H-DisNet

H-DisNet – Innovative technology for district energy networks

Prof. Dr. Philipp Geyer

Innovation Workshop
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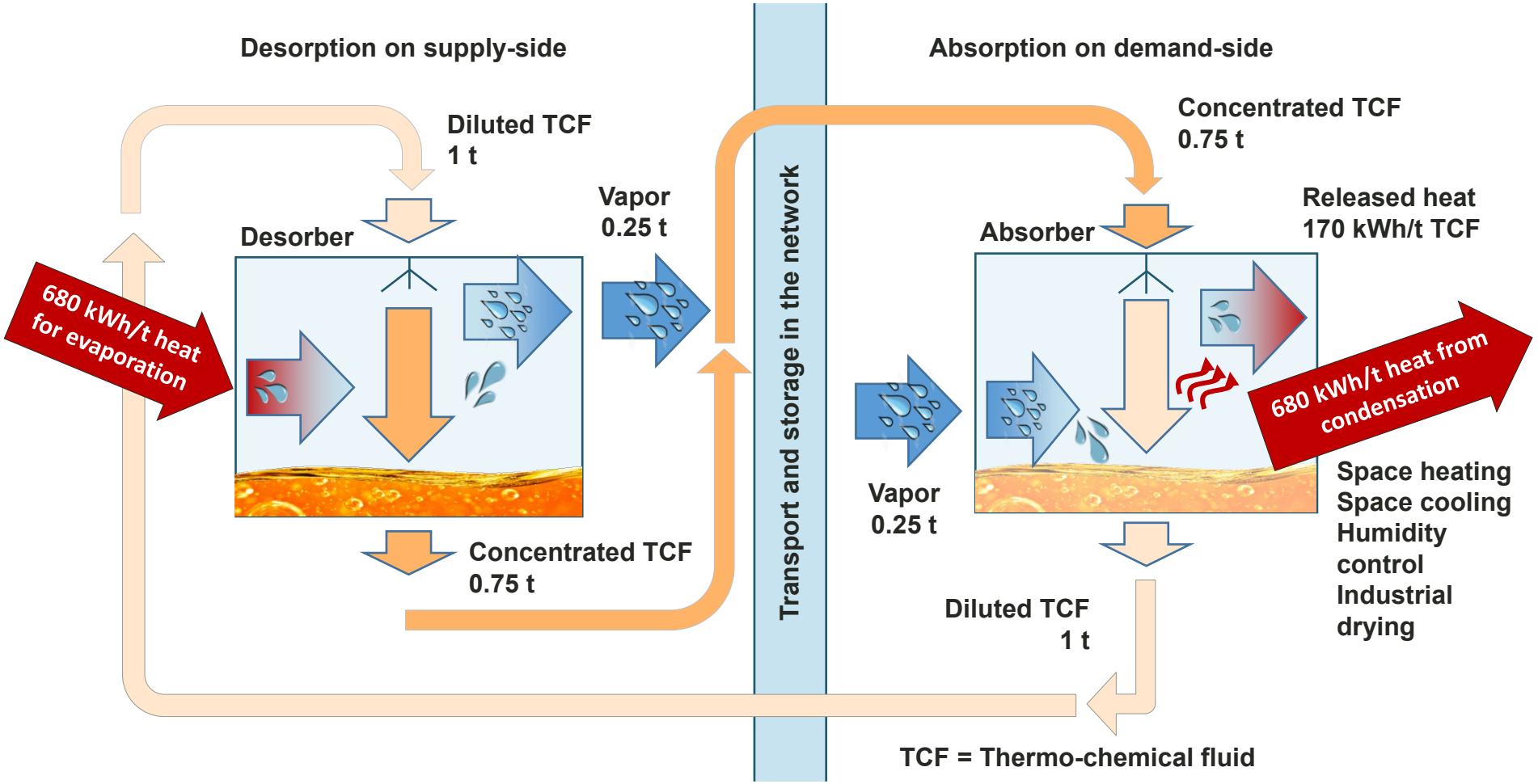
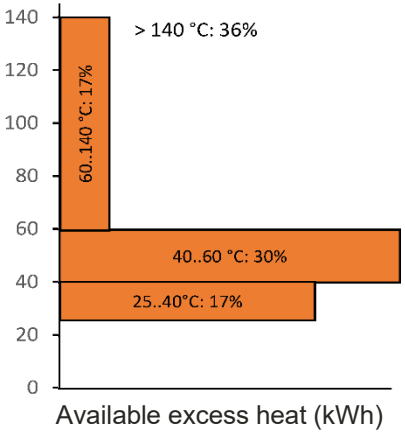
Thermo-chemical processes in a network



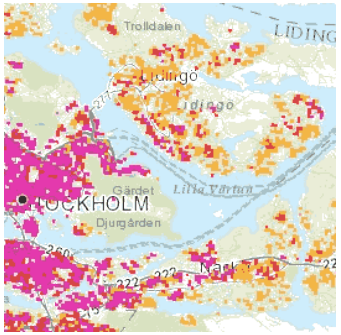
Challenges for district heating

Low-temperature excess heat losses (25 to 60 °C)



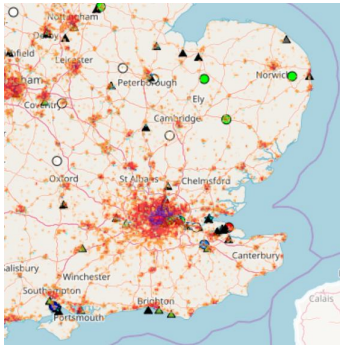
Data source: Enova 2009.

Decreasing heat demand



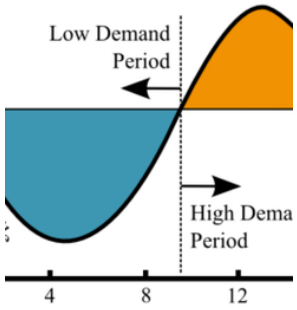
Heat Roadmap Europe, Peta 4.2

Distant excess heat sources



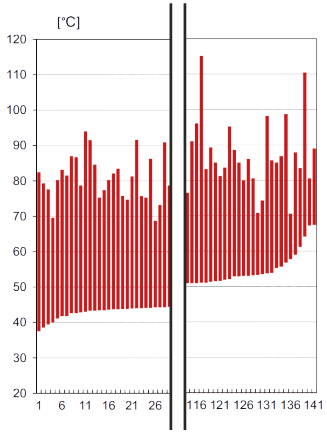
Heat Roadmap Europe, Peta 4.2

Time shift between demand and supply



Sabihuddin et al. 2015

High return flow temperatures



Gadd and Werner 2014

Utilizing low-temperature excess heat

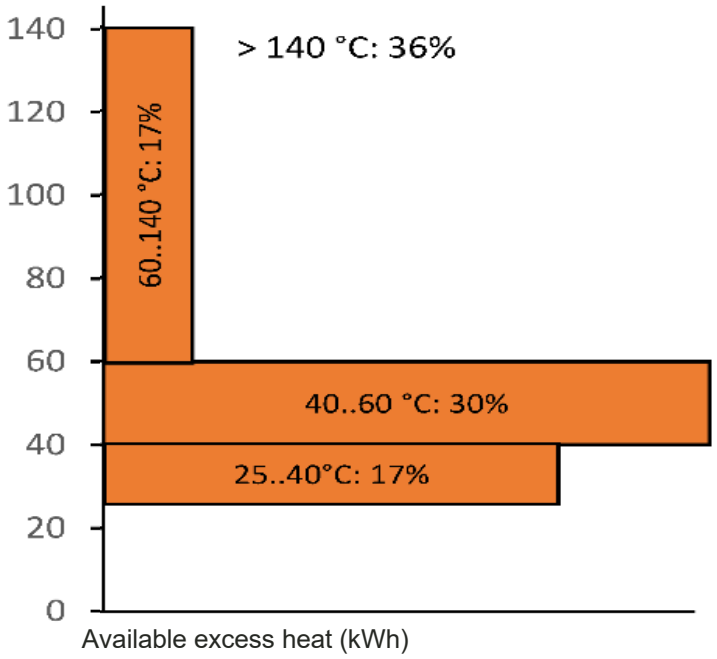
Increasing demand density

Long-distance transport (50 km and more)

Mid-term time shift (storage)

Lowering return flow temperatures

Utilizing low-temperature excess heat (25 to 60 °C)



Data source: Enova 2009.

EU energy efficiency directive (DIRECTIVE 2012/27/EU)

'efficient district heating and cooling' means a district heating or cooling system using at least 50 % renewable energy, 50 % waste heat, 75 % cogenerated heat or 50 % of a combination of such energy and heat;

New electricity generation installations and existing installations […] with high-efficiency cogeneration units to recover waste heat […]. This waste heat could then be transported where it is needed through district heating networks.

Member States shall ensure that any available support for cogeneration is subject to the electricity produced originating from high-efficiency cogeneration and the waste heat being effectively used to achieve primary energy savings.

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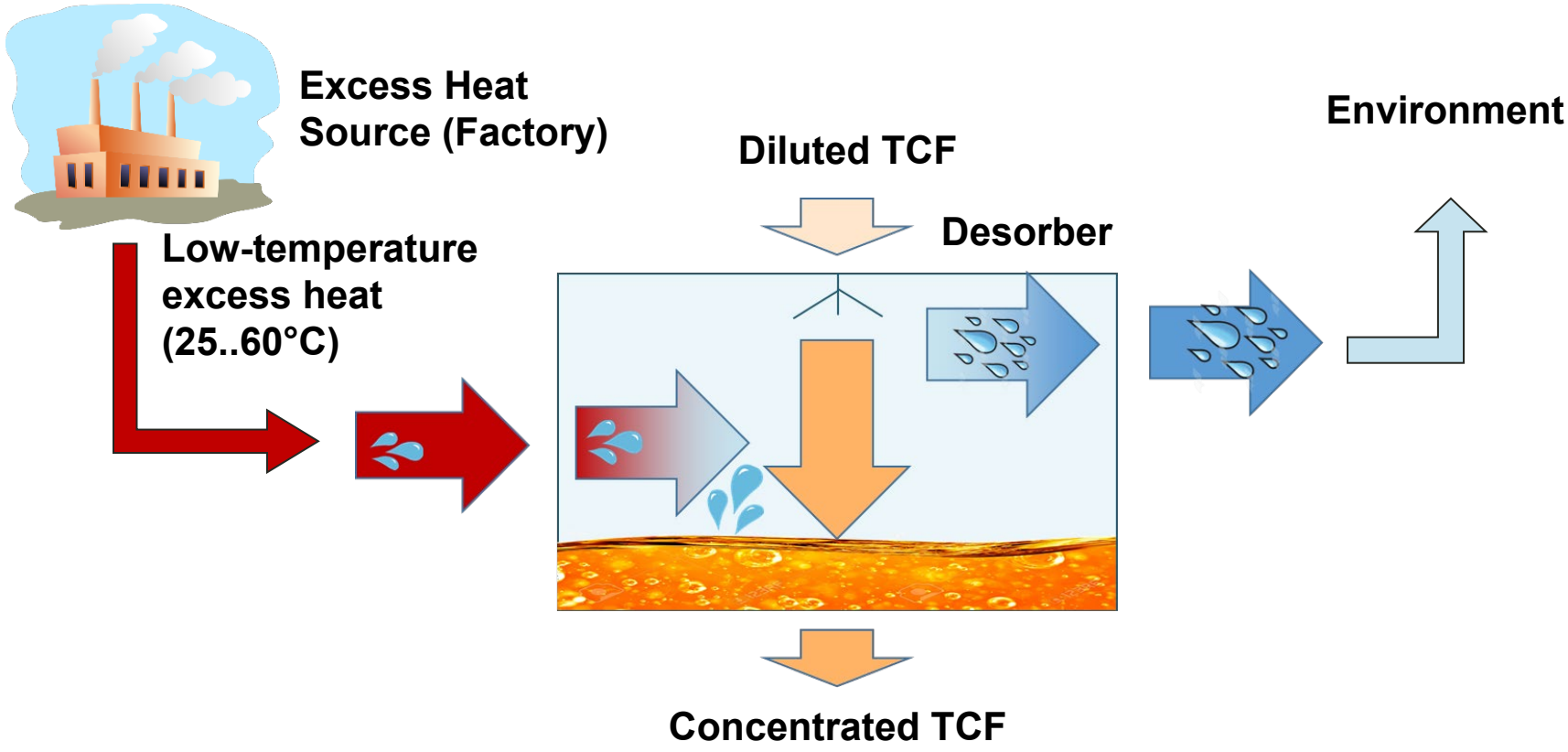
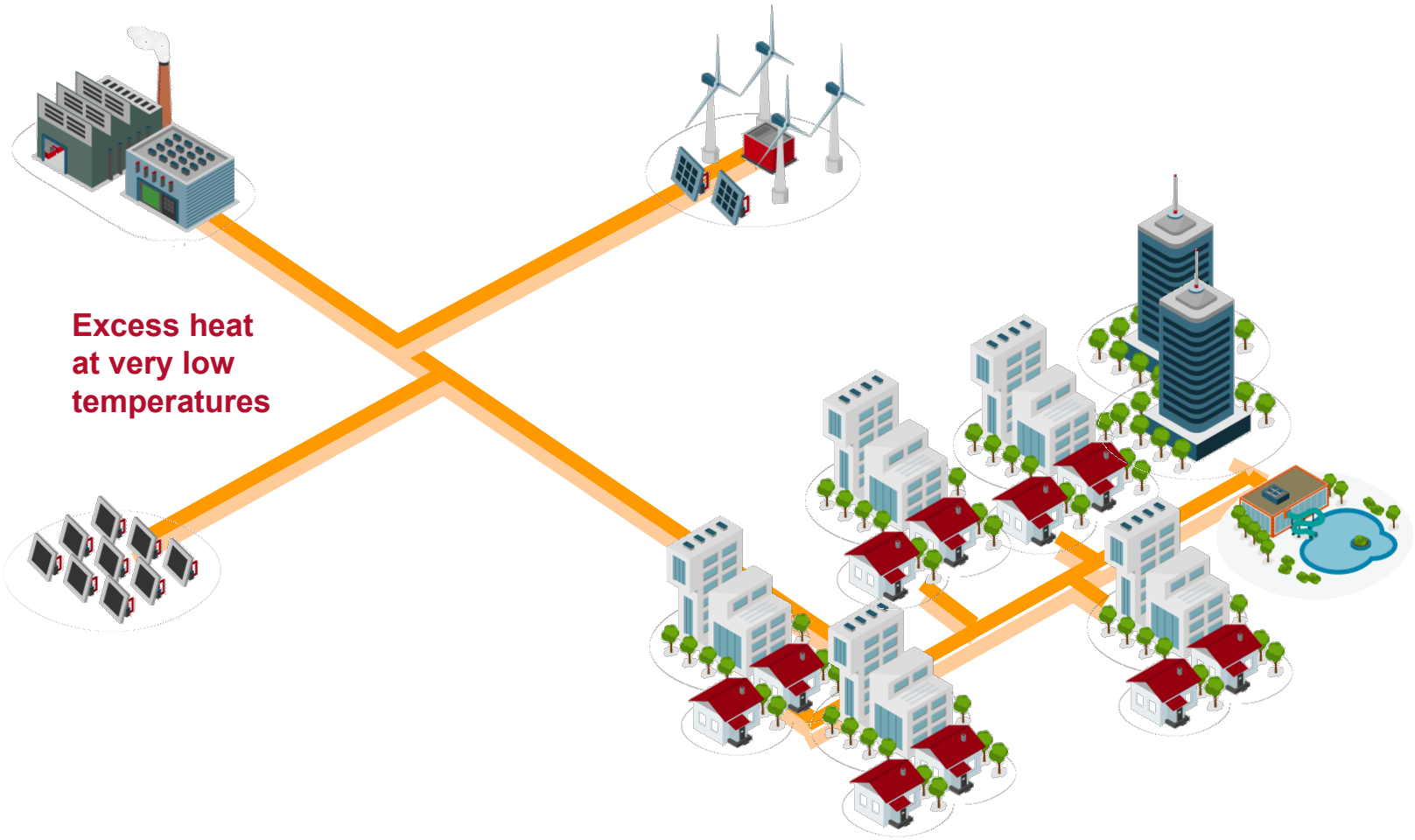
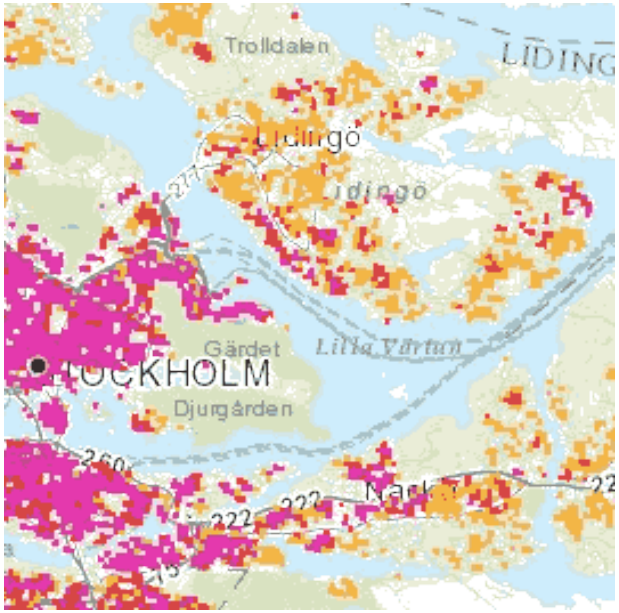
Regeneration with excess heat



Low-temperature excess heat utilization network



Increasing demand density by additional services



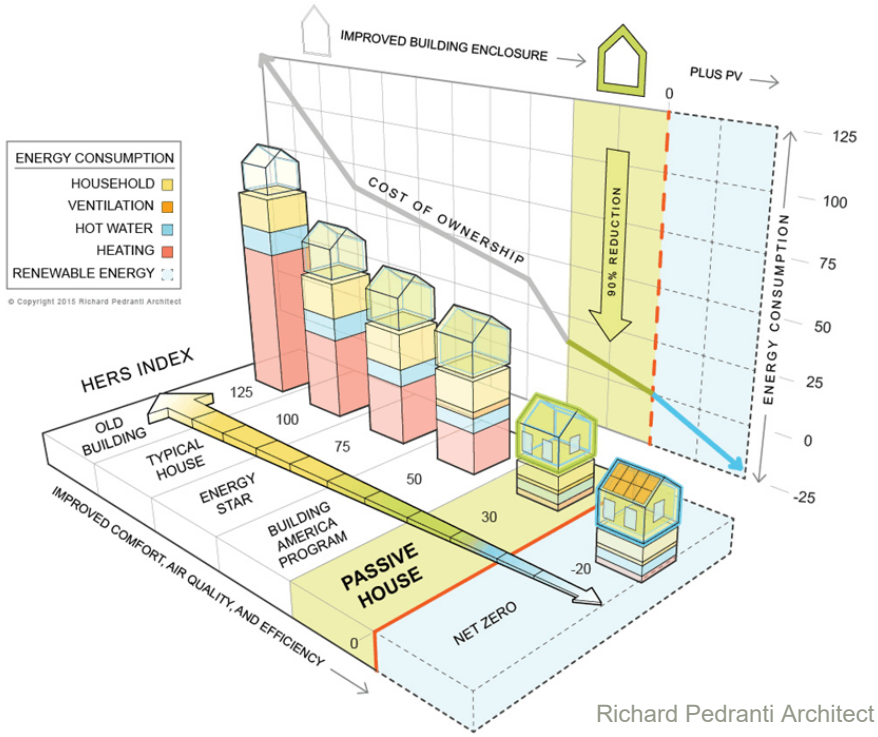
Heat Roadmap Europe, Peta 4.2

EU energy performance of building directive (EPBD) (DIRECTIVE 2010/31/EU)

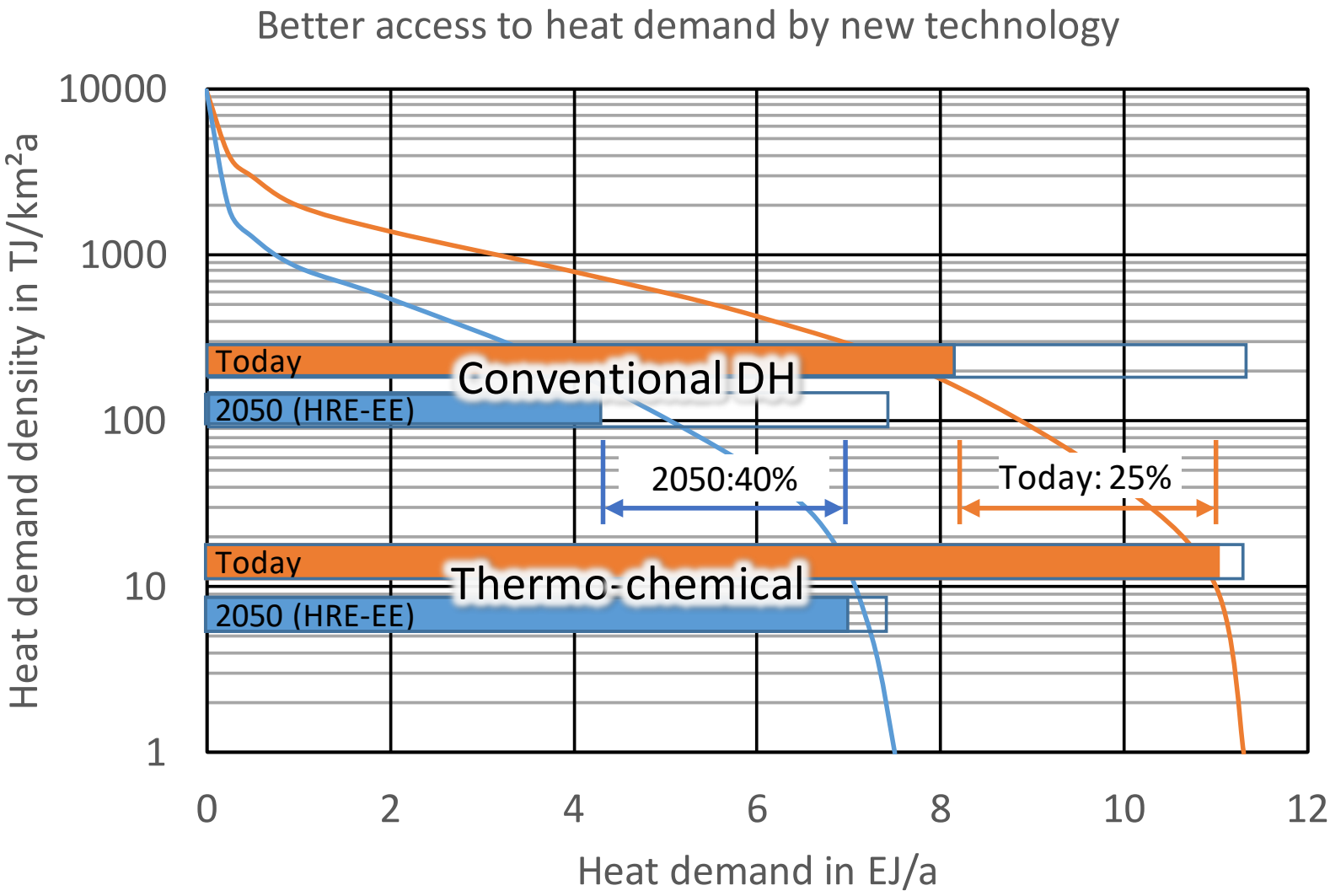
"Member States shall ensure that:

(a) by 31 December 2020, all new buildings are nearly zero- energy buildings; and

(b) after 31 December 2018, new buildings occupied and owned by public authorities are nearly zero-energy buildings."



Heat demand density 2050



Data source: Future scenario Heat Roadmap Europe Energy Efficiency (HRE-EE), Connolly et al. (2014)

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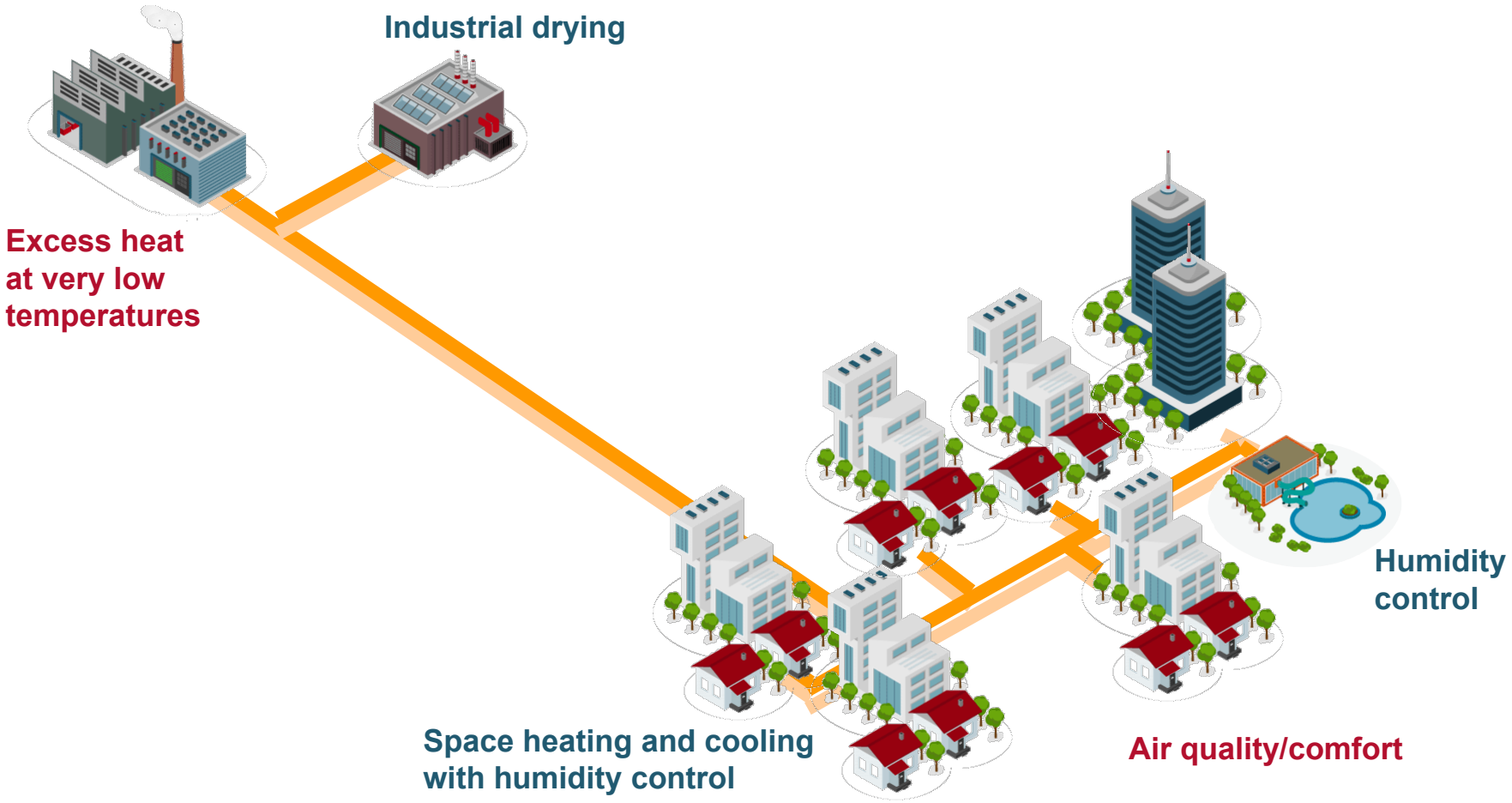
Multi-service thermo-chemical network



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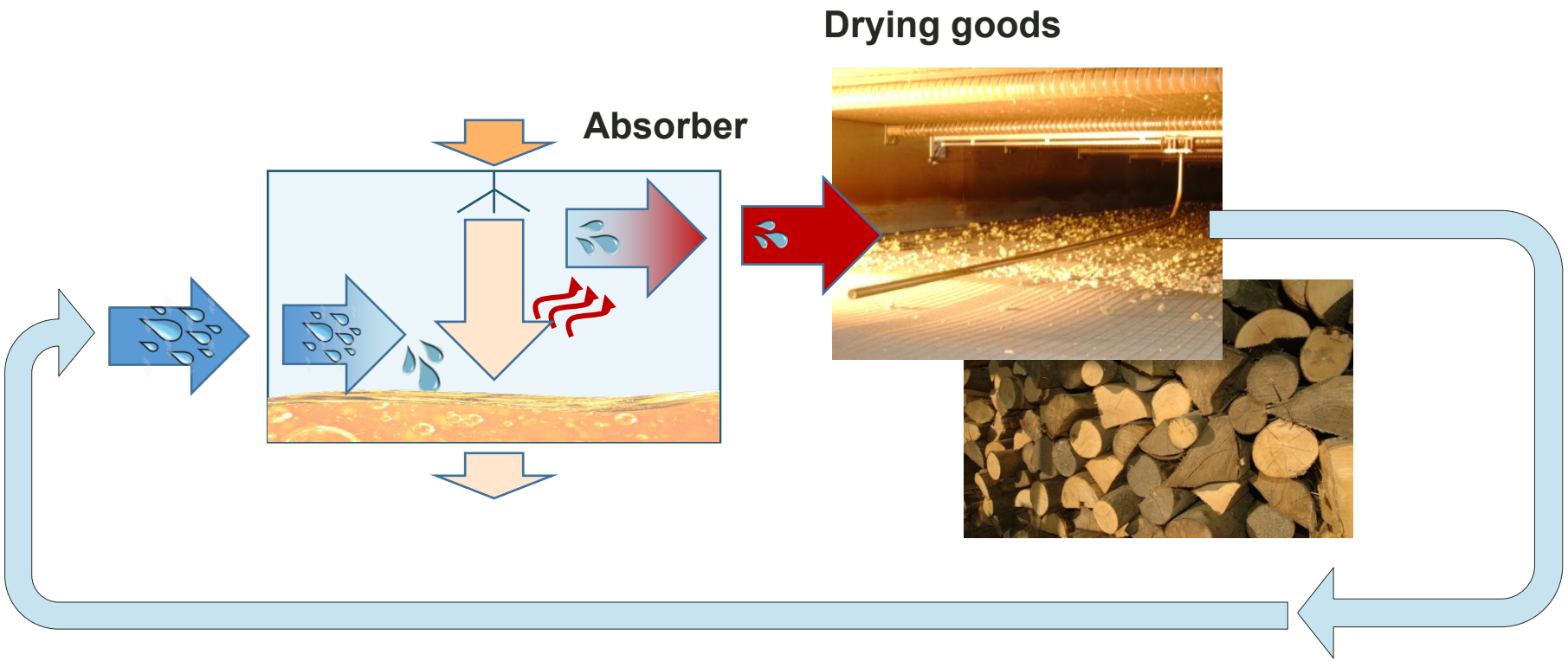
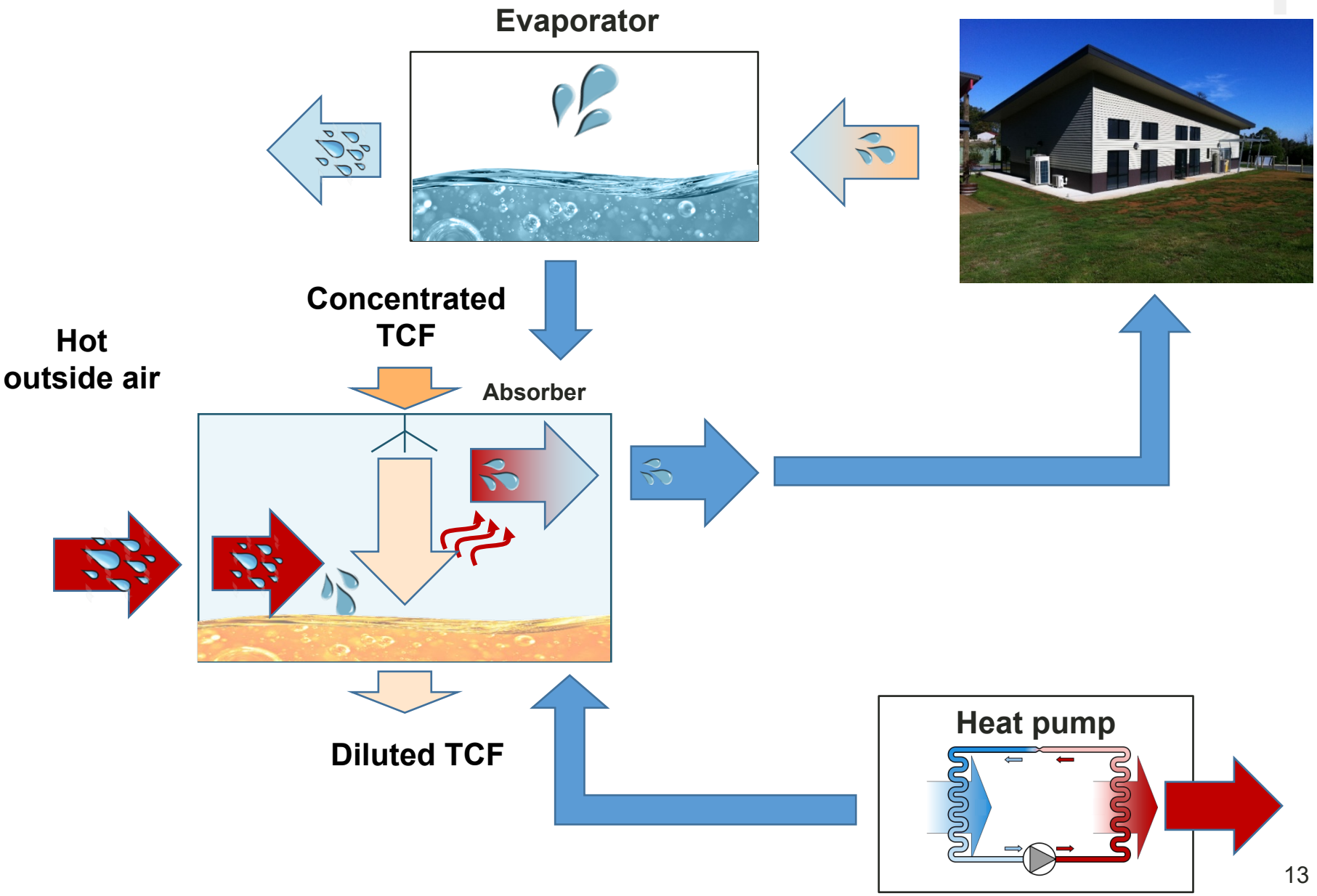
Adding new demand: Industrial drying

- Absorption produces dry air
- Usable directly for drying
  - Reduction of primary energy consumption
- Humidity control by stabilization function of TCF



Adding new demand: Cooling with humidity control



Heating demand: Heating/humidity control with recovery

Bombay Sapphire Distillery

Heating demand

Internal sources: Heat recovery (sensible/latent)

External humid air sources (Humid air solar collector)

Concentrated TCF

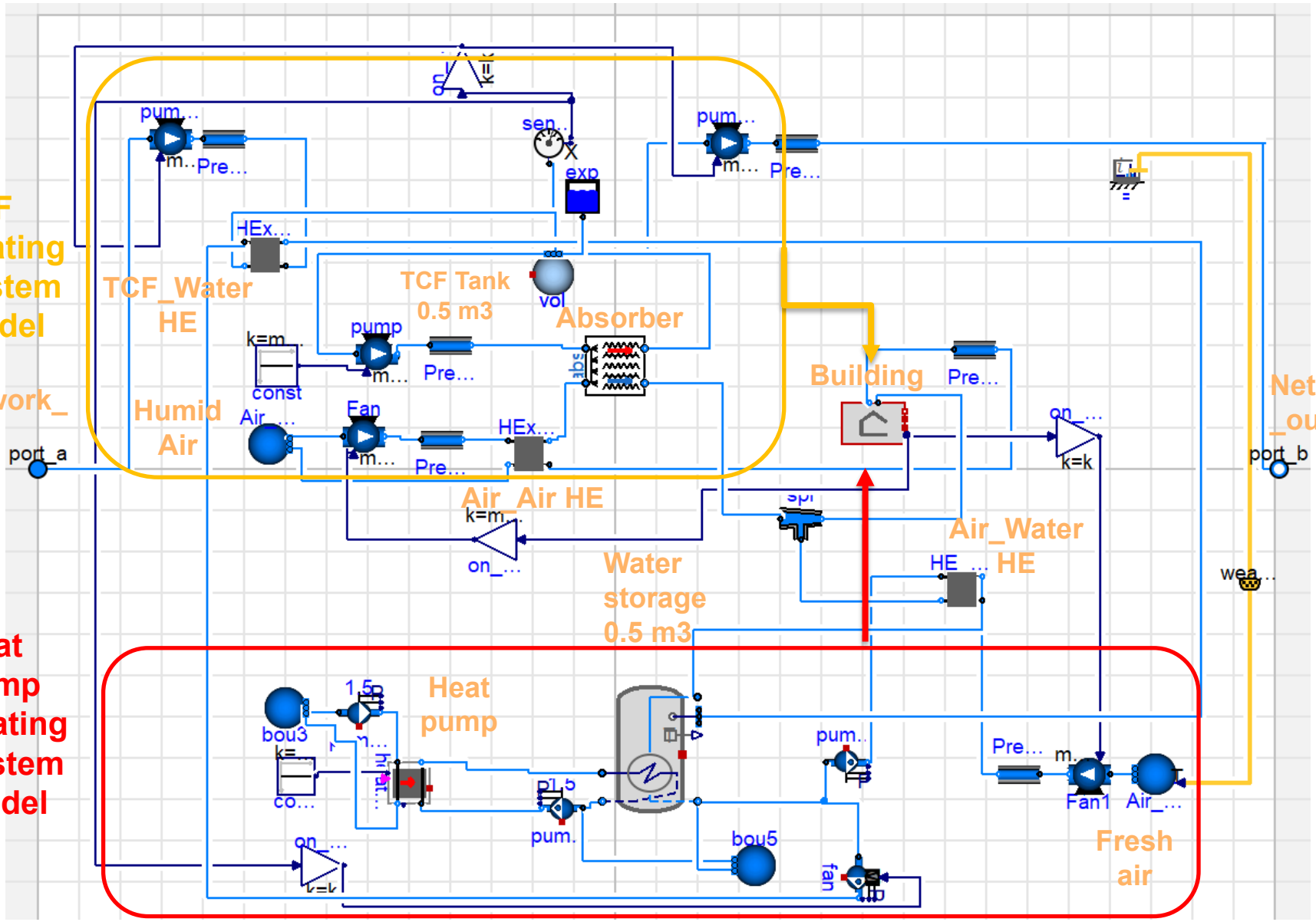
Absorber

Heating and humidity control

Heat pump

Diluted TCF

Modelica Simulation of the H-DisNet heating system



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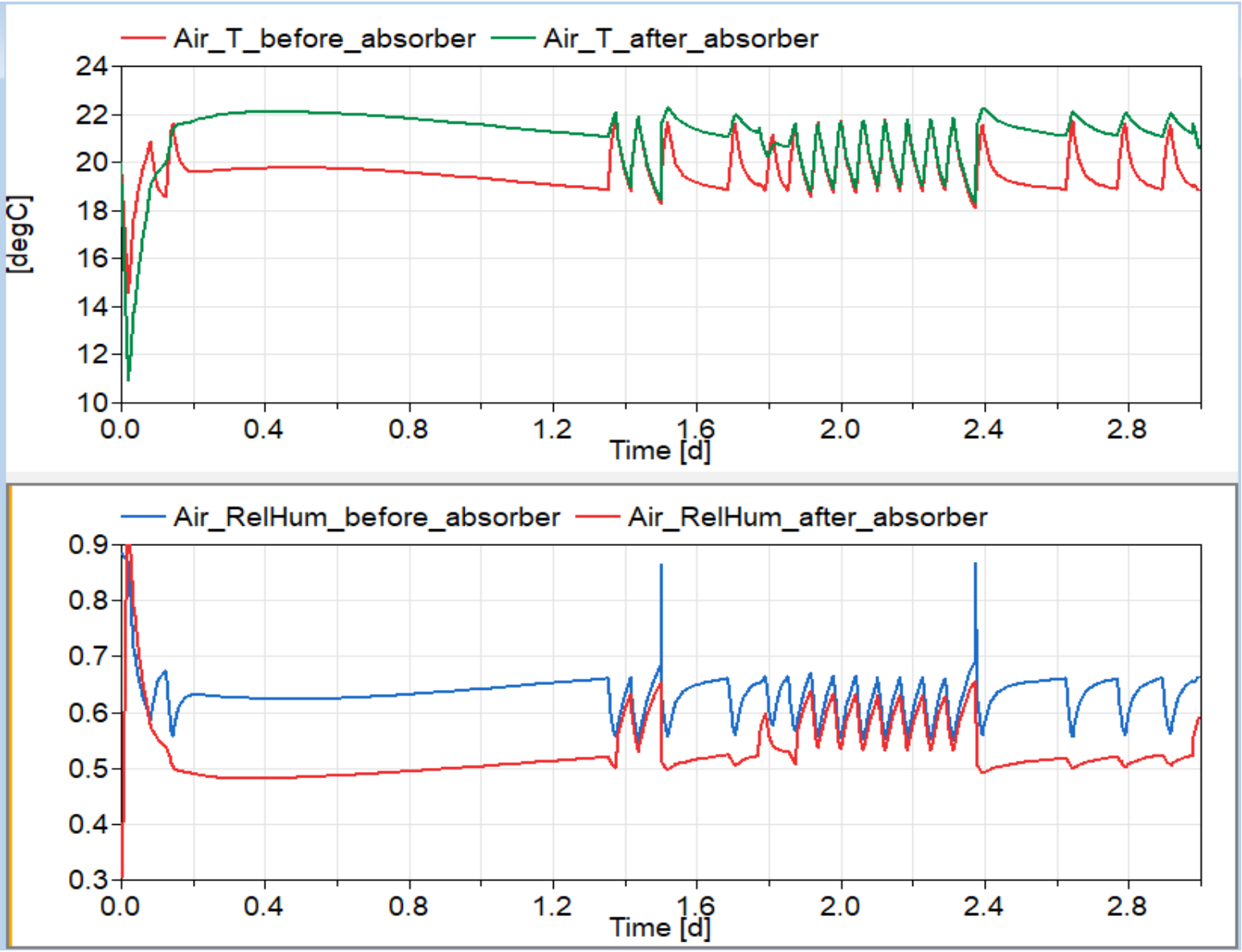
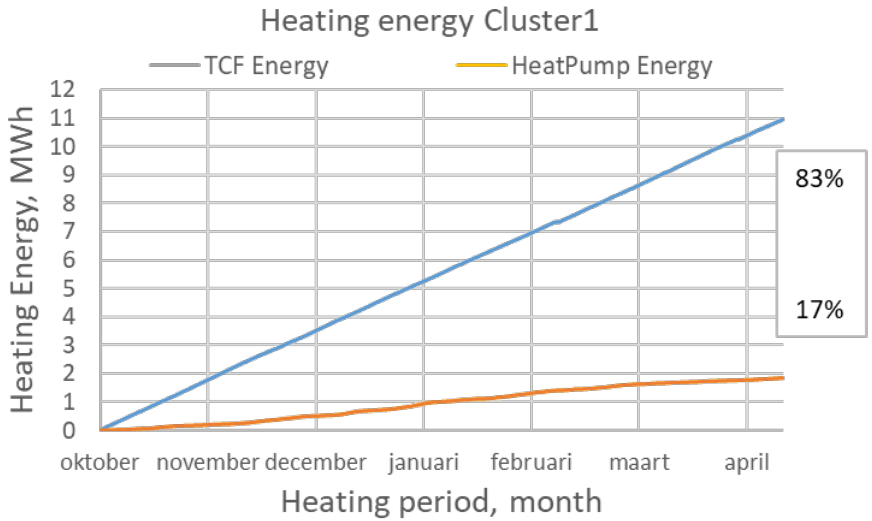
Simulation results

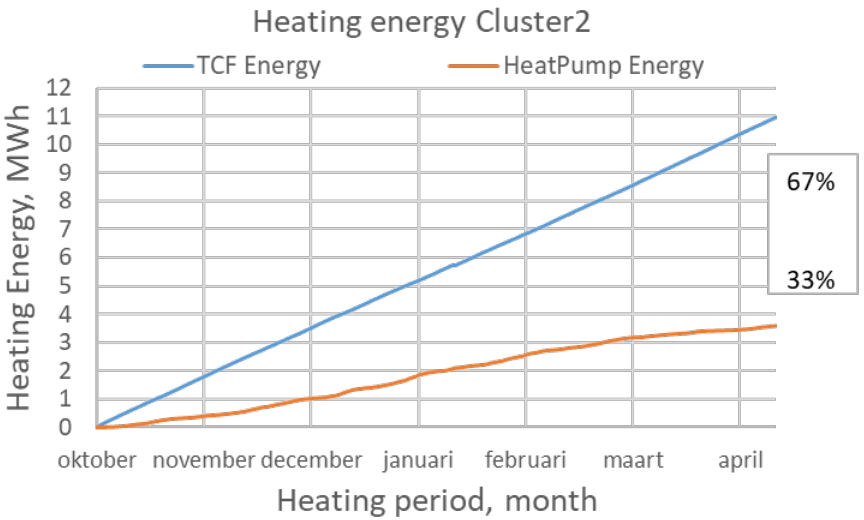


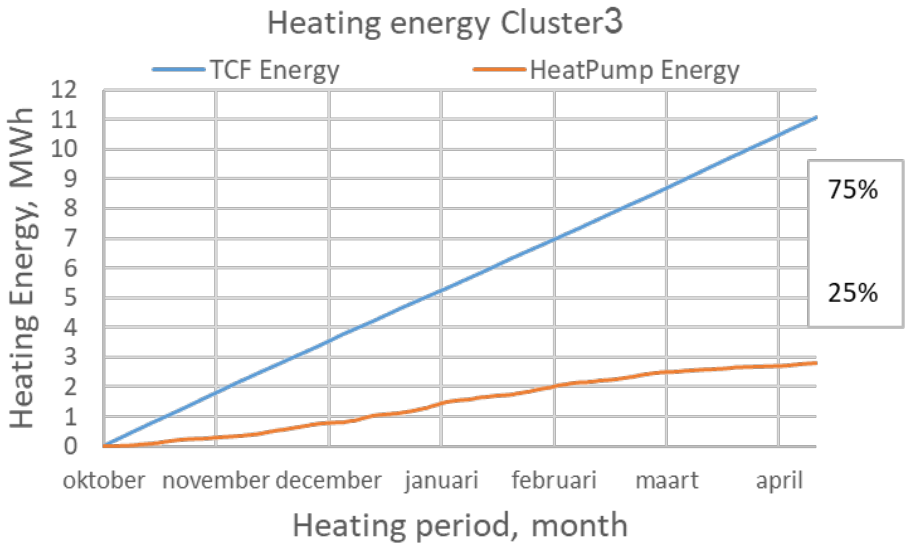
Simulation results of Integrated heating space

Supplied heat to the 3 building clusters of both system



Cluster	No. of Buildings	volume m3	Heat demand (MWh)	Specific_Heat_ Demand (kWh/m2.a)
1	1	345	6.5	106
2	5	489	12.9	147
3	6	346	10.8	352





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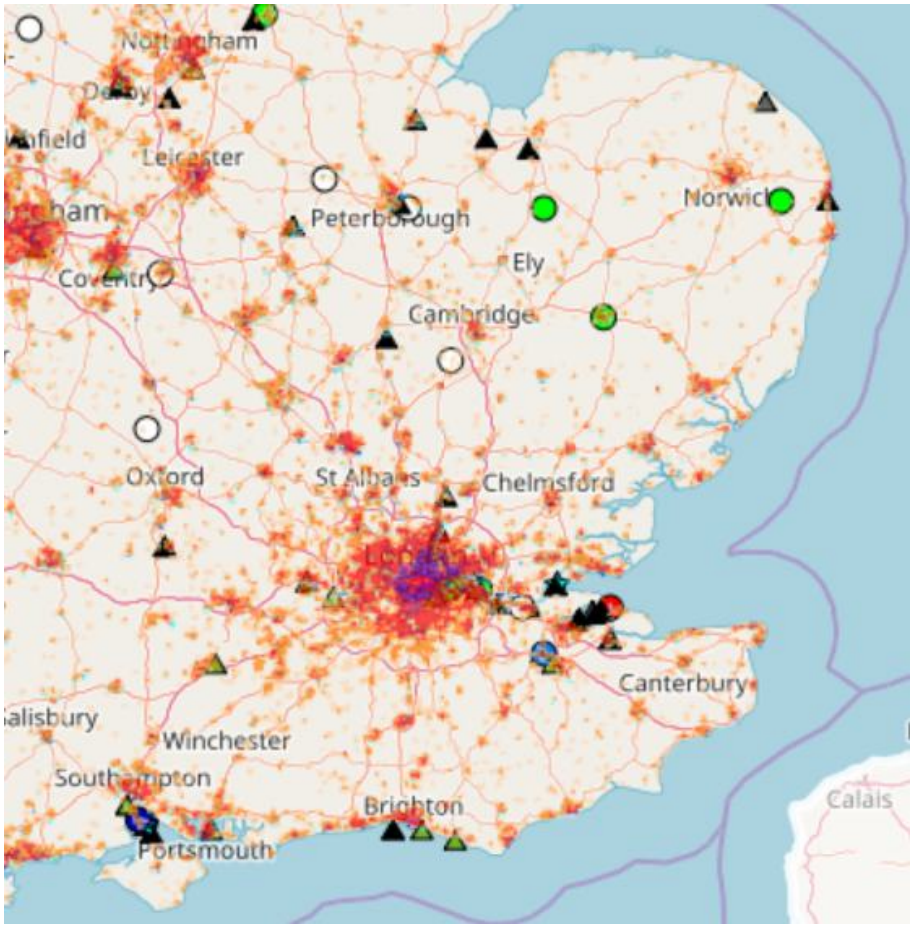
Demonstrators

Germany:
Space Heating
Space Cooling
Humidity control

Switzerland: Humidity control

UK: Drying, Smart Grid Integration

Long-distance transport (50 km and more)



Heat Roadmap Europe, Peta 4.2

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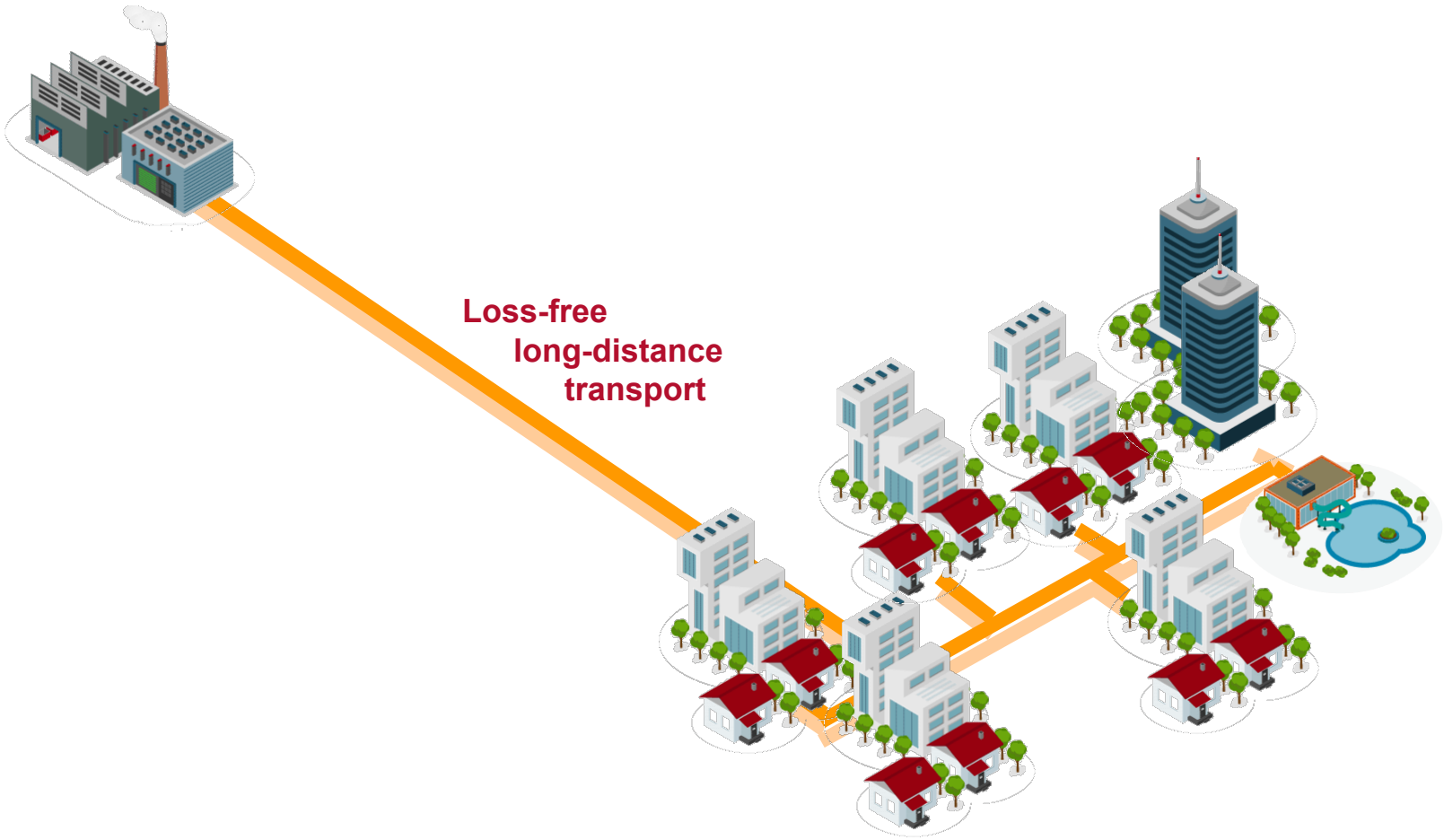
Loss-free long-distance transport



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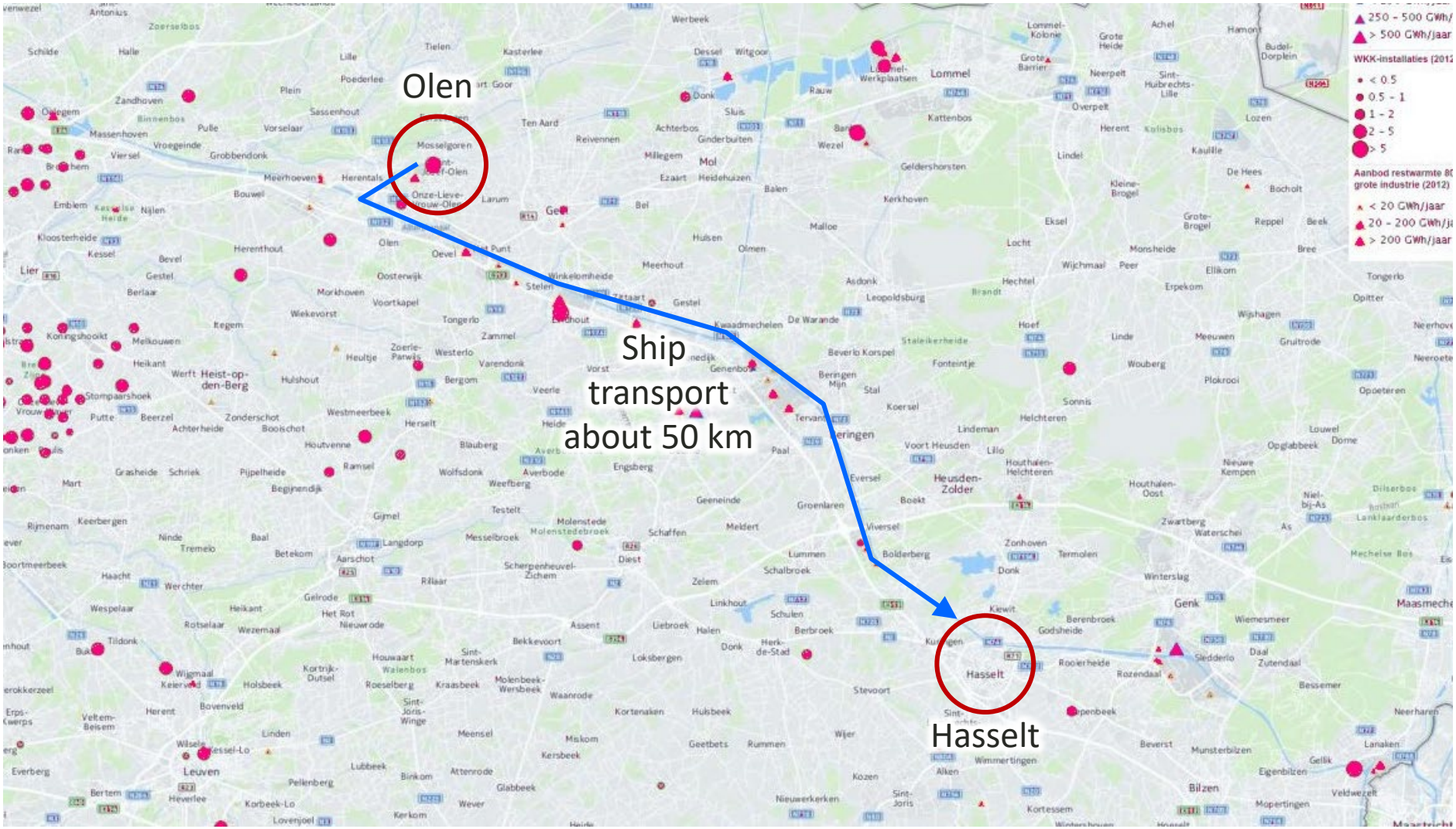
Olen
Ship
transport
about 50 km
Hasselt
Hasselt
250 - 500 GWh/
> 500 GWh/jaar
WKK-installaties (2012
< 0.5
0.5 - 1
1 - 2
2 - 5
> 5
Aanbod restwarmte 8
grote industrie (2012)
< 20 GWh/jaar
20 - 200 GWh/ja
> 200 GWh/jaar

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Case study Hasselt

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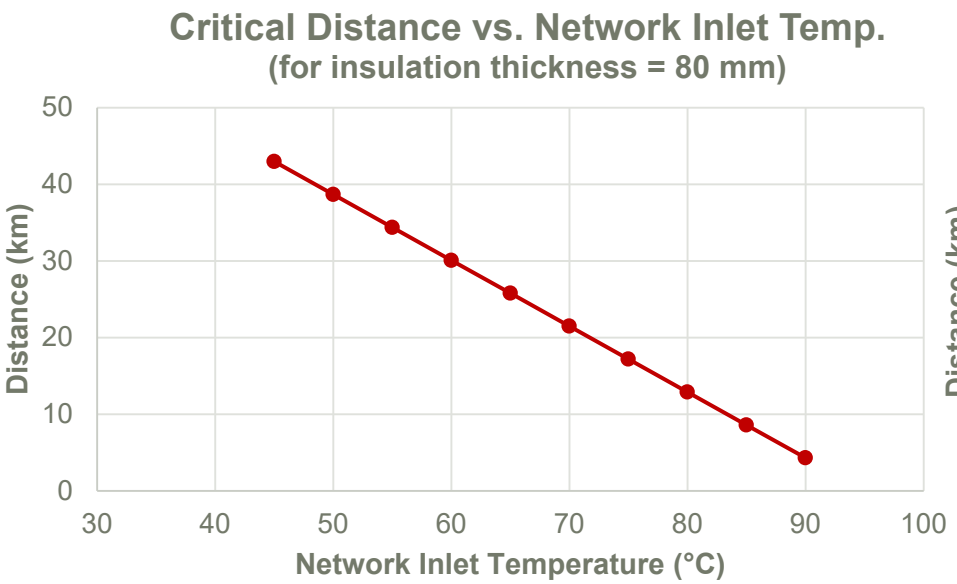
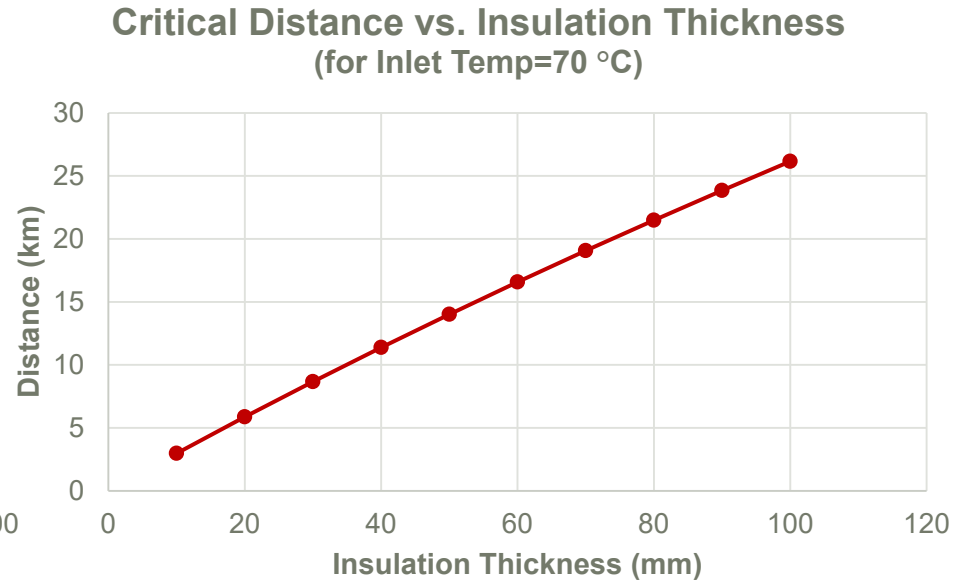
Results from Case Hasselt for Long Distance Transport

- **For Conventional (water-based) District Heating:**
  To maintain a Distribution Network Inlet Temperature of 70°C, losses represent 7% of transported heat potential (80-mm ins.)

  → ***Critical Distance (supply to demand): 21.5 km***





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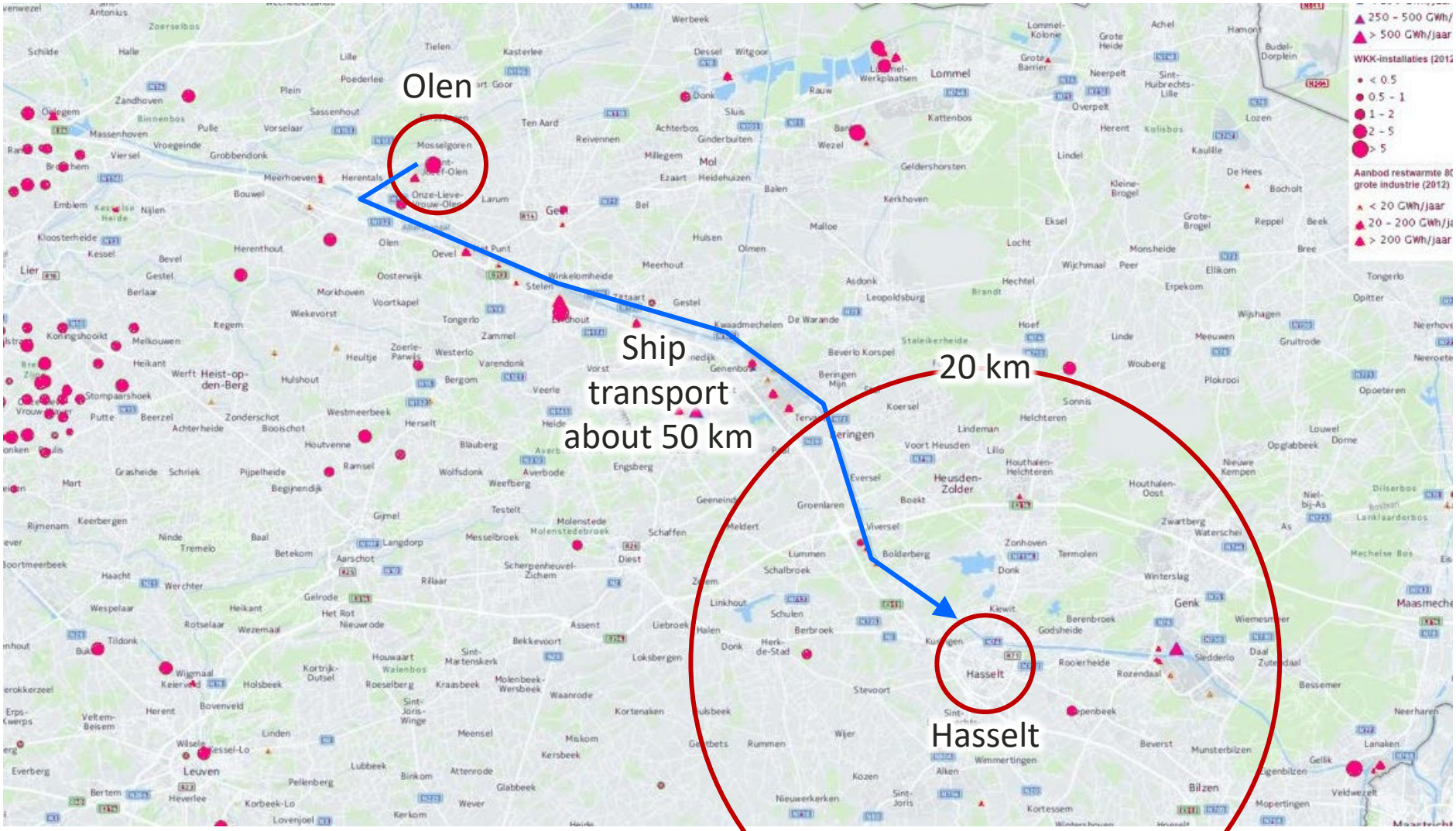
Olen
Ship
transport
about 50 km
20 km
Hasselt
Hasselt
Leuven
Genk
Lommel
Mol
Geel
Heist-op-
den-Berg
Bilzen
250 - 500 GWh/
> 500 GWh/jaar
WKK-installaties (2012
< 0.5
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> 5
Aanbod restwarmte 8
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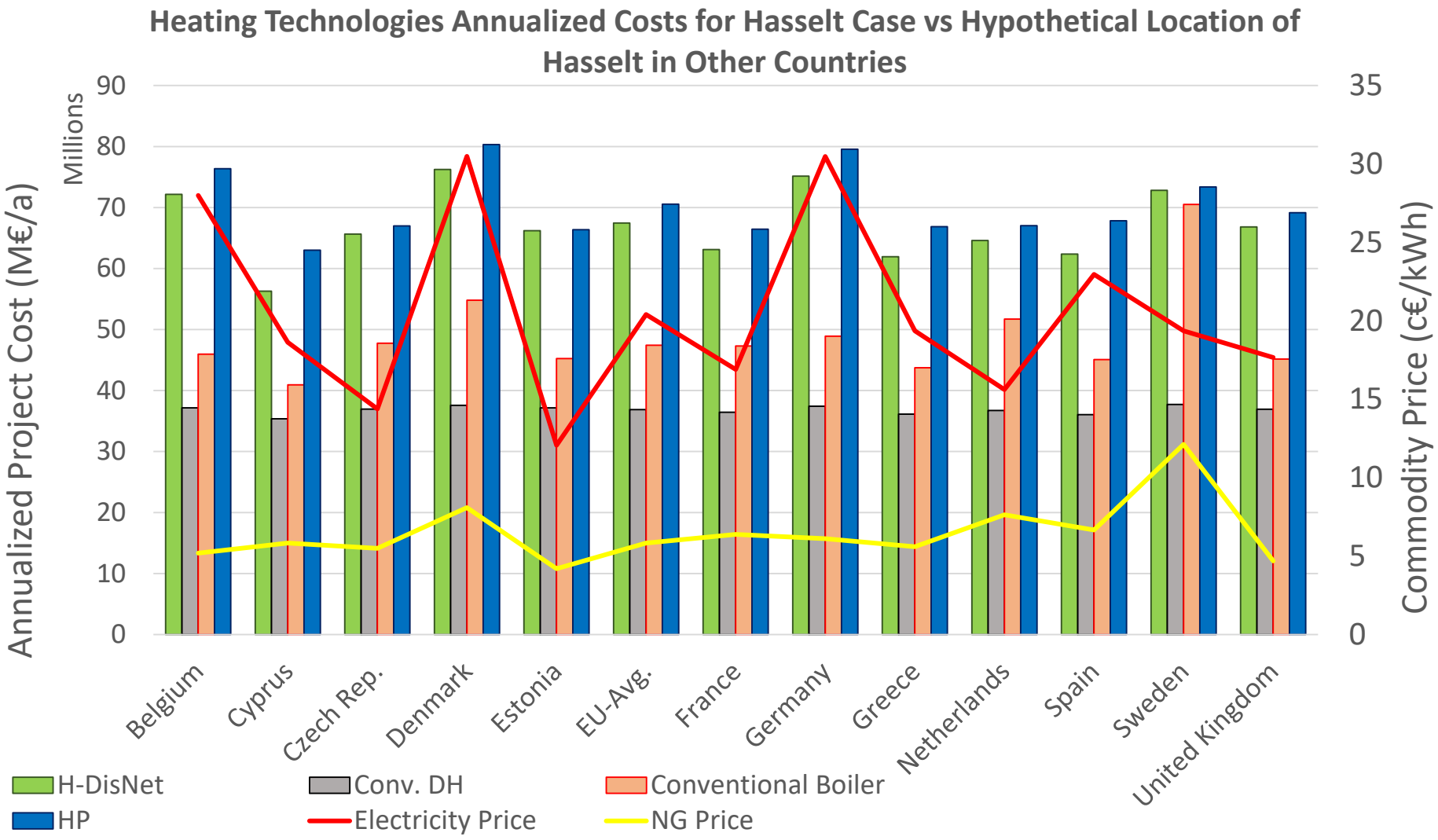
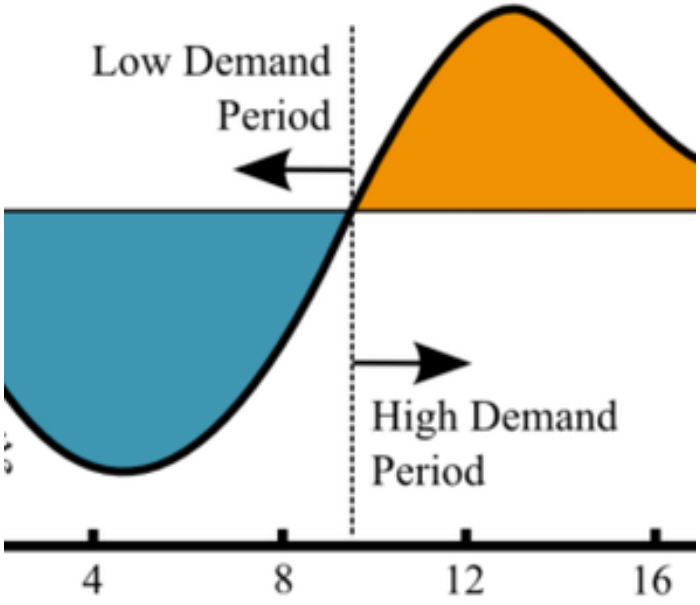
< 20 GWh/jaar
20 - 200 GWh/ja
> 200 GWh/jaar

Economic comparison for Case Study Hasselt



Data for Commodity Prices obtained from European Comission, EUROSTAT Data Statistics

Mid-term time shift (storage)



Sabihuddin et al. 2015

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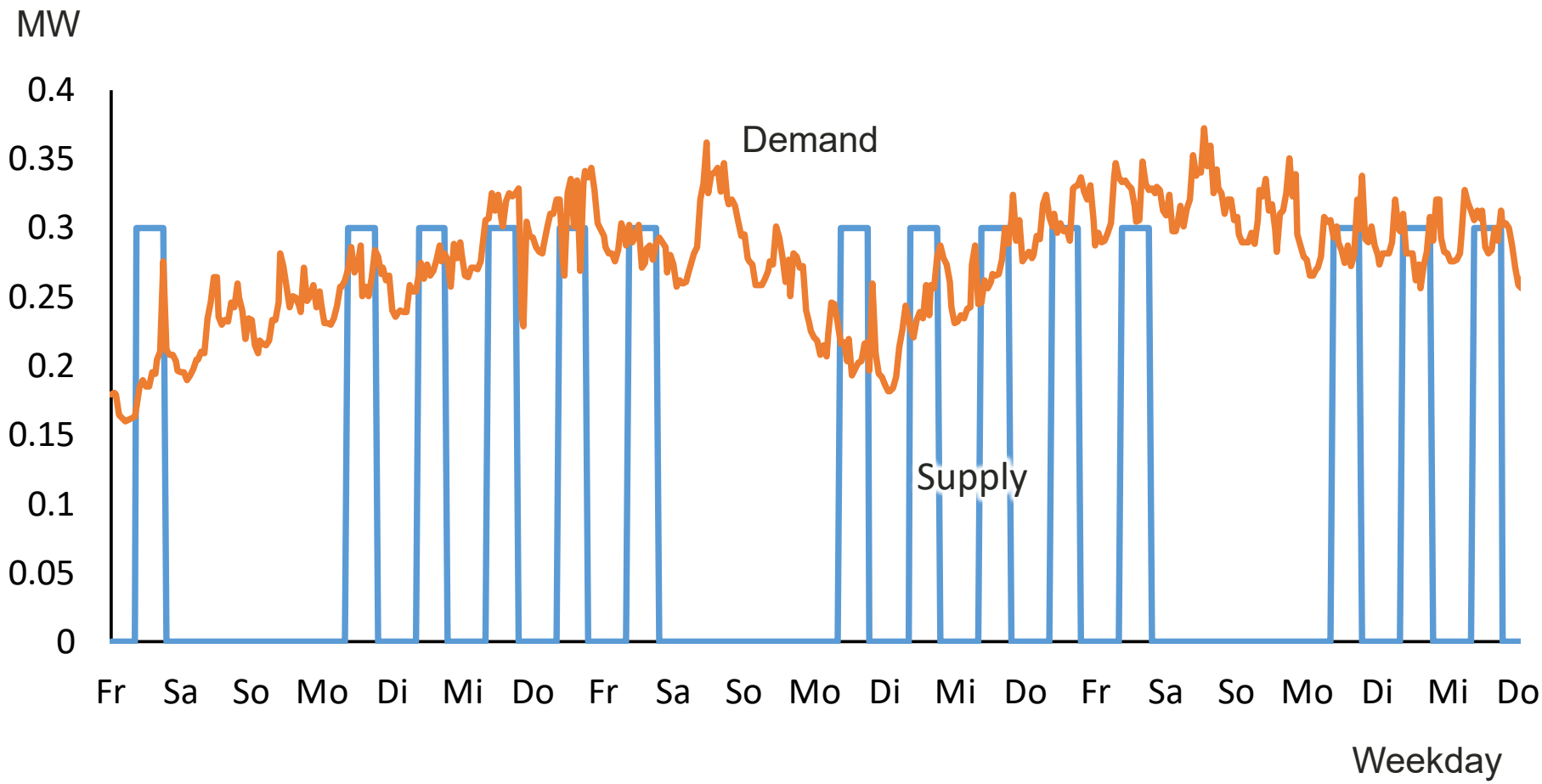
Fluctuating demand over an operating production factory



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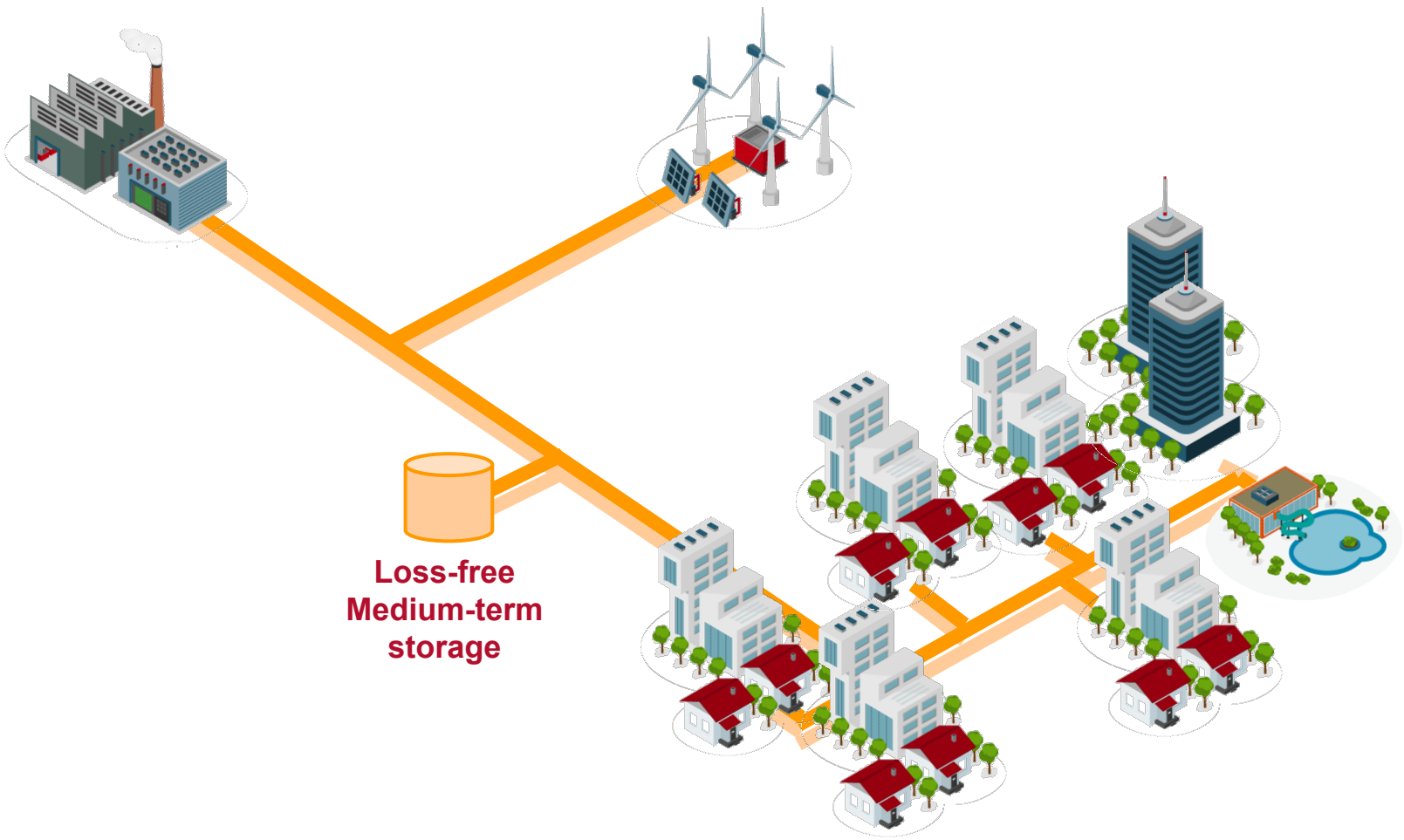
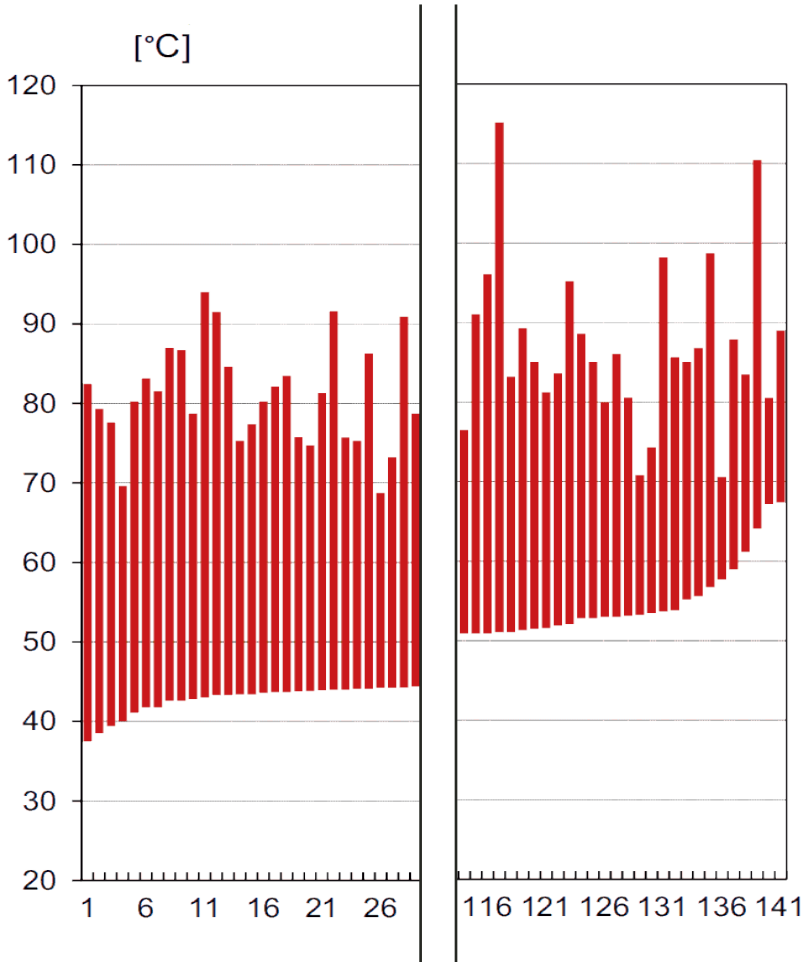
Thermo-Chemical Network

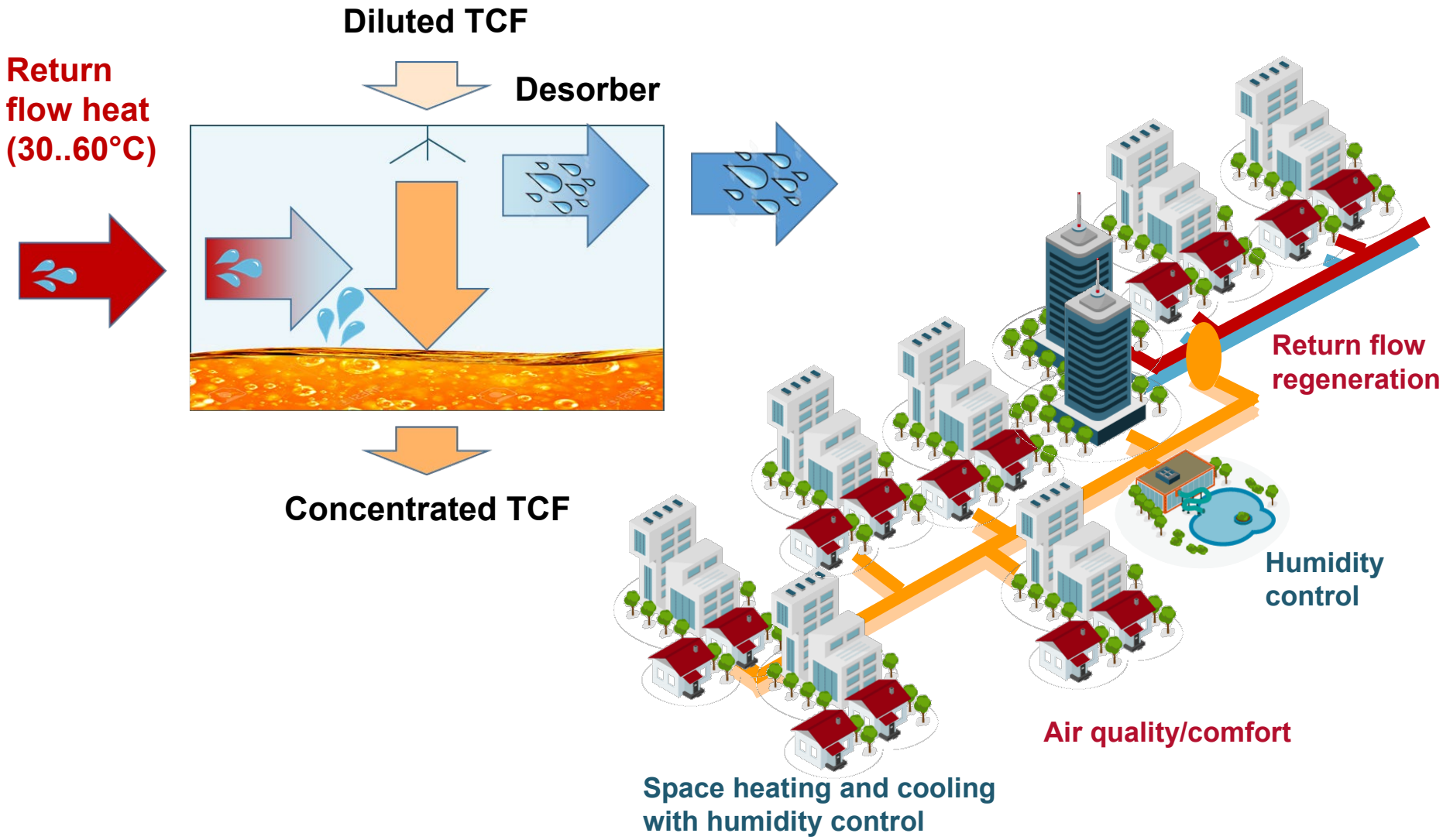


Lowering return flow temperatures



Gadd and Werner 2014

Return flow exploitation



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Patent exploitation of return flow for efficiency

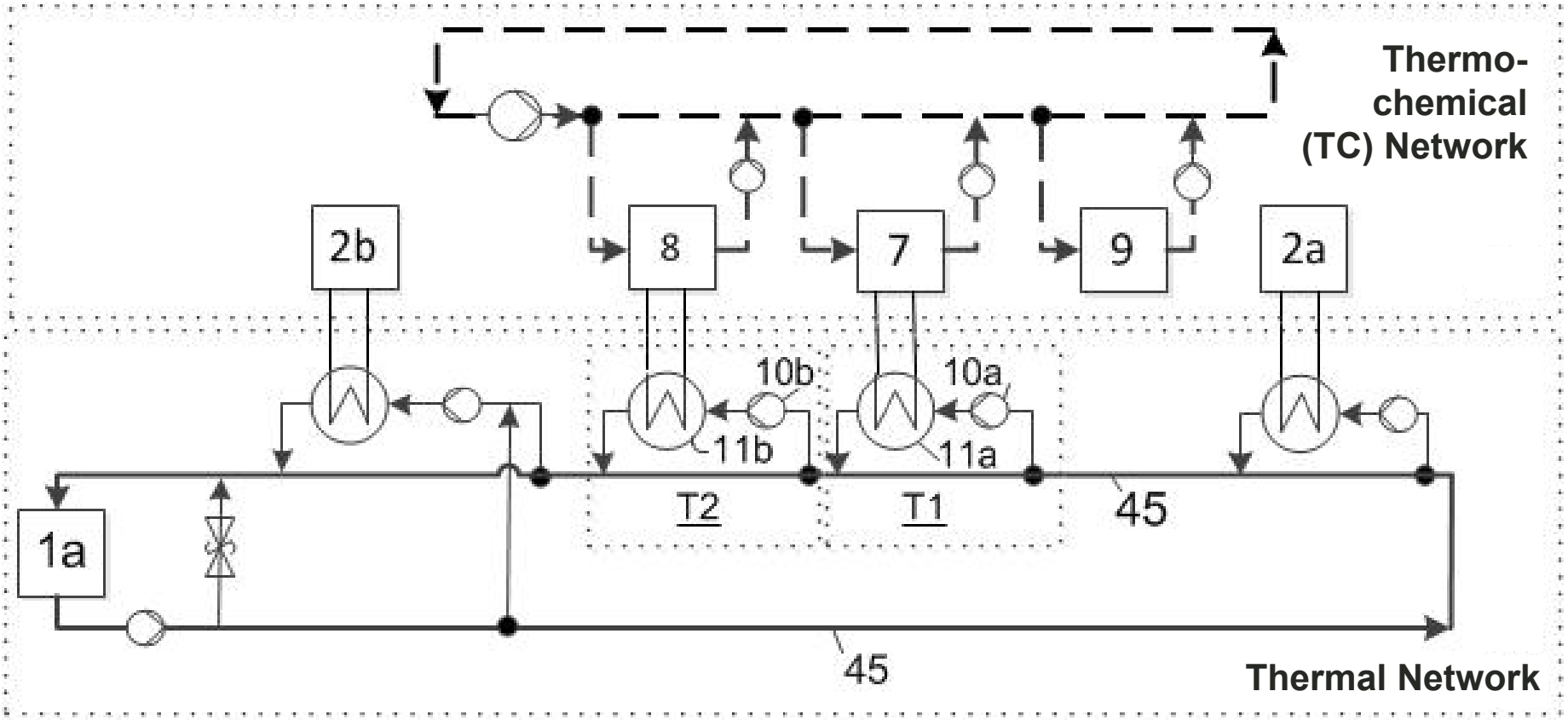

Fig. 1

Patent EP3034953B1: System for transport, storage and use of thermal and thermo-chemical energy potentials

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Thermo-Chemical Network