



# Sustainability Speaker Series (S3)



## Building Efficiency: HEAT PUMPS & ELECTRIFICATION



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President**

# Heat Pump Fundamentals

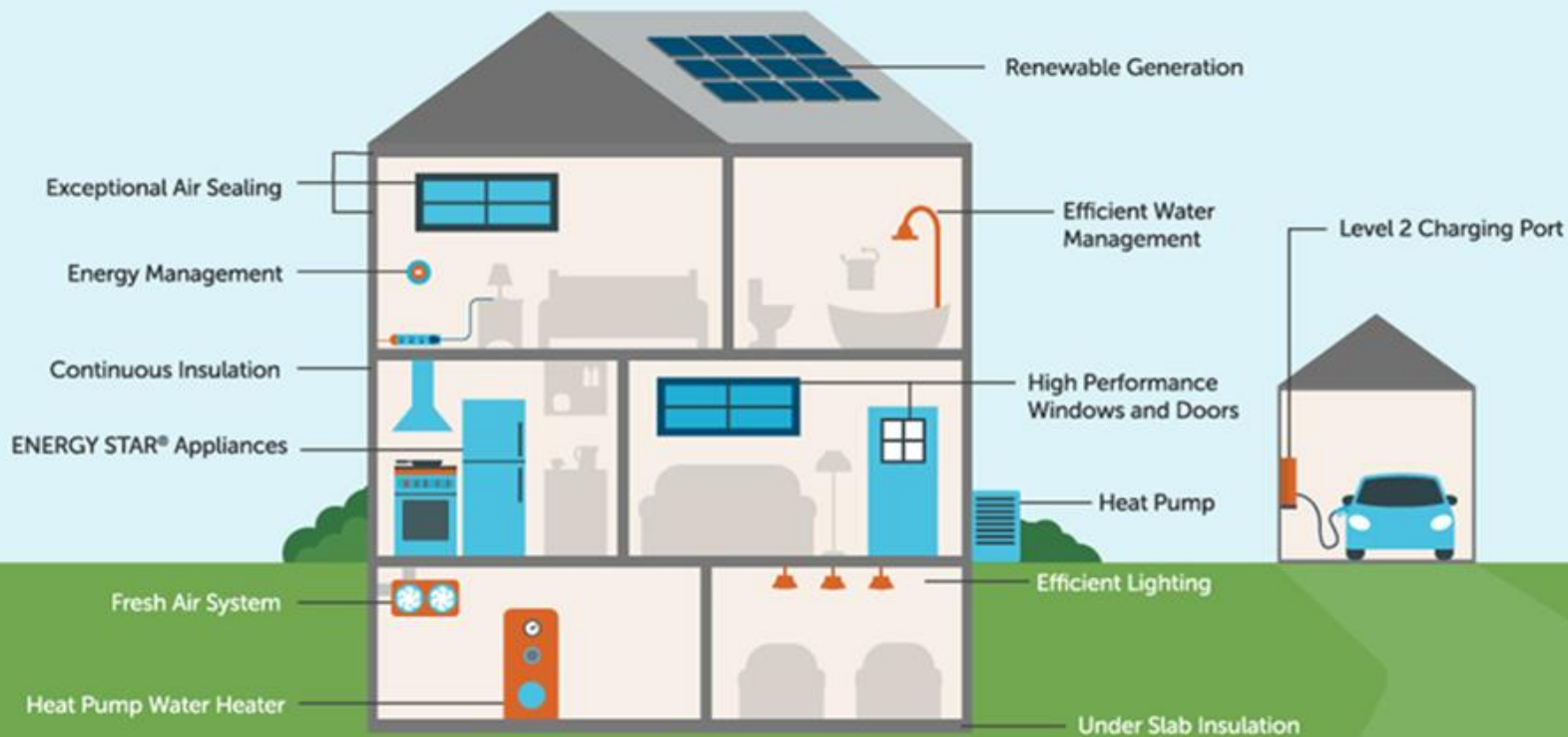
## Air-Source Heat Pumps (Incl. Cold Climate)

## Water-Source Heat Pumps

## Ground-Coupling (Geothermal)

- Closed Loop
- Open Loop

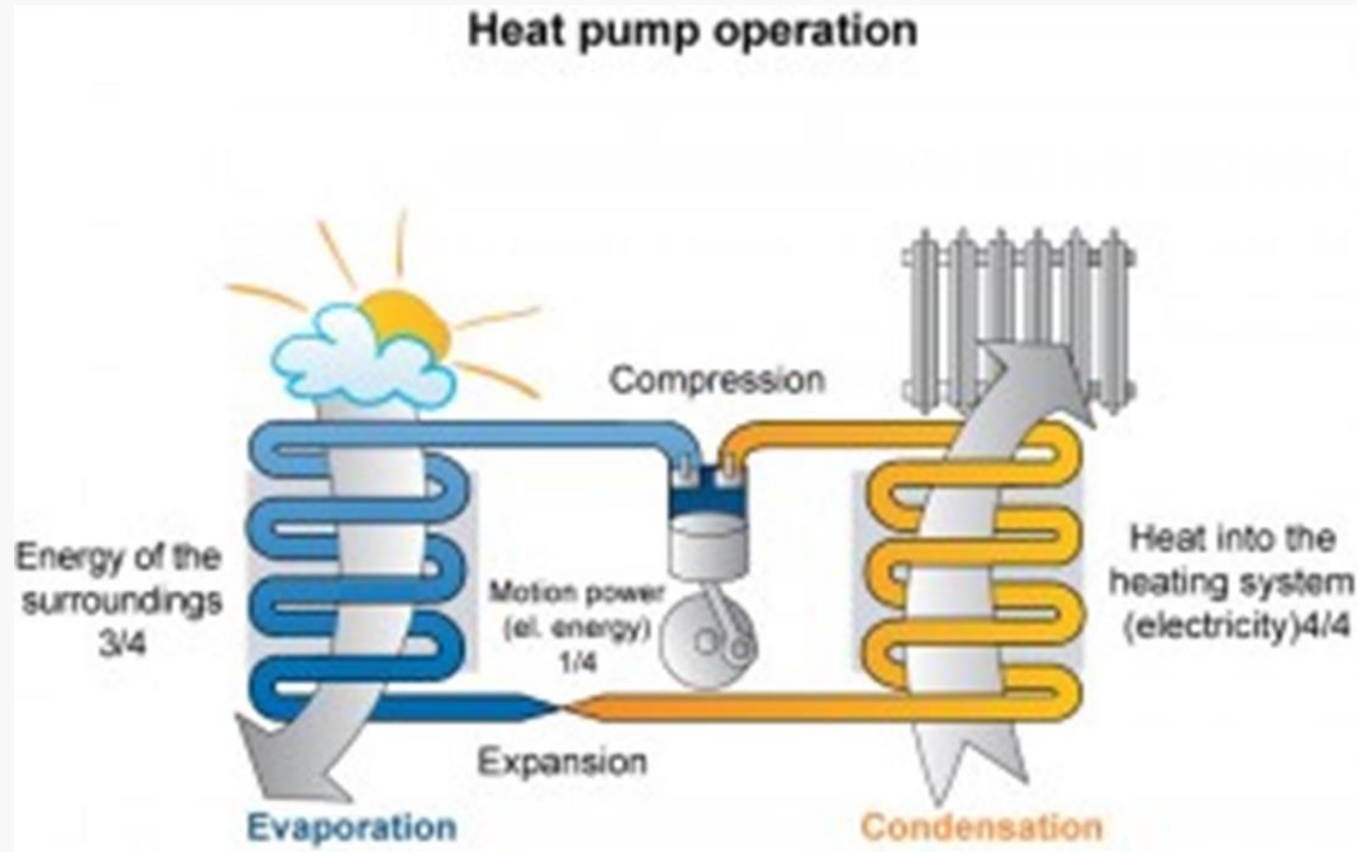
## Outside Air Ventilation



## **BUILDING SECTOR GOALS**

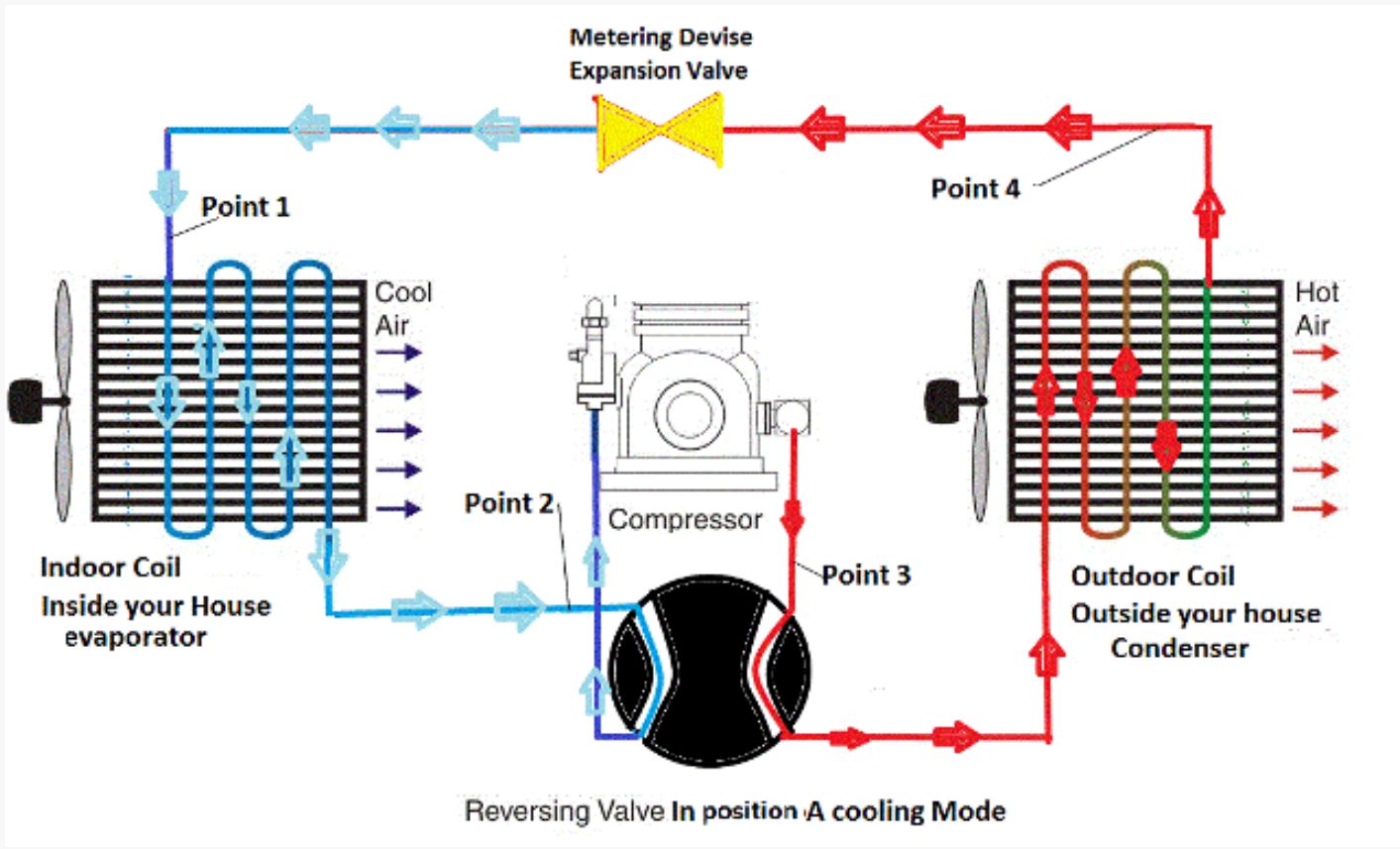
- MINIMIZE ENERGY USE
- INDOOR AIR QUALITY (HEALTHY BUILDINGS)
- DECARBONIZATION (ELECTRIFICATION)

First Law of Thermodynamics:  
Energy can be neither created nor destroyed



Ratio of Useful Heat Movement per Unit of Energy Input = Coefficient of Performance (C.O.P.)

# Heat Pumps “Pump” Heat from one place to another

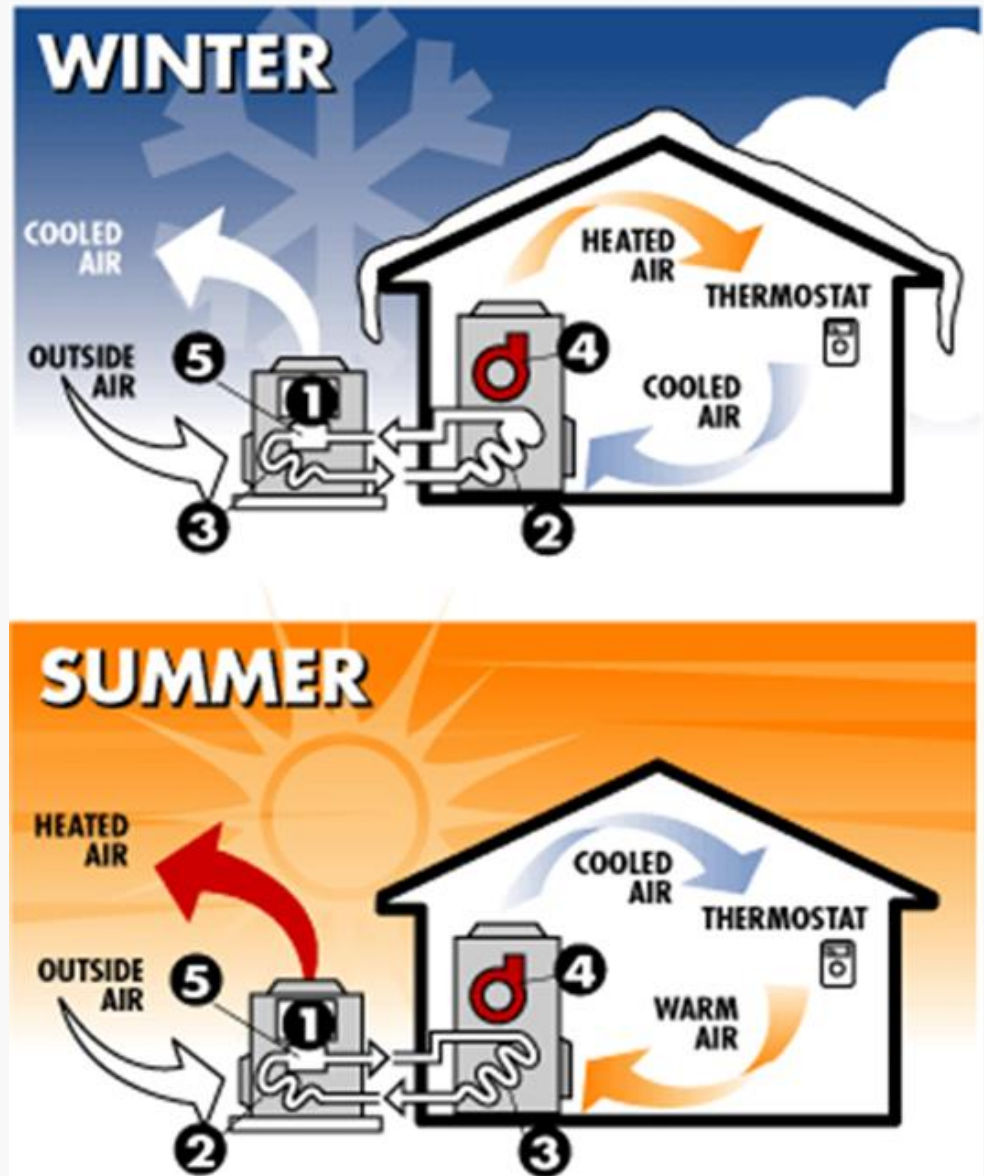


Reversing Valve Reverses the Refrigerant Flow Between the Evaporator and Condenser

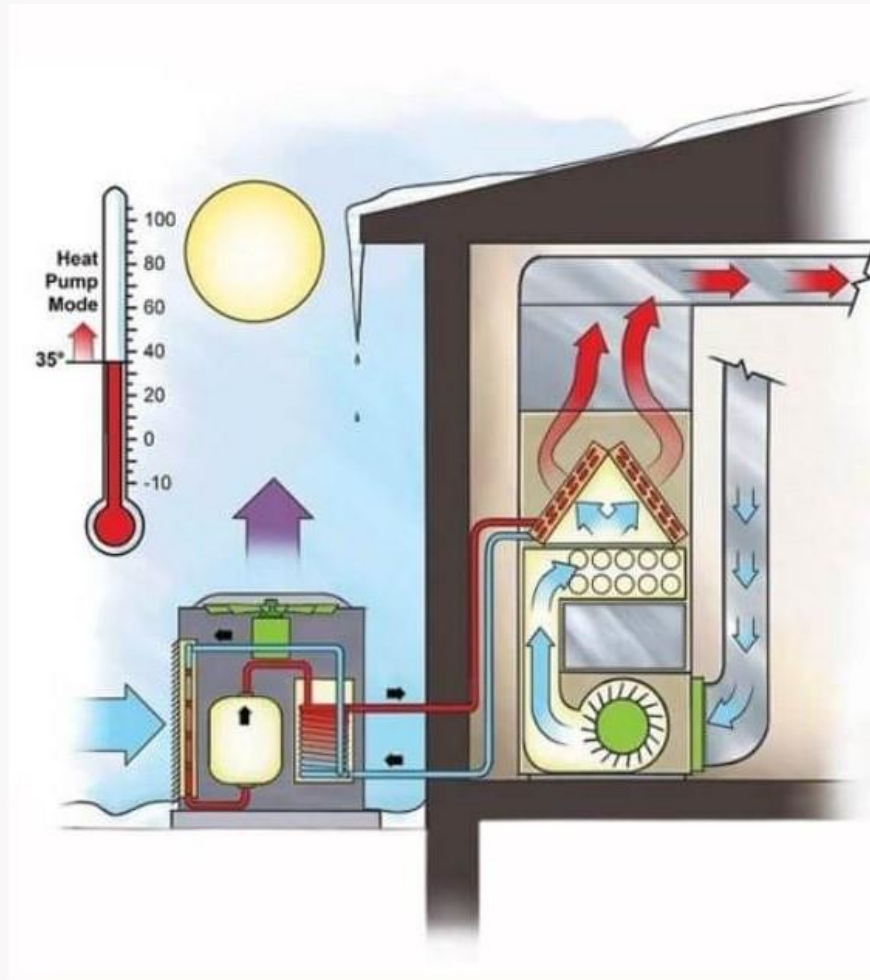
Temperature “Lift”  
(Carnot Efficiency)

30°F - 70°F  
(40° Delta)

75° - 95°F  
(20° Delta)



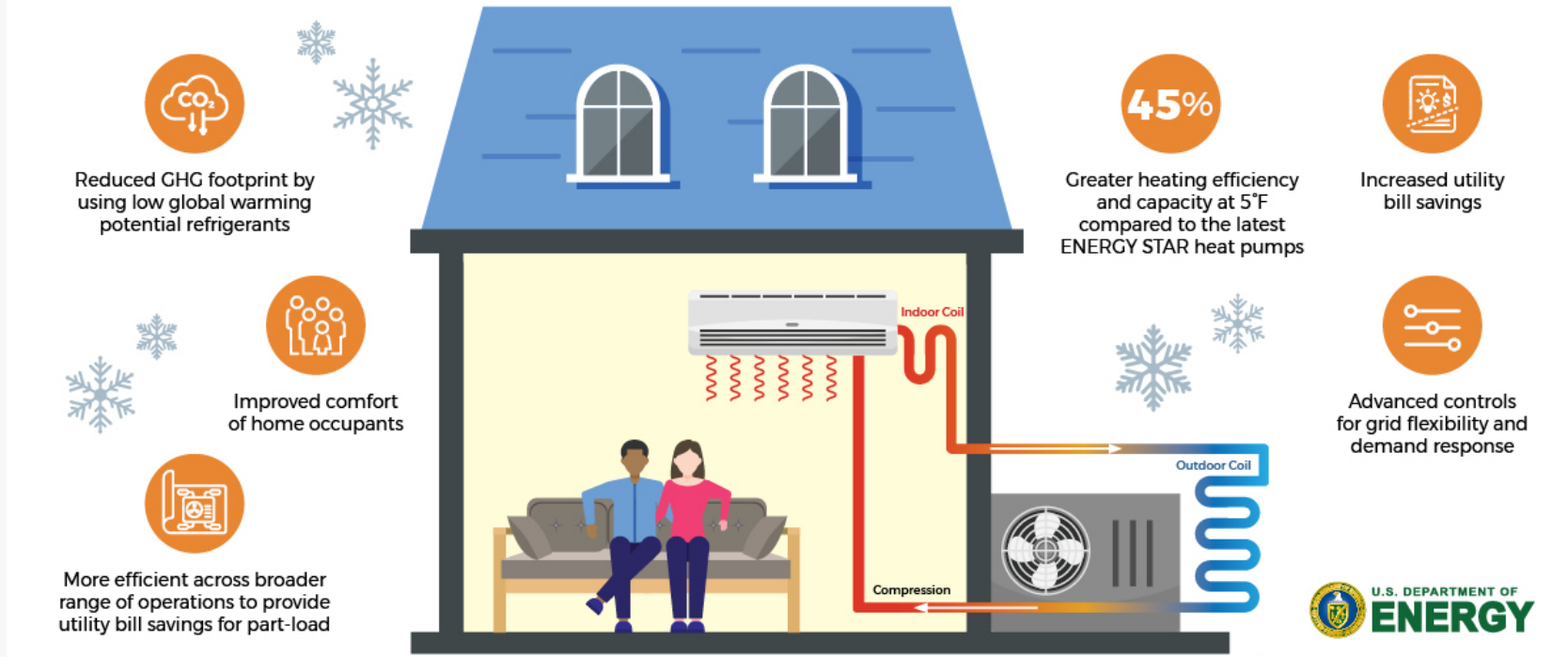
# AIR TO AIR HEAT PUMPS



Old style “Conventional” Heat Pumps use “Back-Up” electric heat when it’s cold out



# COLD CLIMATE HEAT PUMPS



## COLD CLIMATE AIR-SOURCE HEAT PUMP (ccASHP)

Variable Speed, Variable Flow Refrigerant (VRF)

100% Heat Capacity down to 5°F

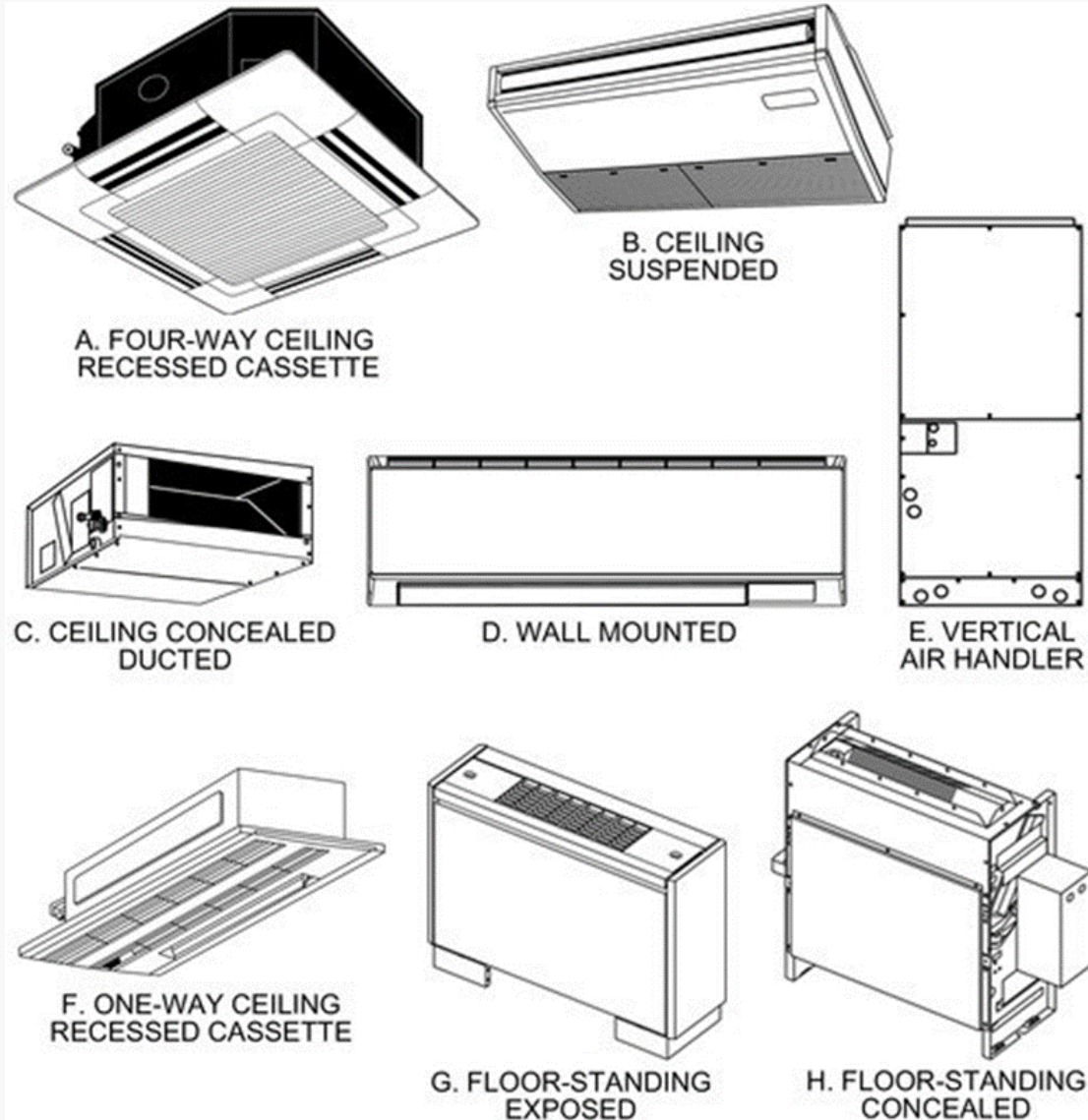
Operation down to - 13°F



# OUTDOOR UNITS



# INDOOR UNIT STYLES



## ccAir Source Heat Pumps

Cooling EER ~ 15  
SEER ~ 23

Heating at 47°F COP ~ 4  
HSPF (Zone 4) ~ 12  
HSPA (Zone 5) ~ 9

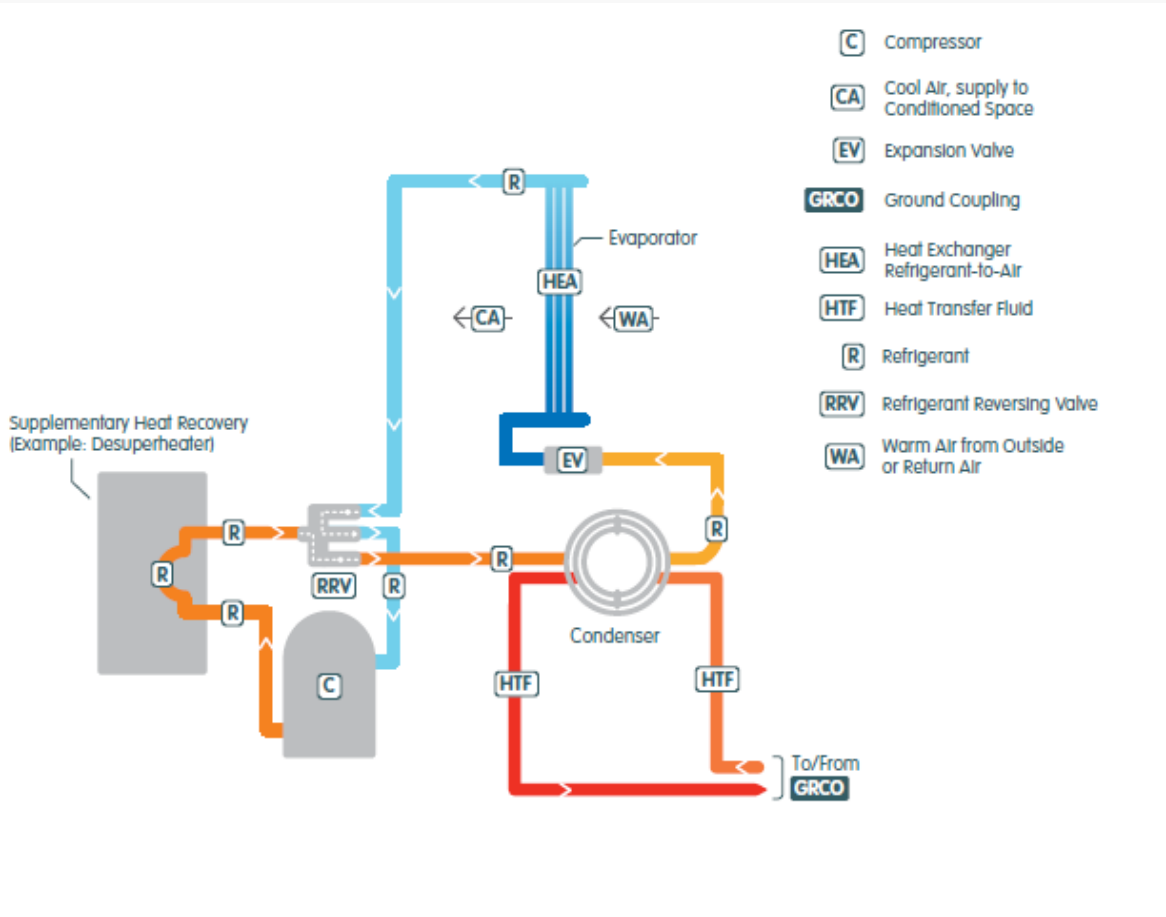
EER: Energy Efficiency Ratio

SEER: Seasonal Energy Efficiency Ratio

HSPF: Heating Seasonal Performance Factor

Typical Values for Mitsubishi Hyper-Heat  
3-Ton Unit

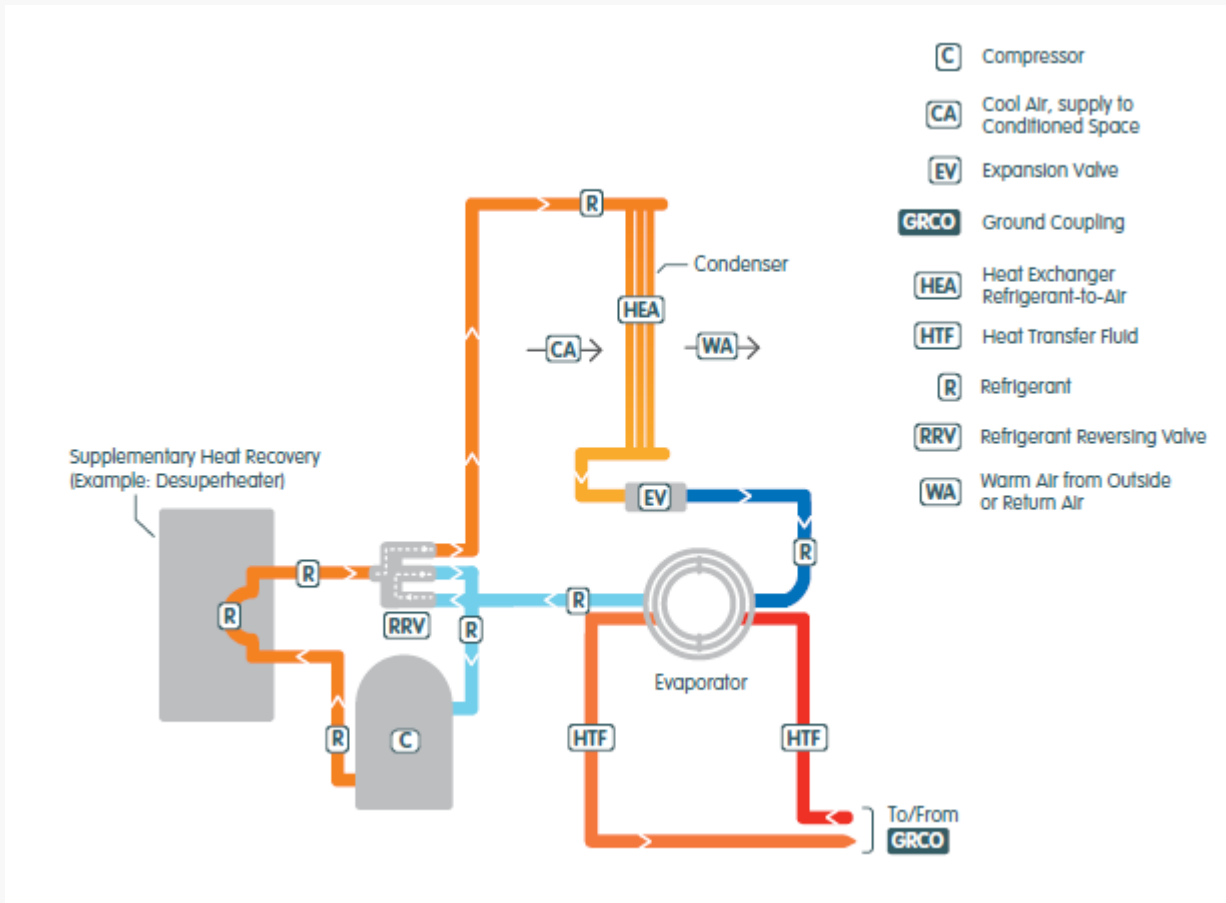
# Water to Air – Cooling Cycle



Water-to-Air Heat Pumps Use Energy from Fluid Systems Instead of the Outside Air



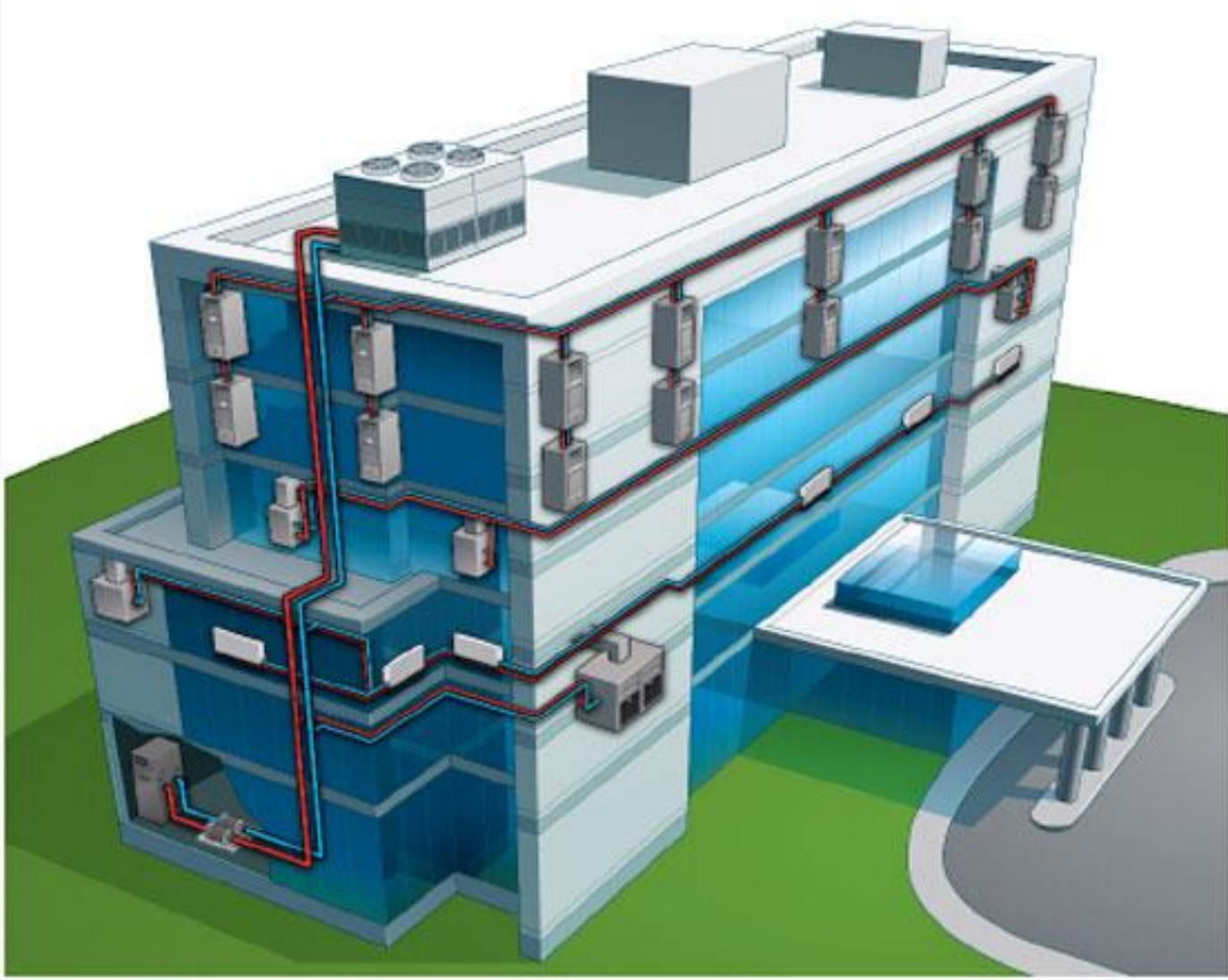
# Water to Air – Heating Cycle





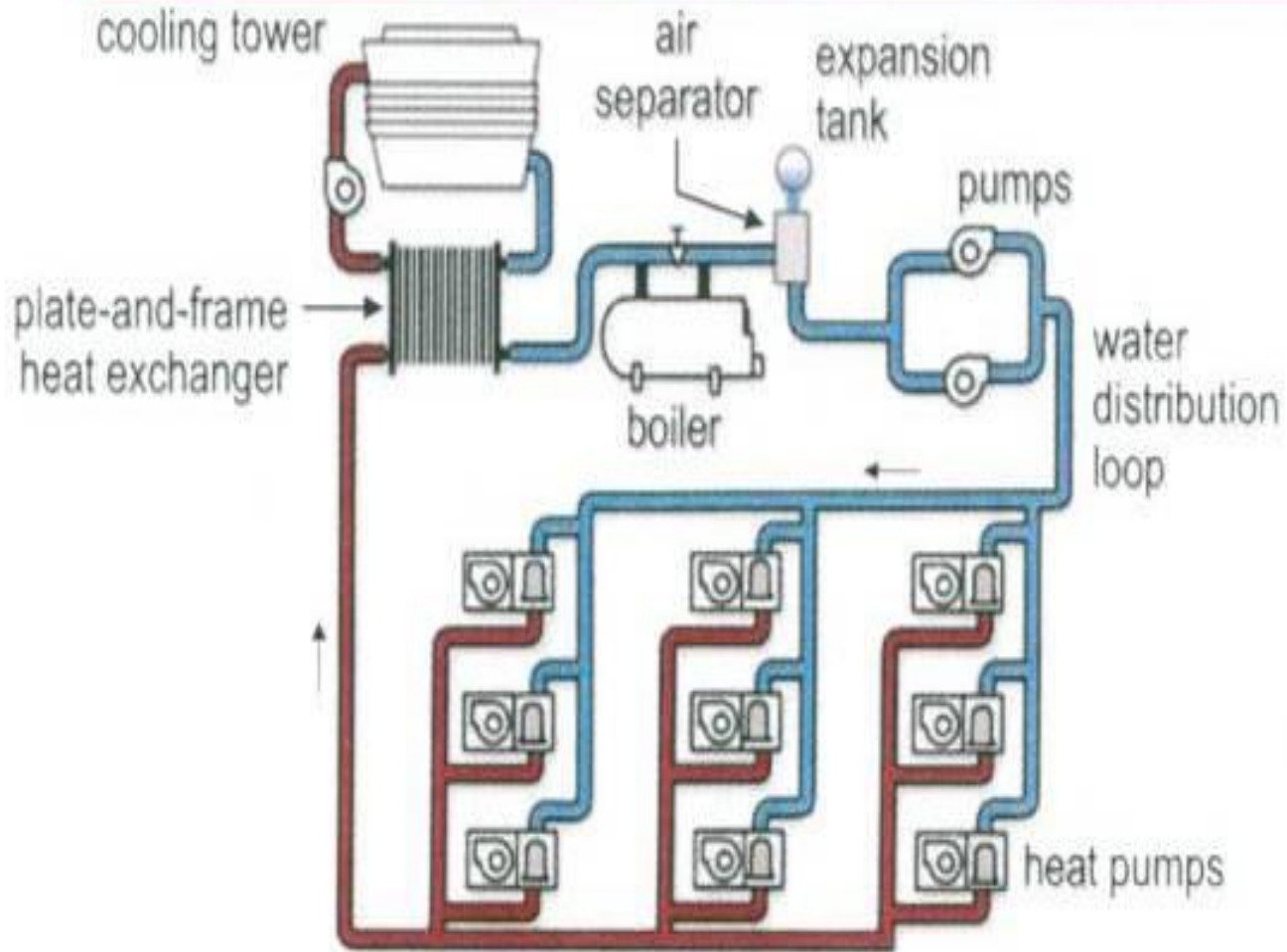
Typical Horizontal and Vertical WSHP Units

# WATER-SOURCE HEAT PUMPS





# Water-Source Heat Pump System



## Water Loop Temperatures:

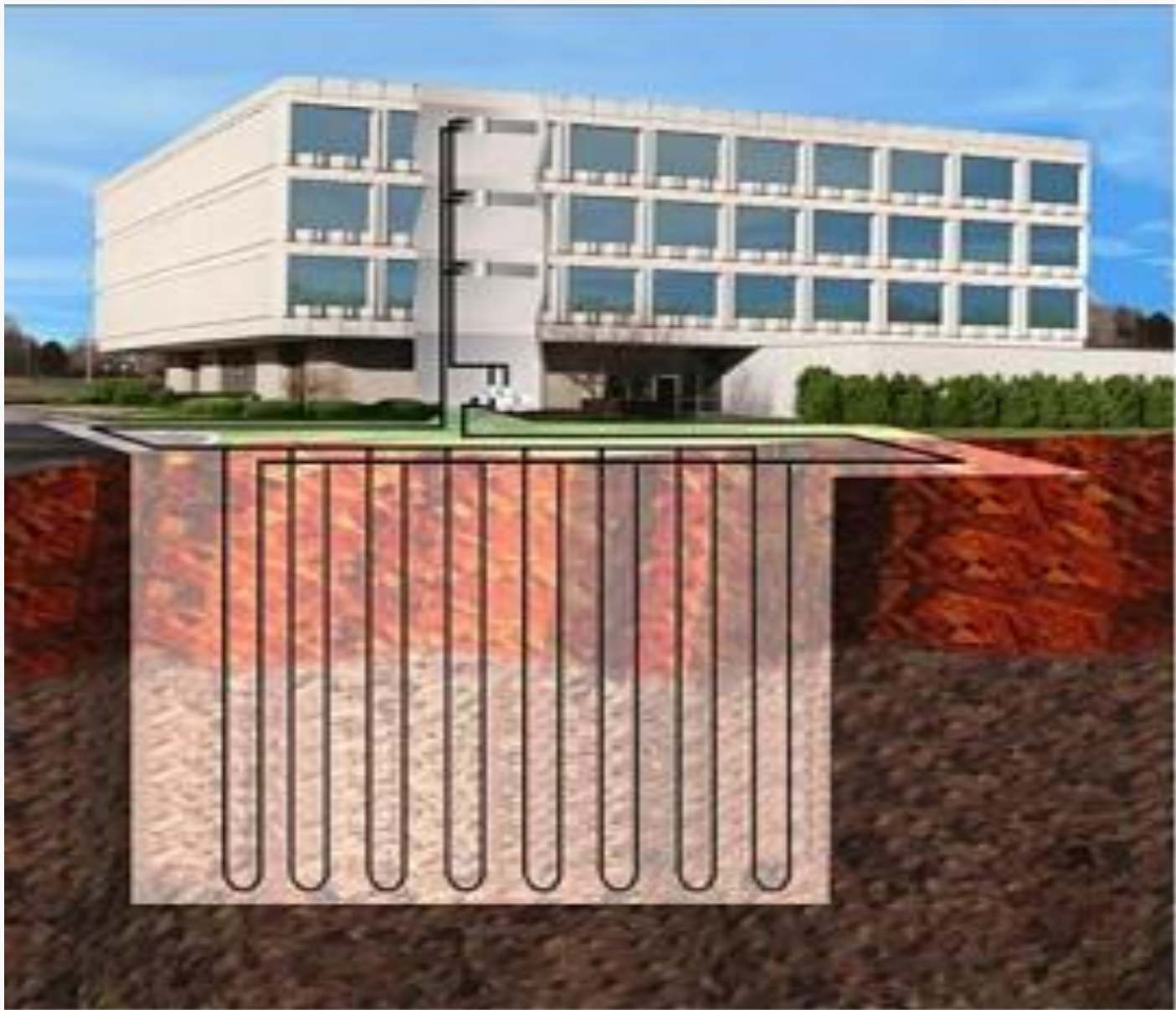
Cooling - 86°F

EER ~ 15 to 18\*

Heating - 68°F

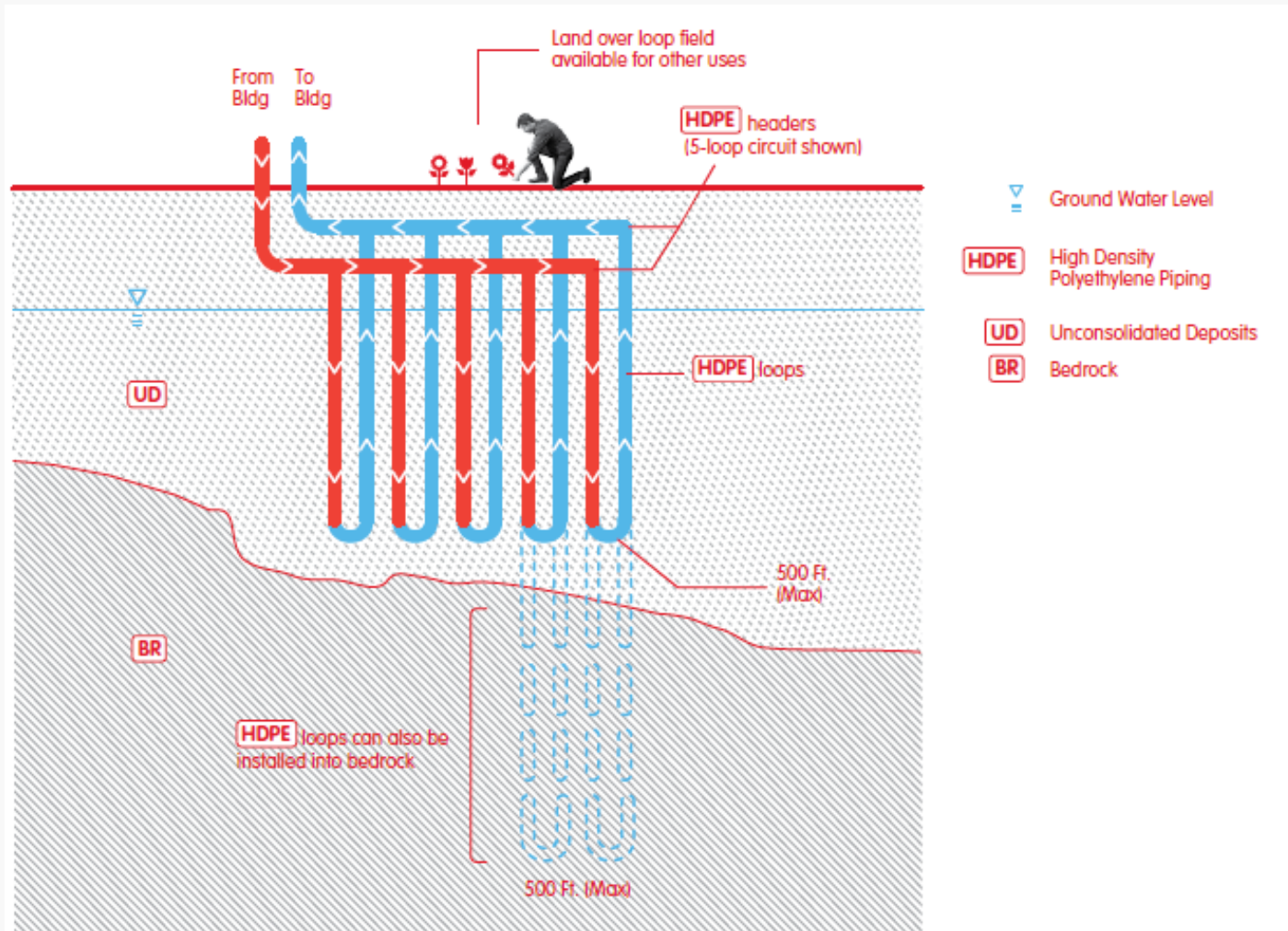
COP ~ 5 to 6\*

\* Typical Ratings for Trane Axiom VSV/VSH  
Variable Speed 2- 5 Tons at Full Load.



Closed-loop Heat Exchanger

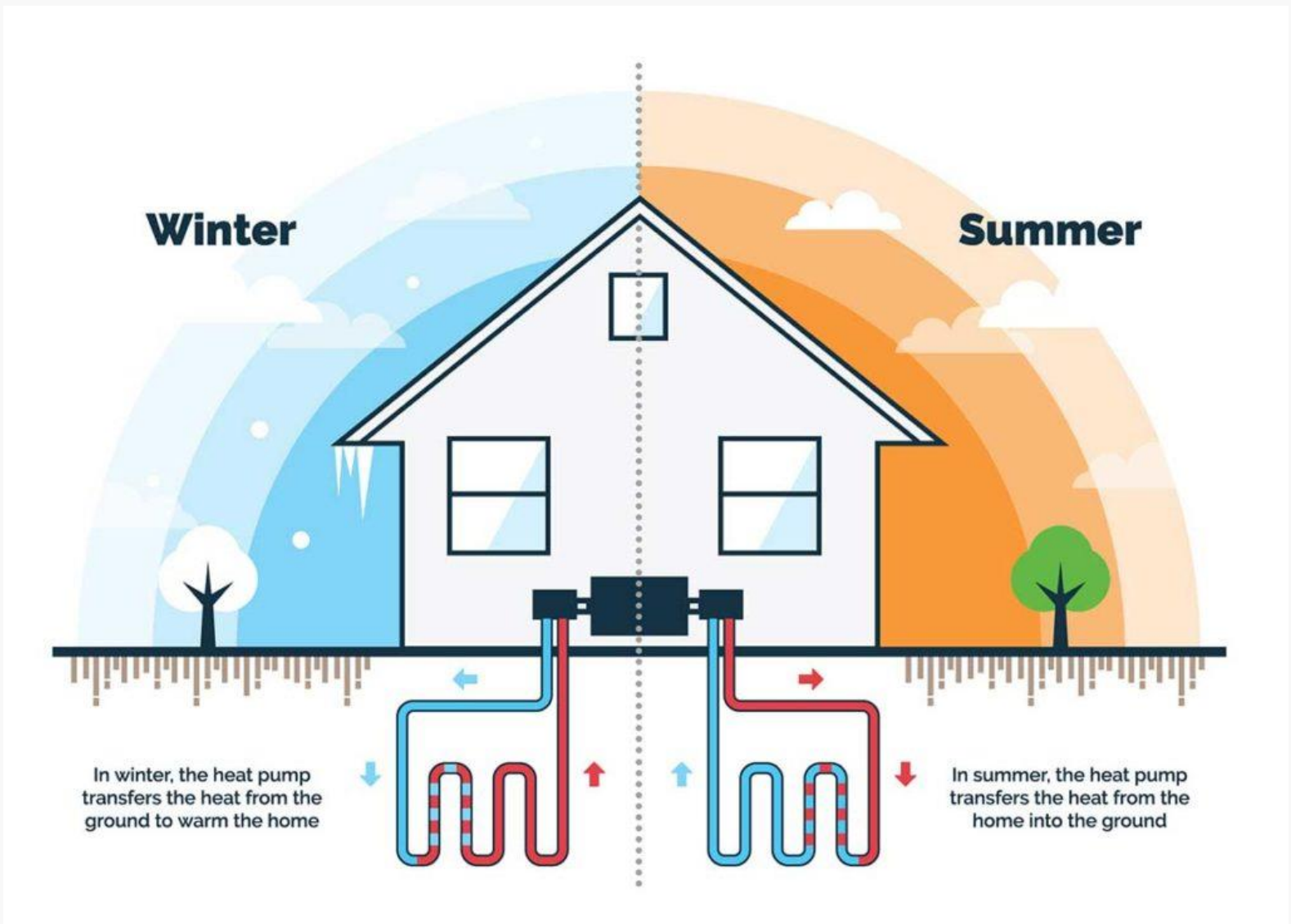
# GROUND-COUPLED HEAT PUMPS



Mean Earth Temperature = 55°F (New Jersey)



# GEOHERMAL HEAT PUMPS



In winter, the heat pump transfers the heat from the ground to warm the home

In summer, the heat pump transfers the heat from the home into the ground

55° - 70°F

75° - 55°F

**Ground-Coupled Closed Loop Temperatures:**

Cooling - 77°F

EER ~ 18 to 22\*

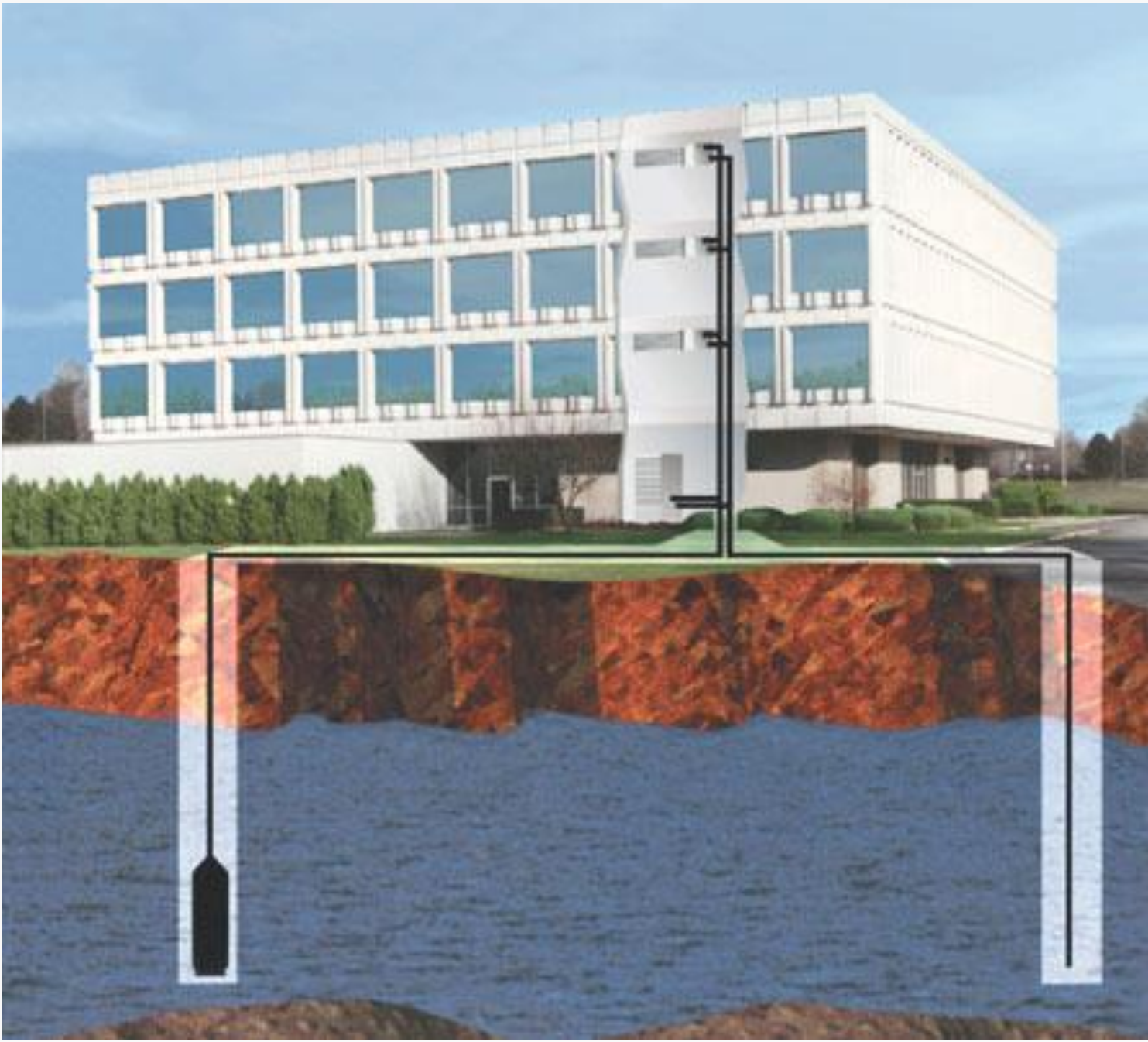
Heating - 32°F\*\*

COP ~ 4\*

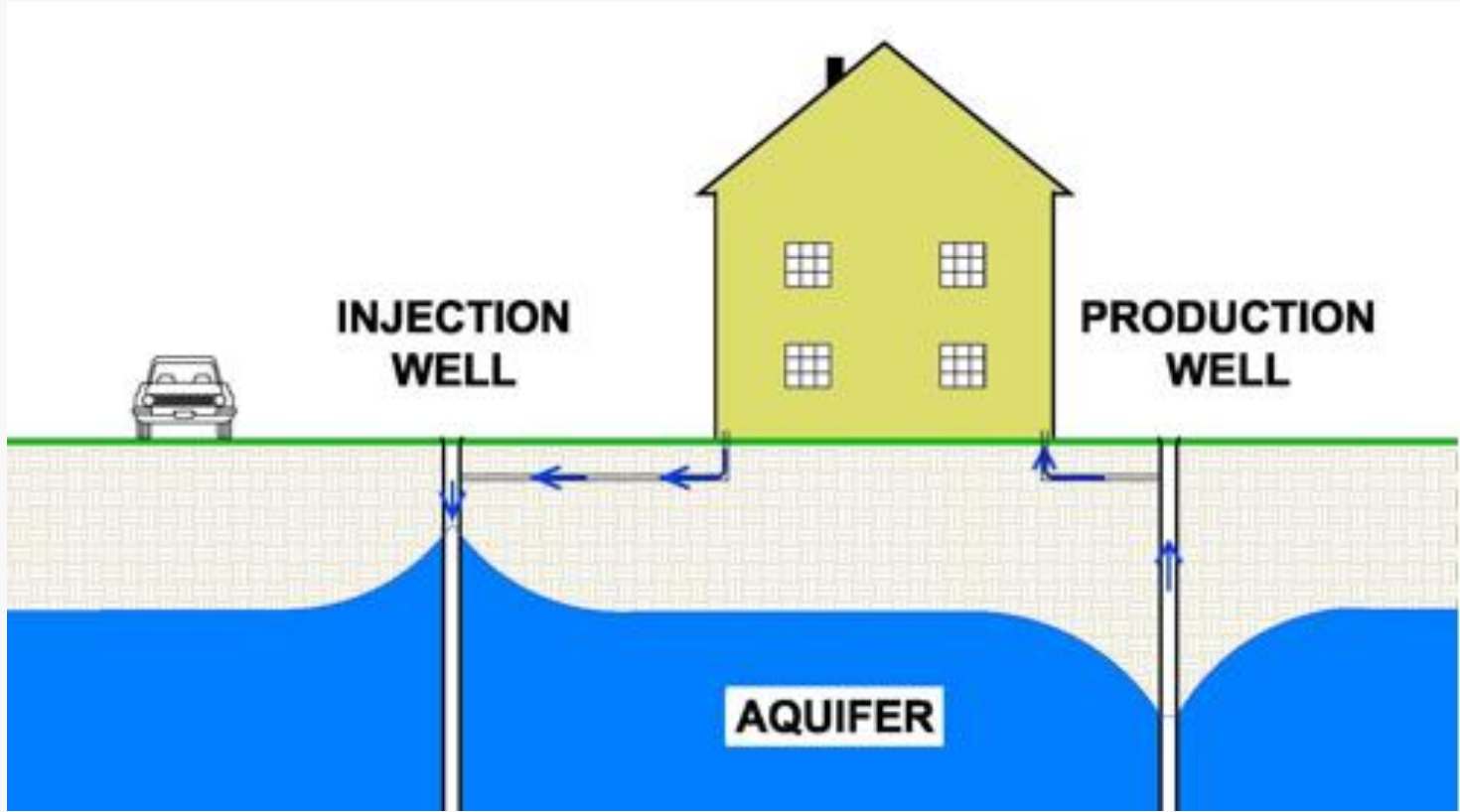
\* Typical Values for Trane Axiom VSV/VSH  
Variable Speed 2- 5 Tons at Full Load.

\*\* Requires Glycol/Brine

# OPEN-LOOP HEAT PUMPS

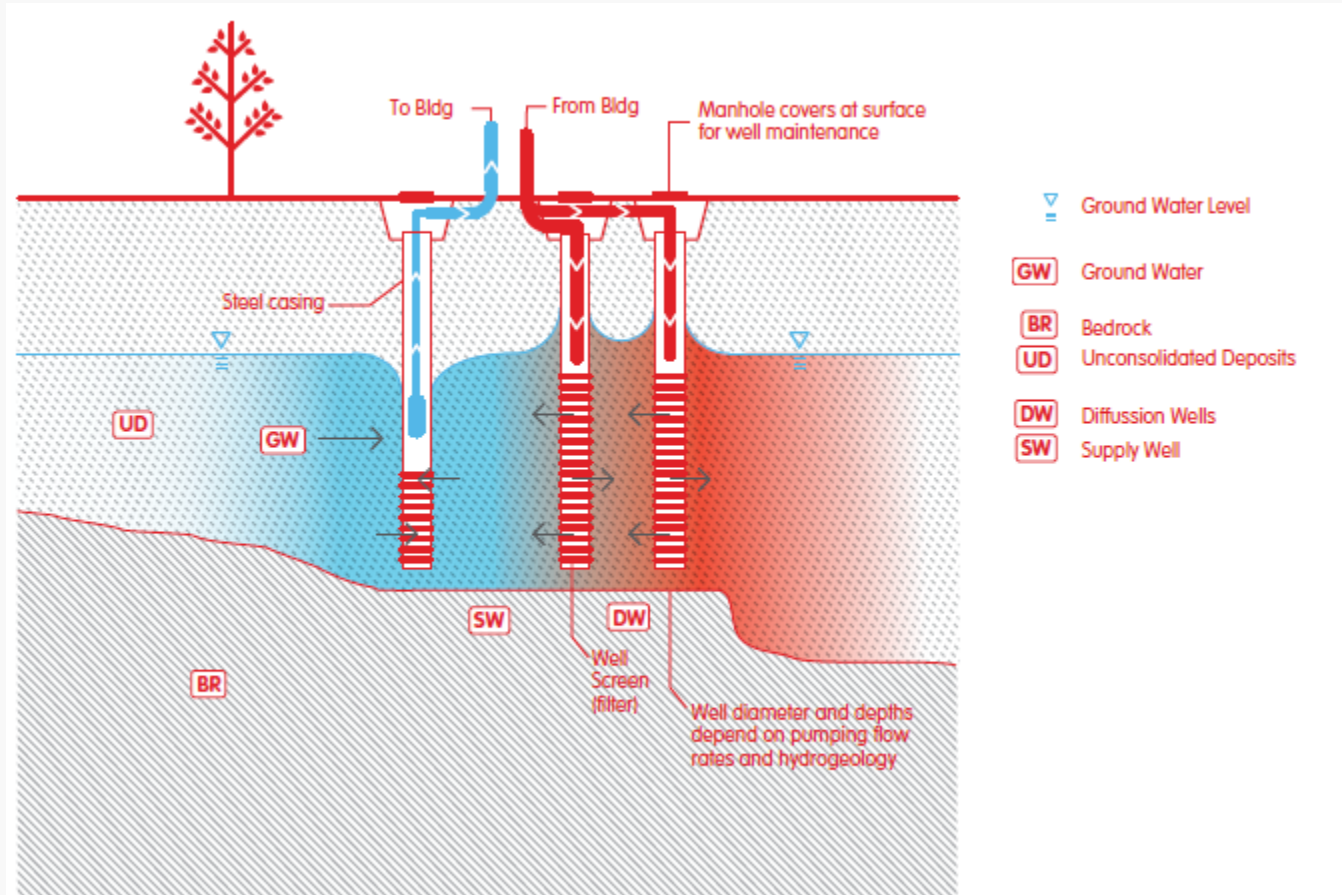






Hydrology Matters

# OPEN-LOOP HEAT PUMPS



Supply Well & Return Wells

## Open Loop Temperatures:

Cooling - 59°F

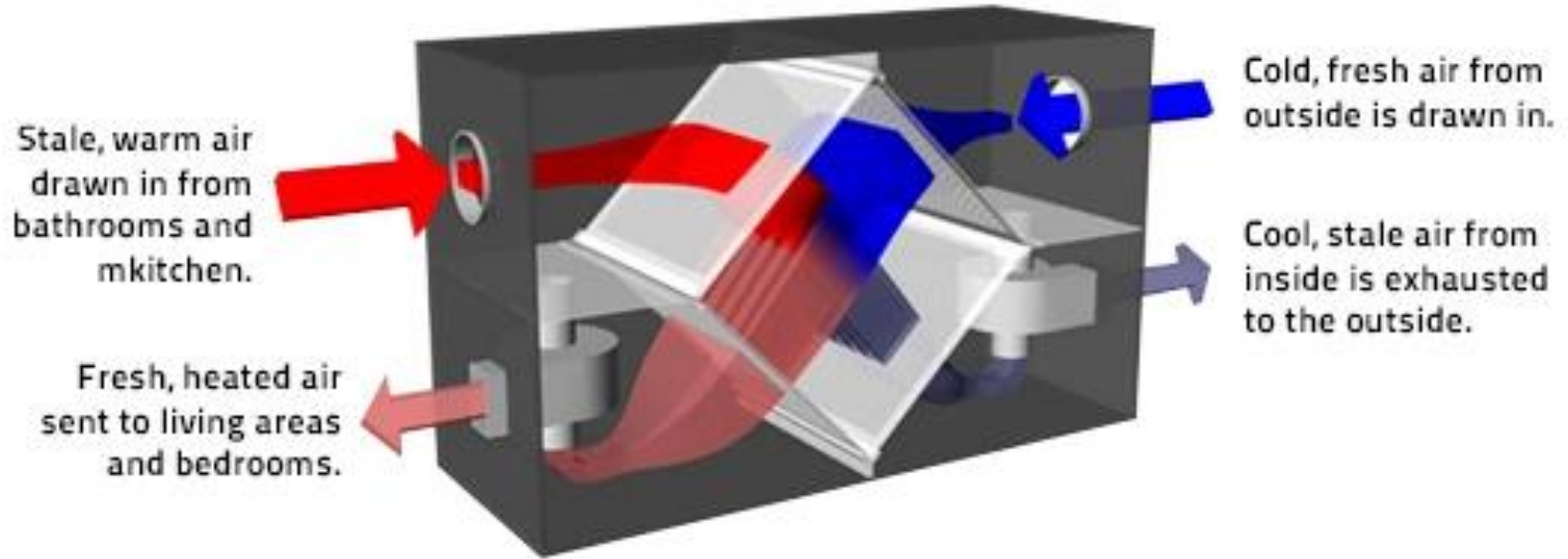
EER ~ 25 to 33\*

Heating - 50°F

COP ~ 5\*

\* Typical Values for Trane Axiom VSV/VSH  
Variable Speed 2- 5 Tons at Full Load.

## How Heat Recovery Ventilators Work



TIGHTLY SEALED HOMES  
NEED OUTSIDE AIR FOR  
INDOOR HEALTH

Job Name

System Reference: DOA-1, DOA-B

Date



## DEDICATED OUTSIDE AIR SYSTEM (DOAS) DESCRIPTION

A CITY MULTI DOAS with reheat capability consists of:

- One PEFY-AF1200CFMR Indoor Unit
- One PURY-P120TK(J)(H)MU or PURY-P120YK(J)(H)MU Outdoor Unit
- One CMB-P108NU-G or CMB-P108NU-G Branch Controller
- One wired remote controller
- Three CMY-R160C-J Joint Adapter

Note: CITY MULTI DOAS can only be a one-to-one, stand-alone HVAC system.

## SPECIFICATIONS

### Capacity\*

Cooling.....	112,000 Btu/h
Heating.....	61,400 Btu/h
Reheat.....	24,200 Btu/h

### Power

Power Source.....	208 / 230V, 1-phase, 60Hz
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### Power Consumption

Cooling (208/230V).....	0.66 / 0.78 kW
Heating (208/230V).....	0.66 / 0.78 kW

### Current

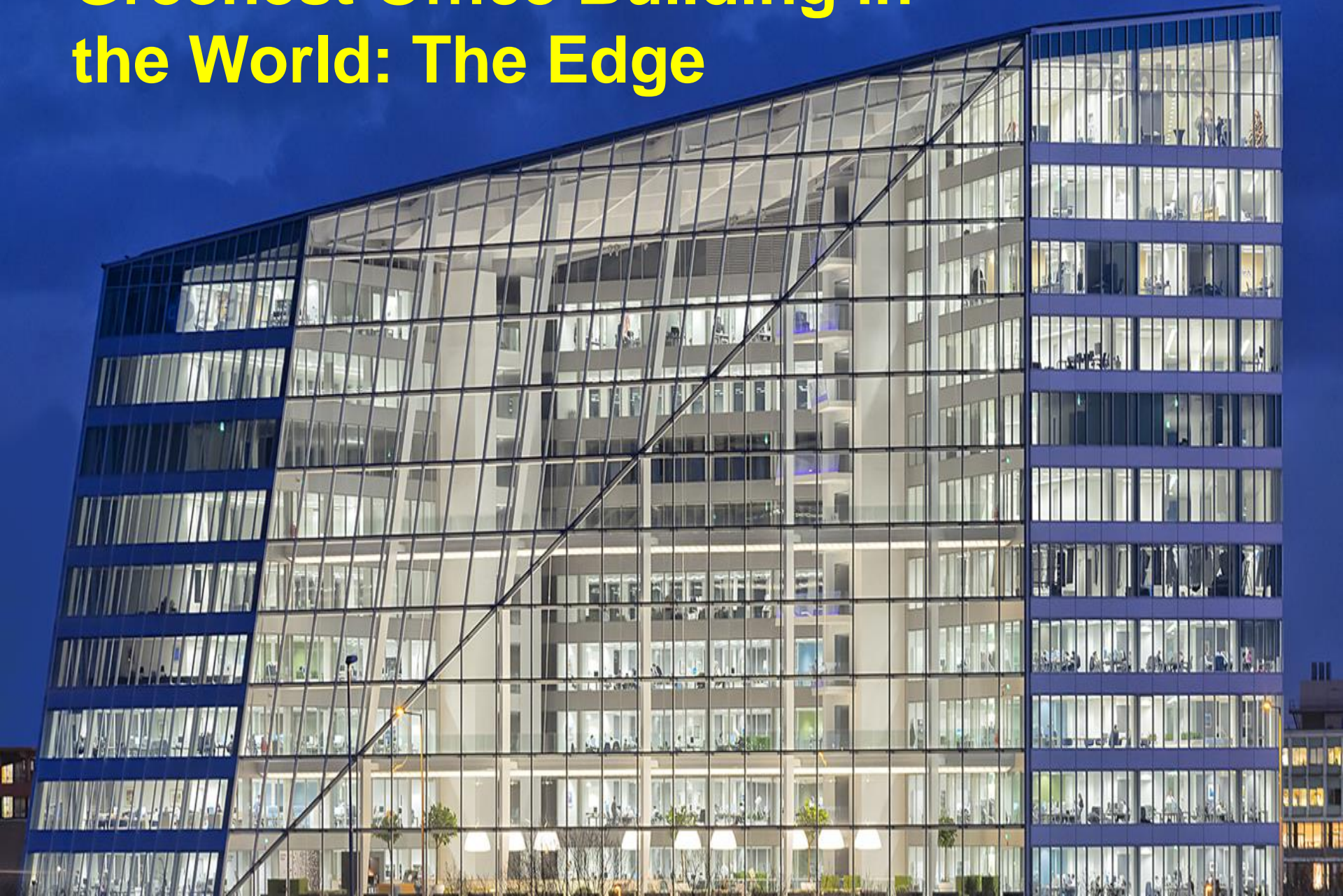
Cooling (208/230V).....	3.19 / 3.45 A
Heating (208/230V).....	3.19 / 3.45 A
Minimum Circuit Ampacity (MCA) (208/230V).....	3.99 / 4.31 A
Maximum Overcurrent Protection (MOCP) Fuse.....	15 A

### Operating Temperature Range

Cooling.....	50° F WB to 95° F WB (109° F DB) (10° C WB to 35° C WB [43° C DB])
Heating.....	-4° F WB to +60° F WB (-20° C WB to +16° C WB)



# Greenest Office Building in the World: The Edge





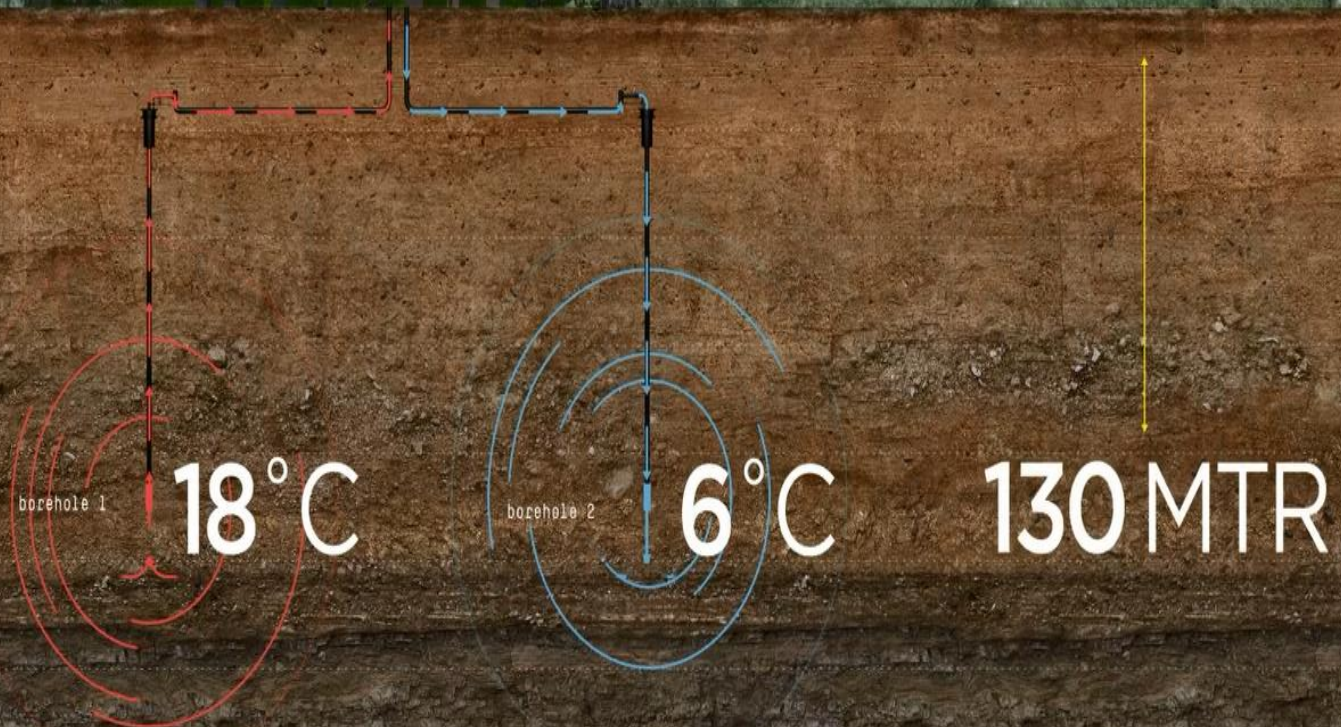
the edge  
office building

zuidas  
amsterdam

sustainable  
and innovative

# NET-ZERO ENERGY

# AQUIFER THERMAL ENERGY STORAGE







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## HEAT PUMPS & ELECTRIFICATION Q&A



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