



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

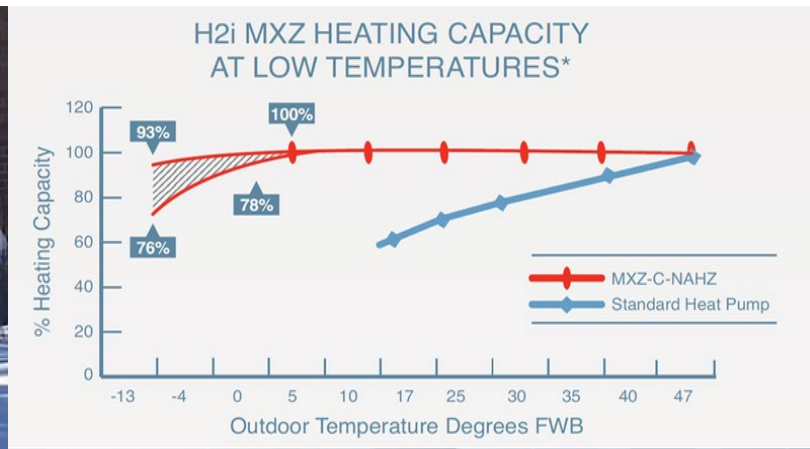
Cold Climate Air Source Heat Pump Strategies

08-24-2021

Shawn LeMons

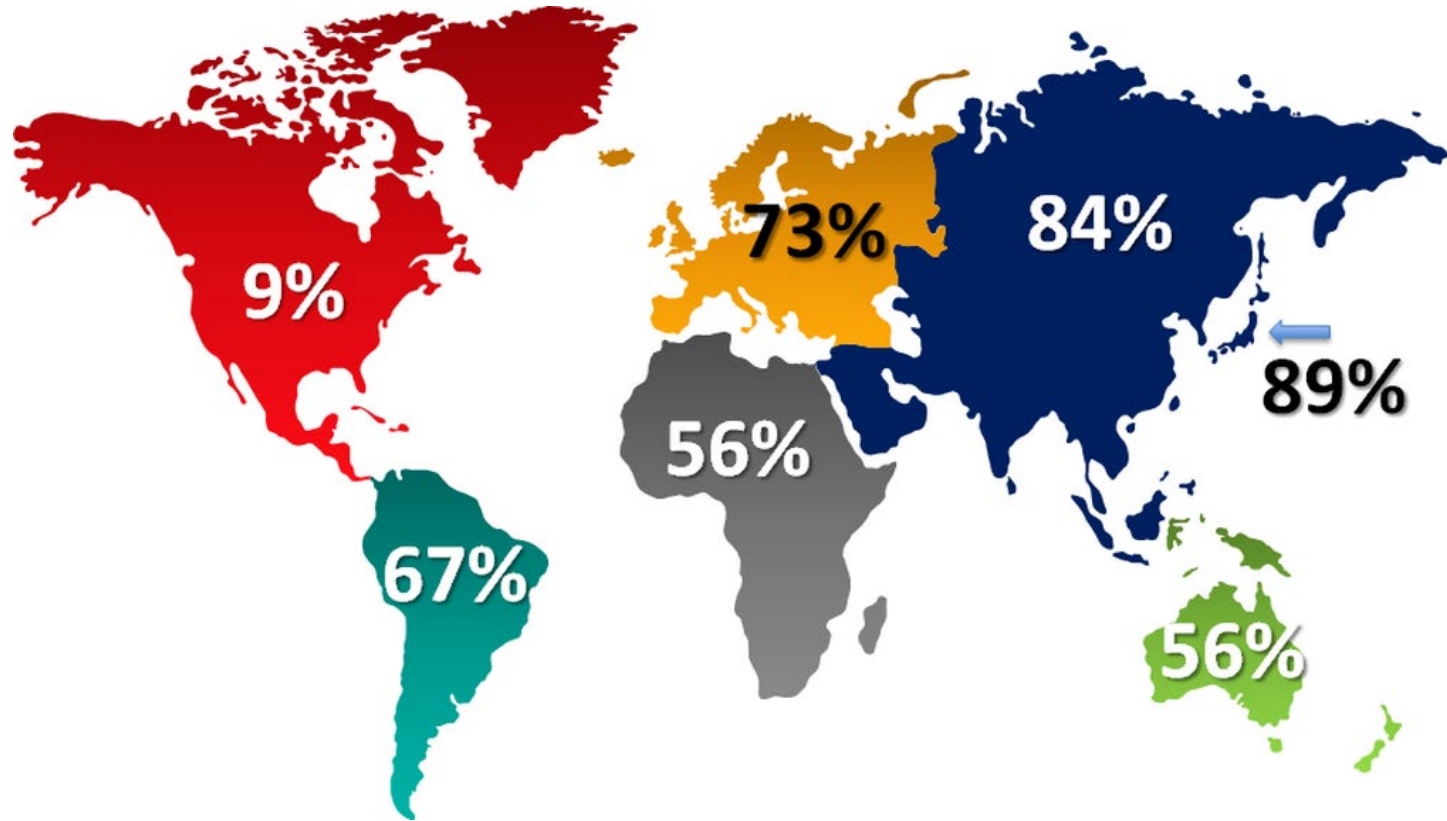
Performance Construction Mgr.

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

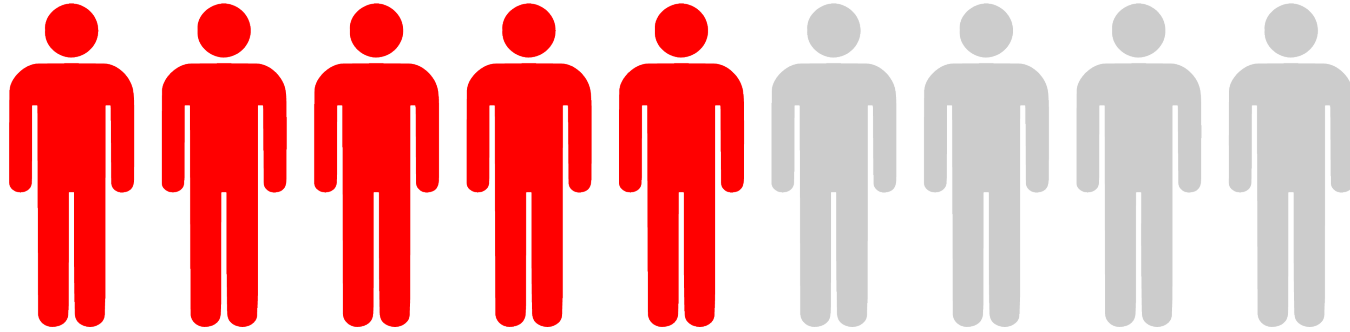


MITSUBISHI ELECTRIC TRANE HVAC US

ASHP International Market



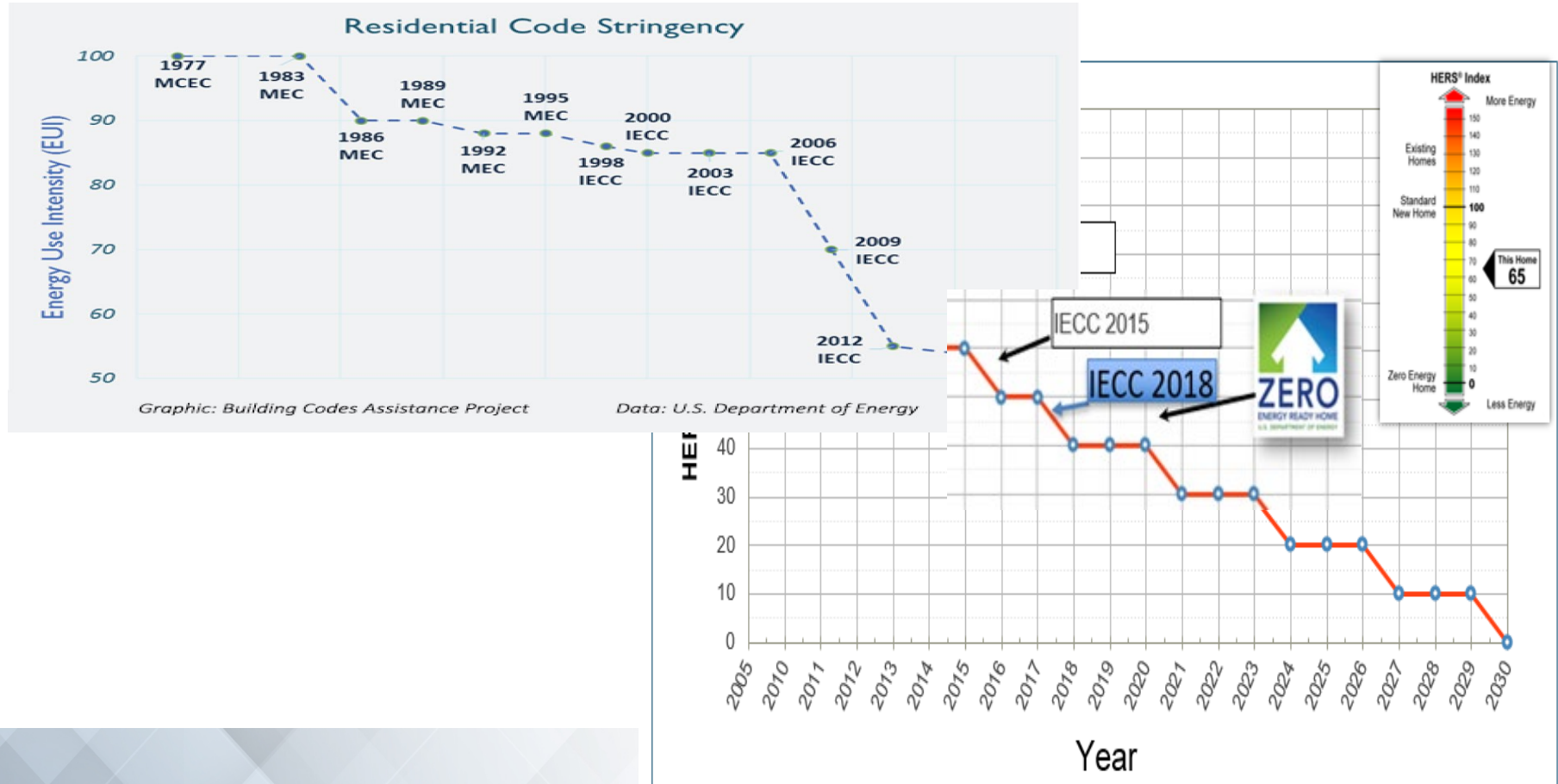
Did you know?



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

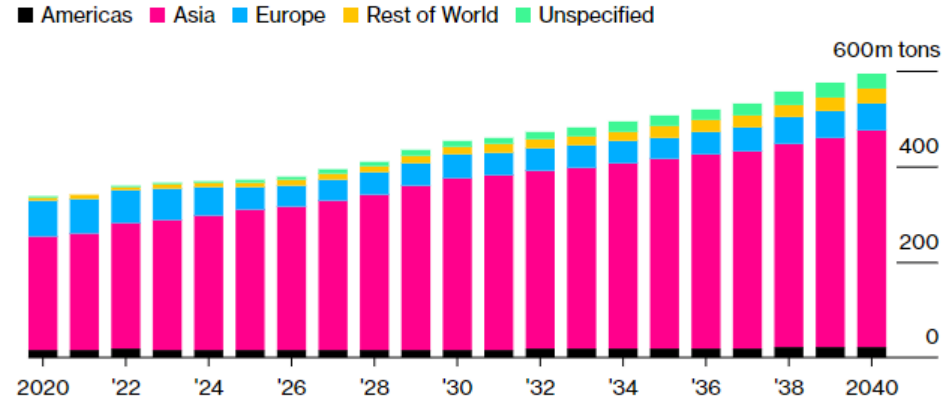
The Era of Cheap Natural Gas Ends as Prices Surge by 1,000%

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.

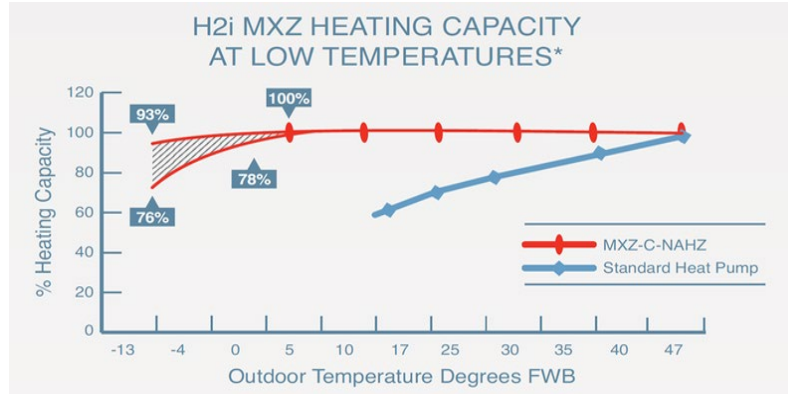
Strong Consumption

Asia seen underpinning global LNG demand growth through 2040



Source: BloombergNEF

What is a “Cold Climate” ASHP?



100% capacity at 5 F
76%-93% capacity at -13 F*
Operation down to -18 F and lower*

* Varies by outdoor model



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

<https://drive.google.com/file/d/1QBgBd4JcVBpNpafsl4leWH24GcurEa9b/view>



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

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

Controls



kumo touch™



Wireless
Sensor



kumo station®



BACnet/Modbus
Interface



Thermostat
Interface



Wired and Wireless Controllers

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	\$	equiv 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/kWh¹ the ccASHP with ER booster annual emissions would be 9,007 equiv. lbs, a 2% reduction over the natural gas furnace.

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

PVA-A36

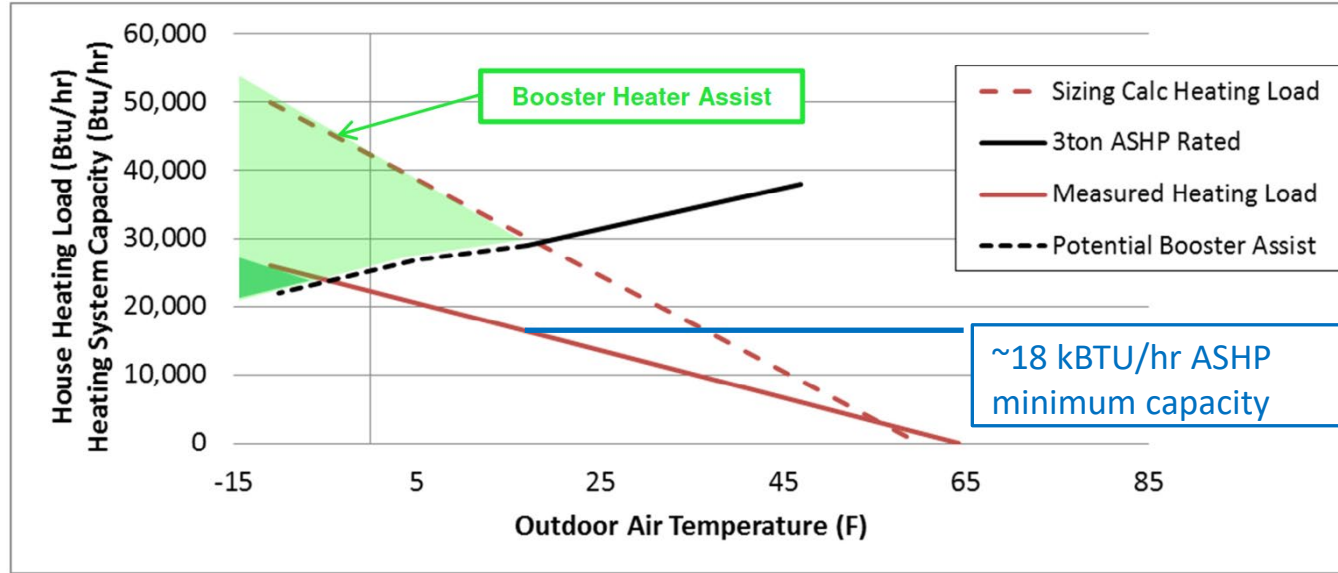


PUZ-HA36NHA5



CEE Case Study 2 (MN, June '18)

Figure 3. Capacity vs. Outside Air Temperature



Site Characteristics

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PVA-A36



PUZ-HA36NHA5



CEE Case Study 2 (MN, June '18)

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

DIAMONDSYSTEM BUILDER

The screenshot displays the DIAMOND SYSTEM BUILDER software interface. On the left, a schematic for 'System 1' shows a PUZ-HA36NHA5 outdoor unit connected to a PVA-A36AA7 indoor unit via 3/8" liquid and 5/8" gas piping over a 50.0ft distance. A table above the indoor unit lists 'Pipe Dia. Liquid / Gas', 'Model Number', 'Clg. Total (Sens.)', 'Pipe Length (Elbows)', and 'Address/ Group / Room / Tag Ref.'. Below this, a red box highlights the calculated load: 31,931 BTU/h (26,216 BTU/h) and 29,701 BTU/h. To the right, the 'Correction Factors' section shows values for Temperature (1.03, 0.82), Piping Length (0.96, 0.99), Defrosting (-, 1.00), and User Derate (1.00, 1.00). Below these are 'Total Derate' (0.96, 0.78), 'Additional Refrigerant' (0.0 lb), and 'Total Refrigerant Amount' (12.0 lb). The 'Conditions' section shows indoor and outdoor DB and Humidity for both Cooling and Heating modes. The Heating mode is highlighted with a red box, showing indoor DB at 70.0 and outdoor DB at -11.0 with 71.6% humidity.

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

Correction Factors		
Temperature:	1.03	0.82
Piping Length:	0.96	0.99
Defrosting:	-	1.00
User Derate:	1.00	1.00
Total Derate: 0.96 0.78		
Additional Refrigerant:	0.0 lb	
Total Refrigerant Amount:	12.0 lb	

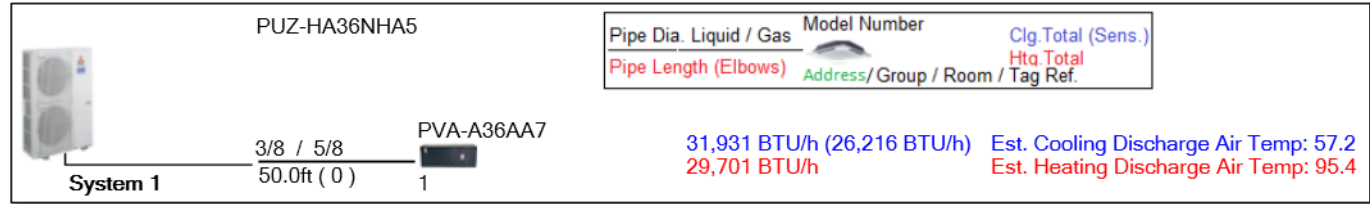
Conditions (°F)		
Cooling		
Indoor DB	80.0	Humidity 51.8%
Outdoor DB	92.0	
Heating		
Indoor DB	70.0	
Outdoor DB	-11.0	Humidity 71.6%

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

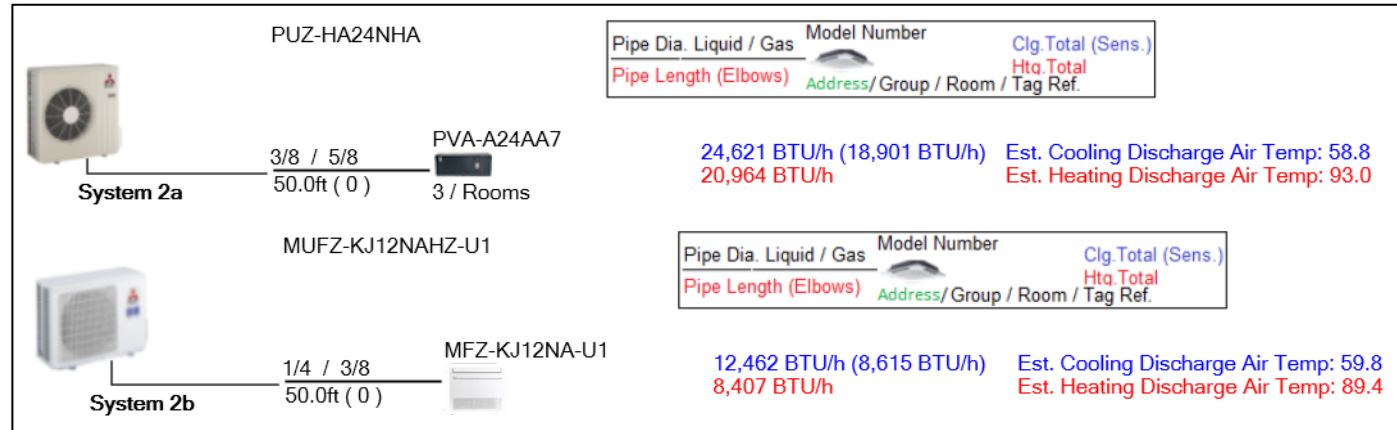
1 outdoor
1 ducted indoor
18.6 kBTU/hr min **Heat**
~1400 Watts at ~20°F



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

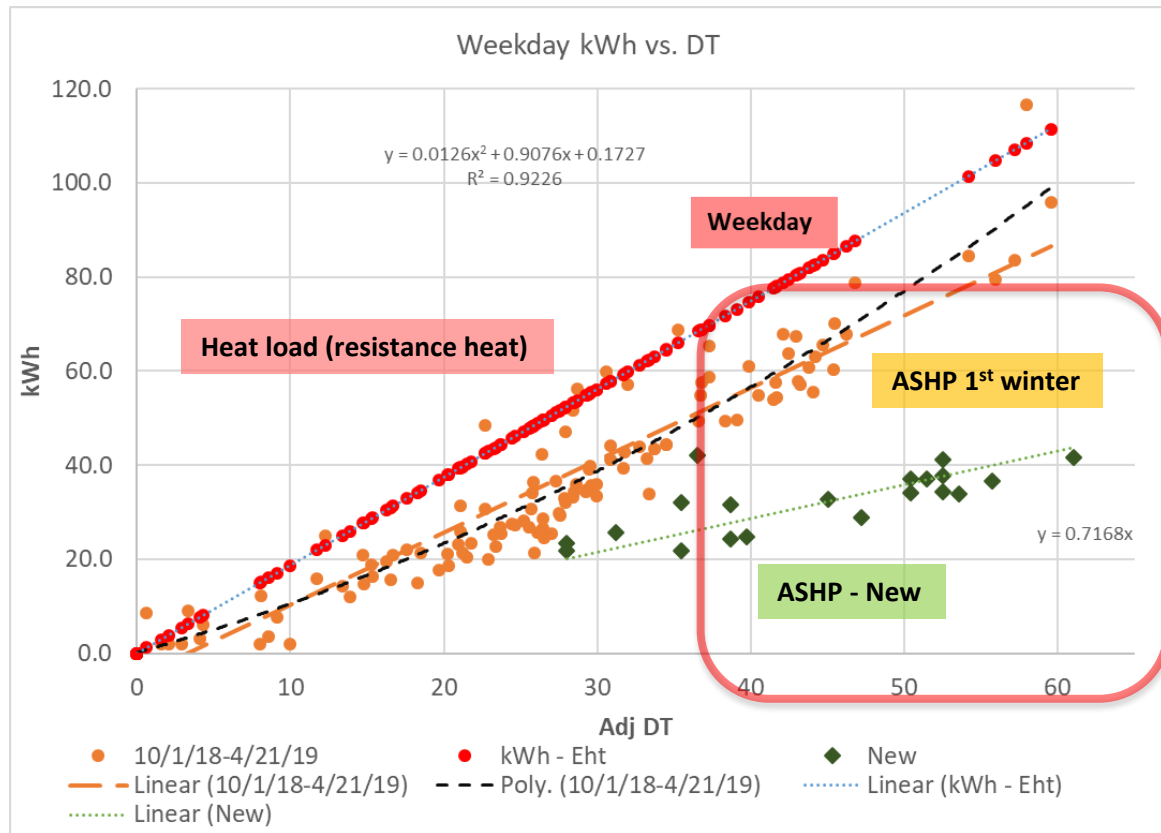


NESEA 2019 study



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



Fall 2021 Install @ 11,300 ft Elevation

Ski Patrol and Warming Hut



Design Resources

Extensive tools for Architects, Builders, Designers, Installers



GET STARTED

TALK TO AN EXPERT
1-800-433-4822

HOME

BENEFITS

TECHNOLOGY

PRODUCTS

REBATES & FINANCING

TOOLS

SHOWCASES

ABOUT US



APPS

OPERATIONS MANUALS

GLOSSARY

PRODUCT REGISTRATION

INTERNET SALES

CATALOGS

DIAMOND SYSTEM BUILDER

DIAMOND SYSTEM BUILDER
VRF DESIGN IS NOW
QUICKER AND EASIER

Diamond System Builder is a layout and system selection tool for efficient and easy design of all Mitsubishi Electric systems.



Use DSB with
Manual S
equipment
selection




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

MITSUBISHI ELECTRIC TRANE HVAC US

Design Resources

Extensive tools for Architects, Builders, Designers, Installers

meus1.mylinkdrive.com/Tech+Tips/index.html

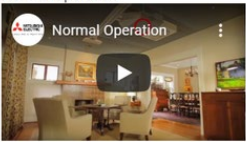


HOME | ACCESSORIES | CONTROLS | M-SERIES | P-SERIES | R2-SERIES | JET TOWEL | SUPPORT | SOFTWARE | POLICIES | APP NOTES | TECH TIPS


Home | Tech Tips

Tech Tips

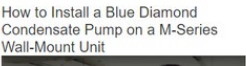
Normal Operation




Diagnosing a Shorted Power Board




How to Install a Blue Diamond Condensate Pump on a M-Series Wall-Mount Unit



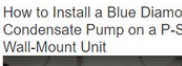
Removing the Blower Wheel




Diagnosing a bad LEV



How to Install a Blue Diamond Condensate Pump on a P-Series Wall-Mount Unit



meus1.mylinkdrive.com/App+Notes/index.html



HOME | ACCESSORIES | CONTROLS | M-SERIES | P-SERIES | R2-SERIES | JET TOWEL | SUPPORT | SOFTWARE | POLICIES | APP NOTES | TECH TIPS

Home | App Notes

Application Notes


Residential Applications Notes (1xxx)

- Application Note 1001 - P-Series A Control Wiring Diagram
- Application Note 1003 - MSY-MSZ Wiring Diagram
- Application Note 1007 - P-Series Twinning Wiring Diagram
- Application Note 1010 - I-3100-115_Si30-115_X87-711_Wiring_Diagram
- Application Note 1011 - I-3100-230_Si30-230_X87-721_Wiring_Diagram
- Application Note 1012 - Drain Line Applications
- Application Note 1013 - Rated Capacity vs. Maximum Capacity
- Application Note 1014 - M-Series Dry Mode Description
- Application Note 1021 - M&P Series High Altitude Applications
- Application Note 1022 - Regarding Refrigerant Accessories
- Application Note 1024 - Supplemental Heat Control
- Application Note 1025 - No Simultaneous Heating and Cooling with MXZ
- Application Note 1027 - MXZ-C Wiring Diagram
- Application Note 1029 - Allowable Configurations of MVZ Air Handling Units with MXZ Multi-Zone
- Application Note 1030 - MVZ PVA Electric Heater Configuration
- Application Note 1031 - TAZ-MIS303 Applications
- Application Note 1032 - Generator Application of HVAC Inverter Systems
- Application Note 1033 - Indoor Fan Continuous Operation
- Application Note 1034 - MXZ Branch Box Applications with Blue Diamond Pump
- Application Note 1035 - Low Ambient Cooling on M-Series Inverters
- Application Note 1036 - Applying MXZ-C Multi-Zone Systems

Commercial Applications Notes (2xxx)

- Application Note 2001 - ASHRAE Standards 15 & 34


meus1.mylinkdrive.com/M-Series/index.html



HOME | ACCESSORIES | CONTROLS | M-SERIES | P-SERIES | R2-SERIES | S-SERIES | Y-SERIES | VENTILATION | JET TOWEL | SUPPORT | SOFTWARE | POLICIES | APP NOTES | TECH TIPS | TECH NOTES


Home | M-Series

R410A Systems




Indoor Equipment


Wall Mounted




Horizontal Ducted




Floor Mounted




Ceiling Cassette




Multi-Position Air Handler




One-Way Ceiling Cassette




Outdoor Equipment



R410a Outdoor



MXZ Branch Box



MITSUBISHI ELECTRIC TRANE HVAC US

Backup Heat

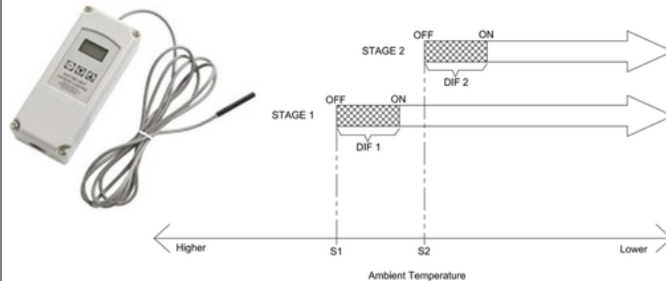
Onboard logic to manage electric heat when needed.

Mode Change	Condition							
	$(T_o - T_{RA}) > 2.7^\circ \text{ F}$ [1.5° C]	AND	T_{RA} has not increased by 0.9° F [0.5° C] in \underline{X} min	EH1 ON for > 7 min	AND	$(T_o - T_{RA}) > 2.7^\circ \text{ F}$ [1.5° C]	AND	T_{RA} has not increased by 0.9° F [0.5° C] in 7 min
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)								

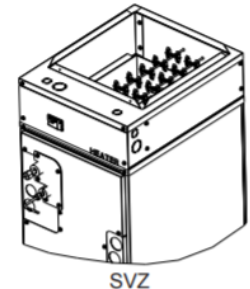
Engage 3rd party heat sources



Elec Heat Lockout

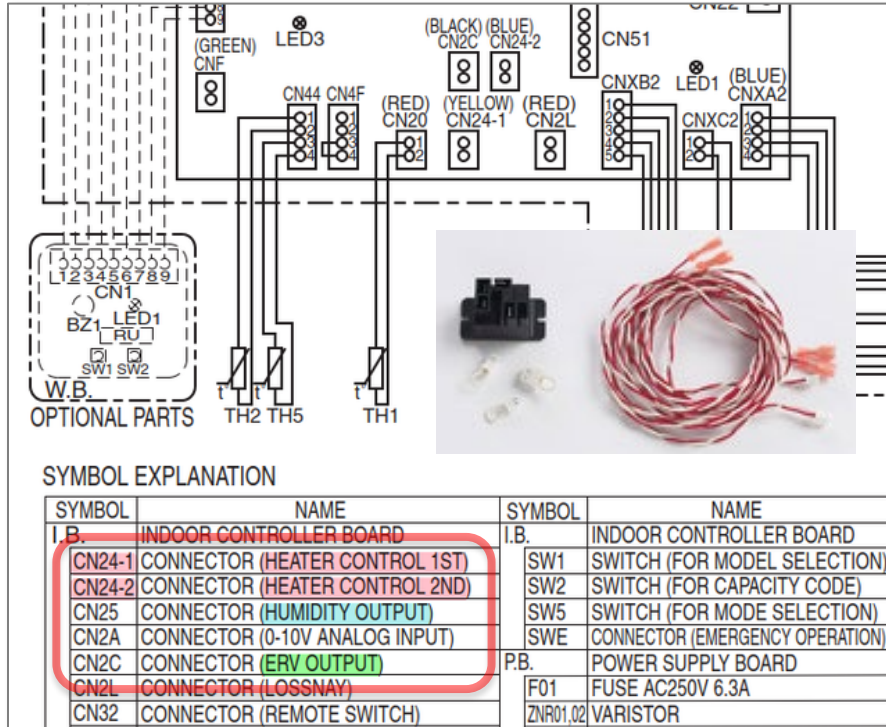


Heat Kit



Integrate Other Equipment

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




Cold Climate Installation Guidelines

Need to managing drainage, ice, and snow level



Good, but...

Better



3 Important Points to Remember When Installing

Follow these recommendations to ensure full capacity and proper defrost in cold areas.

Wind and snow can significantly reduce capacity and the defrost efficiency. Below is a quick install guide for cold weather.

1 Installation location

Be aware of the prevailing wind direction in winter and install the outdoor unit where it is sheltered from the wind when possible. When not possible, it is recommended to use an accessory wind baffle.

Units are easily affected by wind and unit may not be able to run at full capacity.

Less influence of wind and unit runs at full capacity.

2 Measures for drainage of water

Case 1: Unit installed near walkway

Do not install the unit near a walkway as the drainage water can freeze causing a slip hazard.

Correct installation

Point!

1. Install at a sufficient height from the ground to prevent problems caused by frozen drainage water.
2. Install in a location where frozen drainage water will not be a hazard.
3. Install in an upright position to allow proper drainage from the drainage outlet.

Case 2: Multiple units are installed

Do not install units on top of one another as it may cause frozen drainage water on the bottom unit.

Correct installation

Wrong installation

Bottom unit may freeze.

3 Measures for snow

M&P Series

Unit is installed on the ground

To avoid the adverse effects of snow, ice and defrosting issues, install the unit on a stand to ensure a sufficient height from the ground.

Correct installation

Point!

1. Install at a position/height to prevent the unit being buried in snow and the adverse effects of frozen drainage water.
2. Install so as to avoid the effects of snow or snowdrift.
3. Install so as to avoid the damage from falling snow or icicles.

Minimum height (h) should be higher than the highest snowfall depth (H).
 $(h \geq H)$

Wrong installation

Unit may become buried in snow due to heavy snowfall or snowdrift.

Wrong installation

Unit may be damaged due to snowfall or icicles.

Use a stand to add sufficient height to protect the unit's heat exchanger from snow and prevent icicles forming during defrost operation.

Correct installation

Wrong installation

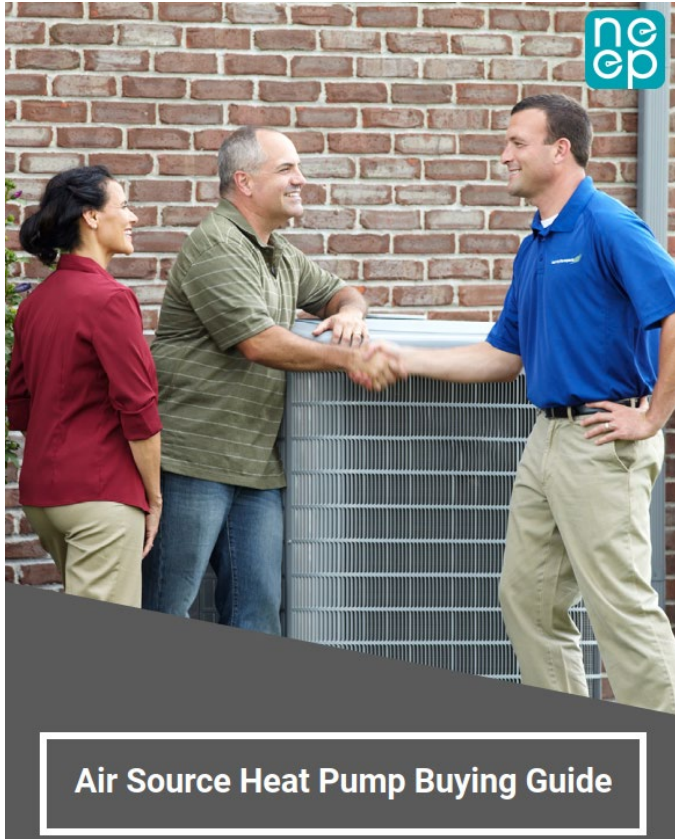
Unit may become covered in snow if the stand height is insufficient.

Necessity of accessories (drain socket & centralized drain)

	Snowy region Countermeasures for snow	Cold region Countermeasures for freezing	
Drain socket, Centralized drain pan	Not used	Not used	Prevents freezing
Stand	Needed	Needed	1. Install so as to prevent snow from piling up in front of the unit. 2. Install so as to prevent snow from piling up in front of the unit. Use a stand with a width of the unit.
Snow protection	Needed if the installation position is subject to snowfall.	—	1. Prevents heat loss. 2. Prevents snow.
			Outdoor unit eq. in the model name recommended. E recommended for.

■ Install snow protection board as necessary.

NEEP - ASHP Guides



Part 1: Air Source Heat Pumps - The Basics

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

Features of Air Source Heat Pumps

Affordable



Clean Energy



Year-Round
Heating & Cooling



Customizable



Healthy & Safe



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:

Set it and Forget it

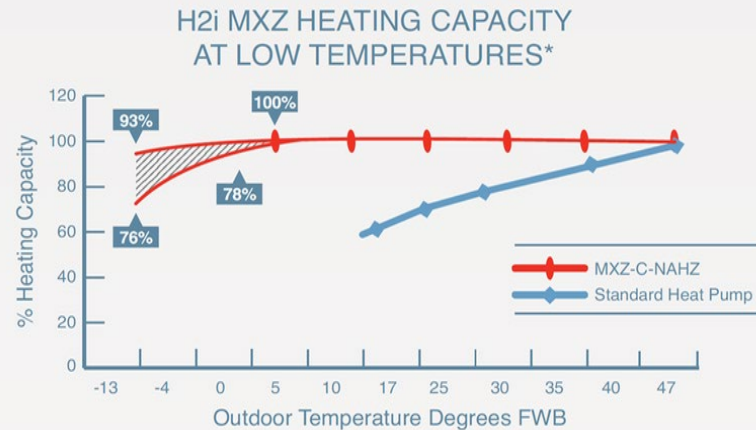
- Avoid frequently adjusting the thermostat; try to keep indoor settings steady.
- It's fine to adjust temperatures up and down as needed for comfort (e.g. turn it down at night if you like it a bit cooler).
- However, unlike conventional heating systems, deep setbacks of cold-

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.

That said...

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

- 475 High Performance Building Supply



Questions?

Shawn LeMons

Performance Construction Mgr.

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

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