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Energy Industry Fundamentals

Introduction to Natural Gas Heat Pumps

Eric Burgis, Energy Solutions Center

This unit is part of Energy Solutions Center's: Energy Industry Fundamentals Training Program

Topics

- Heat Pump Overview & Terminologies
- How Heat Pumps work
- Gas Heat Pumps (GHP)
- Efficiencies & Economics
- Environmental Benefits
- GHP Products
- GHP Resources

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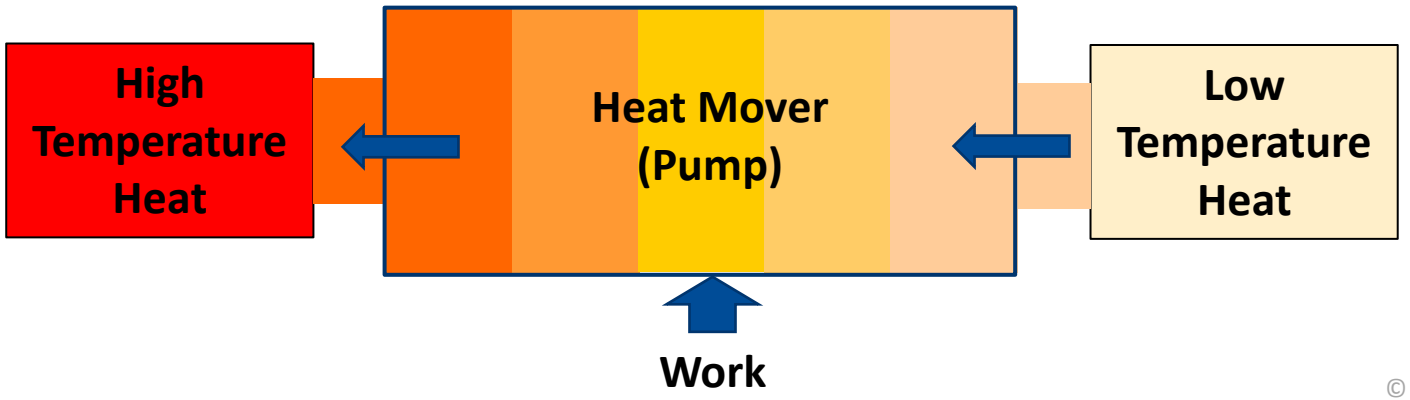
What is a “Heat Pump”

- Device that transfers thermal energy from a heat source to a heat sink
- Move thermal energy in a direction which is opposite to the direction of spontaneous heat flow
- A heat pump uses energy to accomplish the desired transfer of thermal energy from heat source to heat sink and vice versa based on winter or summer operation



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Why Use Gas Heat Pumps

Natural gas heat pumps have system efficiencies that exceed the traditional 100% barrier and offer pathways to substantially reduce greenhouse gas emissions across various climates for residential, commercial & industrial space and water heating.

Advantages of gas heat pumps include:

- GHPs reduce peak electric demands on the grid:
  - Reduce electricity grid demand, congestion & constraints
  - Avoid potential electrical infrastructure upgrades
- GHPs offer environmental benefits:
  - Typically has lower emissions than conventional HVAC
  - Ability to operate on RNG and hydrogen blends and play a key role in reducing emissions to further help reach net-zero goals
  - Some models to operate without the use of harmful refrigerants (No Global Warming Potential)

…continued

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Why Use Gas Heat Pumps….continued

Other GHP features:

- Save consumers money by lowering operating costs as compared to existing gas heating equipment or EHPs
- Higher performance in cold climates because GHPs use gas combustion to deliver the majority of the system's heating load
- Some GHPs provide cooling as well as heating
- Can be 'plug and play' with existing ductwork
- Fit under policy initiatives to adopt technologies with system efficiencies over 100%.

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Cooling System Efficiency Terminology

- Coefficient of Performance – (COP) is the ratio of the heat removed from the cold reservoir to input work (**Output ÷ Input**)
- Seasonal Energy Efficiency Ratio (SEER) = BTU/hr ÷ Watts for Unitary Systems
- Heating Seasonal Performance Factor (HSPF) - ratio of heat output (measured in BTUs) over the heating season to electricity used (measured in watt-hours)
- KW/Ton for Electric Chillers
- Gas Utilization Efficiency (GUE) is the ratio of the energy supplied by a gas-fired heat pump or boiler to the energy consumed by the burner

Note: there is no one standard test method for all systems.

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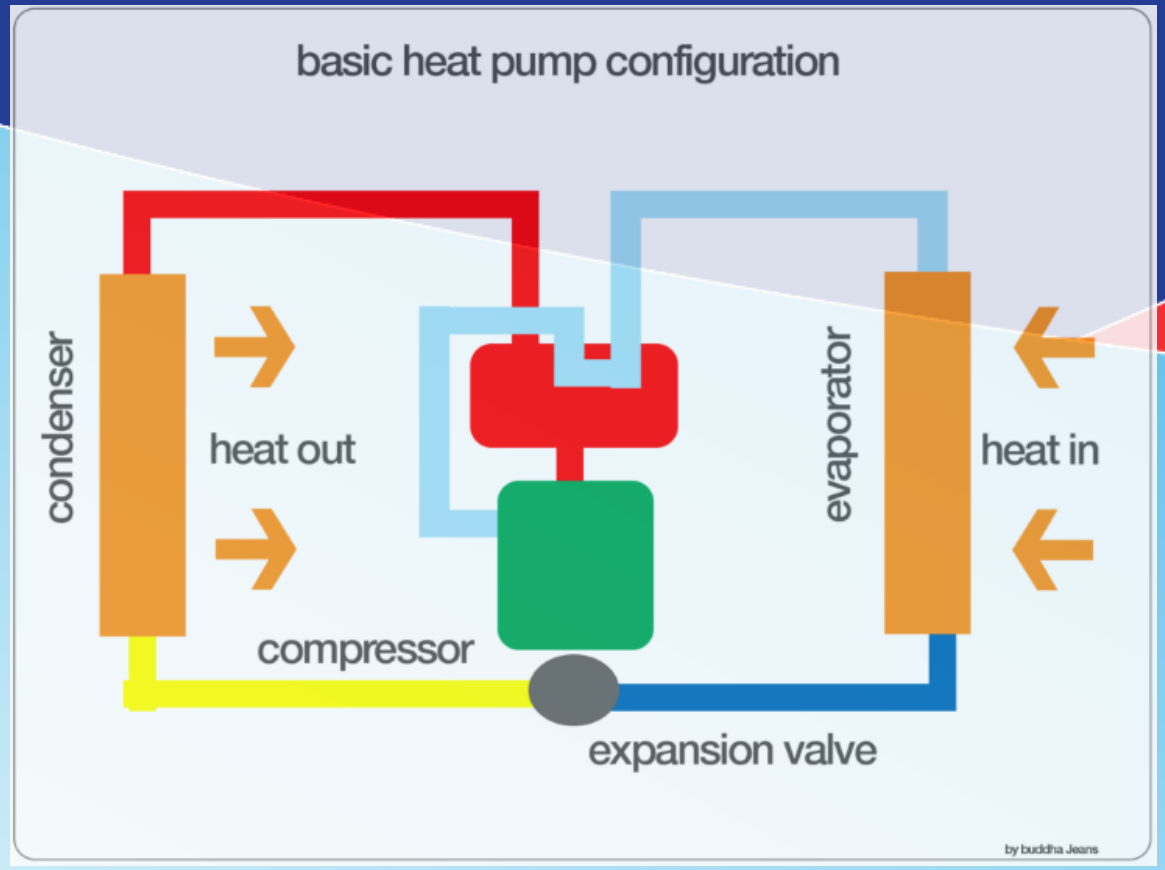
How Heat Pumps Work

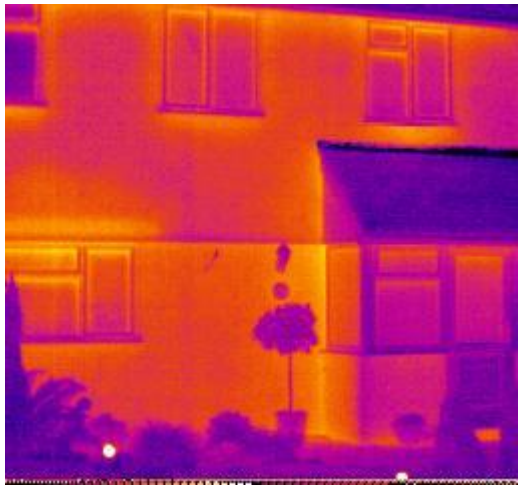


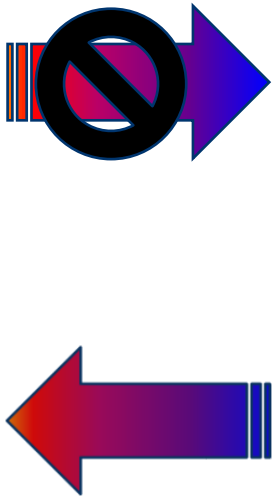
How Heat Pumps Work

How they “trick” nature

Thermodynamic Laws

Heat flows naturally from a **higher-temperature** region to a **lower-temperature** region





Indoor : 72°F (22°C)

Outdoor: -8°F (-22°C)

Heat Pump

They “trick” nature by using **low-temperature** heat (outdoor) and transferring it to a **high-temperature** region (indoor)

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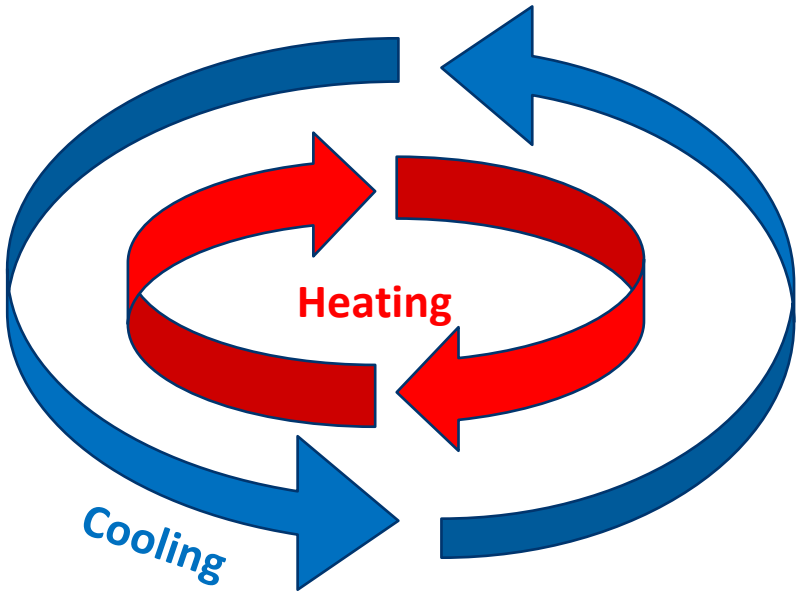
How it Works in Heating Mode

Vapor Compression for Electric and Gas Engine Heat Pumps

- Refrigerant flow is reversed via a valve in the system
  - Reversing valve rotates 90°
  - Changes the direction of the flow of the refrigerant
  - Flow is in the opposite direction – the reverse of the cooling cycle



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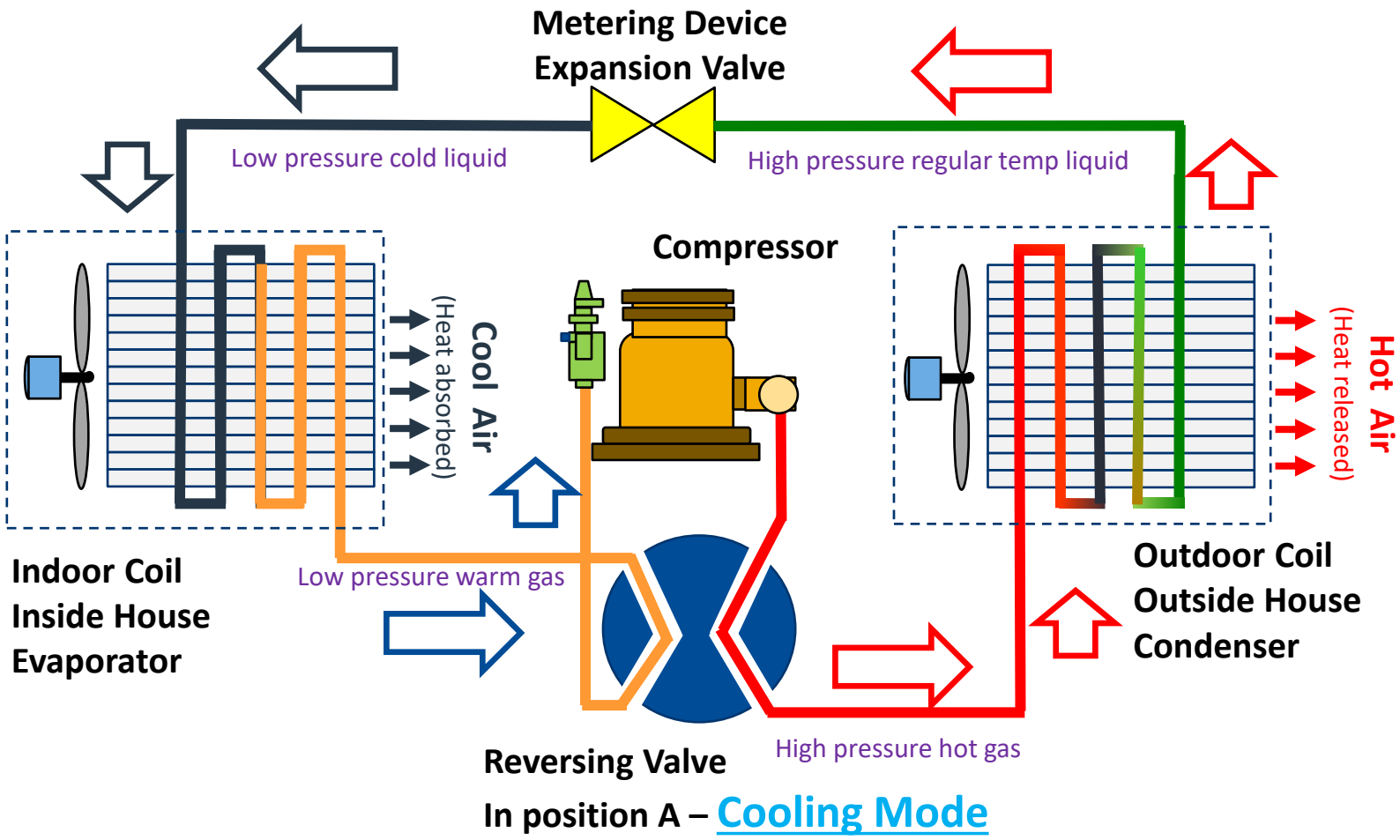
Air Source System in Cooling Mode
(Typical Electric Air Conditioning)



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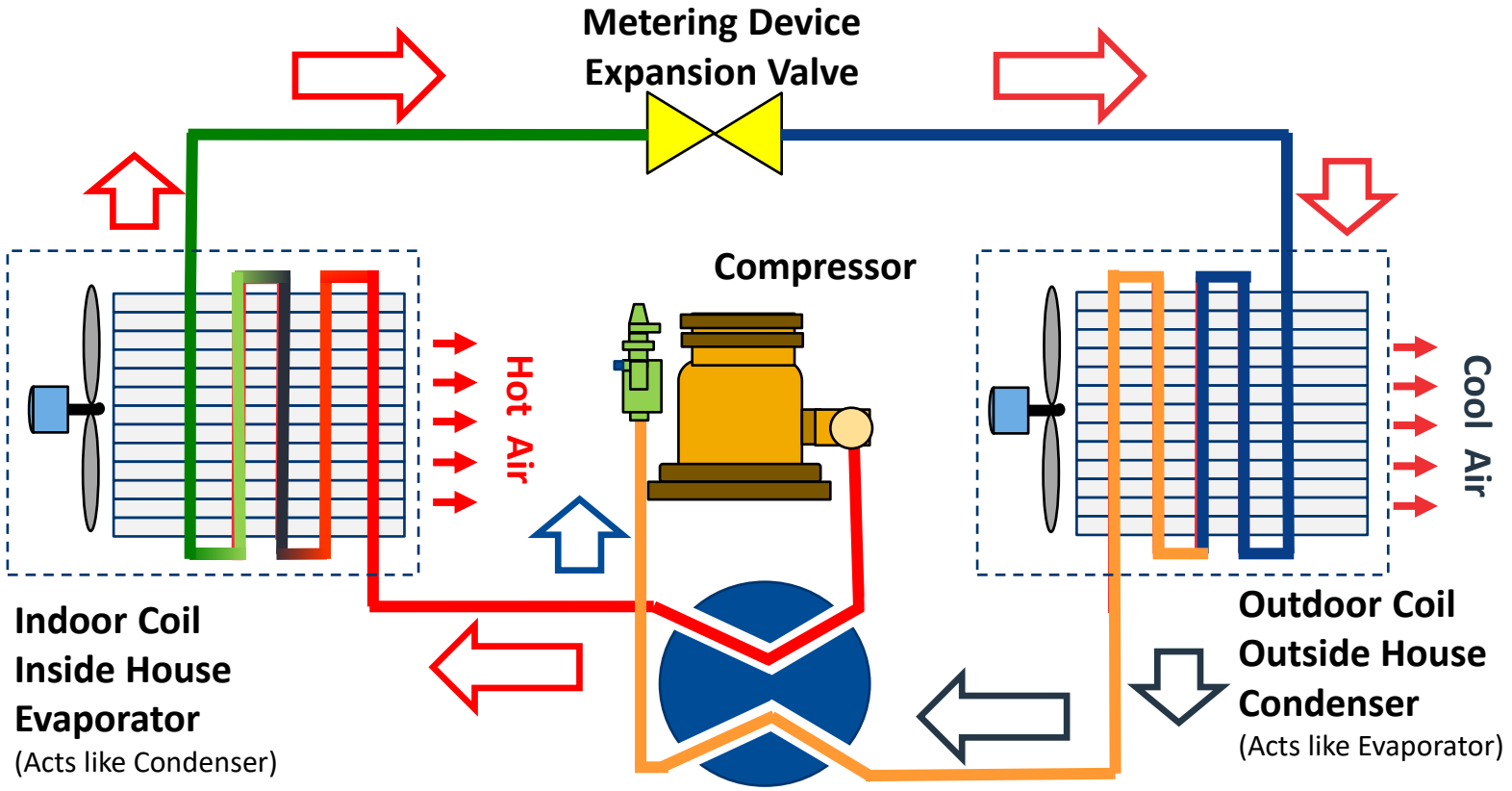
Air Source Heating Mode



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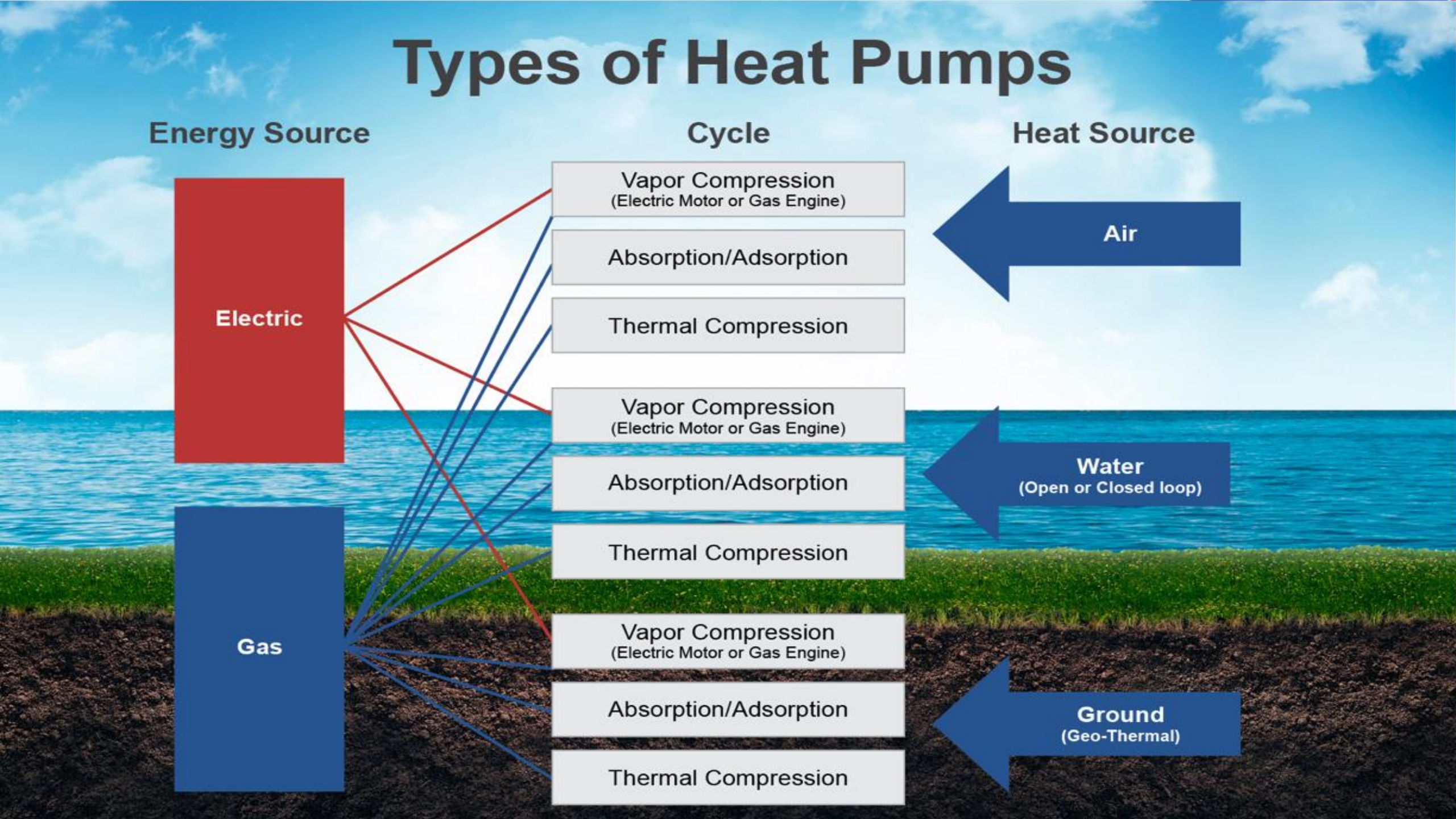
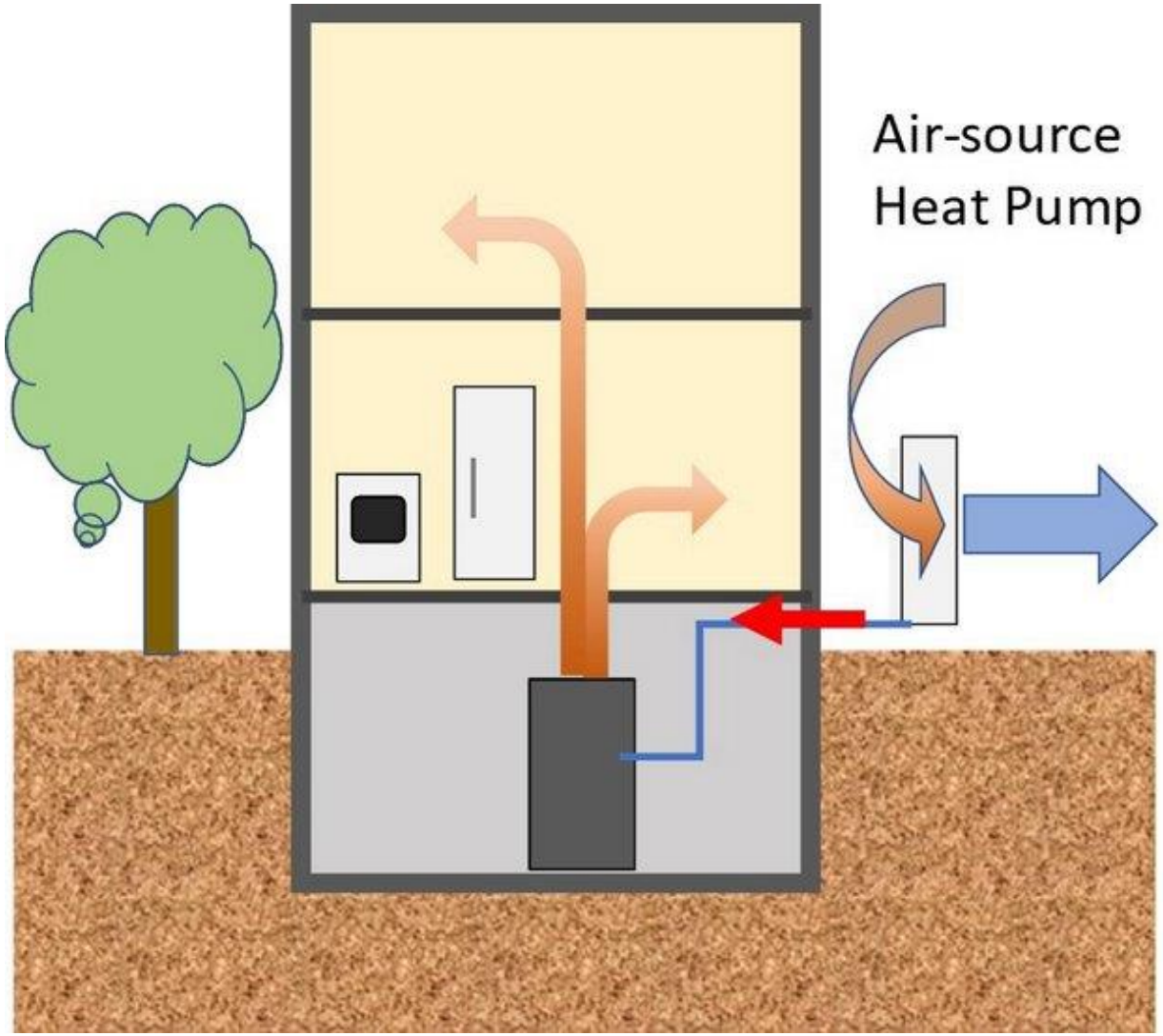

Types of Heat Pumps
Energy Source
Cycle
Heat Source
Electric
Gas
Vapor Compression
(Electric Motor or Gas Engine)
Absorption/Adsorption
Thermal Compression
Vapor Compression
(Electric Motor or Gas Engine)
Absorption/Adsorption
Thermal Compression
Vapor Compression
(Electric Motor or Gas Engine)
Absorption/Adsorption
Thermal Compression
Air
Water
(Open or Closed loop)
Ground
(Geo-Thermal)

Air Source

- Takes heat from air in the winter and uses it to heat the space
- Takes heat away from the space in the summer to cool the indoor air
- Outside unit could be electric, gas engine or absorber



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Water Source Heat Pumps

- Closed Loop
  - Just like ground source, antifreeze solution is in a closed circuit and completely isolated from the water source
  - Water from a close by lake or pond is used as the heat source/sink

- Open Loop
  - Lake or pond water is circulated directly through the loop

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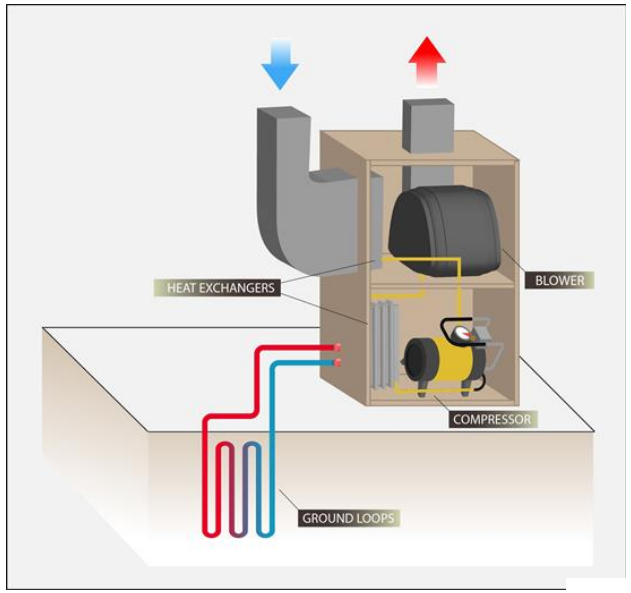
Ground Source Heat Pumps

- Soil temperature is almost constant year round
  - Warmer than air in the winter
  - Cooler than air in the summer
- Types of Ground Source Heat Pumps
  - Electric heat pumps
  - Gas engine heat pumps
  - Absorption heat pumps



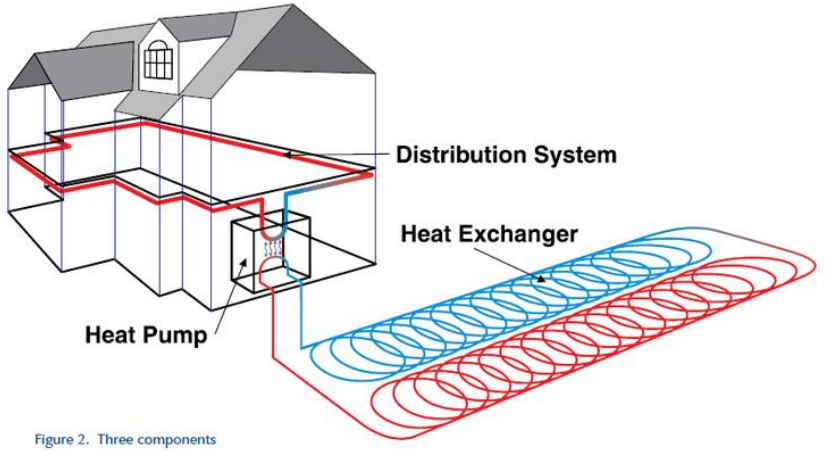


Figure 2. Three components

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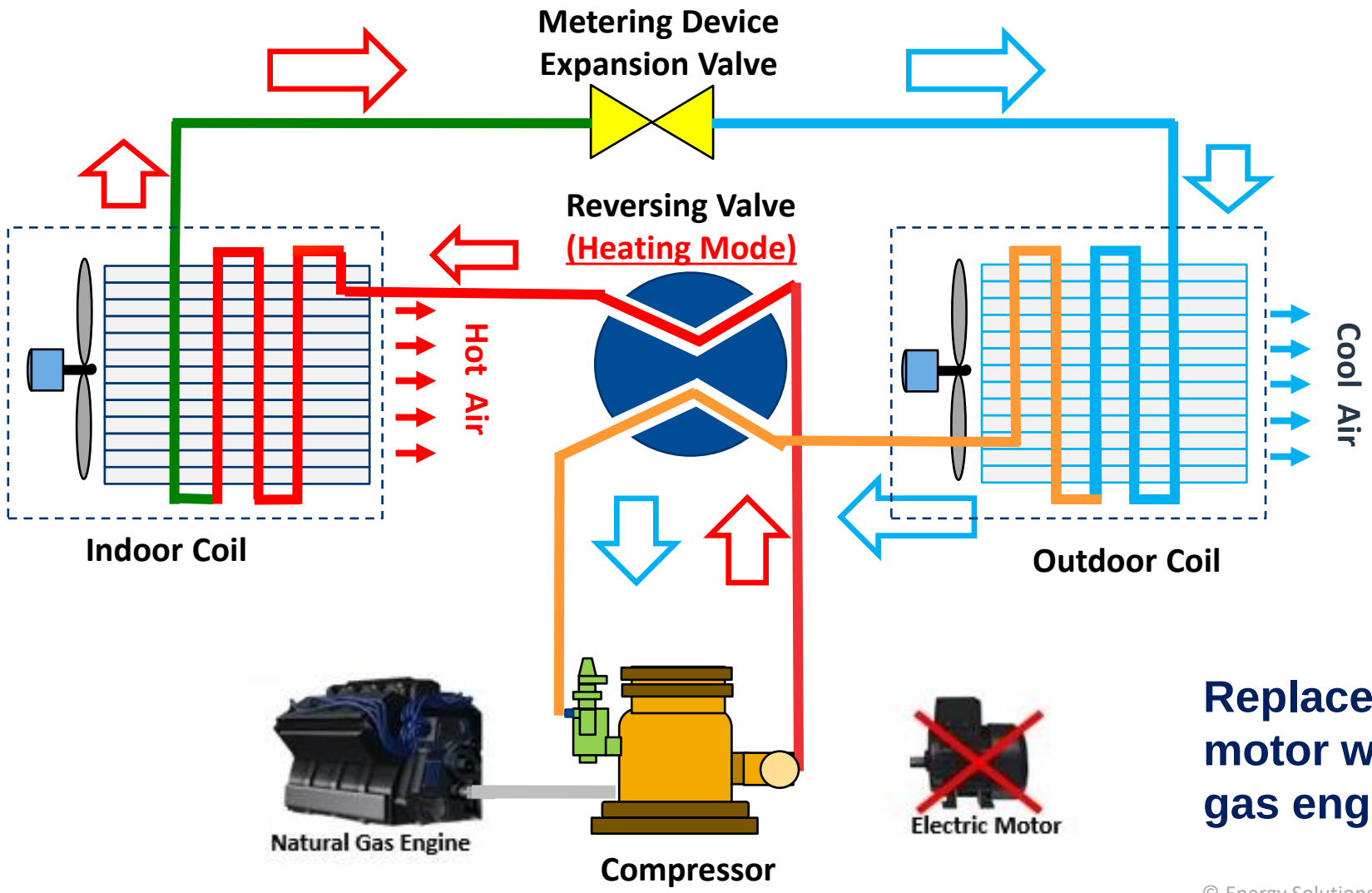
Gas Heat Pumps

GHP: Engine Driven (Heating mode)



Replace electric motor with natural gas engine

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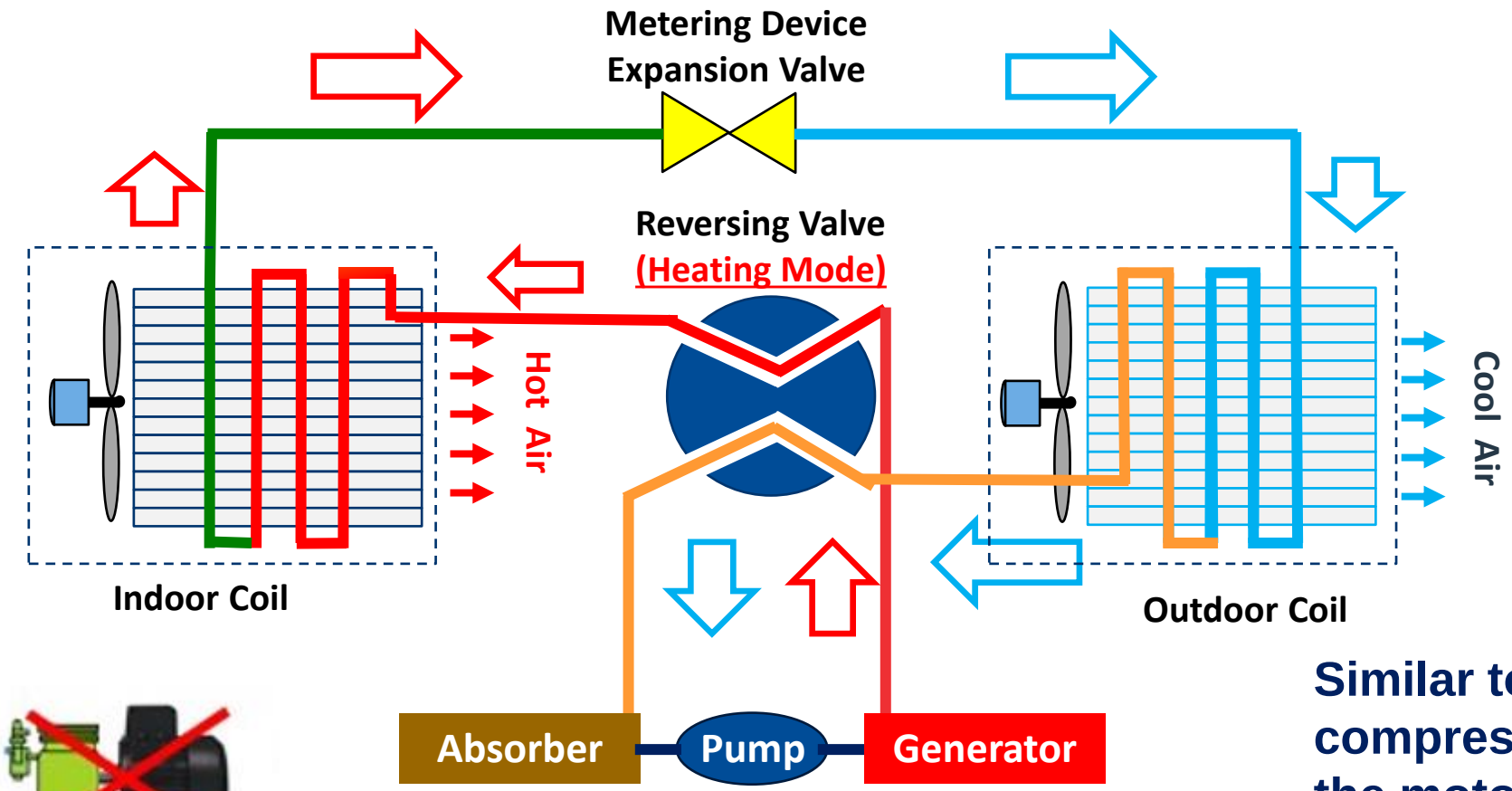
GHP: Absorption (Heating mode)



Similar to vapor compression, except the motor is replaced by a generator, pump, & absorber.

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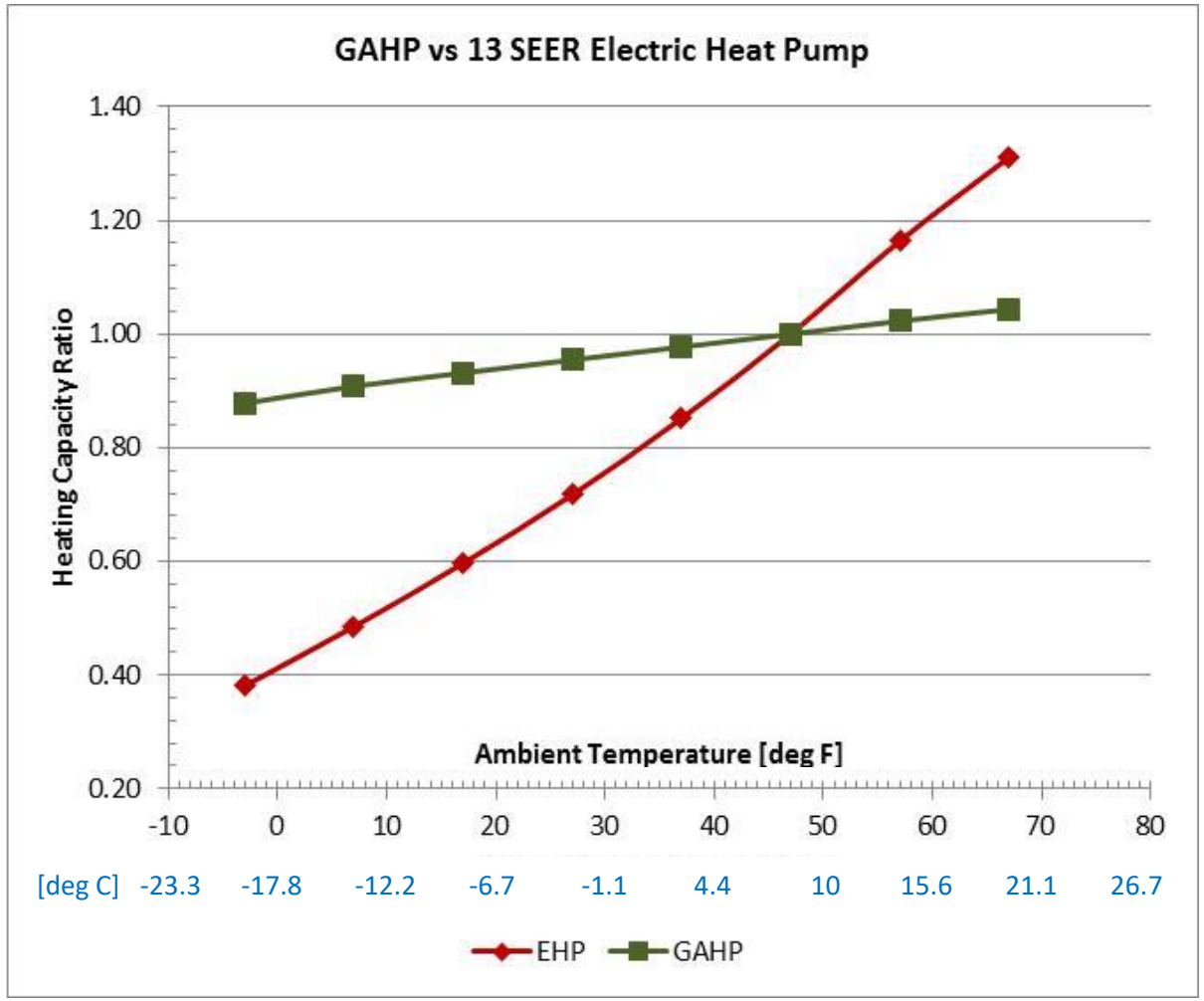
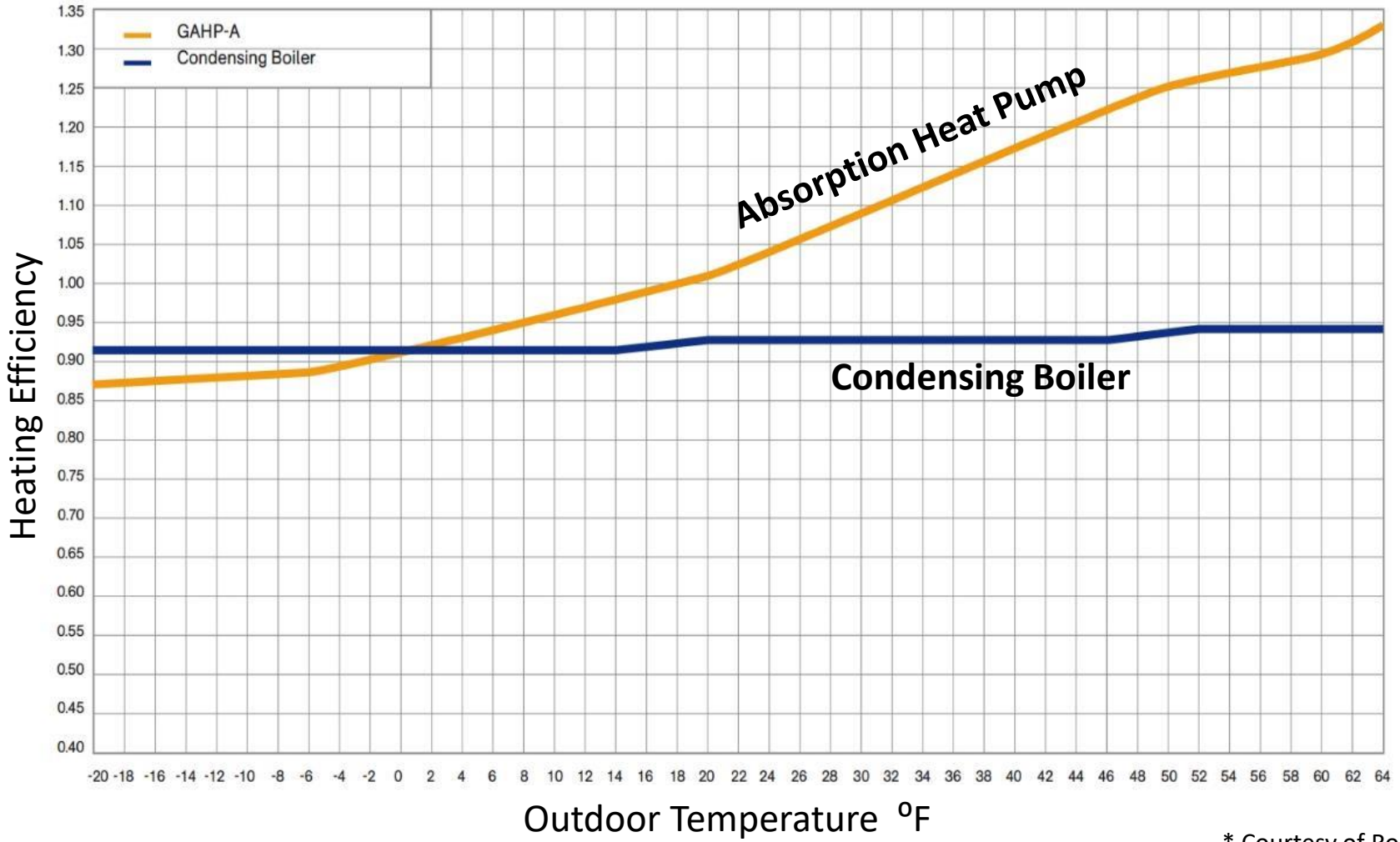
Gas Heat Pump vs EHP Heating Capacity

Gas heat pumps continue to operate at lower temperatures than electric heat pumps.



* Courtesy of Stone Mountain Technologies

Condensing Boiler vs. Air Source Heat Pump



* Courtesy of Robur

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GHP Flexibility

Modular Designs

VRF Capable

Works with a variety of Air Handlers

Round Flow

Ducted Type

T Bar Type

Wall Mounted

Floor Standing

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Typical GHP Applications

- Space Heating Only
- Space Heating & Domestic Hot Water Heating
- Domestic Hot Water Heating Only
- Alternating Heating & Cooling

Special Applications:

- Simultaneous Heating & Cooling
- Variable Refrigerant Flow (VRF)
- Process Applications
- District Heating or Cooling

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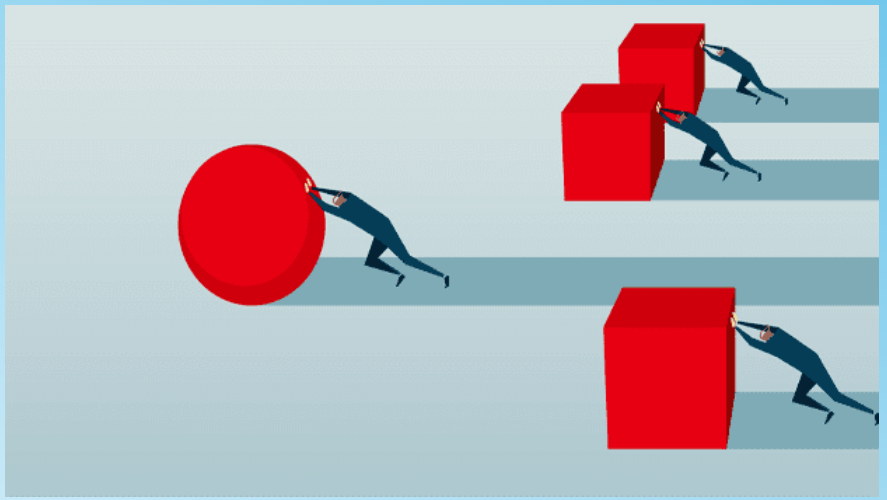
GHP Efficiencies and Economics



Typical Efficiencies

- **Typical COPs**
  - Single effect absorber ~ .6
  - Double effect absorber ~ 1.1
  - Triple effect absorber ~ 1.8
  - Engine chiller ~ 1.2 (1.4 with heat recovery)
  - Gas Heat Pumps:
    - Absorption Heating ~1.4, Cooling .6
    - Engine Heating ~ 1.4, Cooling 1.1
- **Typical SEERs of electric cooling** ~13 to 25
- **Typical Heating Seasonal Performance Factors** ~8.7 to 10

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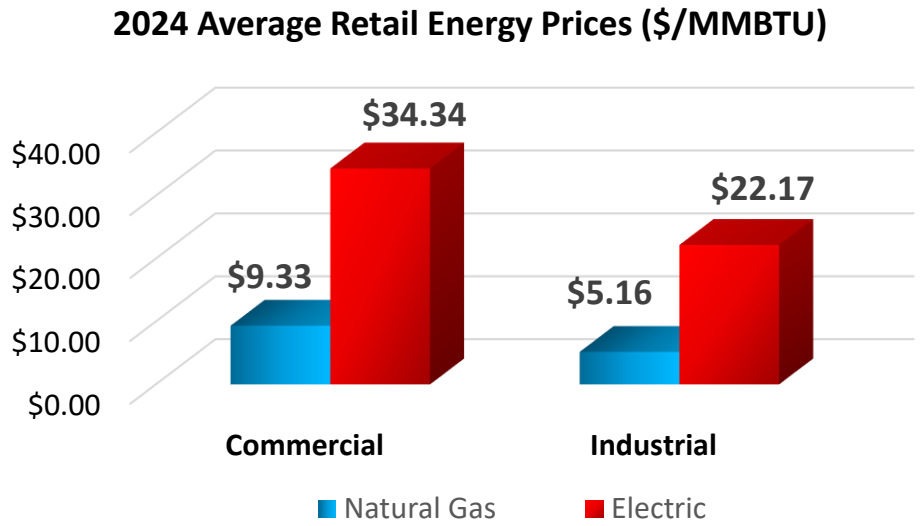
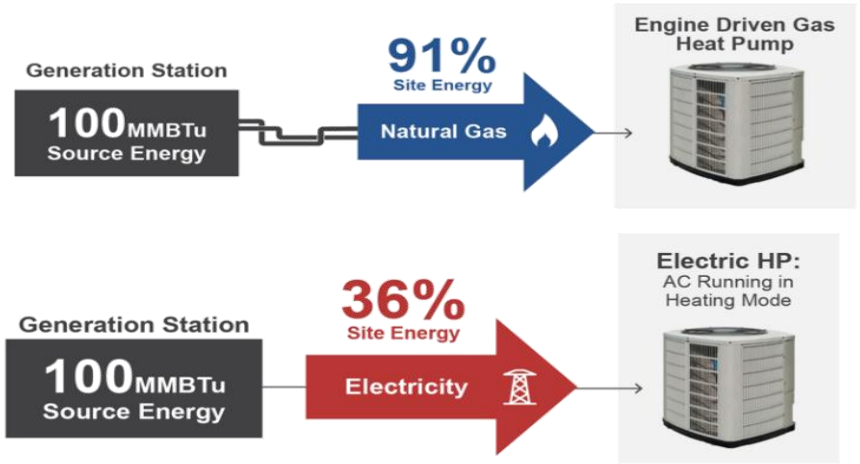
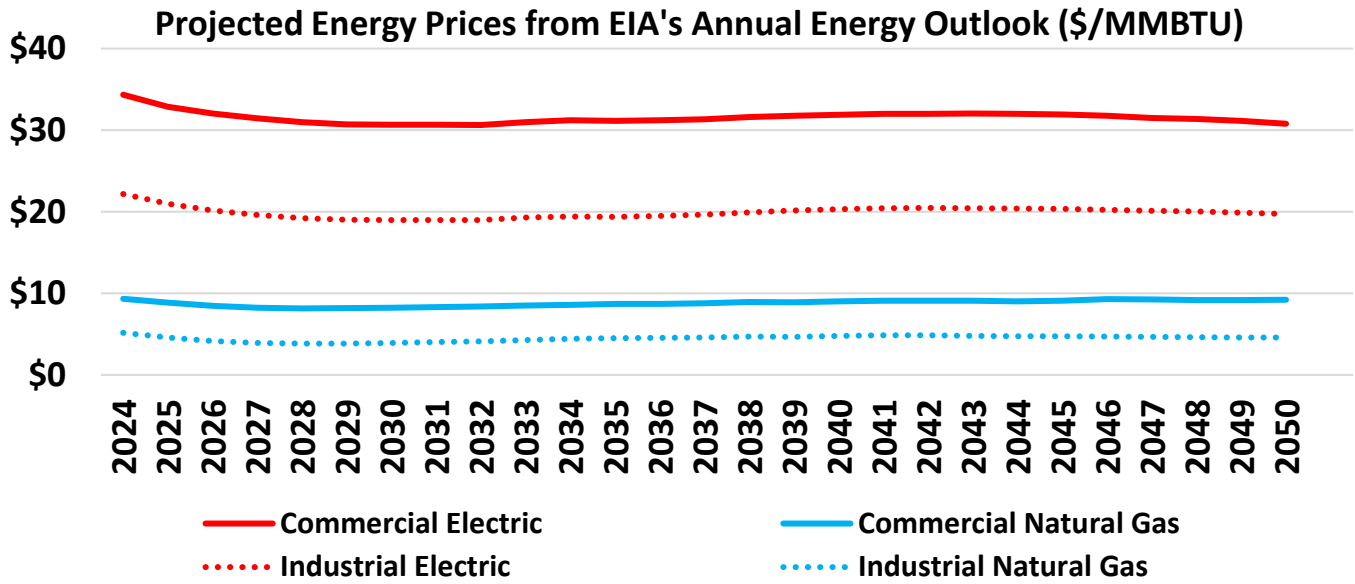
Energy Efficiency & Costs





Electric generation efficiency impacts the price of electric.



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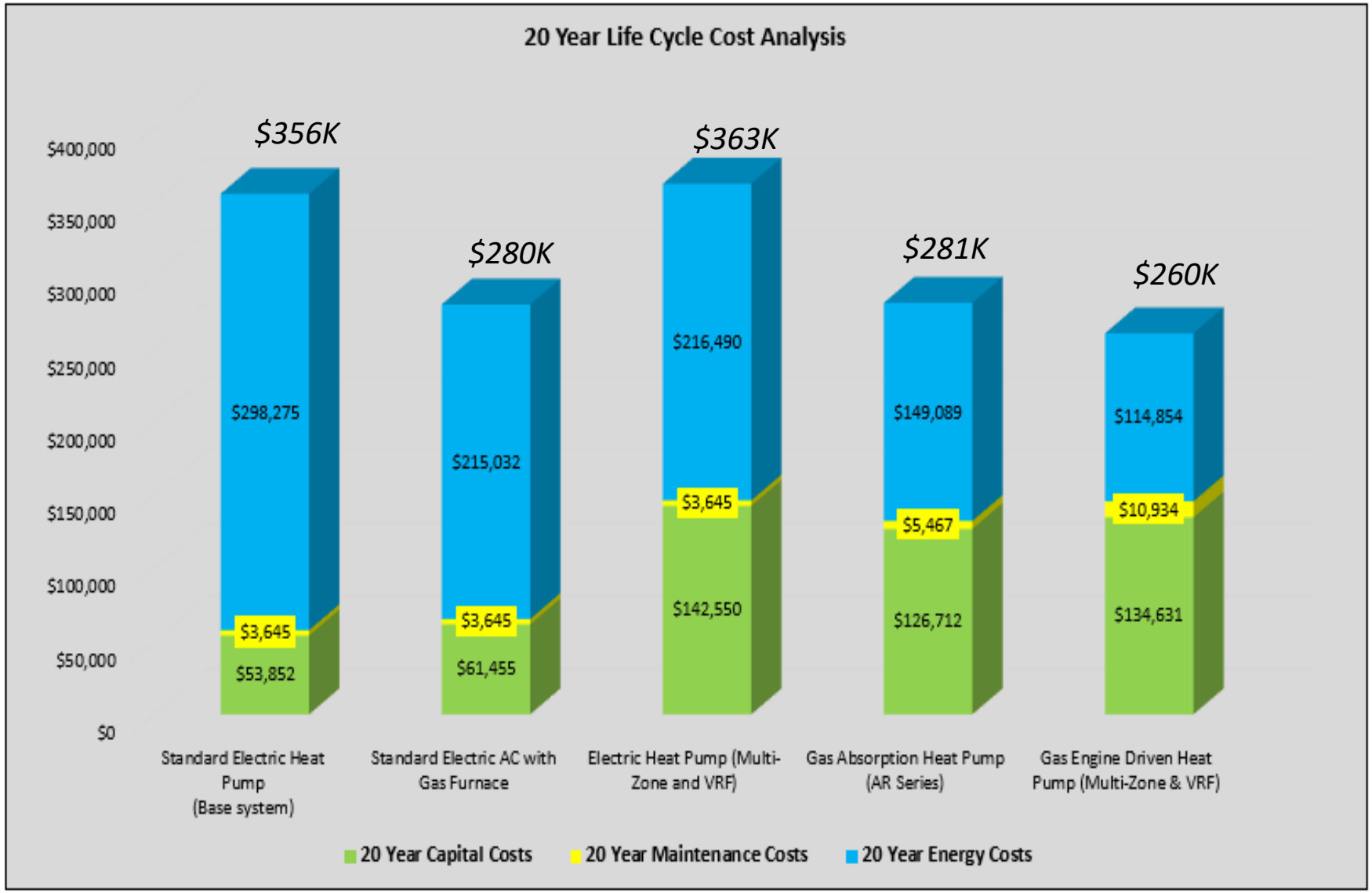
https://www.eia.gov/outlooks/aeo/

Life Cycle Costs of GHPs



Note: GHPs can cost 3X that of conventional HVAC systems, but generally have overall lower life cycle costs than conventional systems.

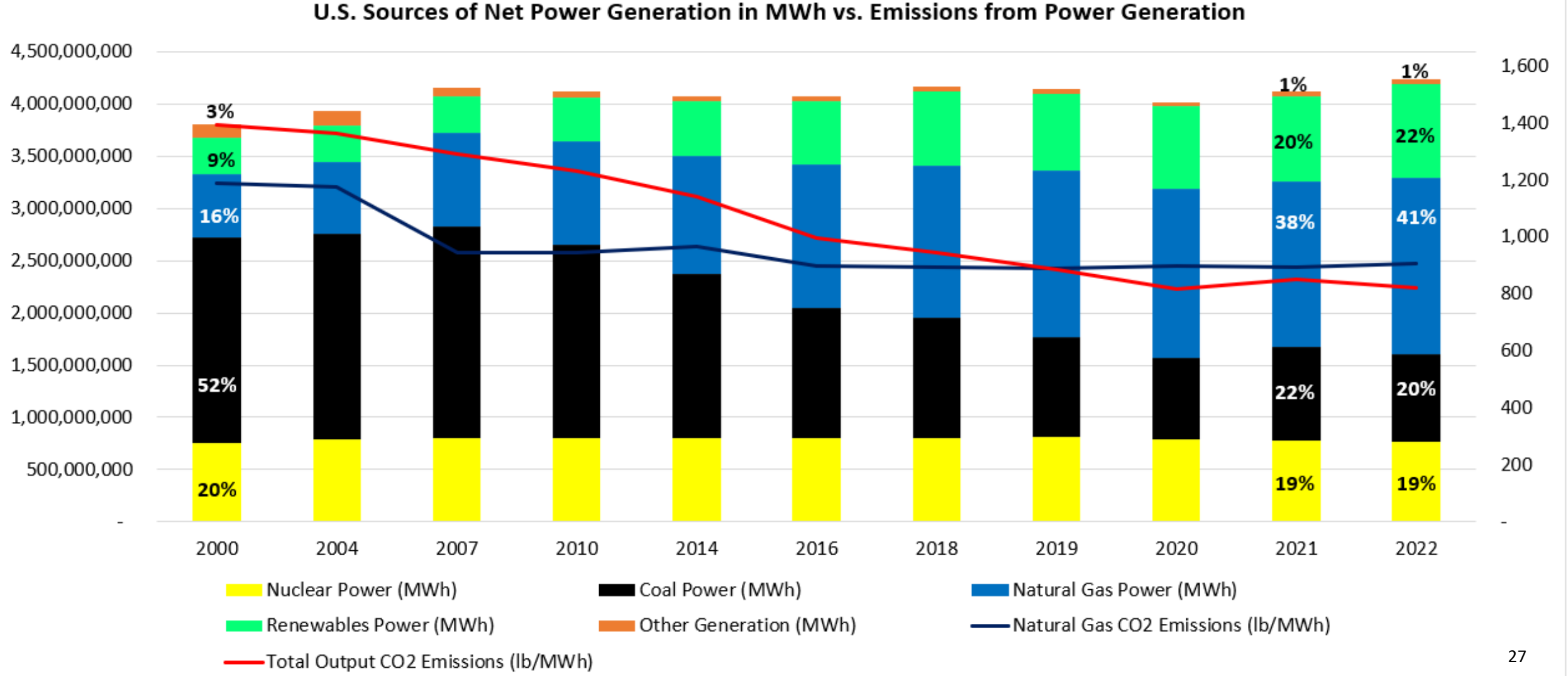
Assumptions: 20-ton system amortized over 20 years at 5% interest with $.15/kWh, $10/kW, and $.65/Therm energy rates, with 2% energy & maintenance inflation rates.

Note that life cycle costs will vary based on regional energy rates.

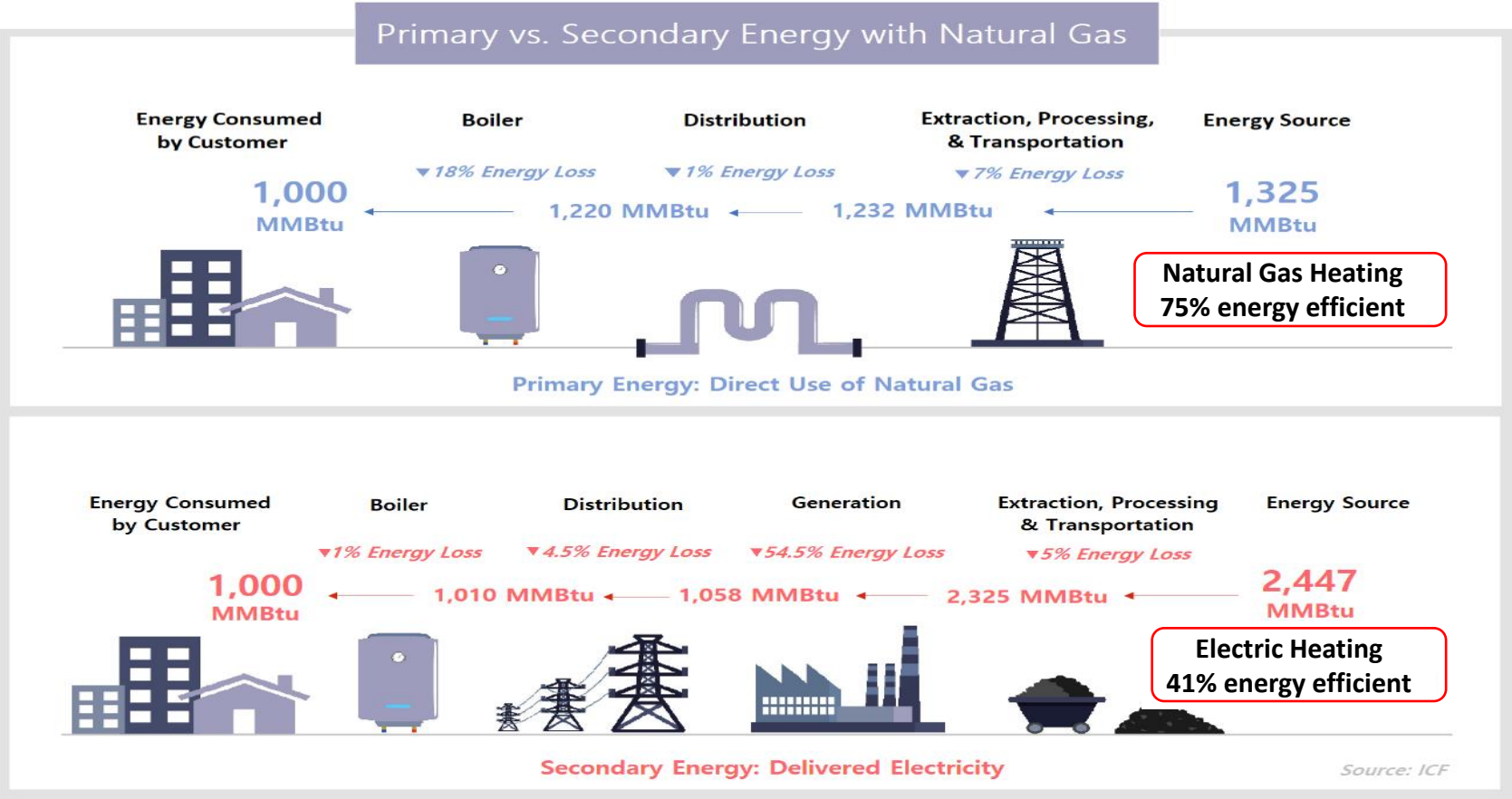
https://gasairconditioning.com/general-resources/tools/

Environmental Benefits

Grid Power Mix : Source to Site Efficiency



Source to Site Energy Efficiency



	Energy Used (MMBtu)	Energy Required (MMBtu)	On-Site CO_2 Emissions (lbs)	Off-Site CO_2 Emissions (lbs)	Total CO_2 Emissions (lbs)
Gas Boiler ***Direct Use of Natural Gas***	1,000	1,220	142,317	11,385	153,702
Electric Boiler ***2021 eGRID Average***	1,000	1,010	0	276,856	276,856
Electric Boiler ***2021 eGRID Non-Baseload***	1,000	1,010	0	458,016	458,016

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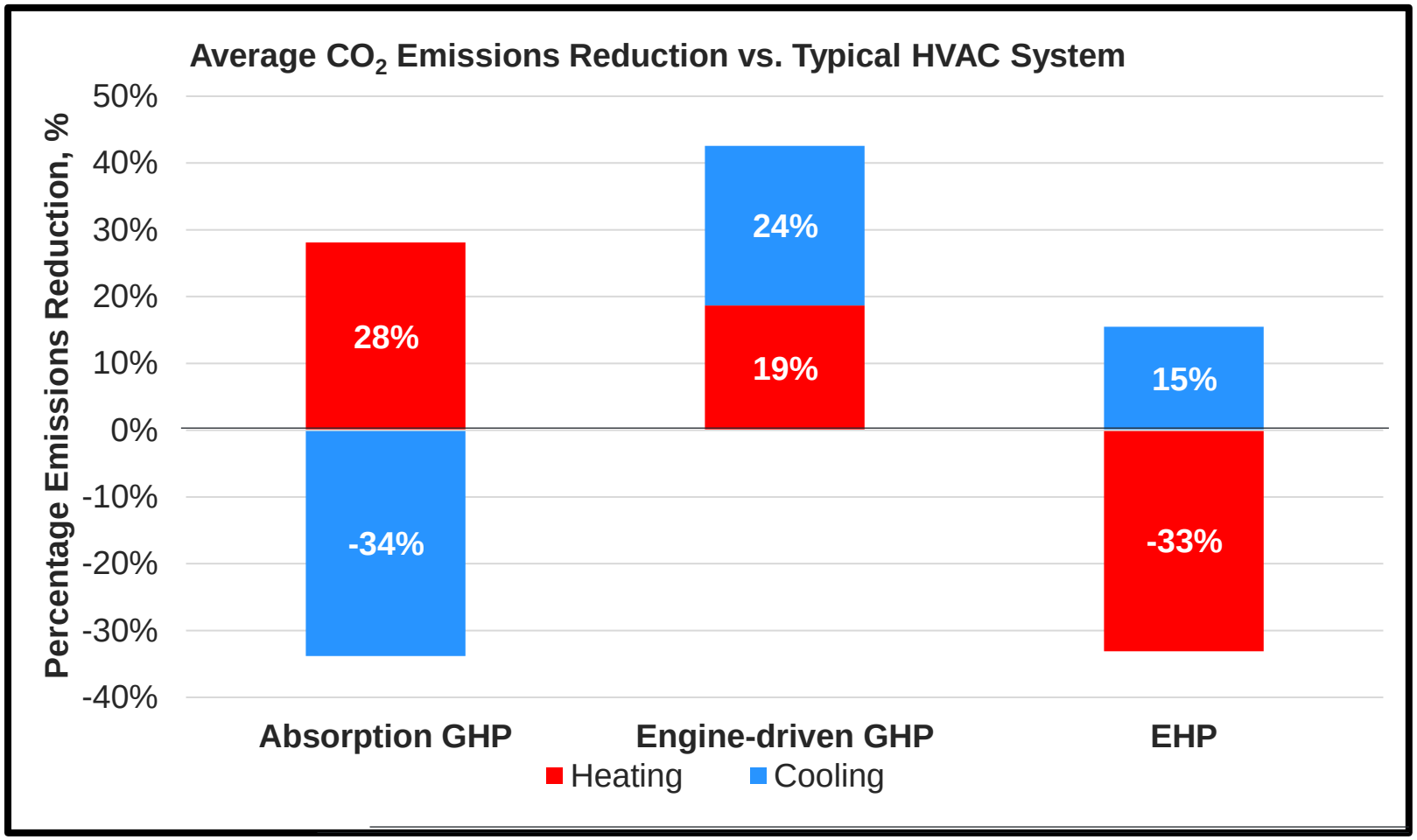
Lifetime Emissions for Gas and Electric Heat Pumps at Commercial Buildings

Baseline is RTU with gas heat & electric cooling.



Source: https://consortia.myescenter.com/GHP/ESC_GHP_Operating_Costs-Emissions-Study-ICF-August2021-Full.pdf

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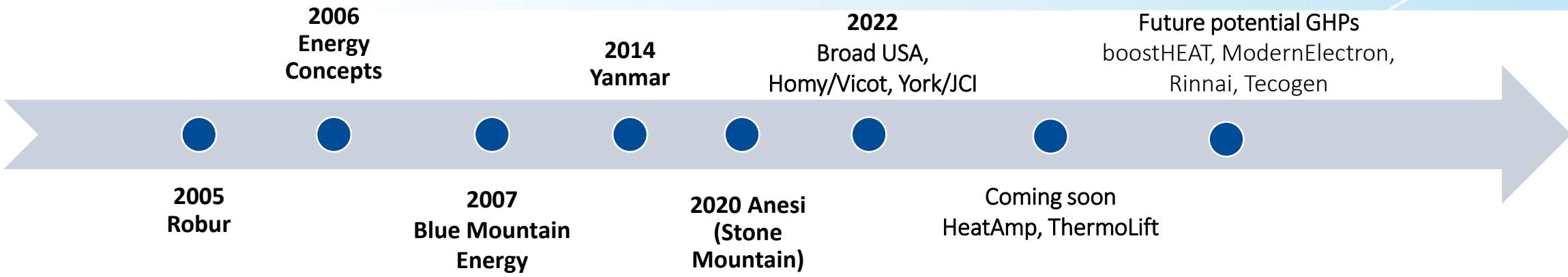
GHP Products

> 3,000
GHPs
installed

History of Gas Heat Pumps in North America



Year	Milestone
2005	Robur rolled out their water-to-water, heat only, and reversible gas fired absorption heat pumps in North America.
~2006	Energy Concepts installed a 100 ton gas absorption heat pump in Livingston, CA. This company develops custom made absorption heat pumps as small as 15 tons in size, mostly for process cooling applications.
2007	Blue Mountain Energy formerly Intellichoice Energy introduced their engine driven heat pump in 2007 and it became commercially available in late 2008.
2013	The Illios(subsidiary of Tecogen) engine driven heat pump water heater introduced. This system is a water source hot water heater that can produce 300-600 MBH of hot water only, or can simultaneously produce 24 tons of cooling + 476MBH of hot water. (Not in production currently)
2014	Yanmar introduced 8, 10, 12, and 14 ton two -pipe engine driven heat pumps plus a 14 ton 3-pipe heat pump.
2020	Anesi (Stone Mountain) developed a residential heat pump heating system and began working on a tank style heat pump water heater.
2022	GHP Products available from Broad USA, Homy/Vicot, & York/JCI
Coming soon	More GHPs under development, testing and demonstration from: HeatAmp, ModernElectron, Robur (K-18 Residential), Rinnai, & Thermolift, and others

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GHP Products

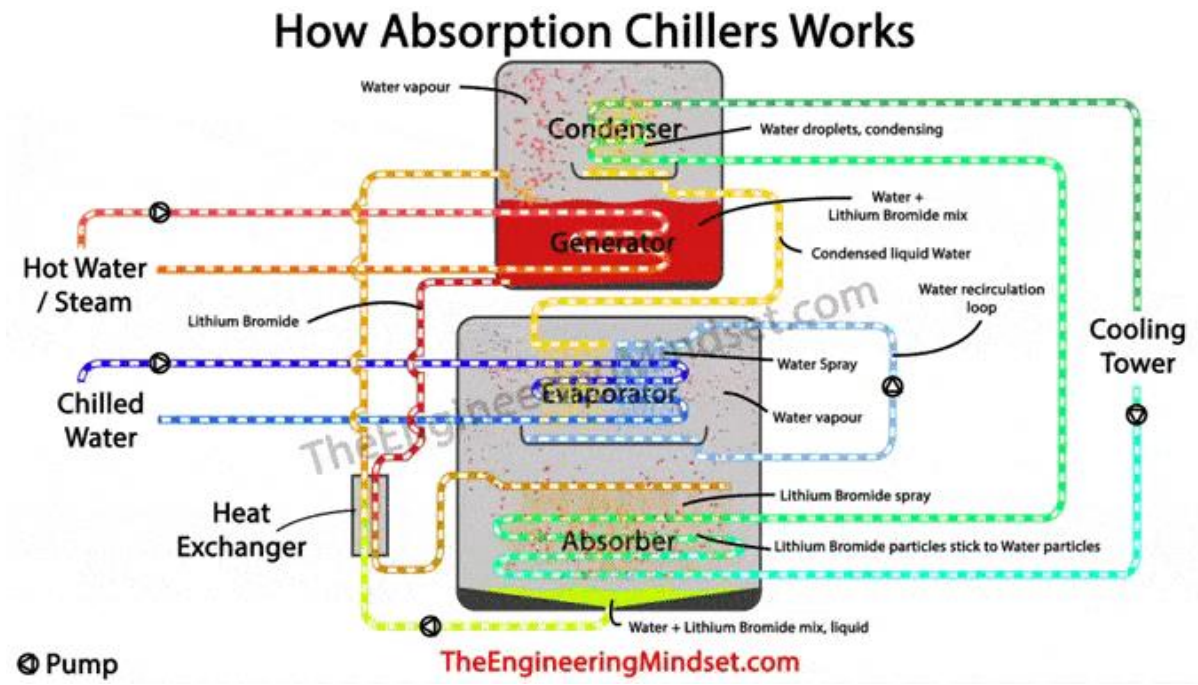
Company	Type	Technology	Best Applications	Status	Heat Sizes	Cooling Sizes
Anesi		Absorption		Commercially available	10,000 to 140,000 BTU/h	Future cooling 1-4 tons
Blue Mountain Energy		IC Engine		Commercially available, 5 & 11 Ton, field testing others	91,000 to 410,000 BTU/h	5, 8, 11, 15, and 30 Tons
Broad USA		Absorption		Commercially available	962,000 BTU to 57,800,000 BTU/h	30 to 3,968 Tons
Energy Concepts		Absorption		Commercially available	396,000 to 40,000,000 BTU/h	20 Tons to 2,000 Tons, down to -50ºF
HeatAmp		Adsorption (Chemisorption)		Field test 2023	Up to 50,000 BTU/h	n/a
Robur		Absorption		Commercially available	120,000 BTU/h	5 Tons
ThermoLift		Thermal Compressor		Field demos	55,000 to 75,000 BTU/h	3 Tons
Thermax		Absorption (Waste heat fired)		Commercially available	835,035 to 136,484,680 BTU/h	n/a
Yanmar		IC Engine		Commercially available	108,000 to 198,000 BTU/h	8, 10, 12, and 14 tons
York		Absorption (Waste heat fired)		Commercially available	10,000,000 to 24,000,000 BTU/h	n/a
Vicot		Absorption		Commercially available. Resid. units: Field Trial	68,000 BTU to 290,000 BTU/h	n/a

Key: Residential, Commercial, Industrial, Heating, Cooling, Water Heating

https:///consortia.myescenter.com/GHP/ESC-GHP_Avialability_Chart.pdf

Absorption Heat Pumps

- Anesi (Stone Mountain)
- Broad USA
- Energy Concepts
- HeatAmp
- Homy/Vicot
- Robur
- Thermax
- York



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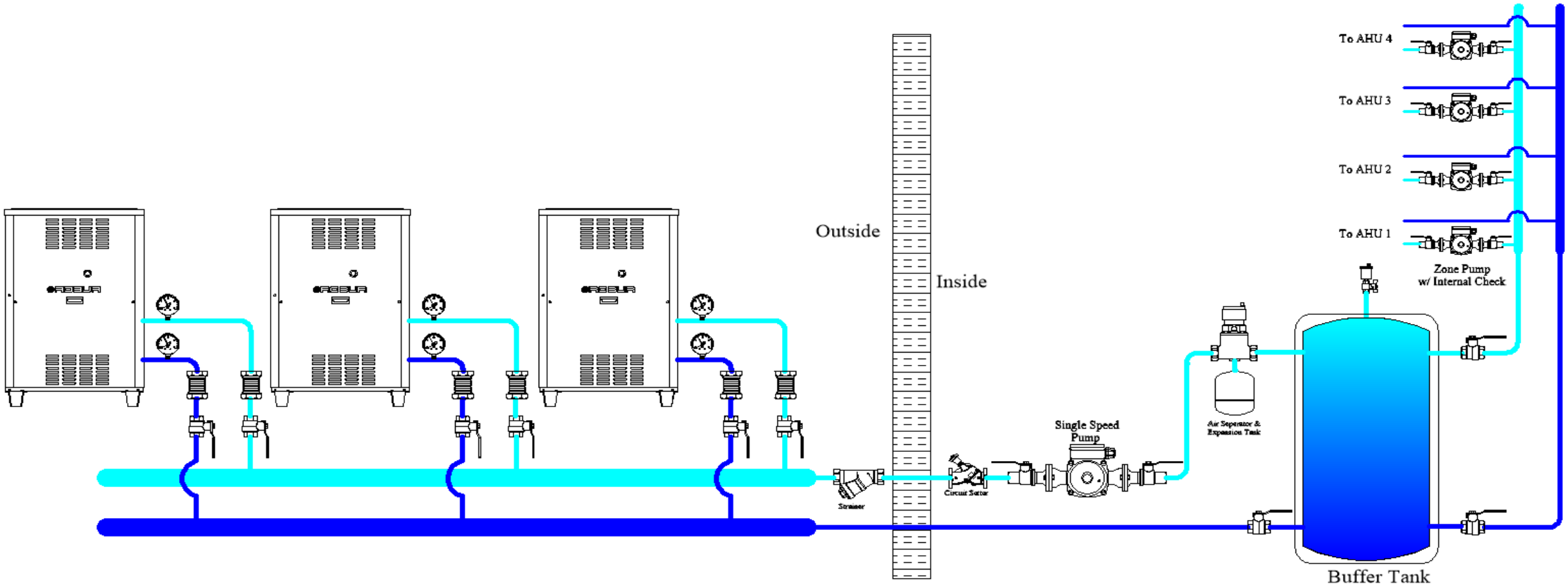
Modular Systems



* Courtesy of Robur

Modular Systems

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Achieving >100% Thermal Efficiency

10%
Heat flue loss

50%
Energy from
natural source
(ground, water, air)

~ 140%
Heat
Energy available

100%
Inlet primary Energy for the combustion

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Anesi (Stone Mountain Technologies)

- 80,000 & 140,000 BTU Space & Water Heating
- AFUE: 140%*, COP_{gas} = 1.45*
- Air to Water
- Condensing
- 4:1 Modulation

- Stand-alone storage tank (60 to 80 gal)
- UEF: 1.15 - 1.20
- FH rating: ~95% tank volume
- Input: 6,300 Btu/hr (1.8 kW), condensing

SMTI / ANESI

** Standard Rating Points: 47°F (8°C) ambient air, 120°F (49°C) supply water*

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Space Heat/Hot Water system commercially available

Anesi: 80,000 BTU/Hr (example)

COP:	1.45 (@47°F, HHV) *std rating point*
	1.20 (@ 0°F, HHV)
AFUE:	140%
Capacity (output):	80,000 BTU/hour
Min. Ambient Temperature:	minus 40°F
Refrigerant:	NH_3 / H_2O
Global Warming Potential:	None
Modulation Ratio:	4:1
Max Supply Temp (steady):	140°F
NOx Emissions:	SCAQMD compliant (<14 ng/j)
Venting:	Direct outdoors
Dimensions:	44”H x 34”W x 48”D
Weight:	<600 lbs.

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140,000 BTU/Hr model also available

Broad USA

- Heating: 962,000 BTU to 57,800,000 BTU/h
  - Heating up to 203°F
  - Heating COP: 1.7~2.4
- Cooling: 30 to 3,968 Tons
- Driving Source: Natural gas, Biogas, Steam, Hot water, Exhaust gas

Photo courtesy of Broad USA

Commercially available

Broad USA Absorption Heat Pump

Absorption heat pump is based on lithium bromide absorption technology

Uses heat as the driving source to recover the heat from the low-temp heat source

Provides mid-temp and high-temp water for process or heating

It transfers heat from low temperature to high temperature.

Driving Source: Natural gas, Biogas, Steam, Hot water, Exhaust gas

Main Application:

Central heating, **B**uilding heating, **P**rocess heating

Heating up to **203°F**

Heating COP: **1.7~2.4**

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Energy Concepts

- Absorption 15 - 300 tons
- Heat Pumps (absorption based)
- Custom systems to 15,000 tons
- Simultaneous heat and cooling, or refrigeration
- Air or water cooled, (ammonia water)
- Delivers both chilling and hot water
- Provides 160°F hot water at a COP of 1.5

Energy Concepts

"Providing practical solutions to pressing world energy problems."

Commercially available

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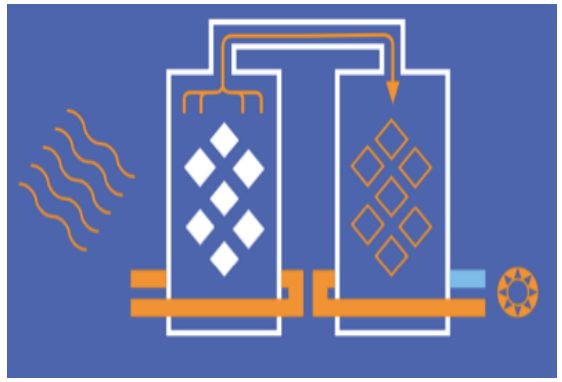
HeatAmp

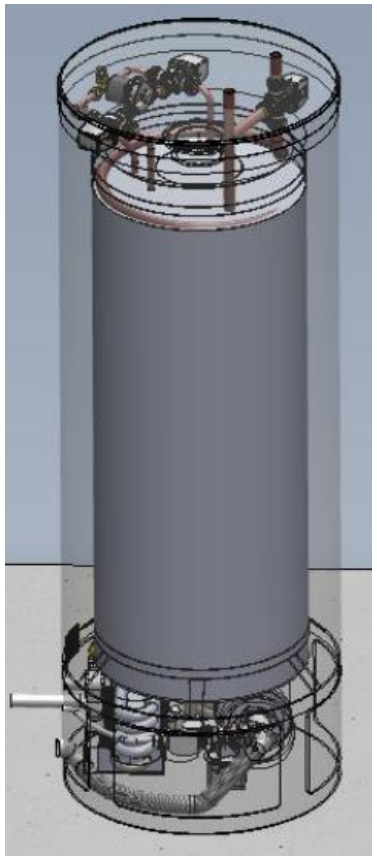
High performance 40-50 gal. drop-in replacement gas-fired heat pump water heater for the residential market in North America with a UEF >1.25.

- 35 kBTU/hr (10 kW) Direct-Firing at condensing efficiency
- Triple-state sorption is neither absorption nor adsorption cycle: intentionally crystallizes salt in reactor, for high energy density
- Ammonia refrigerant, housed in outdoor unit with no moving seals (fully hermetic), enables high delivery temperature at low ambient

Field testing

Chemisorption/Adsorption





Draft rendering of a final GHP HeatAmp product

Current Alfa prototype under testing

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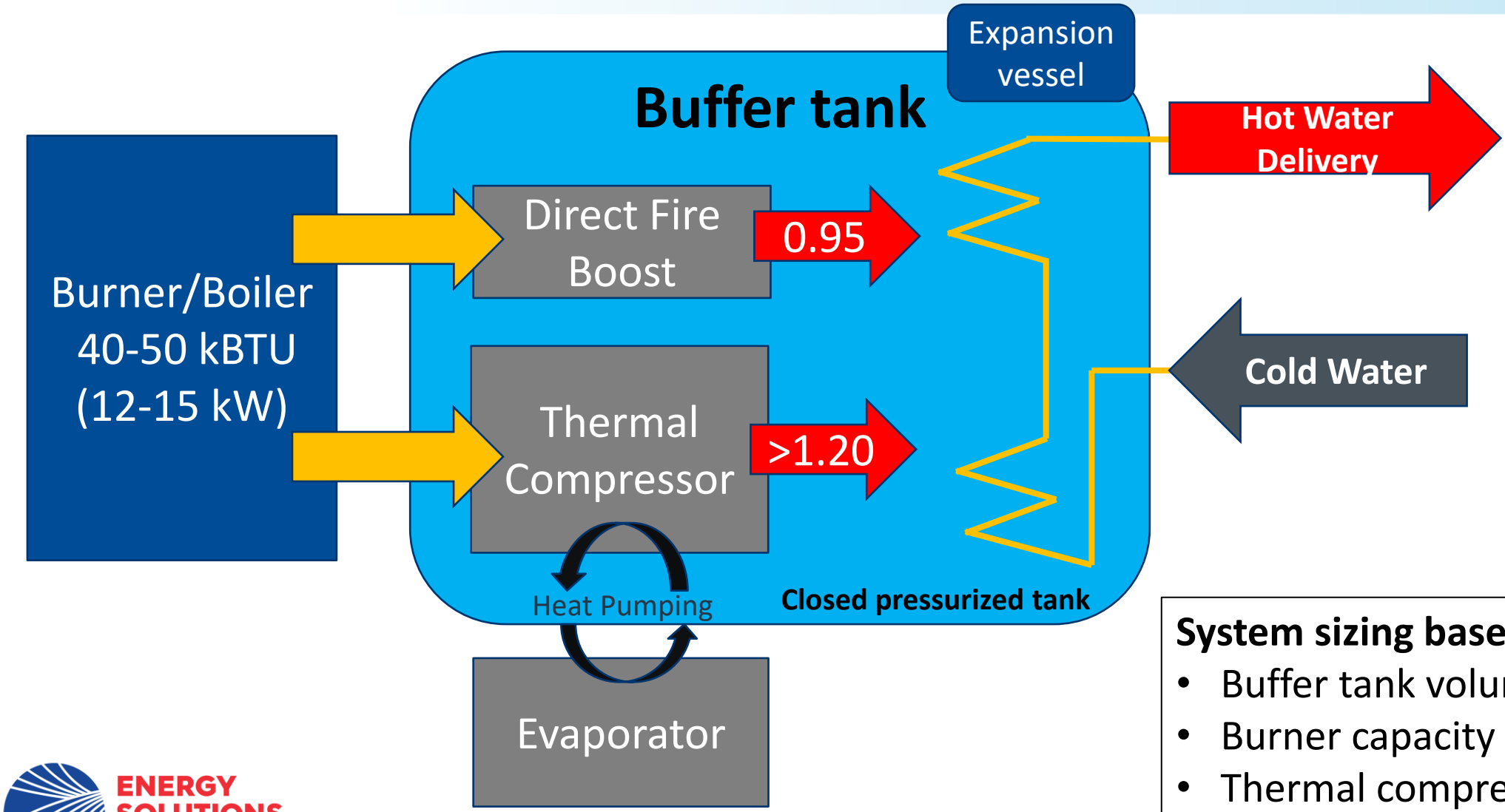
HeatAmp

HeatAmp



System sizing based on:

- Buffer tank volume
- Burner capacity
- Thermal compressor capacity

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Homy / Vicot

- **Heating and water heating:** ~ 65 MBH and 290 MBH models
- **Efficiency up to 140%**
- **Carbon Reduction:** 45% less energy consumption compared to common boilers and furnaces
- **Stepless burner control:** a solution for heating load instability
- **Refrigerant:** Ammonia with 0 GWP & 0 ODP
- **Low electricity consumption :** Using no compressor
- **Long Life Expectancy :** Less moving parts
- **Low noise level**: around 54 dB for a 65 Kw GAHP
- **Cold Climate Equipment:** Maintain Desired Capacity and Efficiency at Very Low Ambient Temperatures -22°F **(-30°C)**
- **Modular installation**

HOMY BUILDING SOLUTIONS

VICOT

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Commercially available

Homy / Vicot

Residential

Model: V20
Capacity: 68 MBH GAHP
Application: Heating/Domestic Homes

Commercial

Model: V65:
Capacity: 221 MBH GAHP

Model: V85
Capacity: 290 MBH GAHP

Combo Type (Higher Capacities)

Combination of GAHP and a Condensing boiler

Model: V35 Combo
68 MBH GAHP
+ 52 MBH boiler
Total heat capacity = 120 MBH

Model: V140
290 MBH GAHP
+187 MBH BOILER
Total heat capacity = 477 MBH

ENERGY SOLUTIONS CENTER

Robur Corporation

ROBUR
caring for the environment

- GAHP Systems
  - 5 Tons cooling, 120,000 BTU heating
  - Water-ammonia absorption heat pump
  - Air-source, water source or ground source heat pumps
  - Up to 149°F (65°C) hot water available
  - Single phase power requirements
  - Can be linked using single or multiple controllers
  - No CFC, HFC, HCFCs. Uses R-717 (Ammonia).

Commercially available

ENERGY SOLUTIONS CENTER

Robur Corporation

GAHP A Air-Source Heat Pump (Heating Only)

GAHP AR Air-Source Reversible Heat Pump (Heating, Cooling and Supplemental DHW)

GAHP W LB Water Source Heat Pump Geothermal Applications (Heating, Cooling and Supplemental DHW)

GAHP W Water Source Heat Pump (Simultaneous Heating, Cooling and DHW production)

Robur Corporation - COPs

GAHP A
Coefficient of Performance Chart
COP – HEATING MODE CAPACITY (BTU/h)

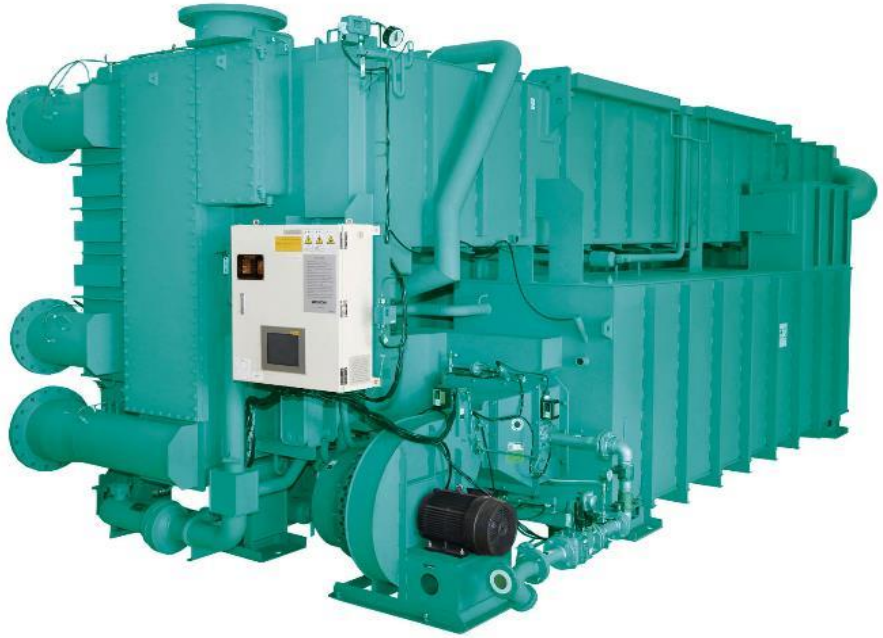
EXTERNAL AMBIENT TEMPERATURE	OUTLET HOT WATER TEMPERATURE °F / °C			
	86°F / 30°C	113°F / 45°C	122°F / 50°C	140°F / 60°C
-20°F / -29°C	1.02 COP 97,600 BTU/h	.93 COP 88,700 BTU/h	.89 COP 85,000 BTU/h	.88 COP 83,600 BTU/h
-13°F / -25°C	1.03 COP 98,600 BTU/h	.94 COP 89,700 BTU/h	.90 COP 86,000 BTU/h	.89 COP 84,600 BTU/h
-4°F / -20°C	1.04 COP 99,600 BTU/h	.95 COP 90,800 BTU/h	.91 COP 87,000 BTU/h	.90 COP 85,600 BTU/h
5°F / -15°C	1.07 COP 102,000 BTU/h	.98 COP 93,500 BTU/h	.94 COP 90,100 BTU/h	.93 COP 88,400 BTU/h
14°F / -10°C	1.21 COP 111,600 BTU/h	1.07 COP 102,400 BTU/h	1.00 COP 95,900 BTU/h	.97 COP 92,800 BTU/h
19.4°F / -7°C	1.23 COP 117,000 BTU/h	1.13 COP 108,200 BTU/h	1.05 COP 100,000 BTU/h	1.01 COP 96,200 BTU/h
35.6°F / 2°C	1.33 COP 126,900 BTU/h	1.28 COP 122,200 BTU/h	1.19 COP 114,000 BTU/h	1.11 COP 105,800 BTU/h
44.6°F / 7°C	1.39 COP 132,400 BTU/h	1.37 COP 130,700 BTU/h	**1.29 COP** **123,500 BTU/h**	1.21 COP 115,300 BTU/h
50°F / 10°C	1.41 COP 134,800 BTU/h	1.41 COP 134,400 BTU/h	1.34 COP 128,000 BTU/h	1.26 COP 120,100 BTU/h
59°F / 15°C	1.43 COP 136,500 BTU/h	1.43 COP 136,500 BTU/h	1.38 COP 132,000 BTU/h	1.29 COP 123,500 BTU/h
66°F / 20°C	1.45 COP 138,200 BTU/h	1.45 COP 138,200 BTU/h	1.40 COP 133,800 BTU/h	1.33 COP 127,300 BTU/h
77°F / 25°C	1.46 COP 139,200 BTU/h	1.46 COP 139,200 BTU/h	1.41 COP 134,800 BTU/h	1.34 COP 128,000 BTU/h

Thermax

- ~.85 MMBTU to 136 MMBTUs Heating
- COP: 1.65 – 1.75
- Hot water temperature: Up to 90 °C (194 °F)
- High Grade Heat Source: Exhaust gas, steam, hot water & liquid/gas fuels (individually or in combination)

JCI - York

- ~ 10 to 24 MMBTUs heating
- Heating COP 1.7



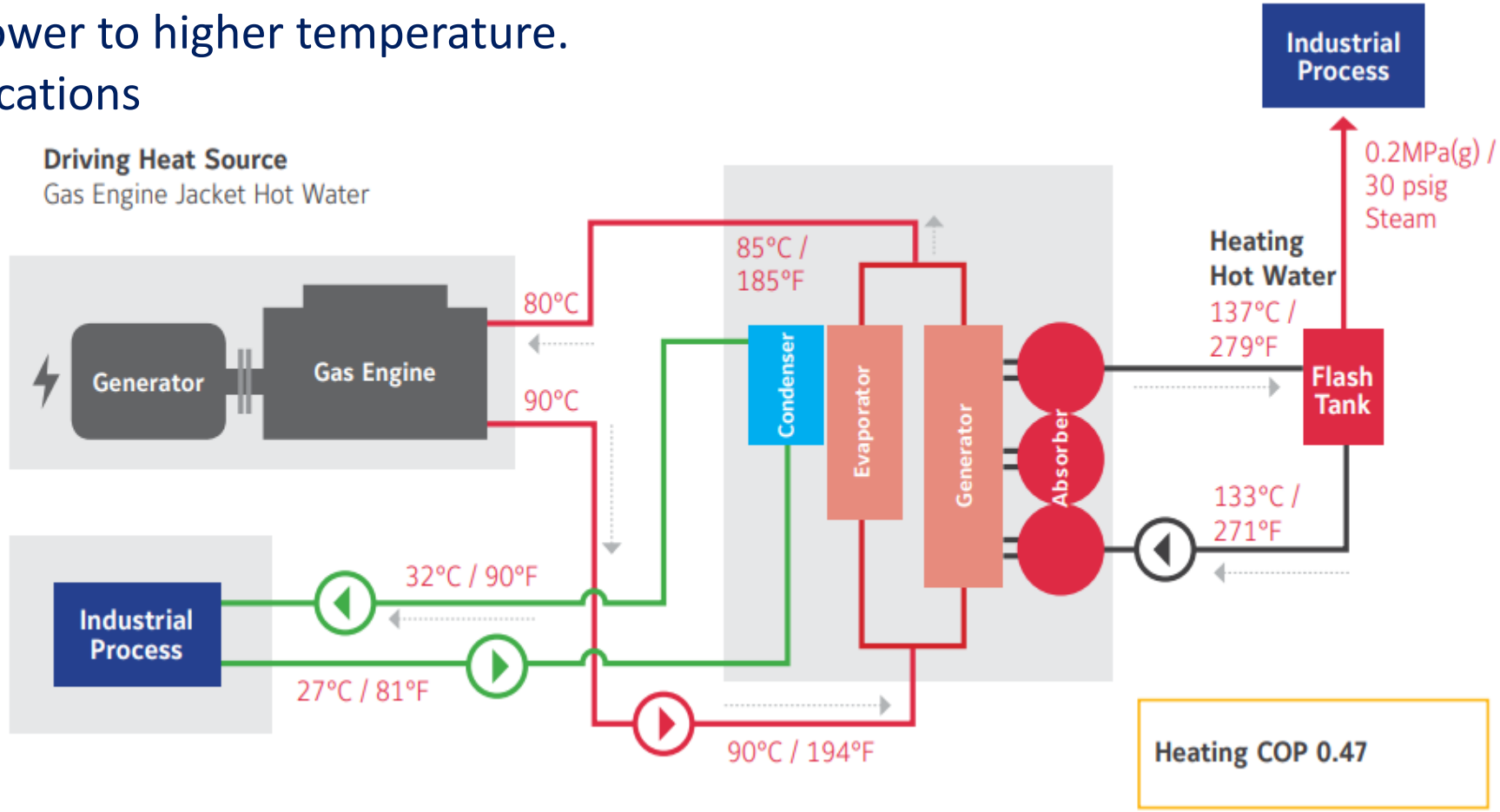
Can be ordered

JCI - York

Type II Absorption Heat Pump

(Heat Transformer)

- Upgrade waste heat from lower to higher temperature.
- Typically for industrial applications
- Heat driven



https://www.johnsoncontrols.com/en_my/-/media/jci/be/china/hvac-systems/files/water-cooled-chillers-and-heat-pumps/jcib4600_05hp_broch_d15g.pdf

Engine Driven Heat Pumps

- Blue Mountain Energy
- Yanmar

ENERGY SOLUTIONS CENTER

Variable Refrigerant Flow (VRF)

VRF is a modular, commercially applied air conditioning and heating system that distributes refrigerant from the outdoor unit to multiple indoor units, providing efficiency, comfortable individual user control and reliability in one flexible package.

Gas Heat Pump VRF Systems are built on 4 basic product elements

Outdoor Unit

+

Indoor Unit

+

Piping

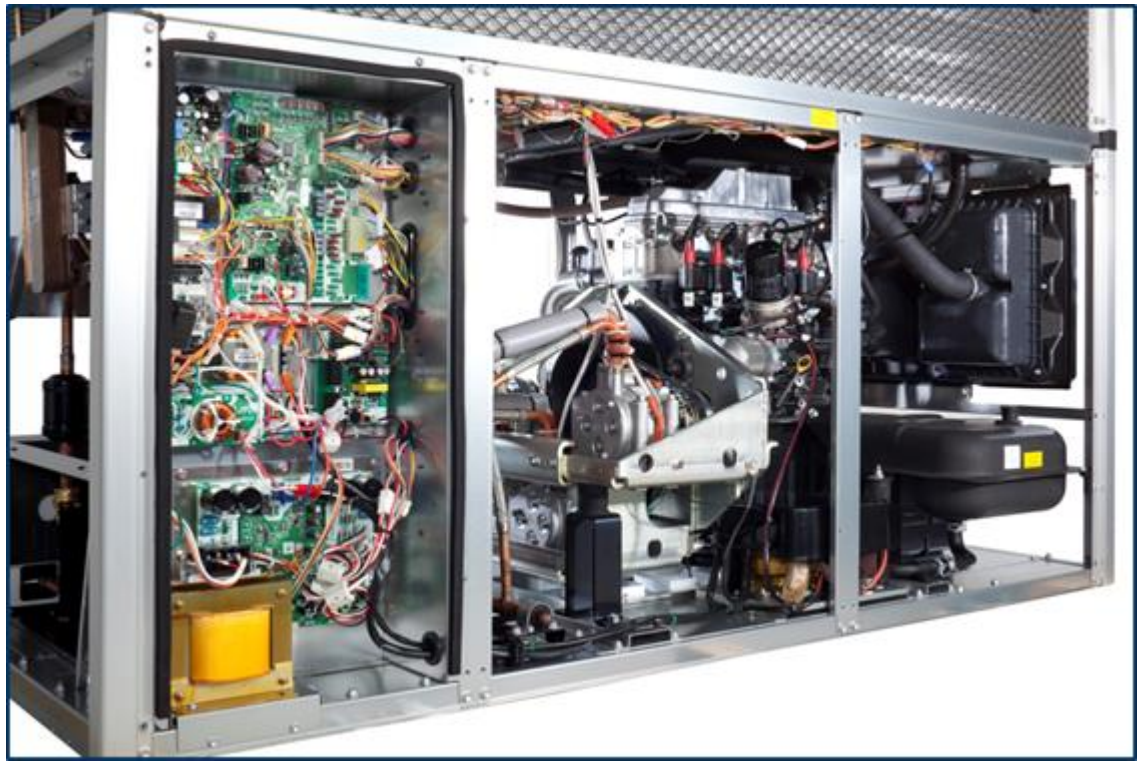
+

Controls

ENERGY SOLUTIONS CENTER

Engine Driven Heat Pumps

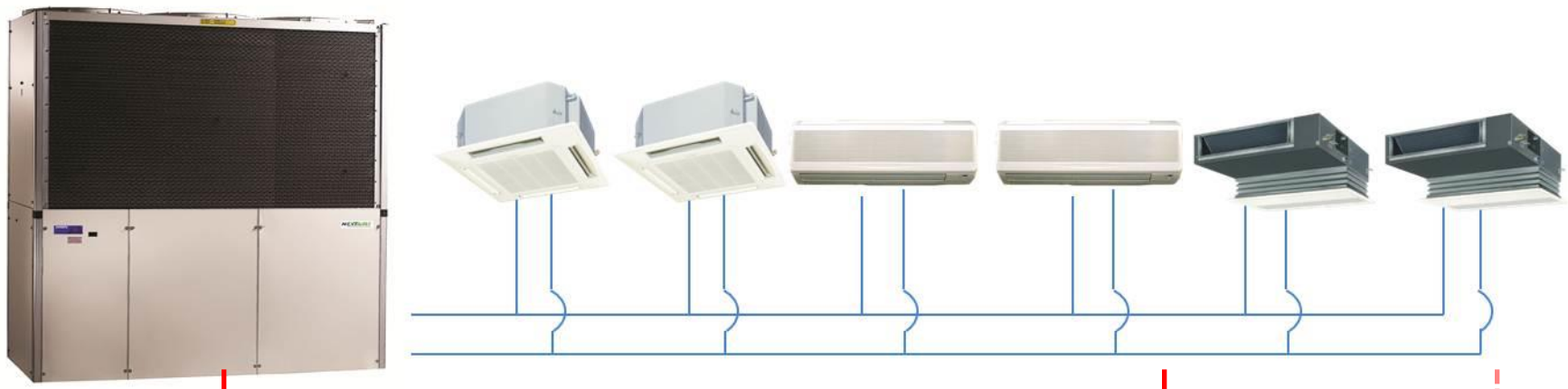
- Similar to electric heat pumps
- Electric motor replaced with a natural gas driven engine
- Excellent part load efficiencies
- Multiple zone capable
- Heating efficiency equivalent to 140%



ENERGY SOLUTIONS CENTER

Flexibility Design & Diversity

- Multiple zones – any combination of ducted or ductless air handlers



ENERGY SOLUTIONS CENTER

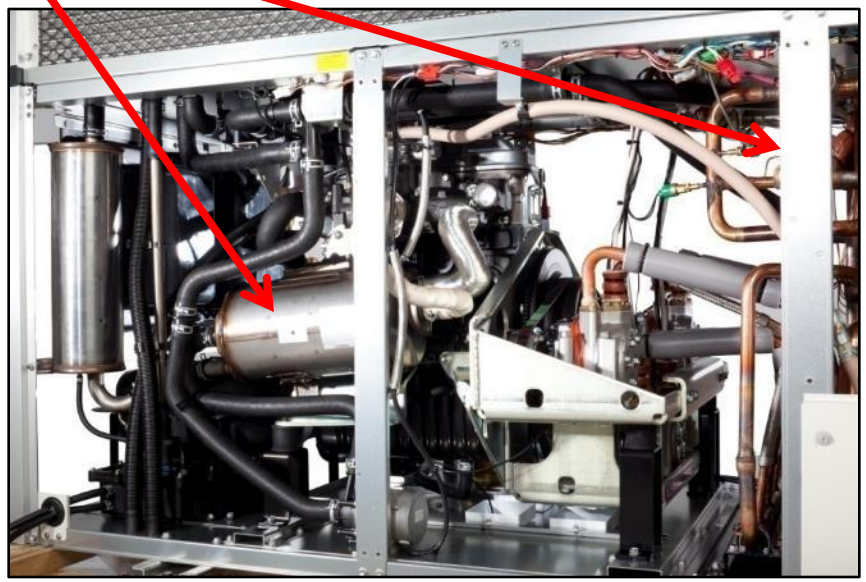
Blue Mountain Energy

- Heating: 91,000 to 410,000 BTU/h, COP of 1.40
- Cooling: 5, 8, 11, 15, and 30 Tons, COP of 1.23
  - 11 Ton is rooftop system
  - Up to 17 zones with 8 Ton Unit
  - Up to 33 zones with 15 Ton Unit
- Ducted or Ductless Options
- Air-cooled condensing in packaged unit
- Ground or roof mounted
- Over 750 units installed

Commercially available, field-testing other sizes

Blue Mountain – Maintenance

- Recuperator & Heat Recovery Exchanger
  - **Built – for – Purpose components**
  - **10K Intervals**
  - **Maintenance costs – $0.0066 per ton-run hour**



- Twenty two point inspection
- Long Maintenance interval

ENERGY SOLUTIONS CENTER

Yanmar: VRF / GHPs

YANMAR

Outdoor Unit

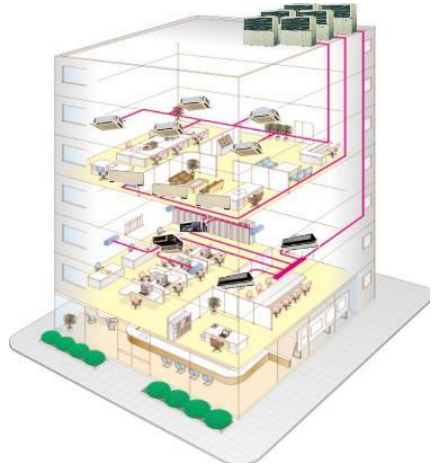
Outdoor unit line-up	Indoor unit connection capacity
8-ton type	16 units
10-ton type	20 units
12-ton type	24 units
14-ton type	29 units

Indoor Unit

Commercially Available

Yanmar VRF Specifications

	MANUFACTURER / MODEL			YANMAR NNCP096J	YANMAR NNCP120J	YANMAR NNCP144J	YANMAR NNCP168J	YANMAR NFZP168J
PERFORMANCE	Capacity	Cooling Capacity	Nominal Tons	8	10	12	14	14
			kW	28	35	42	49	49
		Heating Capacity	BTU/Hr.	106,000	134,000	156,000	189,000	189,000
			kW	31	39	46	55	55
		Low Temp / Cold Temp Heating	BTU/Hr.	106,000	137,000	164,000	178,000	178,000
			kW	31	40	48	52	52



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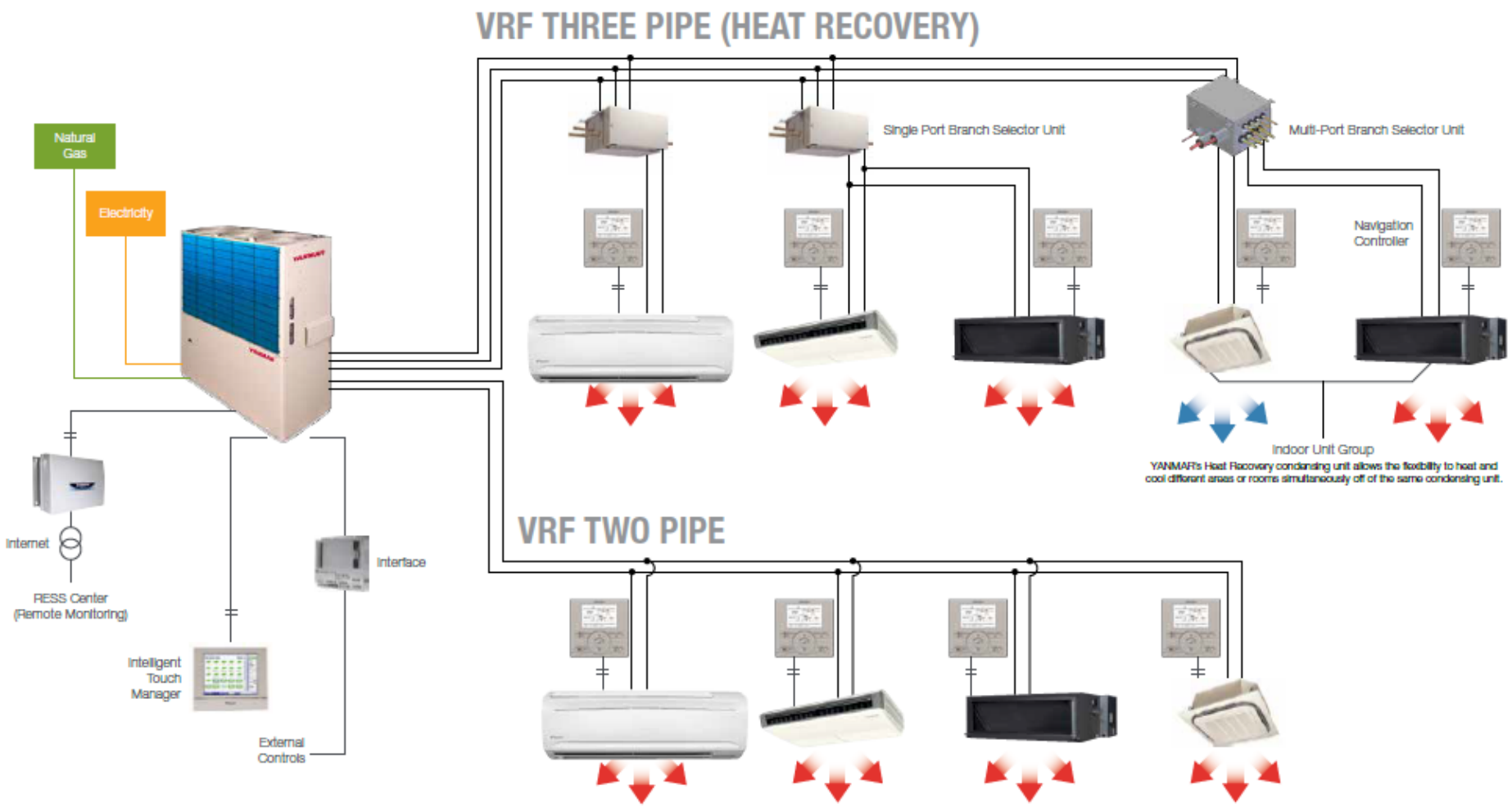
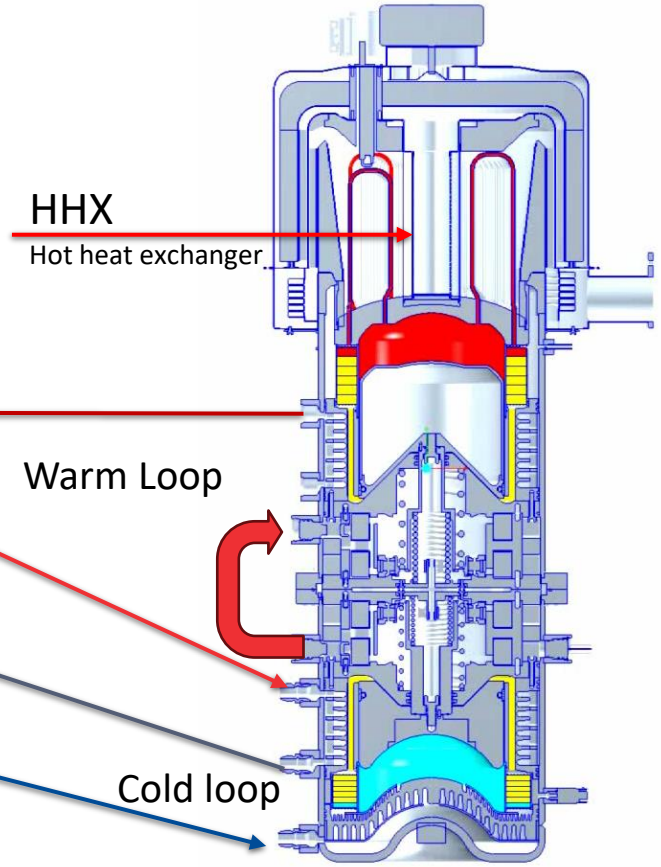
Yanmar - VRF



ENERGY SOLUTIONS CENTER

Thermal Compression Gas Heat Pumps

Combustion Heat Added at the Top: Heat Engine! Helium absorbs the heat, Temp & Press increase starting motion



Ambient Energy pulled into bottom of machine via outdoor HX: i.e. Heat Pump, this energy is moved up through the machine and added as additional energy output

Vuilleumier/Hofbauer cycle uses Thermal compression, where the Heat Input creates a Pressure Wave that drives Motion moving the helium refrigerant back and forth to absorb and then dissipate the energy for useful heating and cooling.

ENERGY SOLUTIONS CENTER

ThermoLift

Capacity: Fully Modulated Capacity

- Full Load – 10 to 15 gal/min Water Flow:
  - Heating Capacity (Btu/hr.) 55,000 to 75,000
  - Cooling Capacity (Btu/hr.) 27,500 to 37,000
  - Storage Enabled Peak Cooling Capacity (Btu/hr.) 48,000 to 60,000
- Partial Load – 5 to 7.5 gal/min Water Flow:
  - Heating Capacity (Btu/hr.) 27,500 to 37,500
  - Cooling Capacity (Btu/hr.) 13,500 to 18,500

Expected Q4 2024

ThermoLift

- Internal Refrigerant Type: R704 (Helium)
- System Type: Hydronic
- External Circulating Fluid: Water / Glycol / Brine
- Est. Sound Pressure (dBA): 55 @ 3 feet
- Net Unit Weight (lbs.): 750
- Shipping Weight (lbs.): 900
- Minimum Number Indoor Units: 1
- Maximum Number of Indoor Units: No Limit
- Fuel: Natural Gas, Natural Gas – Hydrogen Blend, Additional fuel compatibility possible based on application

ENERGY SOLUTIONS CENTER

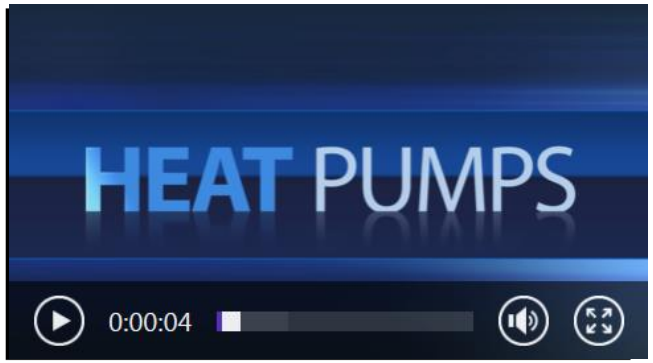
ESC | Gas Heat Pump Consortium

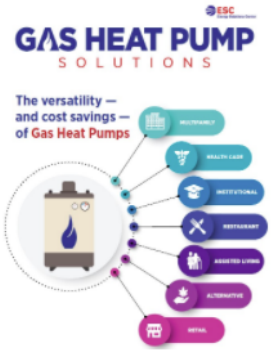
GHP Resources from ESC's GHP Consortium

Gas Heat Pumps – Extremely Energy Efficient – Even at Low Outside Temperatures

Natural gas heat pump options are available today that provide heating and cooling for residential, commercial & industrial customers. These systems utilize natural gas or renewable energy making them very reliable and energy efficient.

These innovative heat pumps can be configured as air source, water source, or ground source (geo-thermal) systems. Check out our video and Magazine:





www.gasheatpumps.com

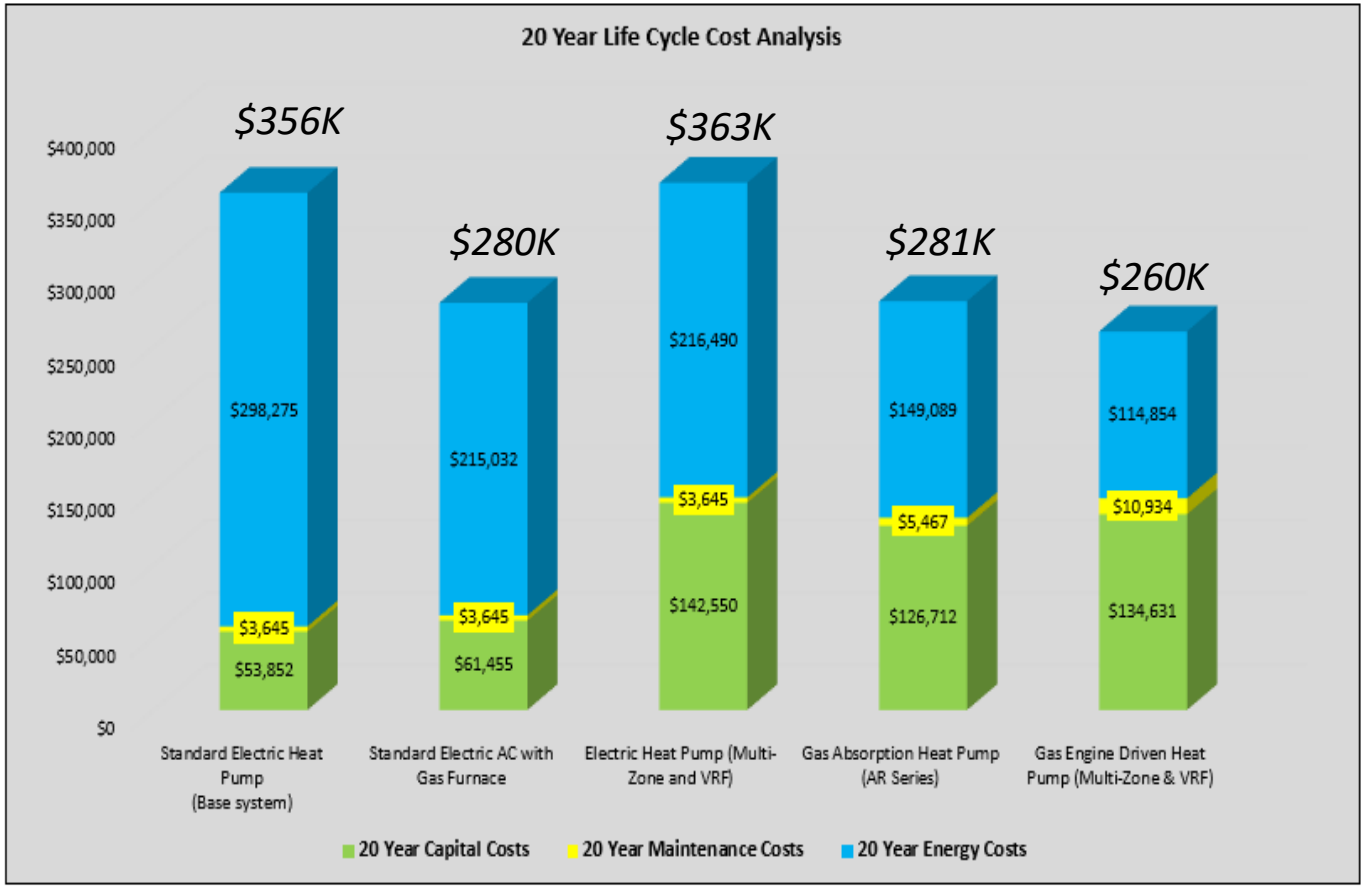
GHP Life Cycle Cost Analysis

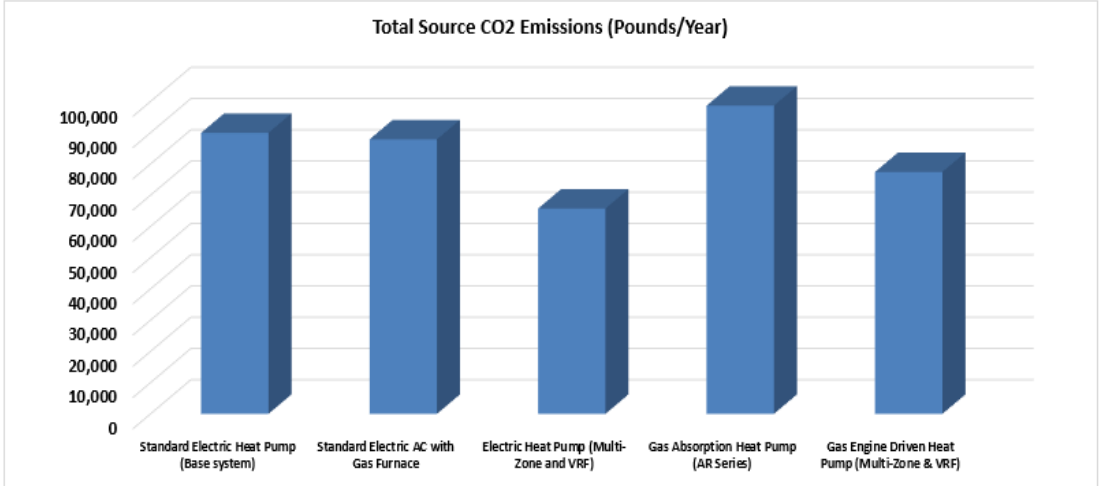
(Produced by ESC's Commercial Building Consortium)

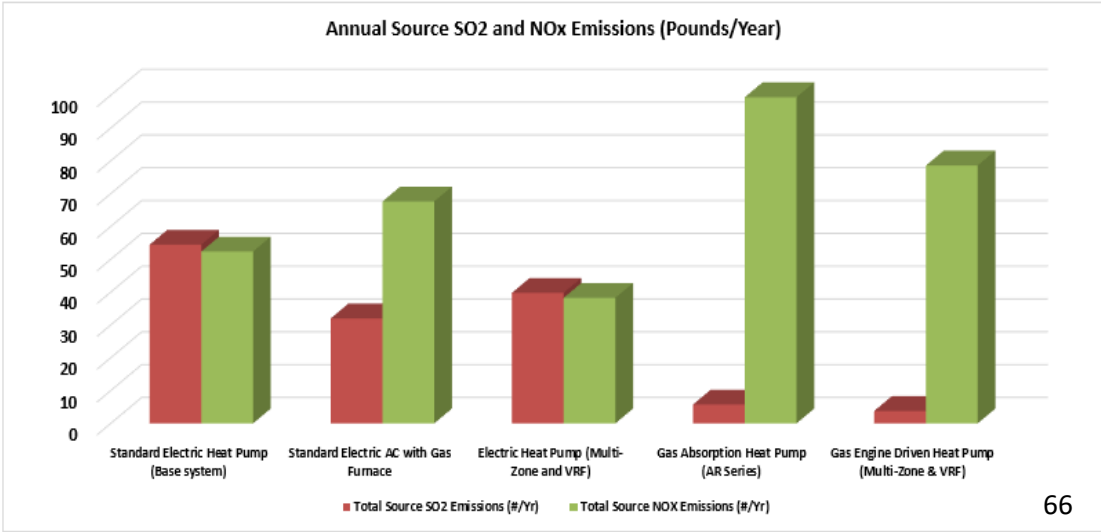
Natural Gas vs. Electric Cooling Analysis - INPUTS			
Average Electric Rate	$0.15	/ kWh	(Enter average or actual local electric cost)
Electric Demand Charge	$10.00	/ kw	(Enter demand charge if not included avg. above)
Natural Gas Rate	$0.65	$ / Therm	(Enter local natural gas rate)
Number of Chillers Installed	1		(For multiple cooling units, enter quantity of units)
Size of each Air Conditioner/Chiller	20	Tons	(Enter the size of a single cooling system)
Typical # of Months Cooling is Used	6	Months	(Include shoulder months)
Country	United States		
State or Province Emissions Profile	US Average		(Select US State or Canadian Province)
Fuel Cost Inflation Rate	2%	/ Year	(Used in life cycle cost analysis, assumes energy costs will increase over time)
Percentage Carbon Free Gas Used	0%		(allows for use of some % of renewable gas blended with natural gas)
Maintenance Cost Inflation Rate	2%	/ Year	(Used in life cycle cost analysis, assumes energy costs will increase over time)
Loan Interest Rate for Capital Equipment	5%		(Interest rate for loan to purchase and install equipment)
Discount Rate	5%		(Rate of return you could get from an investment of similar risk)
Gas Cooling Rebate	$0		(Enter any rebate or incentive being offered)
Equivalent Full Load Cooling Hours	1,500	Hours	(Estimate varies by region, typically from 1,500 in North to 2,500 in South)
Equiv. Full Load Heating Hours	1,000	Hours	

https://gasairconditioning.com/general-resources/tools/

Gas Heat Pump Life Cycle Cost Analysis







Thank You

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