

Integration of the hidden refrigeration capacity as a heat pump in smart energy systems

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This presentation outlines the concepts behind the Danish EUDP-project (64016-0106) 'Super Supermarkets' where rollouts of decentral heat supply provided by supermarkets to district heating systems are planned, designed and executed

Content

THE SUPERMARKET
as smart appliance

FLEXIBILITY
in supermarkets

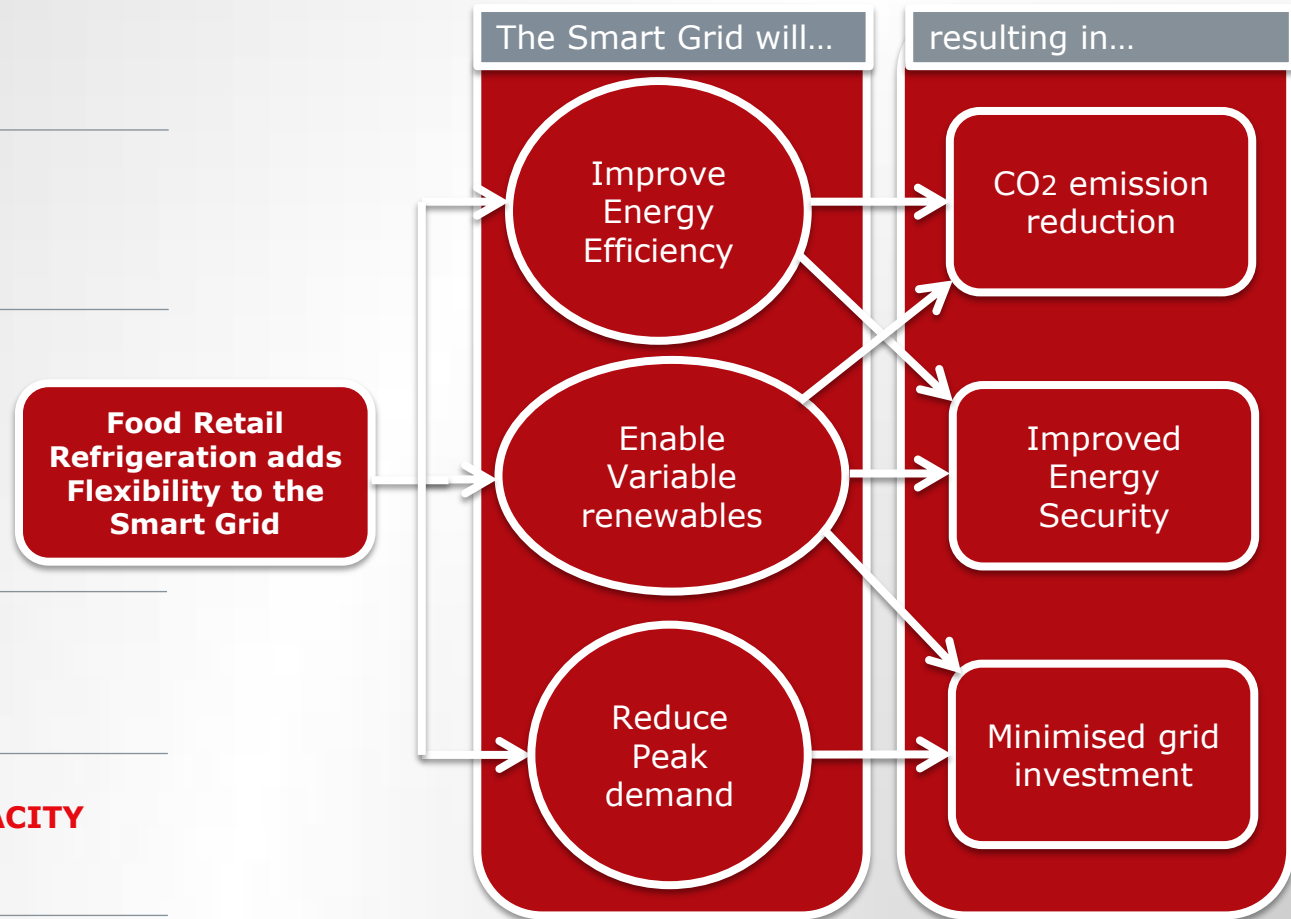
AGGREGATED
Potentials

THERMAL NETWORKS

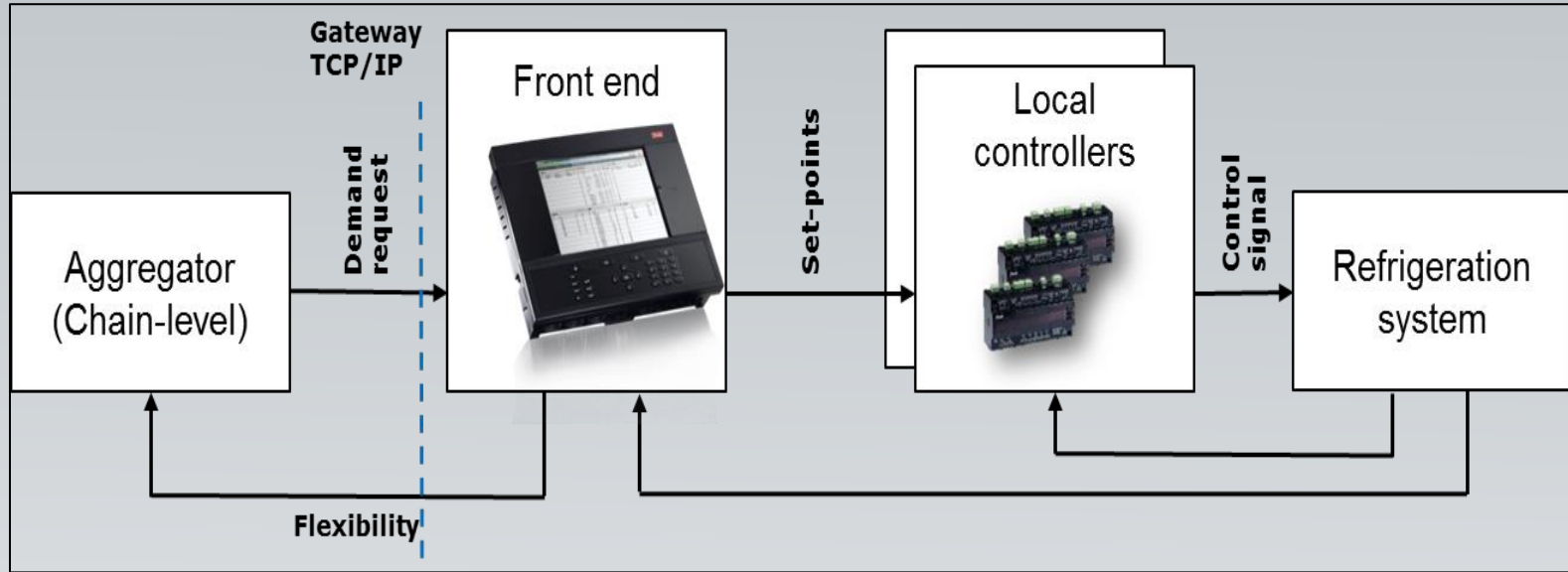
CASE STUDY
on District Heating
Connectivity

HIDDEN COMPRESSOR CAPACITY
is an opportunity

CONCLUSION



Today Smart Supermarkets are controlled

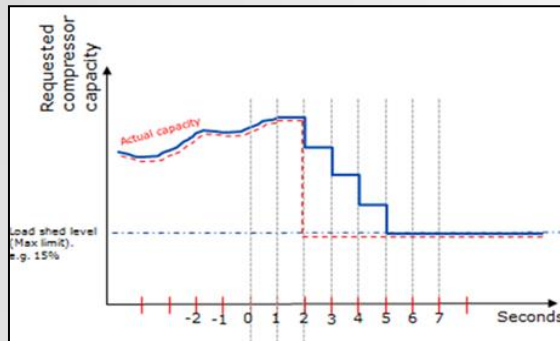


- Exploiting flexibility is doable without big investments
- The existing retail service structure is perfect to leverage on

Flexibility in supermarkets

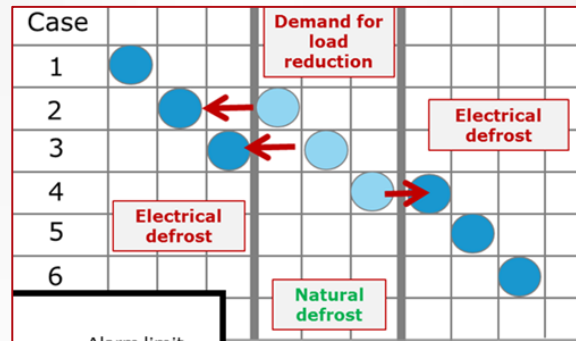
1

LOAD SHEDDING
FFR (COMPRESSORS)



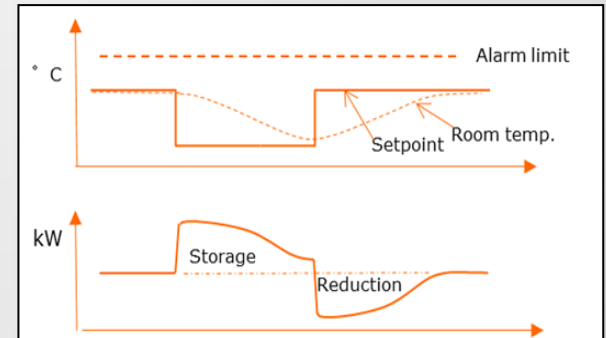
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DEFROST PLANNING

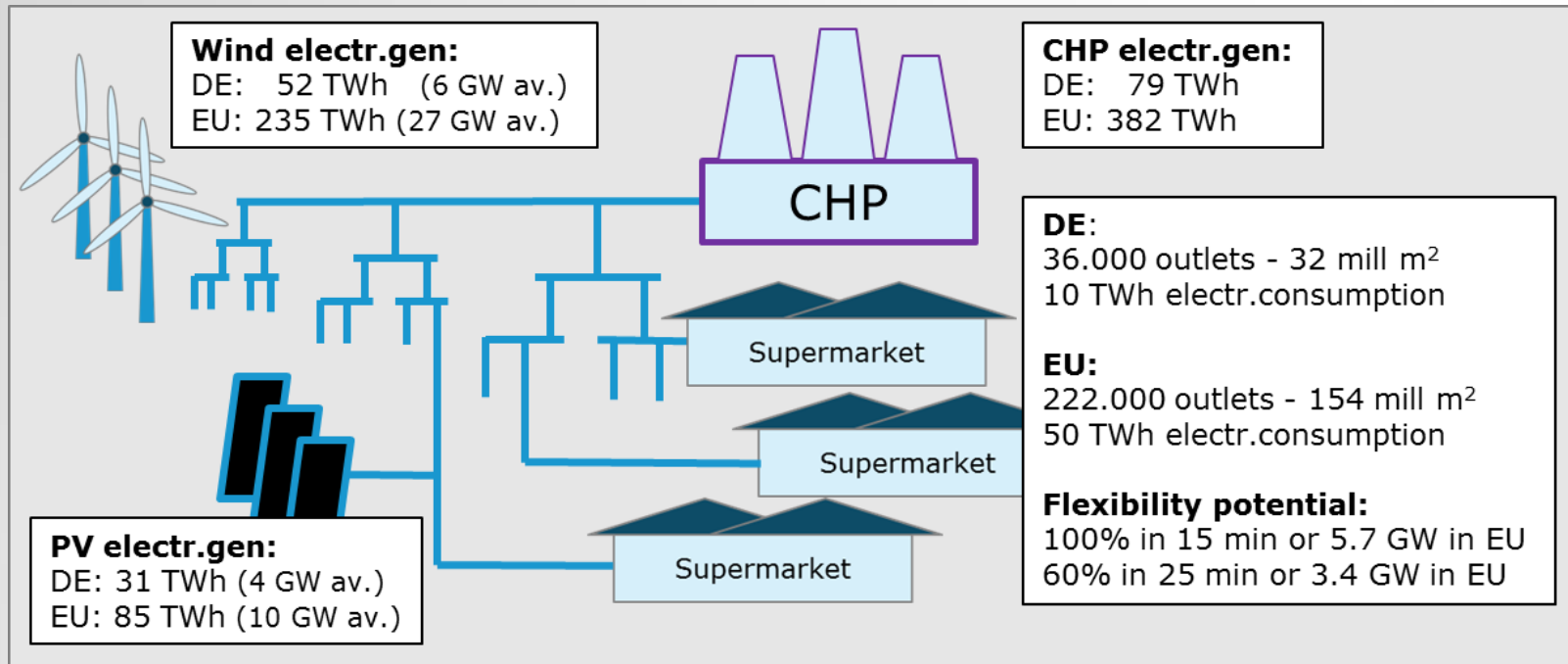


3

THERMAL STORAGE



Aggregated flexibility potentials



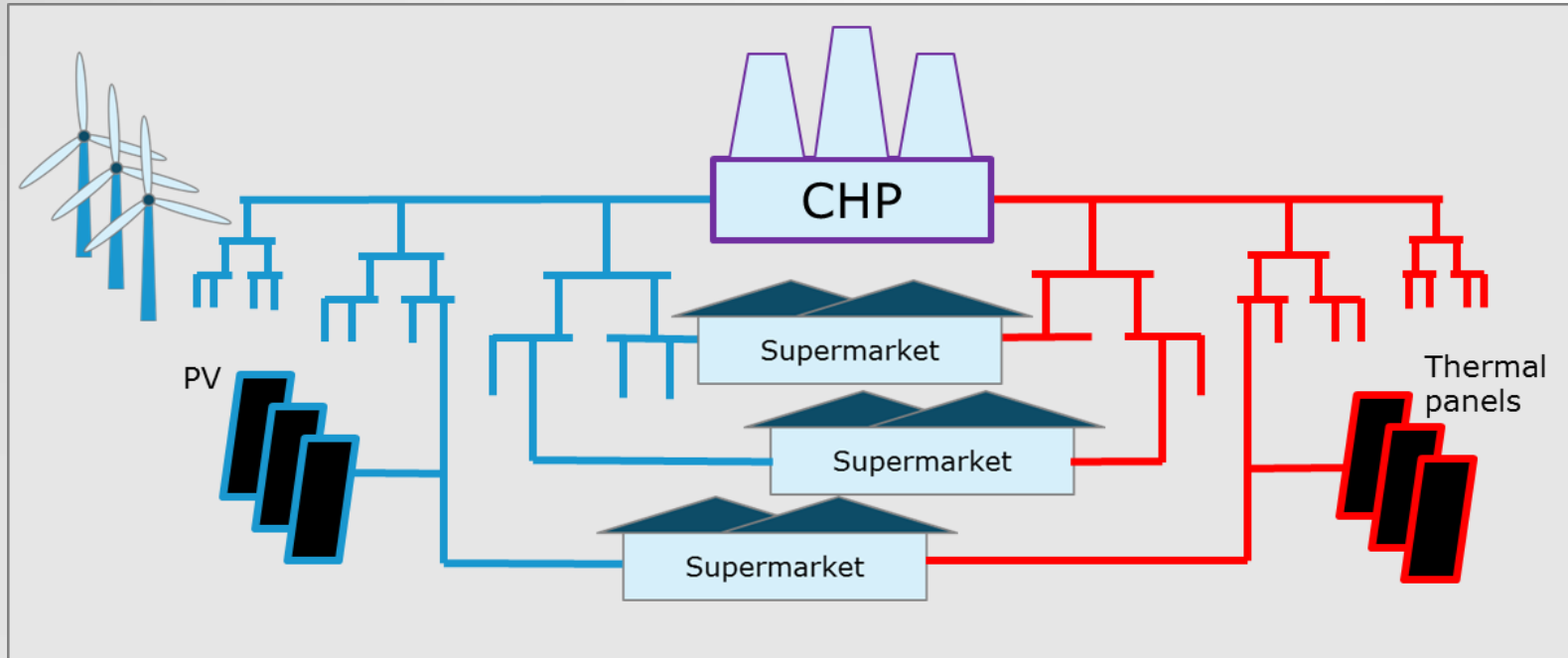
Supermarkets use up to 2% of all electricity use

Flexibility of multiple supermarkets can be aggregated

Total supermarket aggregation would account for
> 20 % of average delivered wind power *
> 50 % of average delivered PV power*

*'EU energy in figures' - 2013 numbers

Thermal networks expand the perception of smart systems and the scope for supermarkets



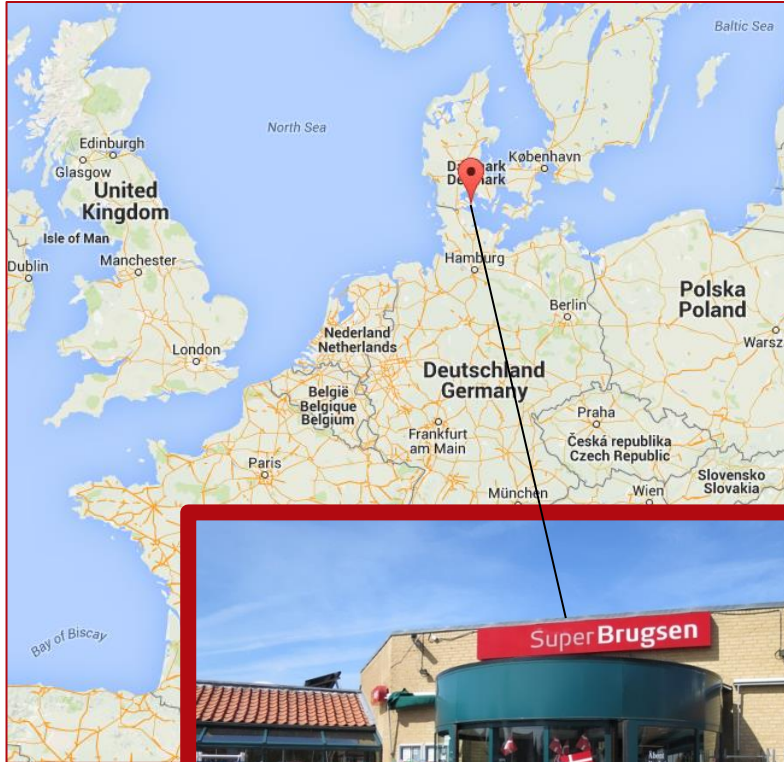
District heating and cooling networks are perfect for energy storage

Waste heat from refrigeration can be exported

Supermarkets can add flexibility and become storage enablers for heating and cooling

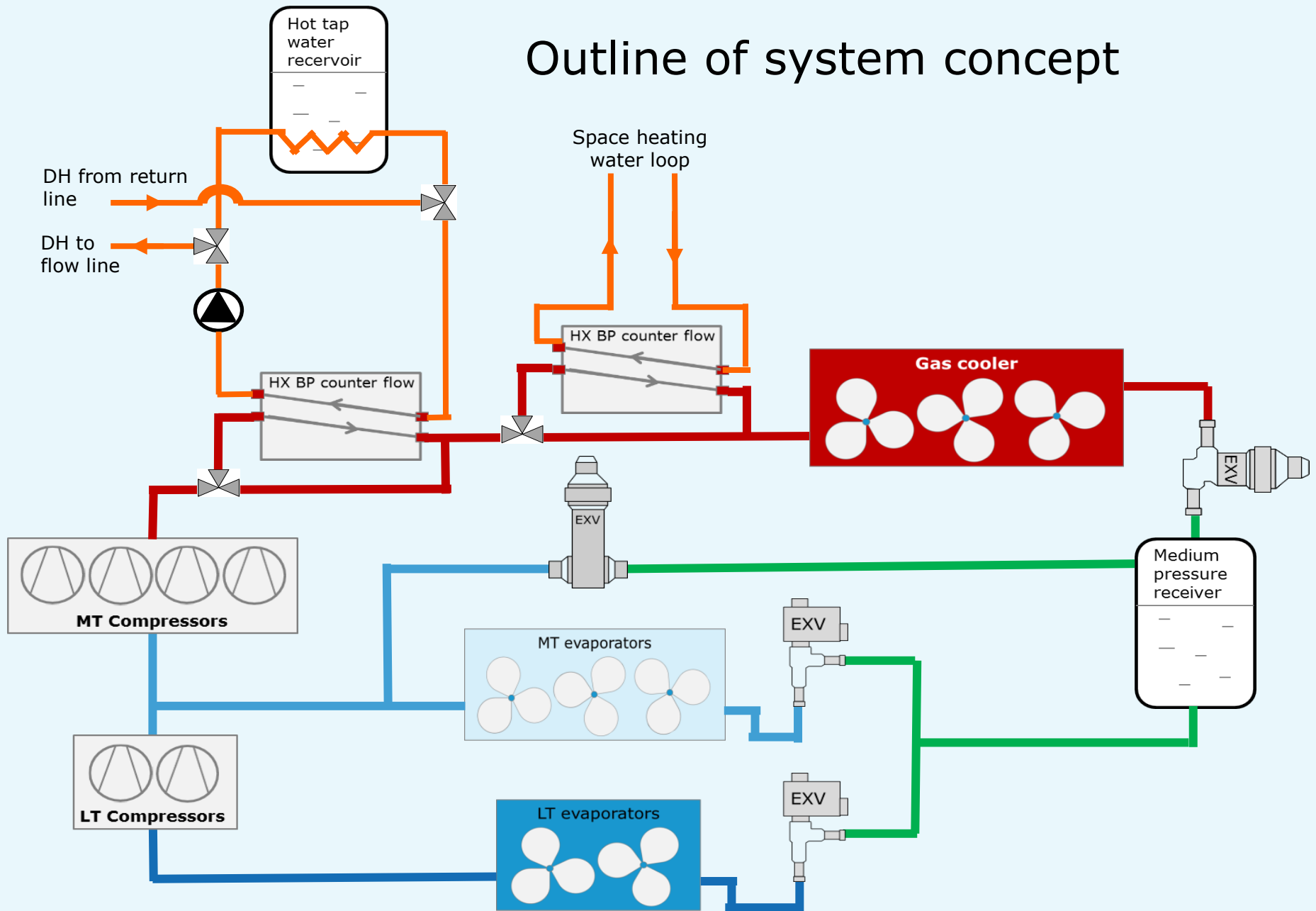
Find a customer for the thermal services

Case study on District Heating connectivity

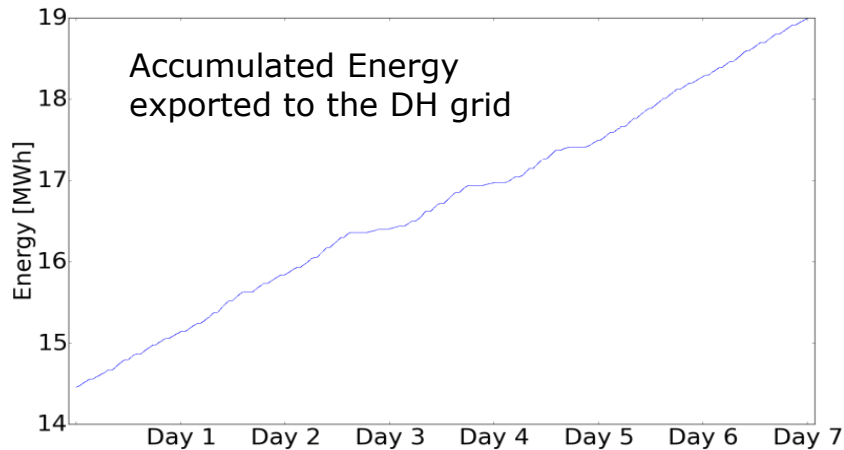
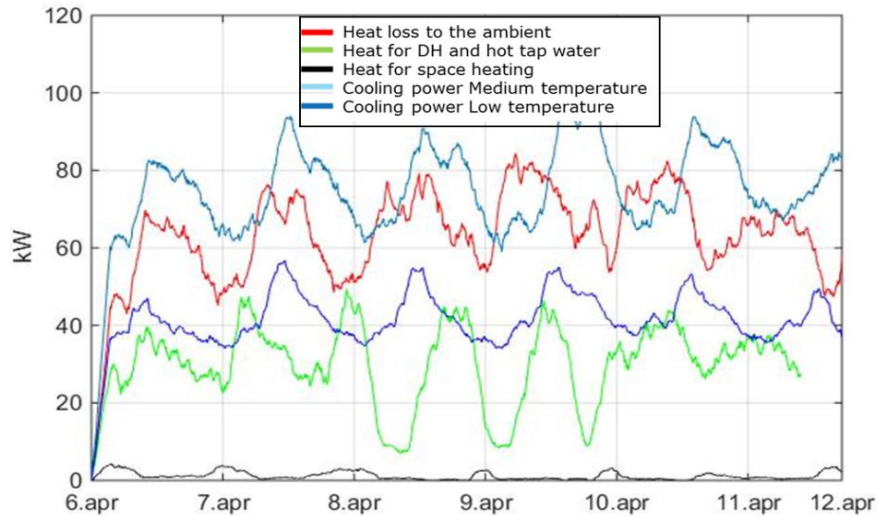


- Southern Denmark
- Area: 1000 m² from 2010
- Compressors: 5 MT (1 VS), 4 LT
- Cooling Capacity: 160 kW
- Online COP calculation
- Heating :
 - Sanitary water (1.8m³ ,65 °C)
 - Space heating/low temp (35 °C)
 - District Heating connection
 - Return line temp. 35-40 °C
 - Flow line temp. 65 °C

Outline of system concept



Results



THE HEAT LOSS

is 65% of the total heat energy

THE HEAT LOSS

is expected to be 35% when space heating cut in at low ambient temp.

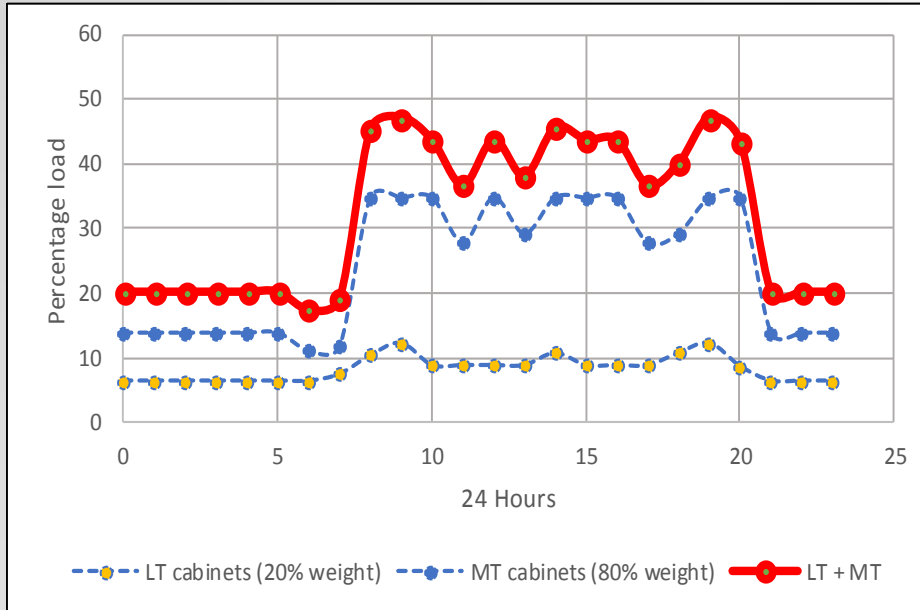
AVERAGE EXPORT OF DH HEAT

is 27 kW at 65 °C . (This can be regarded as an average for the year)

YEARLY DH INCOME

to the supermarket is estimated to be 6000€ (24€ per MWh)

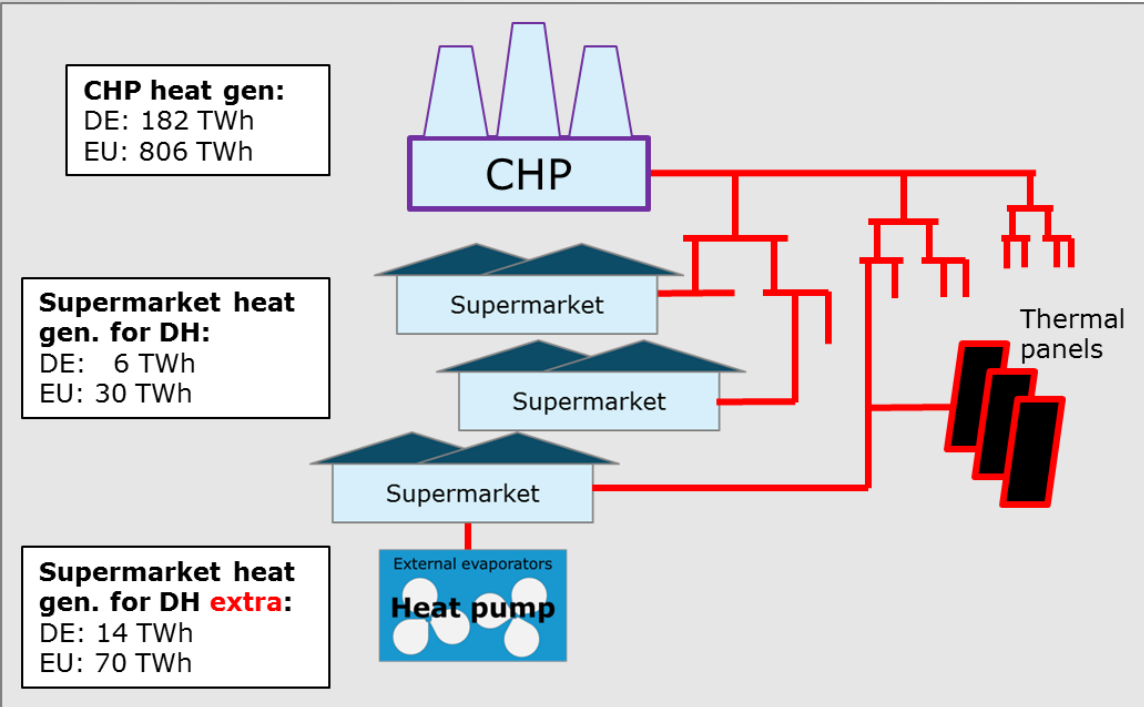
The hidden capacity ..



- The Cooling capacity has a build-in safety margin due to food safety
- Overall capacity exploitation is low
 - Night load is 20%
 - Day load is 40%
 - Free capacity can be up to 70 % in average
- Results can vary dependent on store set up and geographical location

$$Q_c = K * \sum_{k=1}^n Q_{c,k}$$

The opportunity ...

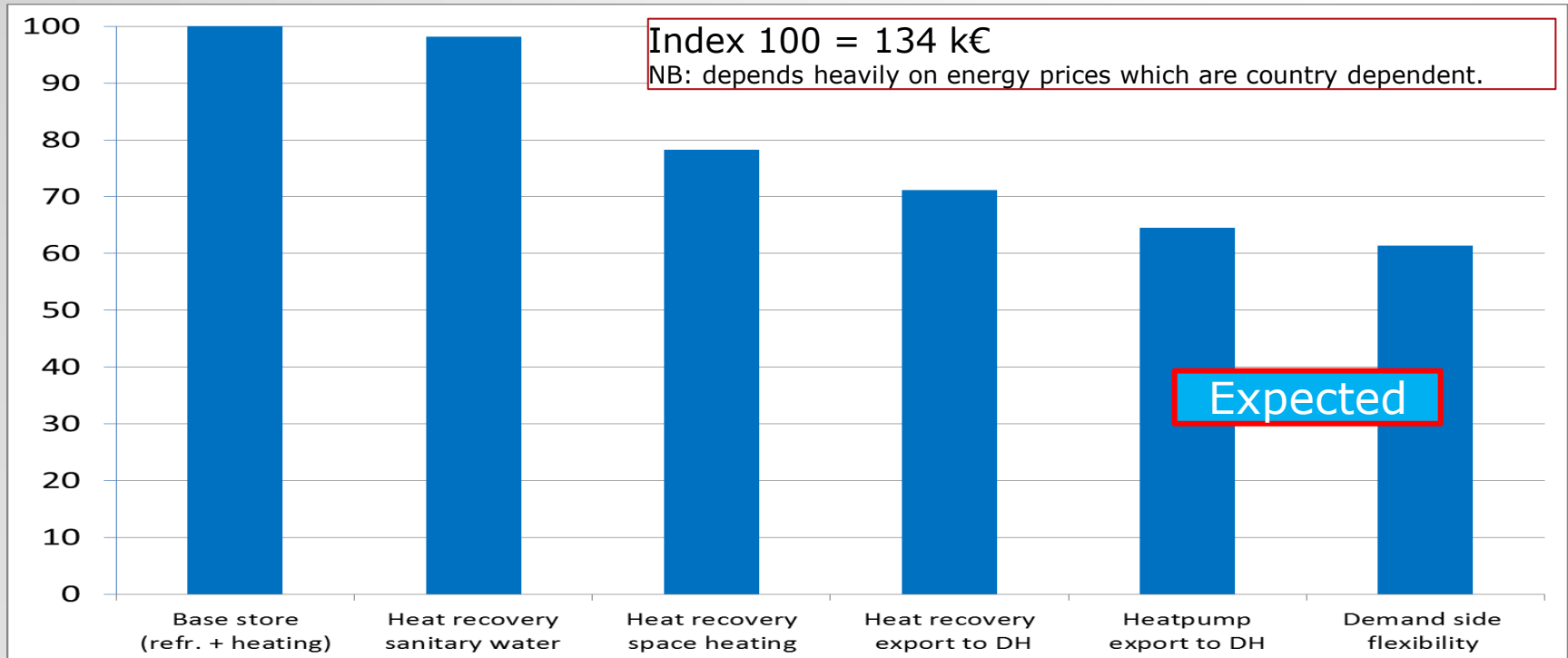


DISTRICT HEATING NETWORKS
can absorb limitless energy

TYPICALLY ONLY 30%
of the total compressor capacity is used

ASSUMING A FACTOR 2
more energy can be produced with
external heat sources

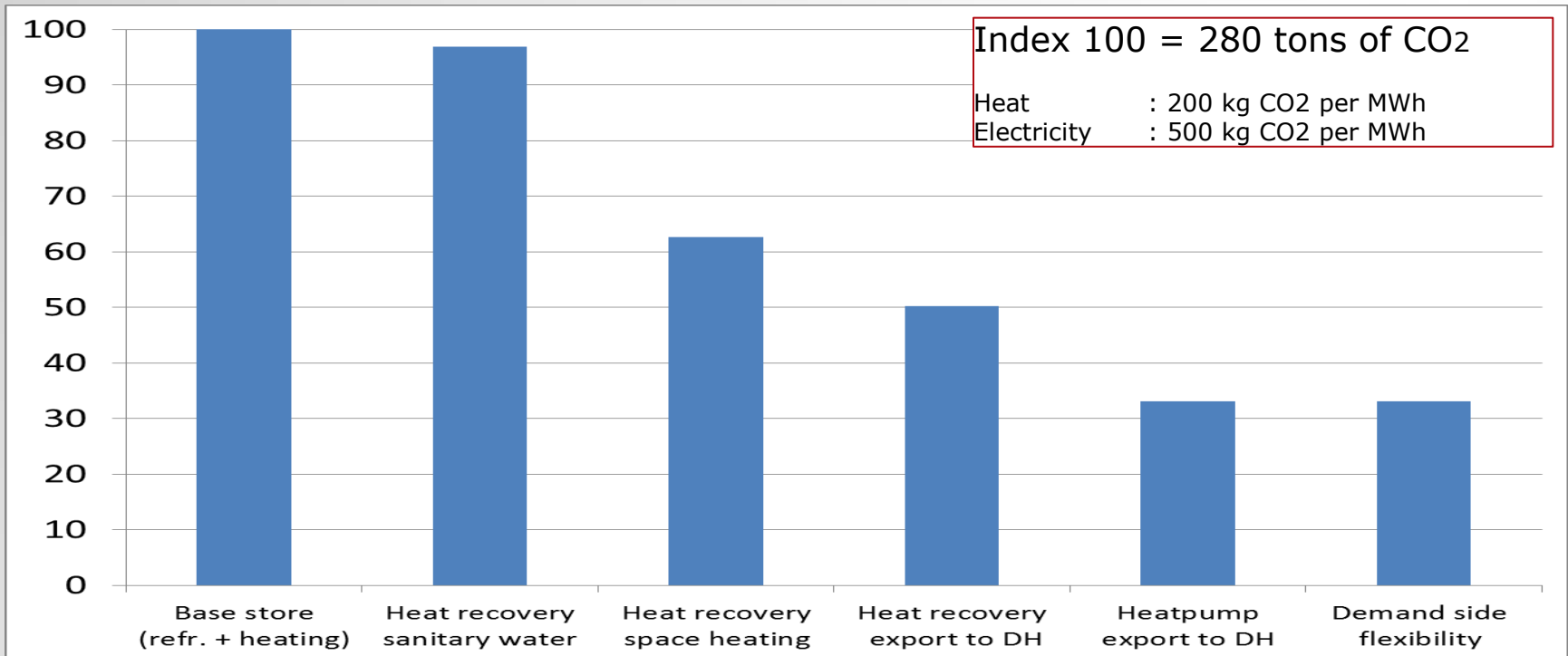
Index of cost



Electricity (base)	0,14 € / kWh
Electricity (HP mode)	0,04 € / kWh
Gas	0,55 € / m ³
District Heating	0,05 € / kWh

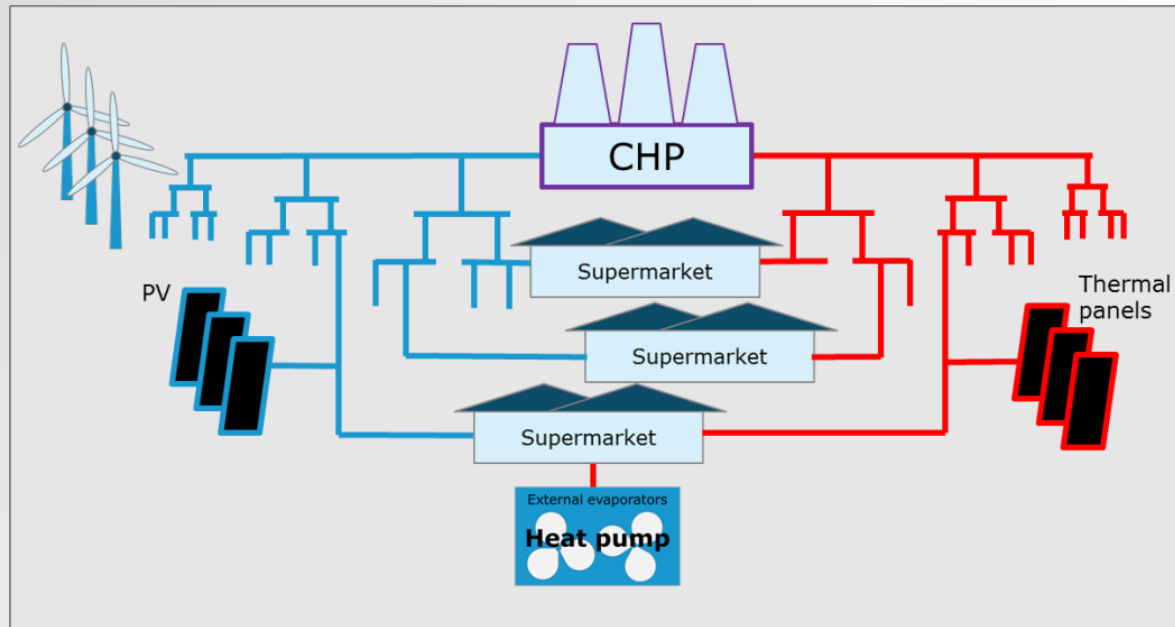
DSF	KW reductn	Min. per event	Events per day	Value per KWh	SUM year €
Defrost	13	90	3	0,03	570
Capacity reduction	20	30	4	0,03	390
Imbalance Service	53	15	n.a.	60	3200

Index of emission savings



- The extra electricity used for HP mode is subtracted the emission saving
- DSF enables renewables and represents indirect emission savings
- Heat recovery can be categorised as energy savings and become subject to incentives in some countries

Conclusion



Supermarkets...

- can play a significant role in smart and integrated energy systems
- are addressable flexibility resources
- require modest investments before they make up a good business case

Heat recovery...

is taken to the next level by connecting DH grids to the supermarket refrigeration system

Extended heat production

can be utilised once connected to the DH grids by utilising the free compressor capacity

Thermal and Electrical Flexibility can enforce each other providing a multiplier factor for the business case

