Cold Climate Heat Pumps and Emerging Tech

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Cold climate Air-source heat pumps; Hurry up, slowly

- Dave Lis, Director, Technology and Market Solutions
- 2020 ENERGY STAR Products Partner meeting

Northeast Energy Efficiency Partnerships

Mission

We seek to accelerate regional collaboration to promote advanced energy efficiency and related solutions in homes, buildings, industry, and communities.

Approach

Drive market transformation regionally by fostering collaboration and innovation, developing tools, and disseminating knowledge

Air-Source Heat Pump Technology (R)Evolution

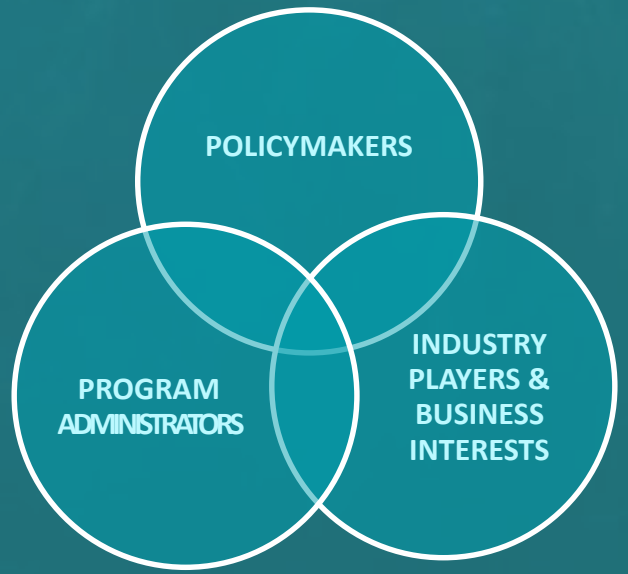
- Not your grandparents ASHP
  - Variable capacity compressors (inverter driven)
  - Sophisticated controls
  - Flash injection
- Delivering capacity and efficiency at low outdoor temperatures
- Air-to-Air- ducted, ductless and everything in between
- Air-to-Water – Variety of distribution options

Market Momentum building

- ~100k ASHPs sold in the New York/New England region in 2017
  - ~50k ASHPs sold in the same region in 2013
  - ~20% Annual growth over four years
- Still significantly smaller than regional furnace (235k)/boiler(160k)/Central AC (220k) markets

Contributing Factors to Growth

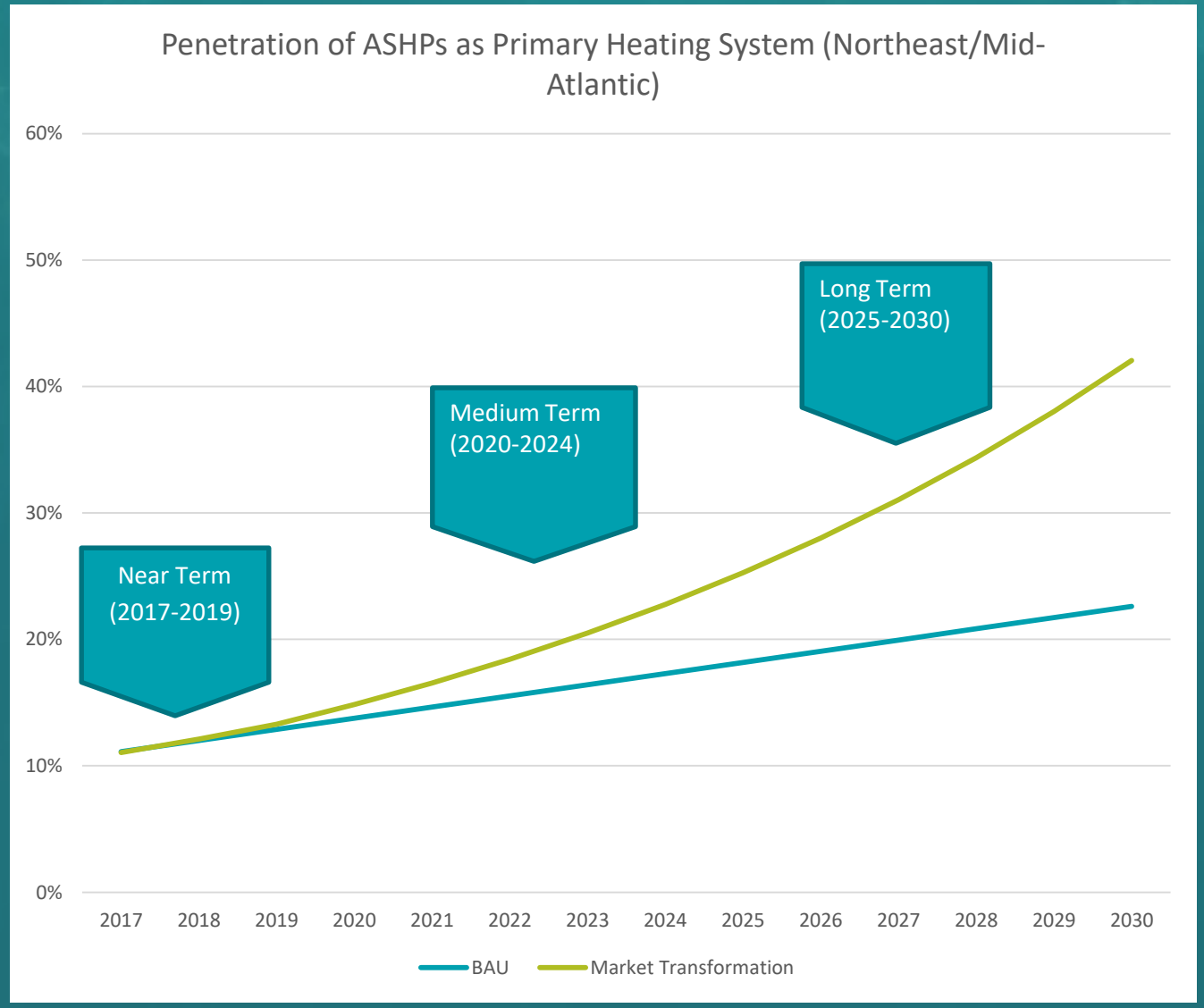
Regional ASHP Market Transformation Initiative



Current Market Transformation Strategies

1. Increase Consumer Education and Awareness
2. Increase Installer/Builder Awareness of, and Confidence in, ASHP through expanded training and education
3. Reduce Upfront Costs of installed systems through robust and aligned promotional programs and the support of alternative business models
4. Mobilize State and Local Policymakers to expand support for ASHPs
5. Promote Advanced Control technologies to allow automated coordination among multiple heating systems
6. Enable the promotion of climate-appropriate ASHPs through Improved Performance Metrics
7. Develop more accurate tools to predict energy, cost and GHG savings associated with ASHP installation through collection and analysis of Real World Performance Data

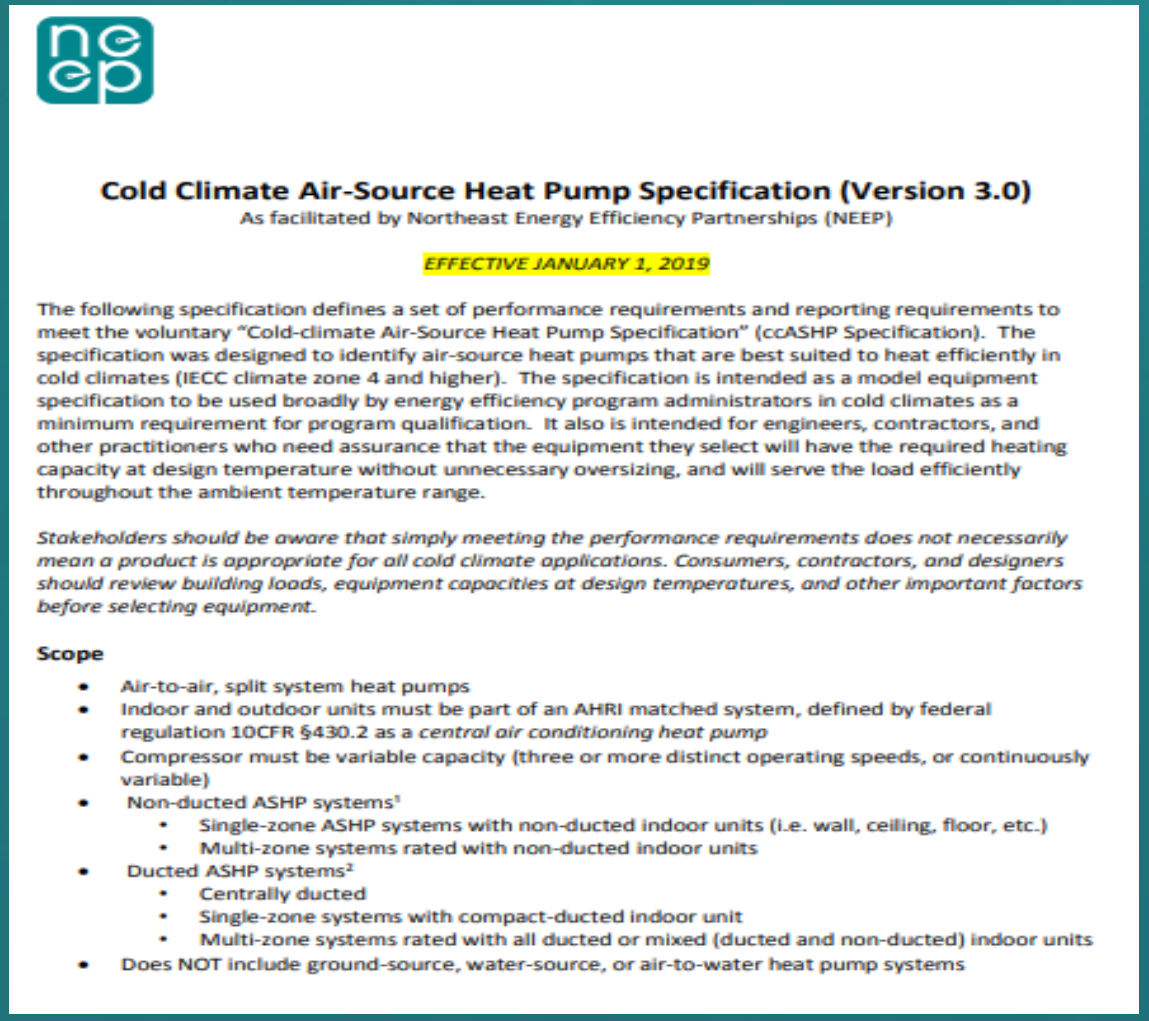
Long-term Adoption Target- 40% Primary Heating Systems by 2030



Hurry up….Slowly

- Balancing Speed and Quality
- Classic emerging technology challenge

Cold-climate Air Source Heat Pumps Specification



Cold Climate Air-Source Heat Pump Specification (Version 3.0)

As facilitated by Northeast Energy Efficiency Partnerships (NEEP)

EFFECTIVE JANUARY 1, 2019

The following specification defines a set of performance requirements and reporting requirements to meet the voluntary "Cold-climate Air-Source Heat Pump Specification" (ccASHP Specification). The specification was designed to identify air-source heat pumps that are best suited to heat efficiently in cold climates (IECC climate zone 4 and higher). The specification is intended as a model equipment specification to be used broadly by energy efficiency program administrators in cold climates as a minimum requirement for program qualification. It also is intended for engineers, contractors, and other practitioners who need assurance that the equipment they select will have the required heating capacity at design temperature without unnecessary oversizing, and will serve the load efficiently throughout the ambient temperature range.

Stakeholders should be aware that simply meeting the performance requirements does not necessarily mean a product is appropriate for all cold climate applications. Consumers, contractors, and designers should review building loads, equipment capacities at design temperatures, and other important factors before selecting equipment.

Scope

- Air-to-air, split system heat pumps
- Indoor and outdoor units must be part of an AHRI matched system, defined by federal regulation 10CFR §430.2 as a *central air conditioning heat pump*
- Compressor must be variable capacity (three or more distinct operating speeds, or continuously variable)
- Non-ducted ASHP systems[1]
  - Single-zone ASHP systems with non-ducted indoor units (i.e. wall, ceiling, floor, etc.)
  - Multi-zone systems rated with non-ducted indoor units
- Ducted ASHP systems[2]
  - Centrally ducted
  - Single-zone systems with compact-ducted indoor unit
  - Multi-zone systems rated with all ducted or mixed (ducted and non-ducted) indoor units
- Does NOT include ground-source, water-source, or air-to-water heat pump systems

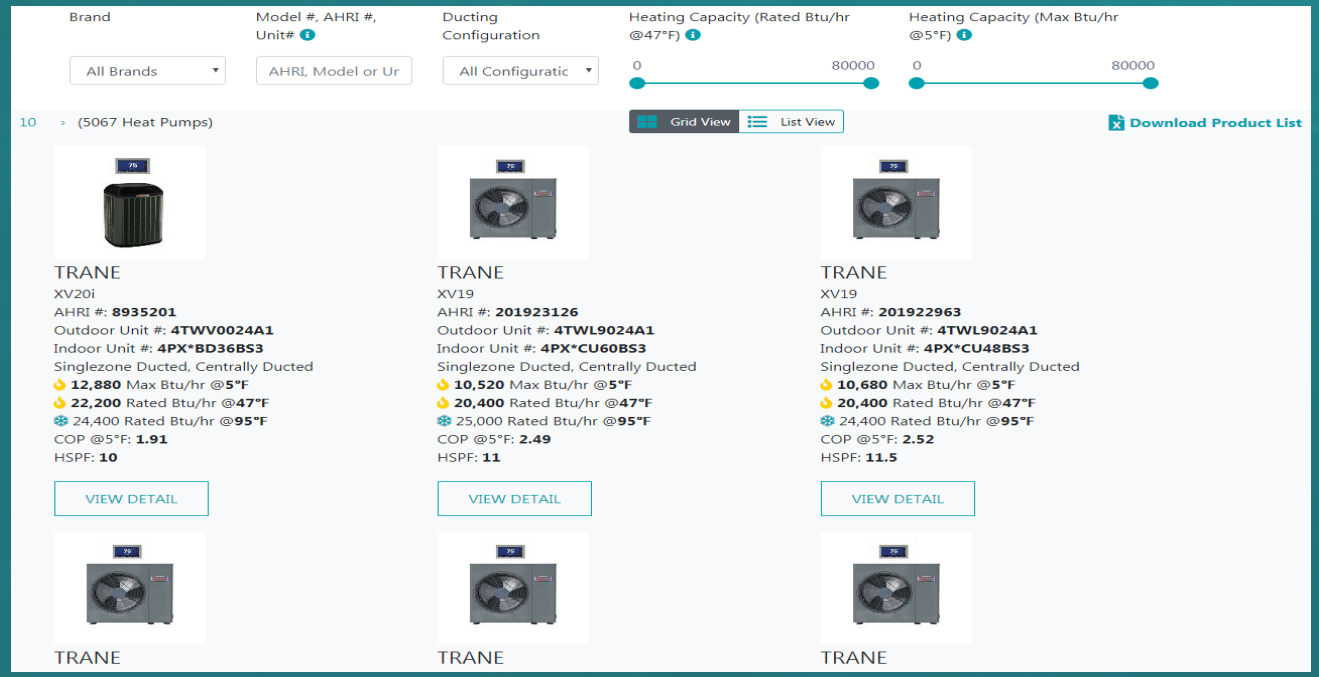
- Antiquated test procedure/performance metrics for latest generation of ASHPs
- Created difficulty in differentiating high performing systems, particularly for cold climate applications

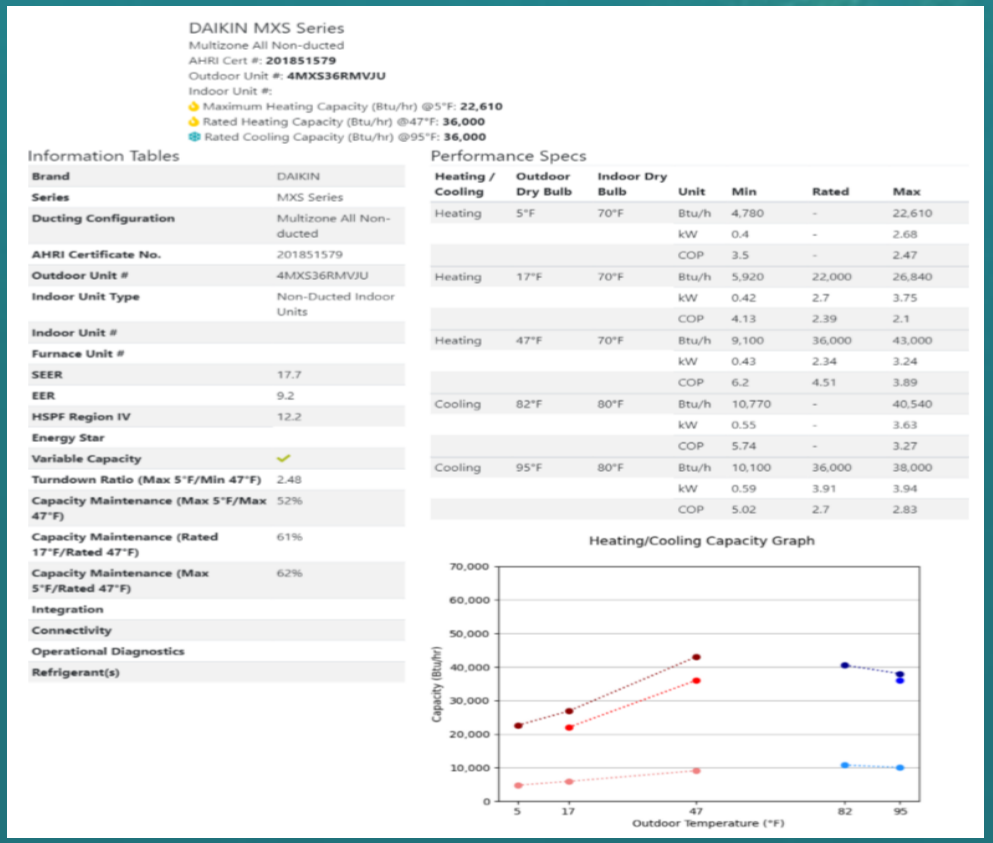
https://neep.org/ASHP-Specification

NEEP's Cold-Climate ASHP Product List

ashp.neep.org

One-stop-shop for cold-climate qualified air source heat pumps



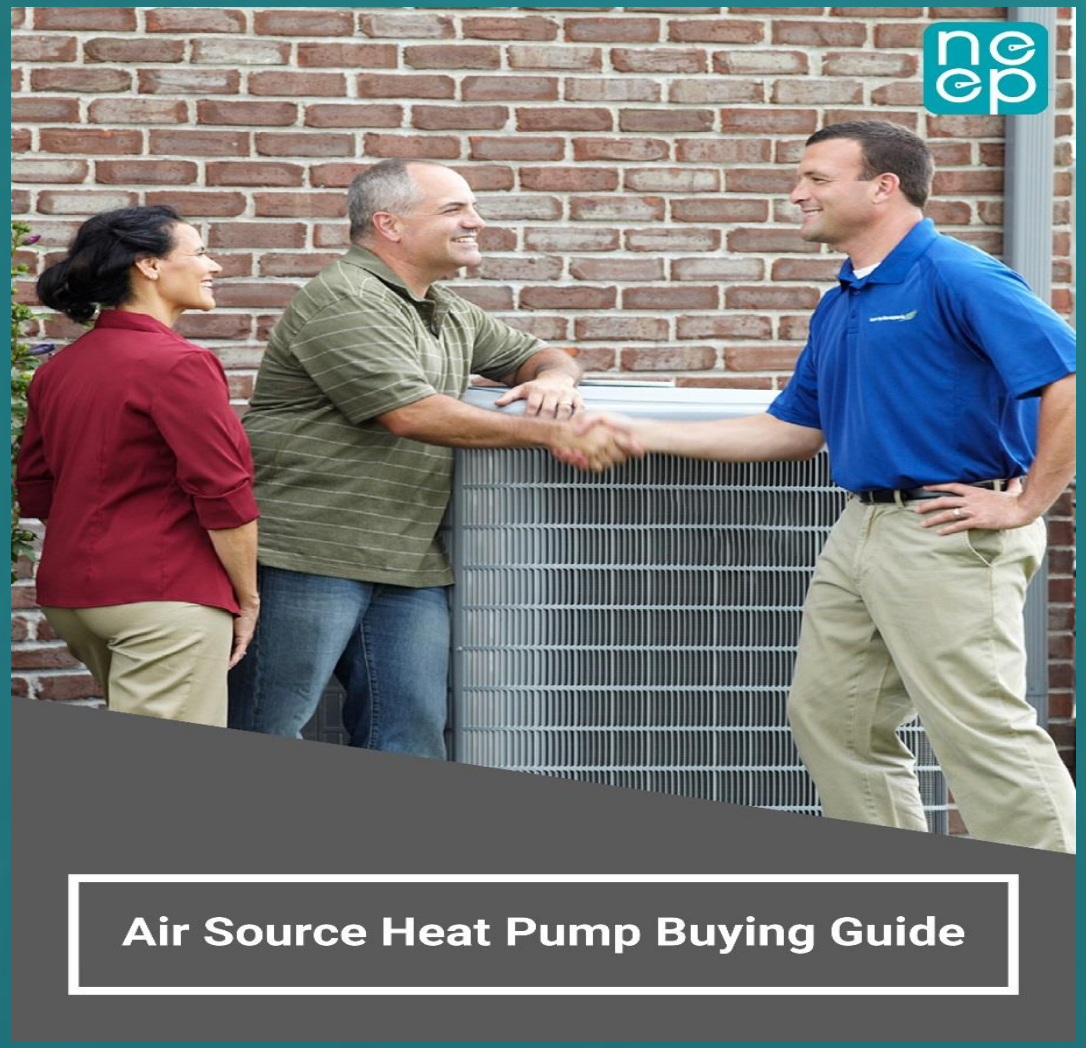


Now 8000+ systems from over 80 major brands

Design and Installation Resources

neep.org/ASHPInstallerResources

Consumer Resources –
NEEP Air Source Heat Pump Buying Guide



- Good resource for all audiences
- Especially for consumers who are looking to learn more about heat pumps
- Check out the O&M guide and Case Studies too

ASHP and VRF Market Transformation Workshop

October 21-22 / 1 PM ET / GoToWebinar

Lead Sponsors

DAIKIN

MITSUBISHI ELECTRIC

THANK YOU!

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Air-to-Water Heat Pumps

SPACE PAK® HYDRONICS

Jim Bashford

SpacePak - a Mestek Company

National Sales & Training Manager

SPACE PAK HYDRONICS

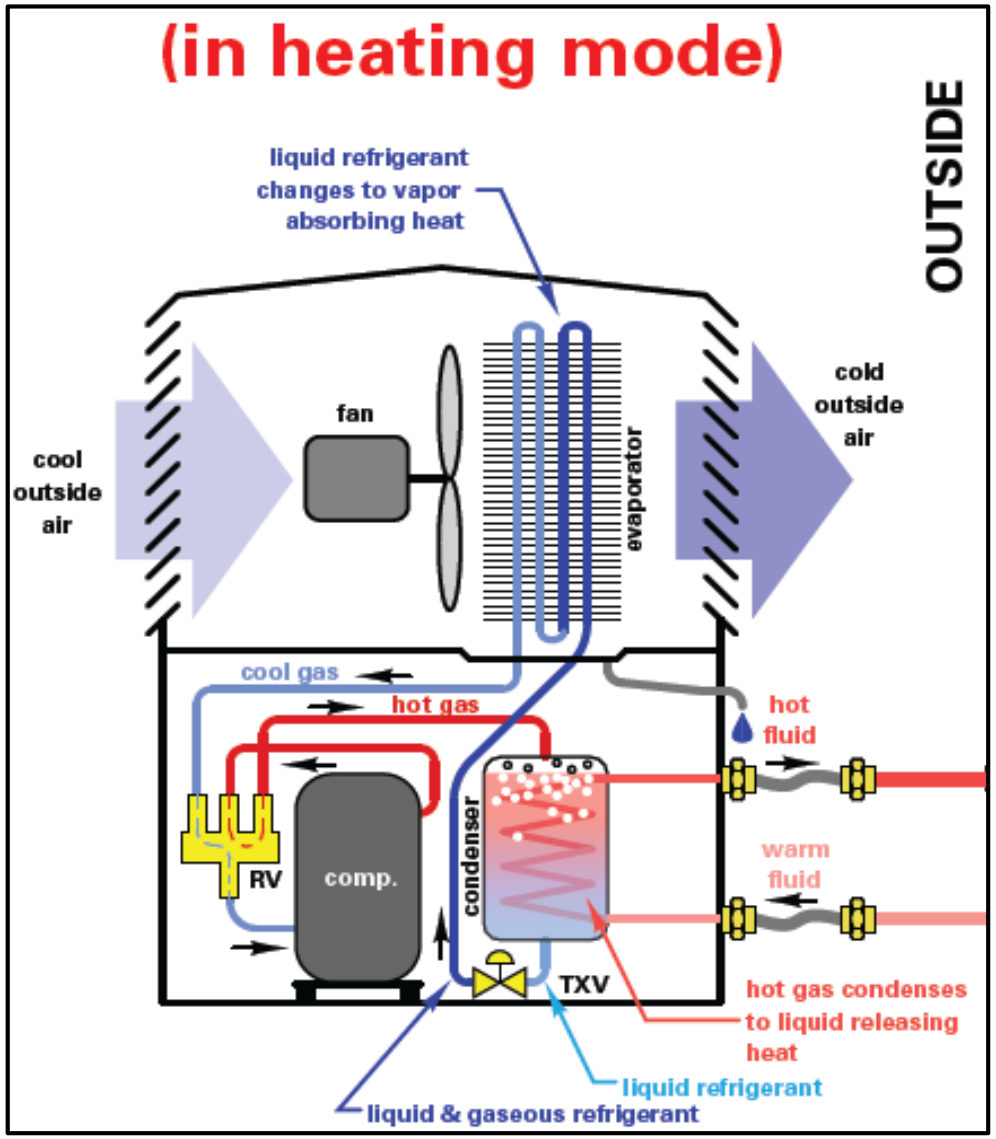
Bringing Modern Hydronics to North America Since 2011

solstice® EXTREME

ENERGY STAR 2019
Emerging Technology Award

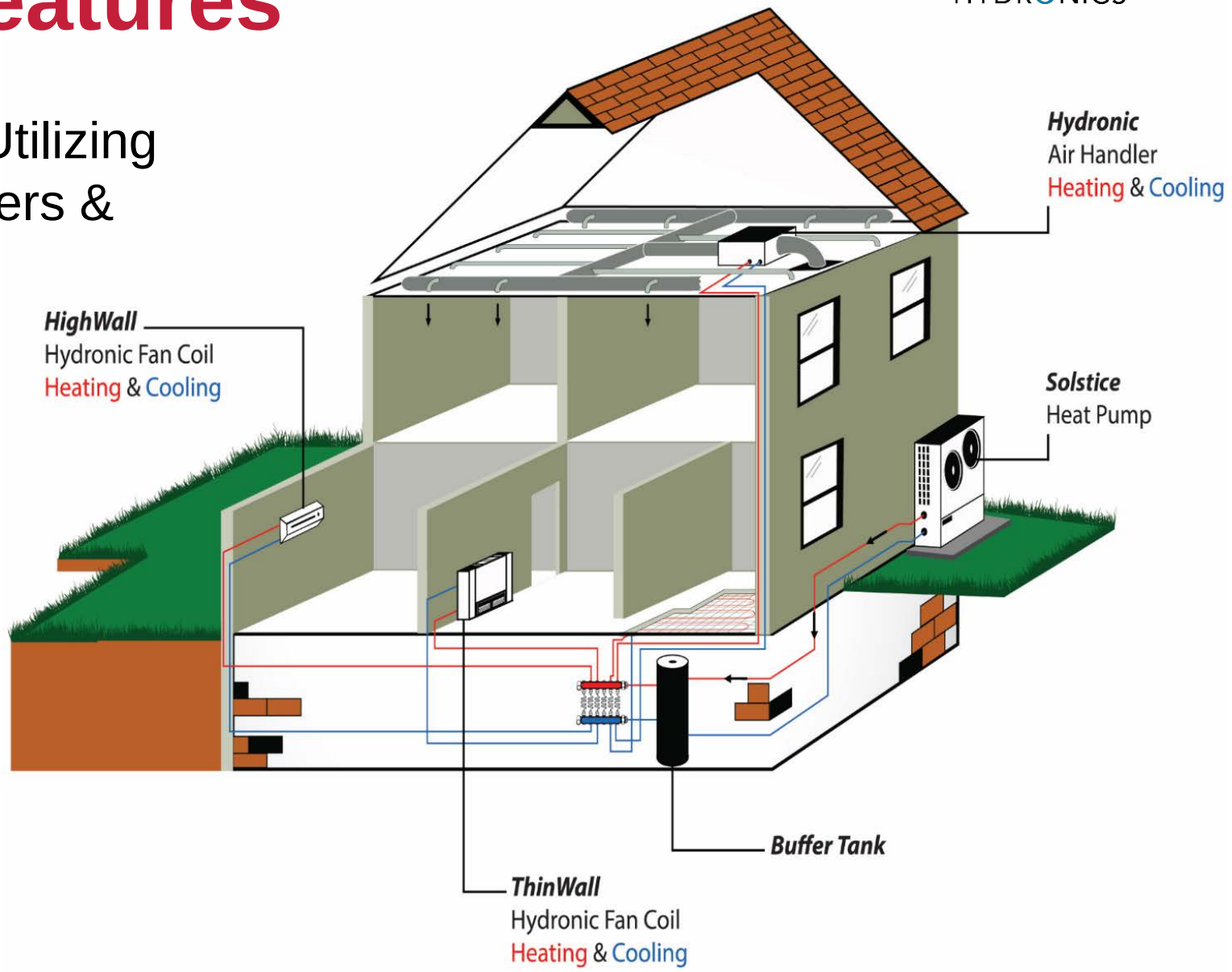
Air-to-Water Heat Pumps & How They Work

- Using the Refrigerant System/Cycle we Add or Remove Temperature from a Water Glycol Mixture via a Heat Exchanger
- 42 – 130°F Output Temp Ranges
- 60k+ BTU Outputs
- Great Low Ambient Performance
- Constant Outputs



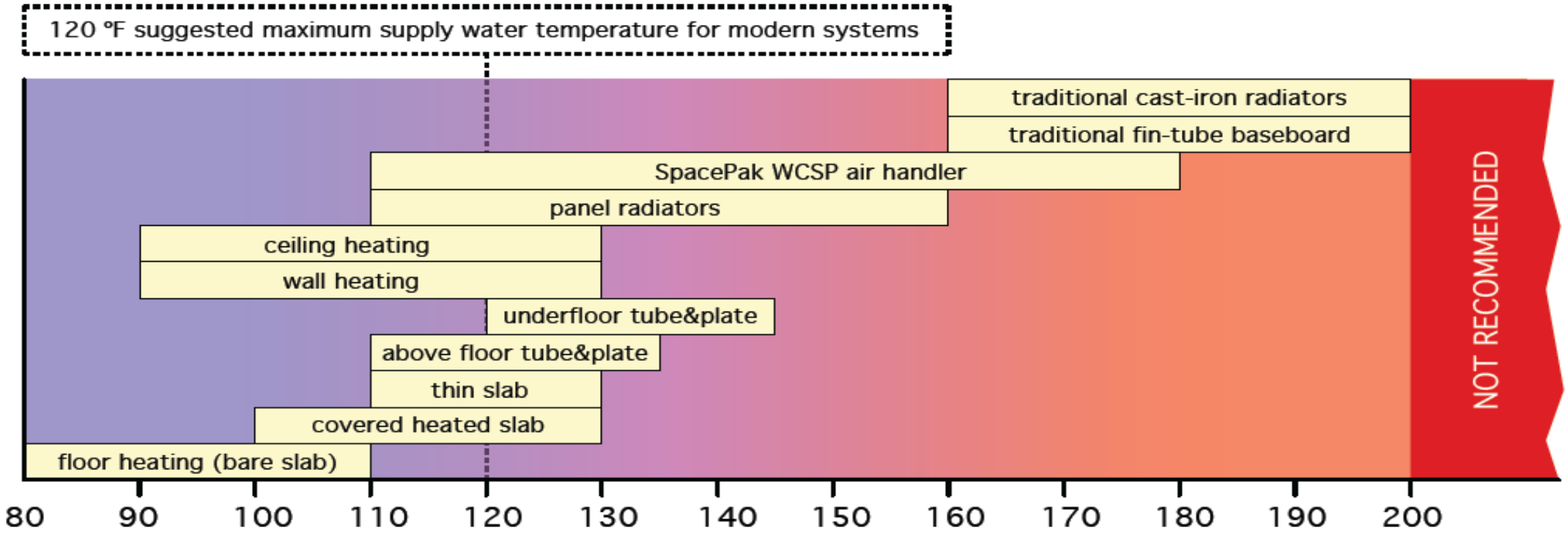
Applications & Features

- Adapts to Existing Systems Utilizing Different Water Temps, Emitters & Conditioning Styles
- Residential & Commercial Applications
- Heating & Cooling
  Water Temps: 40 - 130°F
- Great for Dehumidification

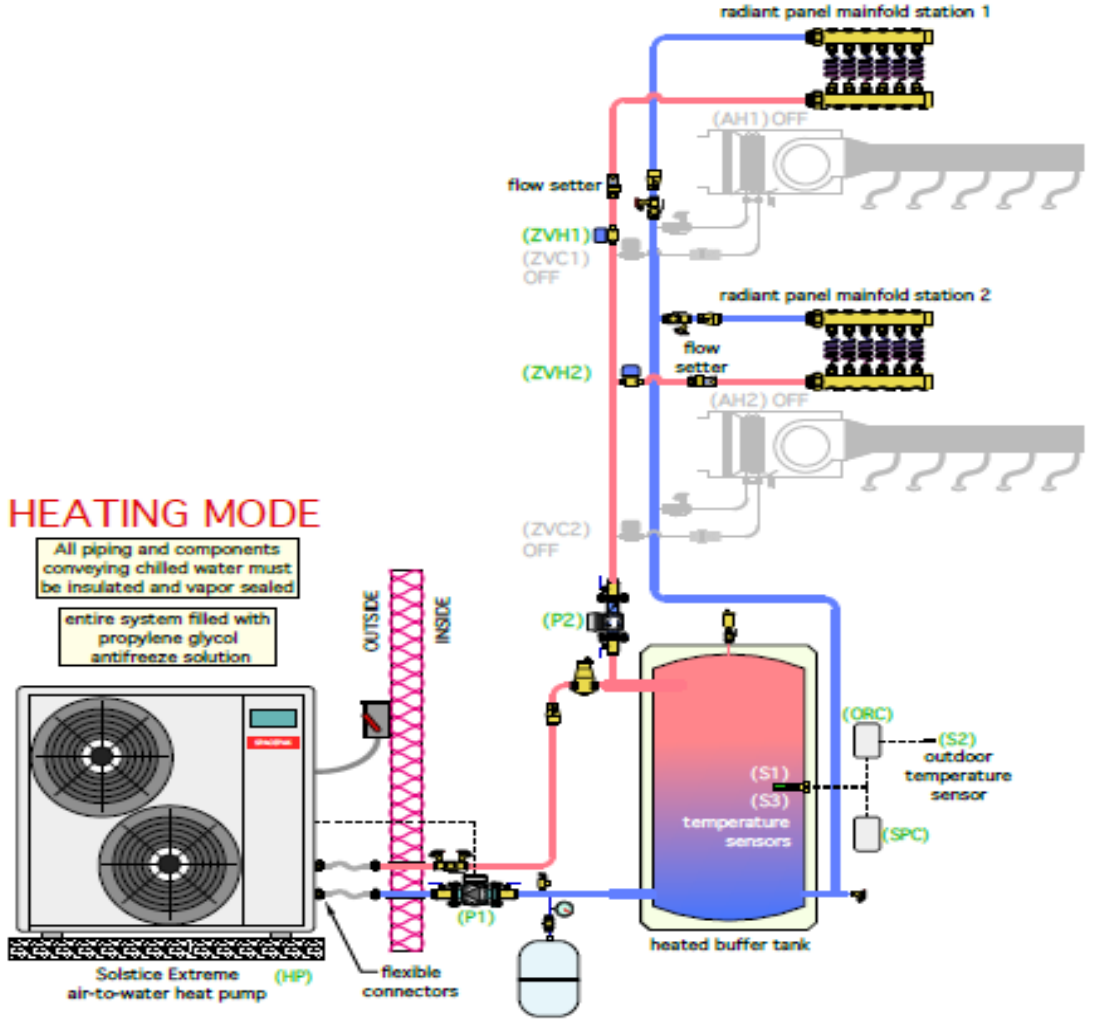


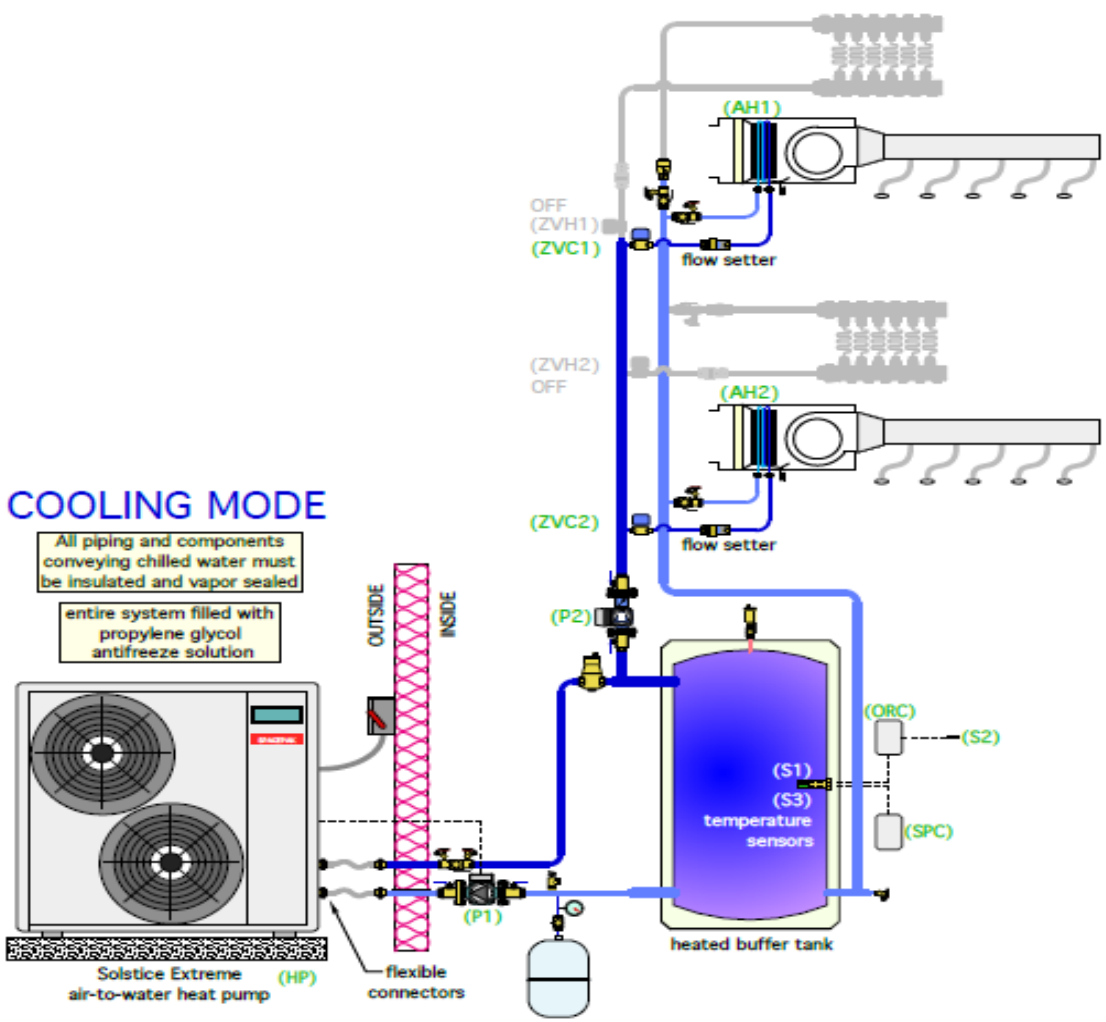
Flexibility

- Adapts to All Types of Existing Hydronic Systems
- Lower Water Temps = Savings
- Water Flow & Temperature Matching



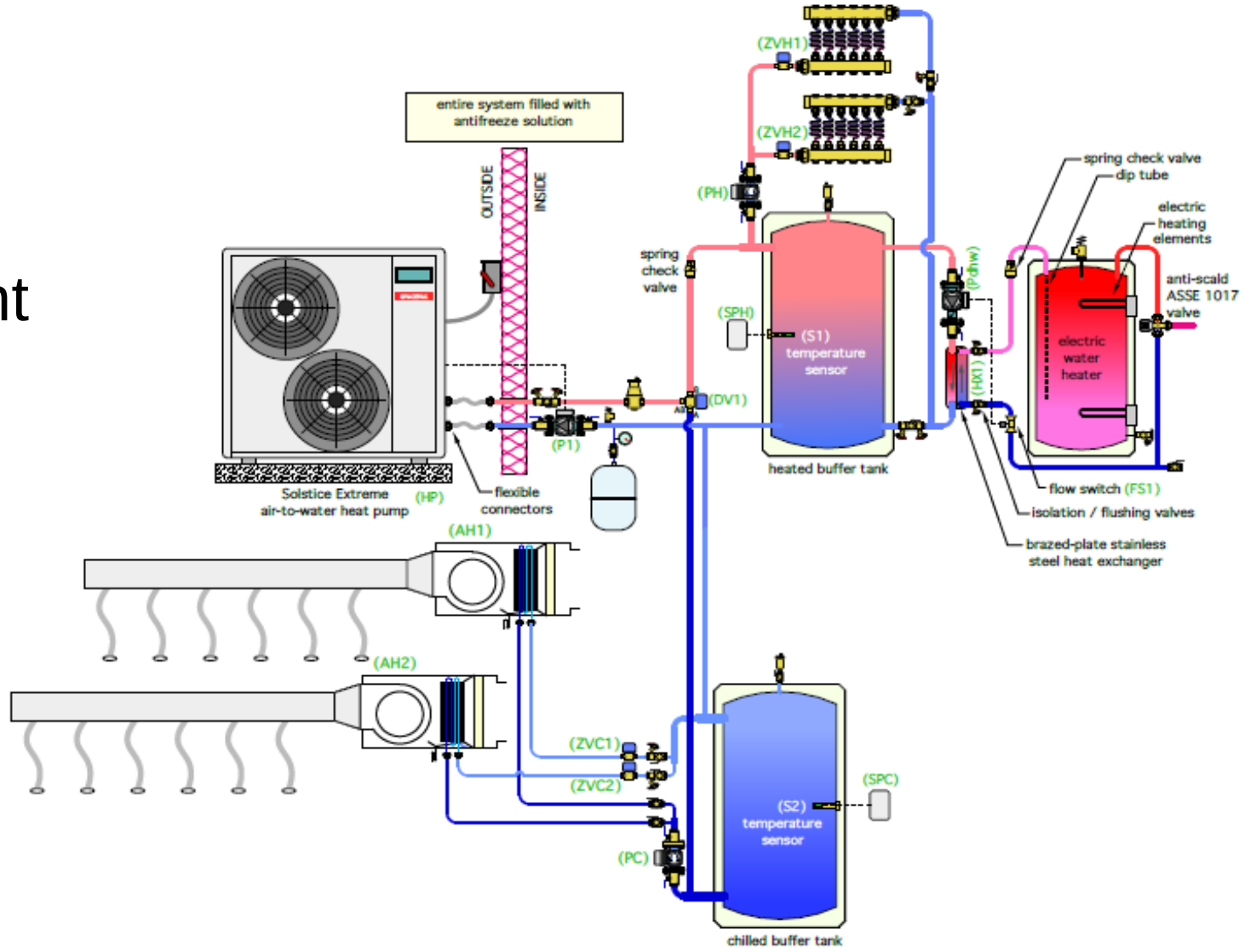
Basic Heat / Cool Systems





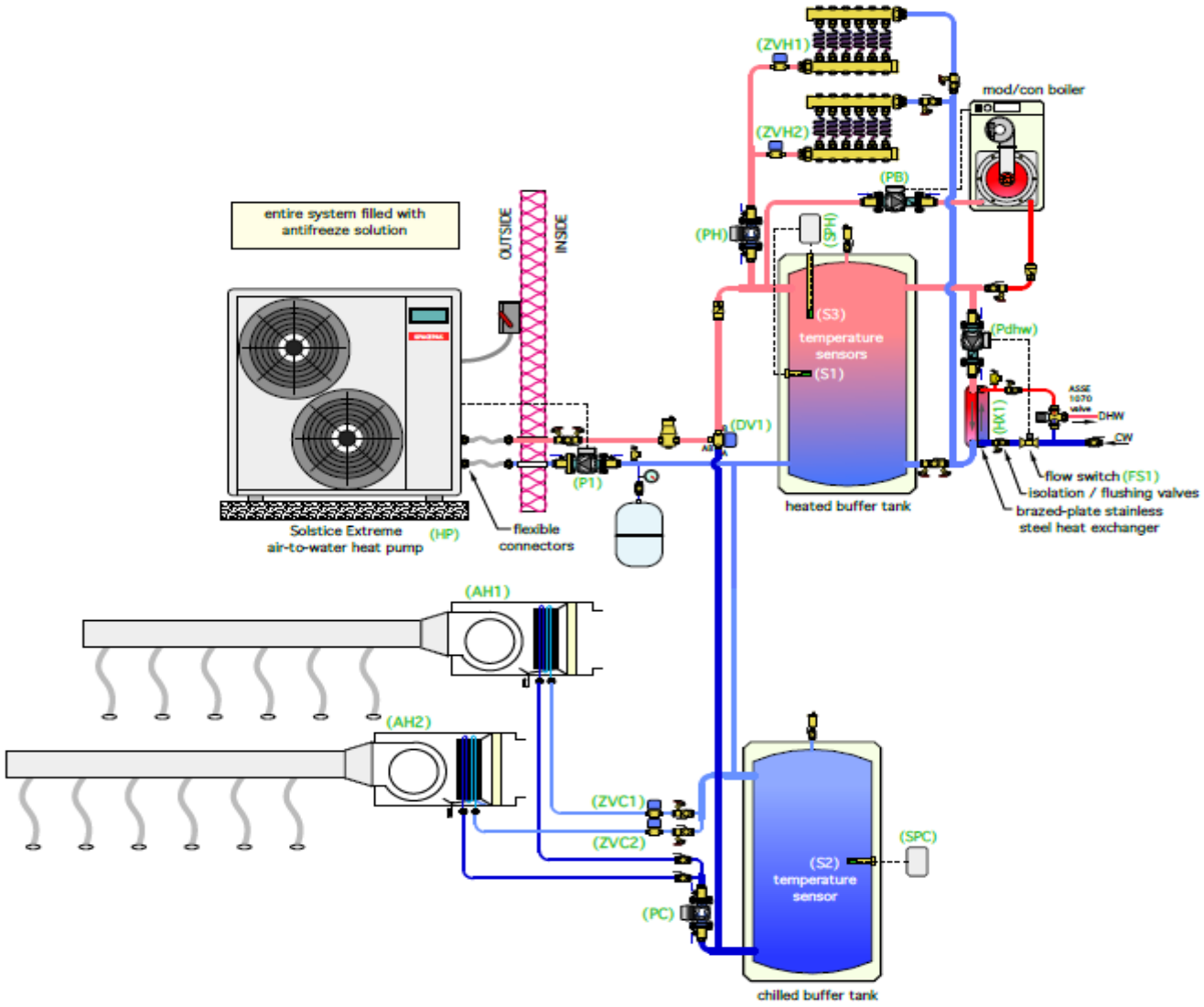
Integration

- Complete System Integration
- Electrification
- High Pressure Refrigerant Stays Outside
- Simultaneous Heating & Cooling
- DHW Pre-Heat



Heating-Cooling-Boiler & HW Pre-Heat

- Boiler Integration
- DHW Pre-Heat
- Simultaneous Heating & Cooling
- Used in Hotel/ B+B Applications



Inverter Technology is the Future!

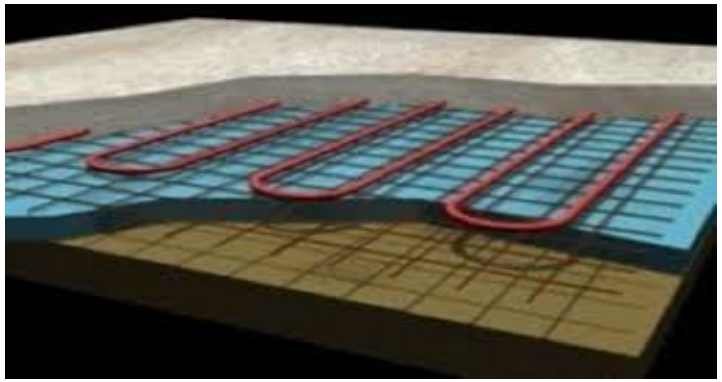
- Higher Consistent Efficiencies
- Low Energy Consumption
- Higher Consistent COP’s
- Priority DHW Settings
- Low Ambient Capabilities
- Ultra Quiet Operation
- Exact Load Matching
- Split Heat Pump Systems

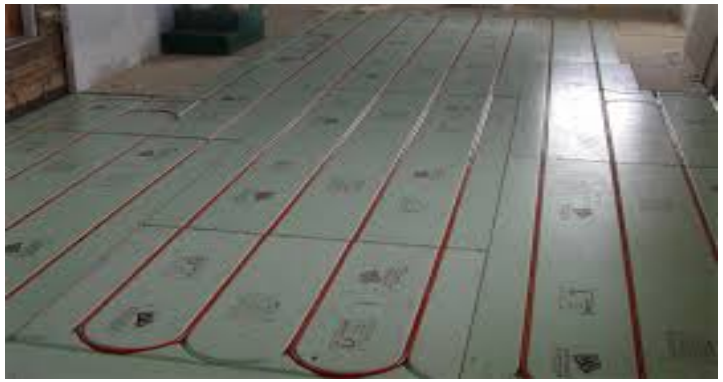
SIM Series (Inverter Mono-Block)

3 ton

5 ton

The PERFECT MATCH for ALL LOW TEMPRATURE Heating Needs





Acadia Maine

- Large Residence
- Replaced Existing 30 ton Commercial
- Connected to Existing Hydronic System
- 12-1 Turndown Resulting in Large Efficiency Gains

Rutland Vermont

- Low Load Primary Heating & Cooling System
- GMP (line power) Solar or Tesla Battery Backup Power
- Slab on Grade with Radiant & Low Temp Baseboard Upstairs

Brattleboro Vermont (School for International Training)

- Added to Existing Forced Air Systems with Hydronic Coils
- Better Efficiencies & Cost Savings over Straight Electric
- Expanding to other Buildings on the Campus

Colorado

Elevation:10,000 ft.

Beta Test Site

SIS Series (Split System Inverter)

- -20°F Design Temp
- Radiant Slab (100°F)
- Primary Heat Source
- No Backup Resistance Elements Needed
- No Antifreeze in Outside Loop

Outdoor Unit

Indoor Unit

SPACEPAK®

CENTRAL AIR ANYWHERE

HYDRONICS

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Cold Climate Heat Pumps + Emerging Tech Advancements with Mini-Split Heat Pumps

ENERGY STAR 2020 Products Partner Meeting

Kevin DeMaster
Mitsubishi Electric Trane HVAC
Manager, Utility & Efficiency Programs

Oct 27, 2020

The Basics - (Not Everything is “Ductless”)

Outdoor Unit

1:1

or

1:Many

Wall-mounted Model:

Ceiling-recessed, Cassette Model:

Floor Mounted

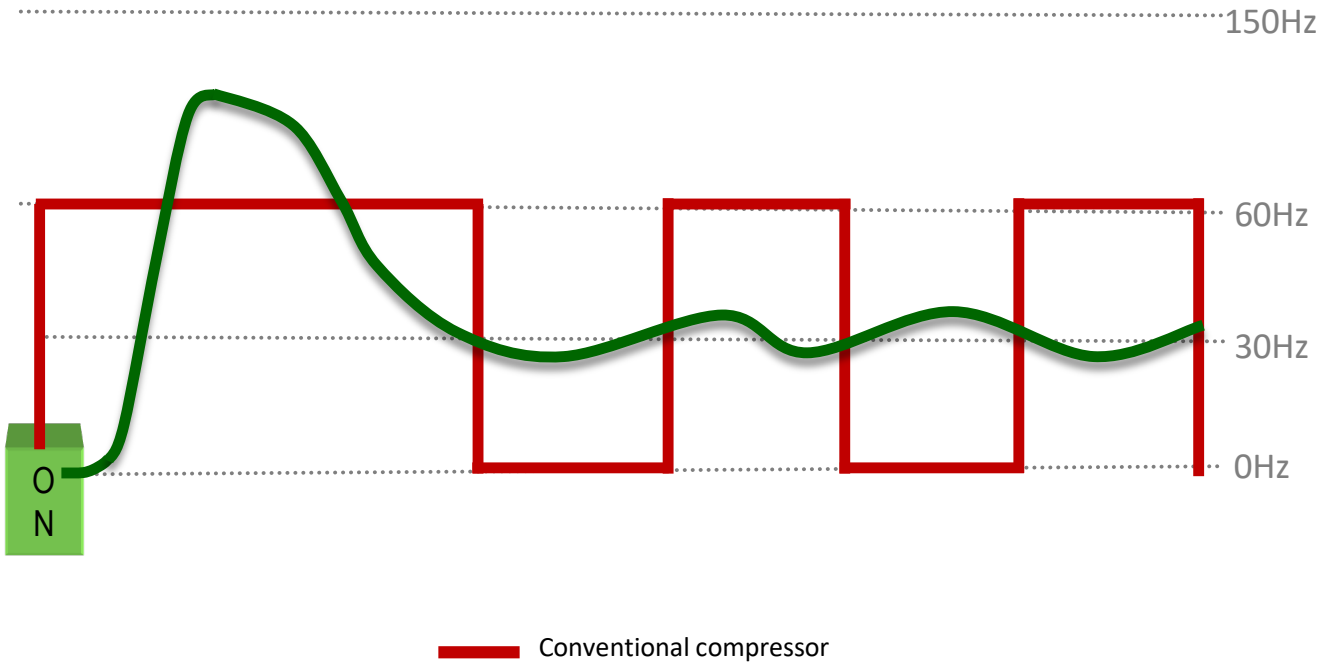
Horizontal-ducted Model:

Air Handler

Indoor Unit (Options)

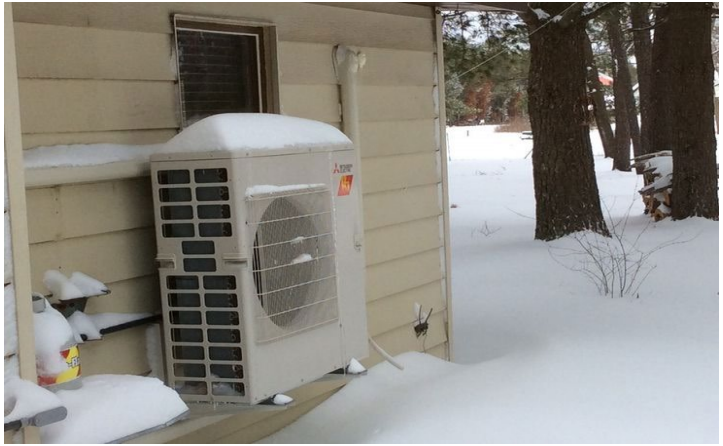
Why Are they So Efficient?

INVERTER Technology



Energy Efficiency – Heat Pumps Not Created Equal

VS.



Energy Star Requirements (15 SEER, 12.5 EER, 8.5 HSPF)

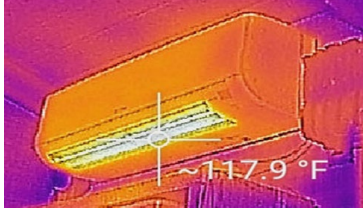
Heat Pumps AHRI 477,712 Listed.

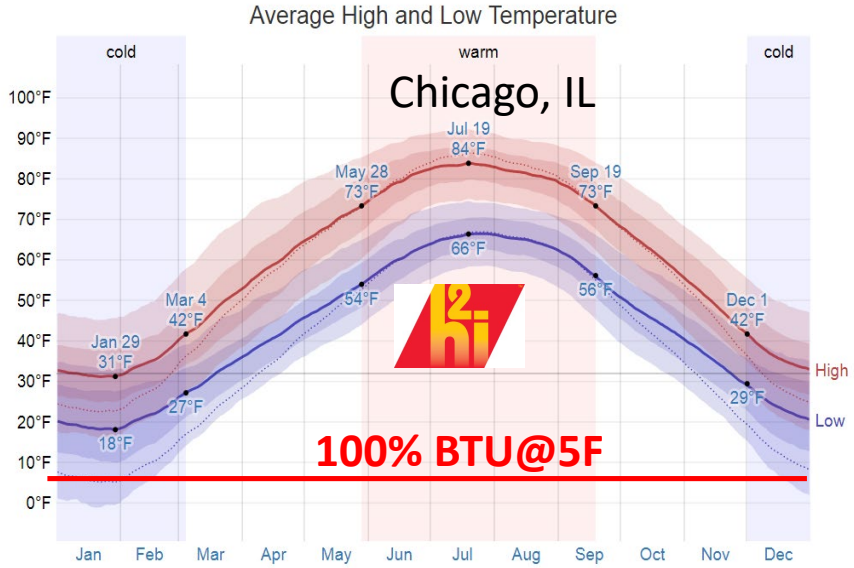
- Energy Star - 200,101 – (42%)
- Increase to 16 SEER – 91,298 (19%)
- Increase to 18 SEER – 12,034 (<3%)

Variable Speed Heat Pumps AHRI 8,240

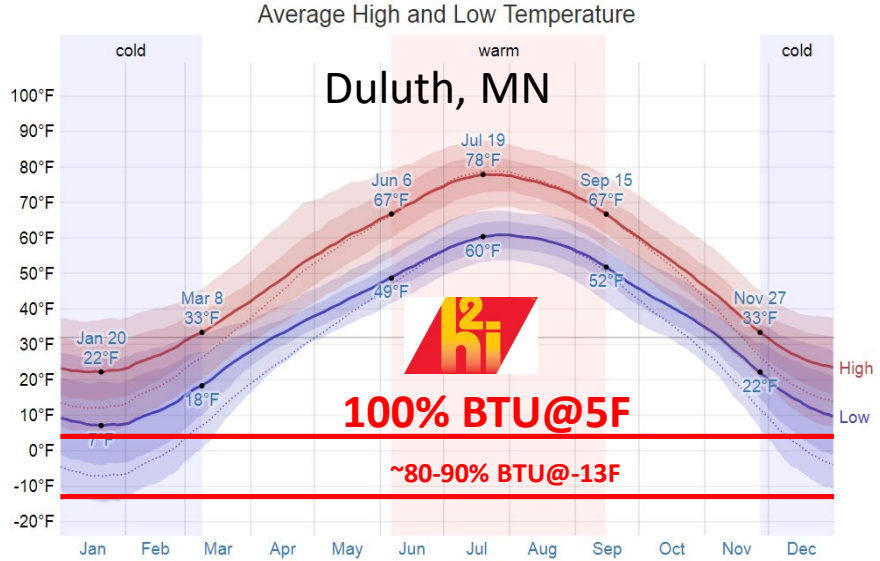
- Energy Star - 3,292 – (40%)
- Increase to 16 SEER – 3,287 (40%)
- Increase to 18 SEER – 3,224 (39%)

Cold Weather Performance – Upper Midwest



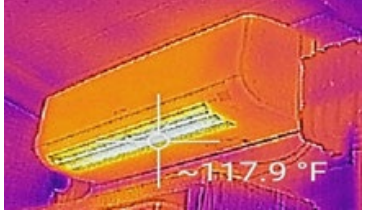


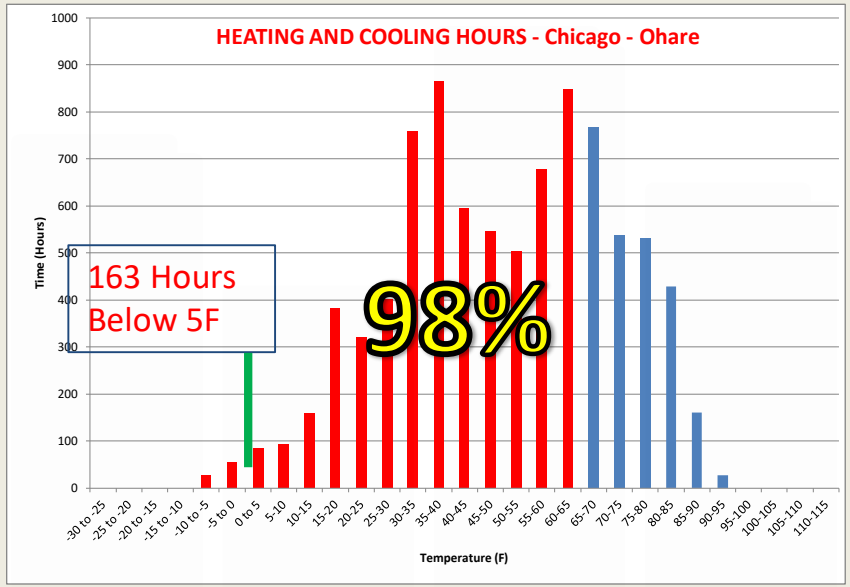
The daily average high (red line) and low (blue line) temperature, with 25th to 75th and 10th to 90th percentile bands. The thin dotted lines are the corresponding average perceived temperatures.



The daily average high (red line) and low (blue line) temperature, with 25th to 75th and 10th to 90th percentile bands. The thin dotted lines are the corresponding average perceived temperatures.

Heating Hours Bin Data – Upper Midwest





Total Heating Hours	Total Cooling Hours	Total Hours
6309	2451	8760

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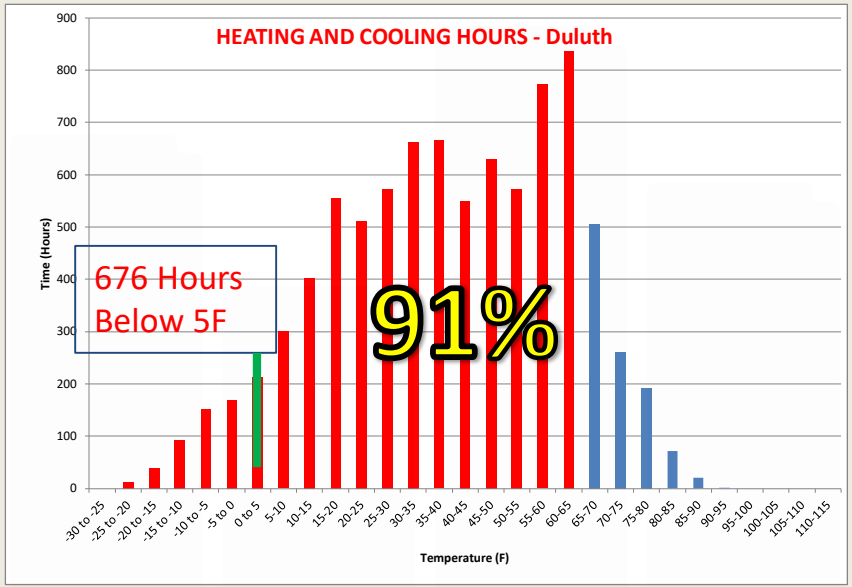
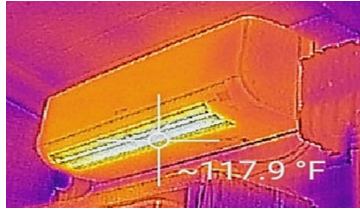


Total Heating Hours	Total Cooling Hours	Total Hours
7710	1050	8760

MITSUBISHI ELECTRIC
COOLING & HEATING

Cost of Heating BTU's – Wisconsin



- Propane – $1.43 / gal
- Natural Gas – $0.73 / therm
- Electric Resistance Heat – $0.13 / kWh
- Cold Climate Heat Pump – $0.13 / kWh
- $0.063 / kWh (Heat Pump Rate

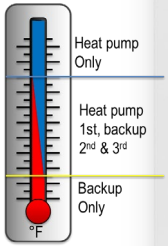
Cost Per Million BTU's
$17.38
$8.11
$38.09
17-47 degrees **$13.85** **$6.67**

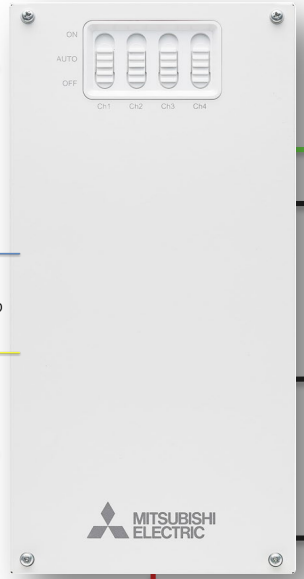
Source EIA – March 2020

Fully Integrated Control Strategy

Outside Air

Ventilation



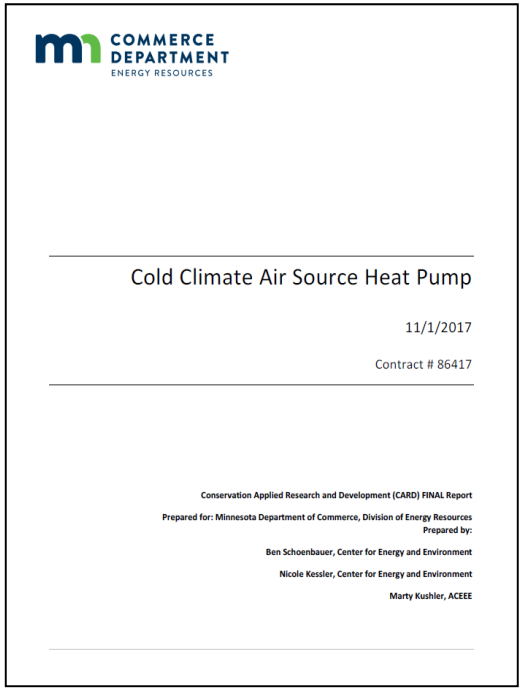


Supplemental Heat

Dehumidification

Humidification

Cold Climate Heat Pump Research


COMMERCE DEPARTMENT
ENERGY RESOURCES

Cold Climate Air Source Heat Pump

11/1/2017

Contract # 86417

Conservation Applied Research and Development (CARD) FINAL Report

Prepared for: Minnesota Department of Commerce, Division of Energy Resources

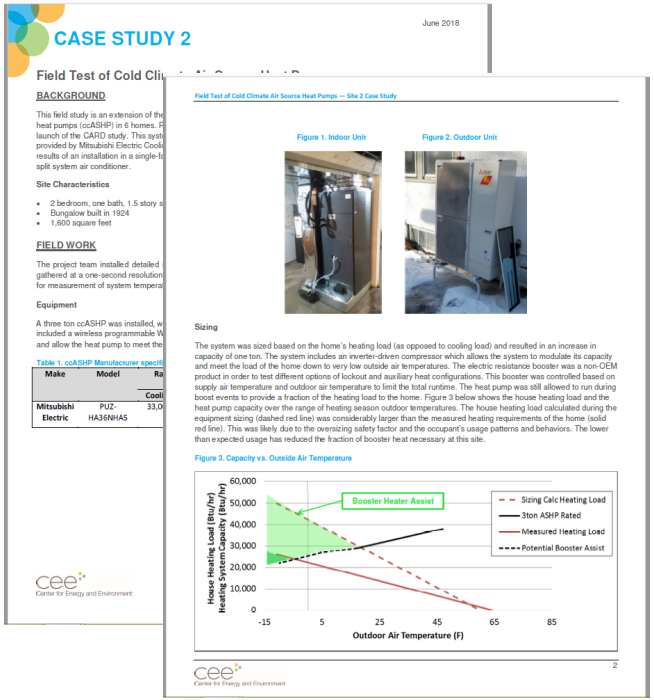
Prepared by:

Ben Schoenbauer, Center for Energy and Environment

Nicole Kessler, Center for Energy and Environment

Marty Kushler, ACEEE

State of MN


CASE STUDY 2

June 2018

Field Test of Cold Cli

BACKGROUND

This field study is an extension of the
heat pumps (ccASHP) in 6 homes. F
launch of the CARD study. This syst
provided by Mitsubishi Electric Cool
results of an installation in a single-fa
split system air conditioner.

Site Characteristics

- 2 bedroom, one bath, 1.5 story s
- Bungalow built in 1924
- 1,600 square feet

FIELD WORK

The project team installed detailed
gathered at a one-second resolution
for measurement of system tempera

Equipment

A three ton ccASHP was installed, w
included a wireless programmable W
and allow the heat pump to meet the

Table 1. ccASHP Manufacturer specifi

Make	Model	Ra
		Cool
Mitsubishi Electric	PUZ-HA36NHA5	33,0

cee
Center for Energy and Environment

Field Test of Cold Climate Air Source Heat Pumps — Site 2 Case Study

Figure 1. Indoor Unit

Figure 2. Outdoor Unit

Sizing

The system was sized based on the home's heating load (as opposed to cooling load) and resulted in an increase in capacity of one ton. The system includes an inverter-driven compressor which allows the system to modulate its capacity and meet the load of the home down to very low outside air temperatures. The electric resistance booster was a non-OEM product in order to test different options of lockout and auxiliary heat configurations. This booster was controlled based on supply air temperature and outdoor air temperature to limit the total runtime. The heat pump was still allowed to run during boost events to provide a fraction of the heating load to the home. Figure 3 below shows the house heating load and the heat pump capacity over the range of heating season outdoor temperatures. The house heating load calculated during the equipment sizing (dashed red line) was considerably larger than the measured heating requirements of the home (solid red line). This was likely due to the oversizing safety factor and the occupant's usage patterns and behaviors. The lower than expected usage has reduced the fraction of booster heat necessary at this site.

Figure 3. Capacity vs. Outside Air Temperature

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2

Xcel Energy - MN


ComEd Cold Climate Ductless Heat Pump Pilot

Ductless Heat Pump Final Report

May 7, 2020

Prepared for: ComEd Energy Efficiency Program Emerging Technology

CMC ENERGY SERVICES™

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and

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Fort Washington, PA 19034
215.540.5800

ComEd - Illinois

Cold Climate Heat Pump Specifications (Future)

Energy Star

DRAFT 6.0

Table 3: Energy-Efficiency Criteria for Certified Residential ASHPs

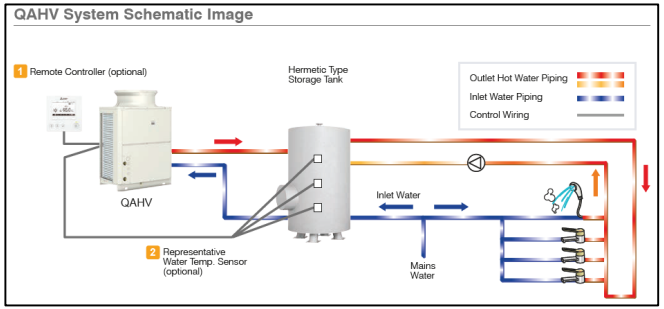
For purposes of ENERGY STAR certification, an ASHP model must be designated as either Moderate and Hot Climate or Cold Climate and meet the associated requirements in Table 3.

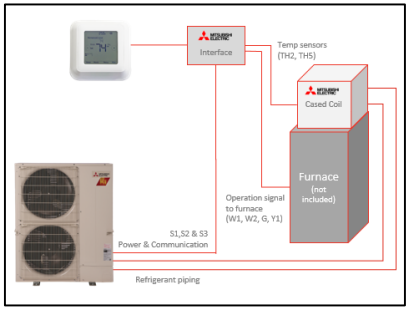
Product Type	Moderate and Hot Climate			Cold Climate				
	SEER	EER	HSPF	SEER	EER	HSPF	COP @ 5°F	Percentage of Heating Capacity @ 5°F
ASHP Split Systems	≥ 16.00	≥ 12.50	≥ 8.50	≥ 16.00	≥ 11.50	≥ 9.00	1.75	80%
ASHP Single Package Equipment[1]	≥ 16.00	≥ 12.00	≥ 8.20	≥ 16.00	≥ 11.00	≥ 9.00	1.75	80%

CURRENT Energy Star Requirements (15 SEER, 12.5 EER, 8.5 HSPF)

40% to 50%

Emerging Products/Program Design





Cold Climate Product Expansion
- 39 additions
- -5F – 100%

2020

Commercial Large Scale CO2 HPWH
- MultiFamily
- Hospitality

Early 2021

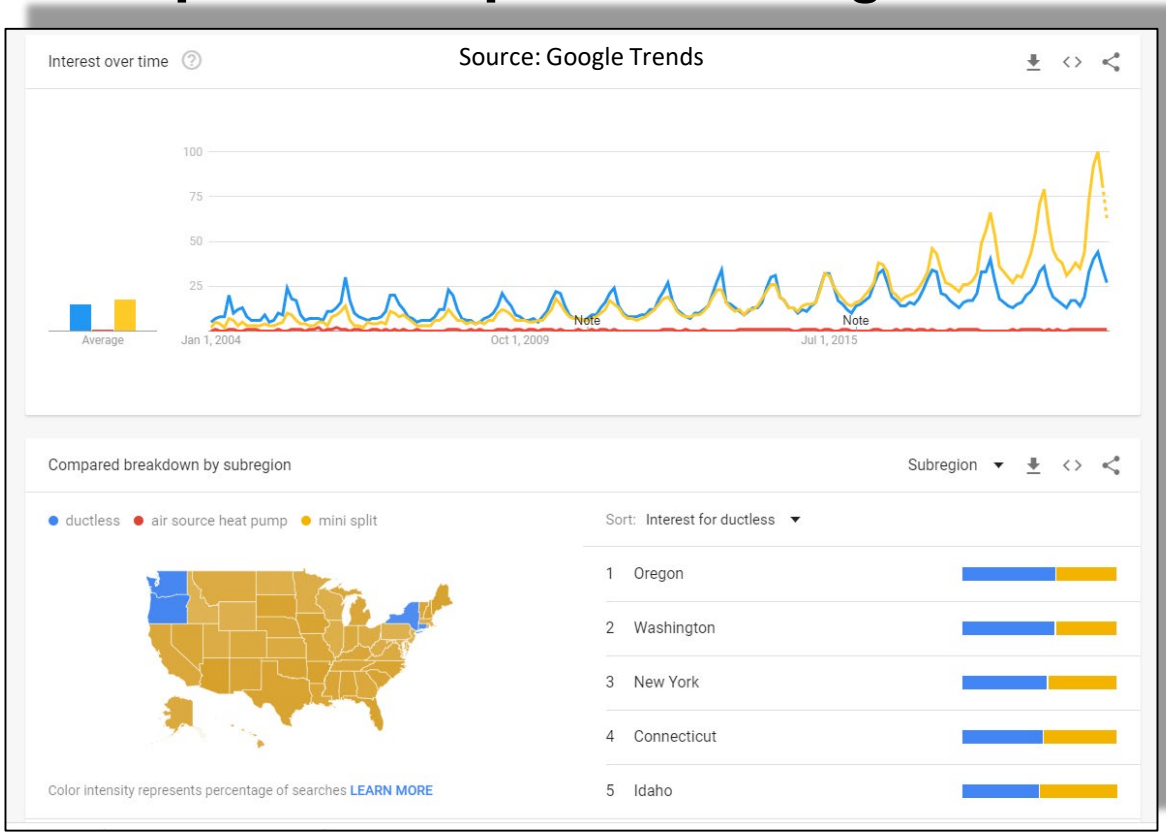
Dual Fuel A-Coil Multi-Zone Any Furnace

Late 2021

US Market Evaluation of UK HPWH Renewable Heating

2021

What Heat Pumps are People Searching For?



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