

CO₂ Transcritical System Benchmarking



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About Sobeys Incorporated

- Established in 1907
- One of Canada's two national grocery retailers
- \$21 Billion (CAD) in annual sales (¥2,000 Billion)
- 125,000 employees
- Approximately 1,500 stores across all 10 provinces and more than 350 retail fuel locations
- Retail banners include Sobeys, Safeway, IGA, Foodland, FreshCo, Price Chopper, Thrifty Foods, and Lawton's Drugs



Canadian Environment

- 10.0 Million km² and 35.5 Million people

- 3.4 people/km²

- ASHRAE Climate Zones

- 5 (Vancouver, British Columbia)

- 8 (Whitehorse, Yukon Territories)

- Energy (average cost)

- Electricity (at plug): \$0.07 to \$0.15/kWh

- Natural Gas (at burner tip): \$0.02 to \$0.08/kWh (\$6 to \$23/GJ)

- CO₂

- Electricity: 0.841 (Alberta) to 0.002 (Manitoba) CO_{2e} tonne/kWh

- 420:1 ratio

- Refrigerant: 3.3 (R507) to 0.0010 (R744 / CO₂) CO_{2e} tonne/kg

- 3,300:1 ratio

- Taxes: \$0.00/tonne (at present; but significant future risk)

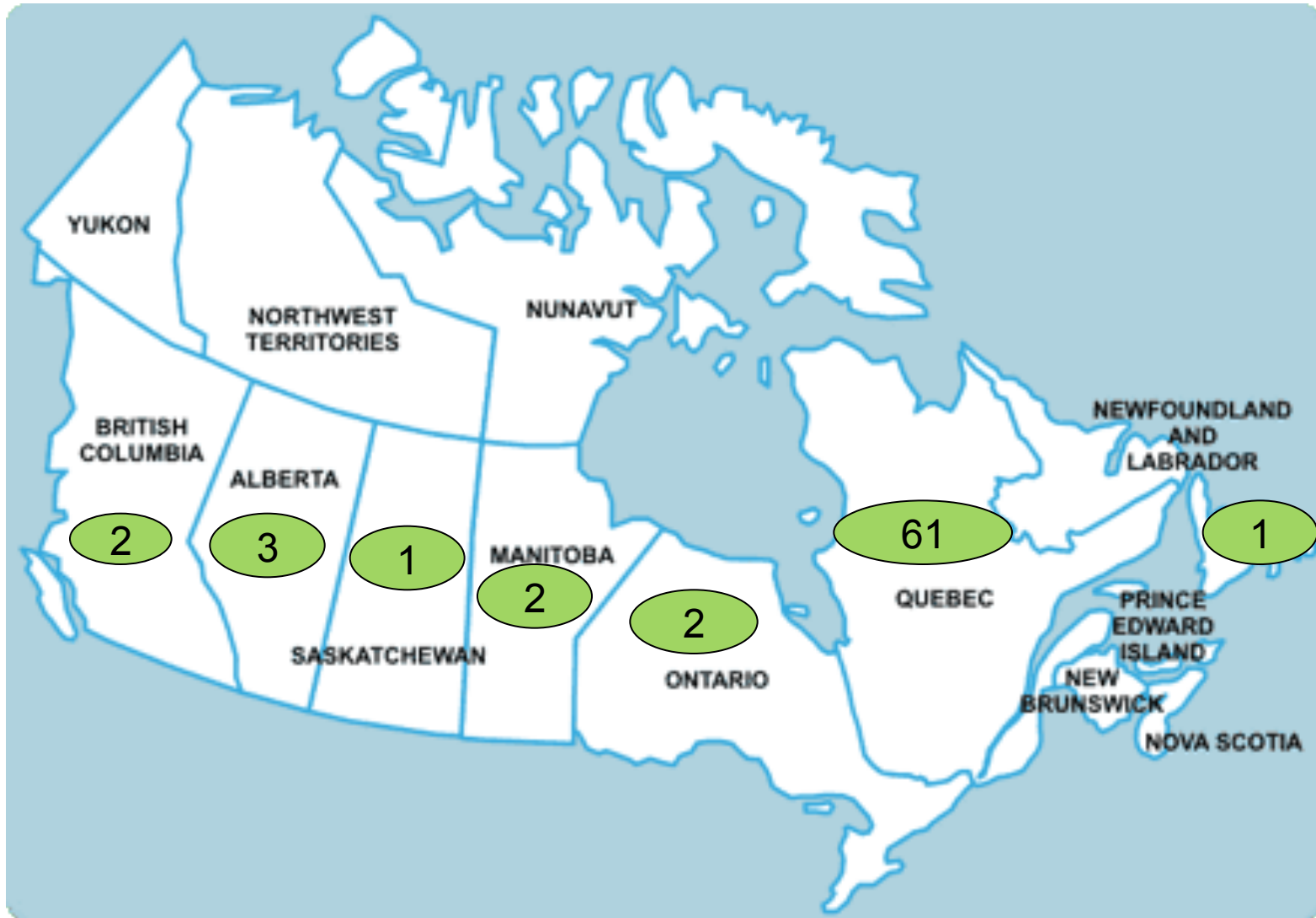
- Energy Usage (Sobeys)

- Refrigeration: >60% (we have a refrigeration rich environment)

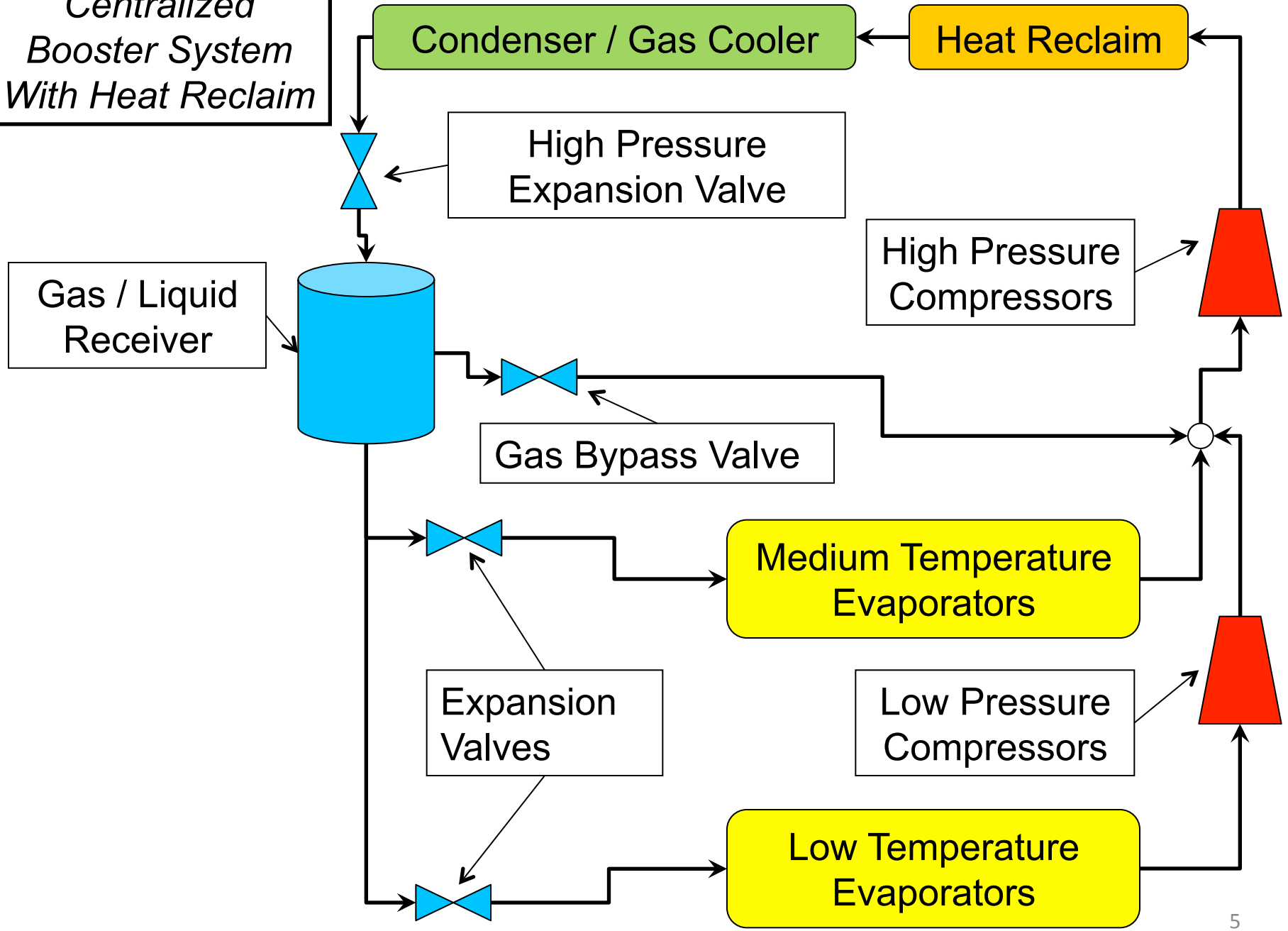


Transcritical CO₂

- Current State: 72 systems
 - 44 sites US EPA GreenChill Platinum certified



*Centralized
Booster System
With Heat Reclaim*



Transcritical CO₂

•Heat Reclaim

- CO₂ has a high rejection heat, which makes it ideal for heat reclaim
- Domestic Hot Water
 - CO₂ to water heat exchanger
 - Year round: Food production equipment cleaning
- HVAC
 - Primary roof top unit
 - CO₂ to air heat exchanger
 - Summer: Post dehumidification reheating
 - Winter: Heating

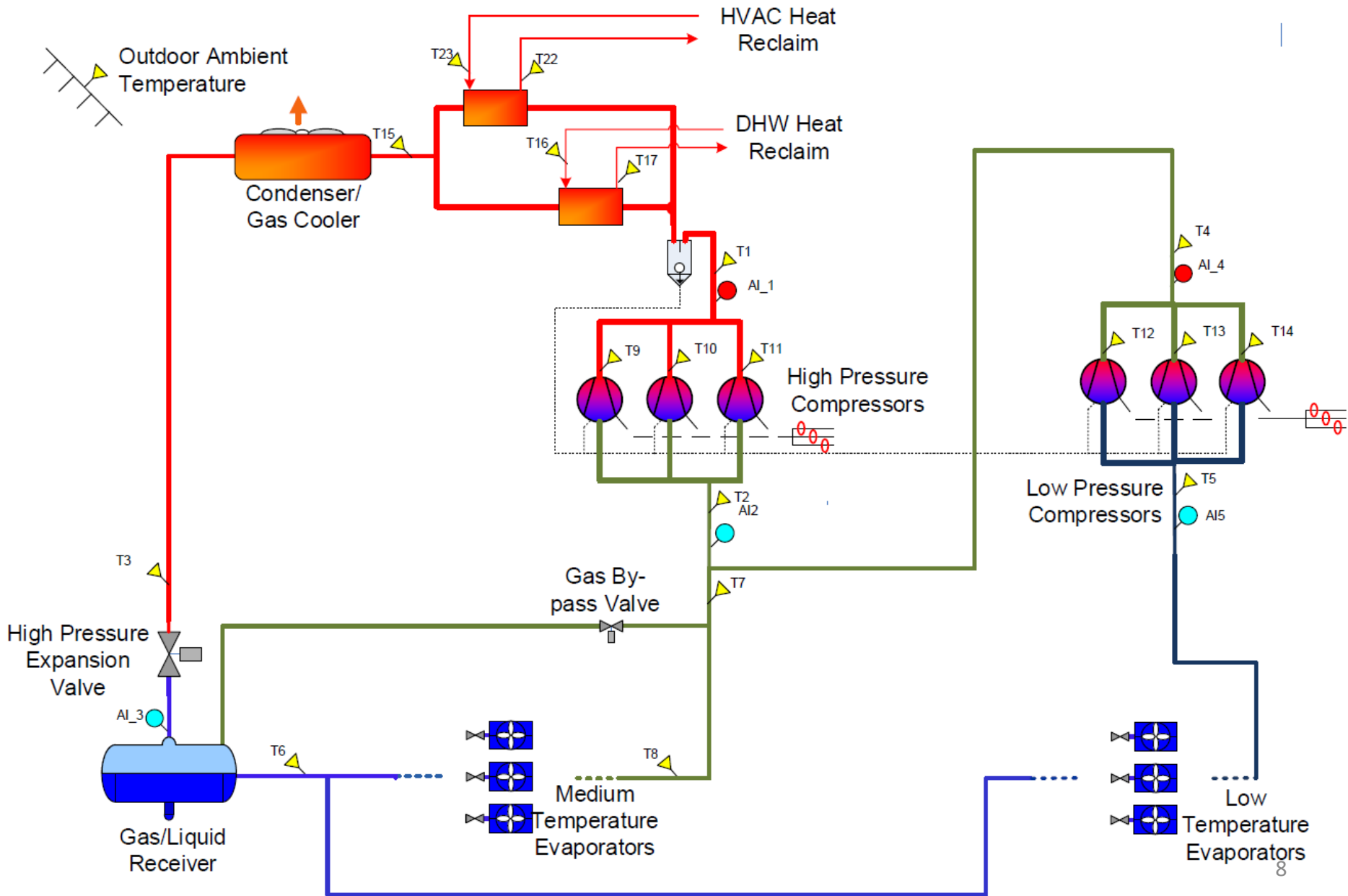
•Gas Defrost

- More energy efficient than electric defrost

Milton, Ontario

- 5,800 m²
- Opened December 2014
- Two racks (Ontario Safety Authority Requirement)
- Cooling Requirements (maximum design day)
 - Rack A
 - Low Temperature: 42.0kW
 - Medium Temperature: 111.5kW
 - Rack B
 - Low Temperature: 52.0kW
 - Medium Temperature: 127.5kW
- Key Thermodynamic Efficiency Features
 - Reverse cycle defrost
 - Latent heat for defrost cycle

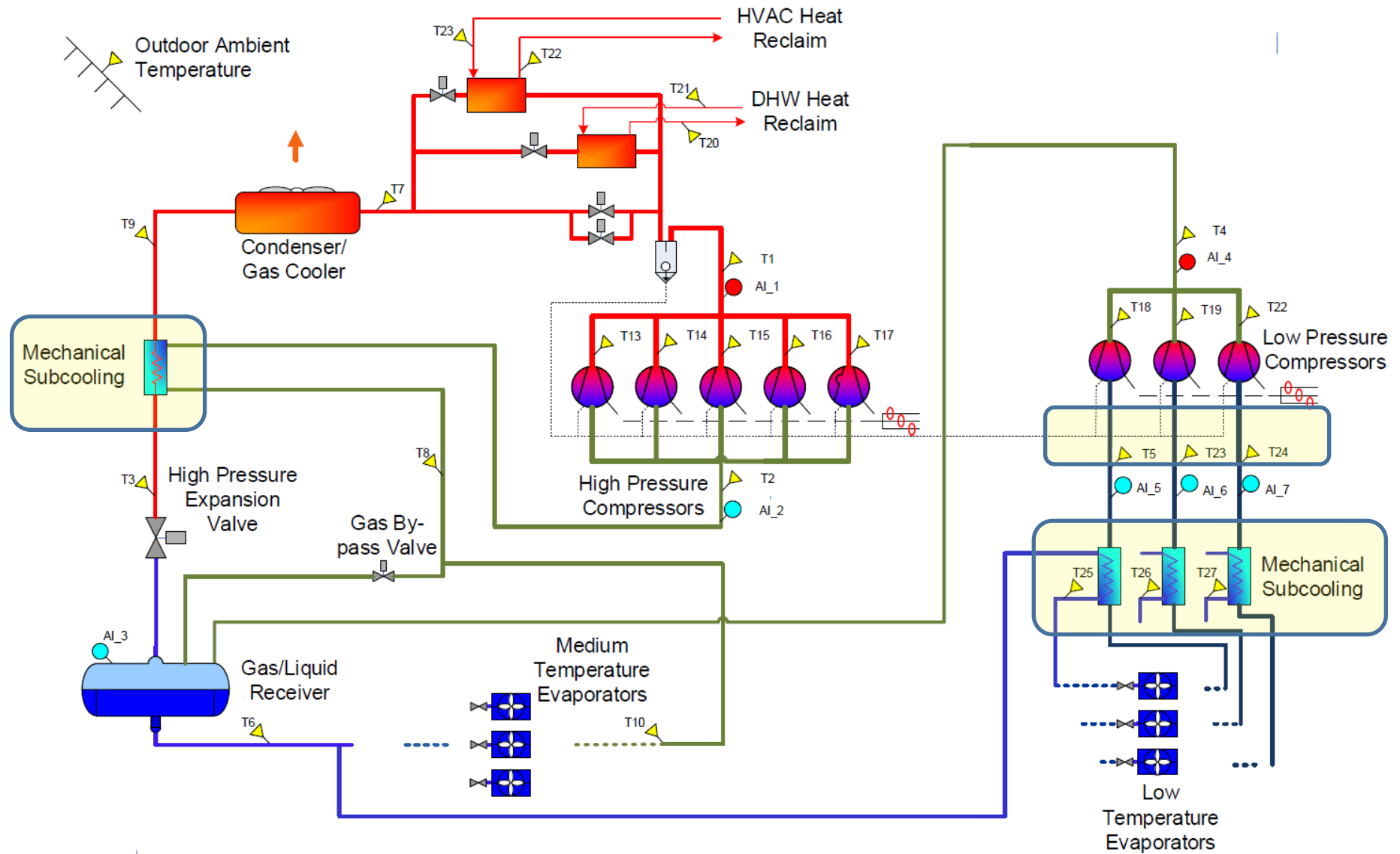
Milton



Stratford, Ontario

- 5,000 m²
- Opening March 2015
- Two racks (Ontario Safety Authority Requirement)
- Cooling Requirements (maximum design day)
 - Rack A
 - Low Temperature: 51.0kW
 - Medium Temperature: 99.5kW
 - Rack B
 - Low Temperature: 46.0kW
 - Medium Temperature: 98.0kW
- Key Thermodynamic Efficiency Features
 - Reverse cycle defrost
 - Latent heat for defrost cycle
 - Three separate Low Temperature suction groups per rack
 - Mechanical sub-cooling / Superheat for suction groups
 - Upstream of Gas/Liquid Receiver
 - Upstream of Low Temperature Evaporators

Stratford



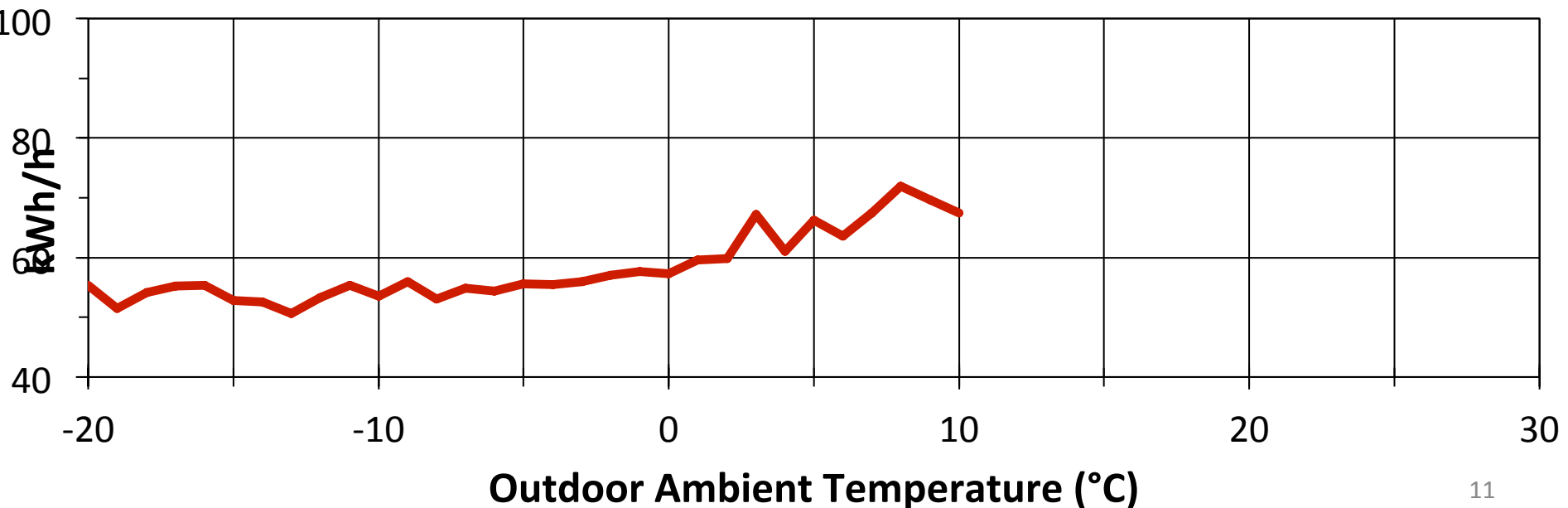
Power Profile: Milton

- Power Profile

- Average kWh at each Outdoor Ambient Temperature (OAT)
- Averaged over one hour
- Averaged by additional data points

- Currently one month of data (-20C to 10C OAT)

- Further monitoring
 - Wider profile (i.e. > 10C OAT)
 - More data points = smoother curve

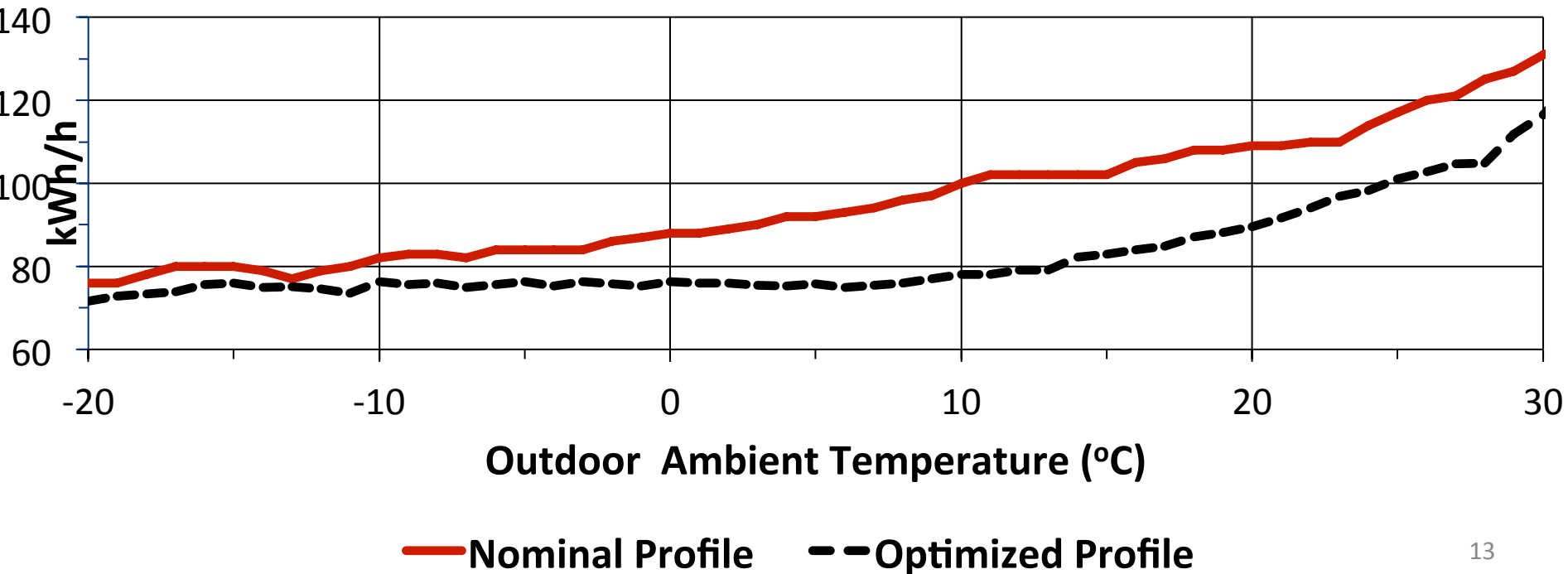


Power Profile: Stratford

Coming Soon!

Power Profile: Measurement & Verification Tool

- R-404A system Power Profile
- Nominal Profile
 - As found
- Optimized Profile = Post Re-commissioning
 - Floating Head Pressure Controls
 - Variable Capacity Compressors

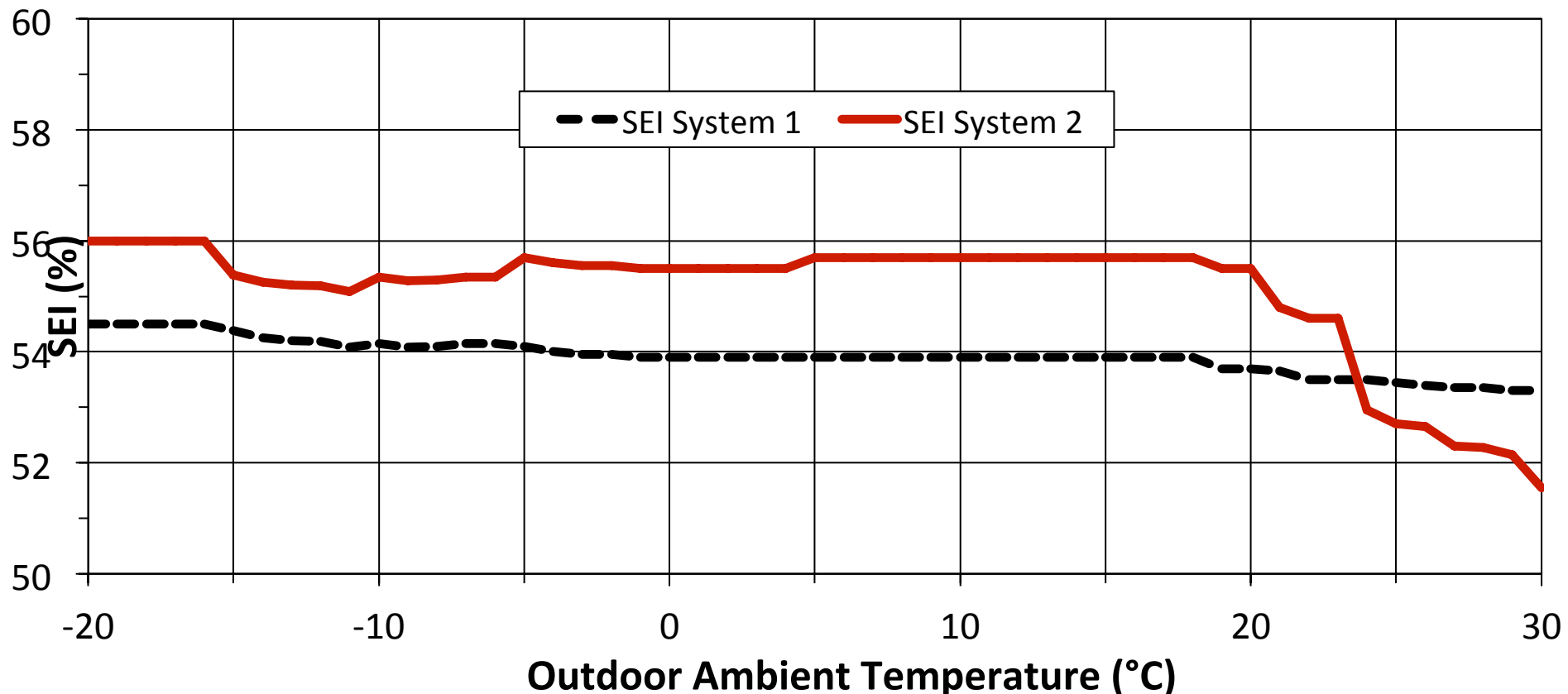


System Efficiency Index (SEI)

- Normalized unit of absolute efficiency
- Introduced by VDMA (Germany) and IOR (UK)
- 100% SEI: System operating at ideal theoretical efficiency (Carnot Cycle)
- Independent of operating conditions
 - Coefficient of Performance (COP), Energy Efficiency Ratio (EER), Etc. based on design/standard conditions
 - Saturated Suction Temperature
 - Condensing Temperature
- Evaluation of sub-system performance
 - Compressor (Isentropic efficiency)
 - Evaporator
 - Condenser
 - Auxiliary loads

SEI Benchmarking

- SEI Independent of Outdoor Temperature
 - Should be consistent across wide range of temperatures
 - Changes Vs temperature represent issues with sub-system performance
 - Differences between systems represent overall efficiency differences



Next Steps

- Continue Logging Milton Data
- Start Logging Stratford Data
 - Start up March 2015
- More to Come
 - ATMOSphere America: June 25/26, 2015 (Atlanta, Georgia)



solutions for asia

natural refrigerants

3-5 February 2015 in Tokyo

Thank you very much!