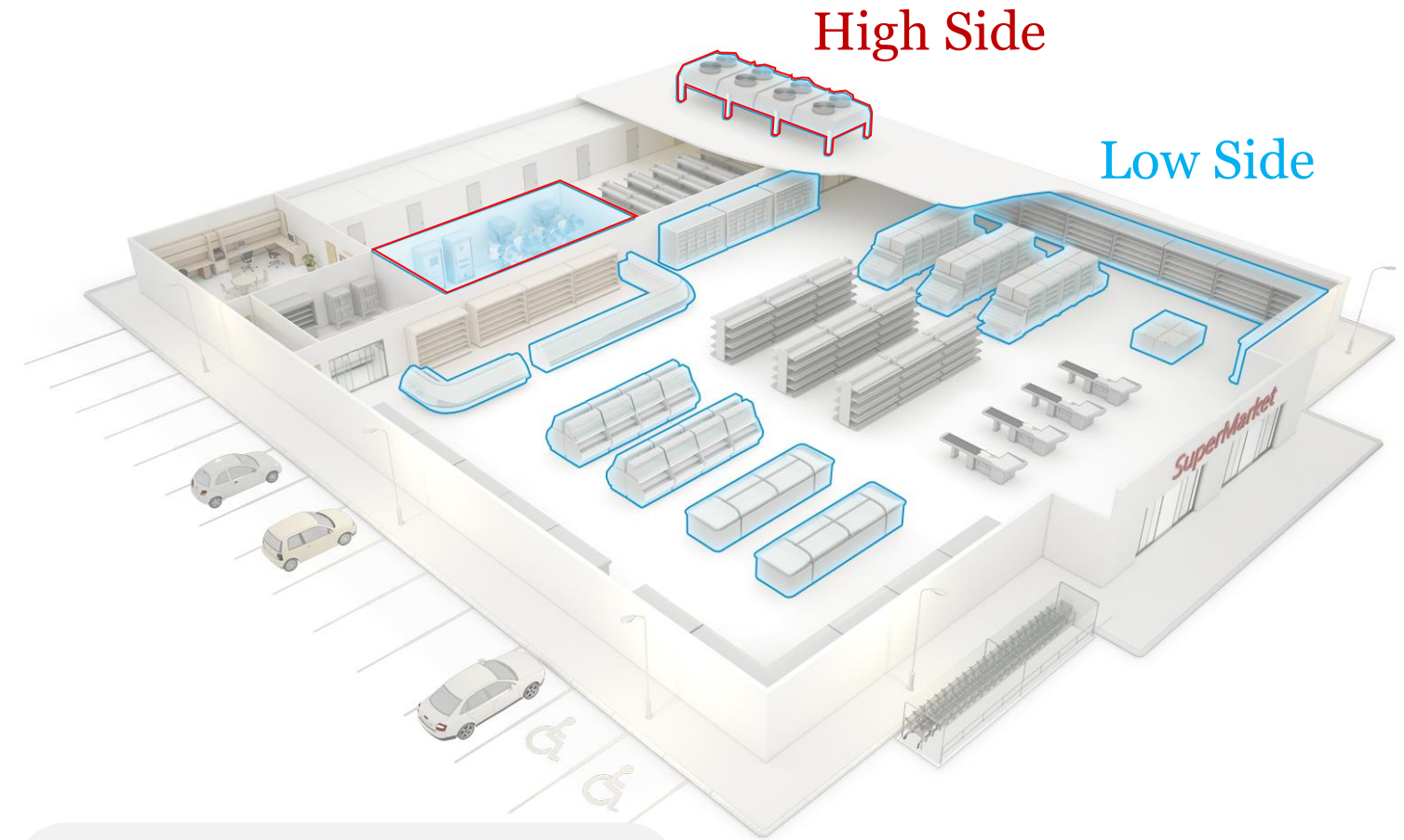




**COPELAND**

## Roundtable Global CO<sub>2</sub> Trends

April 21, 2025



### High Side

- Adiabatic Gas Cooler
- Parallel Compression
- High Side Ejectors
- Mechanical Subcooling
- Heat Reclaim & AC

### Low Side

- Low Evap. Design TD
- Internal HX
- Split Suction
- Liquid Ejectors
- Liquid to Low Temp
- Multi Ejector Low P.

### Others

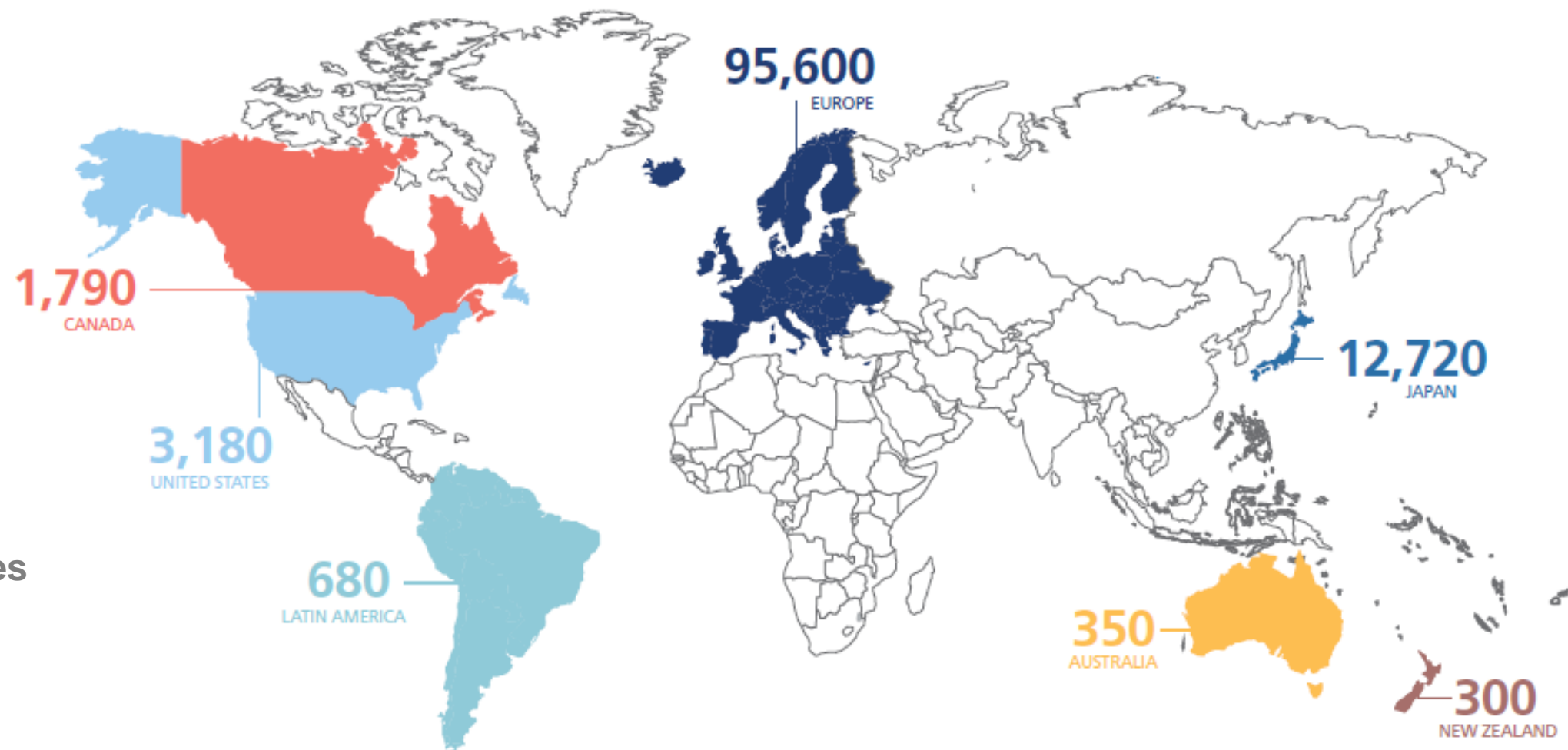
- 90 bar Standstill
- CO<sub>2</sub> CDU
- CO<sub>2</sub> Chillers/Heat Pumps

Approximately  
115,000  
TC CO<sub>2</sub> System  
Globally

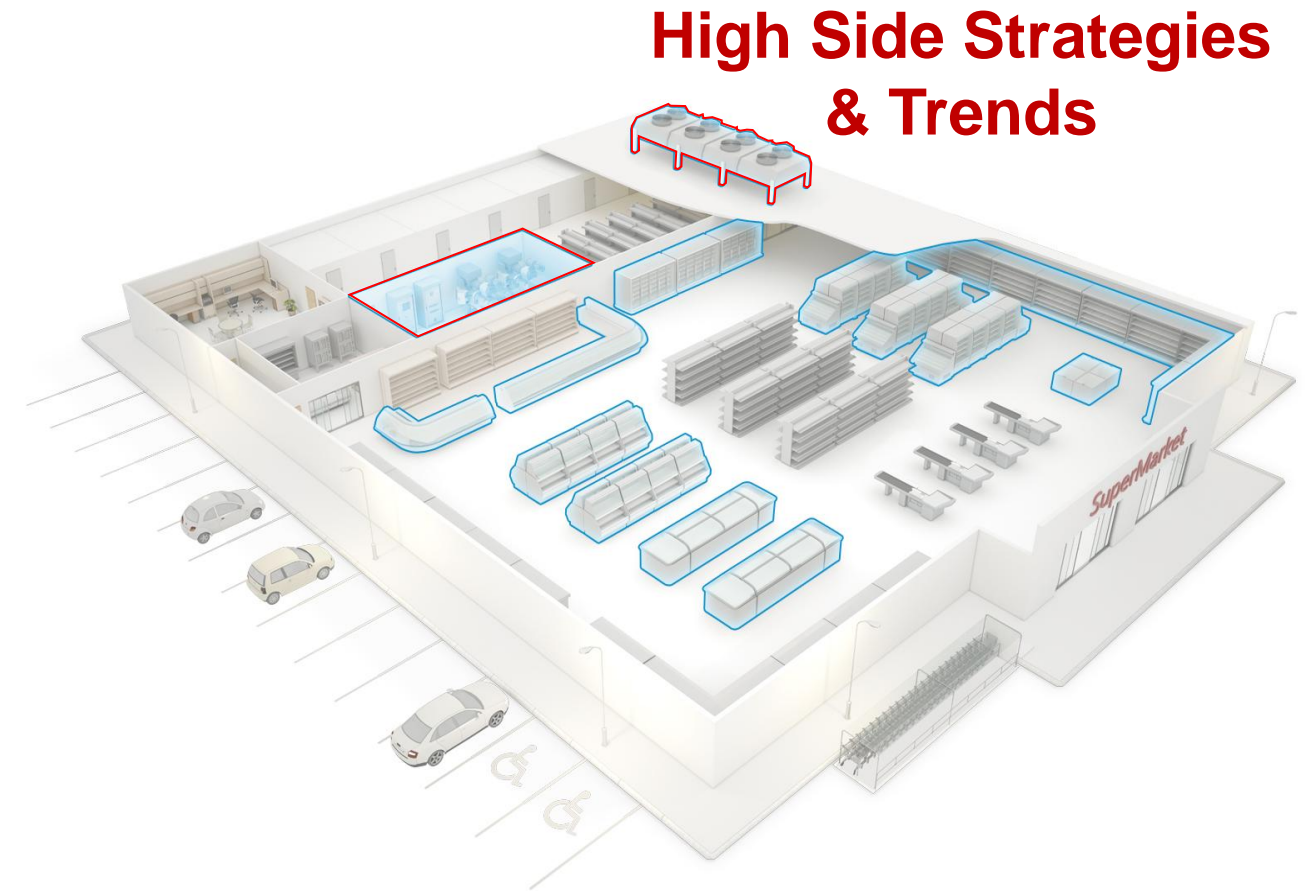
## Figure 1: Transcritical CO<sub>2</sub> Installations in Major Regions

(stores and industrial sites, as of December 2024)

Most Common  
Efficiency Challenge  
is  
High Ambient Temperatures



# CO<sub>2</sub> High Side Strategies to Mitigate the Effects of High Ambient

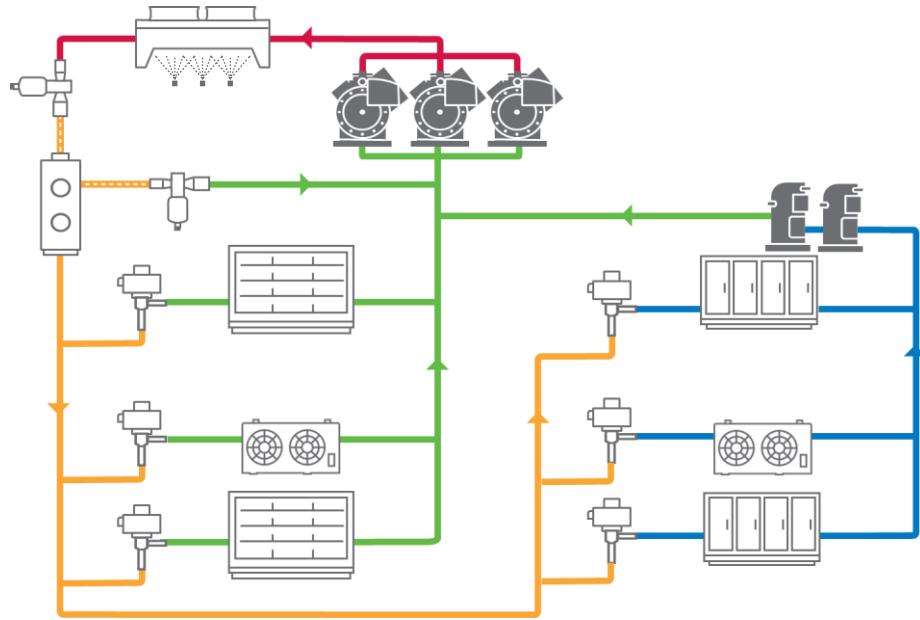


## High Side

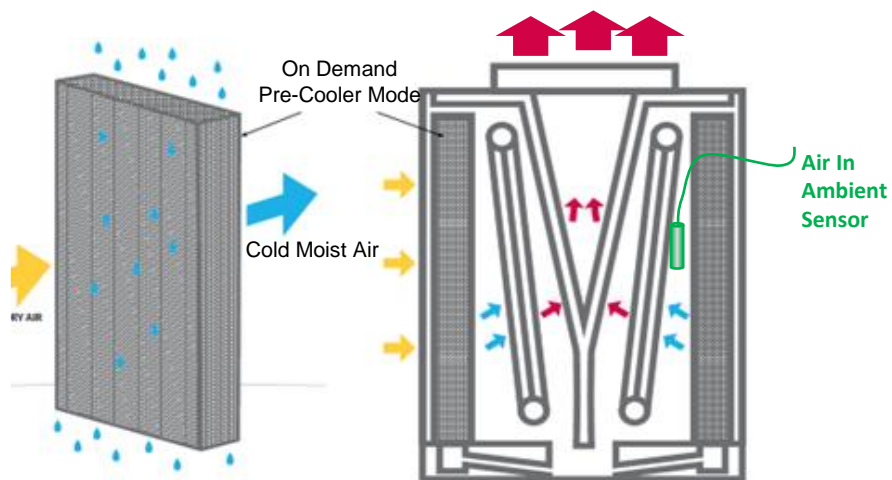
- Adiabatic Gas Cooler
- Parallel Compression
- High Side Ejectors
- Mechanical Subcooling
- Heat Reclaim



# 1. Adiabatic Gas Cooler



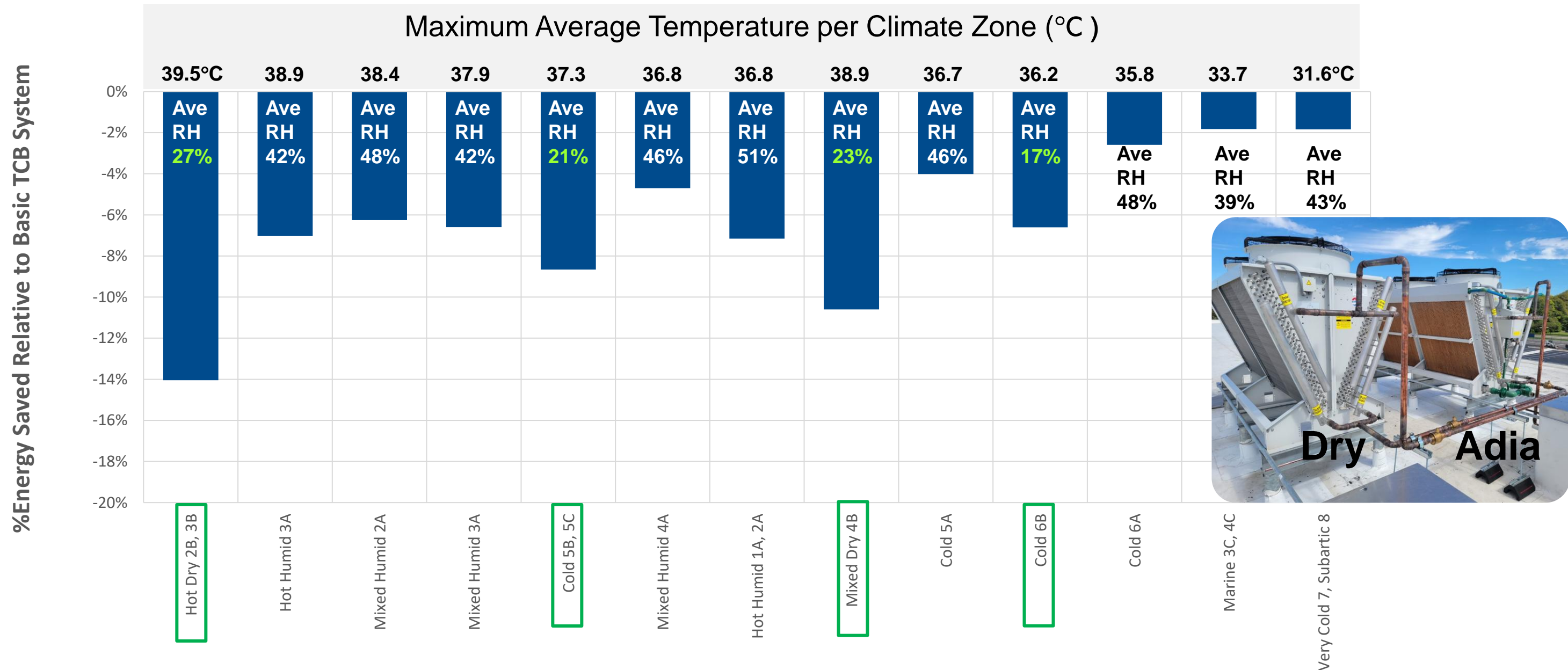
Adiabatic Gas Cooler



Water Flow  
Typical Starts at  
Approximately 22°C

# Copeland CO2 High Ambient Mitigation Study Results

## Percent of Energy Saved with Adiabatic vs Dry Gas Cooler

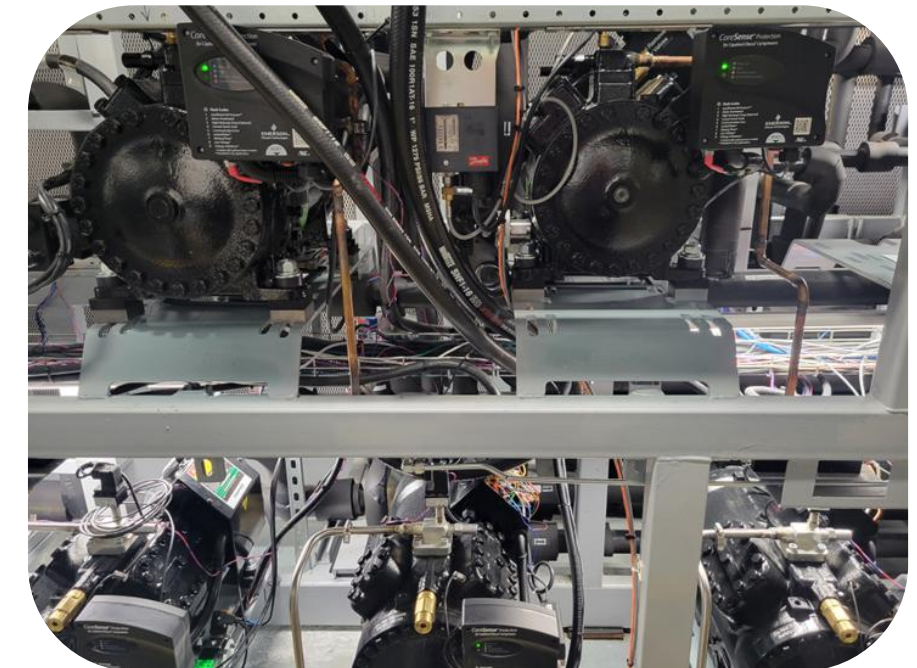
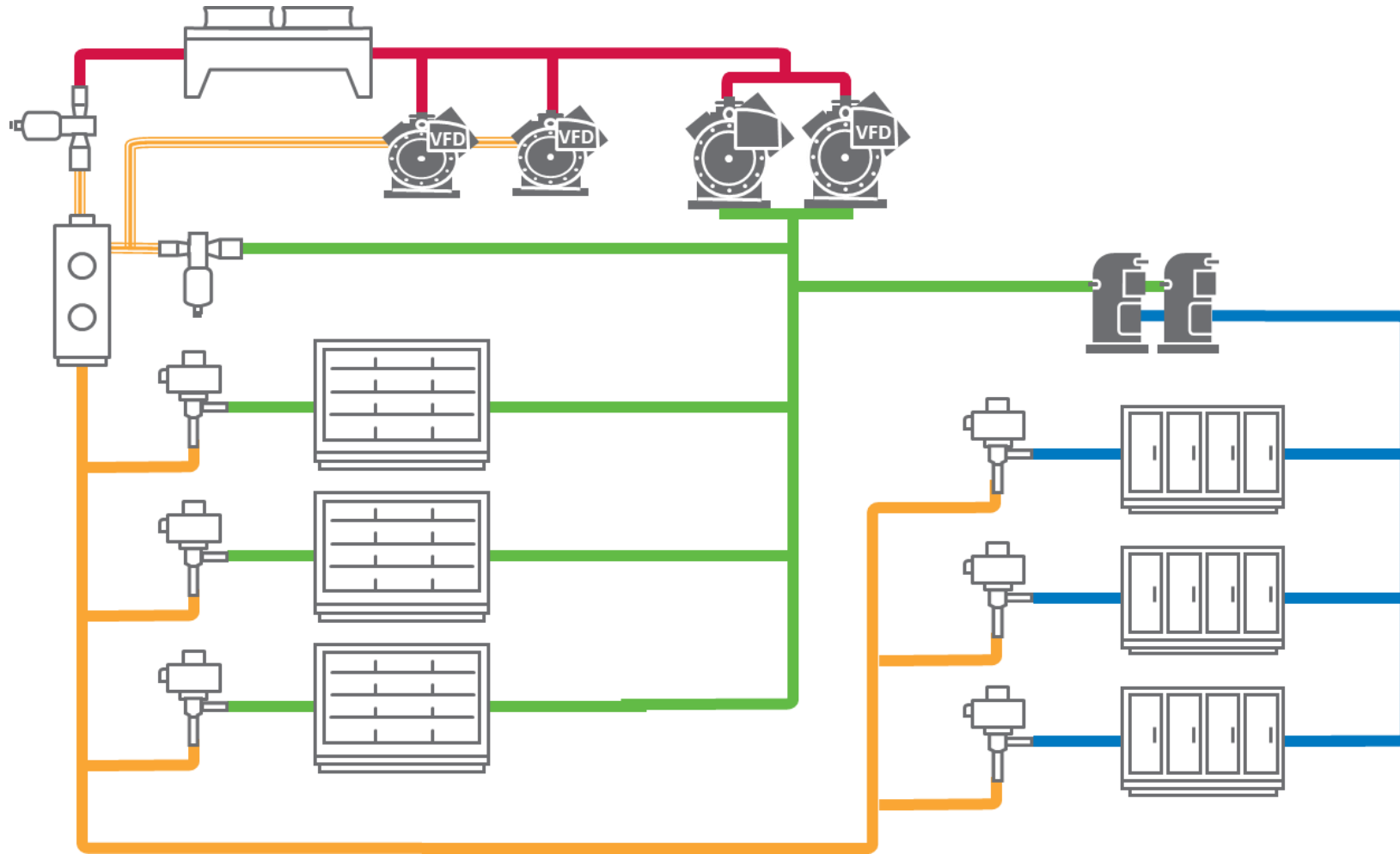


Charts Based on 13 Zones' Average Temperatures for the Americas of **266 Cities**  
Weather Data: NREL TMY3 data, EES Software, 117kW MT +8C SST, 29kW LT -29C

Climate Zones with Lower Average Relative Humidity Show Better Energy Reduction With Adiabatic Gas Coolers than with Parallel Compression...

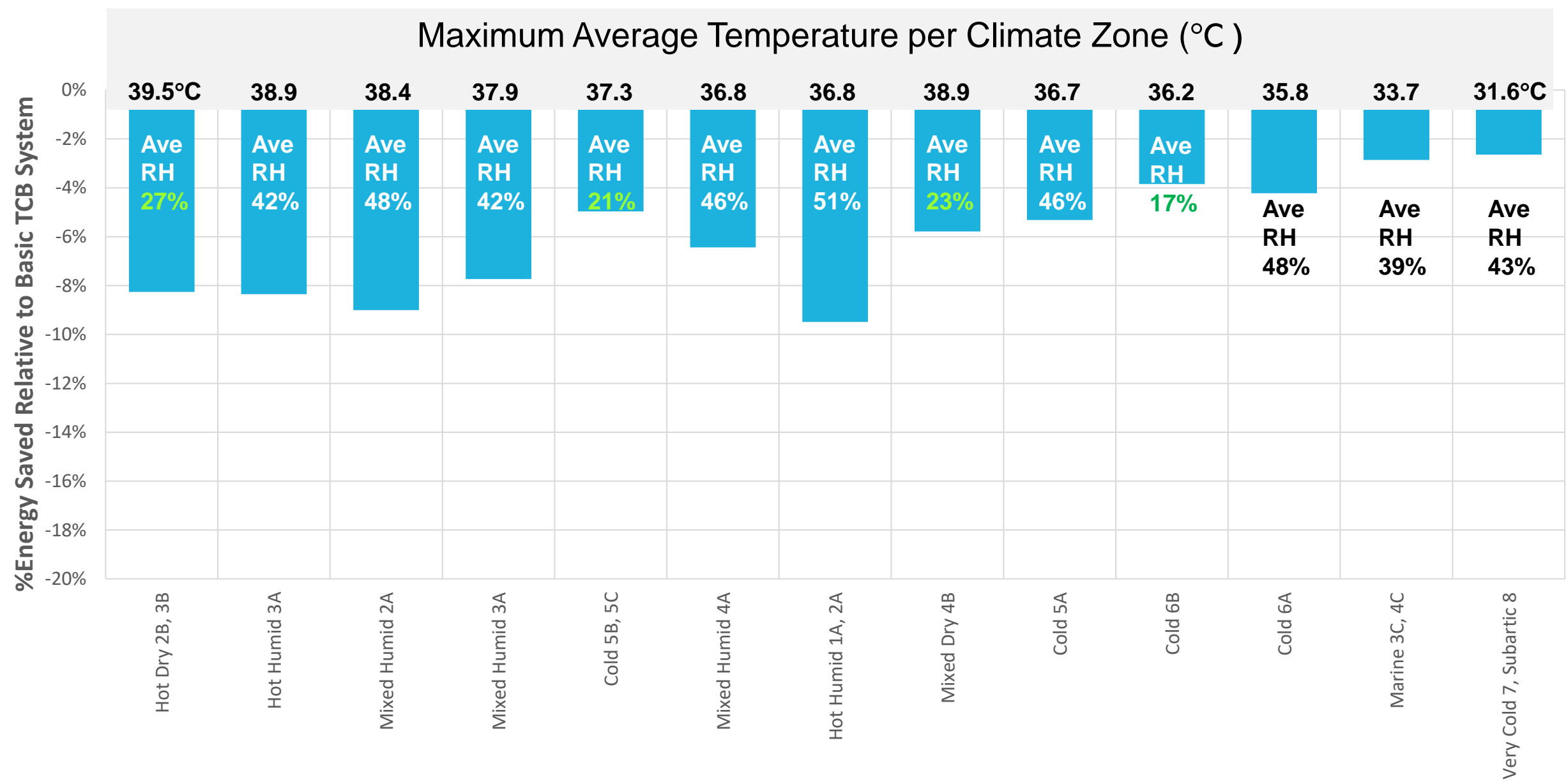


## 2. Parallel Compression (PC) or Intermediate Stage Compression (IT)



# Copeland CO2 High Ambient Mitigation Study Results

## % Energy Saved with Parallel Compression vs Dry Gas Cooler

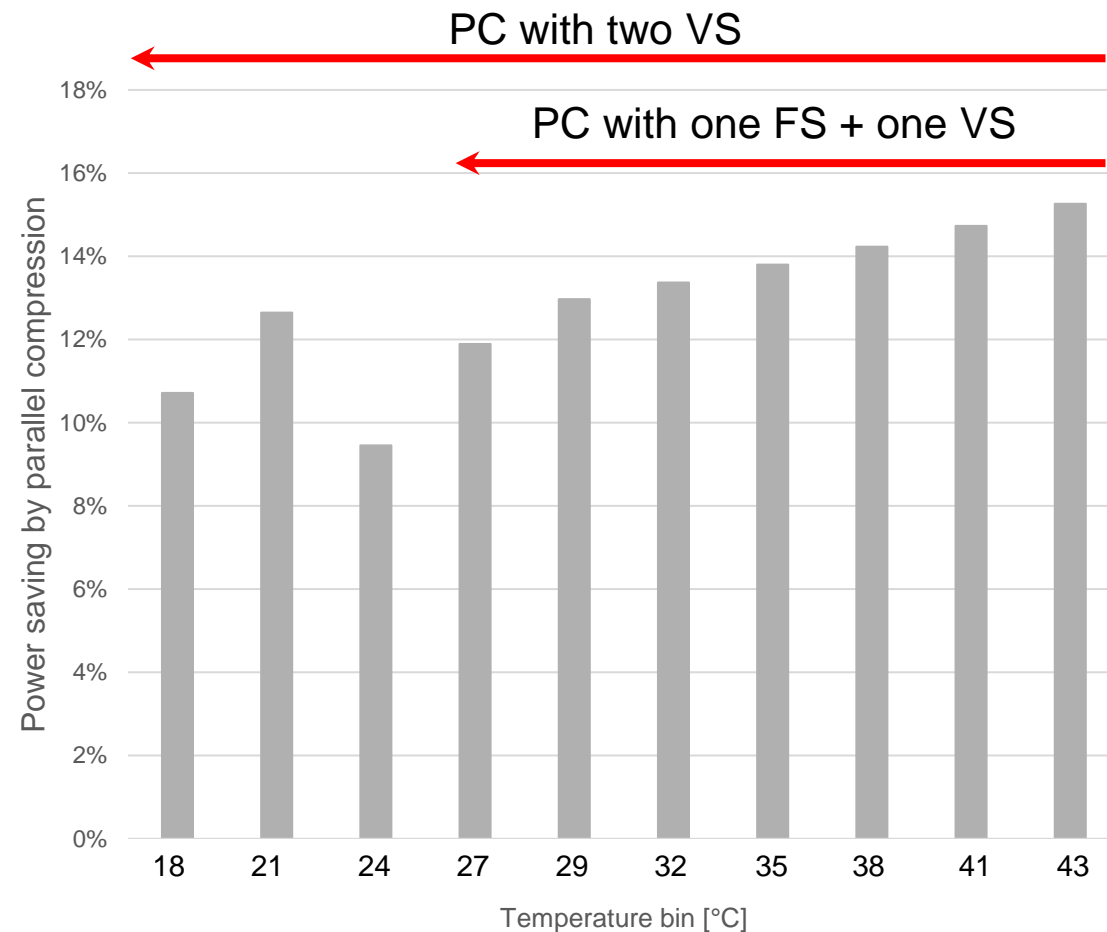


Charts Based on 13 Zones' Average Temperatures for the Americas of **266 Cities**  
• Weather Data: NREL TMY3 data, EES Software, 400MBH MT +18SST, 100MBH LT -20F

Climate Zones with Lower Average Relative Humidity Show Better Energy Reduction With Adiabatic Gas Coolers than with Parallel Compression...

# Copeland CO<sub>2</sub> Lab Validation

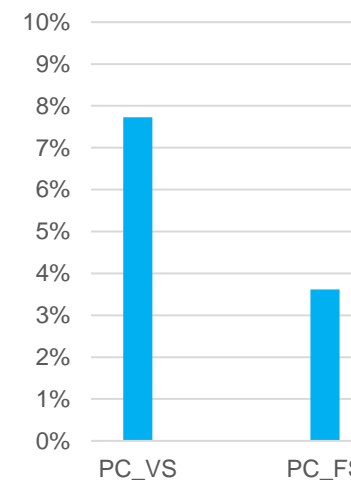
## Benefit of using two VS compressors on the PC suction group



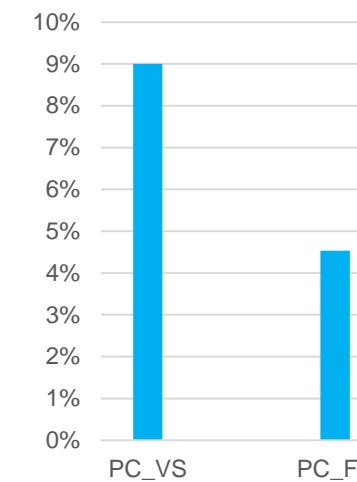
- Data from the Copeland Climate Study
- Full variable speed on the PC suction group allows the PC to be enabled when the  $T_{gc} > 18^{\circ}\text{C}$
- Assuming one FS + one VS only allows the PC to be enabled when  $T_{gc} > 27^{\circ}\text{C}$
- Full variable speed on PC doubles the PC energy saving effect for all the climate zones

### Annual Energy saving of PC compared to Basic TCB

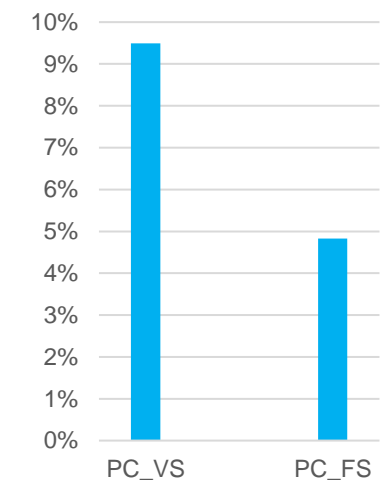
Mixed humid 3A



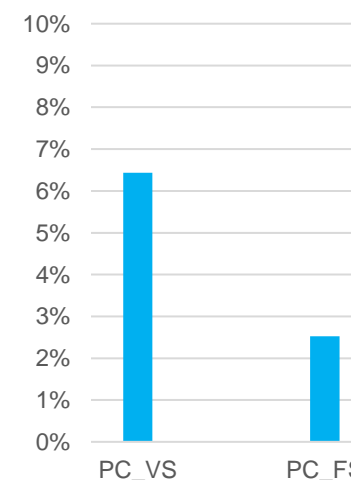
Mixed humid 2A



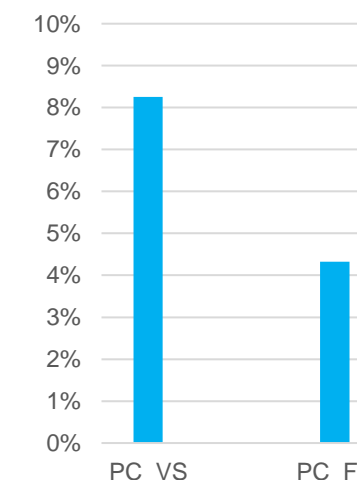
Hot Humid 1A2A



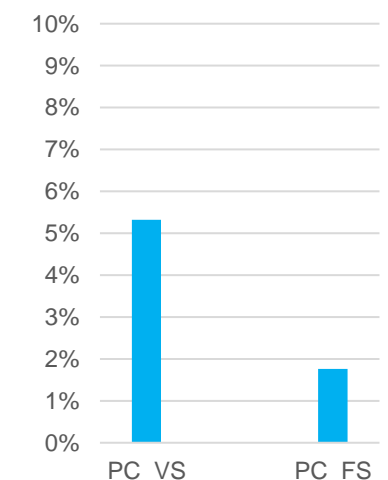
Mixed Dry 4B



Hot Dry 2B 3B



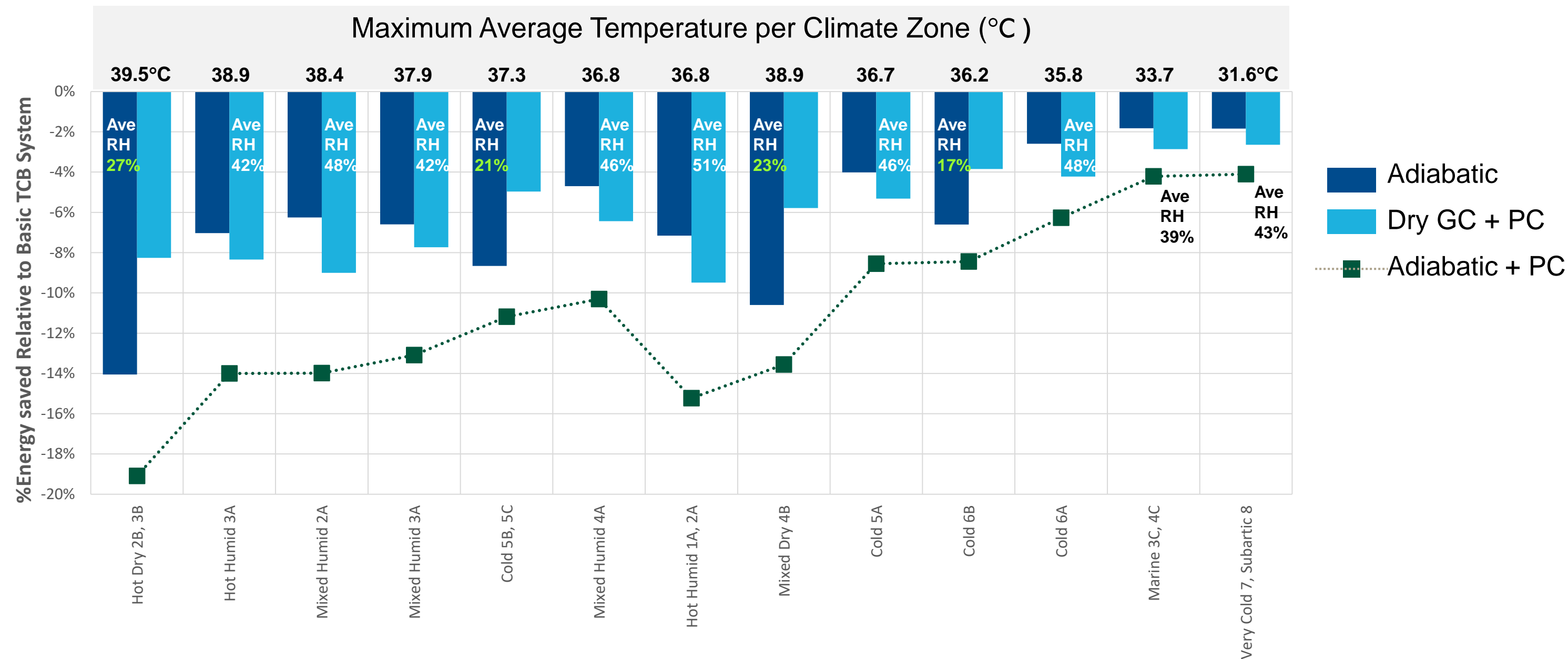
Cold 5A





# Copeland CO2 High Ambient Mitigation Study Results

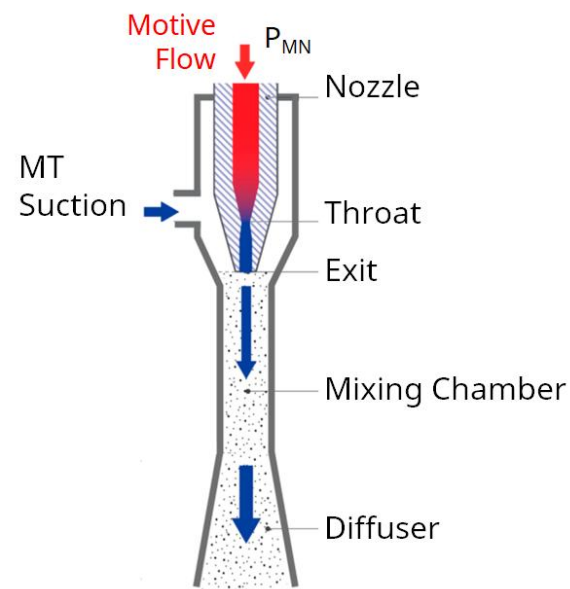
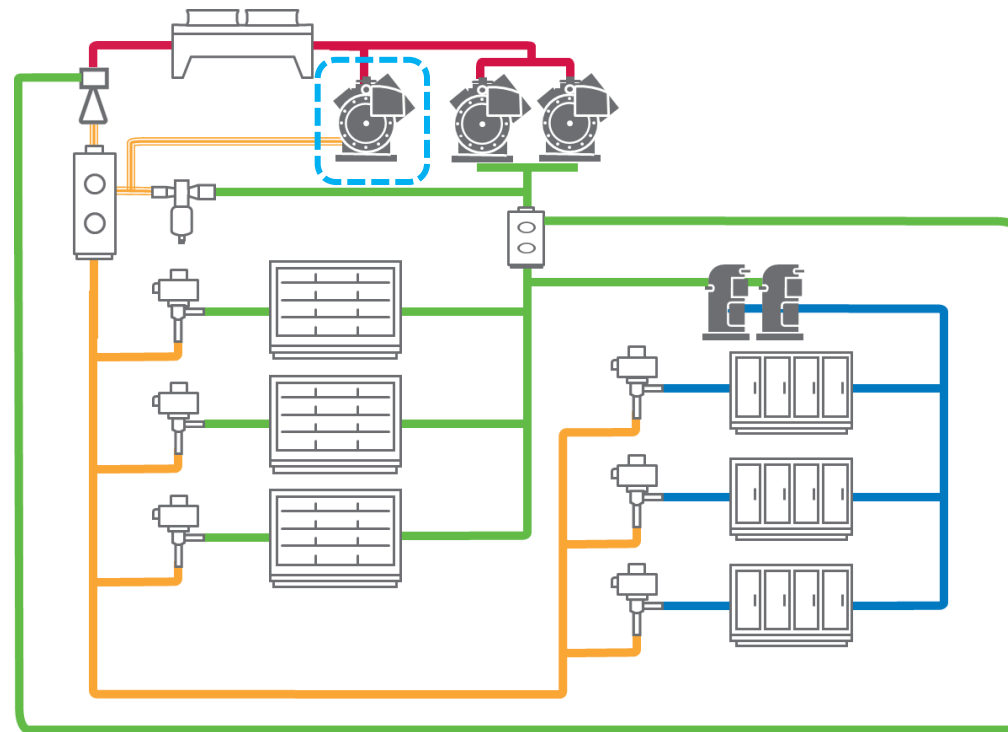
## Percent of Energy Saved : Adiabatic vs Parallel Compression



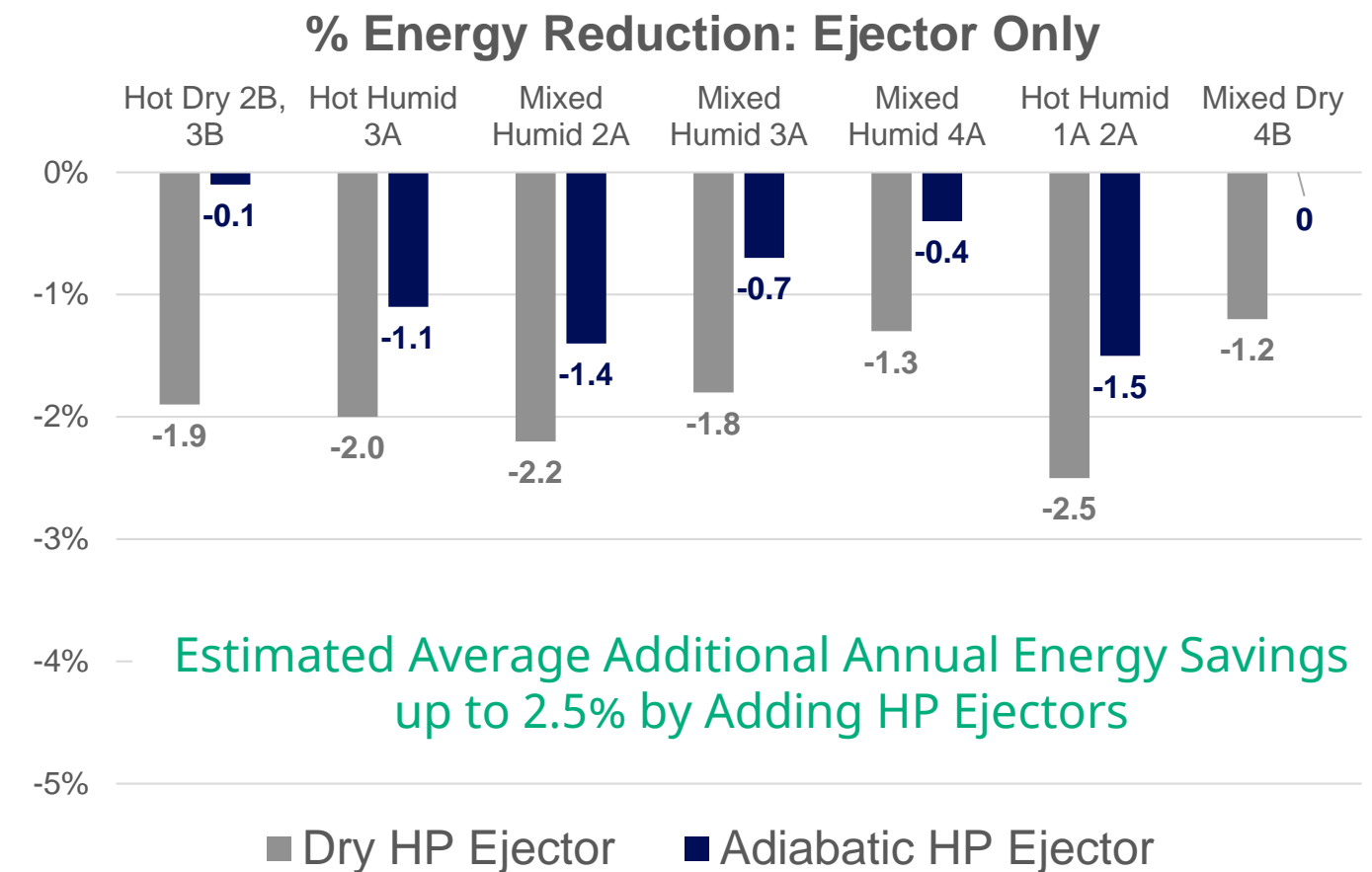
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Climate Zones with Lower Average Relative Humidity Show Better Energy Reduction With Adiabatic Gas Coolers than with Parallel Compression...

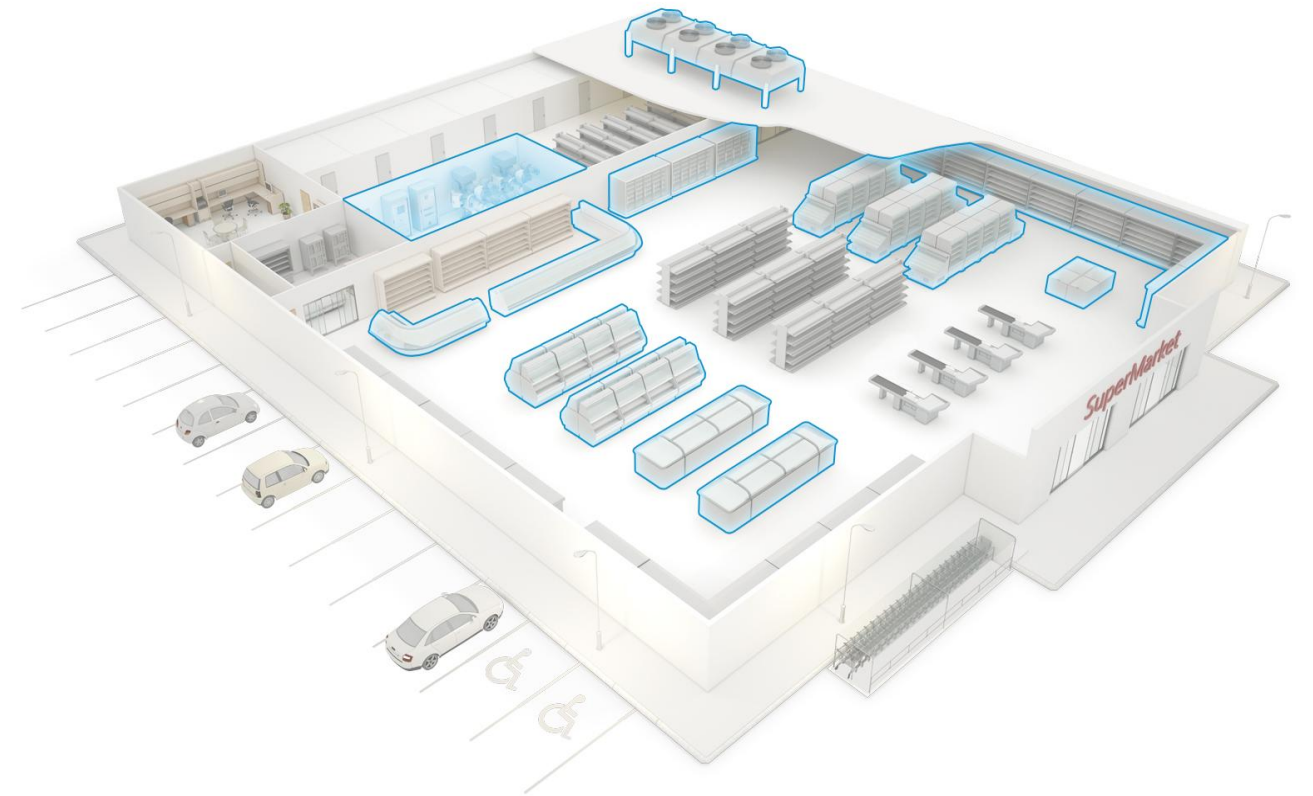
### 3. High Pressure Ejectors Require Parallel Compression



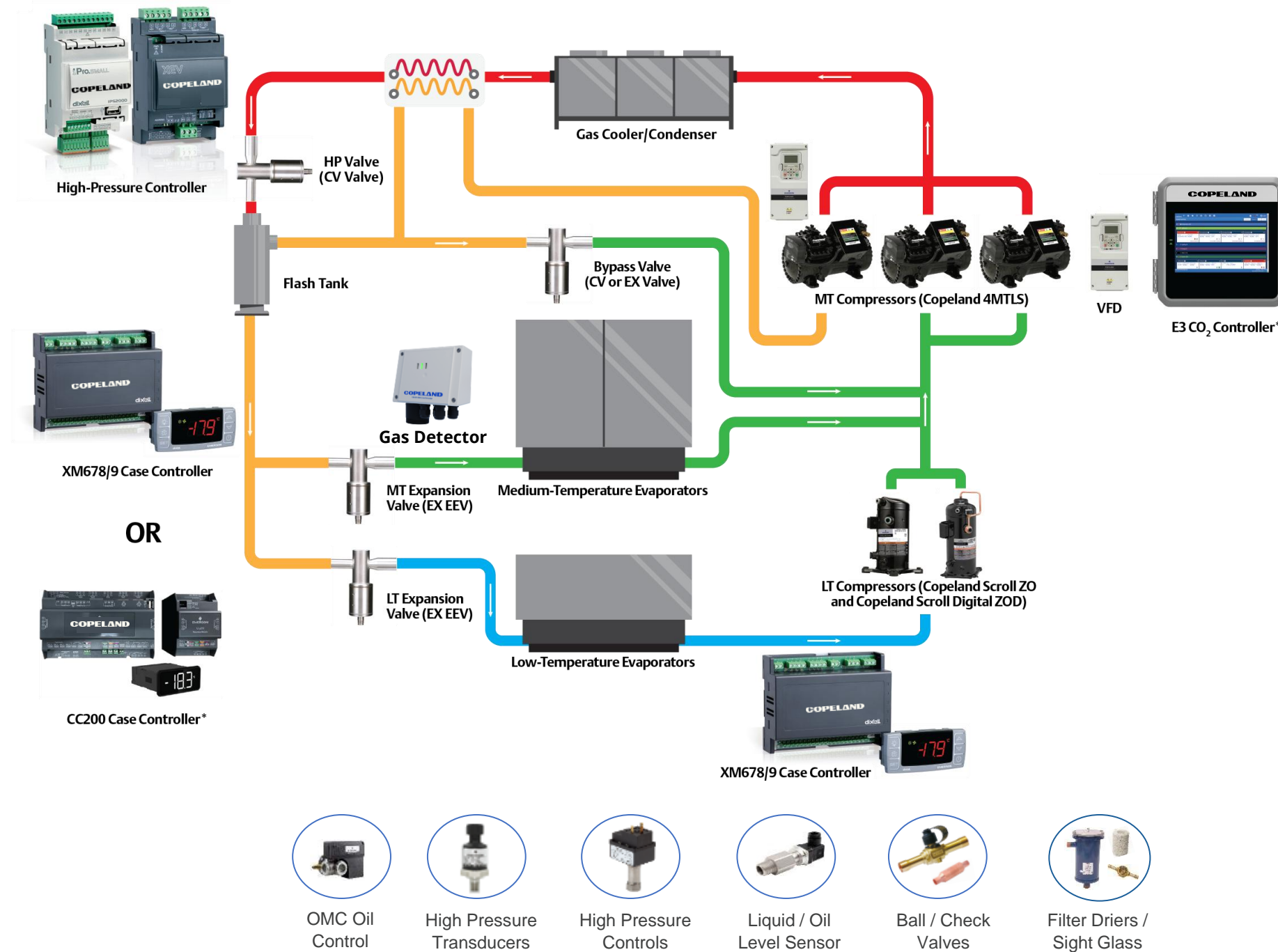
#### Additional Energy Saving Benefit of Adding Ejectors Over and Above Parallel Compression



# How Copeland Technologies & Solutions Respond to the Challenges



# Copeland CO<sub>2</sub> Products and Solutions



## Integrated Solutions

Deliver seamless system integration that enables maximum system reliability, efficiency and simplicity.

- E3 Supervisory Controls
- HPV & BVG Controls
- MT Compressors
- LT Compressors
- Compressor Protection
- Compressor Oil Controls
- Leak Detection
- Pressure / Temp Sensors
- Enterprise Management
- Field Services
- Solutions Team

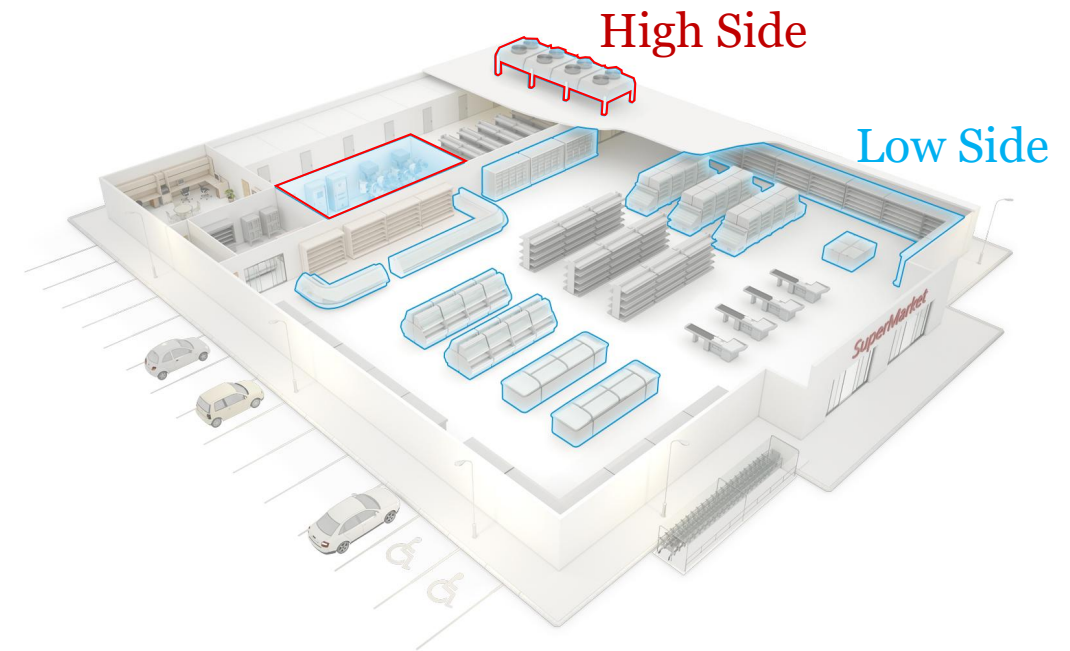




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April 21, 2025



# 谢谢