City of Fort Collins Utilities

Heat Pumps In Colorado: A Cleaner, More Efficient Option to Heat and Cool Homes

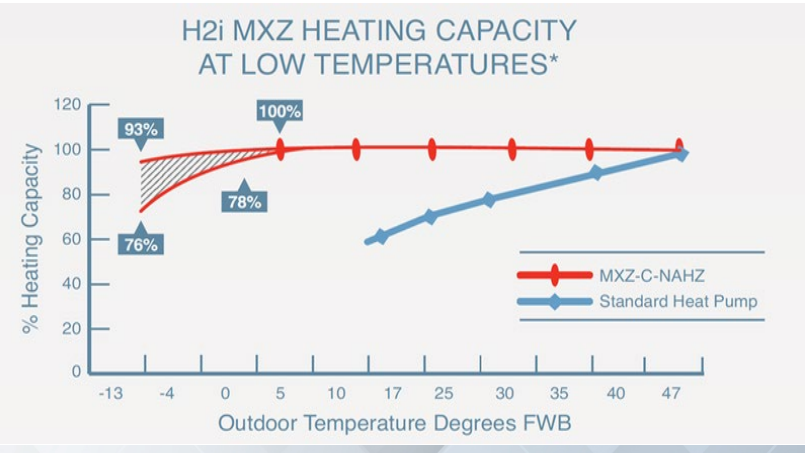
Cold Climate Air Source Heat Pump Strategies

08-24-2021

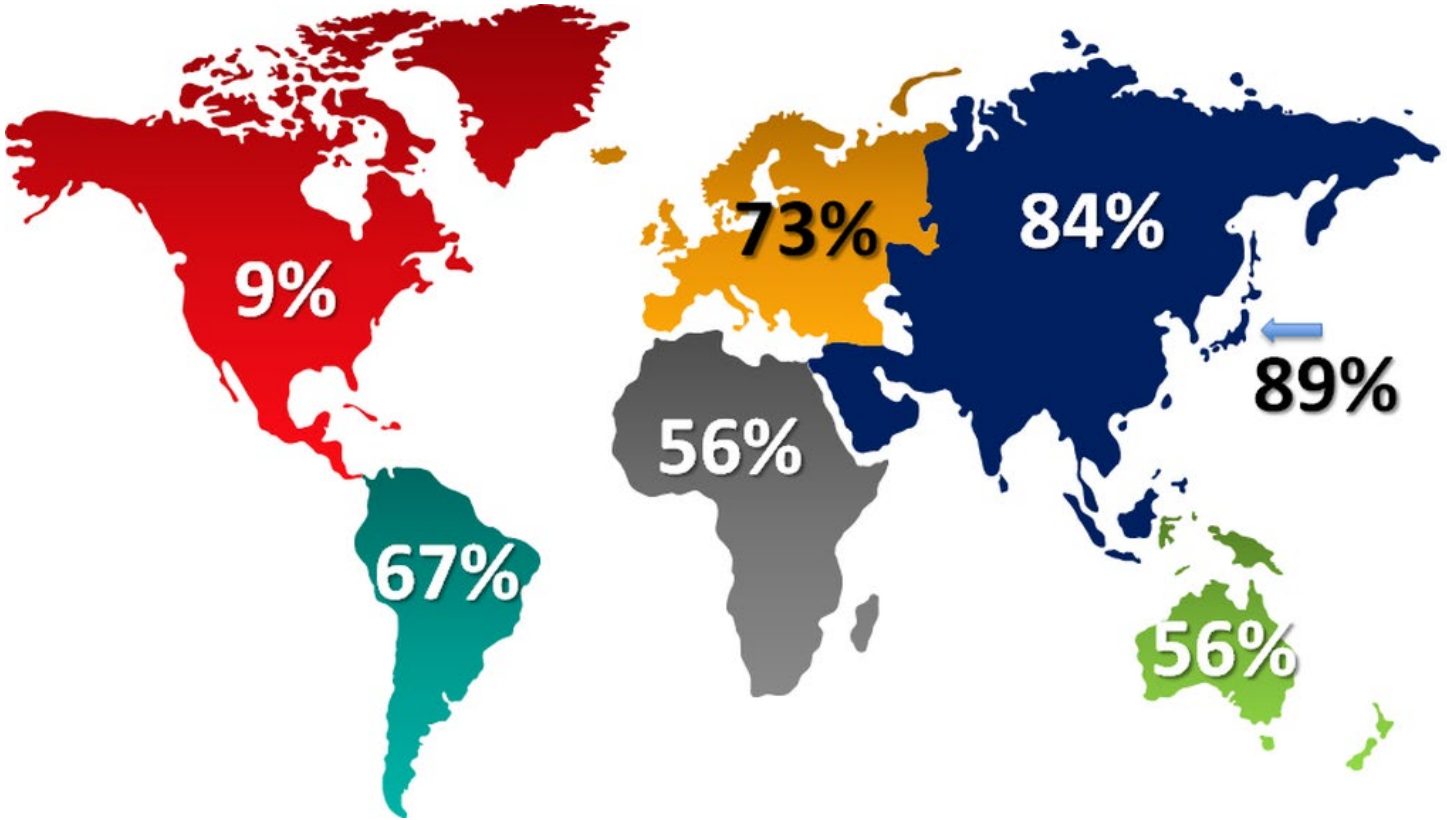
Shawn LeMons

Performance Construction Mgr.

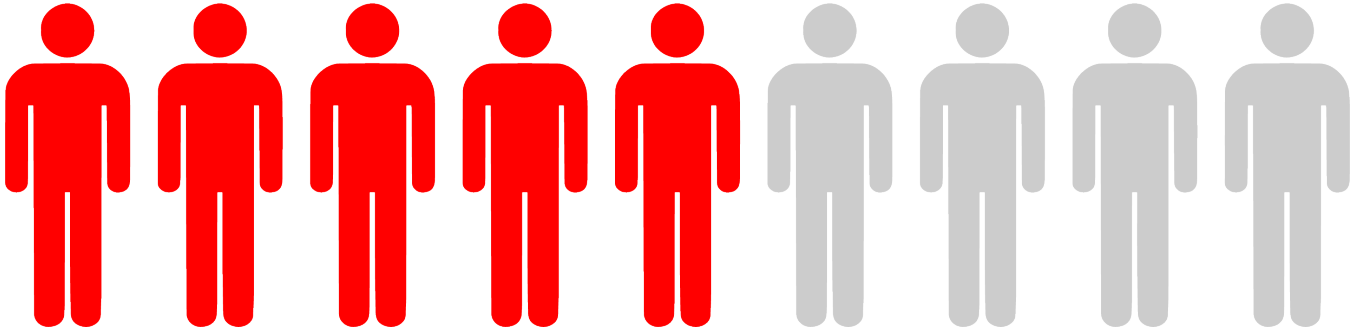
(Former BPI, IECC, RESNET, LEED, PHIUS)



ASHP International Market



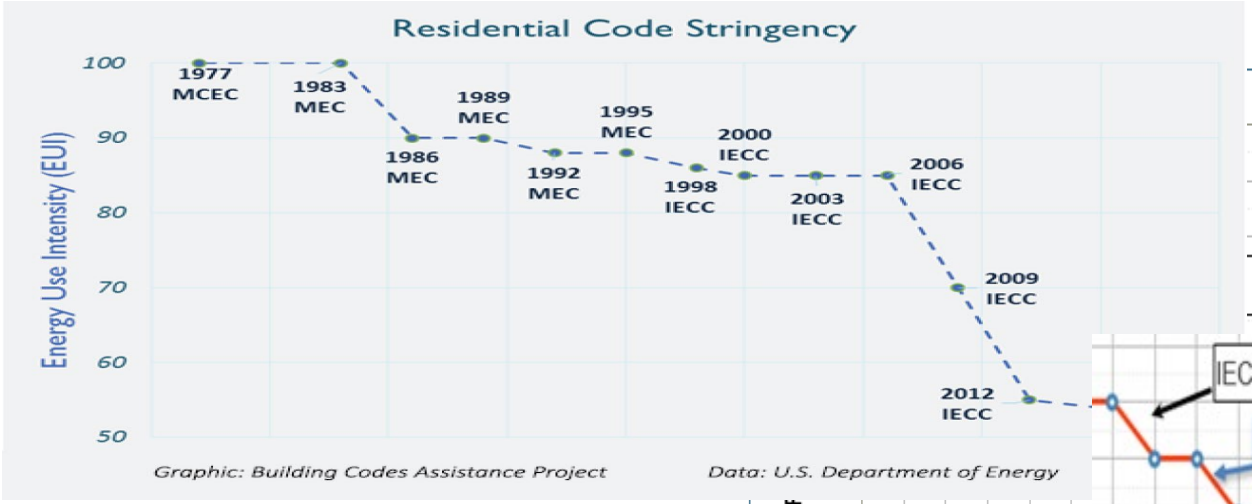
Did you know?

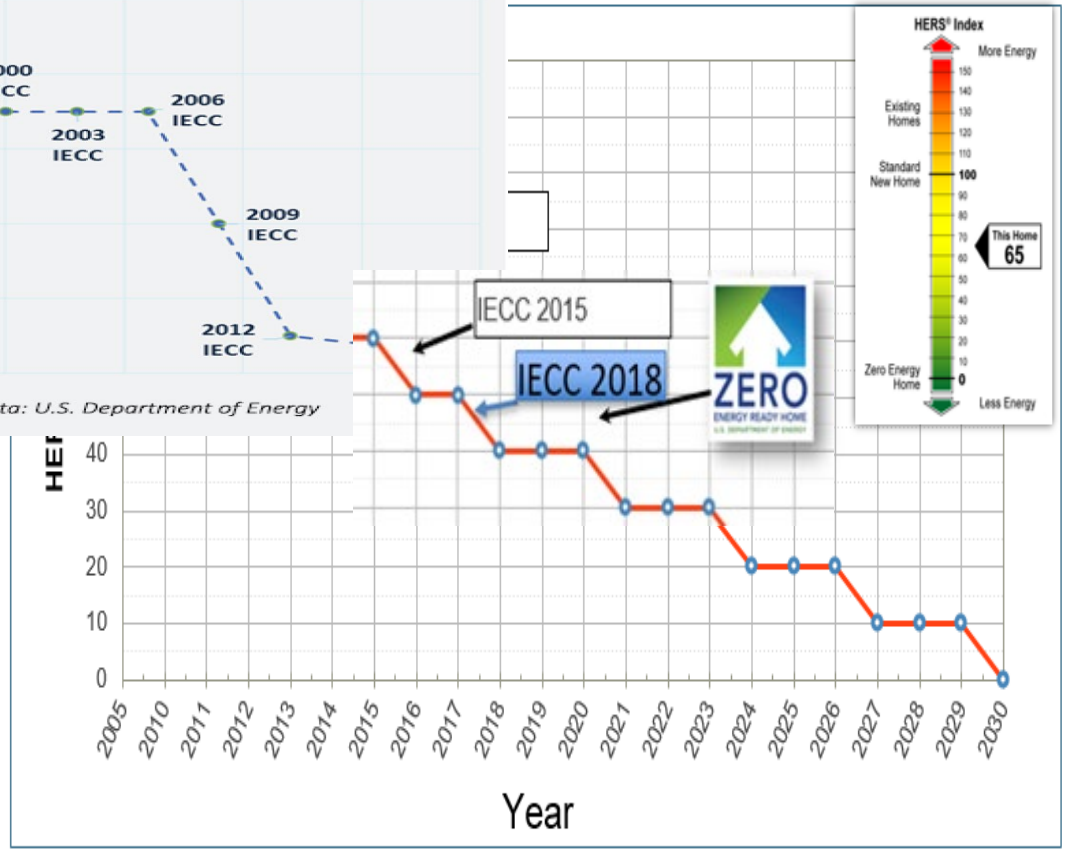


Well over 50% of U.S. HVAC contractors do not size heating & cooling correctly.

source: U.S. Department of Energy - 2016

Codes Changing Over Time





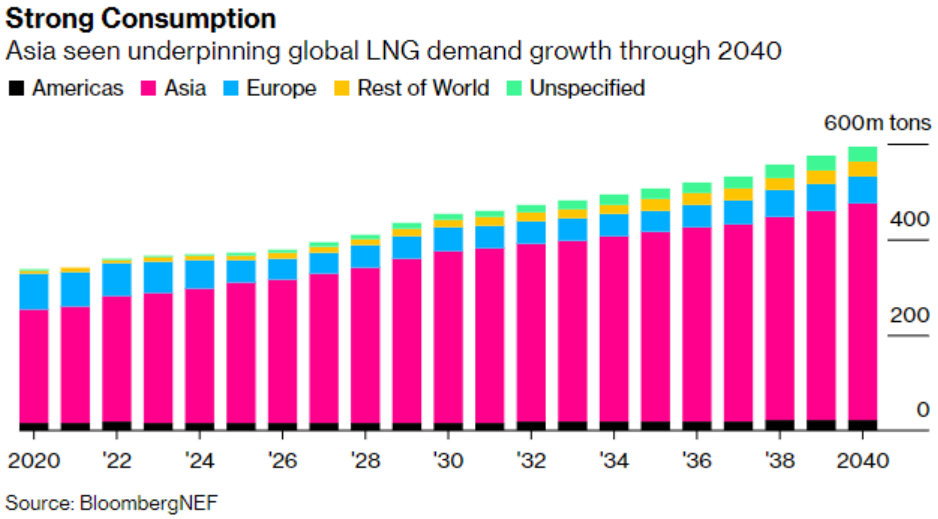
NG Costs Changing Over Time

Bloomberg News

The Era of Cheap Natural Gas Ends as Prices Surge by 1,000%

August 5, 2021, 6:00 PM MDT

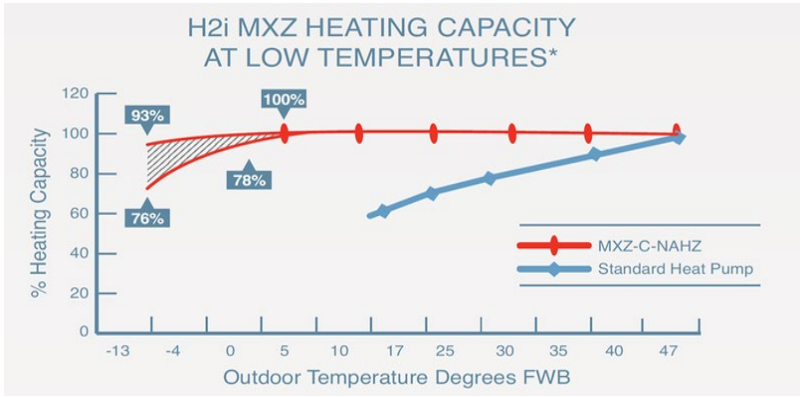
The era of cheap natural gas is over, giving way to an age of far more costly energy that will create ripple effects across the global economy.



What is a “Cold Climate” ASHP?

Chicago, January 29, 2019, with 3 days below -20F

https://drive.google.com/file/d/1QBgBd4JcVBpNpafsI4leWH24GcurEa9b/view



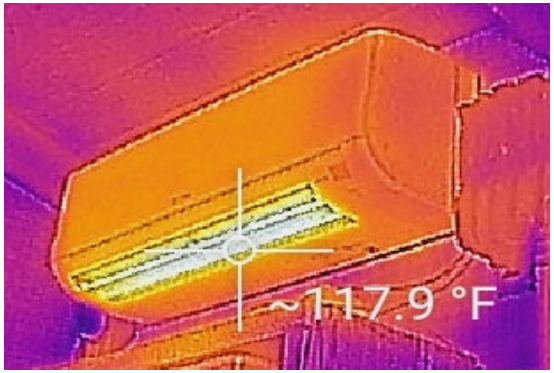
100% capacity at 5 F

76%-93% capacity at -13 F*

Operation down to -18 F and lower*

* Varies by outdoor model

VCHP systems - North Pole, AK



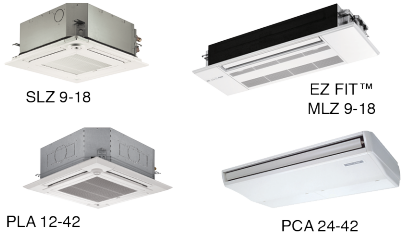
Above spec performance is common

Heat Pumps Have Evolved

Air Handler

SVZ 12-36 PVA 12-42

Ceiling Mount



SLZ 9-18 EZ FIT™ MLZ 9-18 PLA 12-42 PCA 24-42

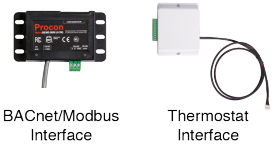
Floor Mount

KJ 9-18

Horizontal Ducted

SEZ 9-18 PEAD 9-42

Controls



Wired and Wireless Controllers

Wall Mount

WR 9-24 HM 9-24 JP 115V 9-12 GL 6-24 D 30-36 EF 9-18 FH 6-18 PKA 12-36

Single-Zone

Cooling Only
Standard HP
Hyper-Heating

Multi Zone

Standard HP
Hyper-Heating

Branch Box

3 and 5 Zone

CEE Case Study 2 (MN, June '18)

Table 1. A comparison of the weather normalized annual performance for several heating systems in this Minneapolis home.

	Heating Load	Annual COP	Electric Use	LPG use	Natural Gas Use	Total Energy Use	Annual Operating Costs[1]	Emissions[2] CO_2
	mmBtu	-	kWh	therms	therms	mmBtu	$	eqiv lbs
ccASHP w/ ER boost	63.1	1.84	10,075	0	0	34.3	$1,310	11,499[3]
Electric Resistance	63.1	0.99	18,491	0	0	63.0	$2,404	21,104
LPG Furnace	63.1	0.79	503	747	0	76.4	$1,404	11,650
Natural Gas Furnace	63.1	0.79	503	0	747	76.4	$807	9,699

1. Average residential pricing in 2017 for propane, natural gas, and electricity from Energy Information Administration were $0.13/kWh for electricity, $1.57/gallon for LPG, and $0.95/therm for natural gas.
2. Monthly average emissions in 2017 monthly were used. For electricity, 1.14 equivalent lb/kWh, 11.7 lb/therm for natural gas, and 13.0 lb/gal for LPG. (See Edwards et al 2018).
3. Using the NSP value of 0.894 lbs/kWh[1] the ccASHP with ER booster annual emissions would be 9,007 equiv. lbs, a 2% reduction over the natural gas furnace.

PVA-A36

PUZ-HA36NHA5

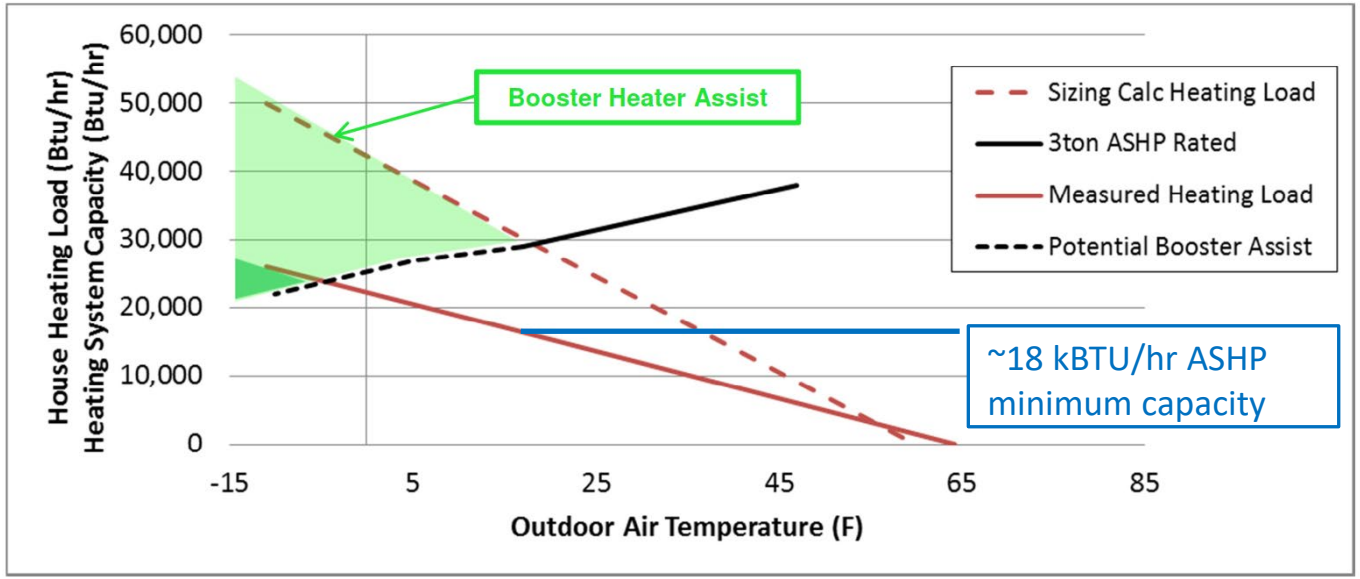
Site Characteristics

- 2 bedroom, one bath, 1.5 story single-family home
- 1924 Bungalow, 1600 sqft, with efficiency upgrades
- 50,000 btu/hr heating load calculation at -11°F
- 26,000 btu/hr measured heating load at -11°F
- 61,000 btu/hr electric heat strip

https://www.mncee.org/MNCEE/media/PDFs/ccashp-Study-2-MPLS.pdf

CEE Case Study 2 (MN, June ’18)

Figure 3. Capacity vs. Outside Air Temperature



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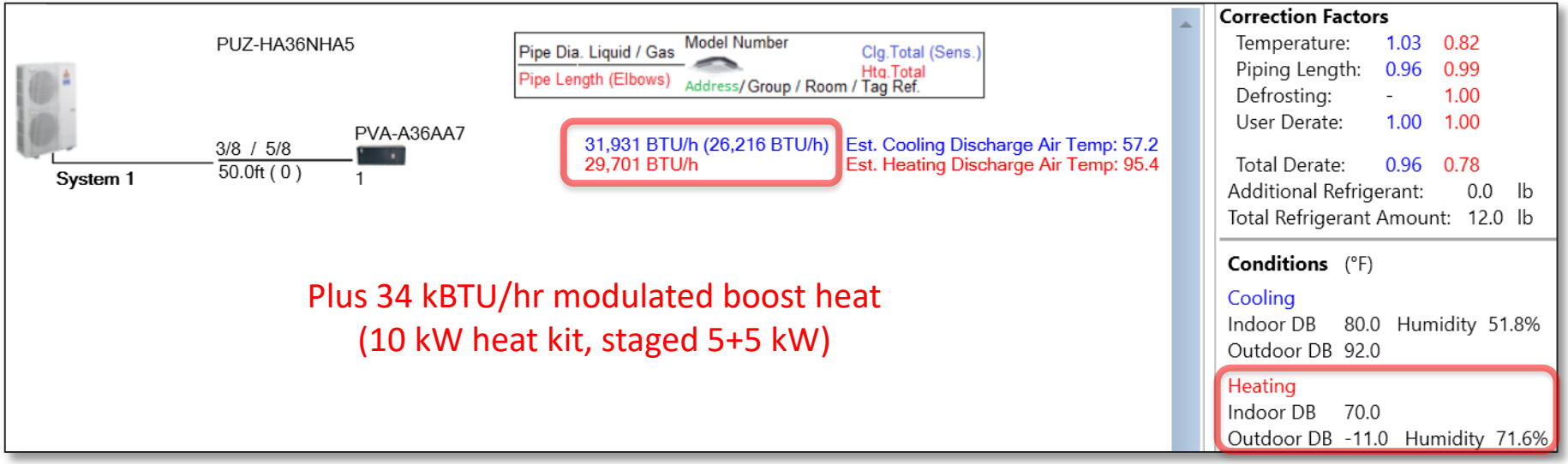
CEE Case Study 2 (MN, June ’18)

If the load calc was closer to the 26 kBTU/h heat load…

DIAMONDSYSTEM BUILDER



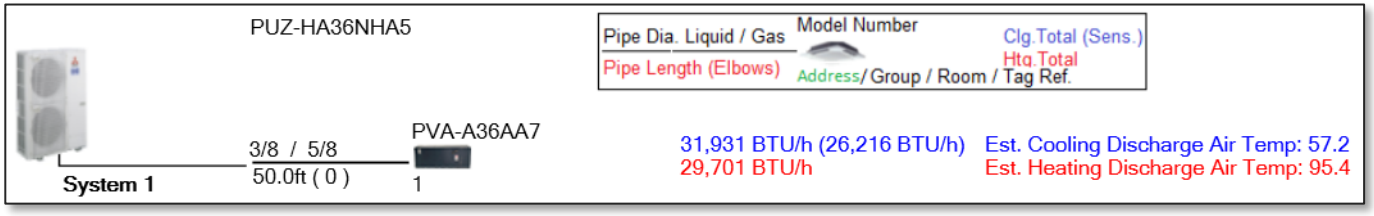
Plus 34 kBTU/hr modulated boost heat
(10 kW heat kit, staged 5+5 kW)

Verify system combination and capacity at design conditions.

Use this capacity and other spec sheet details for Manual S & Manual D compliance.

CEE Case Study 2 – Manual S Decision

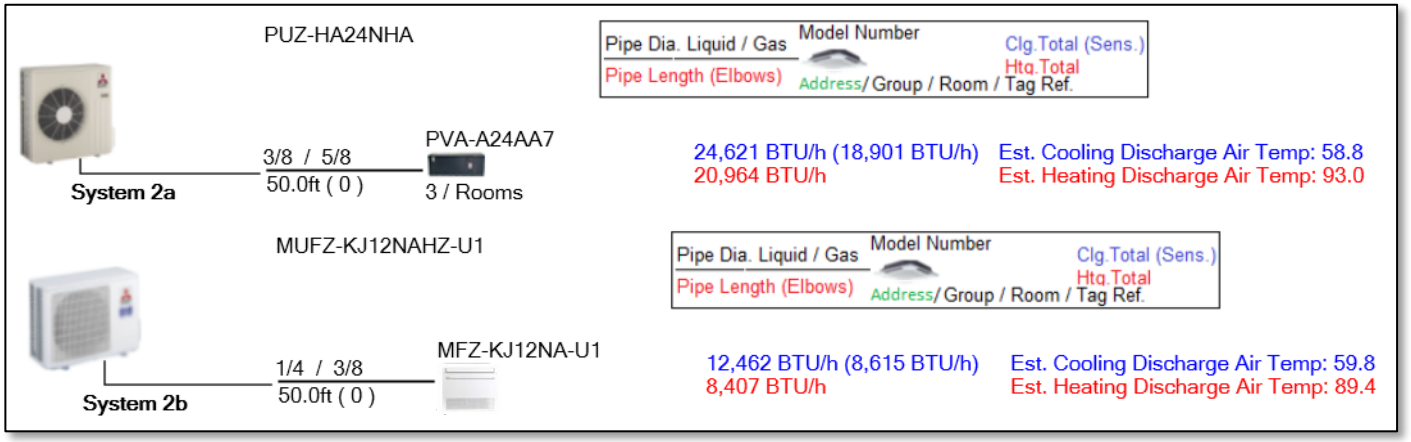
1 outdoor
1 ducted indoor
18.6 kBTU/hr min **Heat**
~1400 Watts at ~20°F



or…

2 separate systems:
Ducted for rooms
Ductless for Liv & Kit
2.9 kBTU/hr min **Heat**
~200 Watts at ~60°F

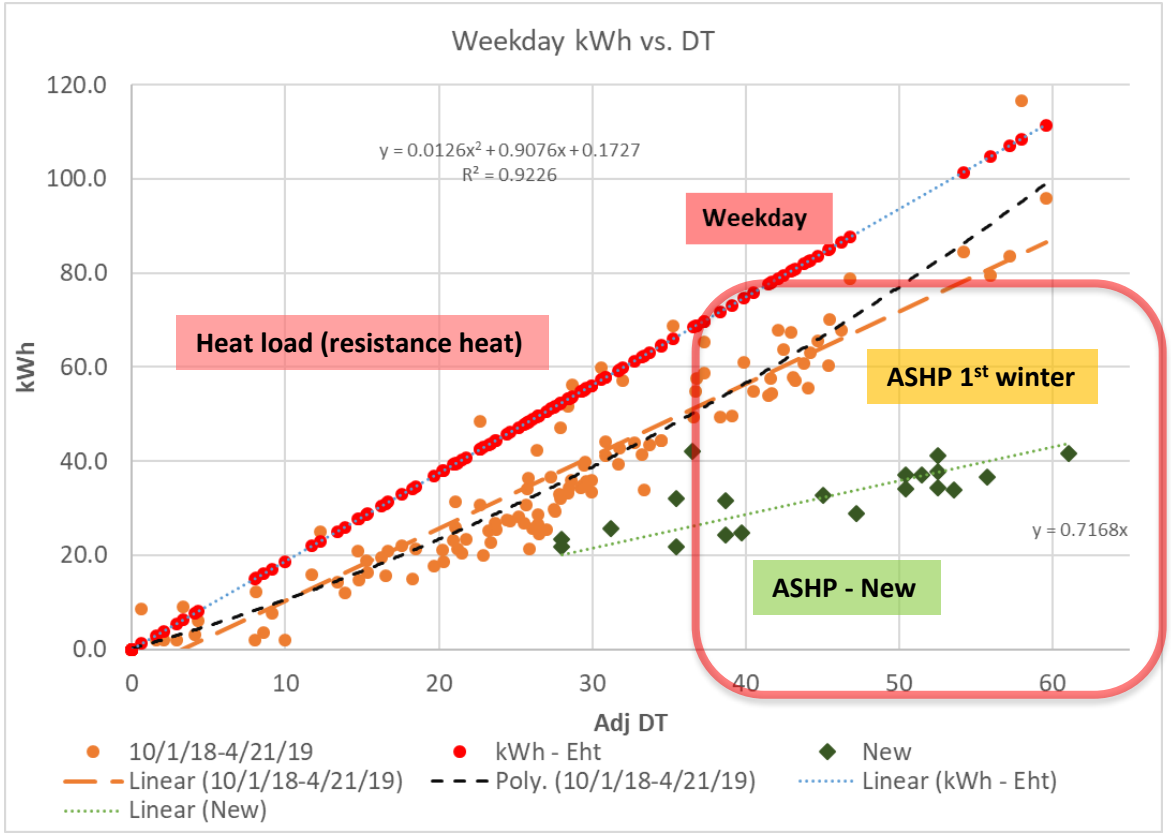
Cooling minimums:
15.5 kBTU -> 2.3
~1170 Watts -> ~170
18.2 SEER -> 25.5



NESEA 2019 study

Site Characteristics

- Hinesberg, VT outside of Burlington
- 1850 farm house deep-retrofit to net zero standards.
- R-60 ceiling, R-40 walls, R-20 slab edge
- 2,800 sf Energy Futures Group offices
- -11 °F heating, 86 °F cooling
- Extreme lows, -21 to -30 °F



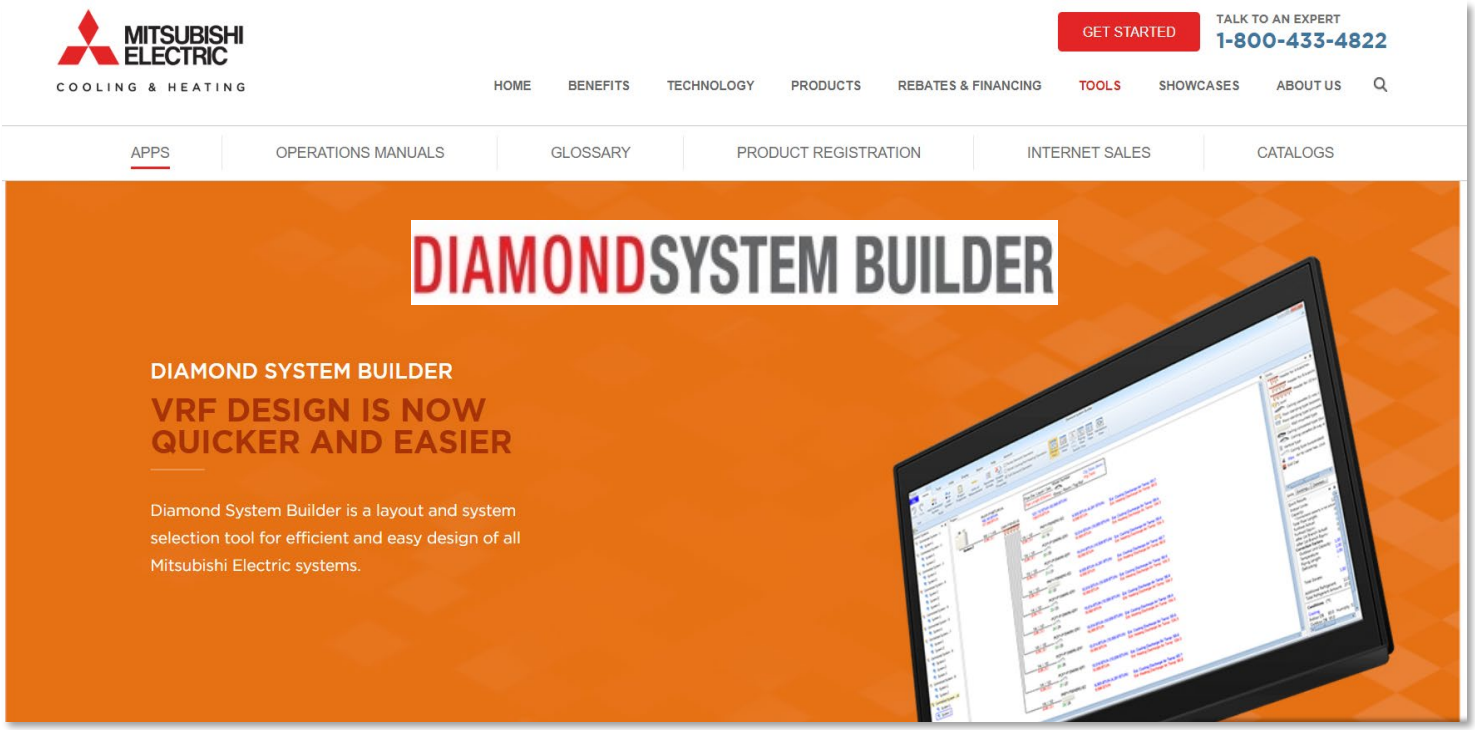
https://nesea.org/session/air-source-heat-pumps-measured-performance-and-best-practices

Fall 2021 Install @ 11,300 ft Elevation

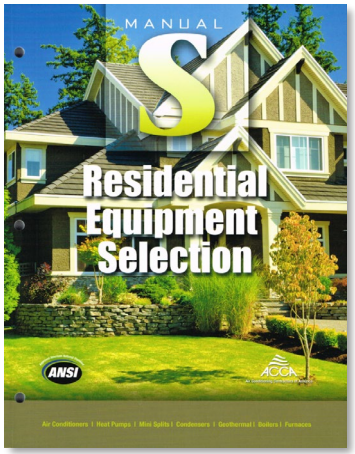
Ski Patrol and Warming Hut

Design Resources

Extensive tools for Architects, Builders, Designers, Installers



Use DSB with Manual S equipment selection



https://www.mitsubishicomfort.com/diamond-system-builder

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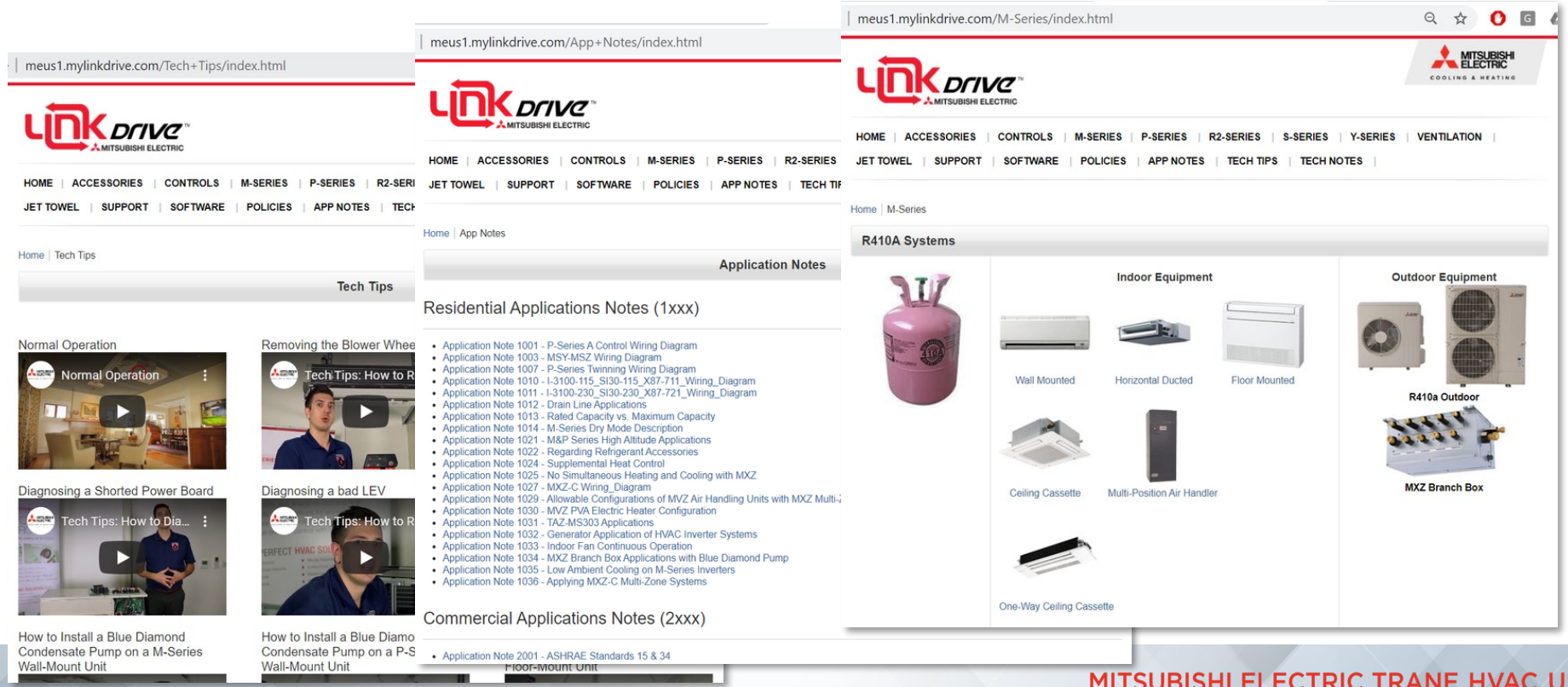


Backup Heat

Onboard logic to manage electric heat when needed.

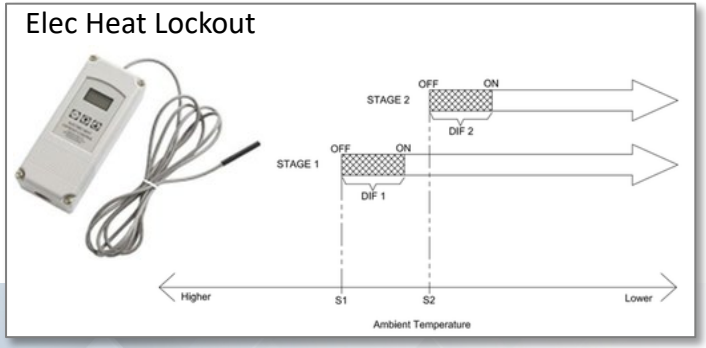
Mode Change	Condition								
	($To - T_{RA}$) > 2.7 °F [1.5 °C]	AND	T_{RA} has not increased by 0.9 °F [0.5° C] in X min	EH1 ON for > 7 min	AND	($To - T_{RA}$) > 2.7 °F [1.5 ° C]	AND	T_{RA} has not increased by 0.9 ° F [0.5° C] in 7 min	($To - T_{RA}$) < 0.9 °F [0.5° C]
EH1 ON	○	AND	○						
EH2 ON				○	AND	○	AND	○	
EH1 OFF									○
EH2 OFF									○

KEY

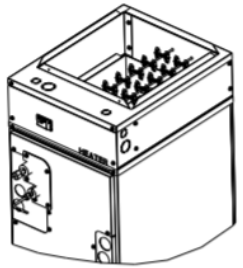
- EH1: Electric Heater 1
- EH2: Electric Heater 2
- To: Set point temperature
- T_{RA}: Return Air temperature
- X: Time delay (Selectable. Default is 24 min. Selectable to 14, 19, or 29 min)

Engage 3rd party heat sources

Elec Heat Lockout



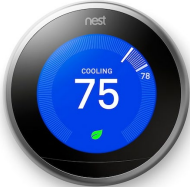
Heat Kit

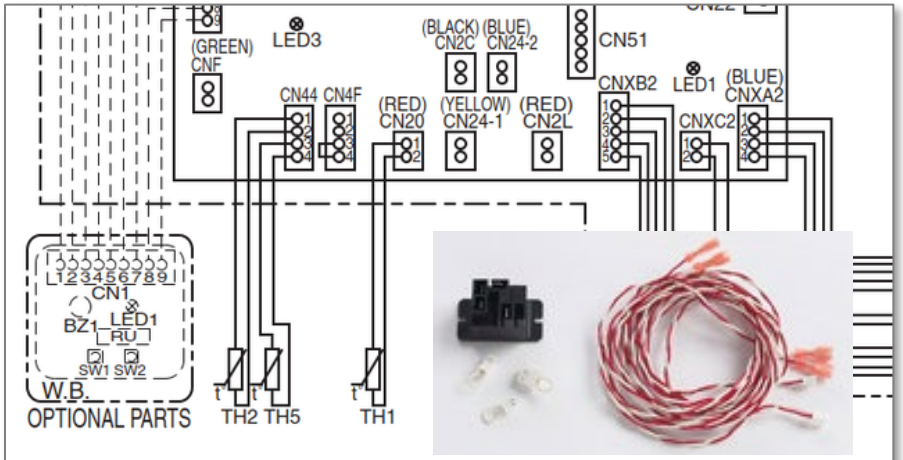


SVZ

Integrate Other Equipment

3rd Party Thermostats, ERV/HRV and Humidity Fan Integration





SYMBOL EXPLANATION

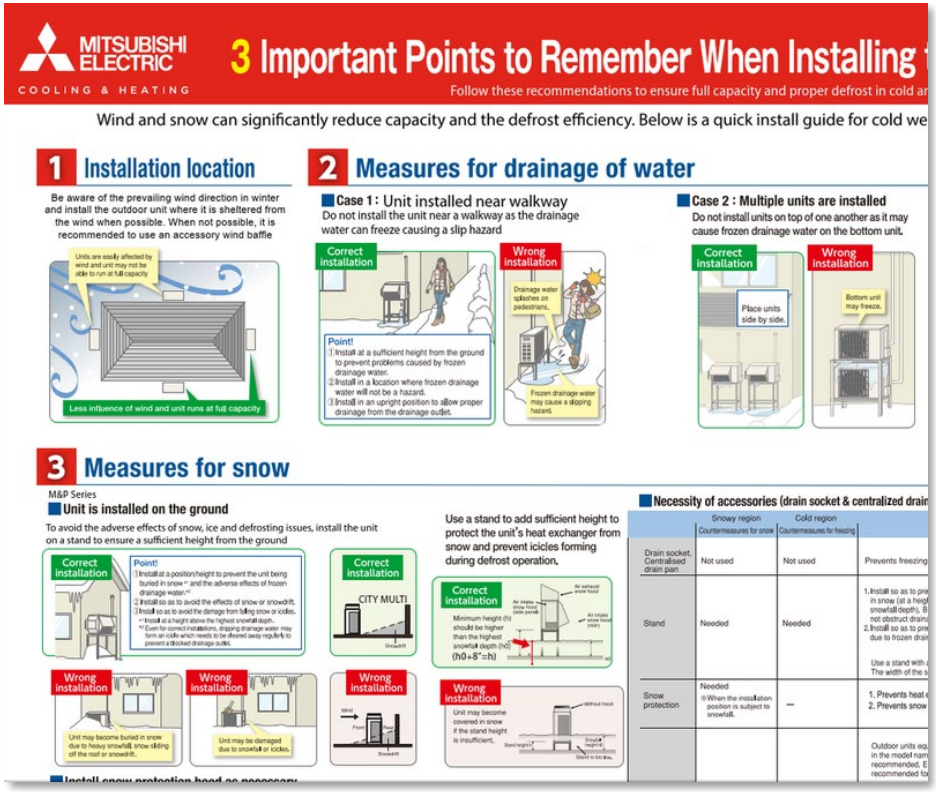
SYMBOL	NAME	SYMBOL	NAME
I.B.	INDOOR CONTROLLER BOARD	I.B.	INDOOR CONTROLLER BOARD
CN24-1	CONNECTOR (HEATER CONTROL 1ST)	SW1	SWITCH (FOR MODEL SELECTION)
CN24-2	CONNECTOR (HEATER CONTROL 2ND)	SW2	SWITCH (FOR CAPACITY CODE)
CN25	CONNECTOR (HUMIDITY OUTPUT)	SW5	SWITCH (FOR MODE SELECTION)
CN2A	CONNECTOR (0-10V ANALOG INPUT)	SWE	CONNECTOR (EMERGENCY OPERATION)
CN2C	CONNECTOR (ERV OUTPUT)	P.B.	POWER SUPPLY BOARD
CN2L	CONNECTOR (LOSSNAY)	F01	FUSE AC250V 6.3A
CN32	CONNECTOR (REMOTE SWITCH)	ZNR01,02	VARISTOR

Cold Climate Installation Guidelines

Need to managing drainage, ice, and snow level

Good, but…

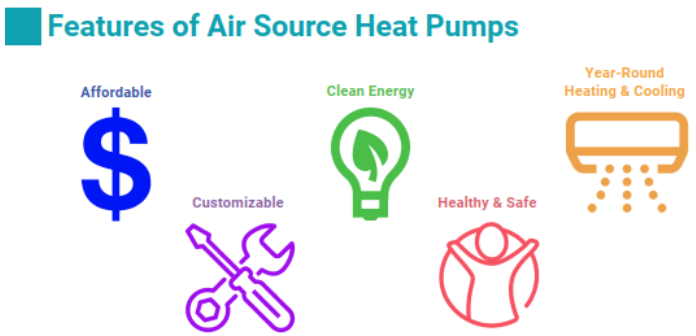
Better



NEEP - ASHP Guides

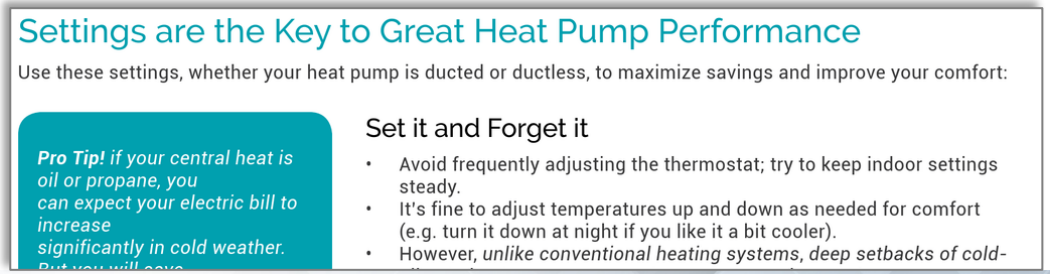
Part 1: Air Source Heat Pumps - The Basics

https://neep.org/sites/default/files/resources/ASHP_buyingguide_5.pdf



Getting The Most Out of Your Heat Pump

https://neep.org/sites/default/files/GettingTheMostFromYourHeatPumpConsumerGuideFINAL.pdf



Settings are the Key to Great Heat Pump Performance

Use these settings, whether your heat pump is ducted or ductless, to maximize savings and improve your comfort:

Pro Tip! *if your central heat is oil or propane, you can expect your electric bill to increase significantly in cold weather. But you will save*

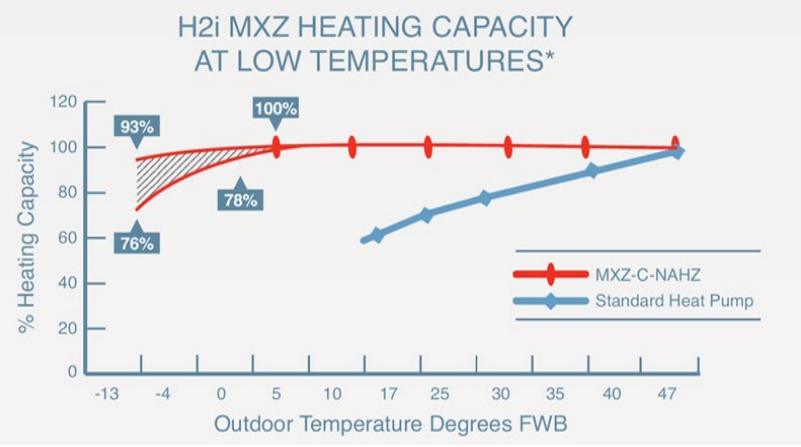
Set it and Forget it

- Avoid frequently adjusting the thermostat; try to keep indoor settings steady.
- It's fine to adjust temperatures up and down as needed for comfort (e.g. turn it down at night if you like it a bit cooler).
- However, *unlike conventional heating systems, deep setbacks of cold-*

That said…

“Let’s Build Like The Future Depends On It”

- 475 High Performance Building Supply



Questions?

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