

Chillventa Specialist Forums 2024 Chillventa Fachforen 2024

**CONNECTING
EXPERTS.**





**State-of-art energy efficient
Smart Store, implemented
technologies and learnings after
1st year of operation**

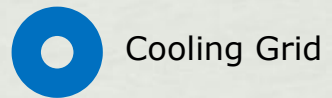
**Mark Sever
Global Solutions Expert FR**

Danfoss Smart Store ADC

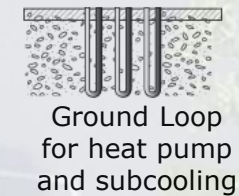
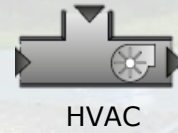
Location: Danfoss' headquarters in Nordborg, Denmark



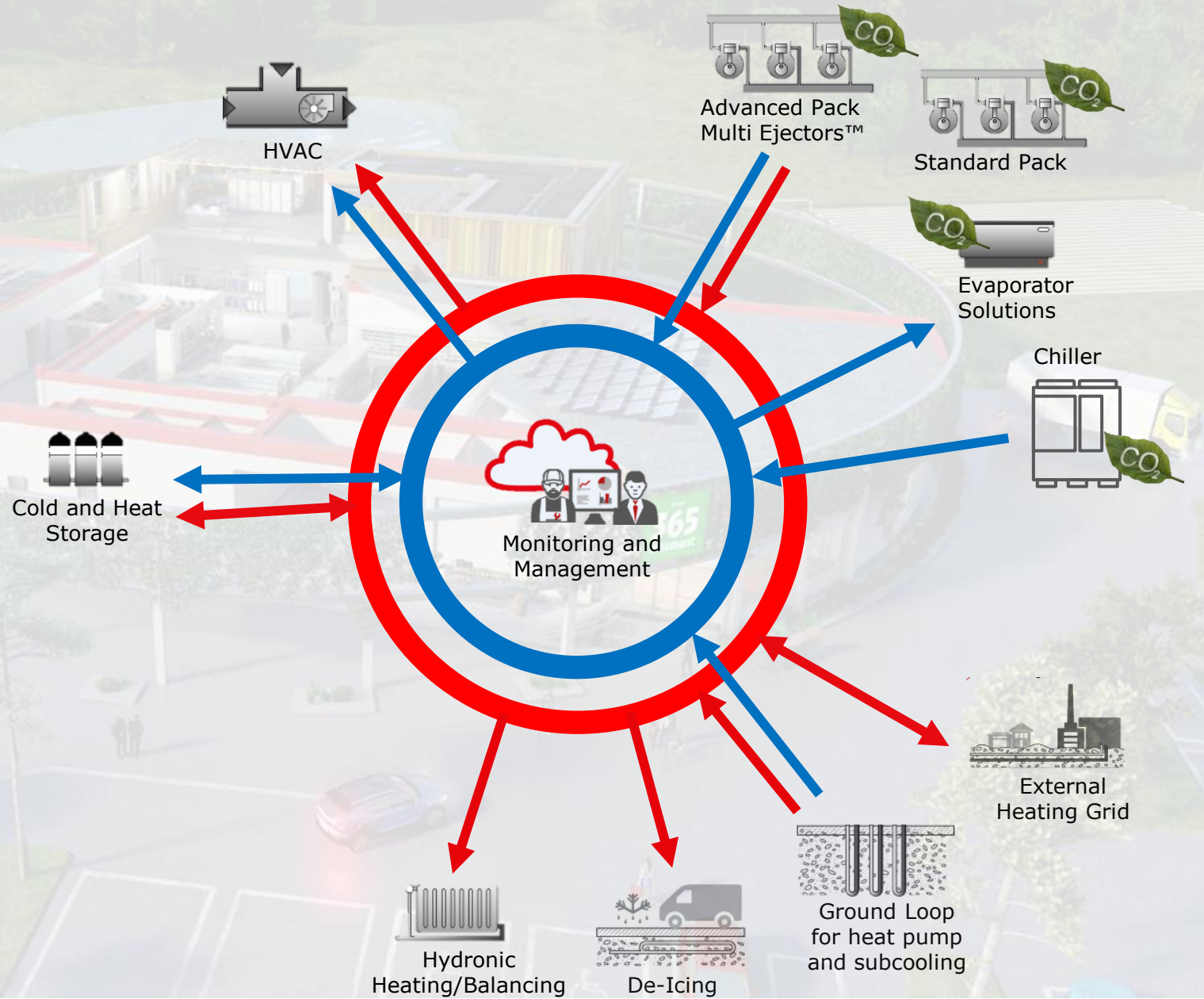
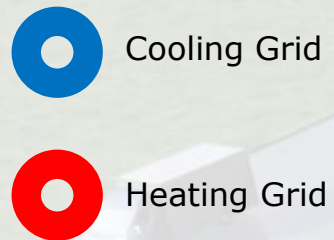
Systems overview



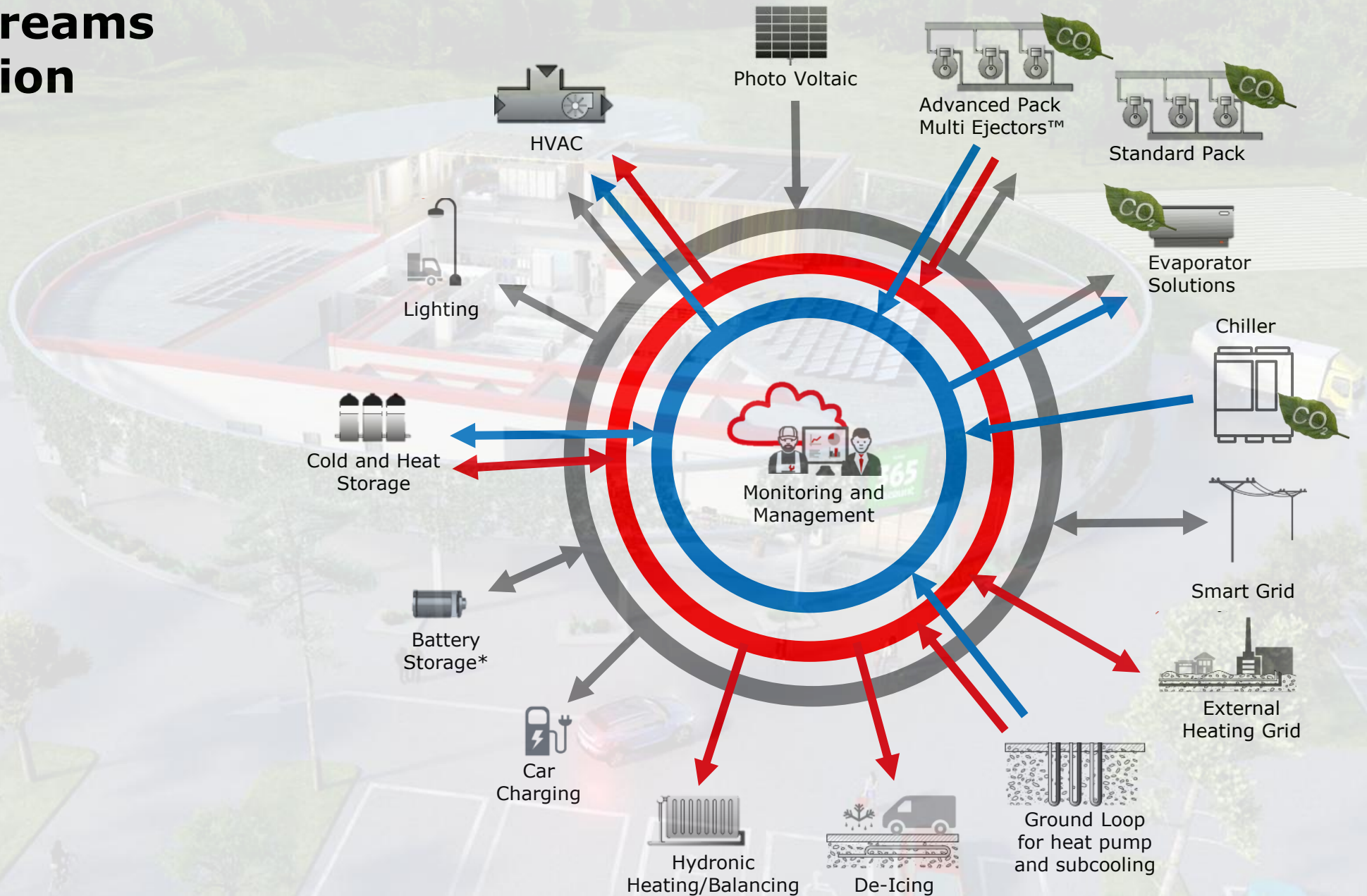
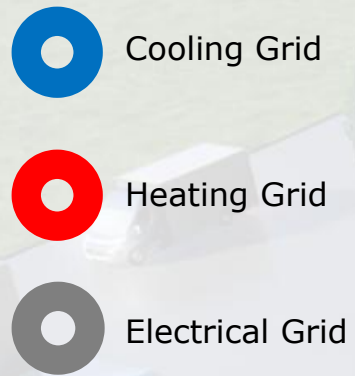
Cold and Heat Storage



Systems overview



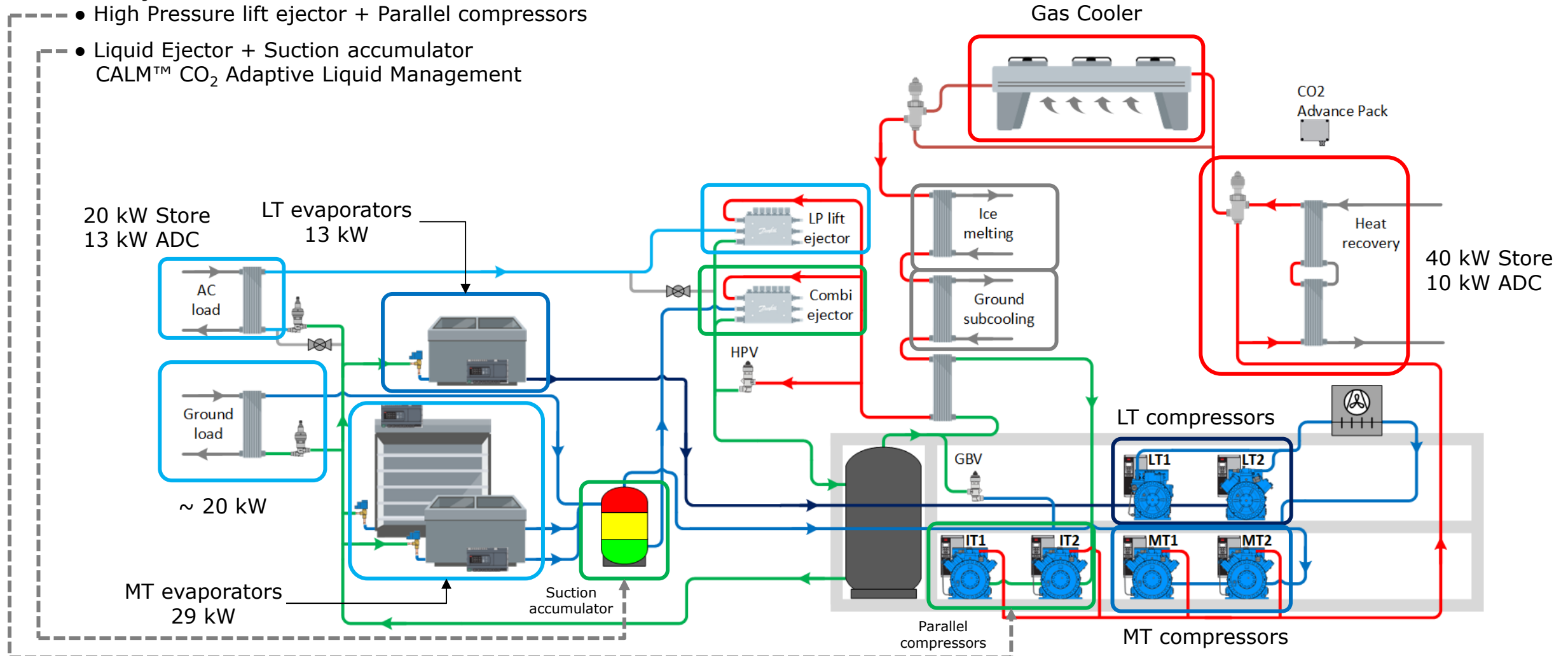
Energy streams optimization



Advanced CO₂ Energy Pack

Multi Ejector Solution™

- High Pressure lift ejector + Parallel compressors
- Liquid Ejector + Suction accumulator
CALM™ CO₂ Adaptive Liquid Management



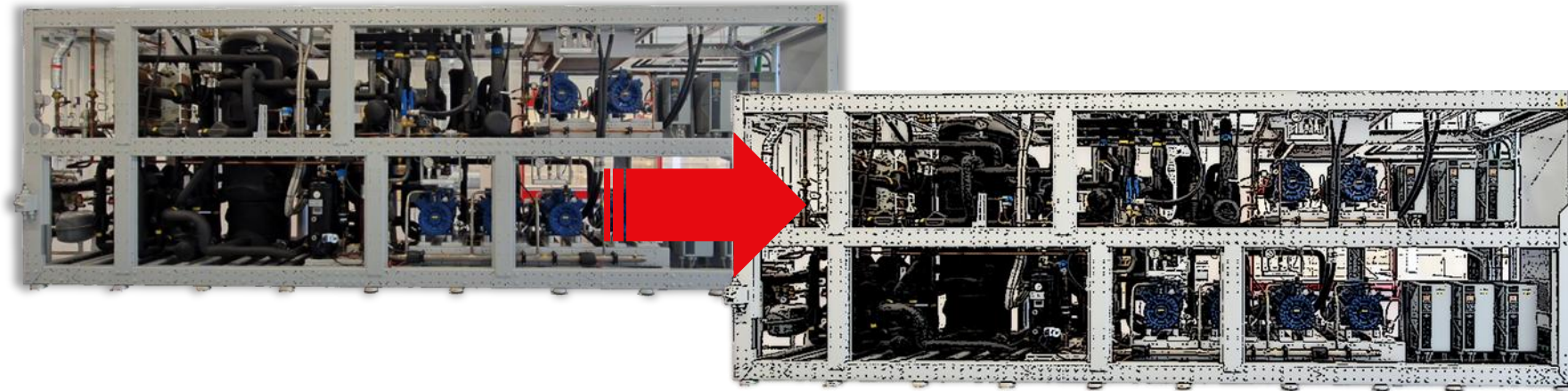
Optimizing Surplus Heat Utilization

The primary objective is to develop the control strategy for a solution, considering:

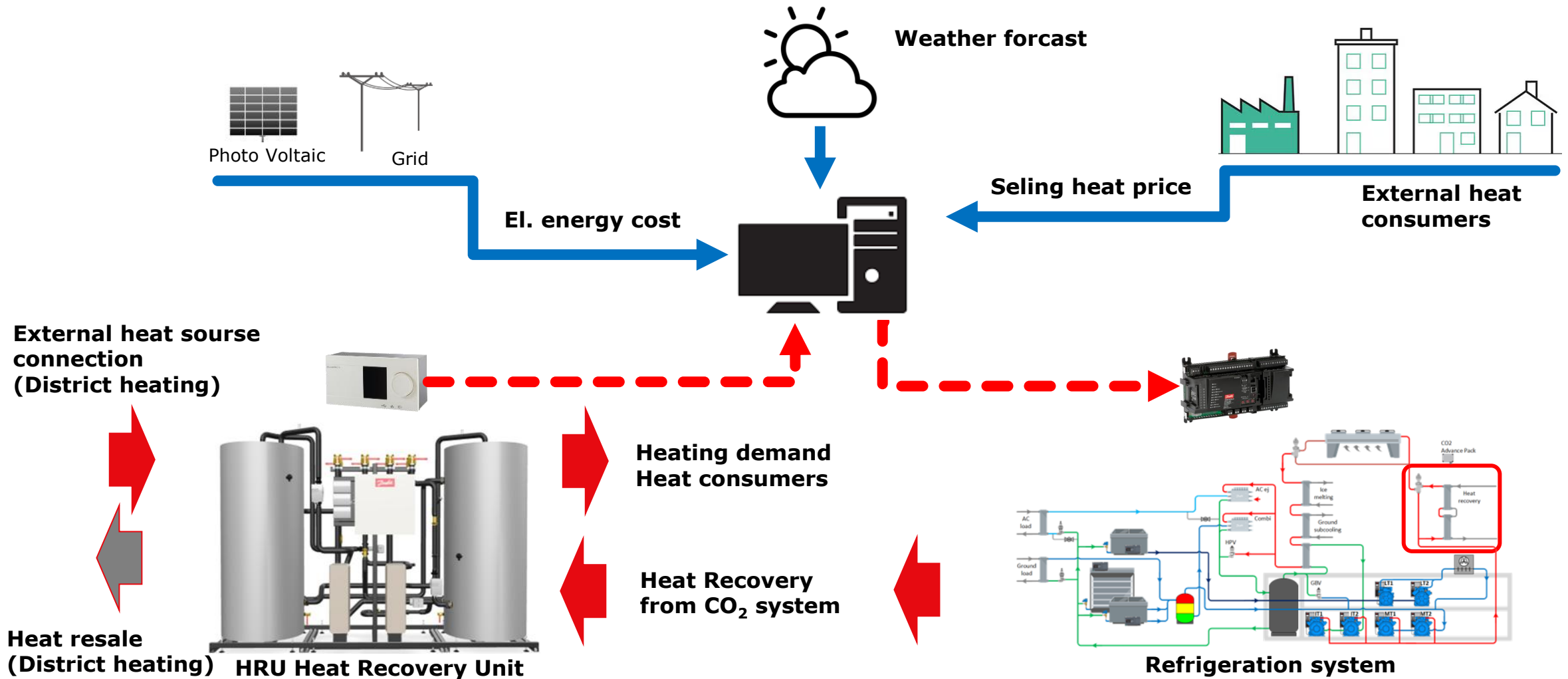
- the electricity price dynamics on an hourly basis
- the pricing structure of the district heating network

Refrigeration system Digital Twin

Follows the same control strategy as the pack controller, so it estimates the proper discharge pressure, gas cooler's capacity and extra heat source in order the heat recovery heat exchanger to satisfy the requested heat, as it has been calculated by the thermal maps or as it is requested by the heat production algorithm.

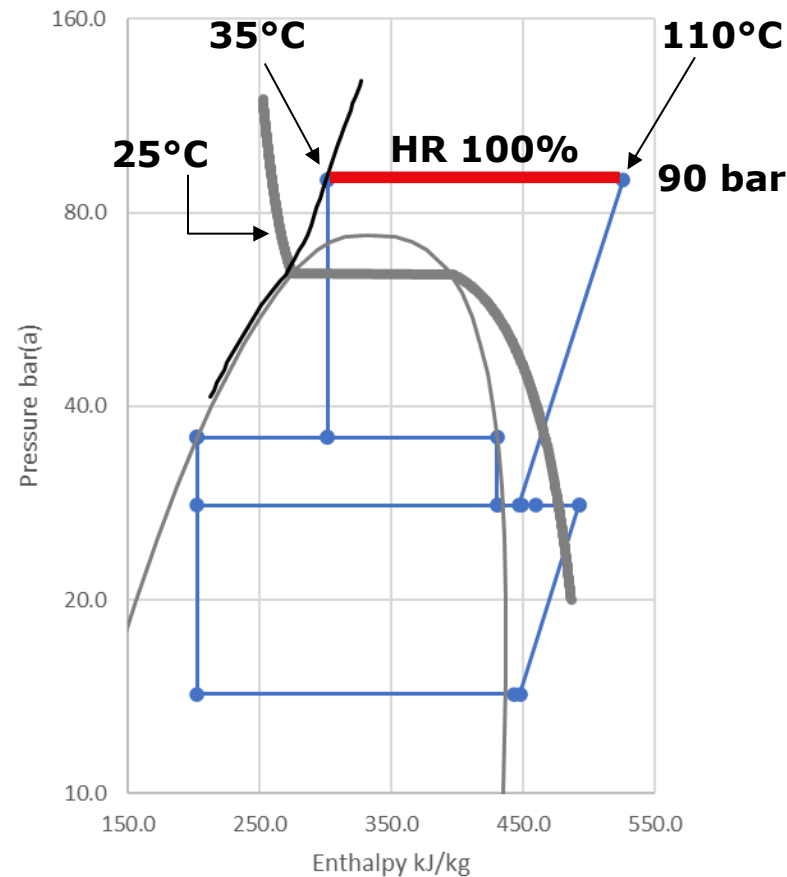


Heat recovery controller set-up

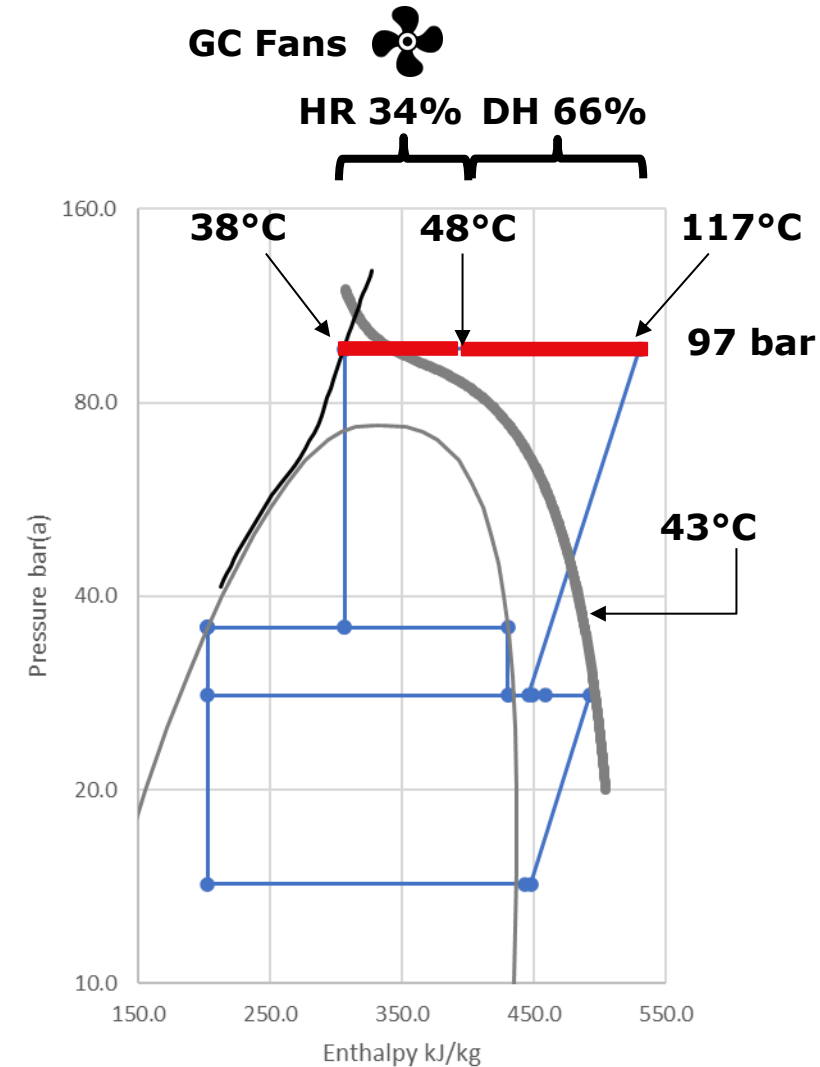


Operation conditions

- When the HRU solely caters to the heating demands of the supermarket, the return temperature of the water averages around 25°C, while the supply temperature reaches a maximum of approximately 55°C
- When surplus heat is exported to the DH network, adjustments are necessary. The supply temperature from the refrigeration cycle must rise to accommodate the DH network's requirements, reaching up to 68°C, while the return temperature stabilizes around 43°C.
- The water inlet temperature to the heat recovery heat exchanger fluctuates between 43°C and 25°C depending on the amount of the sold heat

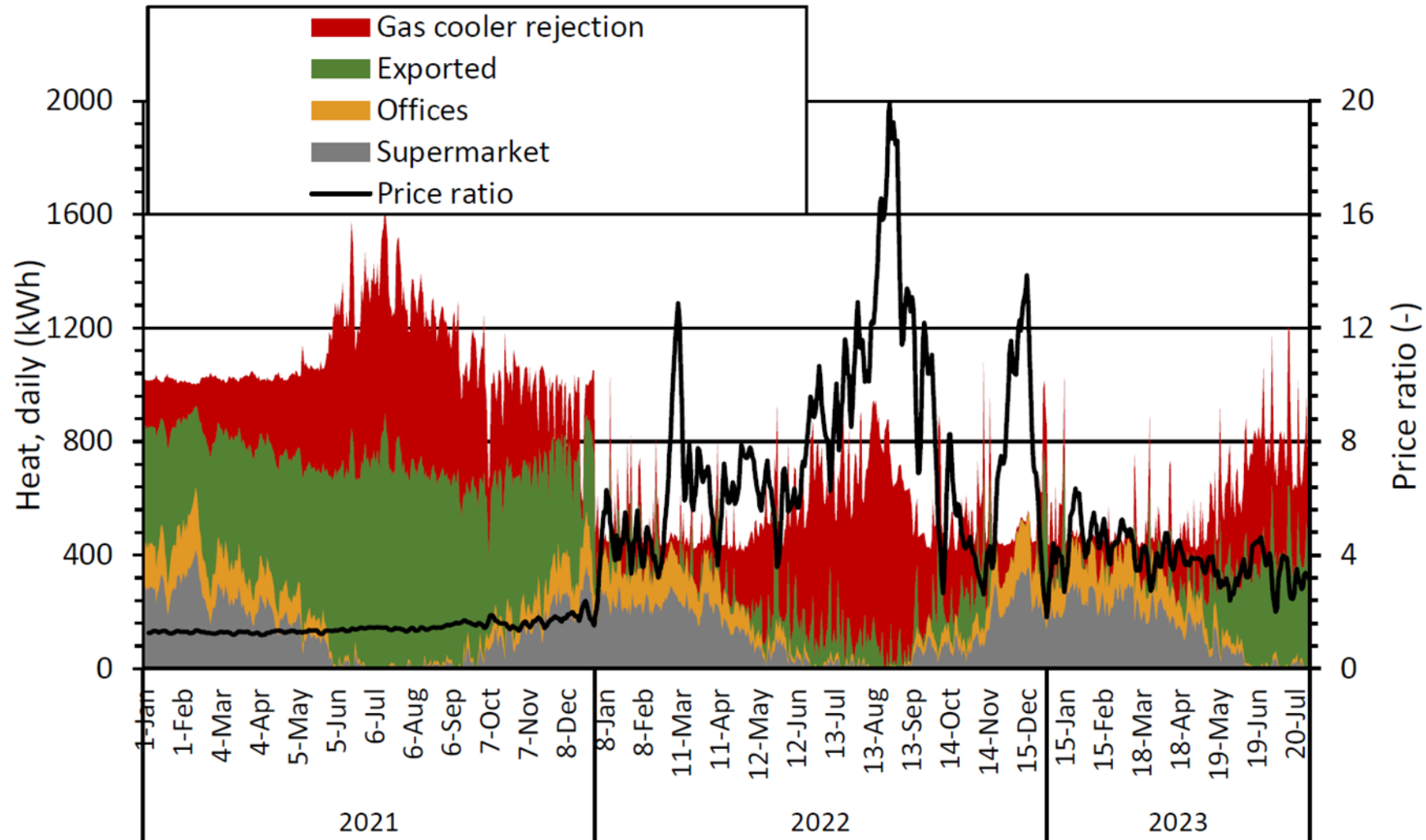


Supermarket heating demand



Supermarket heating demand with export heat to DH

Concept evaluation using Digital Twin simulator



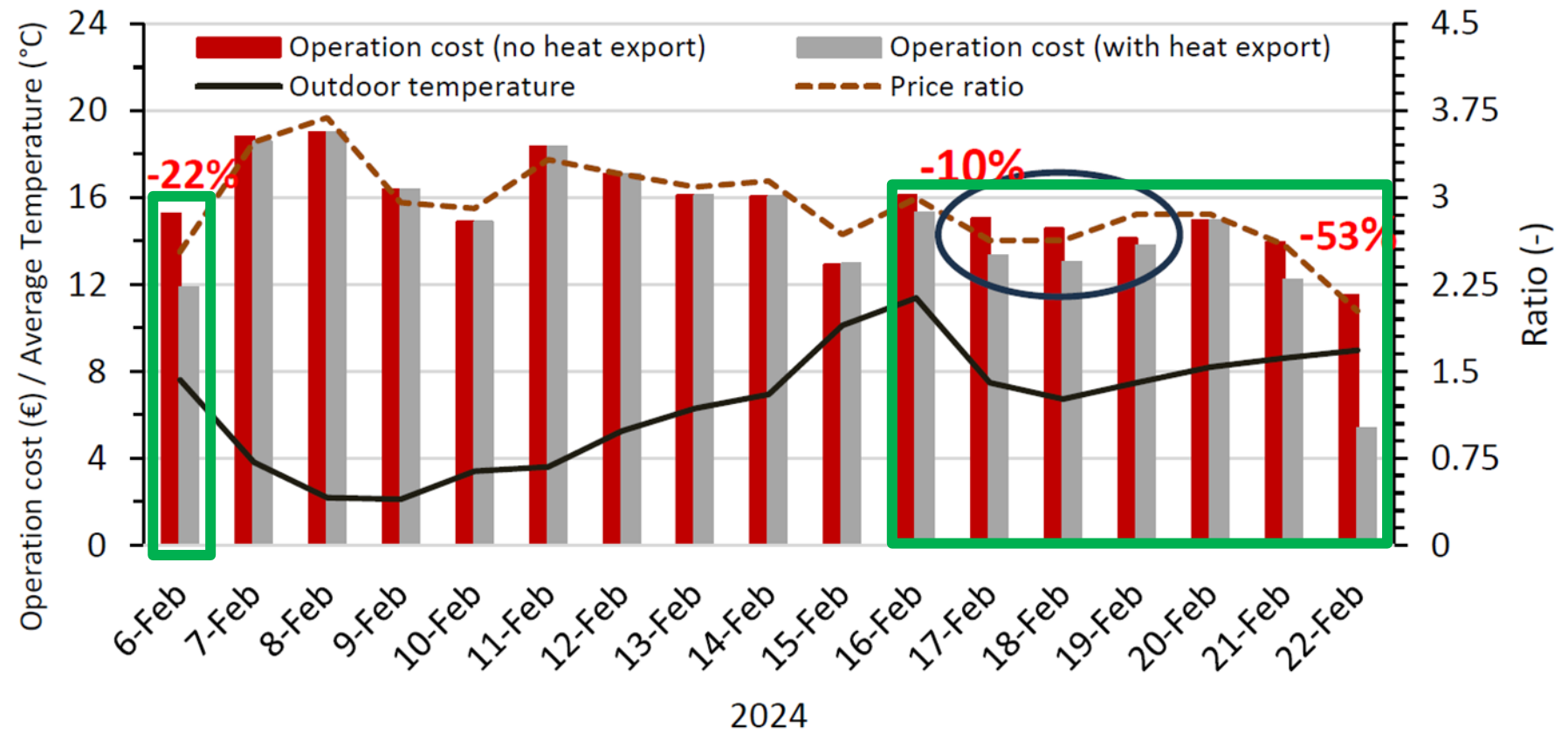
Heat production algorithm evaluation for 2.5 years with different price ratio

Operation cost – field measurements

The algorithm developed for heat recovery and production enables the determination of optimal timing for increased heat production for external consumers based on analysis on heat and electricity prices.

10 to 50%

Decrease in operation cost when favourable electricity price

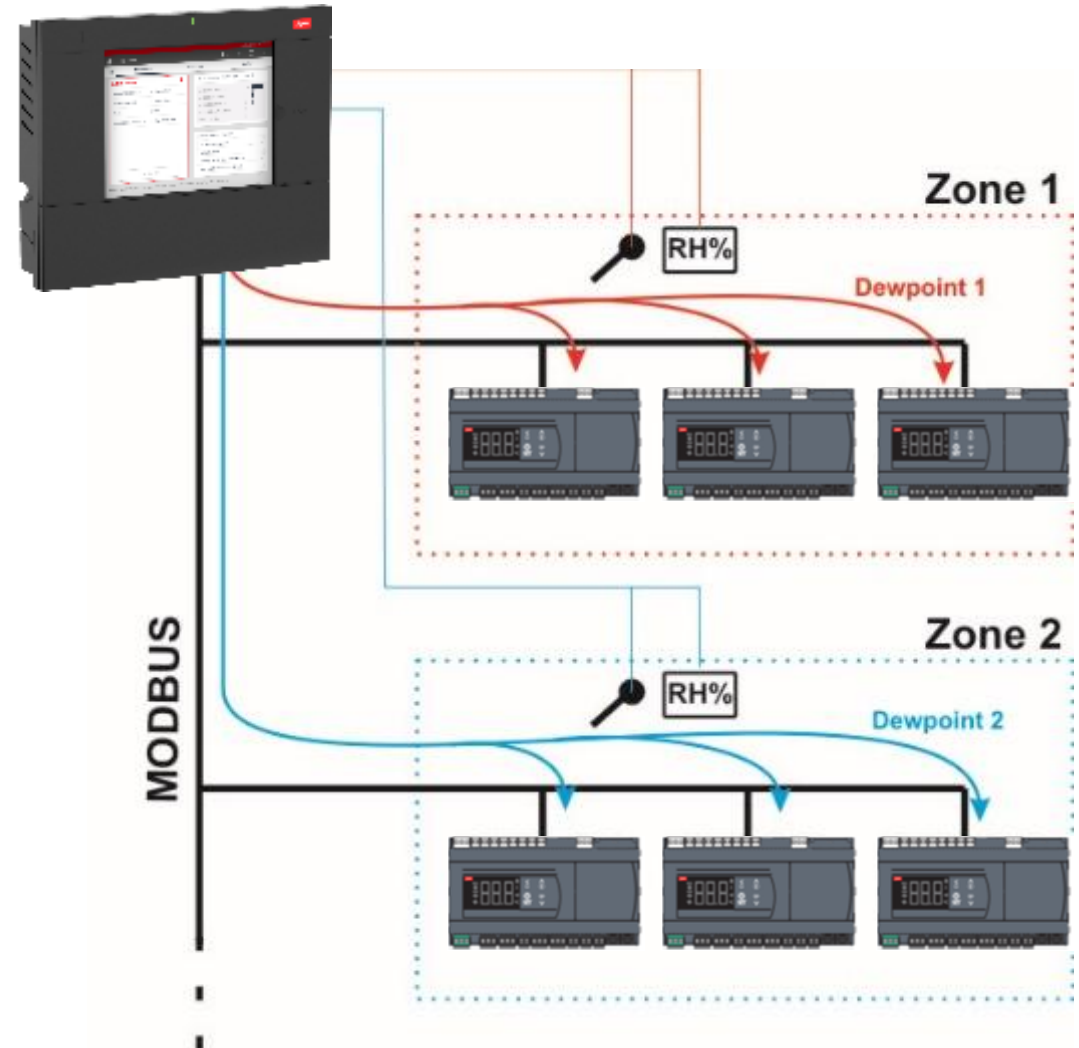


Master control

Rail heat dew point control

- Rail heat ratings are designed for worst case conditions +25°C and relative humidity of 85%.
- By controlling rail heat according to actual dew point measured in the store, significant energy savings can be achieved.
- Procedure:
 - ✓ Relative humidity and temperature is measured by network manager (AK-SM).
 - ✓ Calculated dew point is sent to case controllers.
 - ✓ Rail heat control setup for individual case conditions in each case controller

AK-SM 800A



Rail heat dew point control



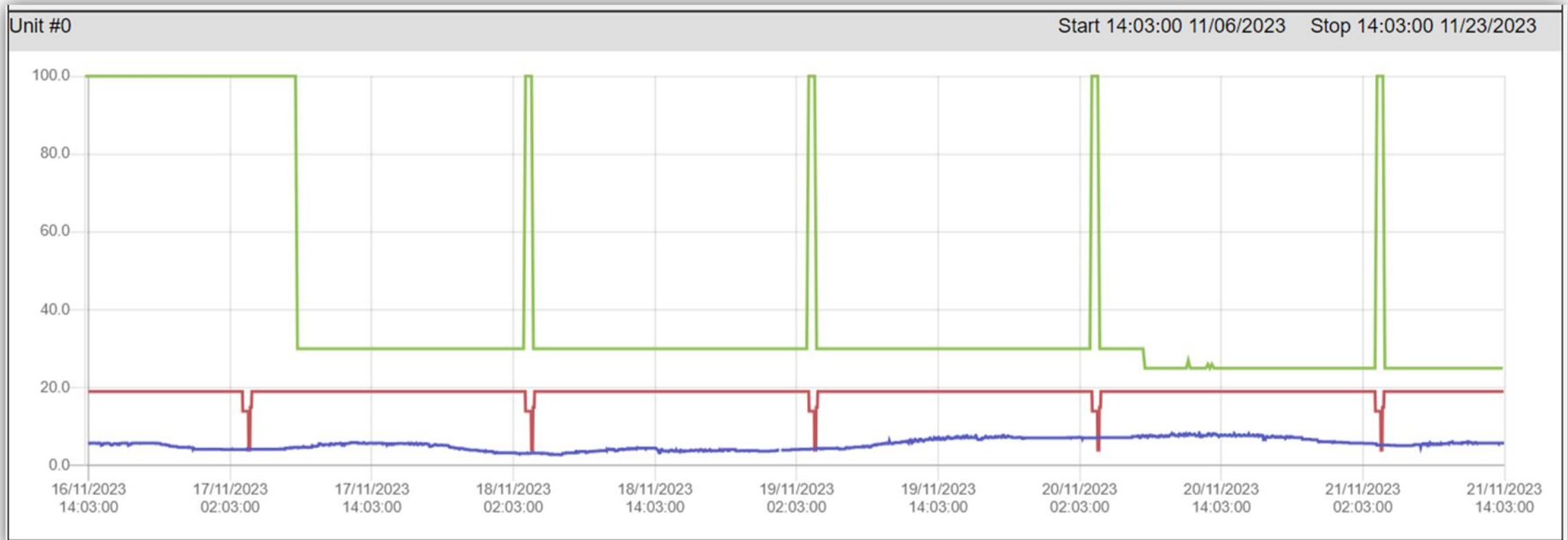
Store measurements

Cabinets used to get maximum savings

Reference cabinets robust control



Rail heat dew point control



Rail heat 100%: 2,6kW

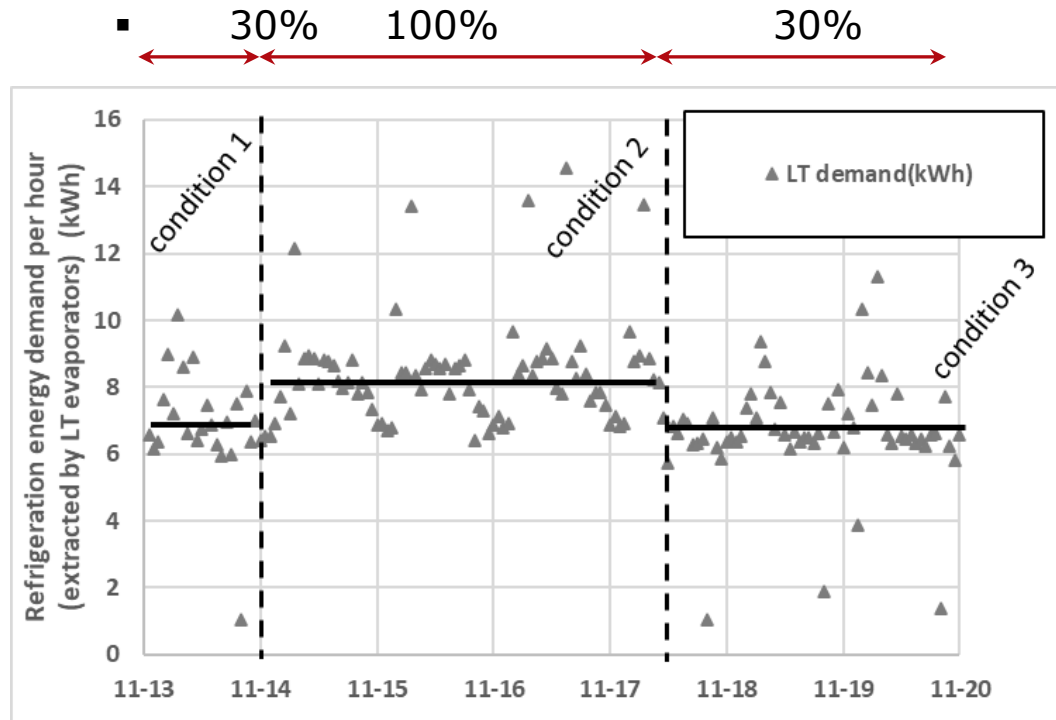
Yearly consumption

@ 100%: $2,6 \times 24 \times 365 = 22.776$ kWh/Year

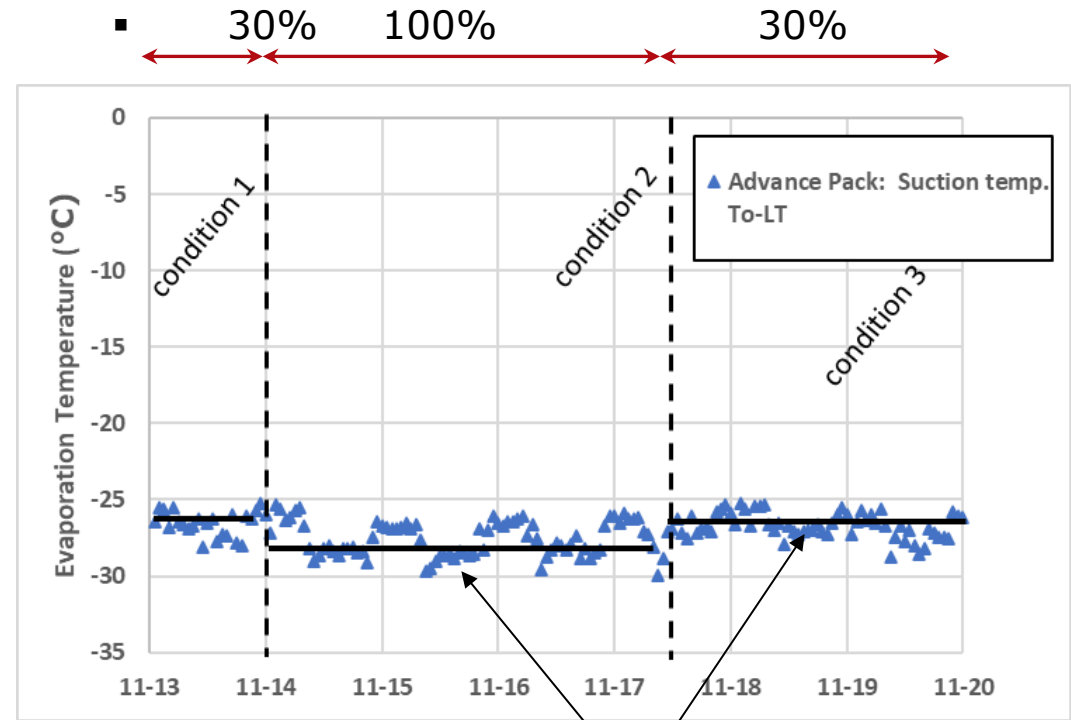
Rail heat load influence on LT compressors

30% vs 100% on LT cabinets

- Refrigeration demand LT – Advanced Pack



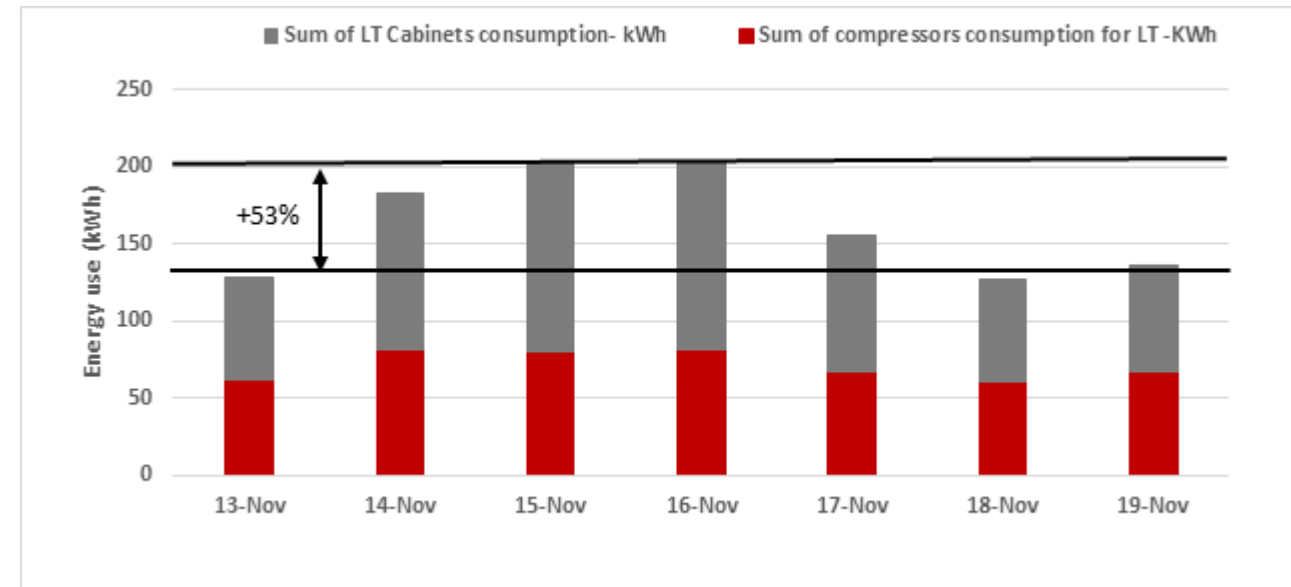
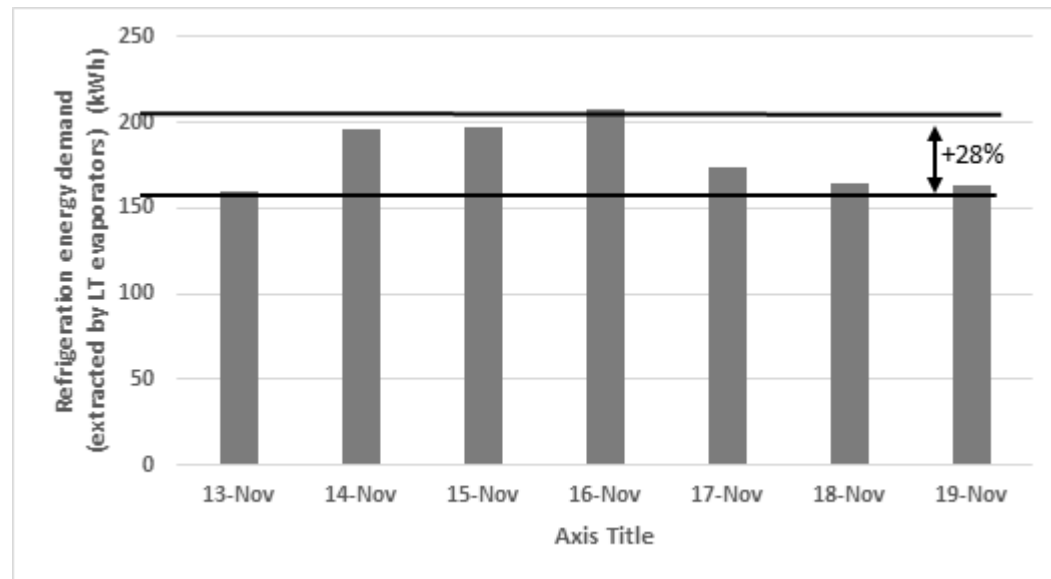
- Suction temperature LT – ADV Pack



Po optimization adjust requested Po LT reference for compressors

LT stage Cooling demand / electricity consumption rail heat 100% vs 30% ON

- Cooling demand increases by 28% when the rail heaters are 100% on
- LT stage (LT evap + comp LT+part of MT for running LT system)
electricity consumption increased by 53%

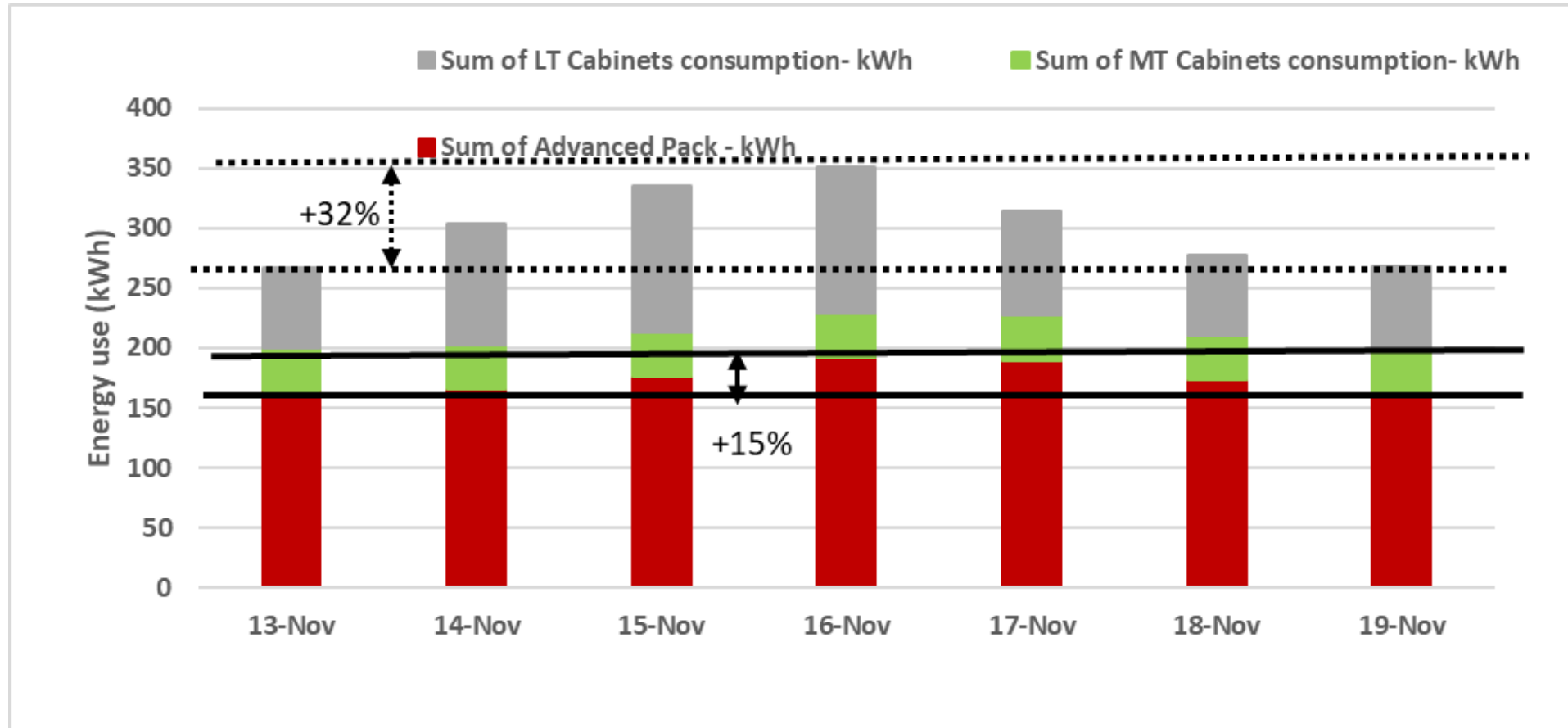


o86 DewP Min lim: all LT cabinets = 8°C

087 DewP Max lim: Cabinet #21,22,23,24 = 16°C, # 25,26,27,28 = 13°C

o88 Rail Min ON%: 30% / 100% / 30%

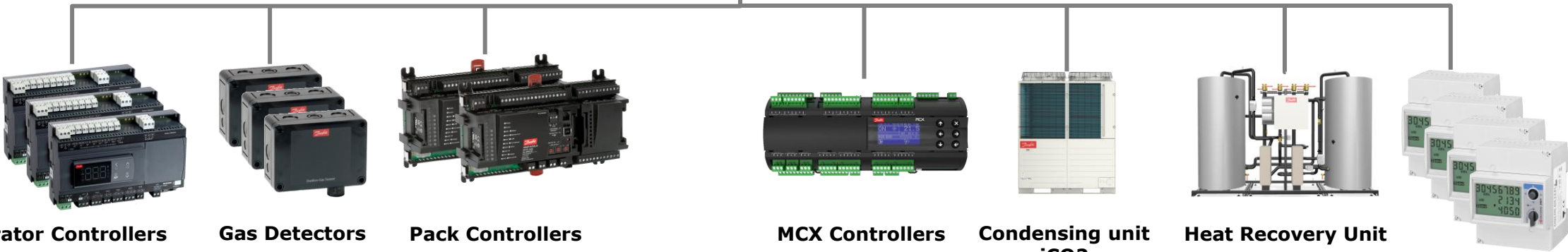
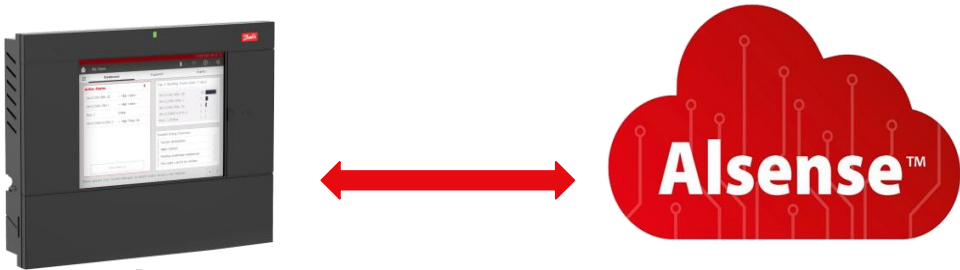
Total energy consumption rail heat 100% vs 30% ON



**up to
30%**

Decrease in
energy
consumption
because of Rail
Heat Dew point
control

Monitoring & management



Evaporator Controllers

Gas Detectors

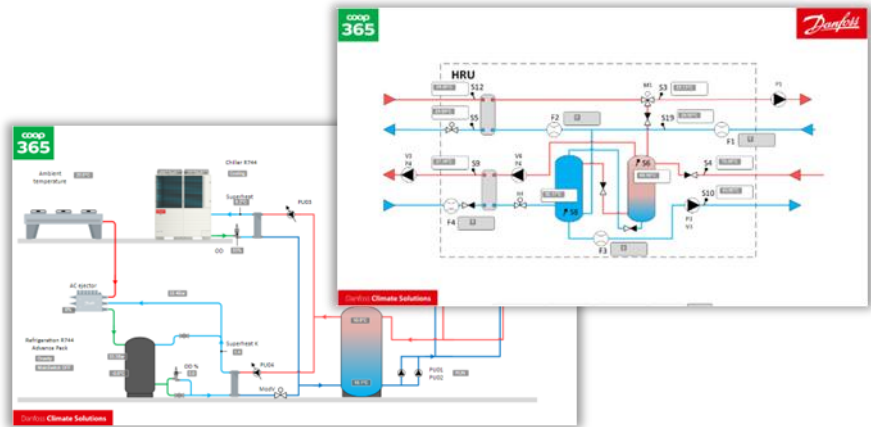
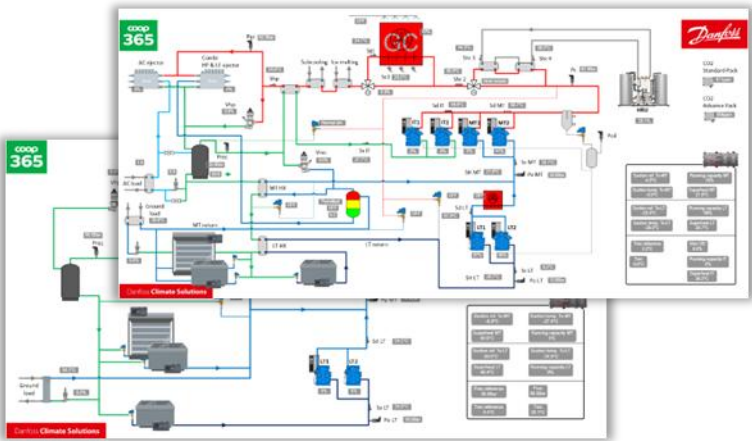
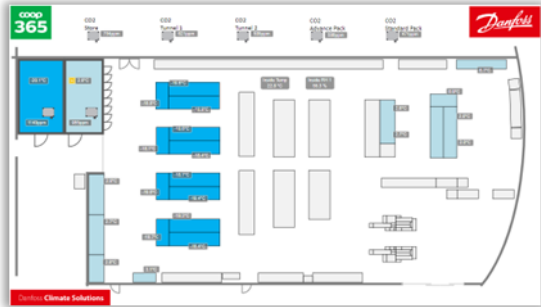
Pack Controllers

MCX Controllers

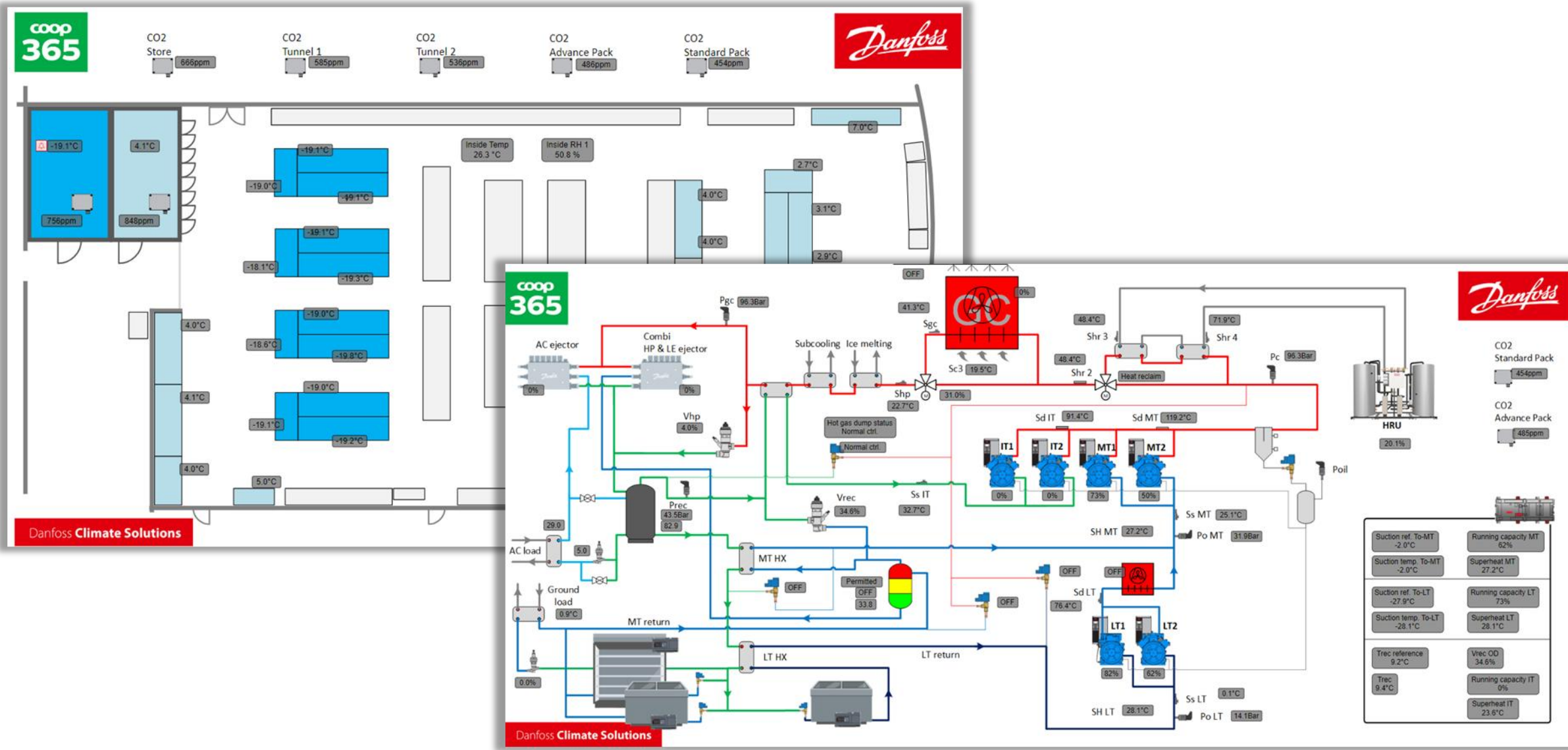
Condensing unit
iCO2

Heat Recovery Unit

Energy Meters

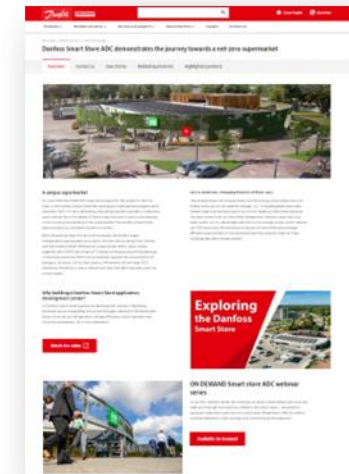


AK-SM 800A Site views



Want to learn more..visit us!

- Visit us at hall 7, booth 251
 - Have a dialouge with our experts
 - Recieve material about Smart Store ADC
 - Learn more about our findings after 1st year of operation
- Visit us in Denmark and see the Danfoss Smart Store ADC.
 - Start by filling out form on web site.
 - We will contact you and make agreement
 - Make your way to - Danfoss' headquarters in Nordborg, Denmark



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