BUILDINGENERGY BOSTON

Decarbonizing and Electrifying DHW Using Commercial-Scale CO2 Heat Pumps

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Northeast Sustainable Energy Association (NESEA)
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MITSUBISHI ELECTRIC
HEATING & AIR CONDITIONING

NESEA
Decarbonizing & Electrifying DHW Using Commercial-Scale CO2 Heat Pumps

Cain White – Director of Commercial Product Management

03/29/2023

QAHV Heat Pump Water Heater

- Utilizes Natural refrigerant
  - CO_2
  - Global Warming Potential of 1
- High efficiency
  - COP up to 4.52
- High Temp Hot water
  - Up to 176°F

CO_2 refrigerant

Low Ambient Temperature Operation

- Operable at low outdoor temperatures
  - Down to -13°F (with capacity rating)
  - Down to -35°F (without capacity rating)
- 100% heating capacity at 36°F
- 50% heating capacity at -13°F

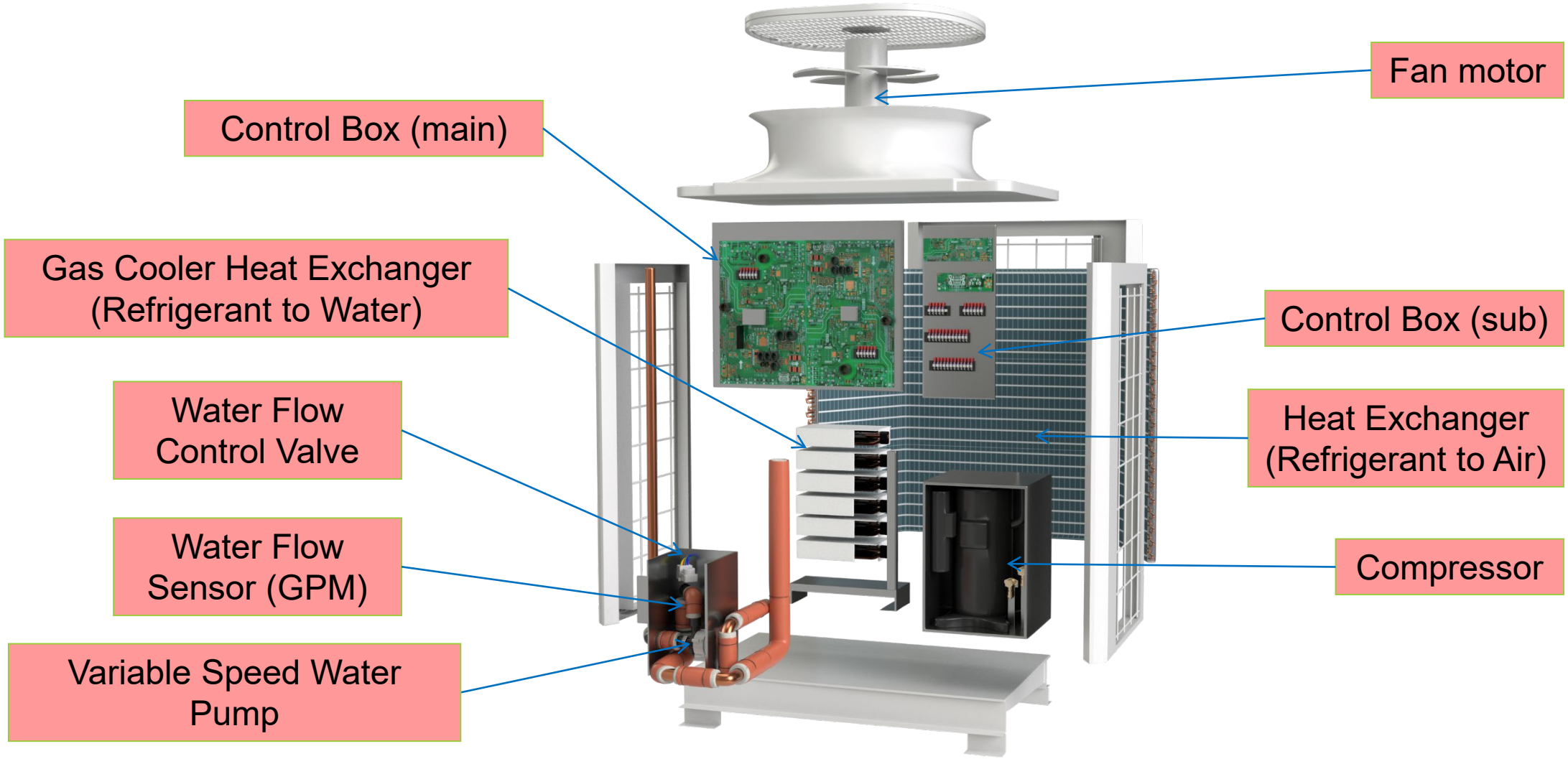
CO_2 refrigerant

Variable Capacity

- 3 Capacity Settings
  - 136,485 BTU/hr. / 40kW
  - 170,607 BTU/hr. / 50kW
  - 204,728 BTU/hr. / 60kW
- Up to 16 units can be piped in parallel
- Maximum system size
  - 2,183,770 BTU/Hr. / 640kW

CO_2 refrigerant

Unit Structure



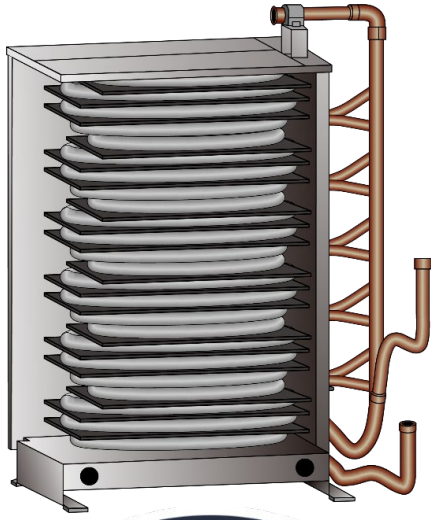
Refrigerant to Water Heat Exchanger

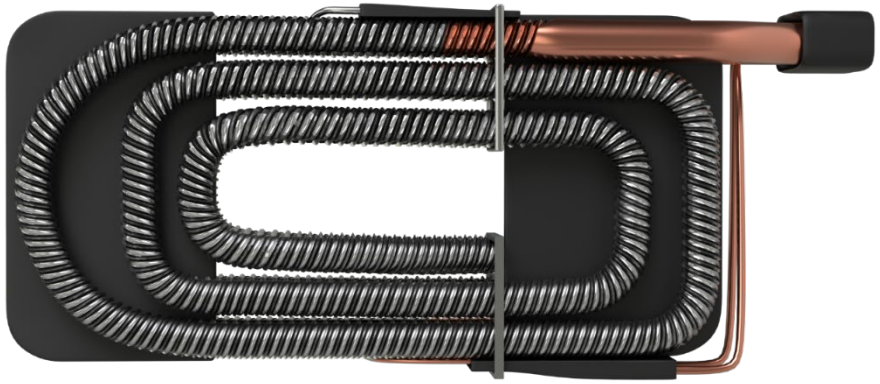
Twisted Spiral Gas cooler

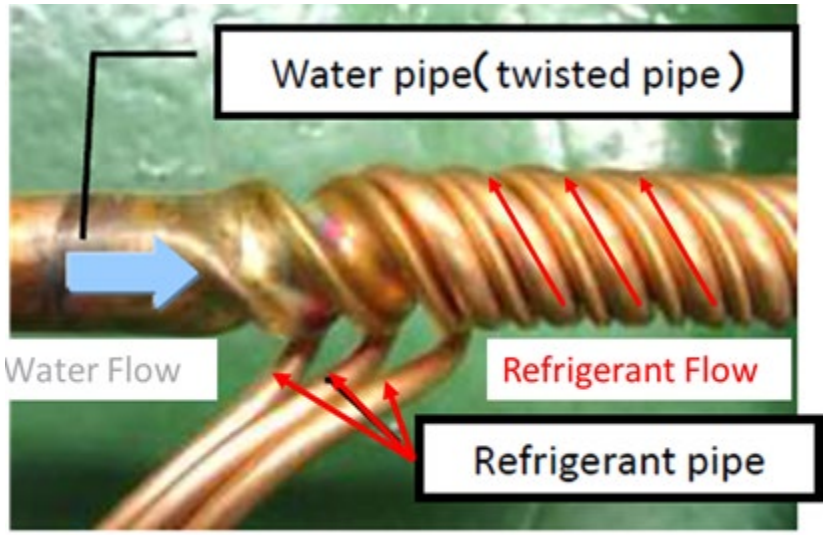
Patented technology

Double Wall construction

6 per QAHV

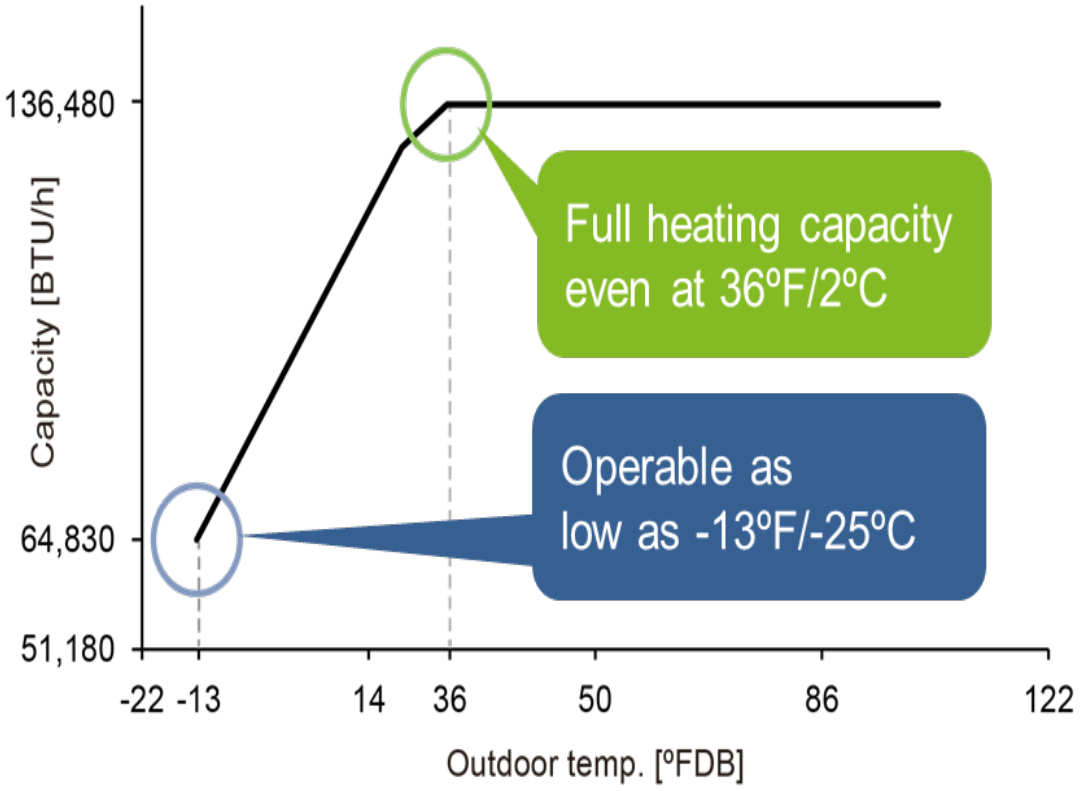


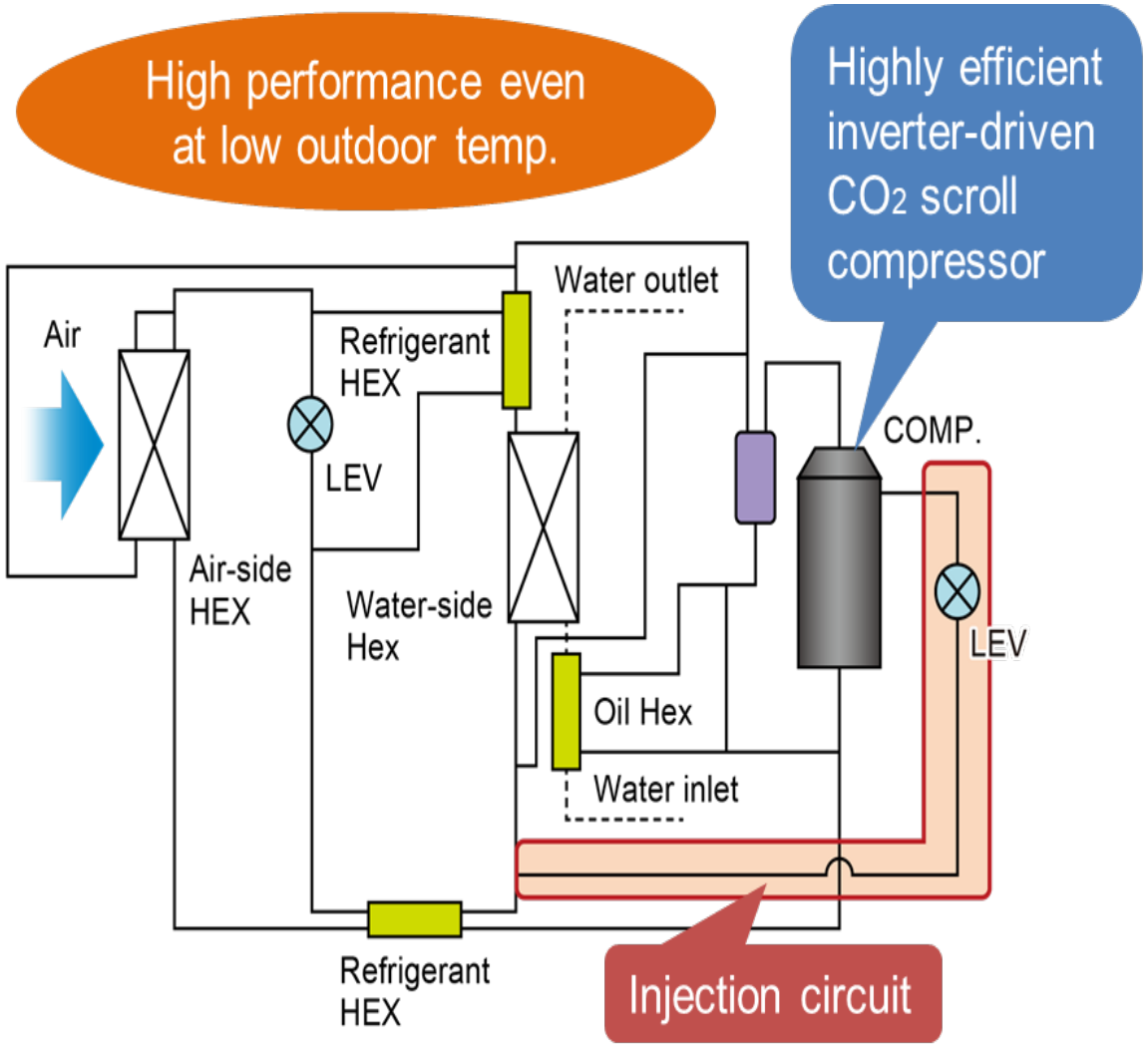




Flash Injection Technology

Stable Heating Capacity even at low temperature





Why CO_2

Environmentally friendly

Global Warming Potential of 1

Ozone depletion potential of 0

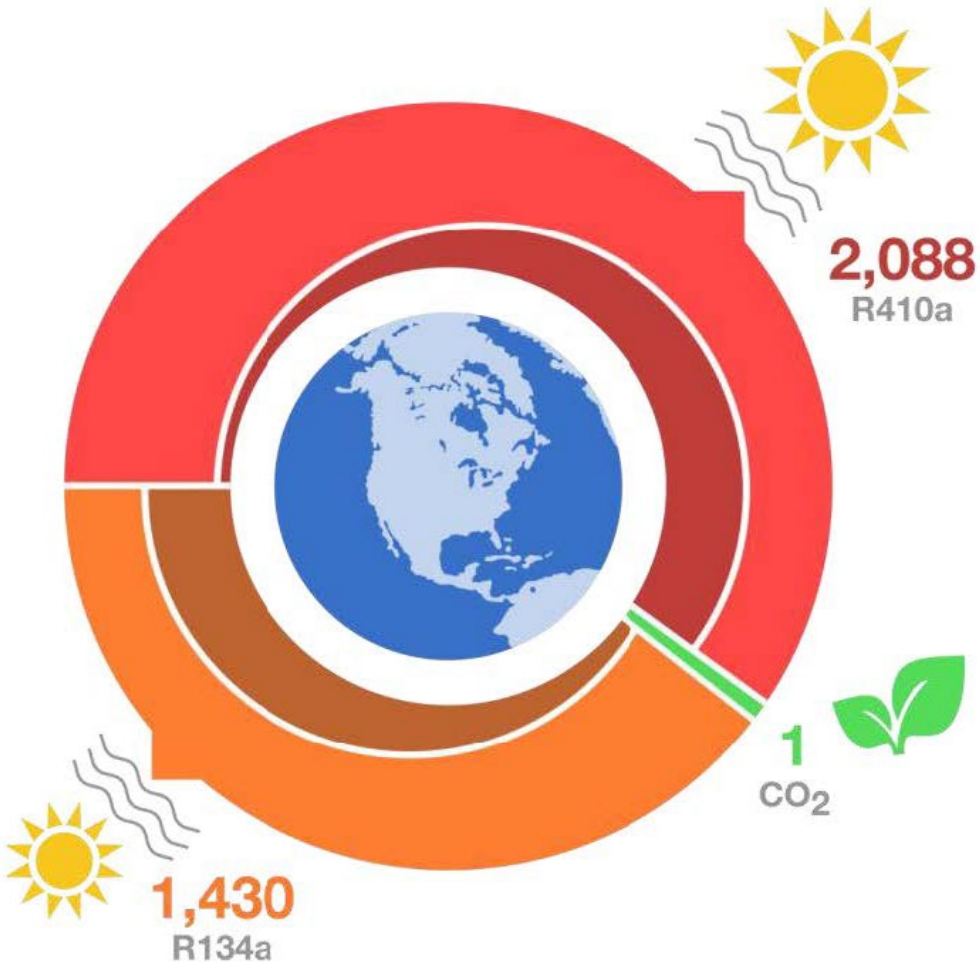
Nonflammable

Nontoxic

High pressure/temperature refrigerant

Excellent Low Ambient Performance

Highly efficient



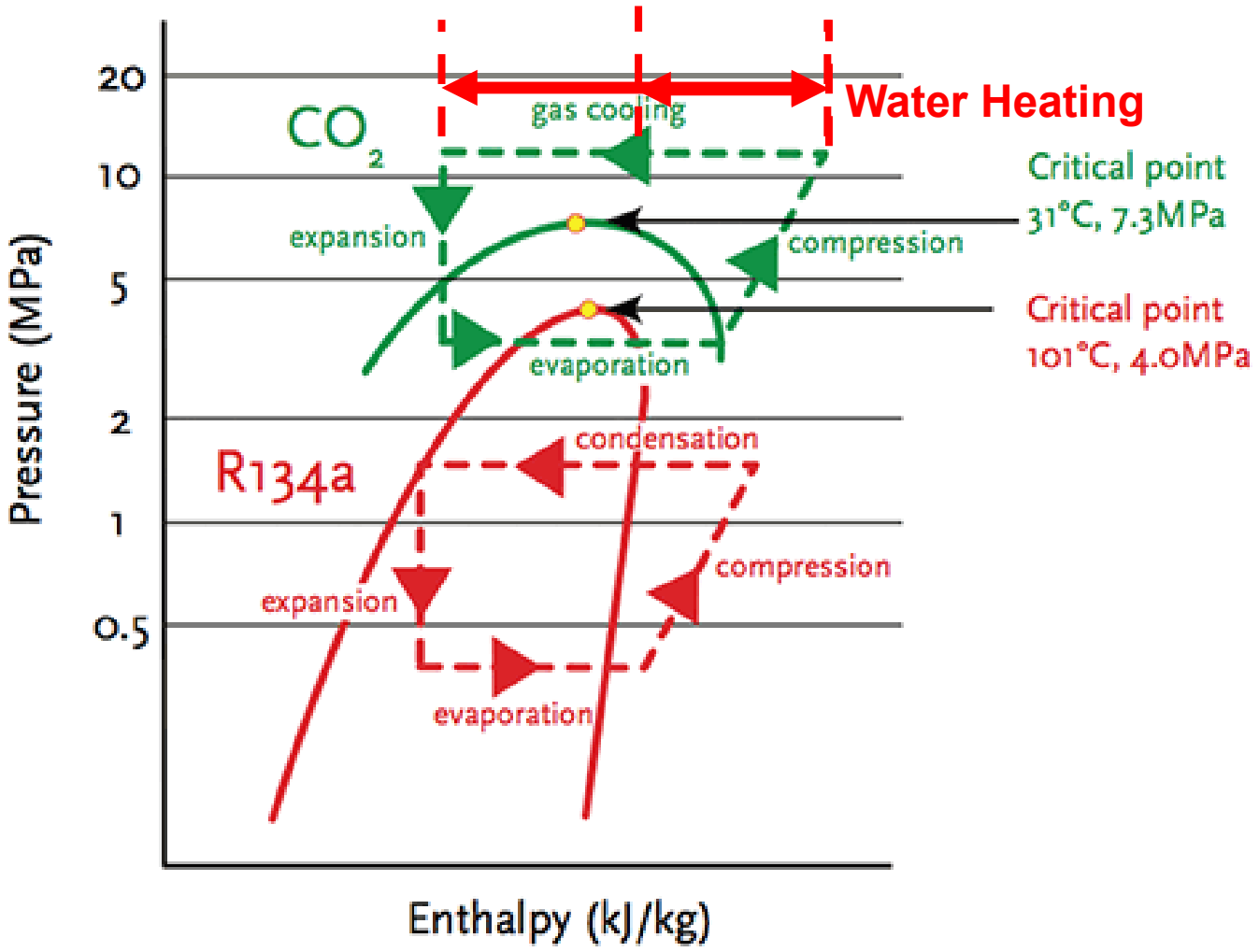
CO_2 and the Trans-critical cycle

Higher Pressure compared to R134a

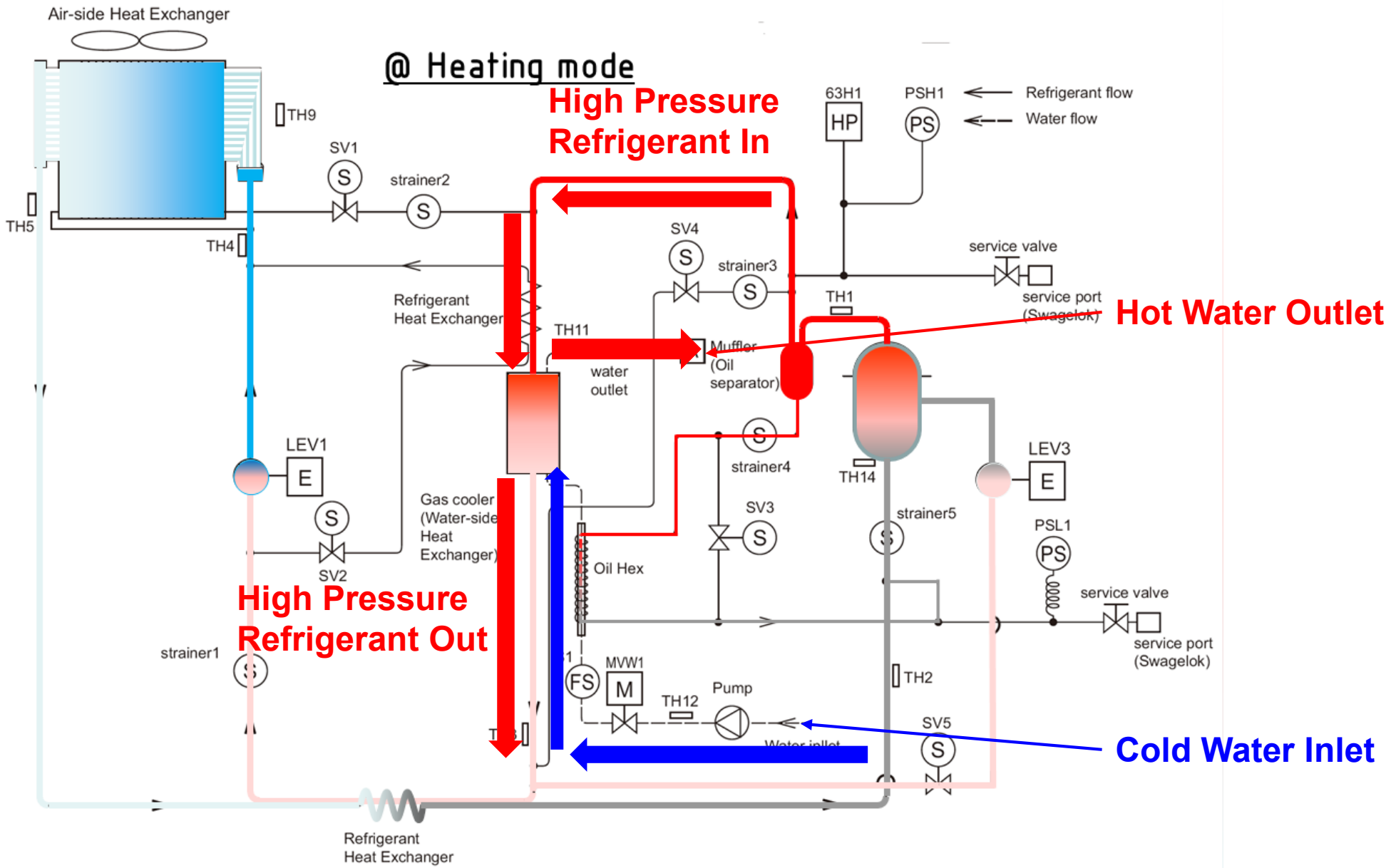
Refrigerant remains in a vapor state during the heating cycle

High heat transfer coefficients

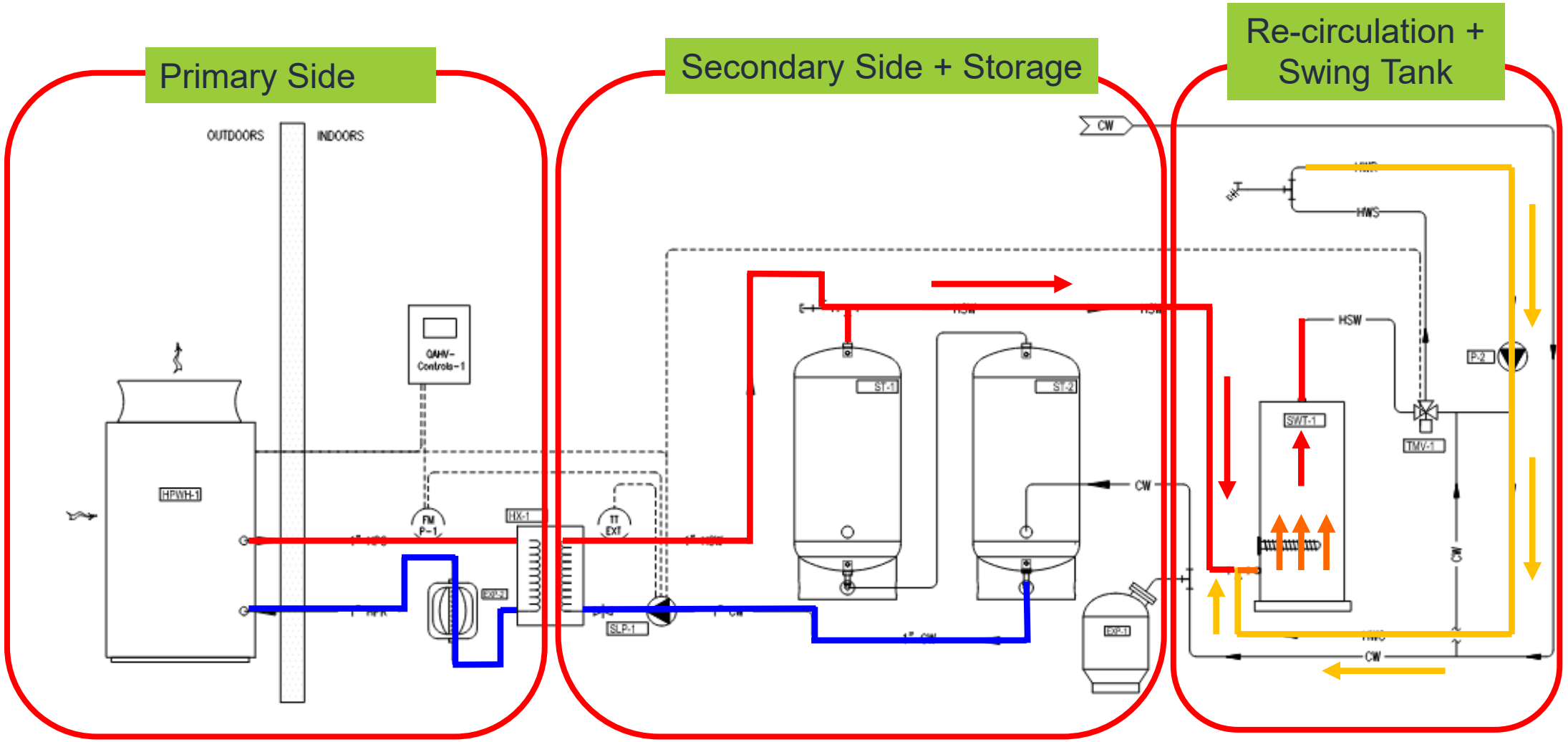
Higher volumetric capacity



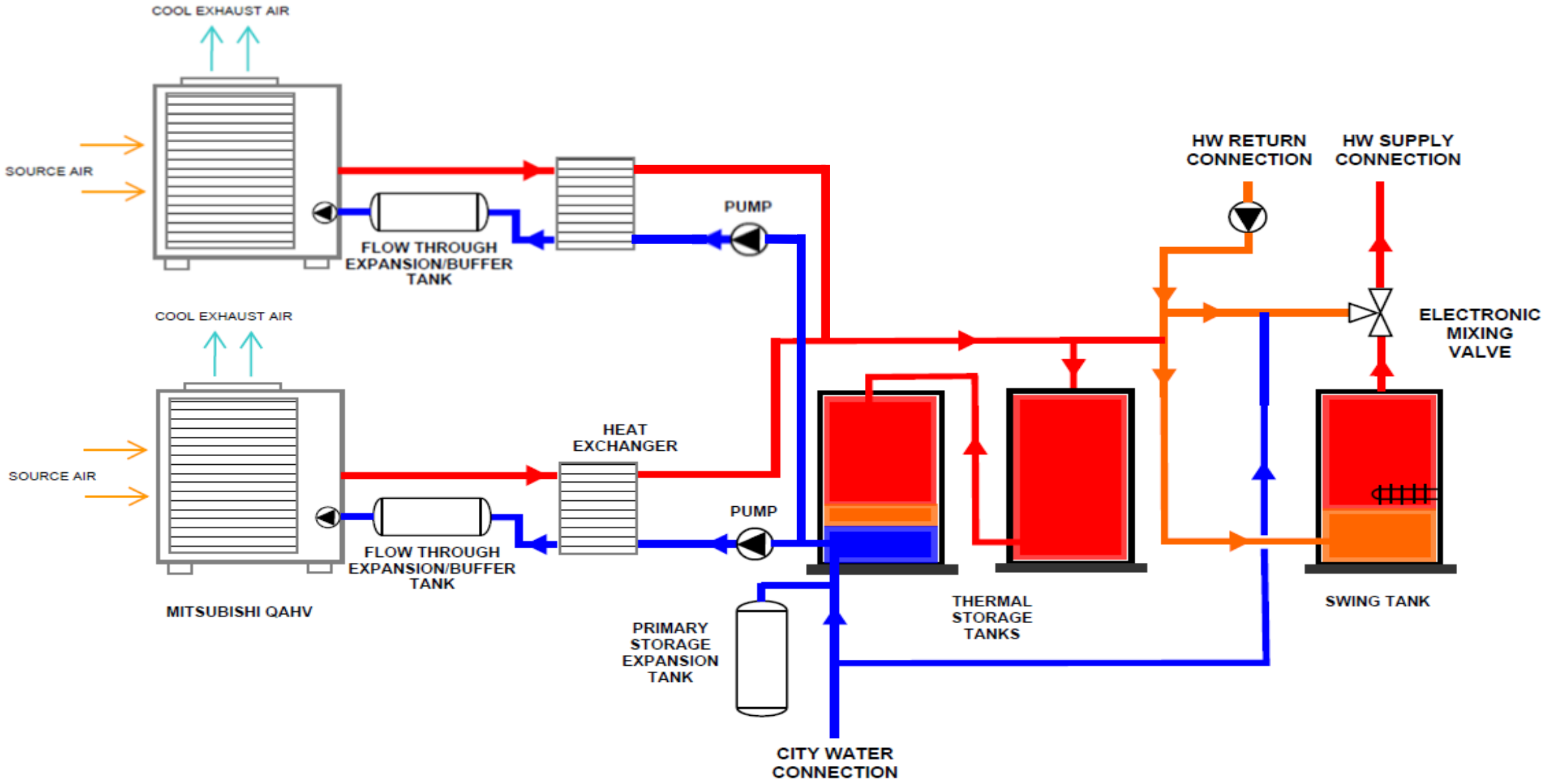
Refrigerant Circuit – Heating Mode



CO2 Heat Pump System Schematic



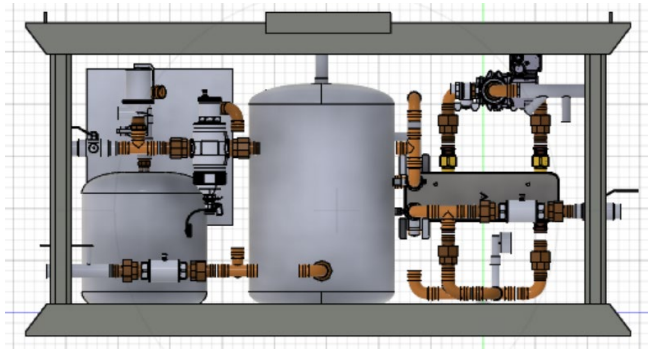
Basic System Schematic – Multiple Heat Pumps



Commercial CO2 System Components

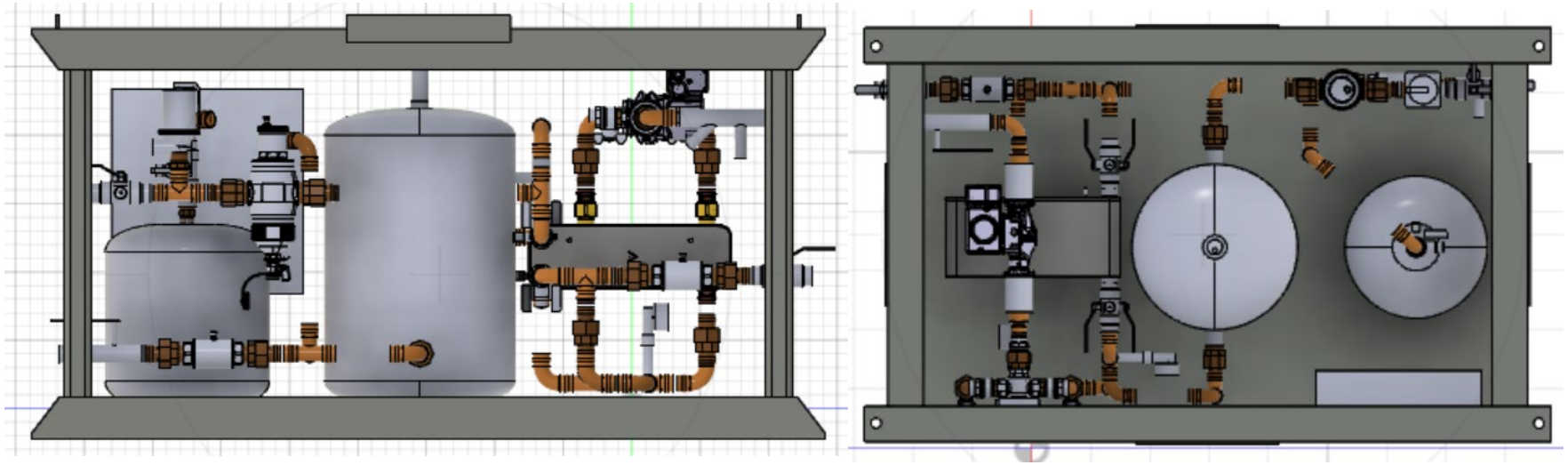
Installation Complexity
Mistakes
Labor
Cost

Skid Approach

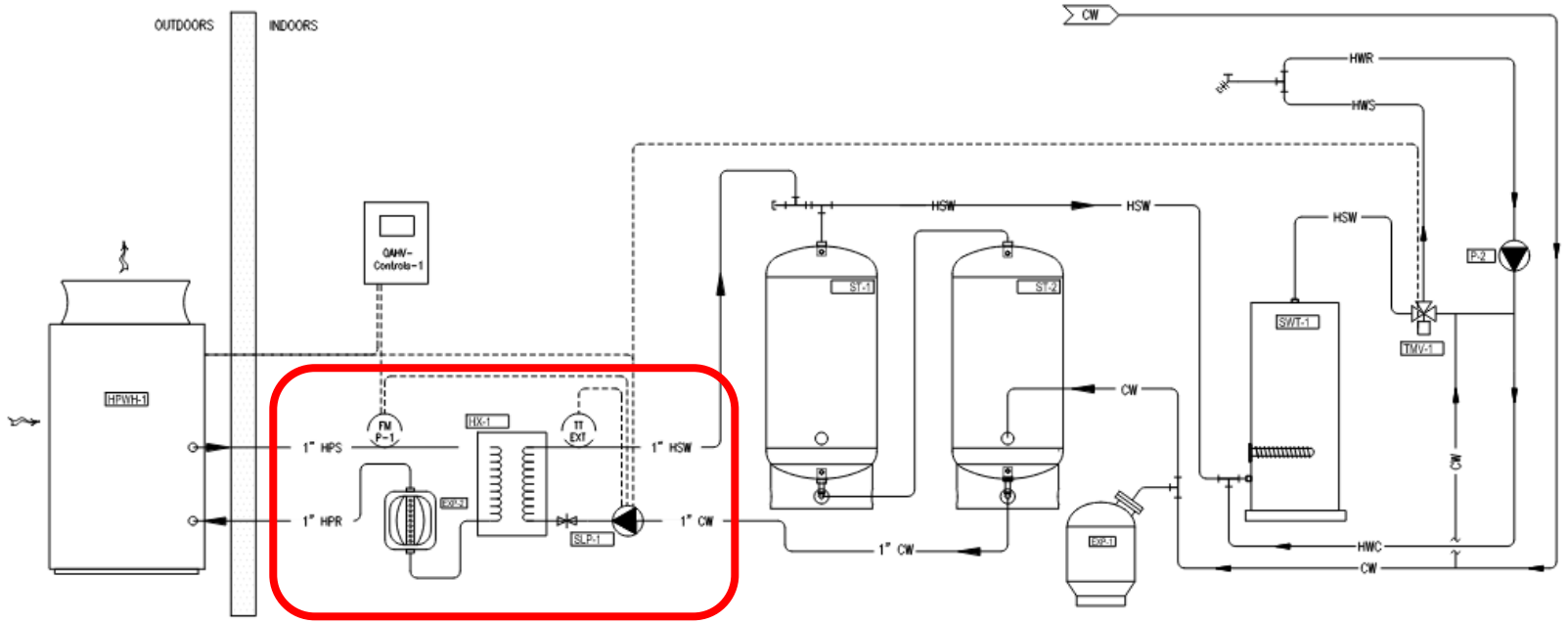


Intermediary Skid

- Factory assembled
- Secondary Pump
- Secondary HEX
- Buffer Tank
- Expansion Tank
- Key Valves
- Controls
- Fits through standard doorway

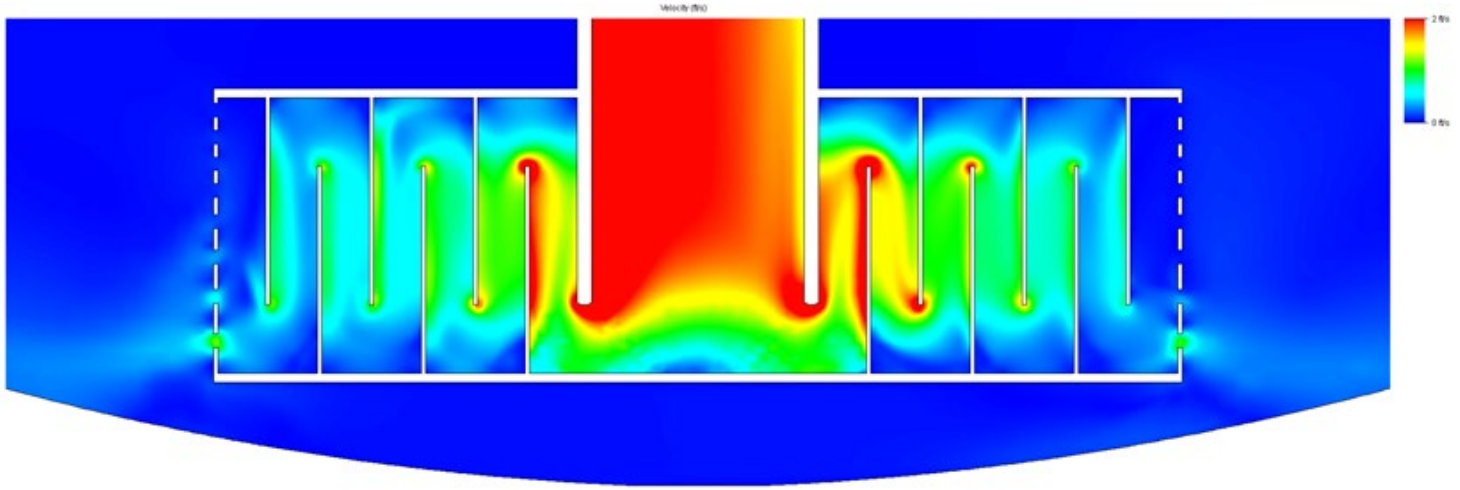


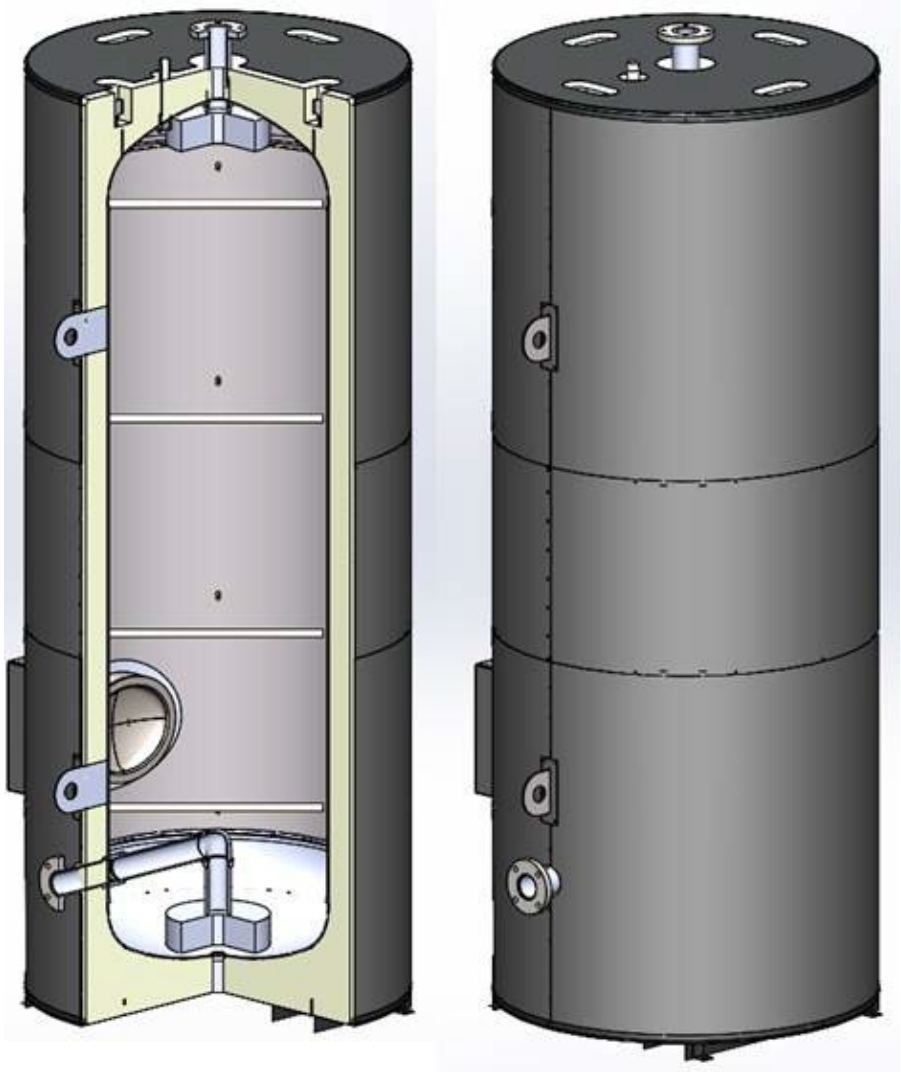
- Reduced on-site complexity
- Less labor required
- Quality - works 1st time



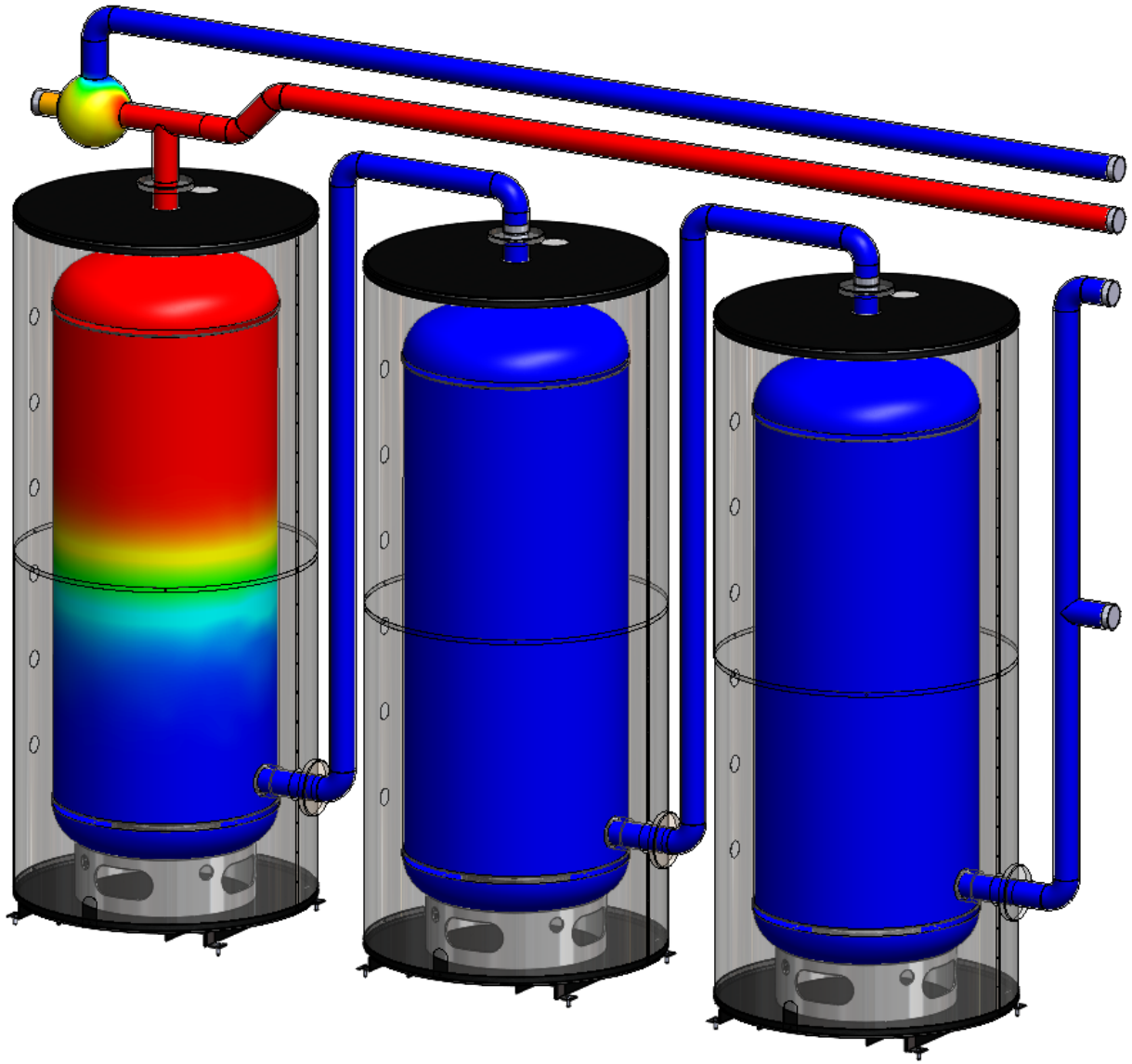
Unique Tank Designs

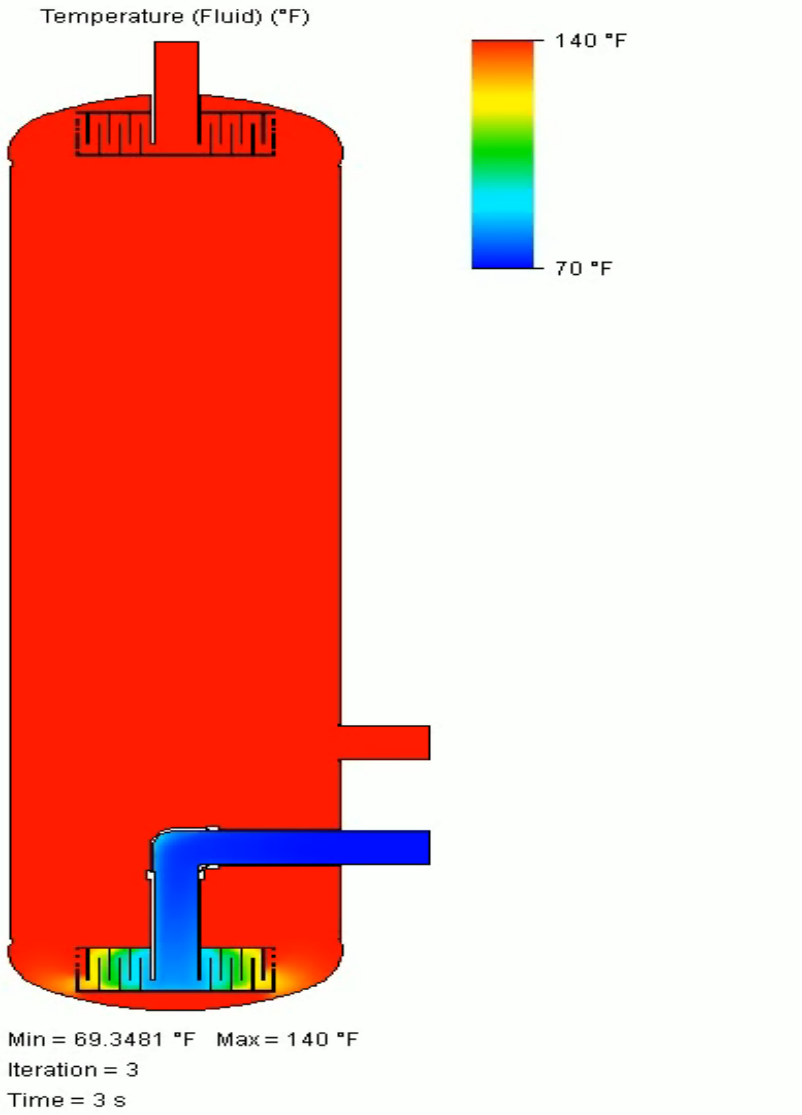
- Engineered storage tank solutions to **maximize** the **efficiency** of the **system**
- Patent Pending baffle design promotes reduced velocity in both directions



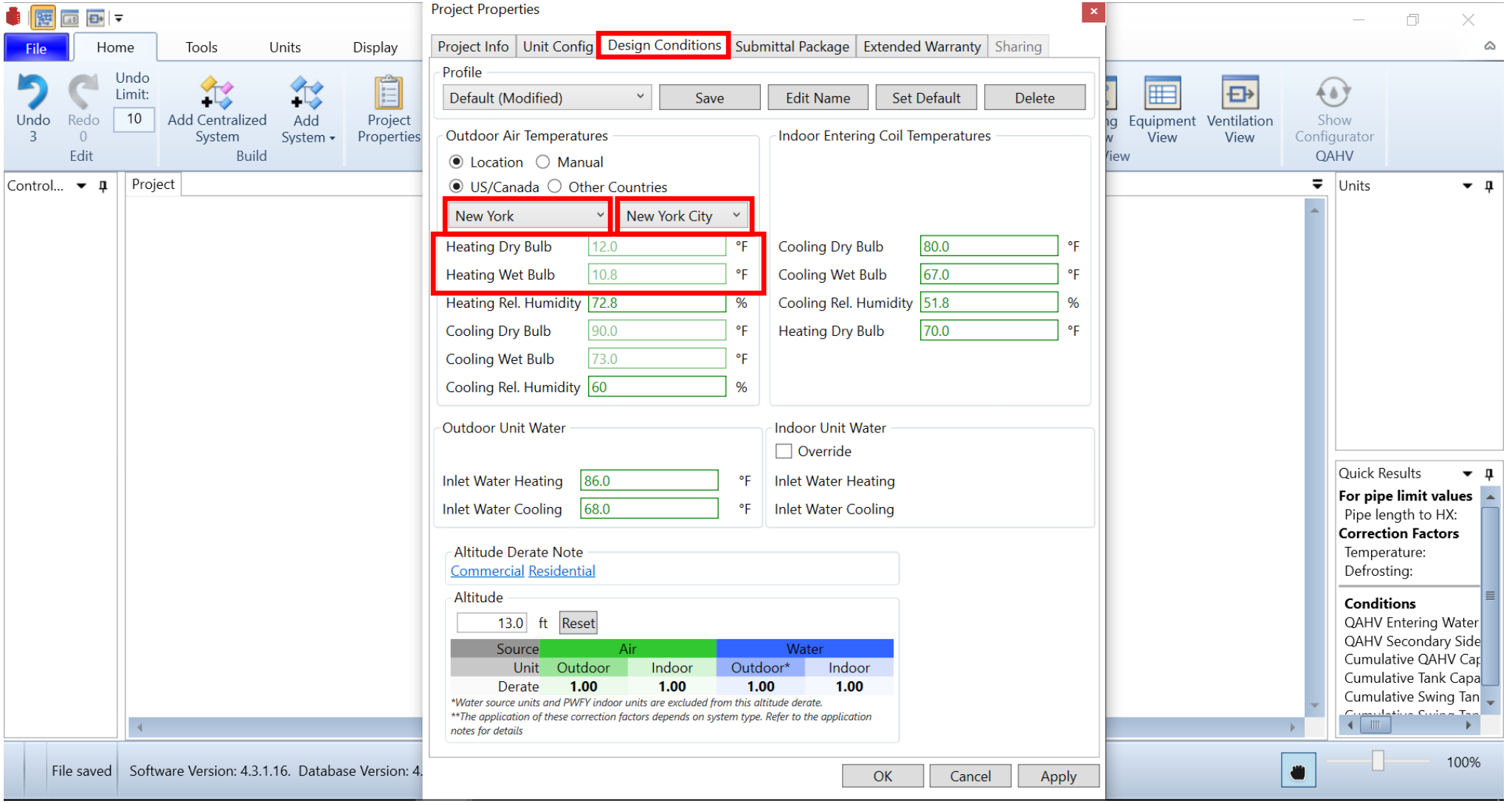


Tank Stratification – 95%Volume Utilization

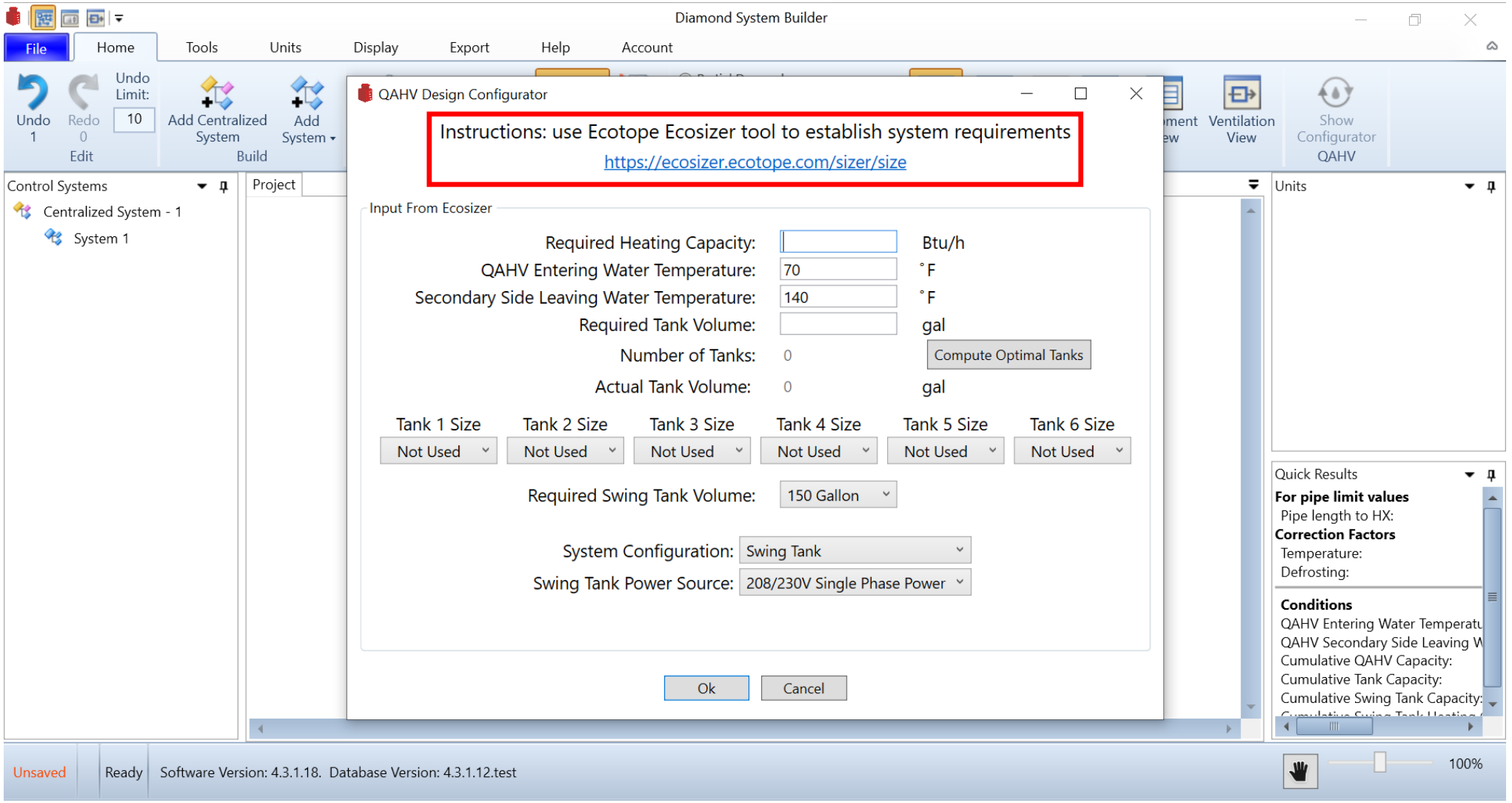




Design Selection Software



Selection Software System Sizing

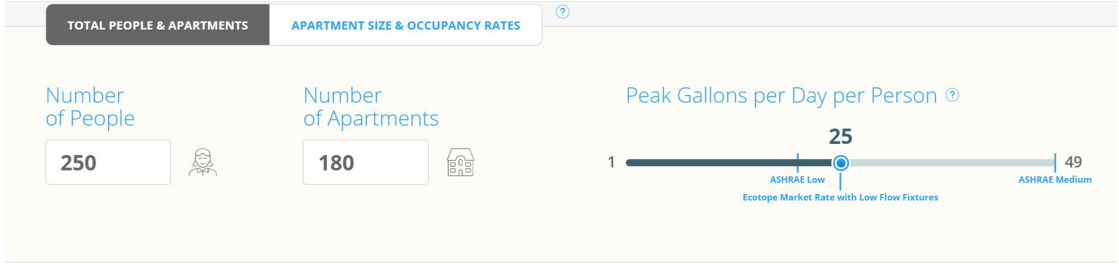


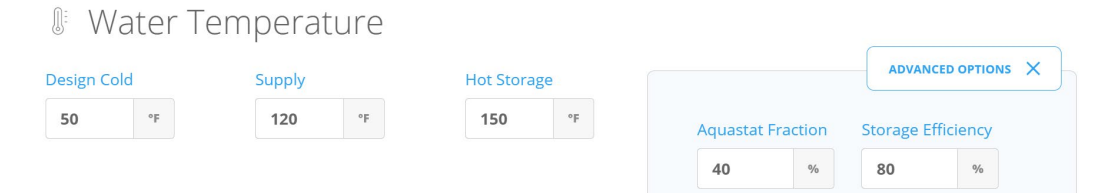
Ecosizer Heat Pump and Tank Sizing Tool

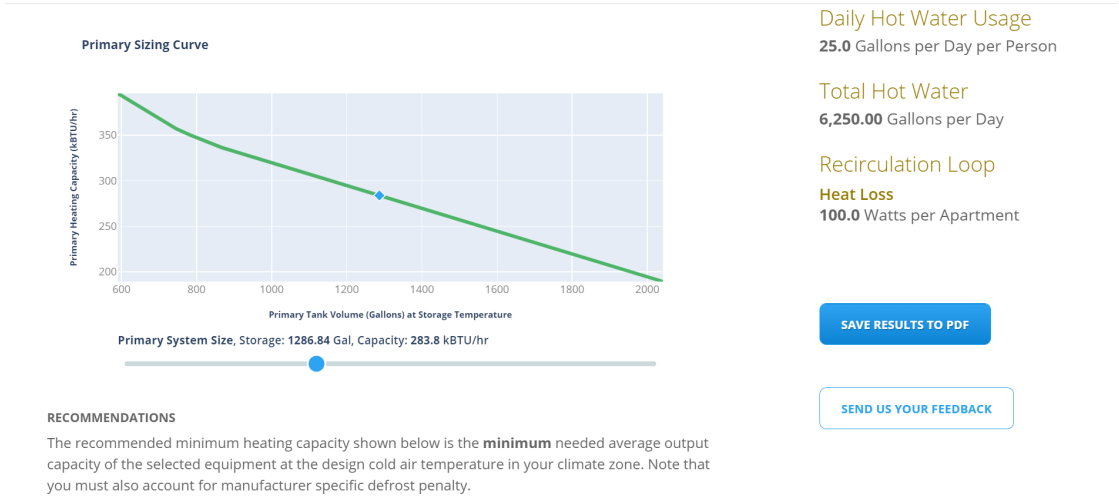
User Friendly sizing tool developed by Ecotope

Simple input options for the user

Quick results with the ability to edit and customize the selection







Tank Volume
1,287.00 Gallons

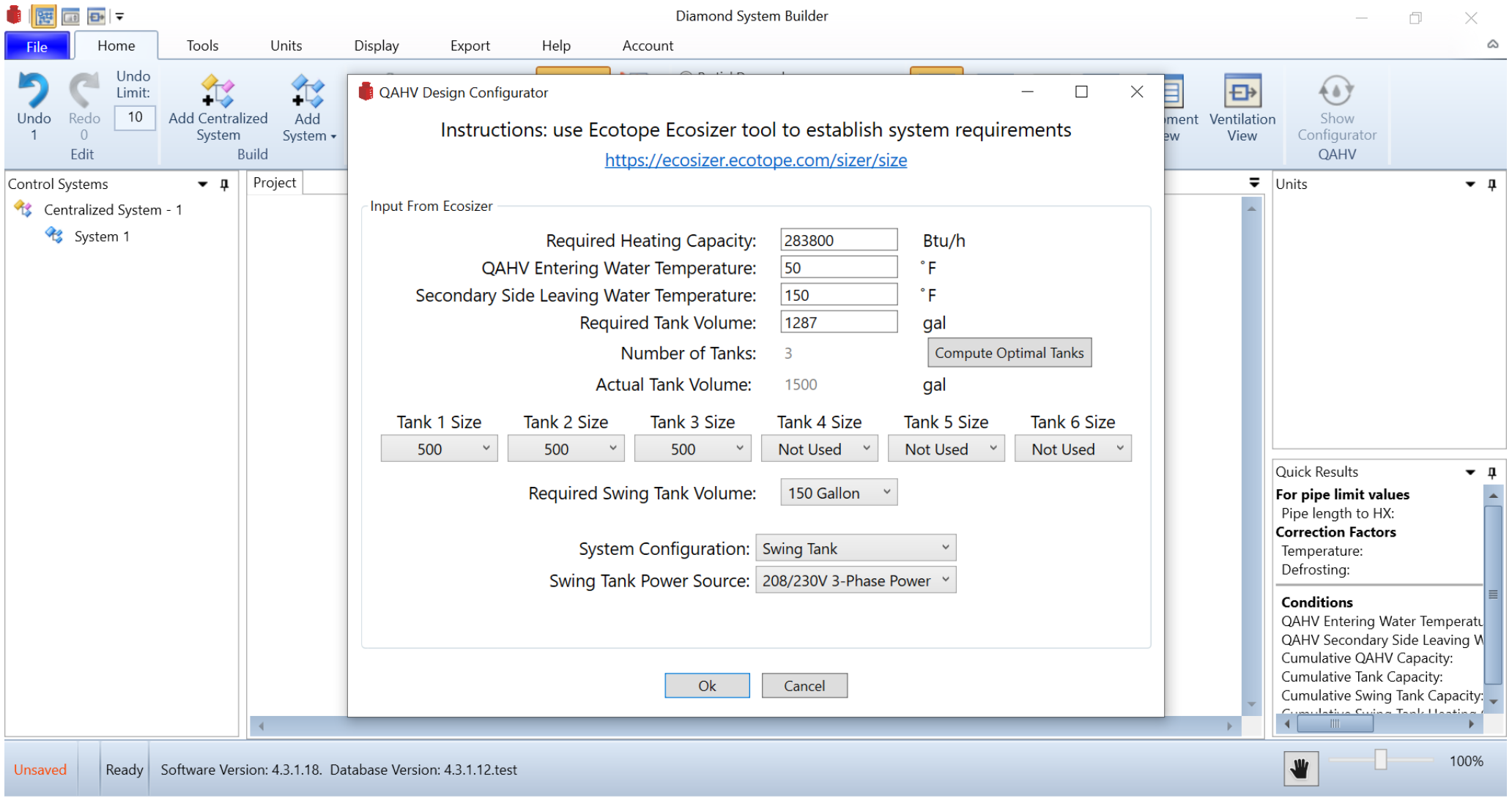
Heating Capacity
283.80 kBTU/hr

Swing Tank Volume
120 - 300 Gallons

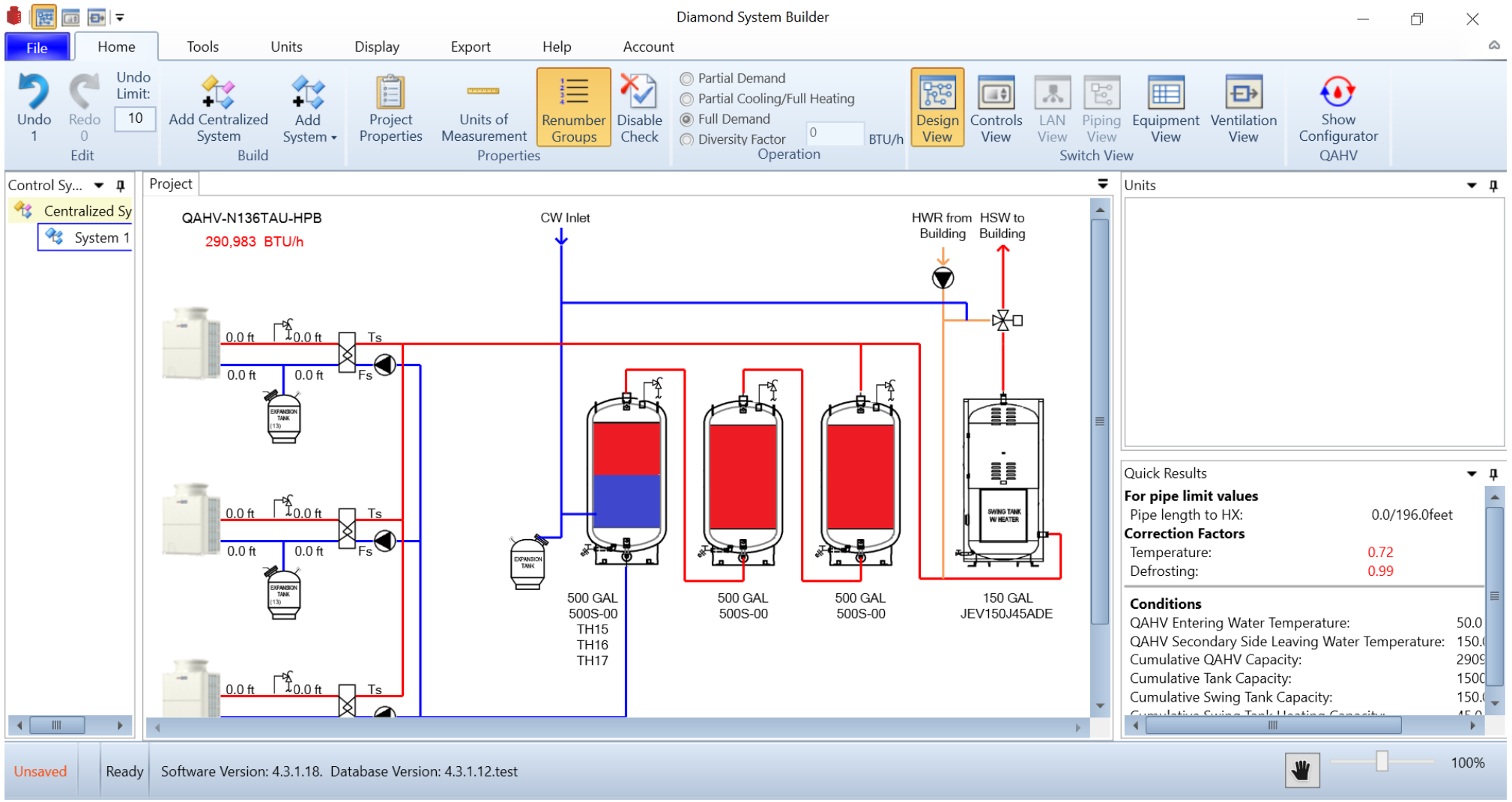
Swing Resistance Element
31.5 kW · **107.5** kBTU/hr

CA Title 24 Swing Tank Volume
480 Gallons

Selection Software Inputs



Selection Software System Schematic



Controls

- Cohesive controls package required
  - BACnet connectivity
  - Load shifting / demand response
  - **CTA2045** compatible
  - Monitoring of 3rd party devices
  - COP Monitoring of System
  - Install wizard

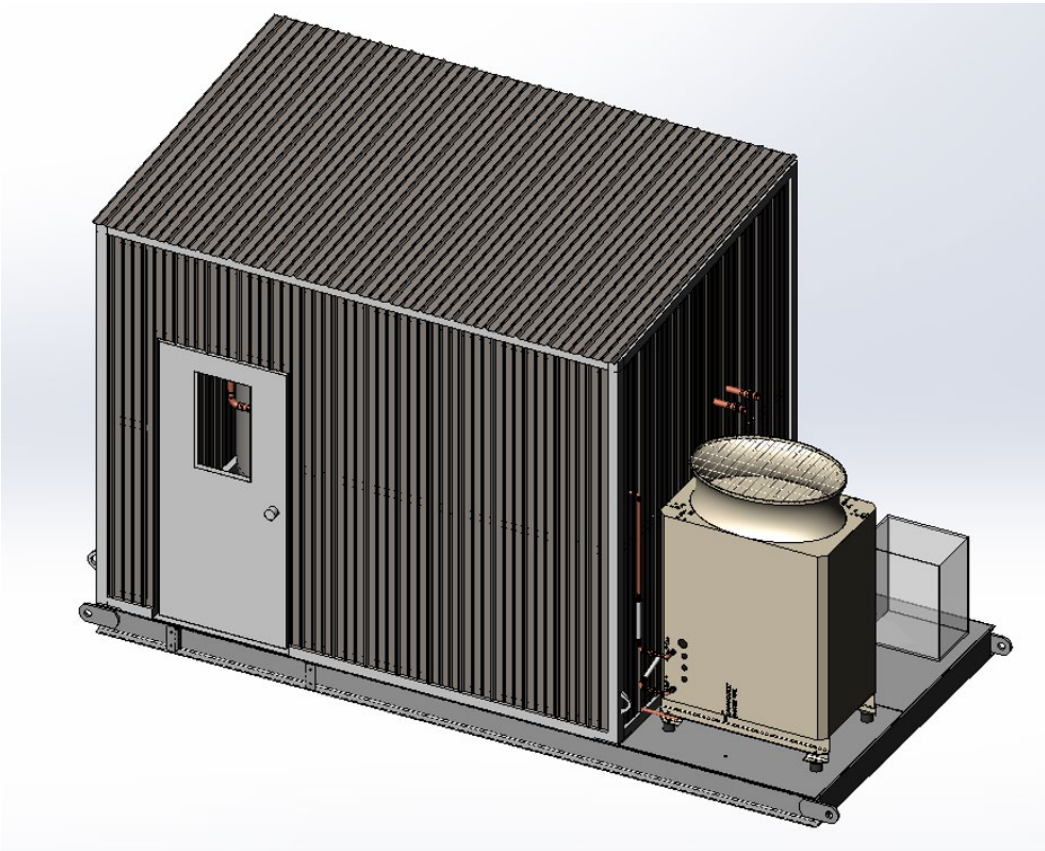
Bayview Tower - QAHV Retrofit Project

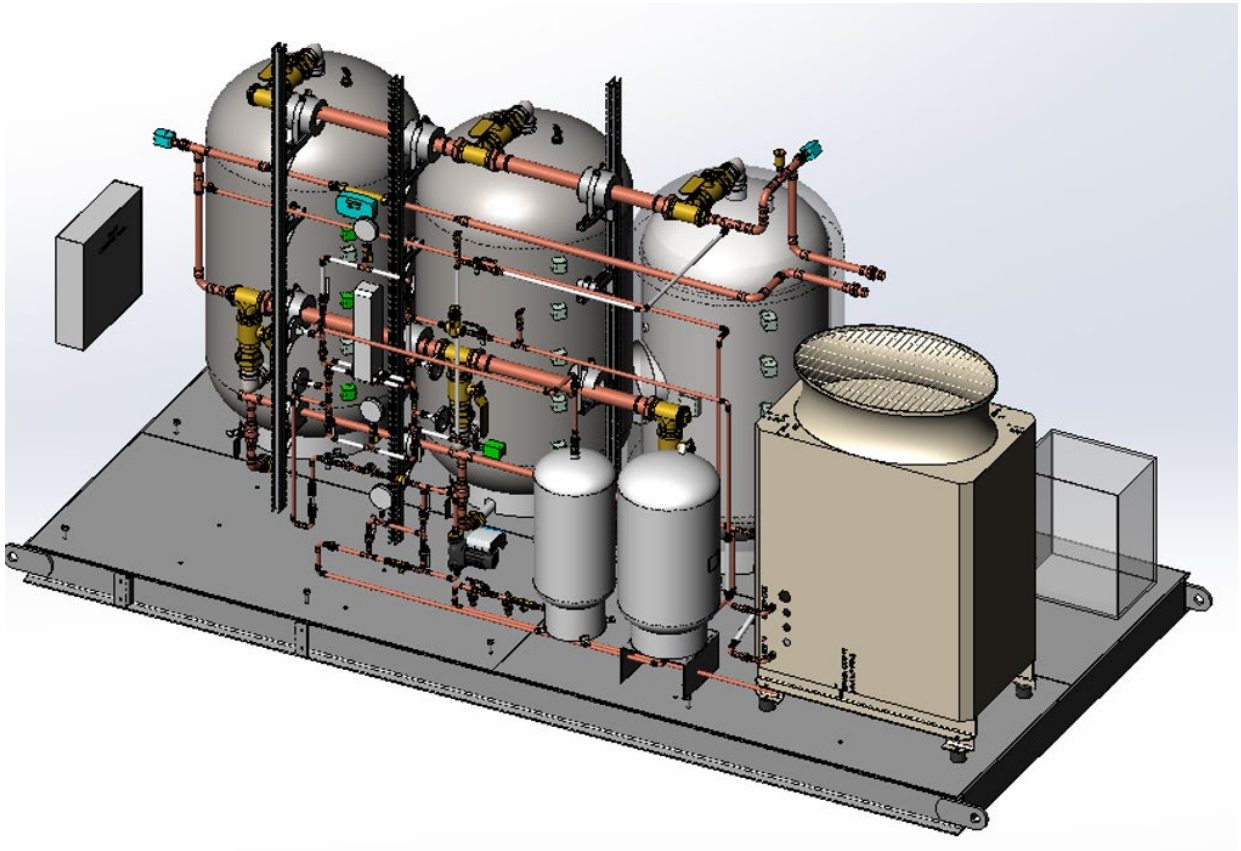
- 100-unit multifamily building
- Pre-retrofit monitoring
- Packaged skid delivered to site
- Demand response controls through CTA-2045
- Measurement and Verification System

Pre-retrofit Monitoring

- 3,600 Gal/day peak load
- 3,150 Gal/day avg load
- ~20 gal/day/person
- 80 W/apt recirculation load
- Recirculation approximately 40% of total load

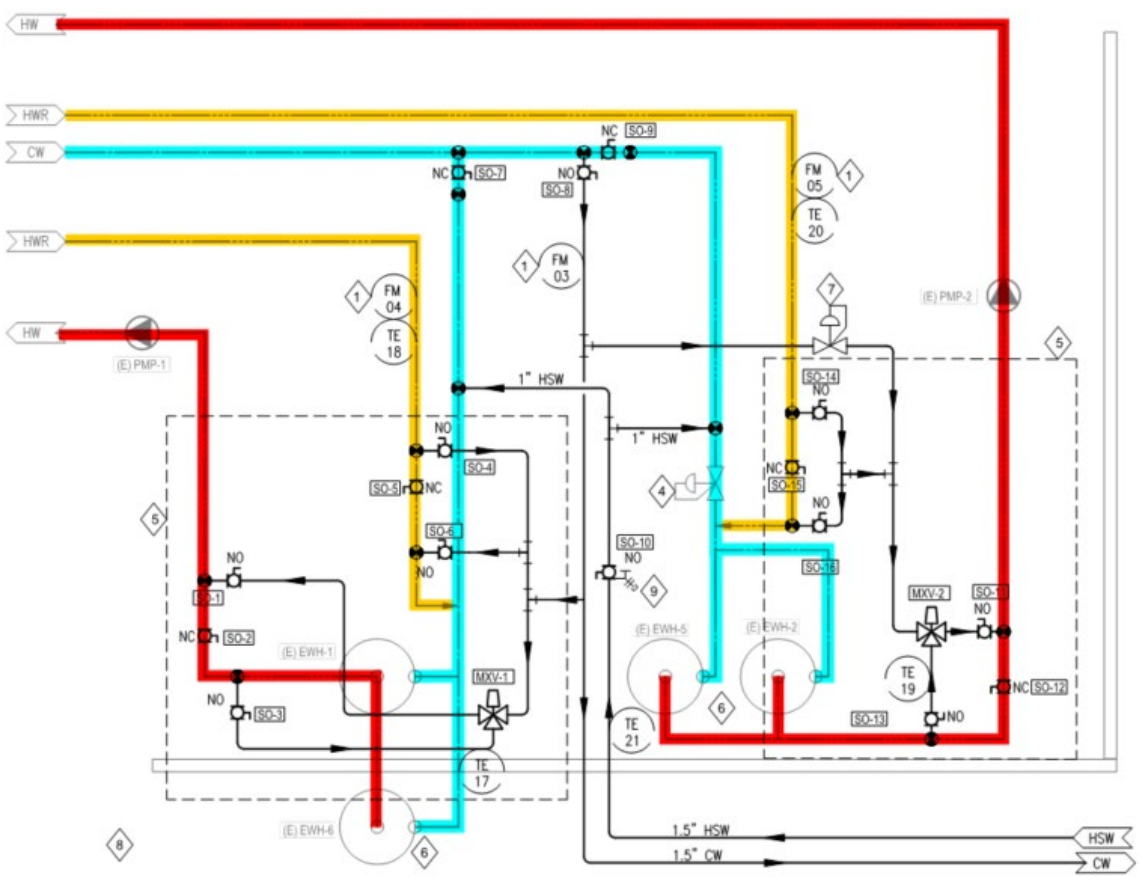
Packaged Skid



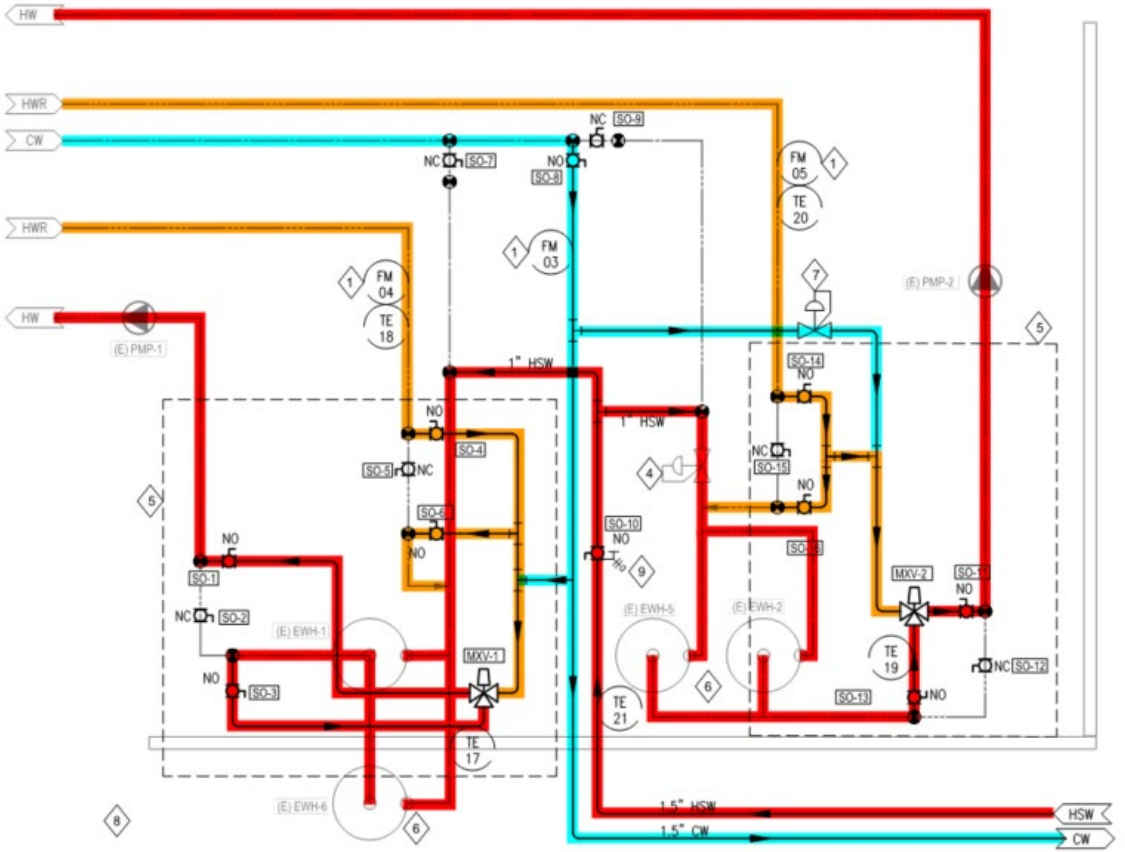


Skid installation

Piping Design



Electric Resistance Operation



Heat Pump Operation

Bayview Tower – Energy Use Comparison

- Previous System
  - 102kW Power Input (6 Rheem Commercial Water Heaters)
- Heat20 System
  - 14kW Power Input (Plus cycling of 4 water heaters during low load/overnight operation)
  - 2 Rheem water heaters removed entirely
  - Estimated energy reduction of 136,875 kWh/year or 40%
  - Estimated annual cost savings of $15,000 based upon $0.11 kWh electricity rate

Hotel Marcel New Haven Connecticut – Historic Pirelli Building

- 1st Net Zero Hotel in the U.S.
  - 110,000 sq. ft. retrofit project
  - 165 guest rooms
  - 60% more energy efficient than code requirements
- All electric building
  - 3 QAHV heat pump units installed
  - 12 Tesla Superchargers
  - Over 1000 photovoltaic panels
  - VRF systems for cooling/heating

Key Considerations

- Engineered solutions required - not just adding heat pump units
- System sizing is critical to operation and efficiency – consider load shifting when sizing system
- Increased storage tank volume for retrofit applications
- Where will the new storage tanks be located?
- Is the existing power supply adequate for the new heat pump loads
- Follow manufacturers recommendations for system design

Thank you!

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