

Field assessment of the performance  
of a state-of-the-art CO2 integrated  
system for supermarket with  
distributed HVAC terminals in the  
shopping area

EU GREEN WEEK 2021 PARTNER EVENT

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# Summary

- The MultiPACK project
- The CO<sub>2</sub> commercial refrigeration system installed in North Italy
- Field data: operations and performances
- Cabinets: dry vs overfed evaporators

# The MultiPACK Project

- EU funded Horizon 2020 Project (Grant number 723137), duration 60 months
- Main goals: **demonstrate** the performance and efficiency of integrated cooling and heating packages based on CO<sub>2</sub> by installation and monitoring of 6 units; **increase confidence** in environmental friendly solutions
- Focus areas:
  - **Supermarkets**
  - High energy demanding buildings (hotel, gyms,...)
- Consortium: partners in all the links of the value chain from initial innovation to the actual end user



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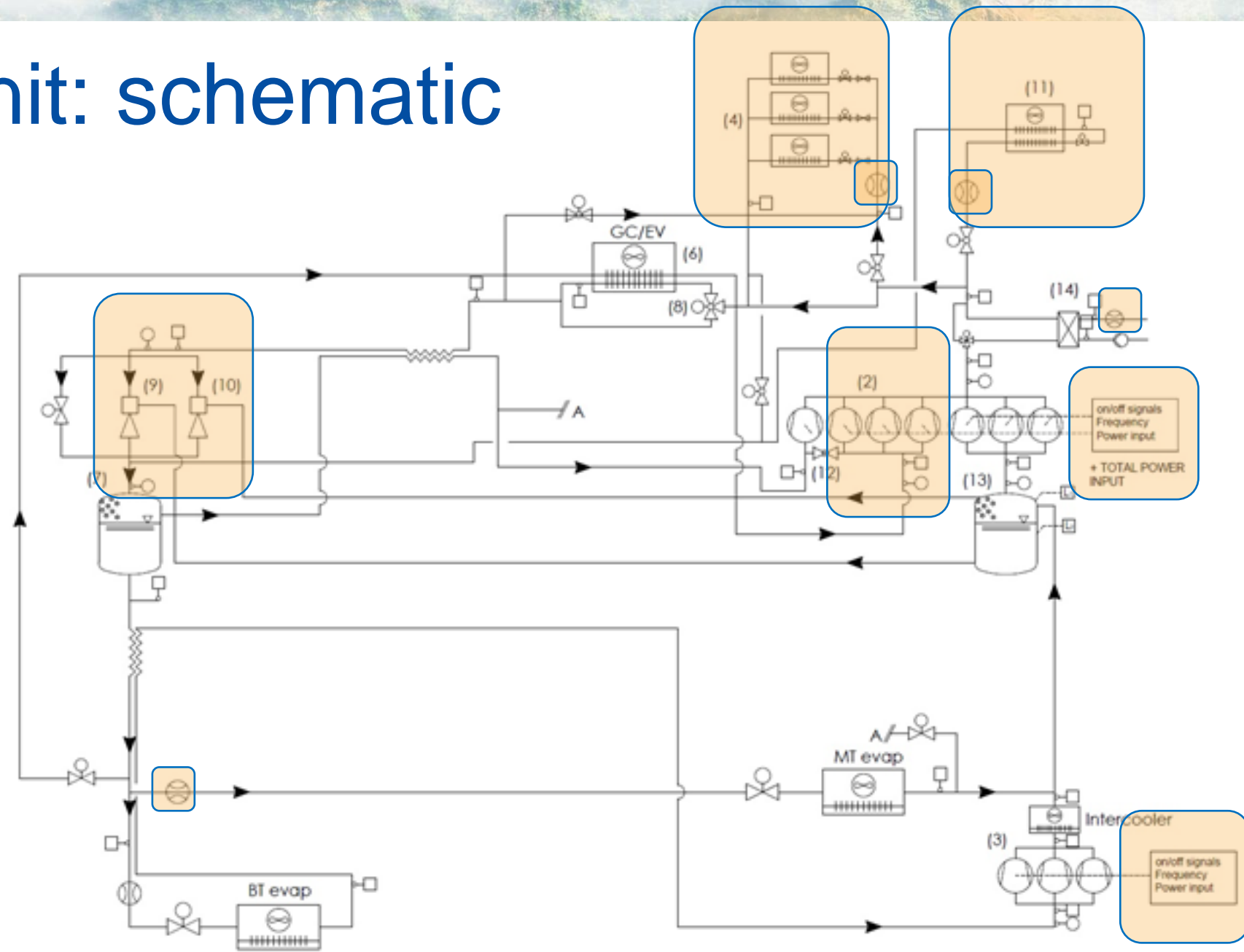
# What is a MultiPACK unit for supermarkets?

- A **fully integrated** unit providing Refrigeration, Heating and Air Conditioning based on **Carbon Dioxide** as the refrigerant
- Suitable for **South European Climate**, thanks to parallel compression, overfed evaporators, ejectors for vapour pre-compression and liquid recirculation
- **Heat Pump** functionality
- Direct expansion **cooling** and **dehumidification**
- **Scalable** and **adaptable** to different load ratios and HVAC design
- **Fully instrumented** for performances monitoring

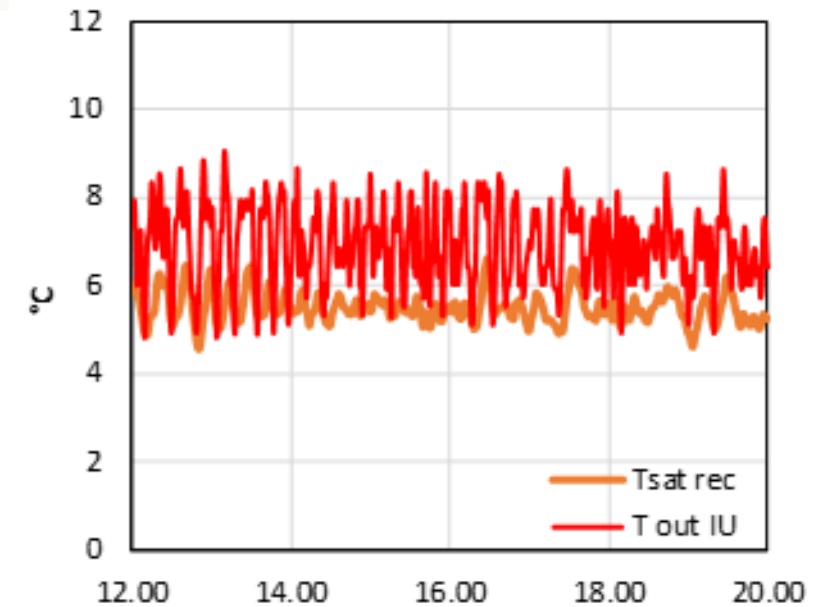
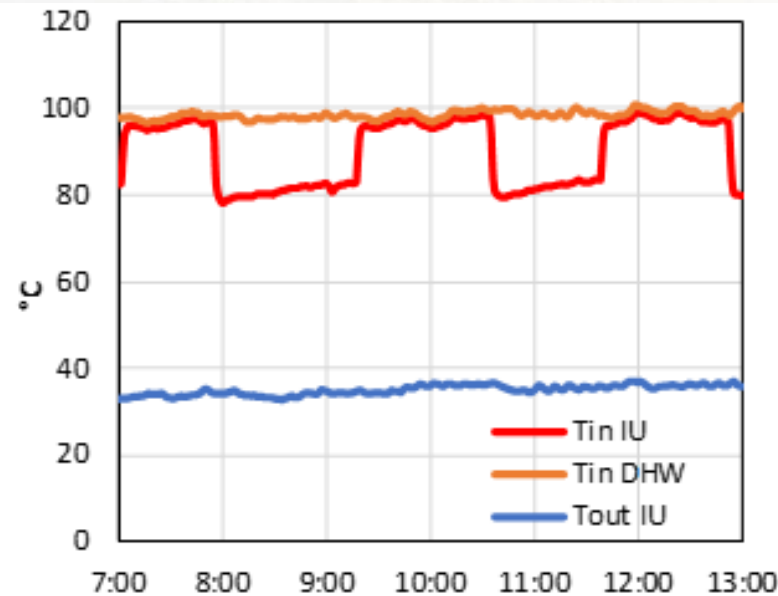
# North Italy Unit: schematic

State-of-the-art booster with parallel compression, including:

- Multiejector for vapour and liquid
- Compressors for HP functionality
- Distributed indoor terminals (ceiling)
- AHU for dehumidification
- Fully instrumented

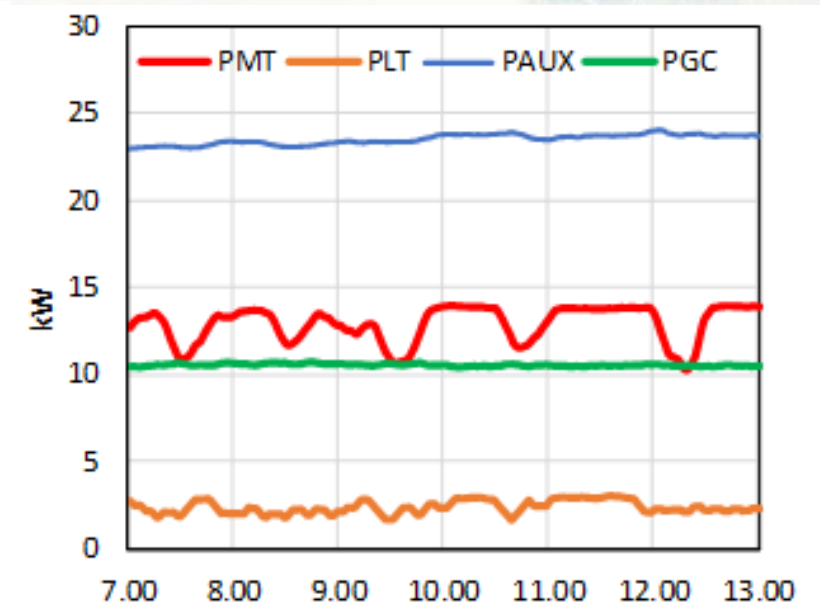
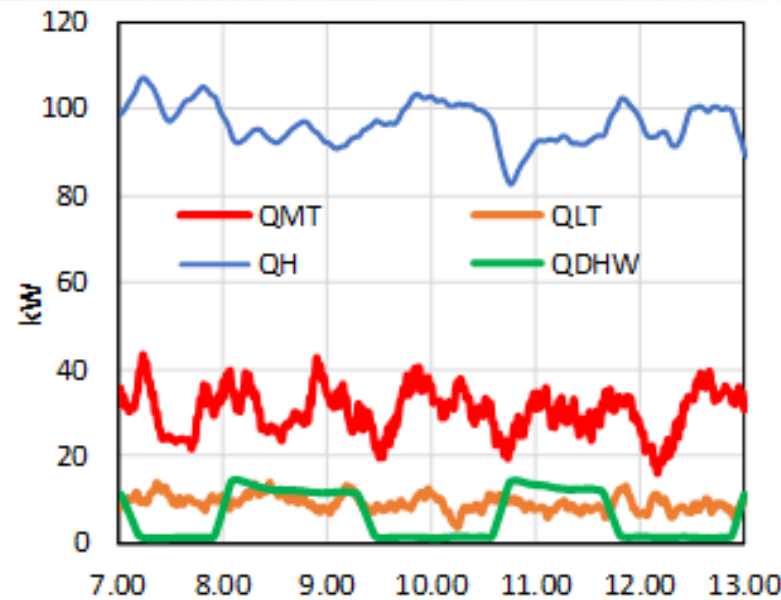
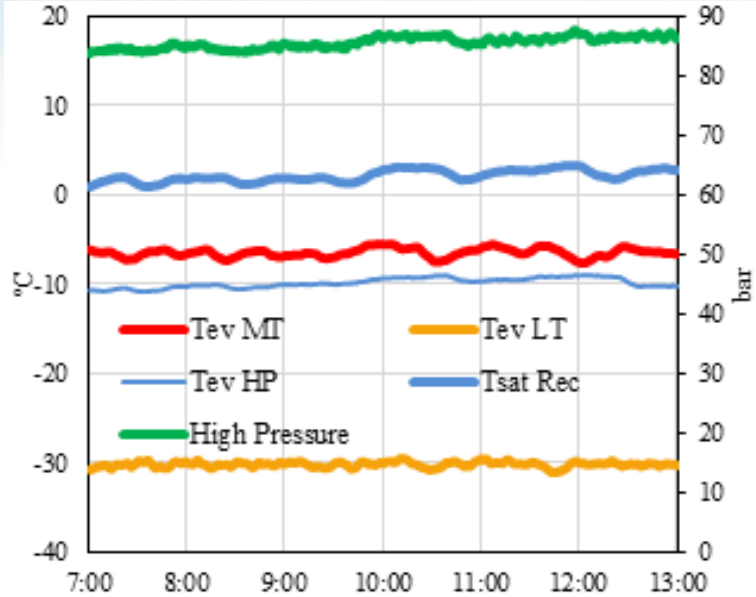


# Indoor units



- Winter: direct flow from compressor discharge line
- Summer: direct expansion from GC outlet and flow back to IPR

# Winter operations

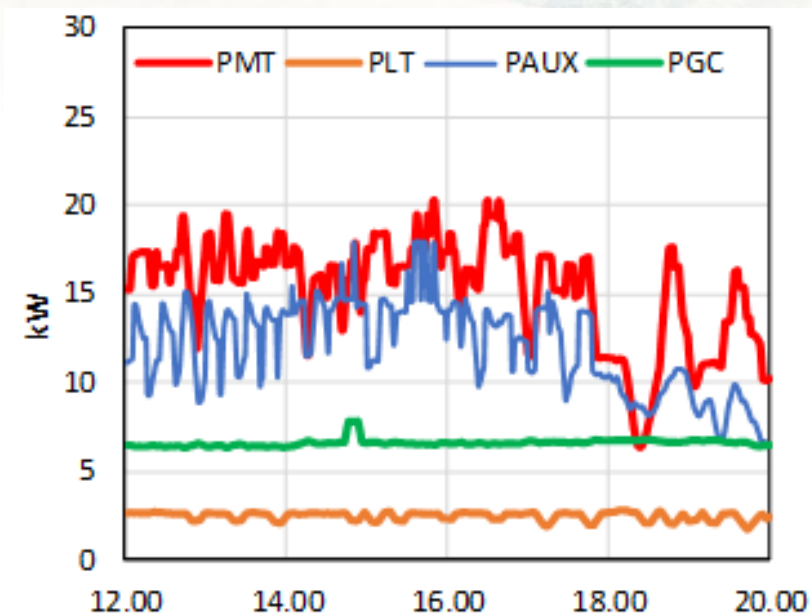
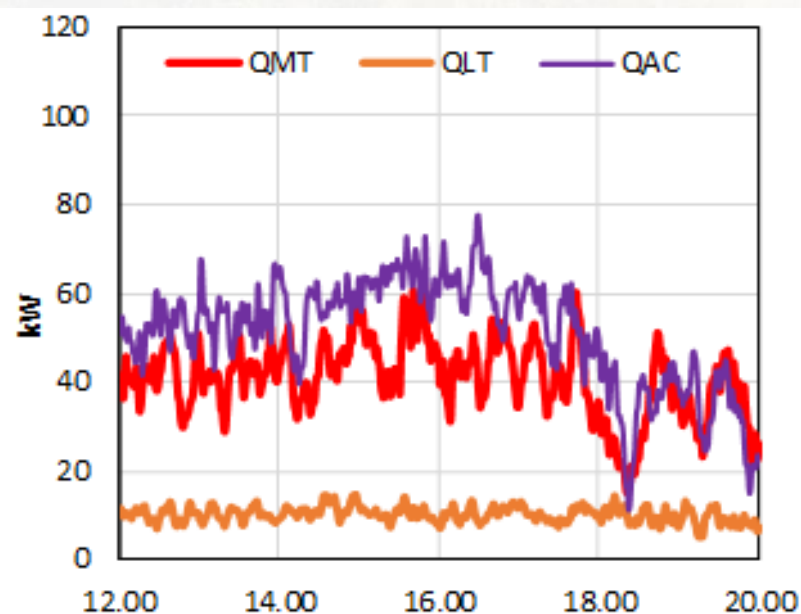
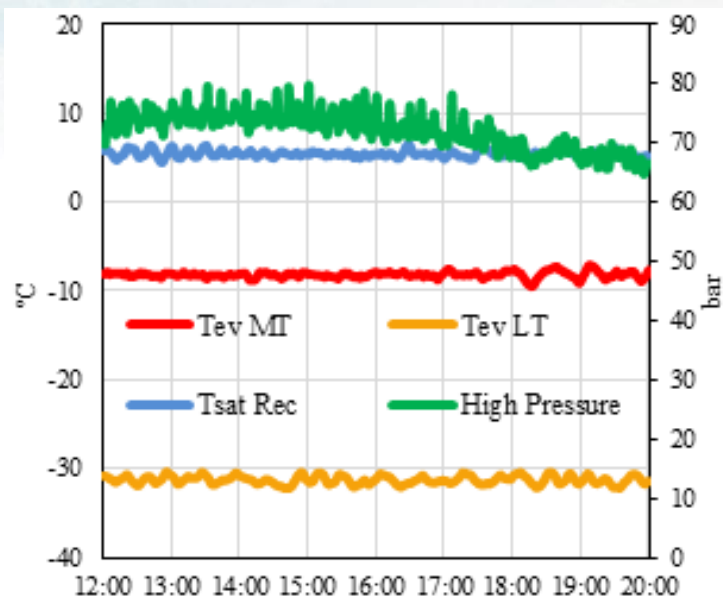


- Transcritical operations for heat recovery
- Independent evaporation temperature for HP functionality
- Relevant power input to HP compressors

07:00-13:00 11 December 2019 (T average outdoor 4.7°C)

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# Summer operations



- Transcritical operations
- Stable LT compressors power input

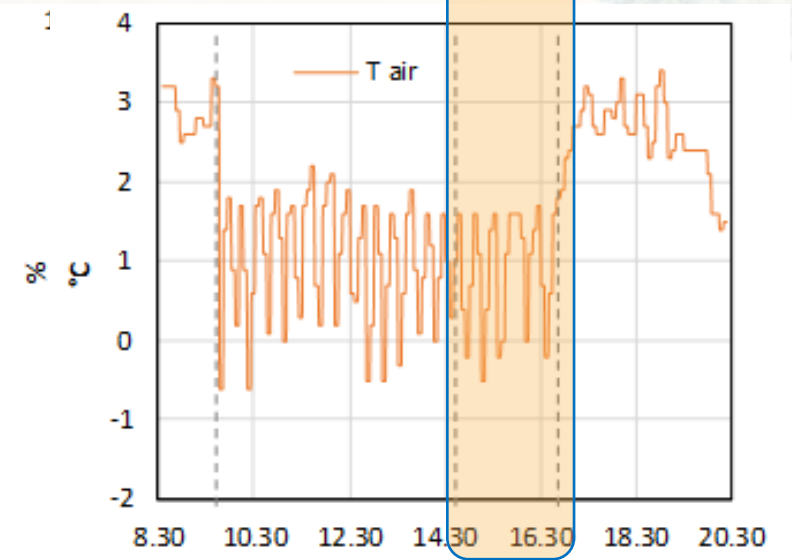
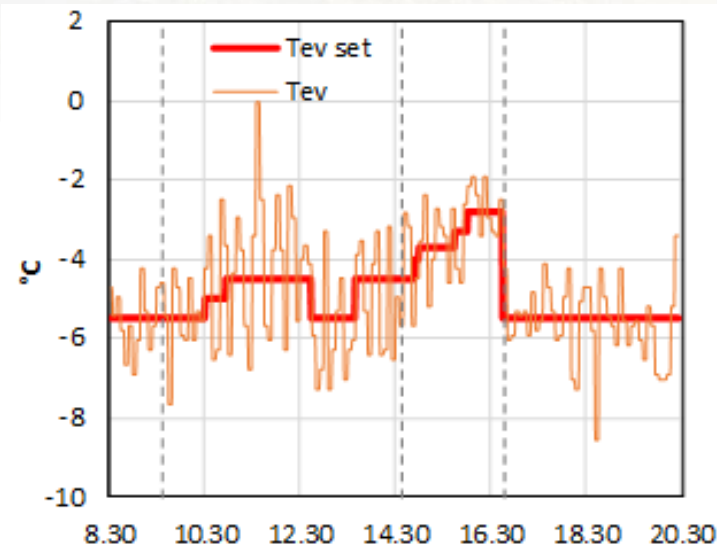
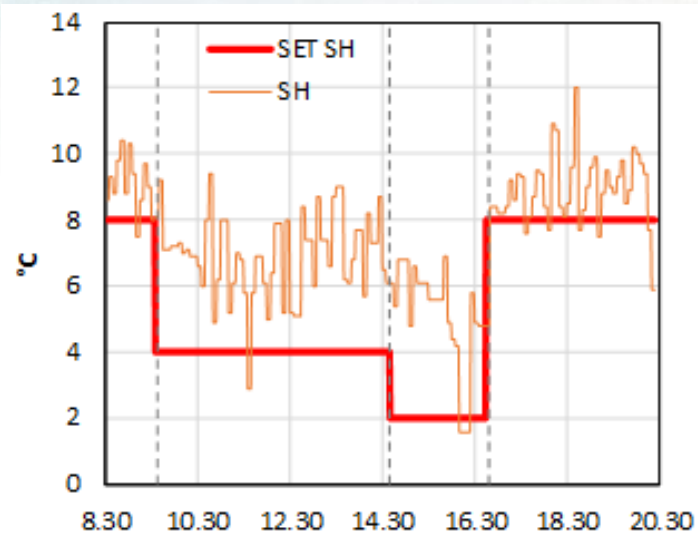
12:00-20:00 16 August 2019 (T average outdoor 26.1°C)



# Performance

Q [kW]	MT	LT	HP / AC	DHW
Summer	40.8	10.2	51.4	-
Winter	30.3	9.5	96.4	6.3
Power input [kW]	MT	LT	AUX	GC
Summer	15.2	2.5	12.0	6.6
Winter	12.9	2.3	23.5	10.5
T [°C]	MT T <sub>ev</sub>	LT T <sub>ev</sub>	AUX T <sub>sat</sub>	HP T <sub>sat</sub>
Summer	-8.2	-31.3	5.5	-
Winter	-6.5	-30.0	2.3	-9.9
COP <sub>tot</sub> [-] (COP)				
Summer	2.8 (3.4)			
Winter	2.9 (3.7)			

# Cabinets: dry expansion vs overfed



- Reduced set for SH
- The EEV opens widely to achieve superheat set
- Air temperature set point is achieved faster, the thermostat closes the valve
- Increased evaporation temperature

# Conclusion

- The MultiPACK project is demonstrating the feasibility and performances of fully integrated CO<sub>2</sub> systems in South European Climate
- The peculiarity of the presented unit lies in the HVAC terminals
- 1 year data collection is completed
- The specific energy consumption for HAC&R (excluded cabinets electrical power and fan coils fans) is 115 kWh m<sup>-2</sup> year<sup>-1</sup> (145 kWh m<sup>-2</sup> year<sup>-1</sup>)

# Thank you



The MultiPACK Project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 723137