

ET Summit 2024

Presented by



Decarbonizing Heating and Cooling with CO2 Heat Pumps

Flow's ANSWER

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The Problems

The EXISTING Built Environment contributes to ~40% of all greenhouse gas (GHG) emissions.

How do we retrofit existing systems?

The global building stock is expected to double by 2060.

How do I build a better building?

We need to reduce building emissions.

- Voluntarily
- Regulatory

Biggest Levers

- Electrification of Heat
- Heat Pumps
- Refrigerants

Solutions for Heating

Legacy: The Past

Combustion

- Furnaces
- Boilers

Electric Resistance

Heat Pumps: the Present and the Future

Air-to-Water

- Hydronic systems

Water-to-Water

- Hydronic Systems
- Simultaneous Heating and Cooling
- Heat Recovery
- Booster
- Geothermal / Geo Exchange

Water-to-Air

- Hydronic systems
- Boiler tower arrangements

Air-to-Air

- DX RTU's
- Hydronic AHU's

VRF

- Refrigerant Based

Movement to Hydronic HP Systems

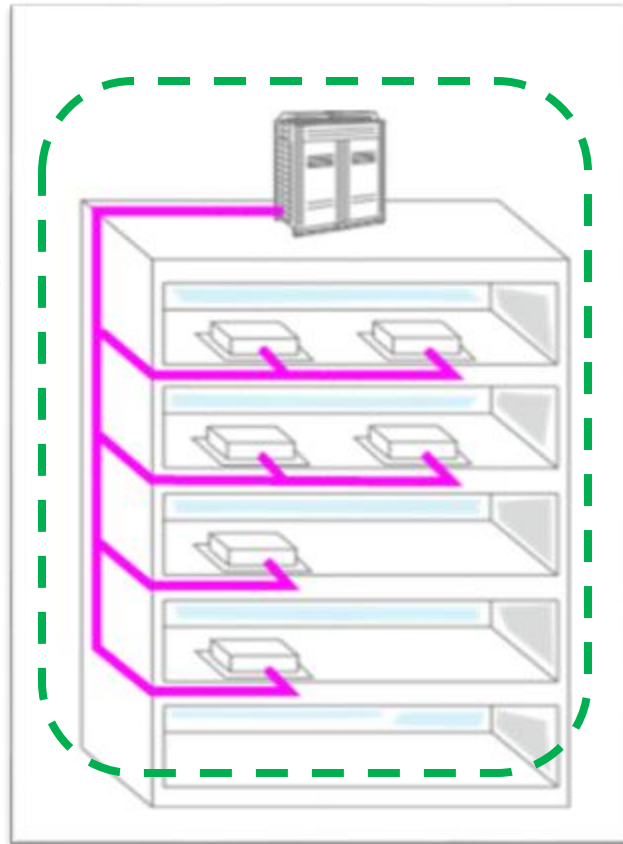
VRF Approach

Distributed **Refrigerant** piping

All equipment refrigerant dependent

Large refrigerant charge

Leakage of high GWP refrigerants



Hydronic Heat Pump

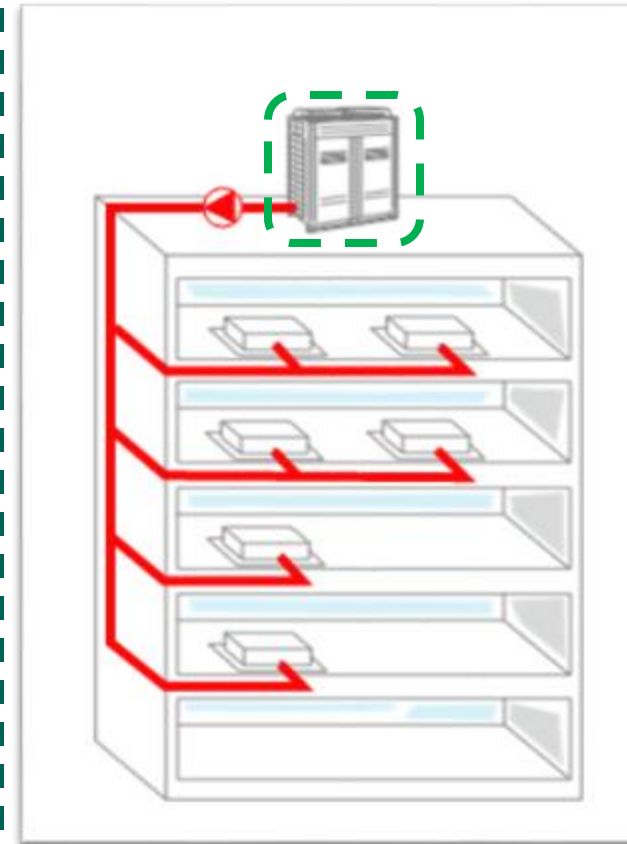
Distributed **Water** piping

Refrigerant limited to Heat Pump

Small refrigerant charge

Thermal storage

Beneficial electrification



Refrigerant GWP restrictions and phaseouts favoring smaller refrigerant volumes and natural refrigerants

Refrigerants for Heat Pumps

Natural
Synthetic High Pressure
Synthetic Low Pressure

	Regulation Targets	R-744 CO2	R-290 Propane	R-717 Ammonia	R-410a	R-32	R-454B	R-134a	R-513A	R-1234yf	R-1234ze	R-1233zd
Composition		Pure	Pure	Pure	Blend 50% R-32 50% R-125	Pure	Blend 68.9% R-32 31.1% R-1234yf	Pure	Blend 44% R-134a 56% R-1234yf	Pure	Pure	Pure
Type		CO2	HC	NH3	HFC	HFC	HFO	HFC	HFC / HFO	HFO	HFO	HCFO
GWP ₁₀₀	<750 <150	1	3	0	2256	677 771	467 531	1530	571	1	1	4
ODP	0	0	0	0	0	0	0	0	0	0	0	0.00034
Safety Class	A1	A1	A3	B2L	A1	A2L	A2L	A1	A1	A2L	A2L	A1
PFAS	No	No	No	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes

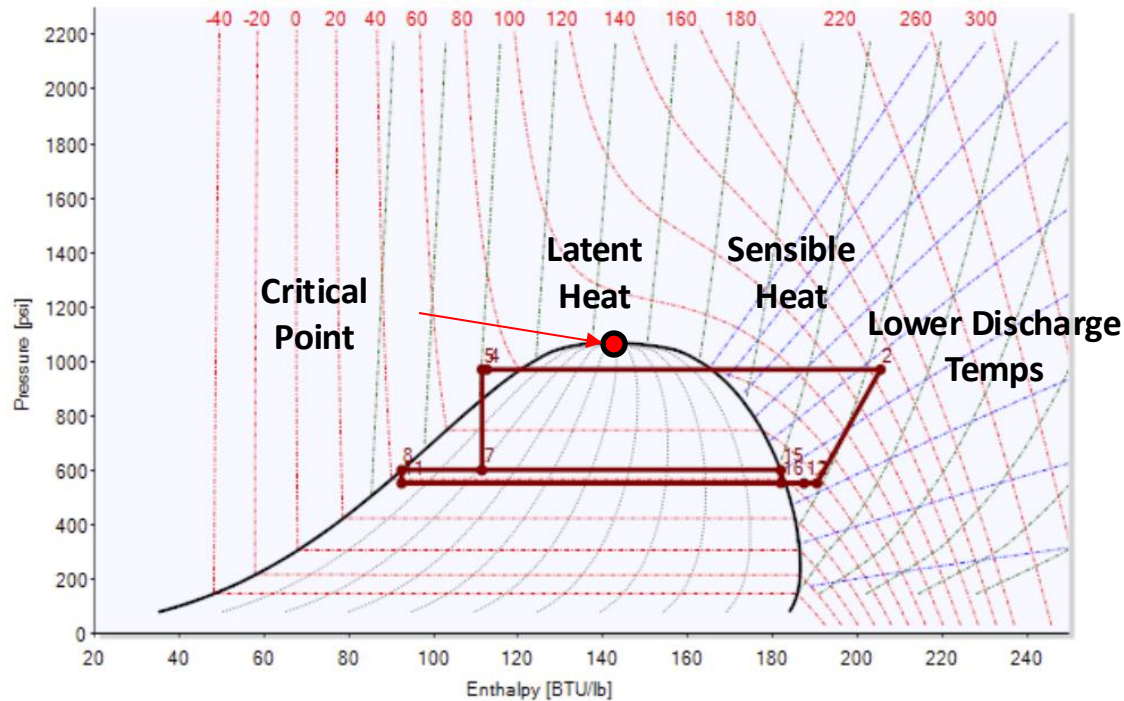
1.) GWP's based on IPCC AR5. Items in yellow are changes coming in IPCC AR6

Transcritical
Subcritical

What is different with a CO2 Heat Pump?

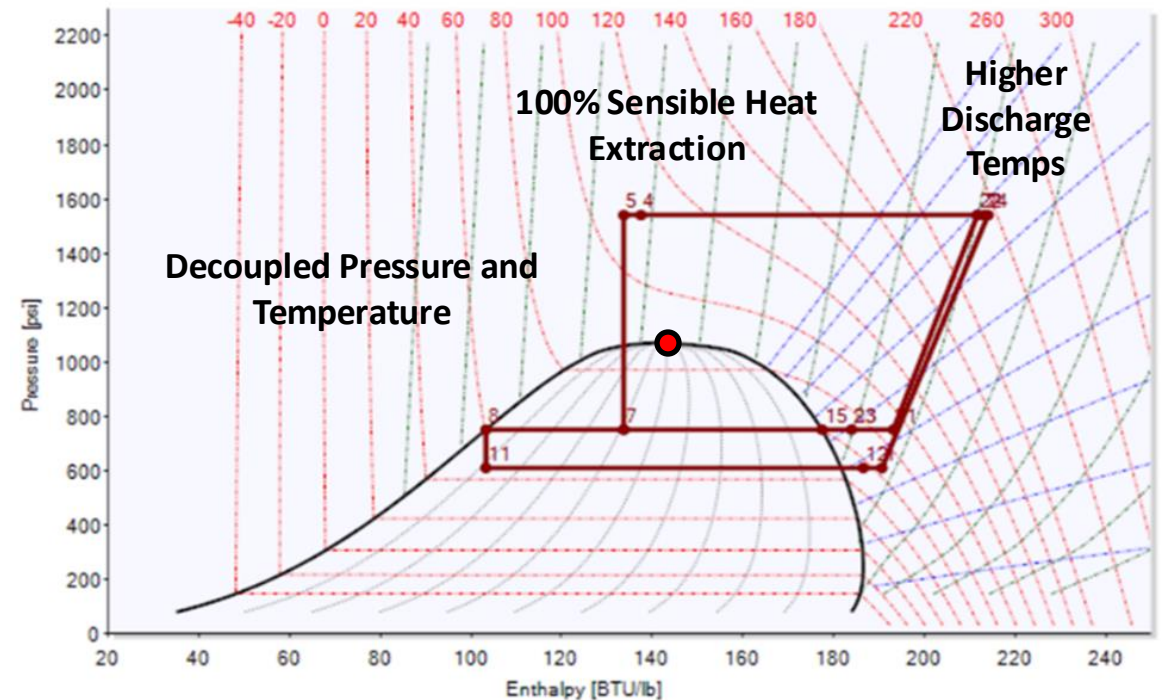
Subcritical

Refrigerant condenses in the condenser



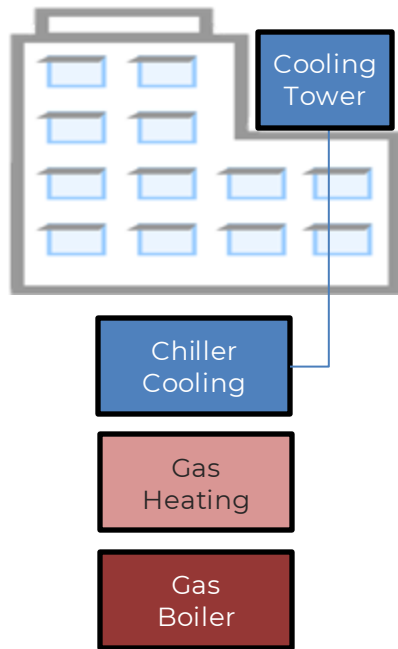
Transcritical

Refrigerant does NOT condense in the gas cooler

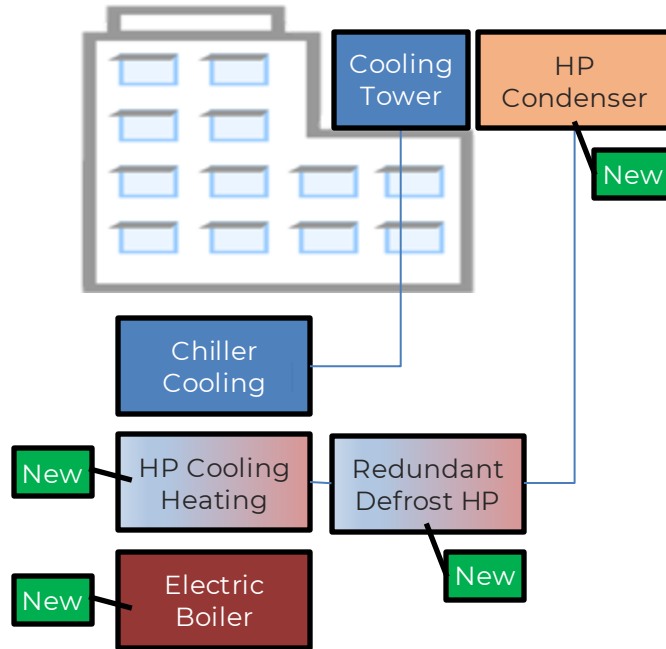


CO2 Heat Pumps

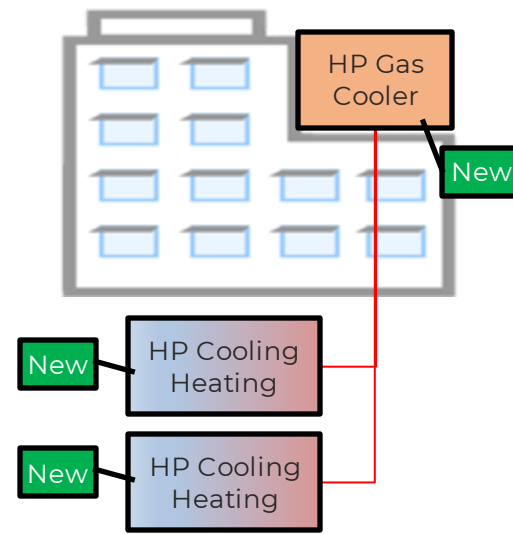
Legacy Systems



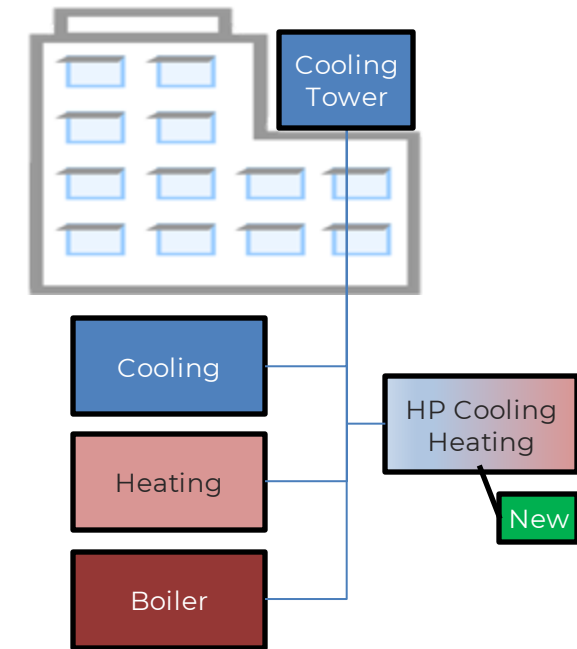
Synthetic Heat Pumps



CO2 Heat Pump New Construction



CO2 Heat Pump Retrofit



- Many separate systems
- Cooling: Central Chiller with high GWP refrigerant
- Heating: 100% combustible fossil fuel

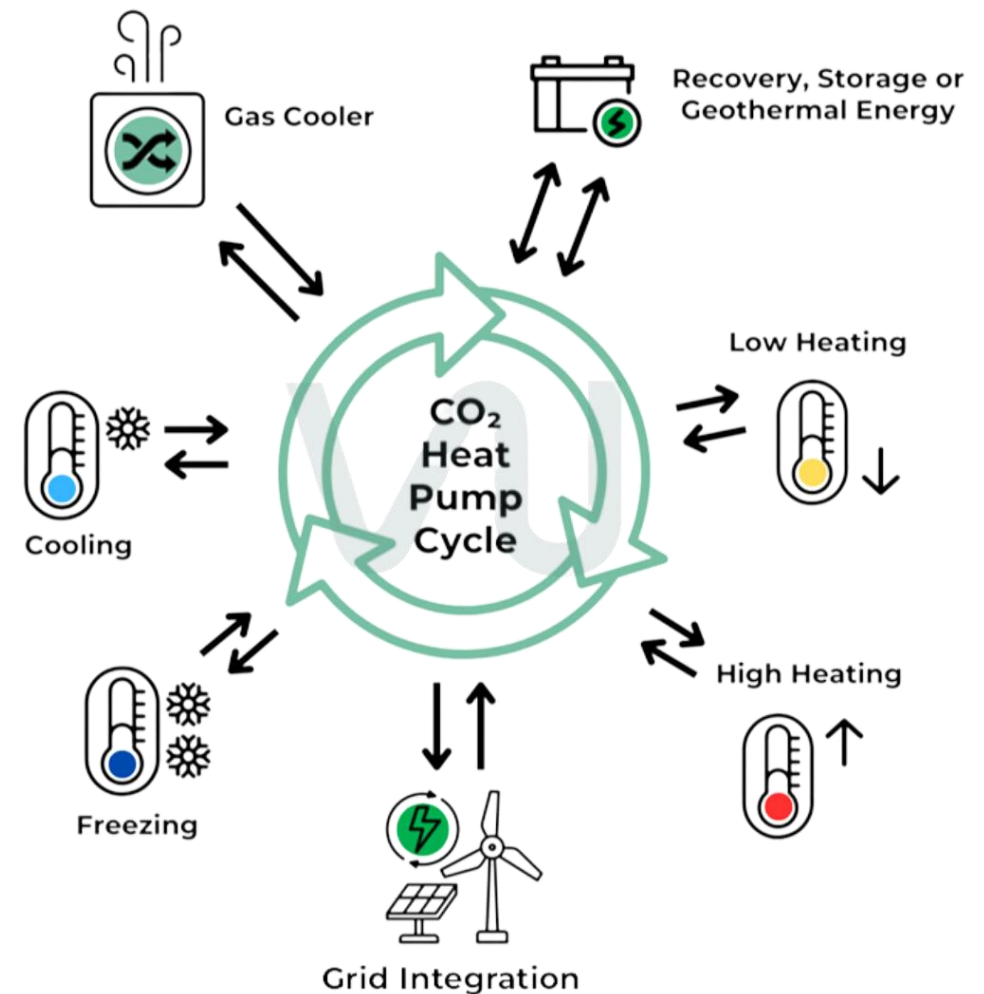
- More equipment
- Cooling: 100% electric central system with high GWP refrigerant
- Heating: HFC/HFO equipment with high GWP's
- Heating Supply Temps >135°F: Electric boiler or booster heat pump

- **Eliminate Redundant Defrost**
- **Eliminate Electric Boiler**
- **Efficient:** 1 power feed, multiple outputs
- **Save Space, less equipment**
- Parallel for **large installations**

- **No new power feed**
- **Electrify heating, replace chiller**
- **Do not need to change building systems** (pipes, coils, AHU's, etc...)
- **Stage installation.**
- **Wide operational range to match load at all OAT**

Key Benefits

- Environmentally friendly natural refrigerant (CO₂/R744)
- Simplified system design and installs
- High delivery temperatures (up to 180°F)
- Cold climate performance (down to -40°F)
- Efficient (High COP, no defrost, no derates, etc...)
- Seamless transition between heat, cool, and simultaneous heating and cooling
- Robust supply chain
- Low carbon emissions
- Low total cost of ownership
- Minimal infrastructure changes
- Future proof (Regulations)





Decarbonize and Detoxify

Eliminate the need for fossil fuels

Serve harder to electrify end-use cases

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