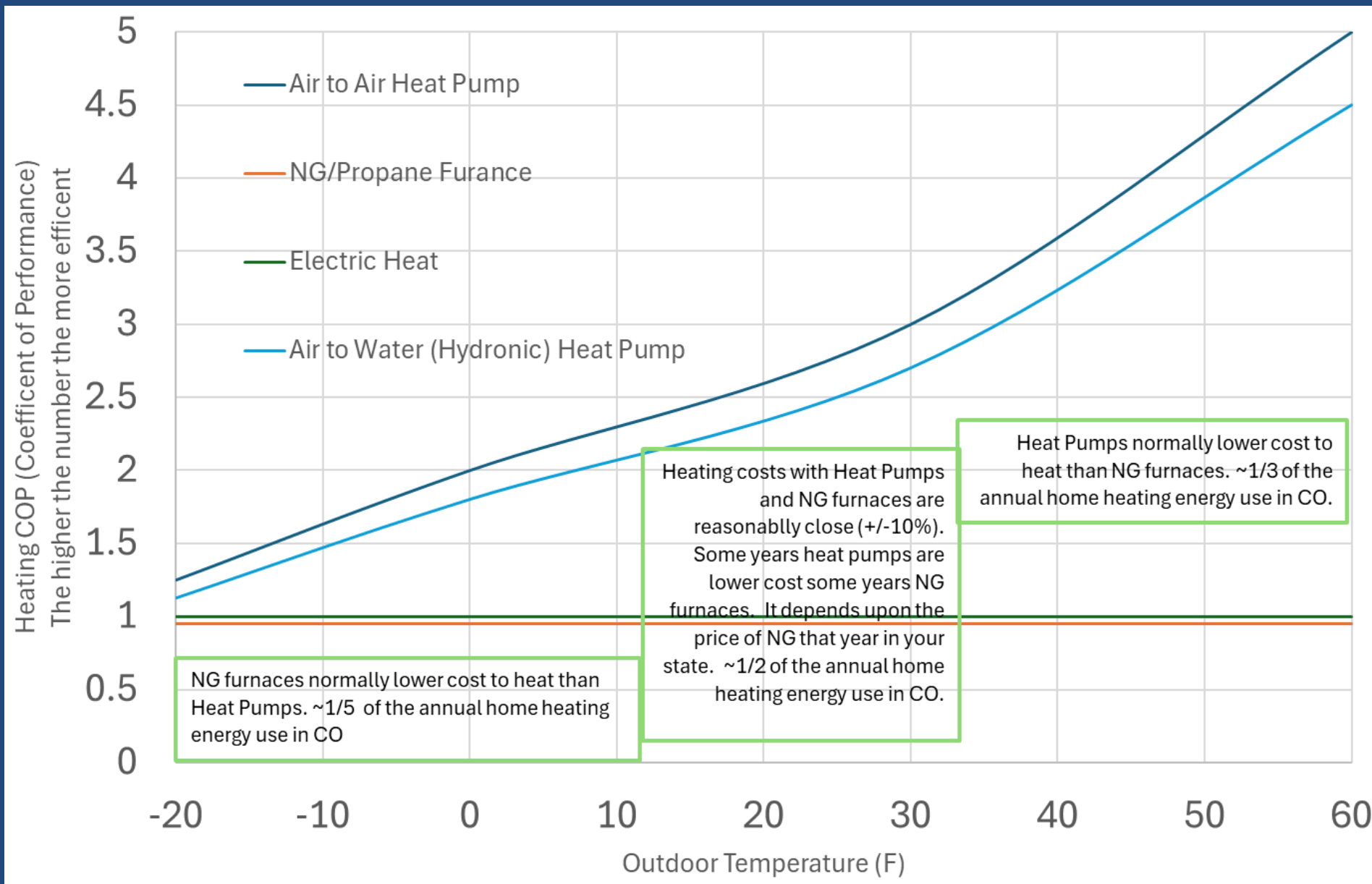
Eagle Heat Pumps → Heating Comparison



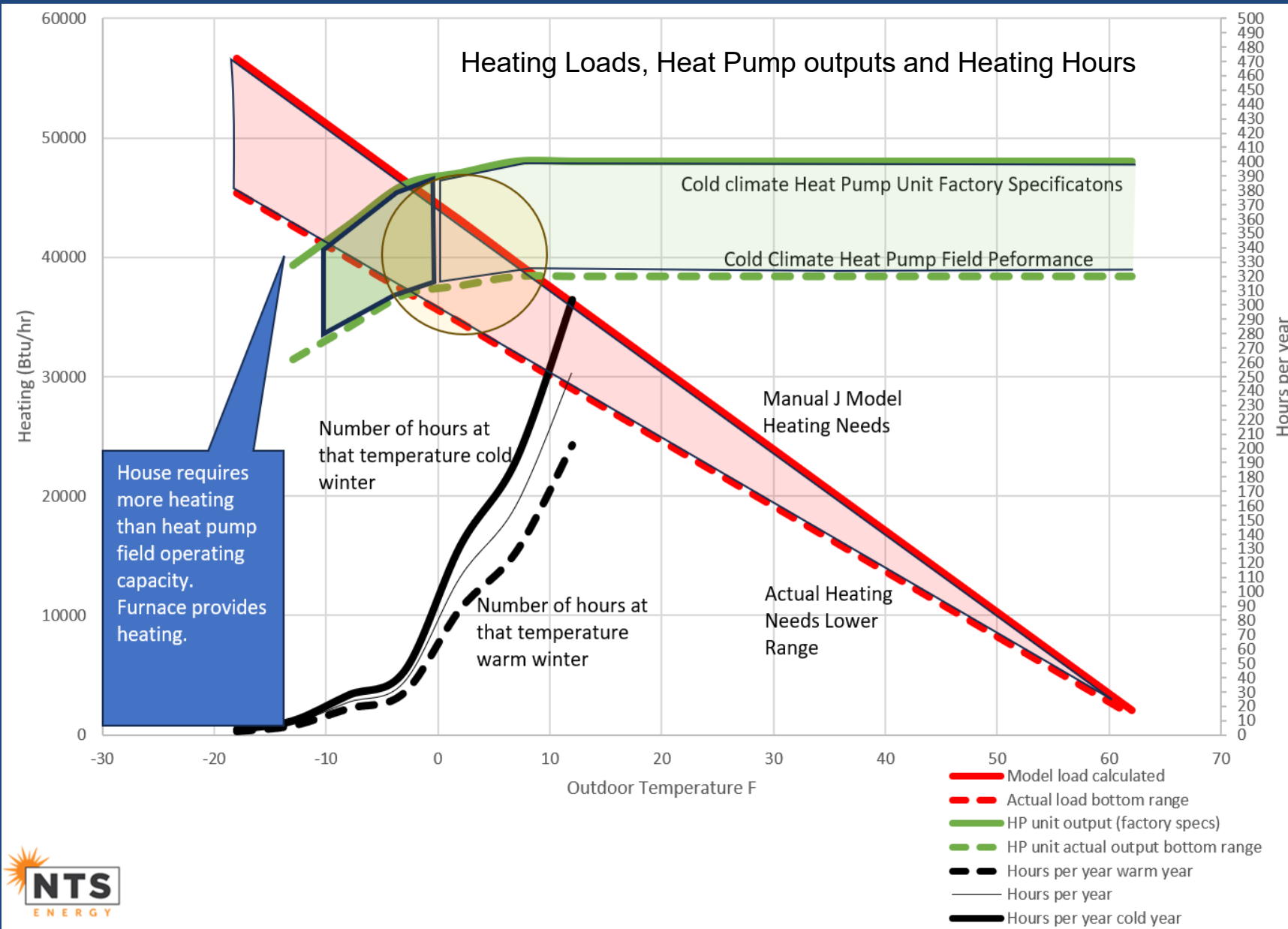
HP&Auxiliary

Cold Climate Heat Pump

Energy Efficiency & Relative Heating Cost of Home Heating Sources



Sizing → Cold Climate All Electric System



- Manual J to determine how much heating/cooling a home needs yearly, based on outdoor temps
- Cold Climate Heat Pump should be sized to carry the entire heating load down to $\sim 5^{\circ}\text{F}$.
- Must adjust capacity* for ALTITUDE
 - Zone 5 below 7°K : 5-10%
 - Zone 5/6, $7-8^{\circ}\text{K}$: $\sim 10-15\%$
 - Zone 6/7, above 8°K : 15-20%
 - * Somewhat mfg dependent

Note: Heat Pump Size → There are not infinite choices; for any given home, choices are between just a few sizes

When Heating Load is Between Unit Size Capacities → *Upsize*

Issue	Impact on System Capacity in the Field
Manual J load (tends to overestimate with perfect model)	+/- 10%
System Specification	Tested under <i>perfect</i> factory conditions
Systems as shipped from the factory	+/- 1%
High-quality field installation – slight deviation from the <i>perfect</i> factory conditions	0 to -2%
Field operation under harsh winter storm conditions	-5 to -10%
Annual performance degradation; excellent annual maintenance; median solar panels (~0.95%)	0 to -1%
Annual performance degradation; sporadic maintenance (most common)	0 to -5%

Upsizing a system by ½ ton does not increase initial cost; efficiency difference at milder temperatures is insignificant due to inverter compressor system

Turndown is ~65% from upper capacity to lower capacity

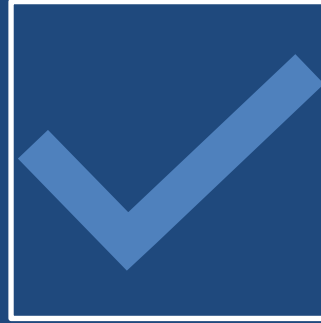
Cold Climate ~65+%

What Size System Will Work For You Without Changes?



What is the maximum size that my existing electrical panel/service can support for the heat pump system?

- Electric Panel upgrades will add a few thousand dollars to the system cost
- There are sometimes local rebates for panel upgrades
- Future plans: Electric cars, new electric appliances → Is now a good time to upgrade?



What is the maximum size heat pump that my existing duct system can support?

- A heat pump produces 95-105°F warm air; a furnace produces 140-170°F warm air → to carry the same amount of heat to a room, the ducts for heat pump need to be larger
- Ducts designed for furnace heating are typically large enough to heat your home down to ~20°F outdoors with lower heat pump air temperatures
- In older homes, furnace and ducts were sometimes oversized; this may enable the heat pump to heat your home with the existing ducts down to a lower outdoor temperature

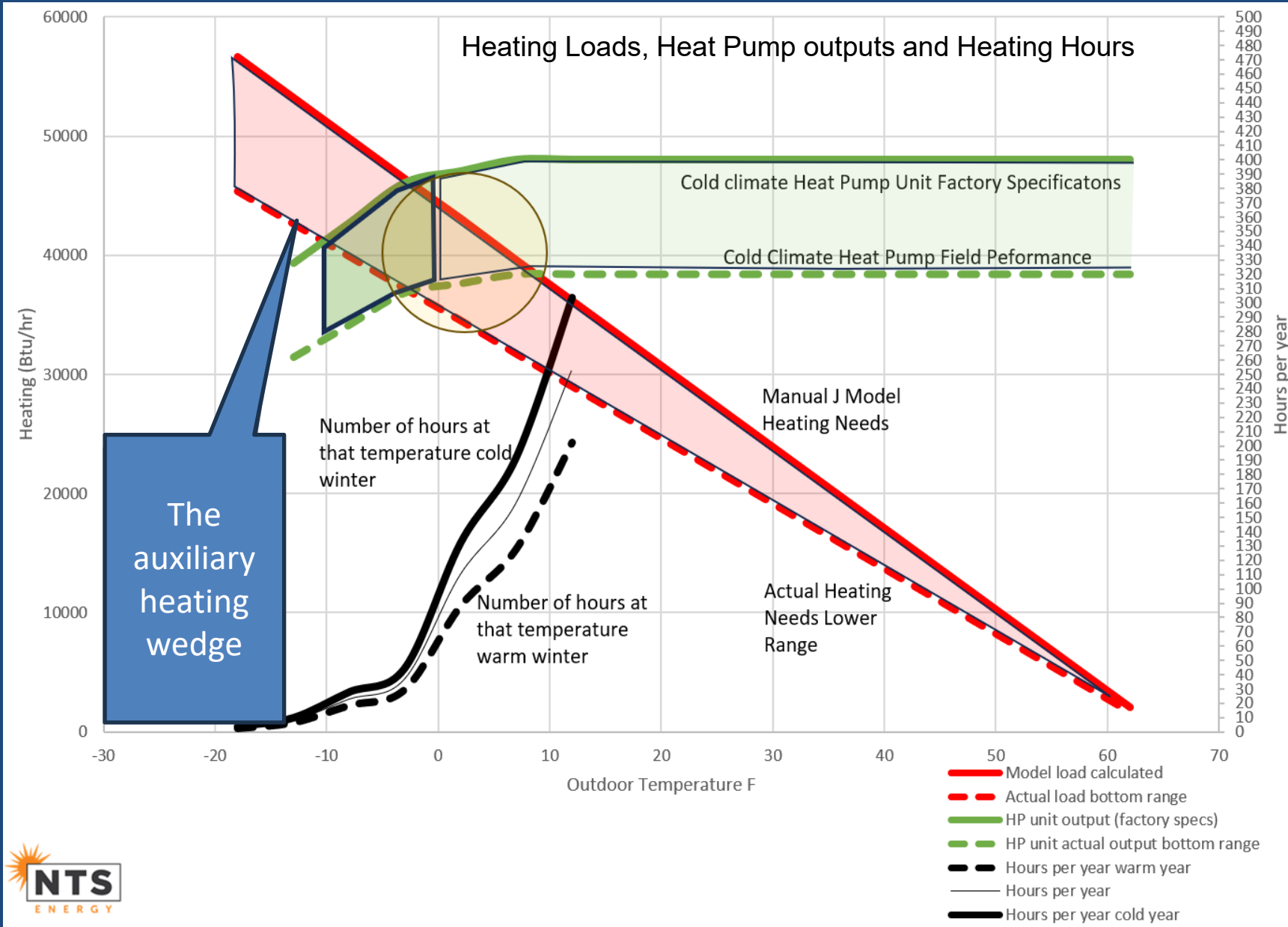
What Size System Will My Electrical Support?

Size (ton)	BTU	220V Breaker Size
1	12,000	15 amp
1.5	18,000	20 amp
2	24,000	25-30 amp
3	36,000	30-40 amp
4	48,000	40-60 amp
5	60,000	60-70 amp
2x – 3 units	72,000	80-90 amp

- 100-amp panel service will often limit you to a 2 – 2.5 ton heat pump
- 150-amp panel service 3 – 3.5 ton should be doable and often 4 ton
- 200-amp panel service 4 ton and often 5 ton
- Auxiliary/Backup Strip heater – additional 30-50 amps



Auxiliary/Backup Heating



- Climate Zone 4 – electric strip is only used as backup in the case of heat pump repair.
- Climate Zone 5 – electric strip is used for supplemental heating for all electric systems
- Climate Zone 6 – Will require significant supplemental heating for all electric. Dual fuel option should be evaluated as it often is a more cost-effective option
- Climate Zone 7 – dual fuel strategy recommended

Supplemental Heating Strategies

Electric Strip auxiliary/backup heating

- Size the electric strip to make-up the majority of difference between the heat pump capacity and the load at -13°F (zone 5), -18°F (zone 6)
 - 3-8kW electric strip heat; if available supplement with wood pellet stove, masonry stove, wood fireplace
 - If you must put in 10kW, then stage as two 5kW circuits
 - If >10kW, upsize the heat pump a half ton or 2- heat pump strategy or dual
- Sharing 40amp (8.8kW) circuits with EV charging circuit is a good strategy to keep total electric service to a minimum
 - Off the shelf device to share EV charging and HP strip heat → www.simpleswitch.io
- Smart electric panel → talk to your utility provider about financial, technical and system support

Fireplace/Wood Stove

- When the outdoor temperatures go <0°F, will likely need to run these heating sources to assist the heat pump
- Set the heat pump air circulation control to continuous → this will move the heat around the home

No Supplemental Heating Zones 4&5 Only (Aggressive strategy no climate, field performance or design risk mitigation)

- What outdoor temperature was used as the design temperature? Will the heat pump meet 100% load at design?
- How much will the indoor temperature decrease when the temperature goes below that temperature?
- Minimally Have the electrical circuit installed in the air handler even if not connected

Electrical Backup Sizing Example

% Annual Heating	Outdoor Temp (°F)	Avg Bin Hours ASHRAE 2021 (30 years data)	Eagle (Climate Zone 6) (heating load btu/hr)	Mitshubishi Hyperheat Capacity (4 ton, alt correction 6%)	Capacity shortage (btu/hr)	Strip Kw Cover Shortage	Amps @ 220v
99%	1	101	42294	45,120	-2,826		
99.60%	-4	31	45232	37,901	7,331	2	10
Mean Extreme	-13	8	50528	35,645	14,883	4	20
Lowest Heating Bin	-18	2	53767		26,884	8	36
% Annual heating	Outdoor Temp (°F)	Avg Bin Hours ASHRAE 2021 (30 years data)	Denver (Climate Zone 5) (heating load btu/hr)	Mitshubishi Hyperheat Capacity (4 ton, alt correction 6%)	Capacity shortage (btu/hr)	Strip Kw cover shortage	Amps @ 220v
99%	6	66	39403	47,376	-7,973		
99.60%	0	29	43086	38,803	4,283	1	6
Mean Extreme	-10	9	49284	36,096	13,188	4	18
Lowest Heating Bin	-13	4	51062	35,645	25,531	7	34

Why Correct Airflow is Critical for Heat Pump Performance

Heating Mode

Airflow too high or low – can reduce air temperature leaving the coil hurting efficiency and potentially comfort

Cooling Mode

Too high or low can affect humidity control

Temperature Rise

Affects efficiency and comfort; possible temperature protection faults

Airflow Heat Pumps vs NG Furnace

When using the existing duct system, at what lowest outdoor temperature can the heat pump still handle the full heating load? The Conservative Approach:

- Assume 400 cfm/ton for heat pump and 350 cfm/ton for furnace; ~15% more ducting required for heat pump
- For Cold Climate Heat determine equipment size at ~0°F outdoor from Manual J; based on specific heat pump capacity specified and cfm/ton, determine if the duct trunk supply and return are adequate for full heating at ~0°F

Heat Pump: Typical output temp ~100°-105°F,
~375-400 cfm/ton
Refer to equipment manual for specific value at elevation

Furnace: Typical output temp ~125°F,
~300-350 cfm/ton

What Drives the Cost of Duct System Upgrades

What are my options if upgrades are prohibitively expensive?

Common upgrades

- Main supply trunk adequate in the 0°-10°F outdoor temperature range, but not for 0°F
- The number of supplies will be short → typically 2-5, especially at the end of long trunk runs or in uncomfortable rooms
- Return air registers are often undersized for heat pumps and need expanded capacity
- Dry wall repairs and painting

Options if the duct system upgrades too difficult and expensive for your home

- Consider a dual fuel system
- Downsize and replace the existing NG furnace and install a mini-split heat pump system to provide the heating and cooling needs for the largest room(s) in the home

Measuring Static Pressure and Airflow



<https://www.youtube.com/watch?v=eFmDmk1Siqc>

AC Service Tech LLC



Customer Friendly Thermostats

- Programmable third party → at least day/night setback but as simple as possible
- Manufacturers fully communicating integrated thermostats
- No more than 4° nighttime or daytime setback; larger setback will unnecessarily run the backup strip heat and notably increase heating bills. Some systems have an eco mode which will decrease the use of the electric strip for comfort.
- Set a lockout on the thermostat so that the strip heat is not activated when outdoor temperature is above 60°F



Electric Furnace to Heat Pump Conversion

All Benefits with No Downside

- Reduce energy use and heating costs by 65+%
- Will not need to upgrade electrical capacity
- Minor or no duct system changes
- Air handler will replace the existing furnace unit
- Challenge is to find a location for the outdoor unit and route for the line set runs

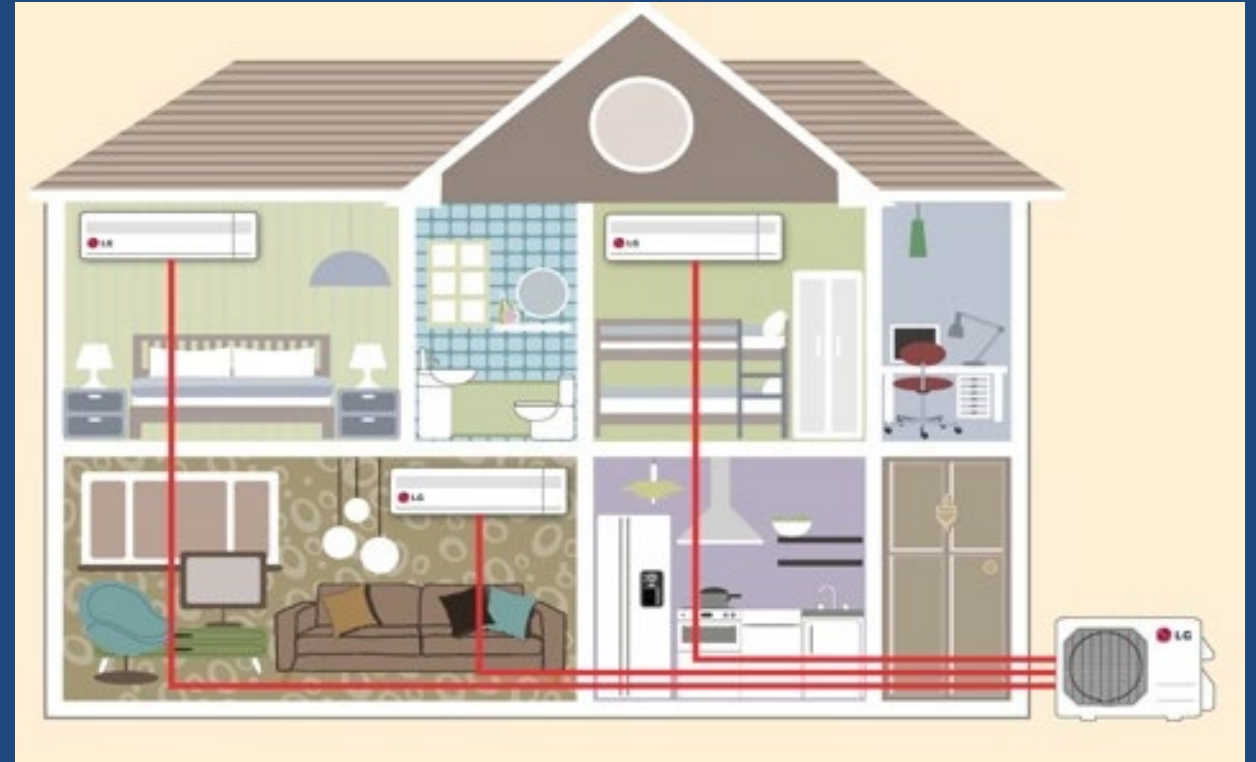
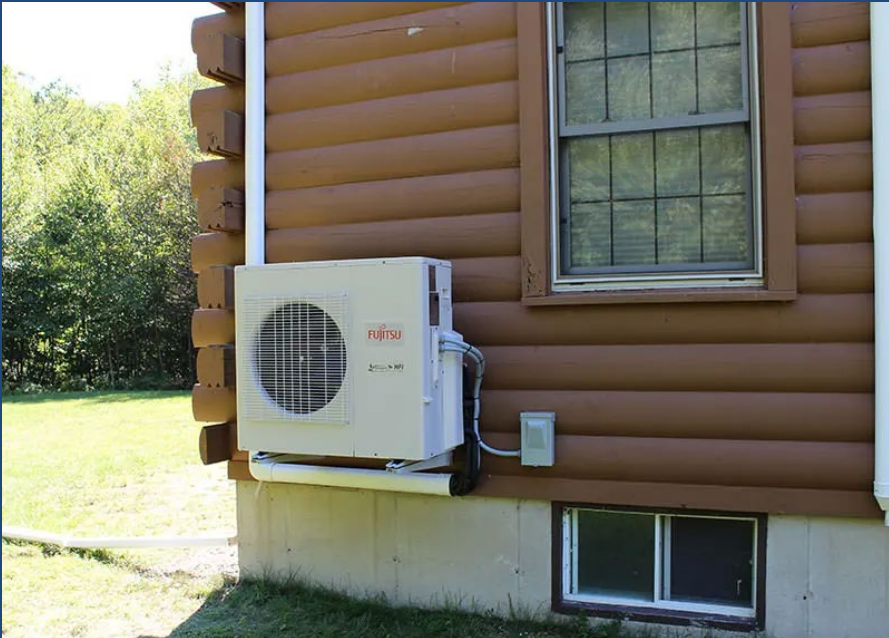


Replacing Electric Baseboard Heaters with a Mini-Split Heat Pump System

- Reduce energy use and heating costs by 65+%
- Will not need to upgrade electrical capacity
- Can do the larger rooms. Smaller rooms remain on electric baseboard.
- Challenge is to find a location for the outdoor unit and route for the line set runs

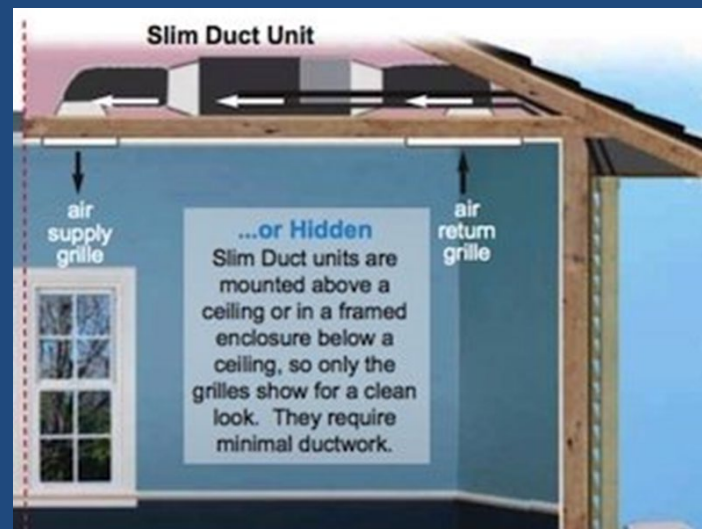
ASHP-MS Multi-Zone Mini-Split/Ductless Heat Pumps

- One outdoor unit; up to 4 indoor units
- Each zone independently controlled thermostat
- Less than 6" diameter space needed for runs, outside or inside of building
- Variety of very quiet indoor unit options
- Outdoor unit powers indoor units



Multiple Indoor Unit Options

Wall, Floor, Ceiling, Slim Duct, Air Handler



Mini Split ASHP and Electric Baseboard Strategy

1. Prioritize the largest volume room(s) in your home that can be served with 1(2) indoor units, and cooling would be appreciated
2. After largest rooms, consider medium rooms: kitchen, family room, office/study
3. Four rooms is practical maximum for one system
4. The heating capacity for the indoor heads needs to be sized for each room. All indoor heads on one outdoor unit must be relatively close in capacity
5. Keep all the small rooms on baseboard heating as it is not cost effective to get another system for small rooms
6. Remove the number baseboard heaters in the largest rooms and repurpose the electrical circuits to provide the power necessary to operate the heat pump unit



Good Outdoor Installation → Good Performance (1 of 2)

Best location is on the south side your home; sun helps defrost

- East and West are fine; avoid the North side if possible
- If practical, install soft or hard landscaping to protect from west winds

Assess and mitigate noise impact around patios, bedroom windows

- Vibration impacts: Wall mounts need damping
- Review all equipment noise specifications

Do not locate unit under the edges of overhangs

Mount at height above the avg snow depth at max month (Jan)

- Vail – 31" Feb
- Rifle – 4" Jan
- Front Range – 12"



Good Outdoor Installation → Good Performance (2 of 2)

Erect a snow shelter over the unit

- For Side Flow Units → the shelter can be close to the top of the unit
- For Top Flow Units → need 24" clearance



Effective drain pan heater and drain to safe location

Crankcase heater wiring

Protect condensate line

Lineset Best Practices

Layout → no sharp bends or kinks, curves instead of 90 bends

Insulation

- Closed cell foam
- Attach with zip ties not tape
- UV protection (south side)
- Insulate outdoors and in unconditioned spaces
- No gaps
- Seal penetrations with sealant that meets minimum temperature requirements



Duct system checks and improvements

Check ducts in unconditioned/partially conditioned spaces

- Attic, crawl space, basements
- Check duct joint sealing
 - Duct leakage test, if not accessible
 - Note: Some rebates for duct sealing are available
- Ensure ducts are well insulated



Evaluate duct sizing to ensure efficient heat pump performance

- Add supplies and returns in uncomfortable rooms if possible
- Returns can generally be installed near the air handler/furnace unit and relatively easy to locate
- Small return lines can sometimes be added in finished basements

Consider adding duct system zoning to the main trunk to create 2 zones

- Increased comfort
- Improved overall efficiency

Other Installation Considerations

Nitrogen Purging during Brazing → Failing to do this creates internal scaling which later clogs valves

Incorrect Refrigerant Charge → System shutdown/failure

Miswiring Communication Controls → Incorrect gauge, cross wiring or wire nuts; results in lockouts

Summary (1 of 2)

- Size systems for the correct climate and altitude.
- Evaluate the appropriate backup options based on climate zone
 - Climate Zone 4 – Electric strip
 - Climate Zone 5 – Electric strip, dual fuel
 - Climate Zone 6 – Dual Fuel, electric strip
 - Climate Zone 7 – Dual Fuel
 - For all climate zones, depending upon the size and location in the home a fireplace, wood/pellet stove may provide adequate backup.
- Ensure ducting is adequate for Cold Climate based on climate zone. If upgrades are prohibitively expensive go to other options.
- Check that electrical is adequate for all electric system. If panel and line upgrades are required and expensive consider dual fuel.

Summary (2 of 2)

- Keep the controls as simple as possible → *Teach the Customer*
- Follow installation best practices for the specific system for all phases of the project → sizing, air flow, outdoor unit, line sets, ducting, electrical, refrigerant

Finally → Know all the requirements of your equipment *before* installation



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- **Owner** – NTS Energy → Home Energy Solutions Consulting: HVAC, Solar, EVs
- **Consultant** – Xcel Energy → Customer Personalized Energy Use Education, EVs
- **Sustainability Manager** – Golden Aluminum (Large CO industrial power user)
 - Facility wide energy monitoring system
 - Energy saving upgrades on large industrial production
- **Founder/President** – Blue Valley Energy → HVAC Company focused on ground source & mini-split heat pump engineering design & installation
- **Lead, Technical Sales** – RMS Electric → Solar & Energy power systems
- **MS in Geophysics** – Washington University, St. Louis