

# A CO<sub>2</sub> dream solution for a supermarket – a concept case



Torben Funder-Kristensen, Head of Public Industry Affairs  
[TFK@danfoss.com](mailto:TFK@danfoss.com)

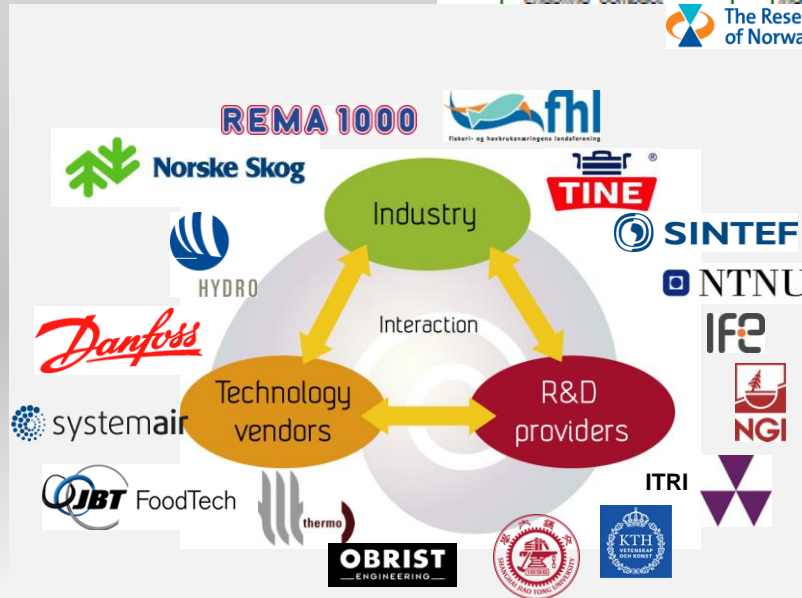
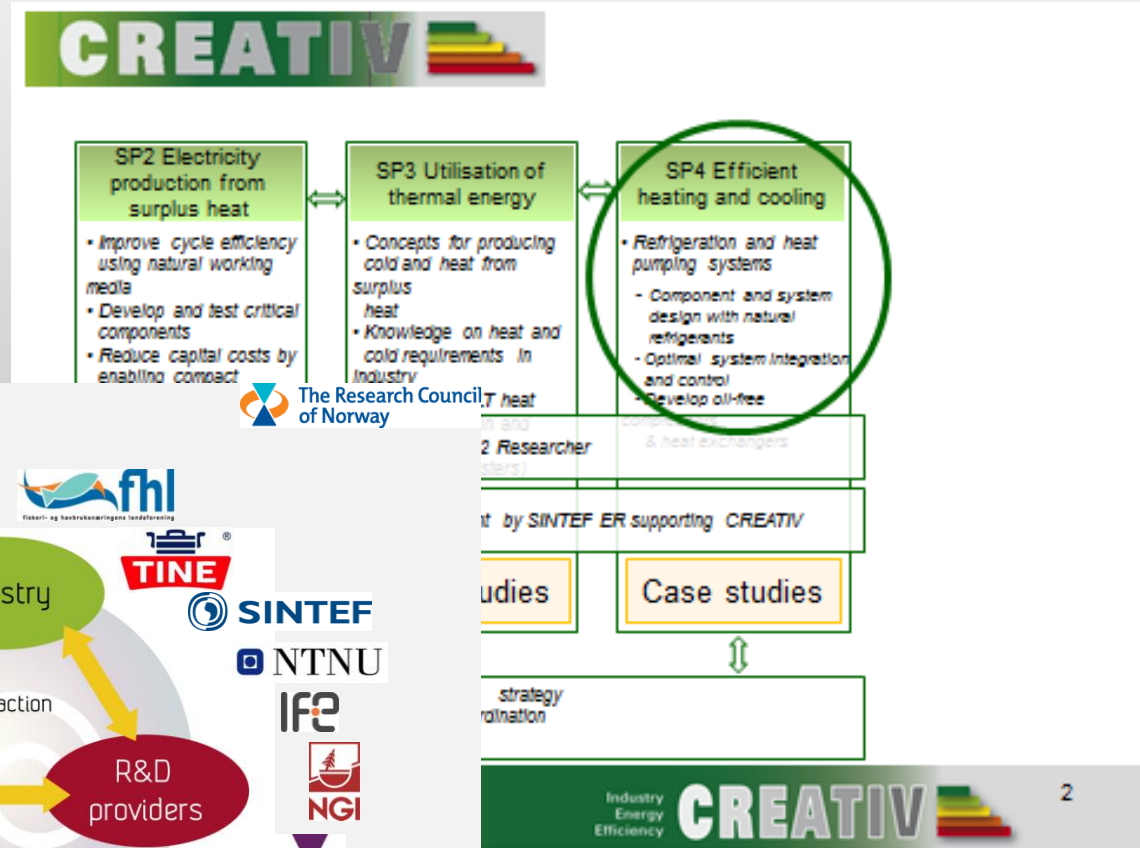
## Agenda



- The project
- Facts about the case
- Description of the store refrigeration & HVAC system build up
- Why CO<sub>2</sub>
- The controls used in the concept
- Actual status
- Conclusion and next steps

# The Project

- Total budget: ~6 mill €
- Timeframe: 2009-13

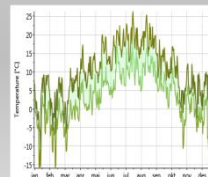
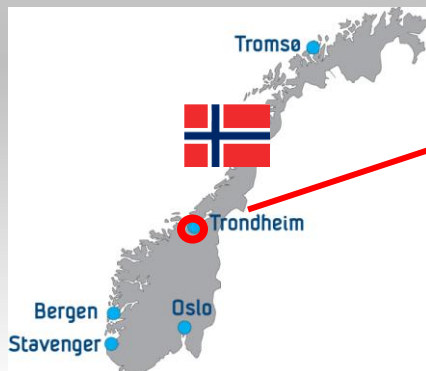


CREATIV project, performed under the strategic Norwegian research program RENERGI (195182/S60). The CREATIV is financially supported by the Research Council of Norway and several industry partners.



## Facts about the case

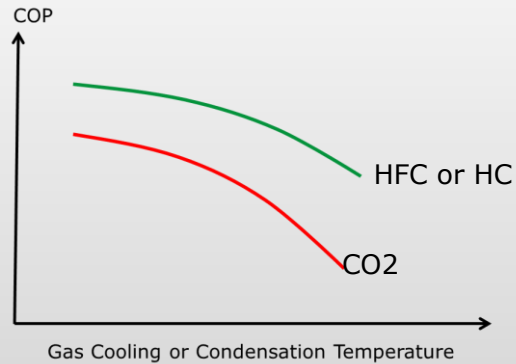
- Supermarket size: 700 m<sup>2</sup> sales area
- Compressor Capacity:
  - MT: 3x 4KTC-10KI-40 -> 73 kW
  - LT: 1x 2MHC-05KB-40 -> 7 kW
- Air Handling Unit : (New Design)
  - Heat recovery
  - Heating and cooling
  - Bypass of all devices not in use
  - PM motors
- Heat management: (storage and distribution)
  - Tanks + indoor and outdoor concrete
  - Ref. System with heat pump function:
    - Heat from energy wells (4x170m)
    - Floor heating inside the store (0-60%)
    - Heated air from the AHU (0-100%)
    - Snow melting at entrance and goods delivery
- Space cooling
  - Free cooling from energy wells
  - Additional sub cooling via refrigeration unit



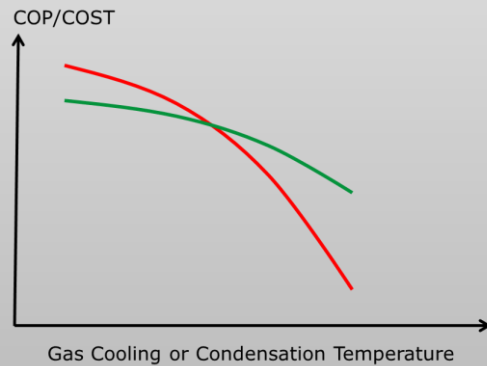
YAT : 6.5 °C  
SAT : 14.0 °C

## Why CO<sub>2</sub>?

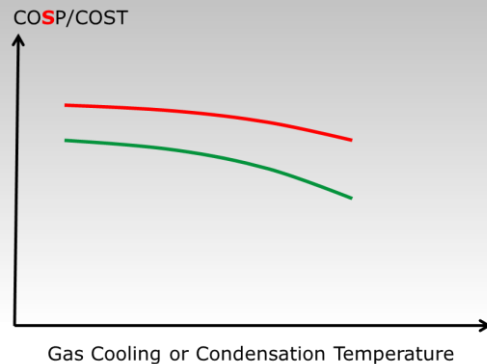
Theoretical COP based on pure thermodynamic properties



Actual performance utilising CO<sub>2</sub>'s thermophysical properties

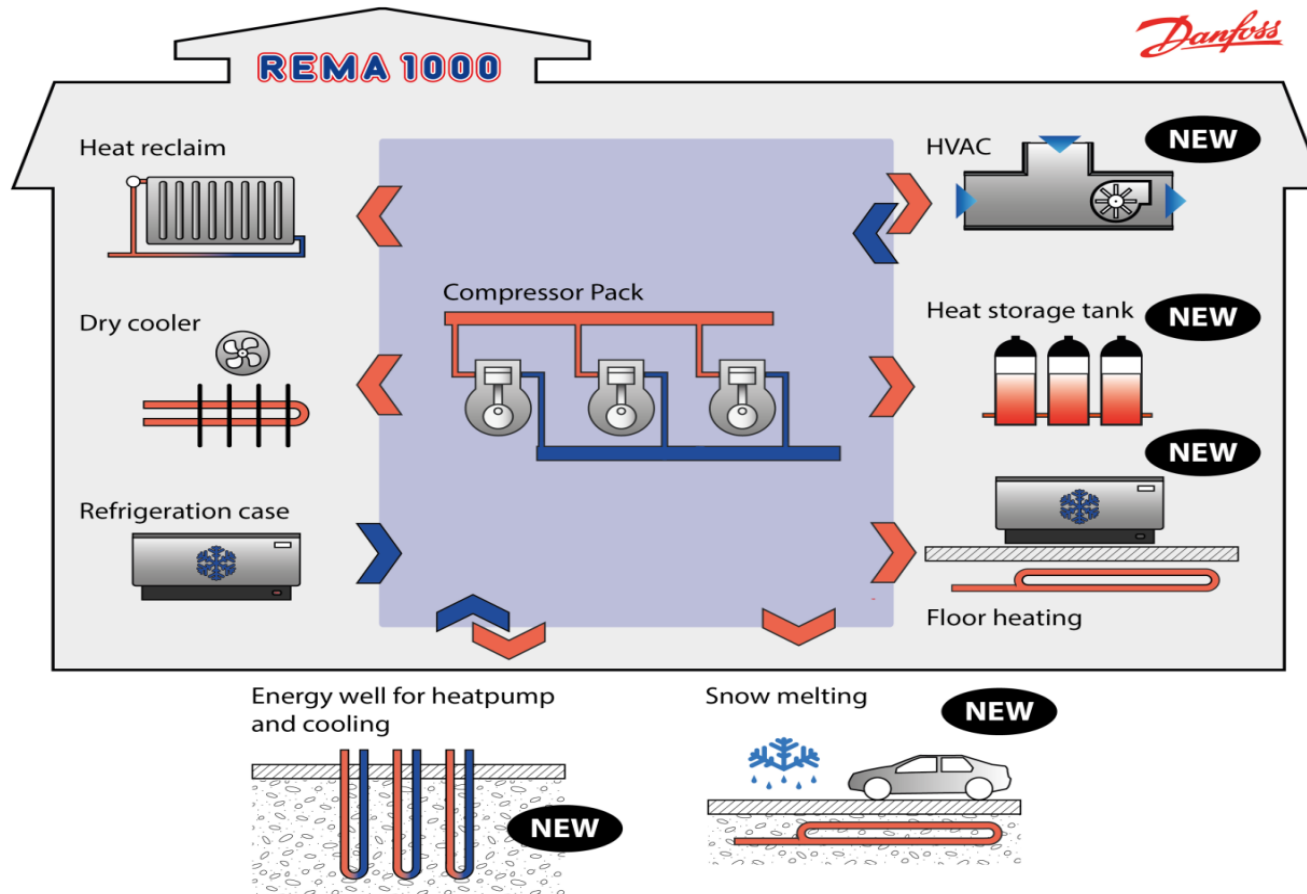


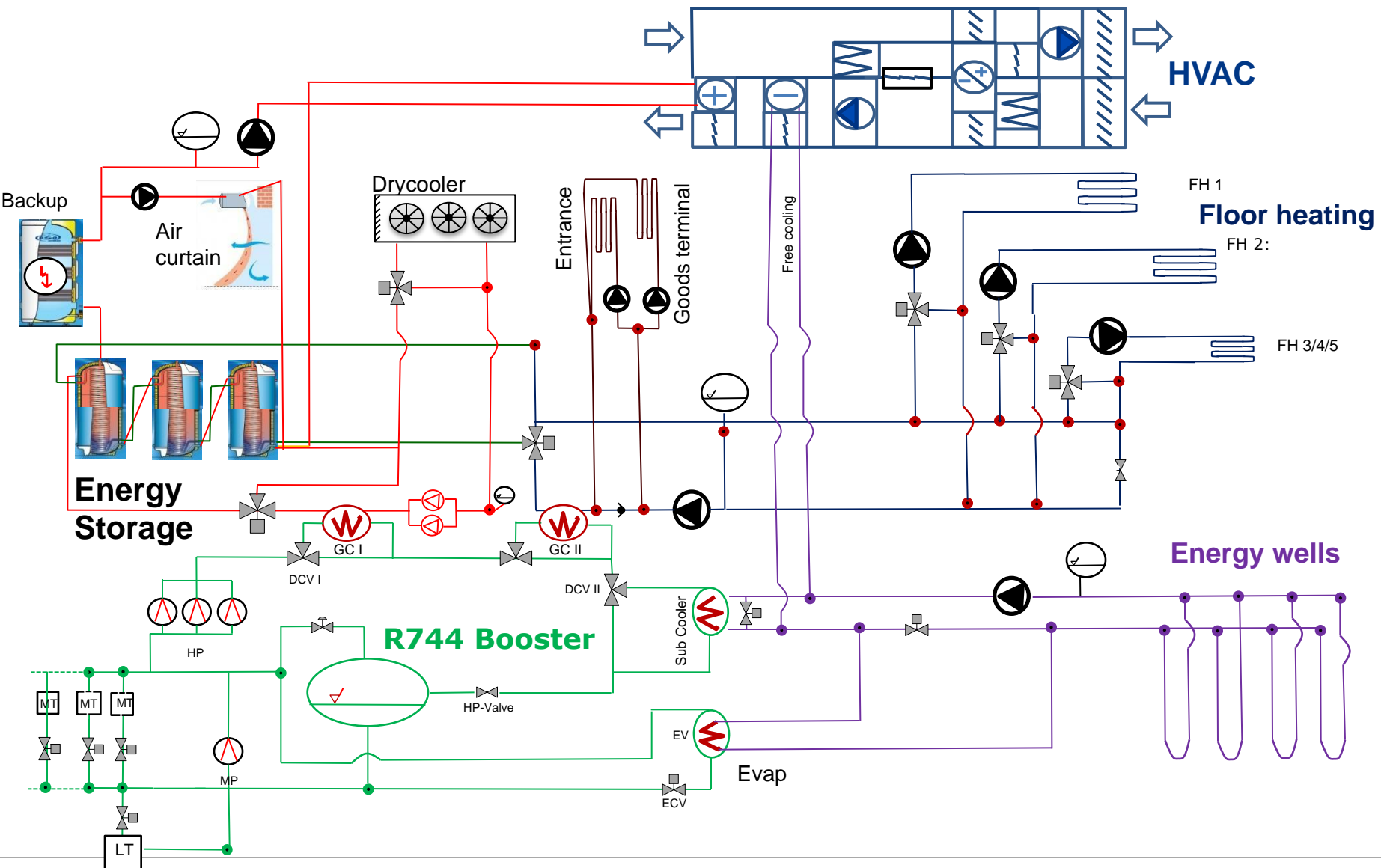
Actual performance utilising CO<sub>2</sub>'s thermophysical properties with heat recovery



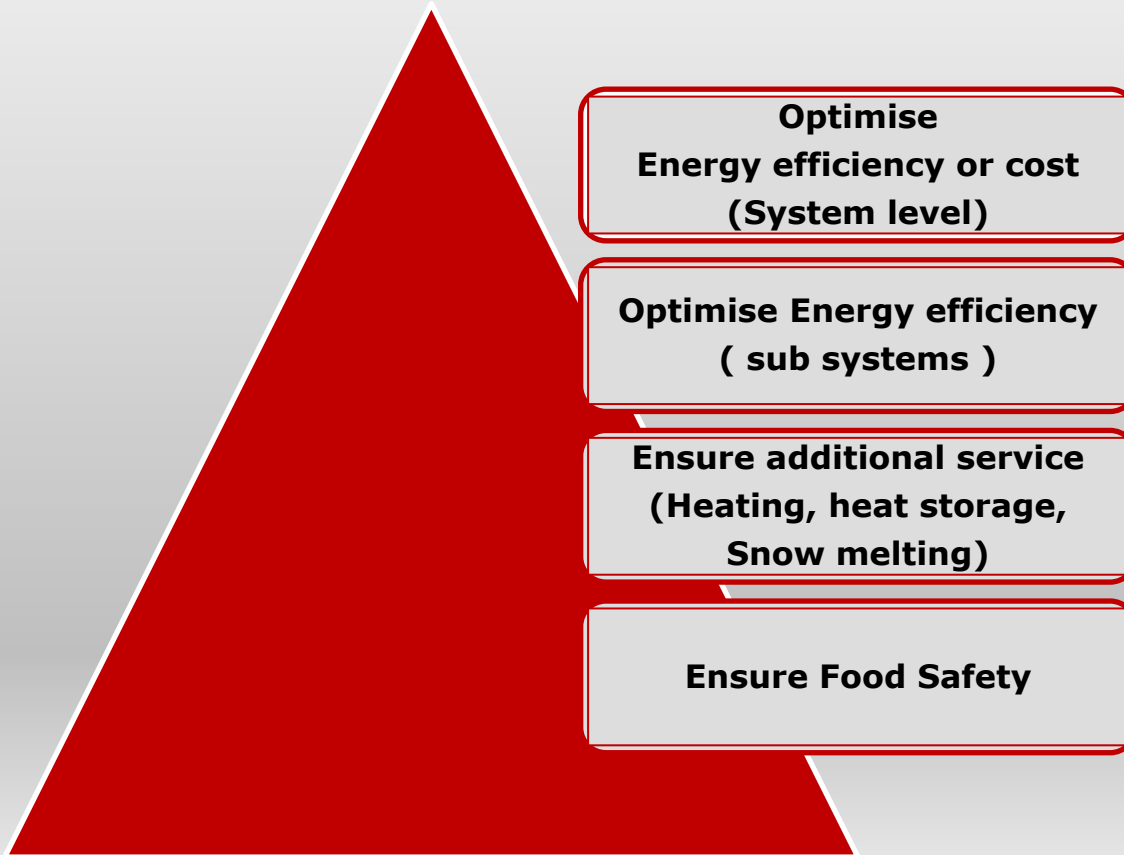
- Mature status as refrigerant for refrigeration – more than 2000 systems running in the EU
- Heat recovery has shown to be a very good solution which is being implemented in many new stores
- Beyond heat recovery there are more options to be exploited i.e. heat pump functions and combination with the HVAC system
- Good opportunities for further efficiency optimisation using thermal buffering

# Overview of the integrated system concept





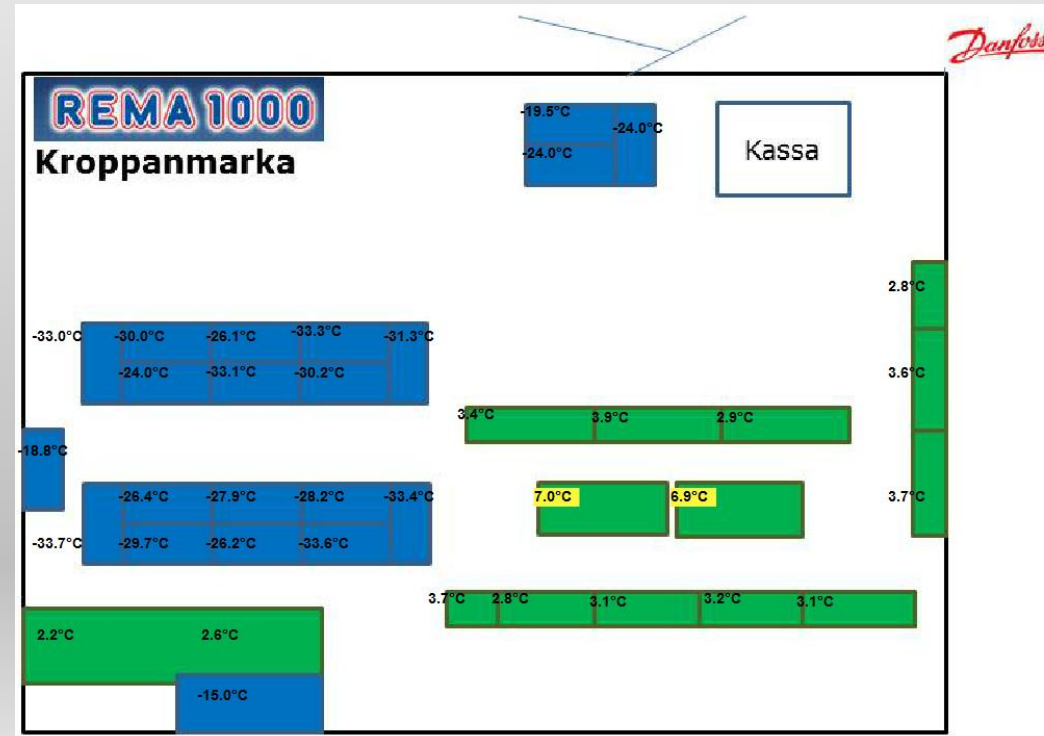
# Controls structure





# Actual status and close future activities

- The supermarket has been open since 15th of August
- All systems are performing as expected
- The sub-system tuning is on-going
- Measurements + quality assurance on-going to document and double check more than 500 measurement points
- Measurements are applied to tune and validate simulation models
- Dynamic simulation tools, developed within CREATIV, will be applied to evaluate various control strategies



Publication of findings in the near future:

[www.danfoss.com](http://www.danfoss.com); IIR Gustav Lorentzen Conference; [www.R744.com](http://www.R744.com);



## Conclusion

- An advanced energy integrated supermarket installation has been realised within the CREATIV project in Trondheim, Norway.
- The energy sub-systems are interconnected and controlled to minimize the entire power consumption of the supermarket building.
- Danfoss controllers manage & optimize:
  - Operation of the refrigeration system
  - Heat storage devices
  - Air Handling Unit
  - Heating systems
- Besides being a show case for the Industry this system will be used to test and develop new advanced controls

*Danfoss*

MAKING MODERN LIVING POSSIBLE