Sustainability
Speaker Series (S3)

Building Efficiency:
HEAT PUMPS
& ELECTRIFICATION

William Amann, P.E., LEED Fellow
President

Heat Pump Fundamentals

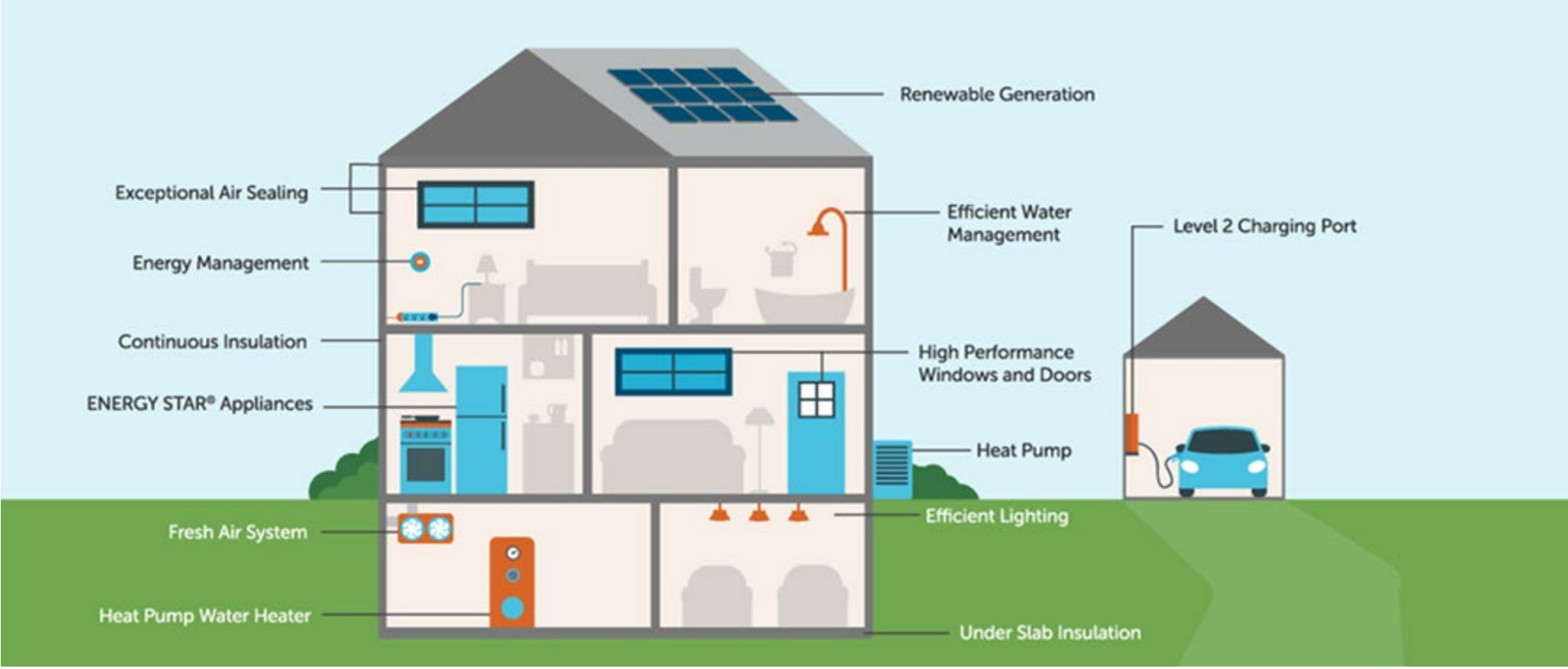
Air-Source Heat Pumps (Incl. Cold Climate)

Water-Source Heat Pumps

Ground-Coupling (Geothermal)

- Closed Loop
- Open Loop

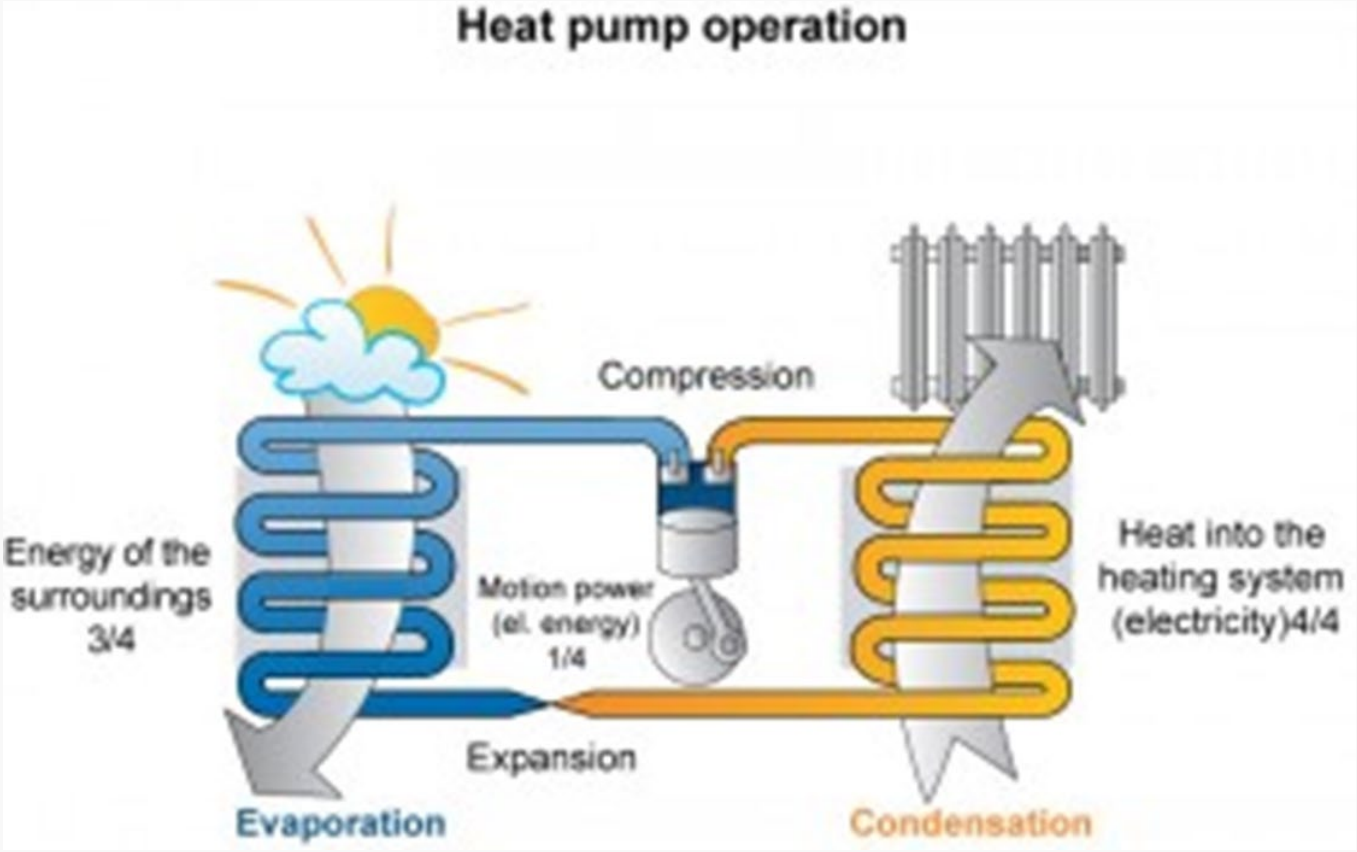
Outside Air Ventilation



BUILDING SECTOR GOALS

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

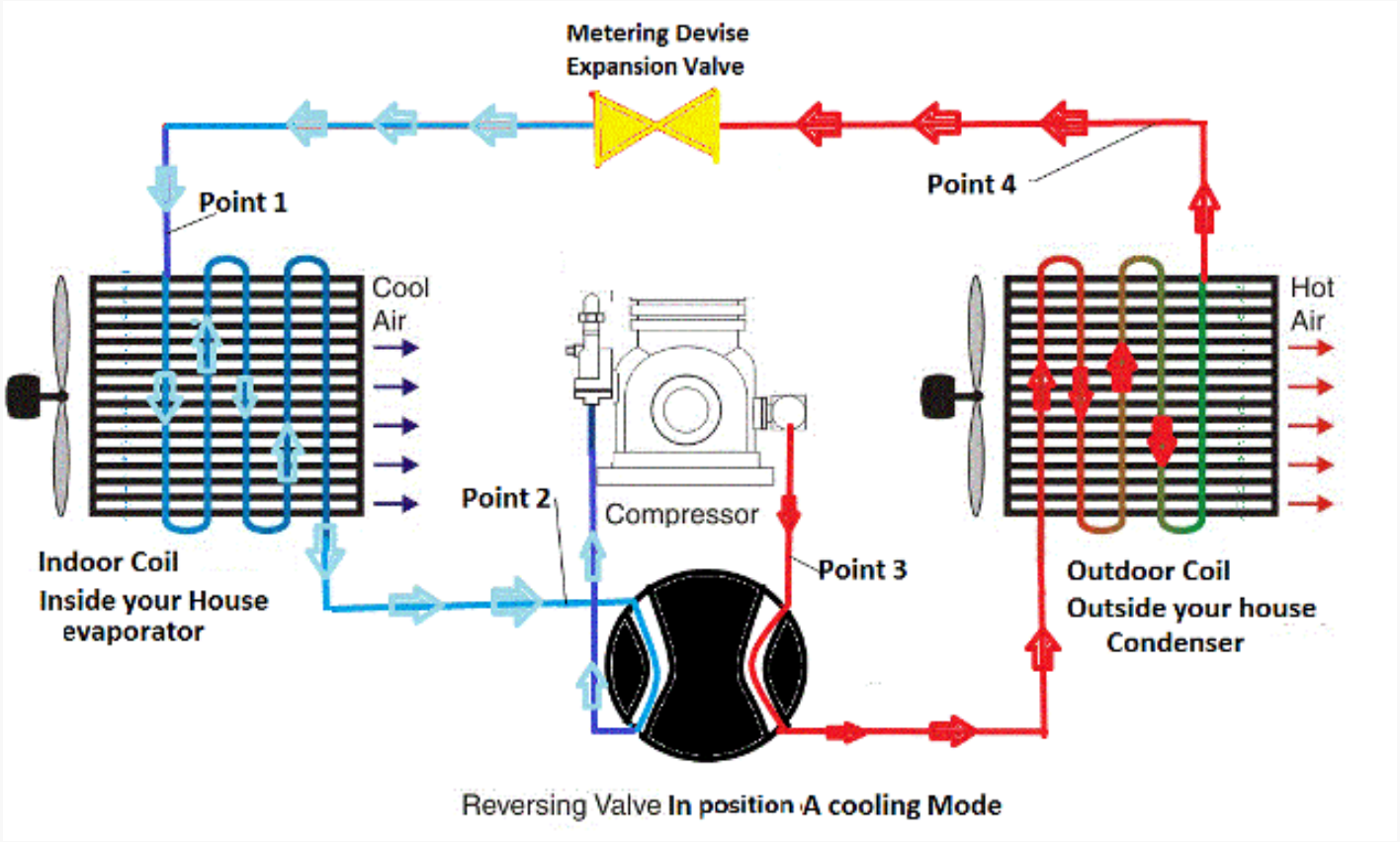
First Law of Thermodynamics:
Energy can be neither created nor destroyed



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

HEAT PUMP FUNDAMENTALS

Heat Pumps “Pump” Heat from one place to another



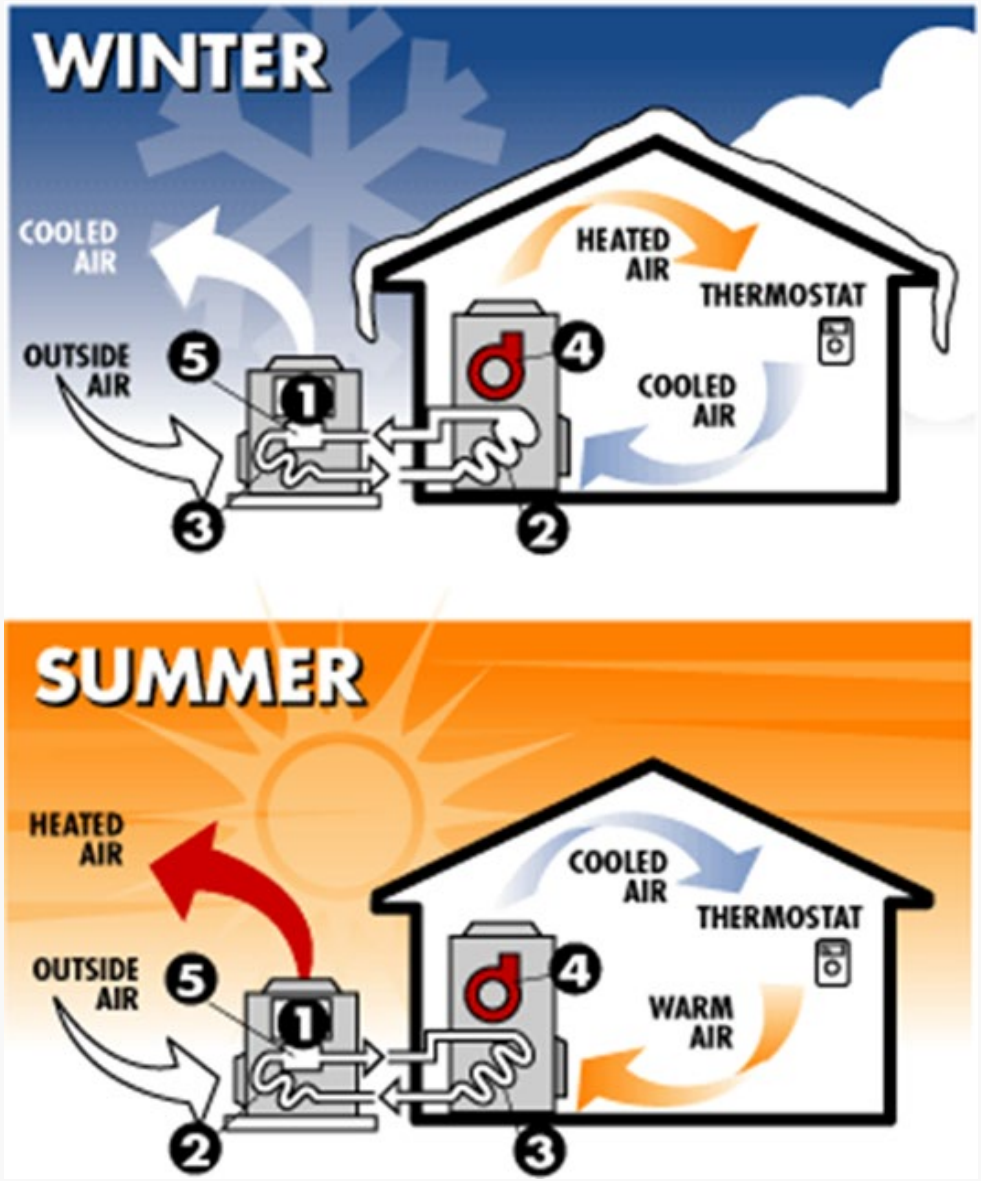
Reversing Valve Reverses the Refrigerant Flow Between the Evaporator and Condenser

AIR TO AIR HEAT PUMPS

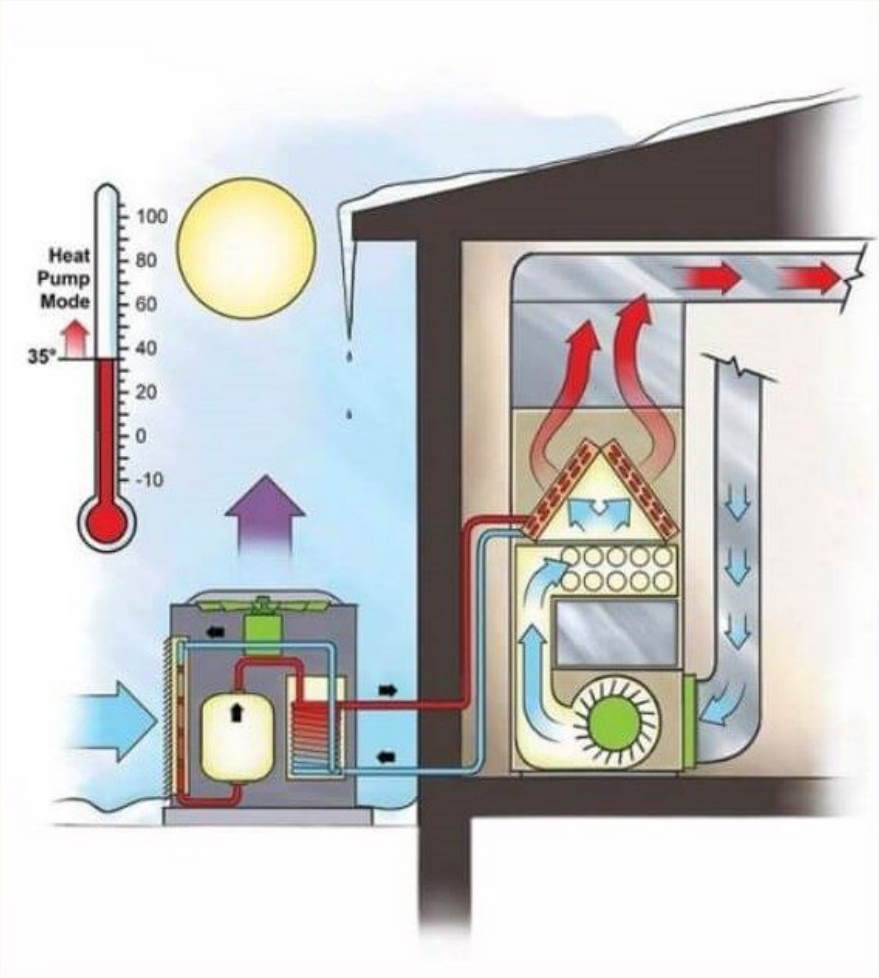
Temperature “Lift”
(Carnot Efficiency)

30ºF - 70ºF
(40º Delta)

75º - 95ºF
(20º Delta)

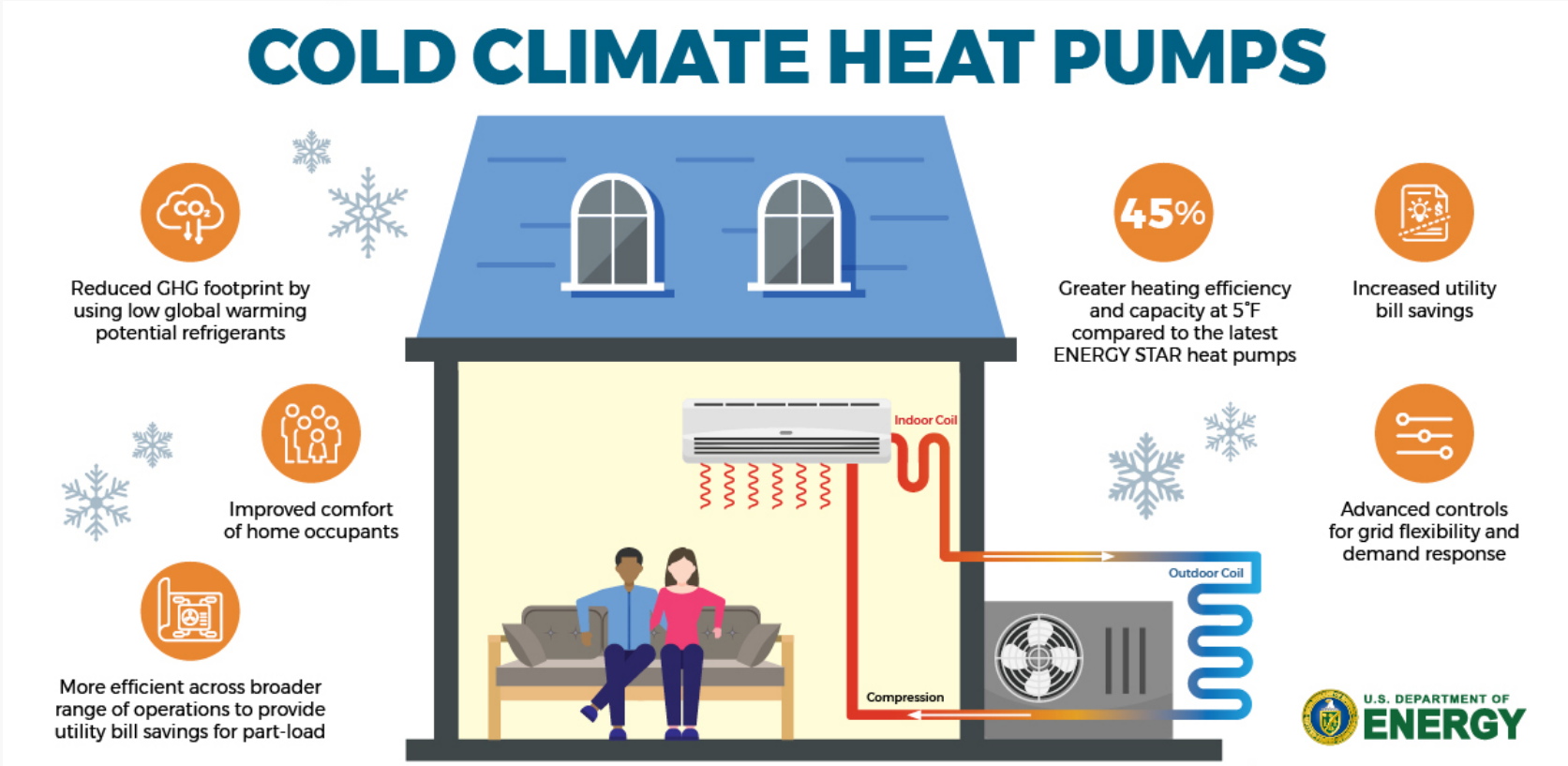


AIR TO AIR HEAT PUMPS



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)

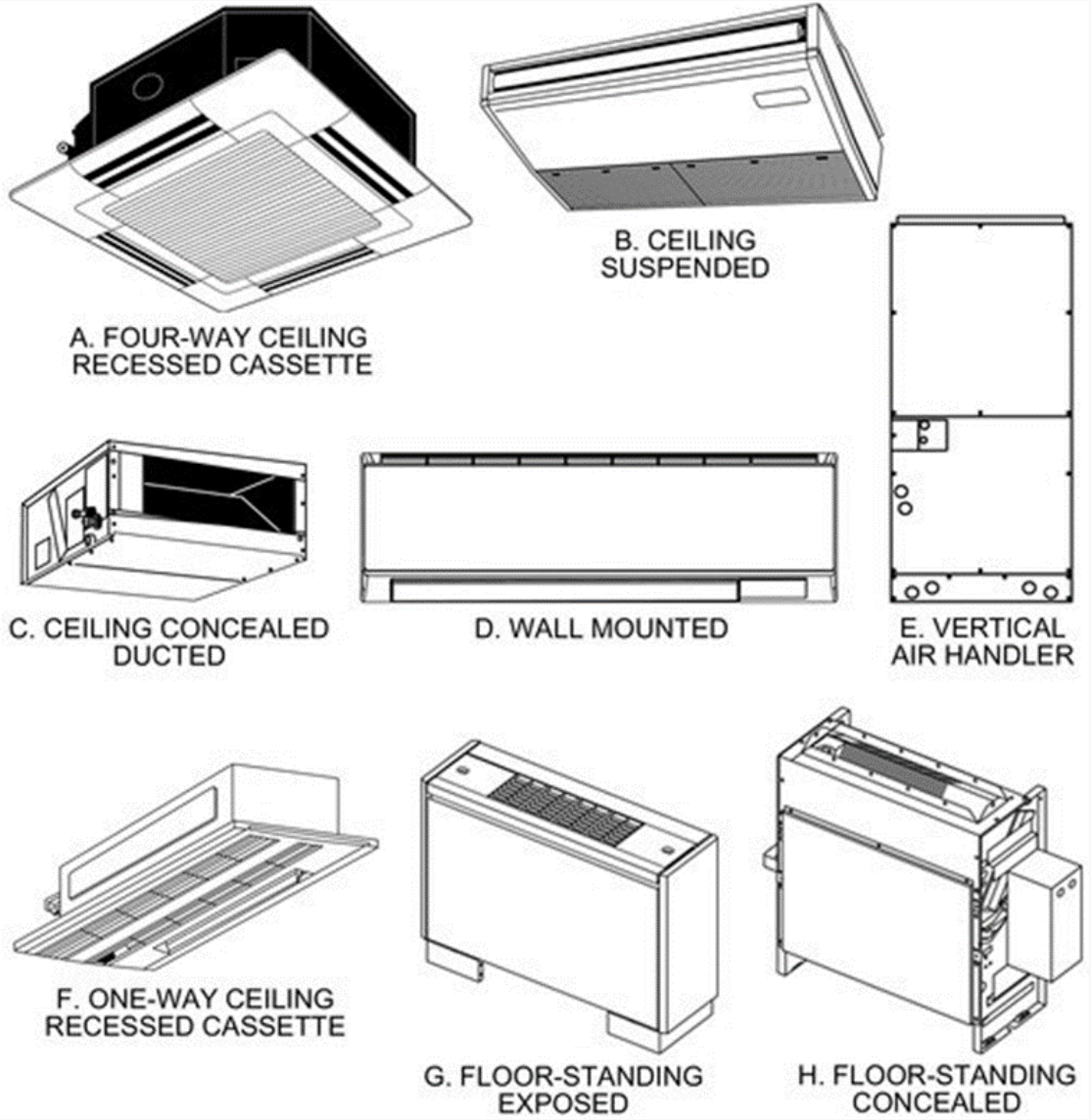
100% Heat Capacity down to 5ºF

Operation down to - 13ºF

ccASHP

OUTDOOR UNITS

INDOOR UNIT STYLES



ccASHP

ccASHP

ccAir Source Heat Pumps

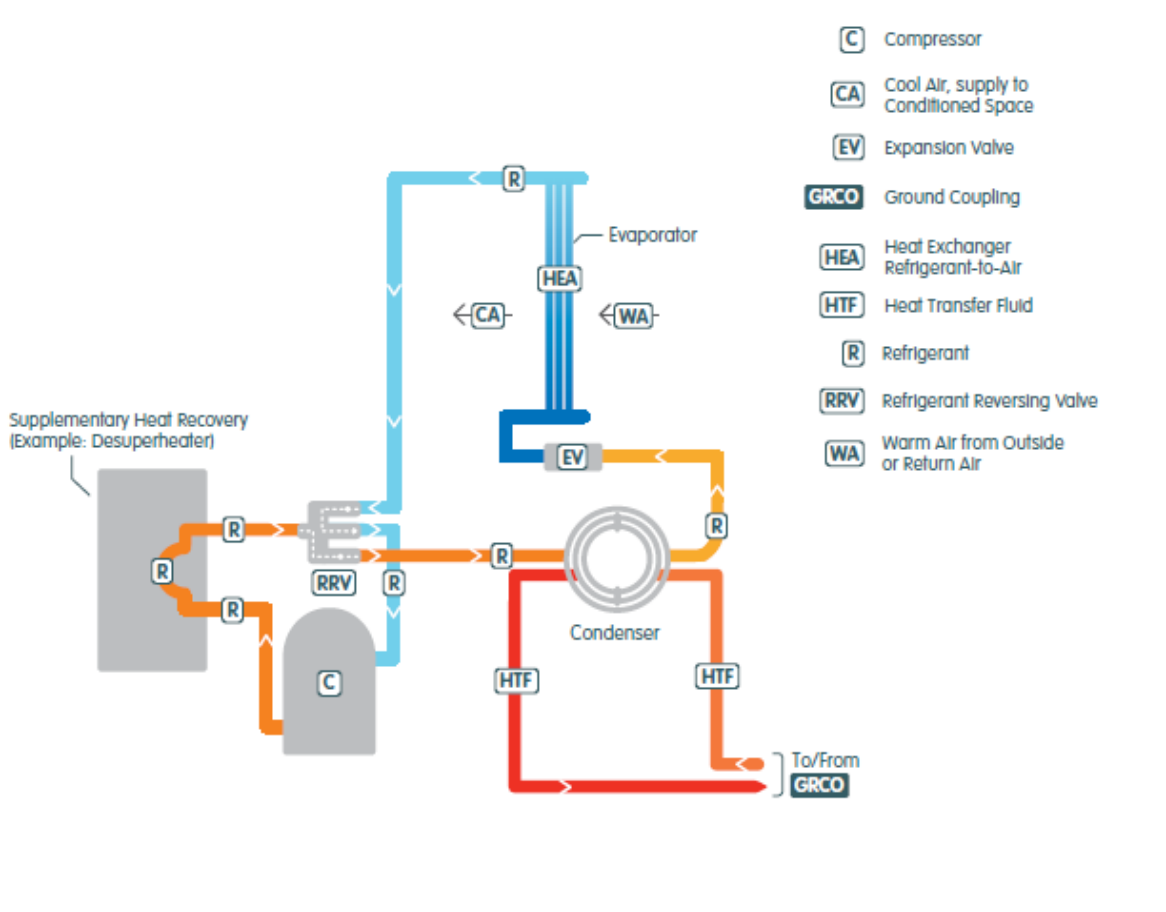
Cooling	EER ~ 15
	SEER ~ 23
Heating at 47ºF	COP ~ 4
	HSPF (Zone 4) ~ 12
	HSPA (Zone 5) ~ 9

EER: Energy Efficiency Ratio
SEER: Seasonal Energy Efficiency Ratio
HSPF: Heating Seasonal Performance Factor

Typical Values for Mitsubishi Hyper-Heat
3-Ton Unit

WATER-SOURCE HEAT PUMPS

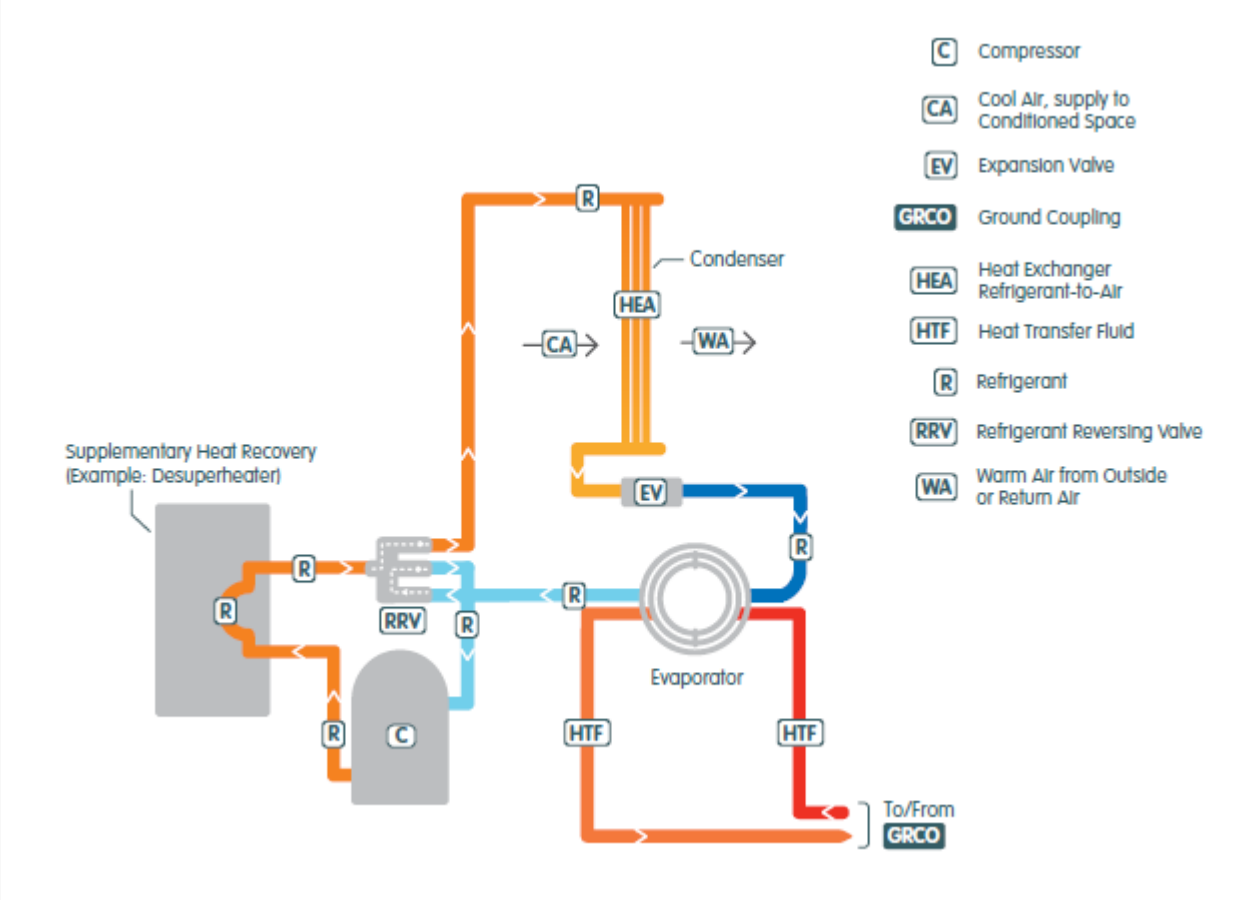
Water to Air – Cooling Cycle



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

WATER-SOURCE HEAT PUMPS

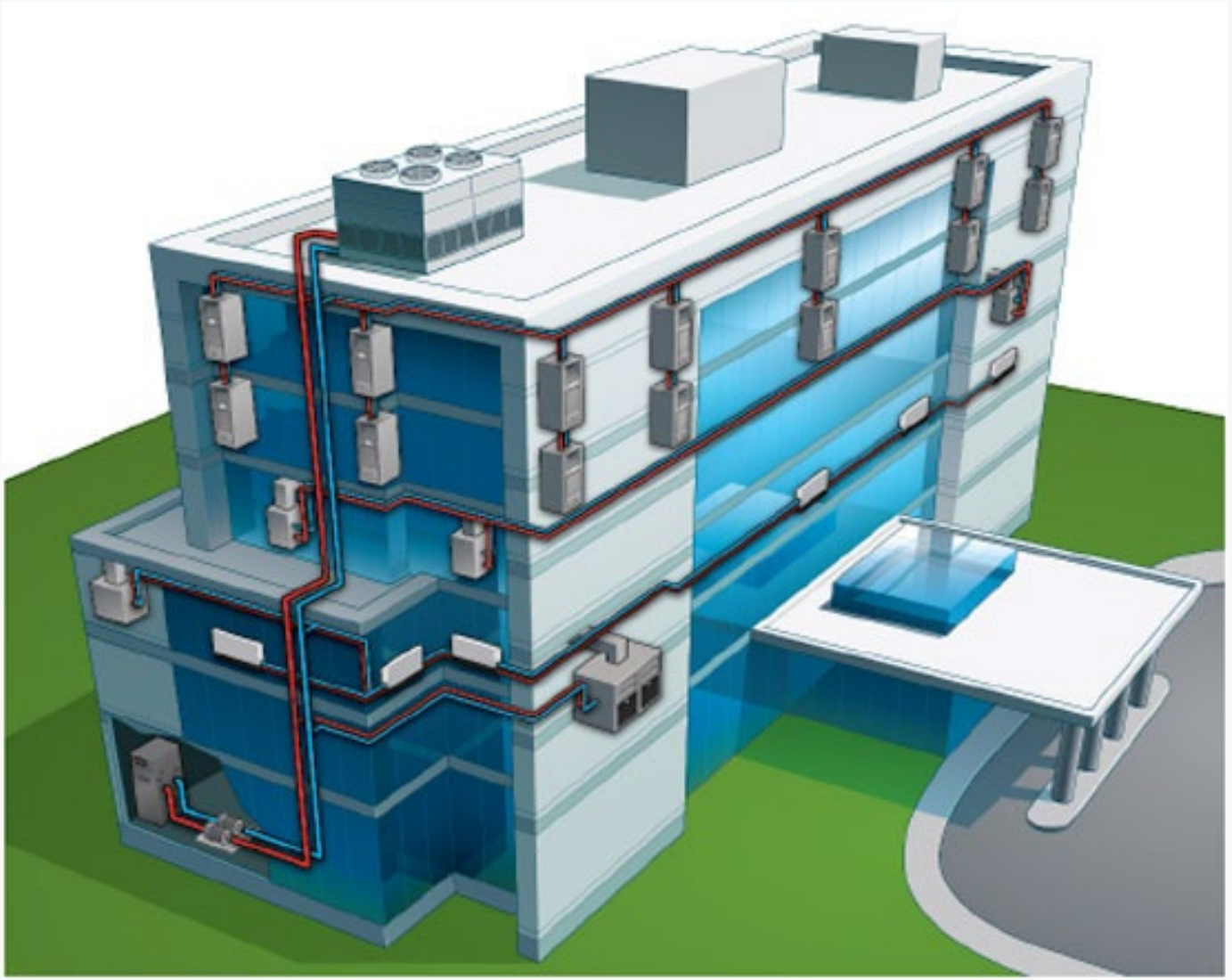
Water to Air – Heating Cycle



WATER-SOURCE HEAT PUMPS

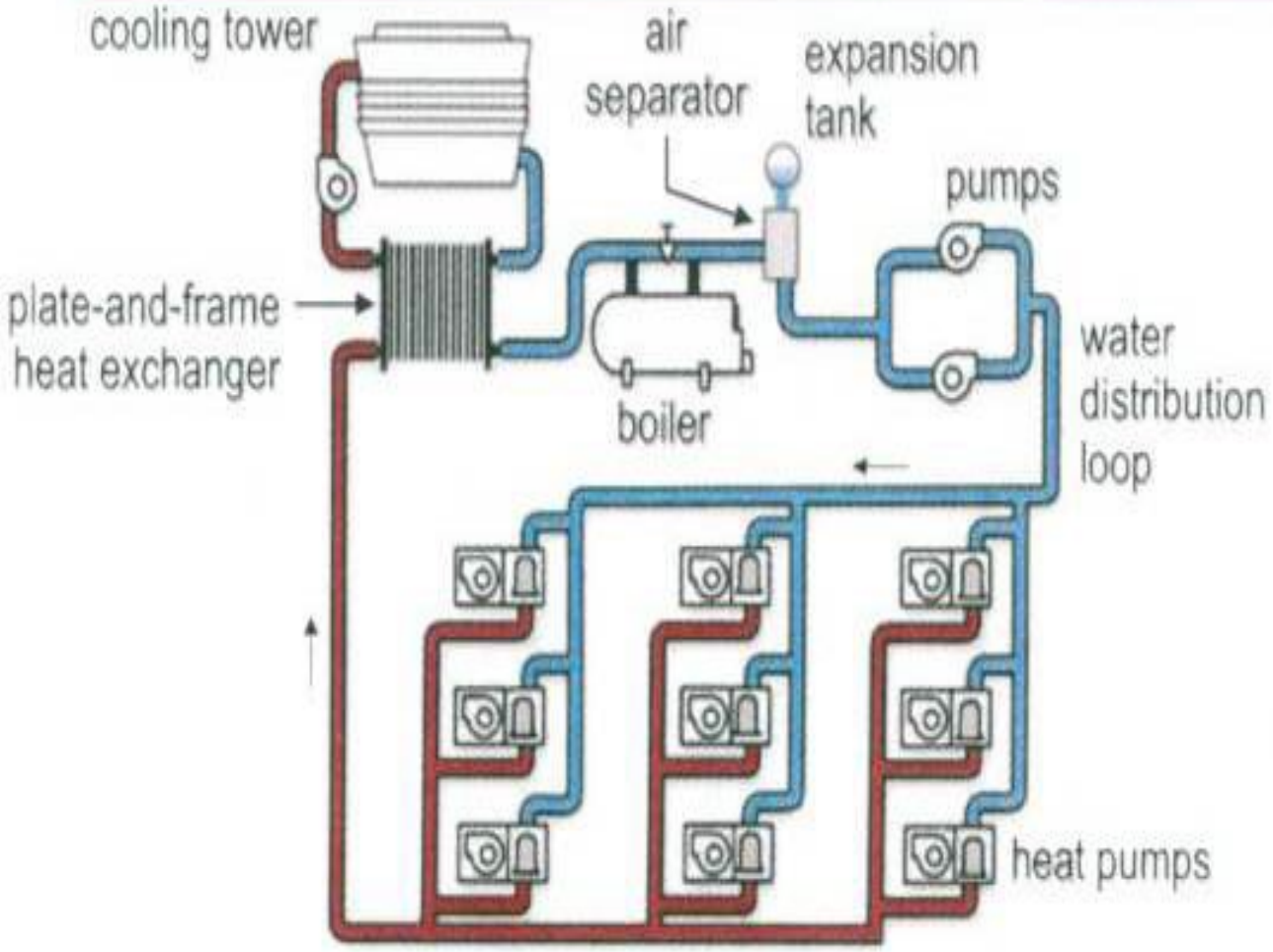
Typical Horizontal and Vertical WSHP Units

WATER-SOURCE HEAT PUMPS



WATER-SOUCE HEAT PUMPS

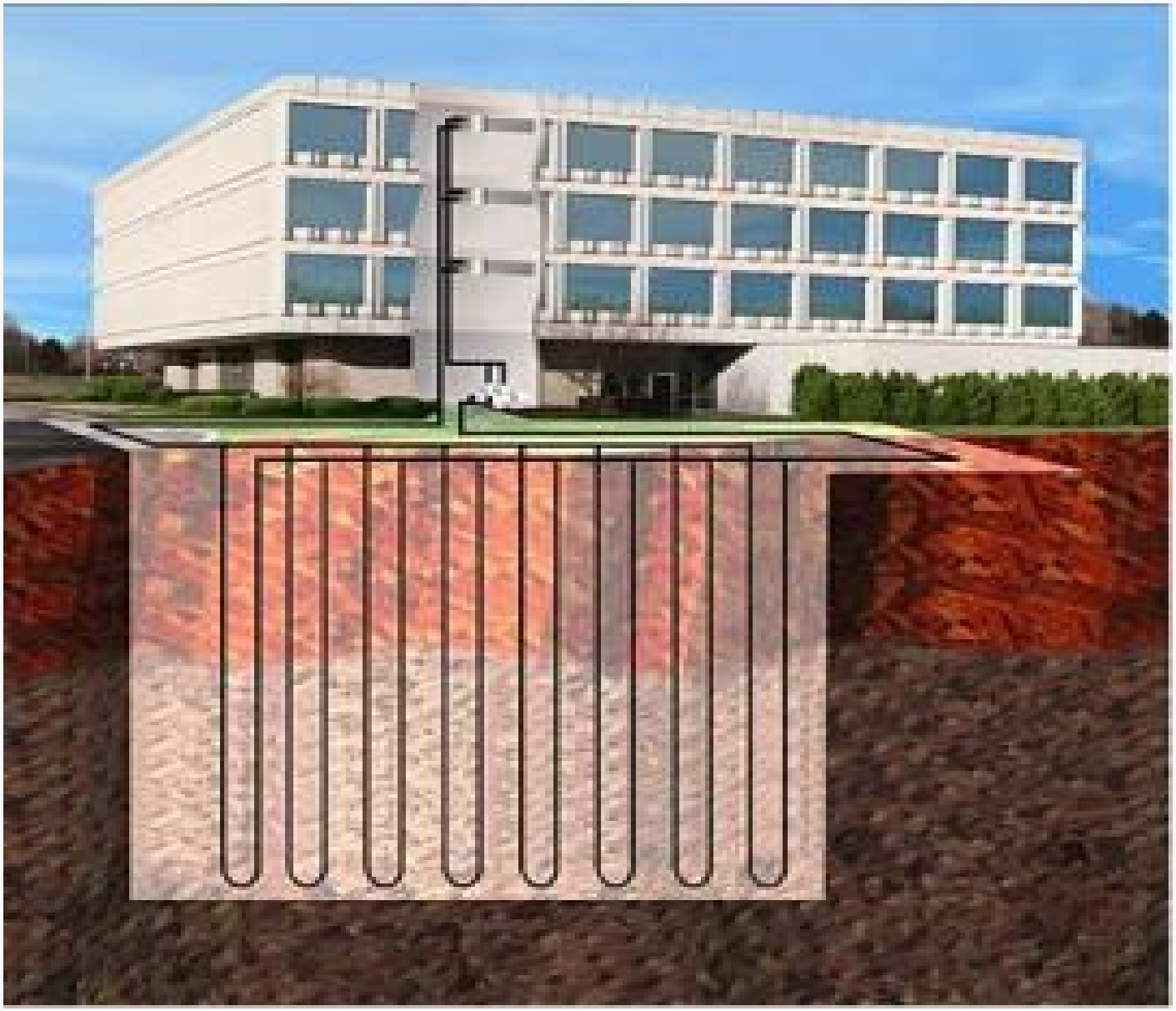
Water-Source Heat Pump System



Water Loop Temperatures:

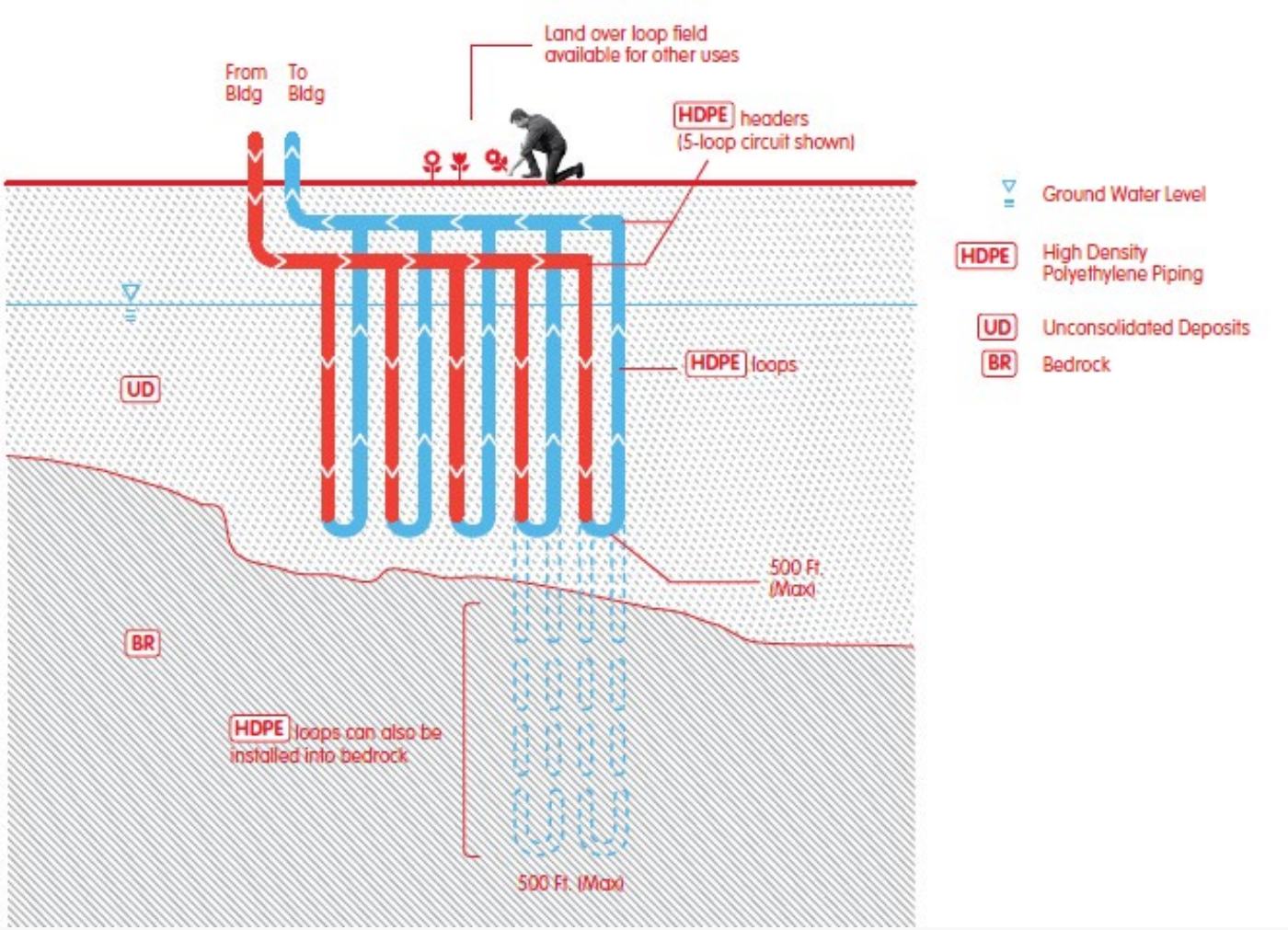
Cooling - 86ºF	EER ~ 15 to 18*
Heating - 68ºF	COP ~ 5 to 6*

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



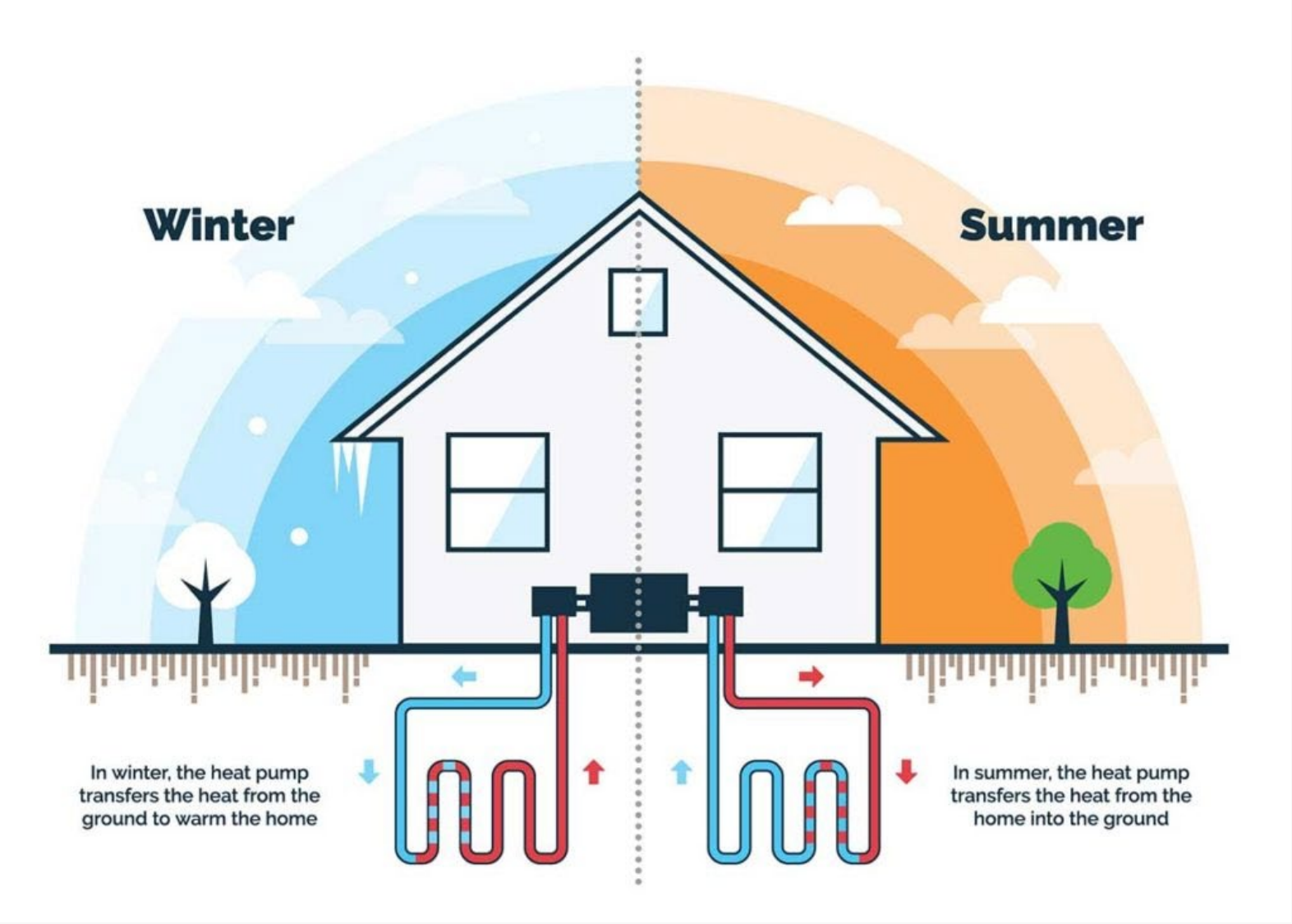
Closed-loop Heat Exchanger

GROUND-COUPLED HEAT PUMPS



Mean Earth Temperature = 55ºF (New Jersey)

GEOTHERMAL HEAT PUMPS



55º - 70ºF

75º - 55ºF

Ground-Coupled Closed Loop Temperatures:

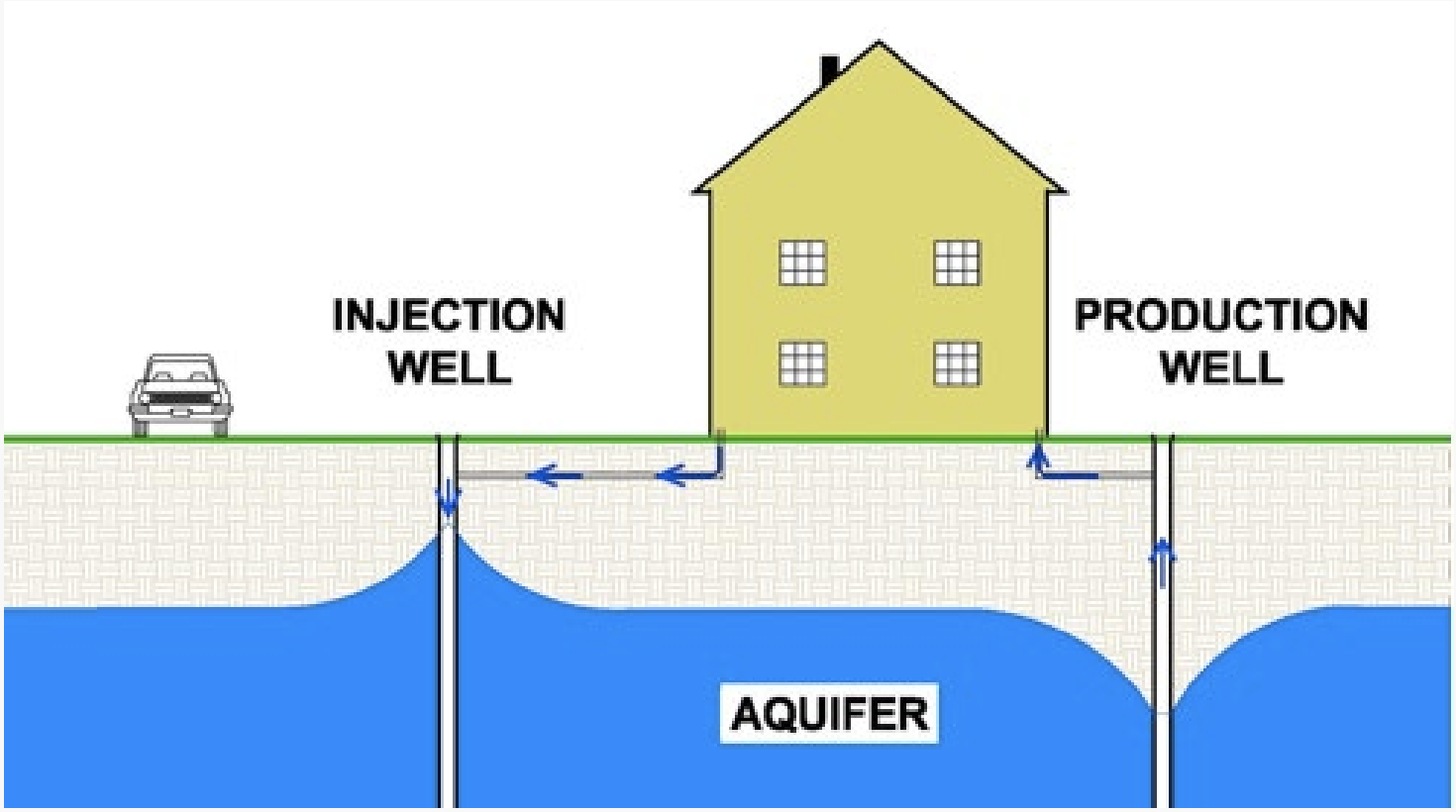
Cooling - 77ºF	EER ~ 18 to 22*
Heating - 32ºF**	COP ~ 4*

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

** Requires Glycol/Brine

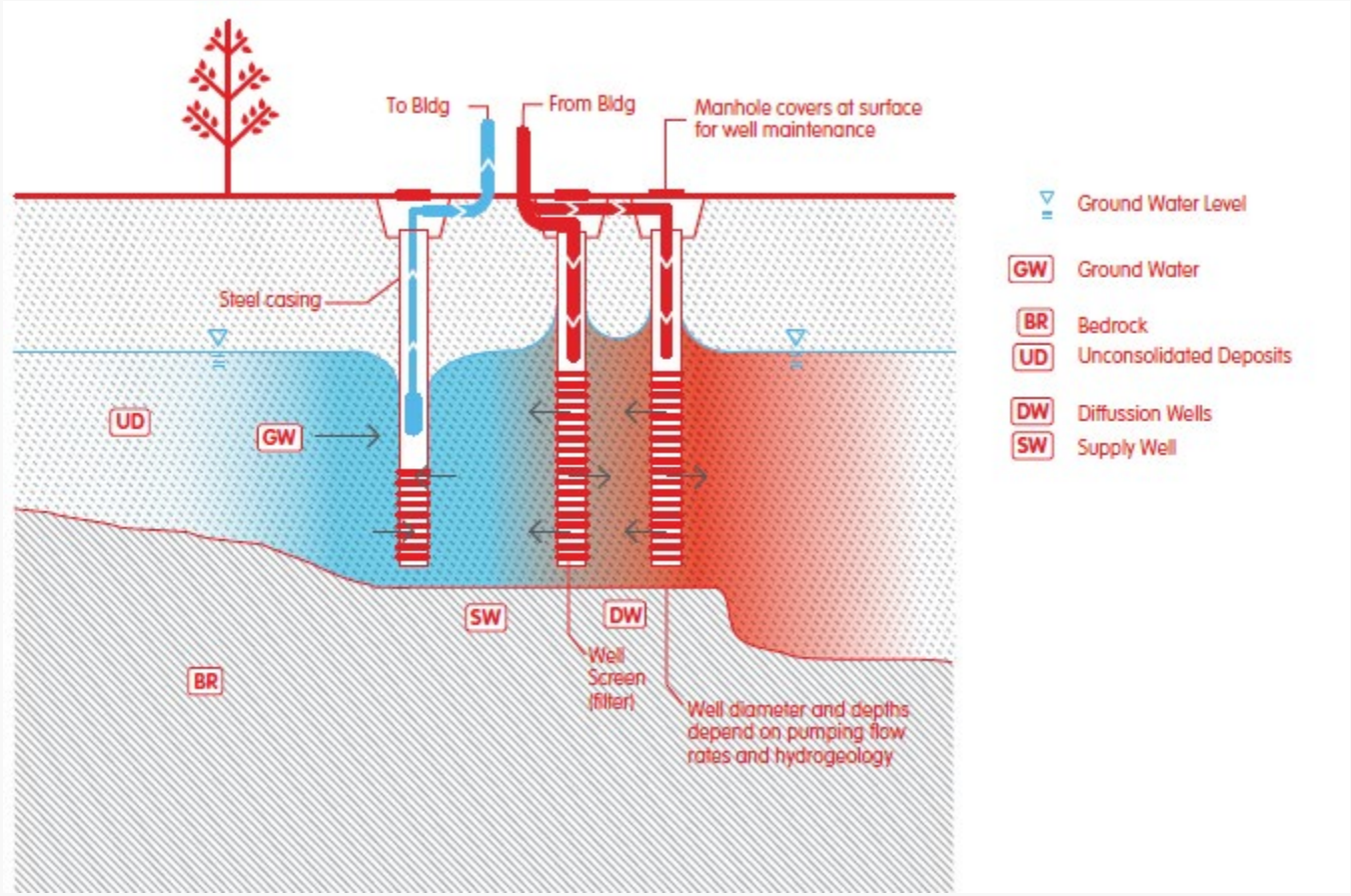
OPEN-LOOP HEAT PUMPS

OPEN-LOOP HEAT PUMPS



Hydrology Matters

OPEN-LOOP HEAT PUMPS



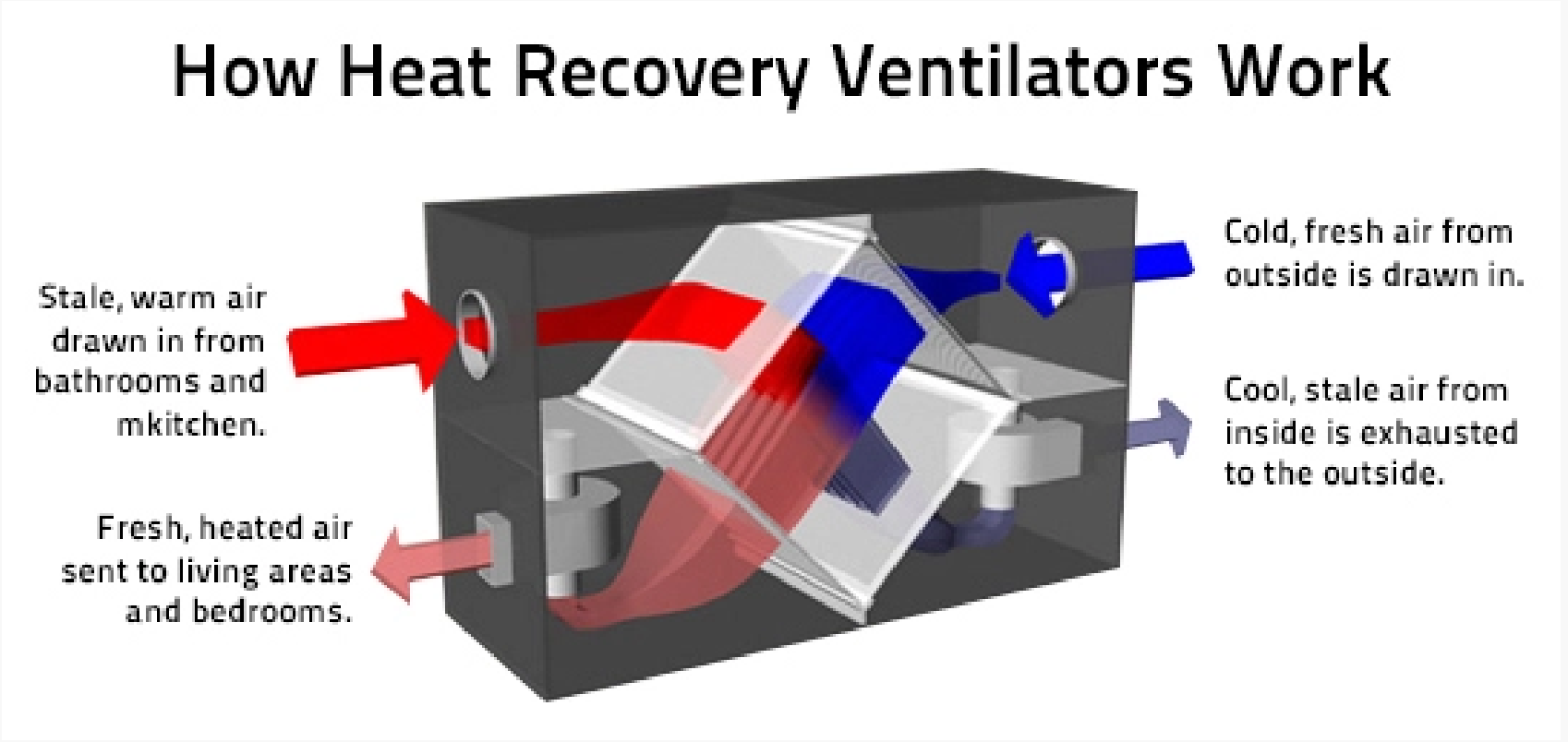
Supply Well & Return Wells

Open Loop Temperatures:

Cooling - 59ºF	EER ~ 25 to 33*
Heating - 50ºF	COP ~ 5*

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

ENERGY RECOVERY VENTILATOR



TIGHTLY SEALED HOMES
NEED OUTSIDE AIR FOR
INDOOR HEALTH

DEDICATED OUTSIDE AIR SYSTEM

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-P106NU-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

Power Consumption

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

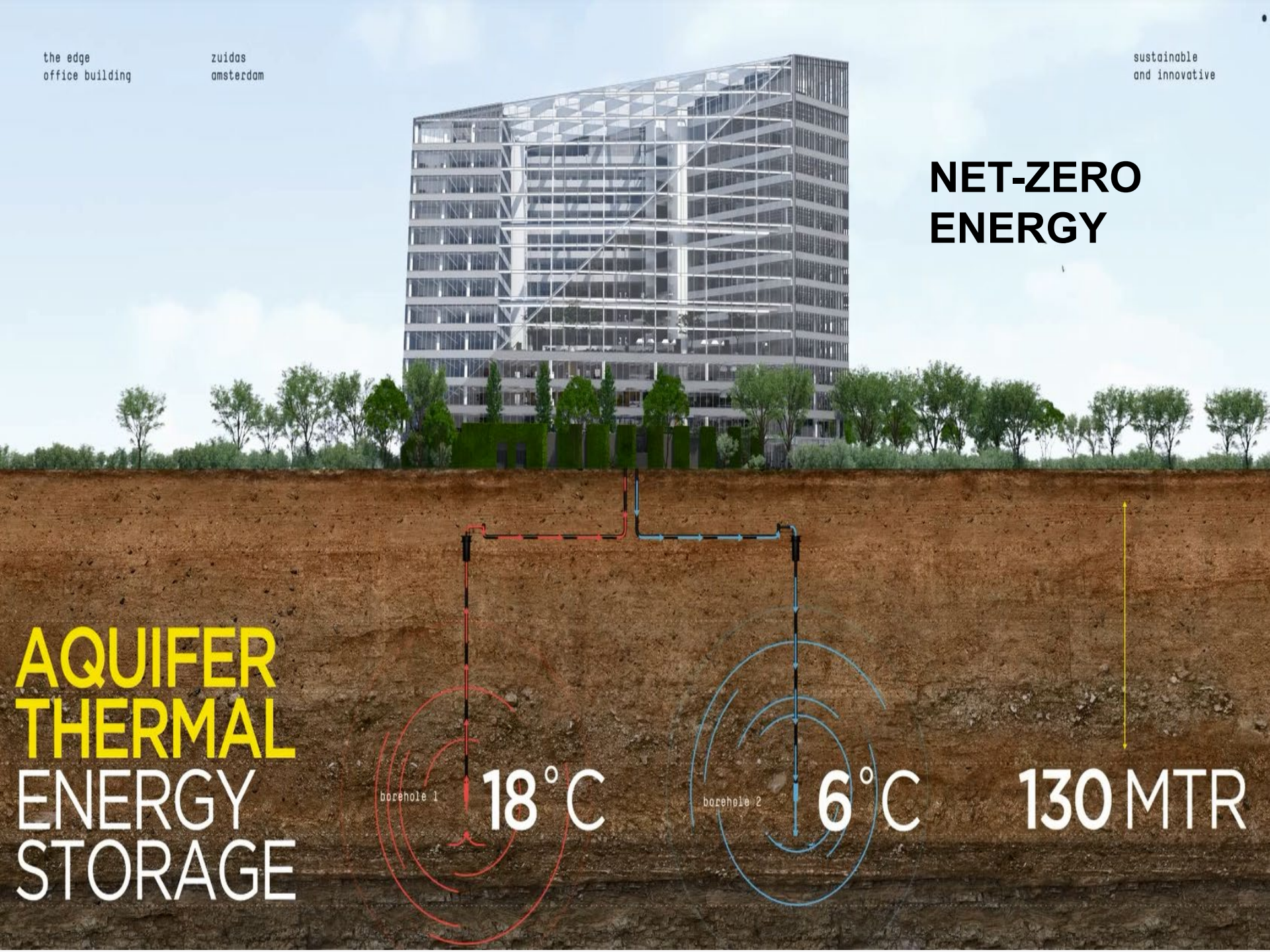
Current

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
borehole 1
18°C
borehole 2
6°C
130 MTR

Sustainability
Speaker Series (S3)

HEAT PUMPS & ELECTRIFICATION Q&A

William Amann, P.E., LEED Fellow
www.MEengineers.com
(908) 526-5700