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Hasselt case study, Preliminary economic aspect and Simulation

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OVERVIEW

- Thermo-chemical District Network Introduction
- Modeling & Simulation Strategy for Hasselt Case Study
- Simulation results → Integrated System Integrated& DH of Hasselt
- Hasselt Case Study (Intro., Objectives & Key Figures)
- Hasselt: Results, Economics & Reflections
- Conclusion

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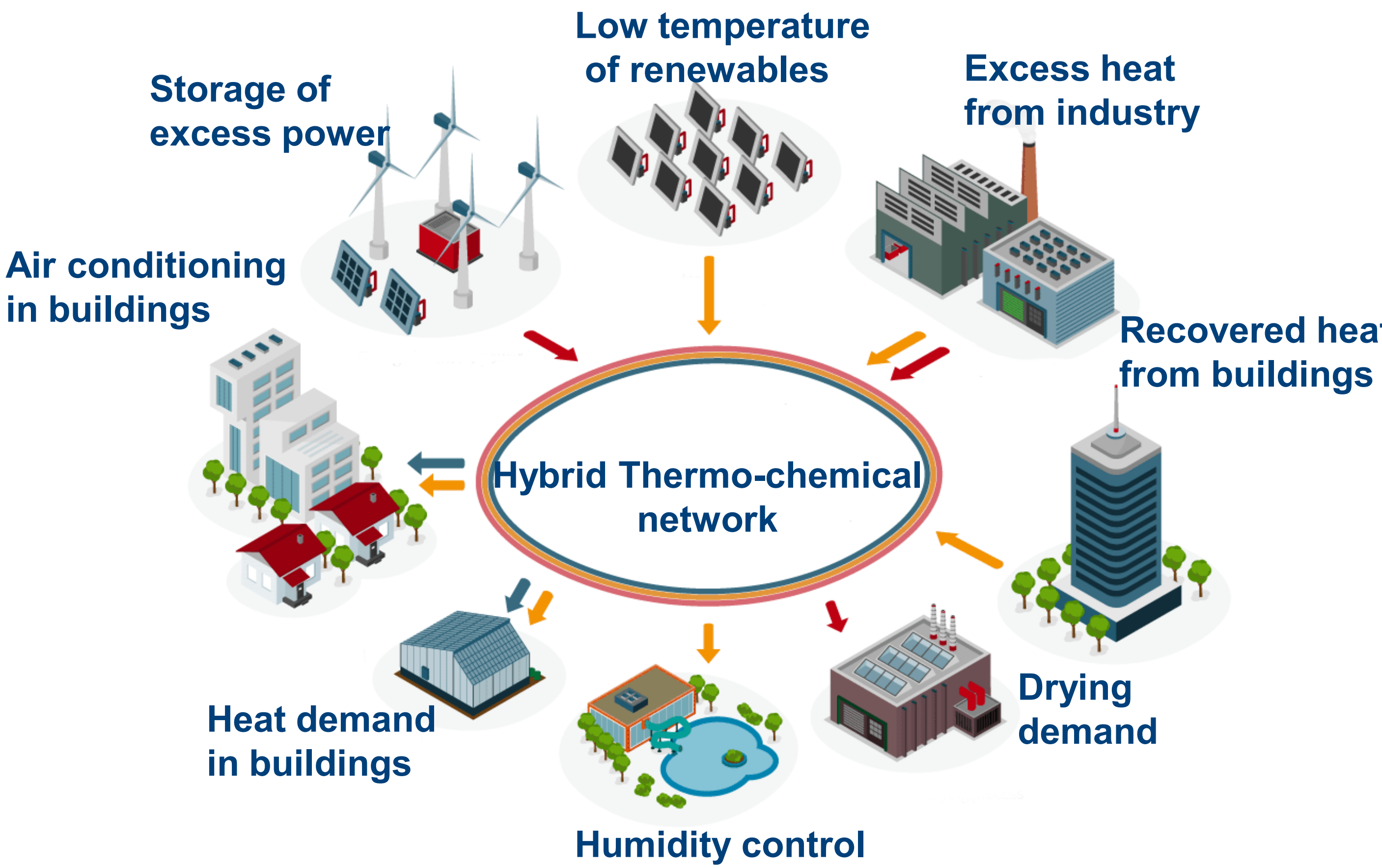
Thermo-chemical District Network Introduction

Excess heat
from industry
11,274 PJ / a

Heat demand
in buildings
11,724 PJ / a

Excess heat and heat demand ←→ Network



Data source: Persson et al. 2014

Thermo-Chemical(TC) District network(DN) system

TC District network system parts and components

Supply-side	Networks	Demand-side
• Excess heat sources (industry, renewables, recovered heat) • Pumps &fans • Desorber • Diluted TCF • Heat exchangers • Control	• Pipes • Pumps • TCF supply/return • TCF Storage	• Buildings/industries • Humid sources (green house,…) • Pumps &fans • Absorber • Concentrated TCF • Heat exchangers • Heat Pump • TCF Storage

TCF : Thermo-chemical fluid (brine), MgCl2, LiCl,..

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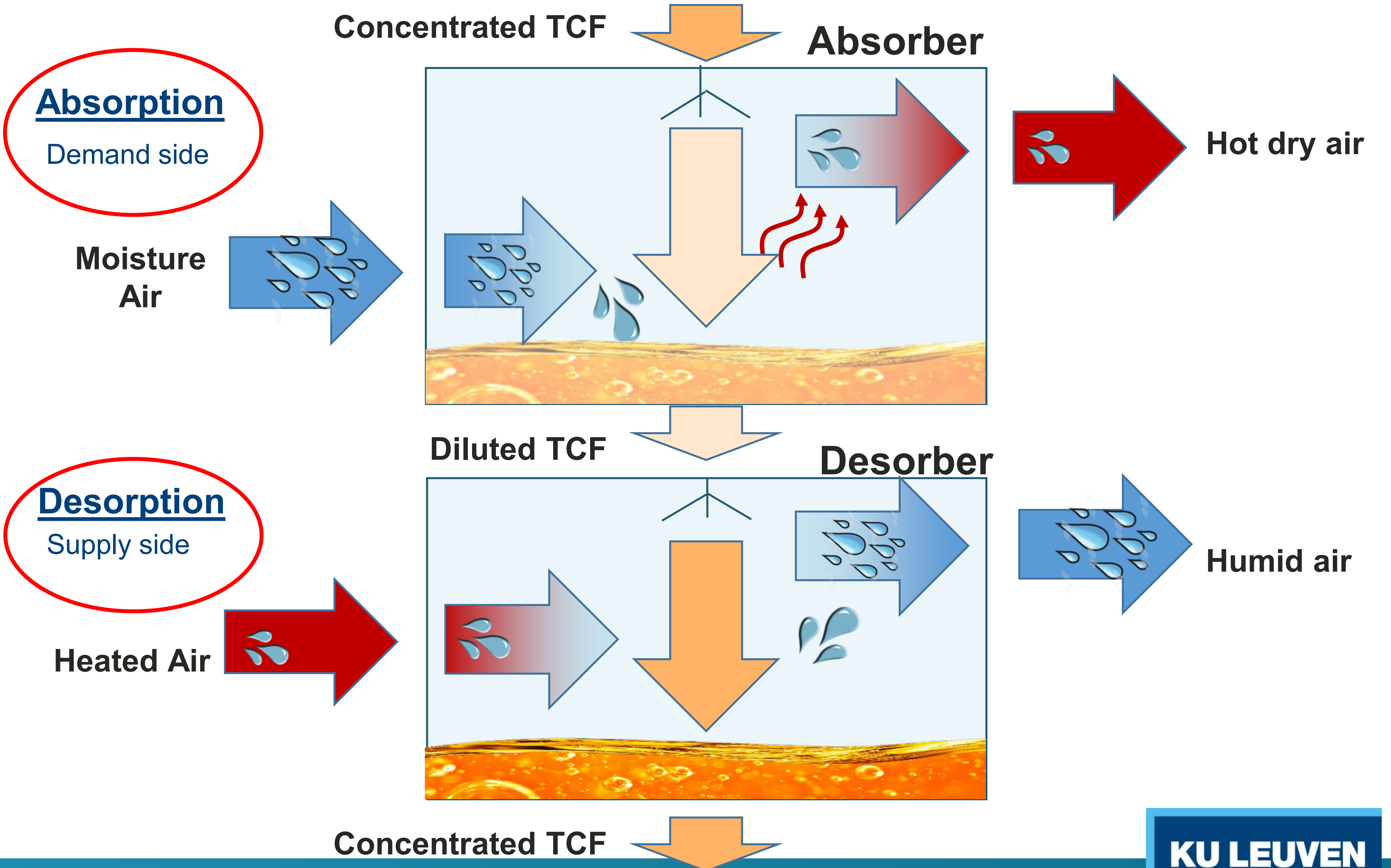
Absorption/Desorption Technology



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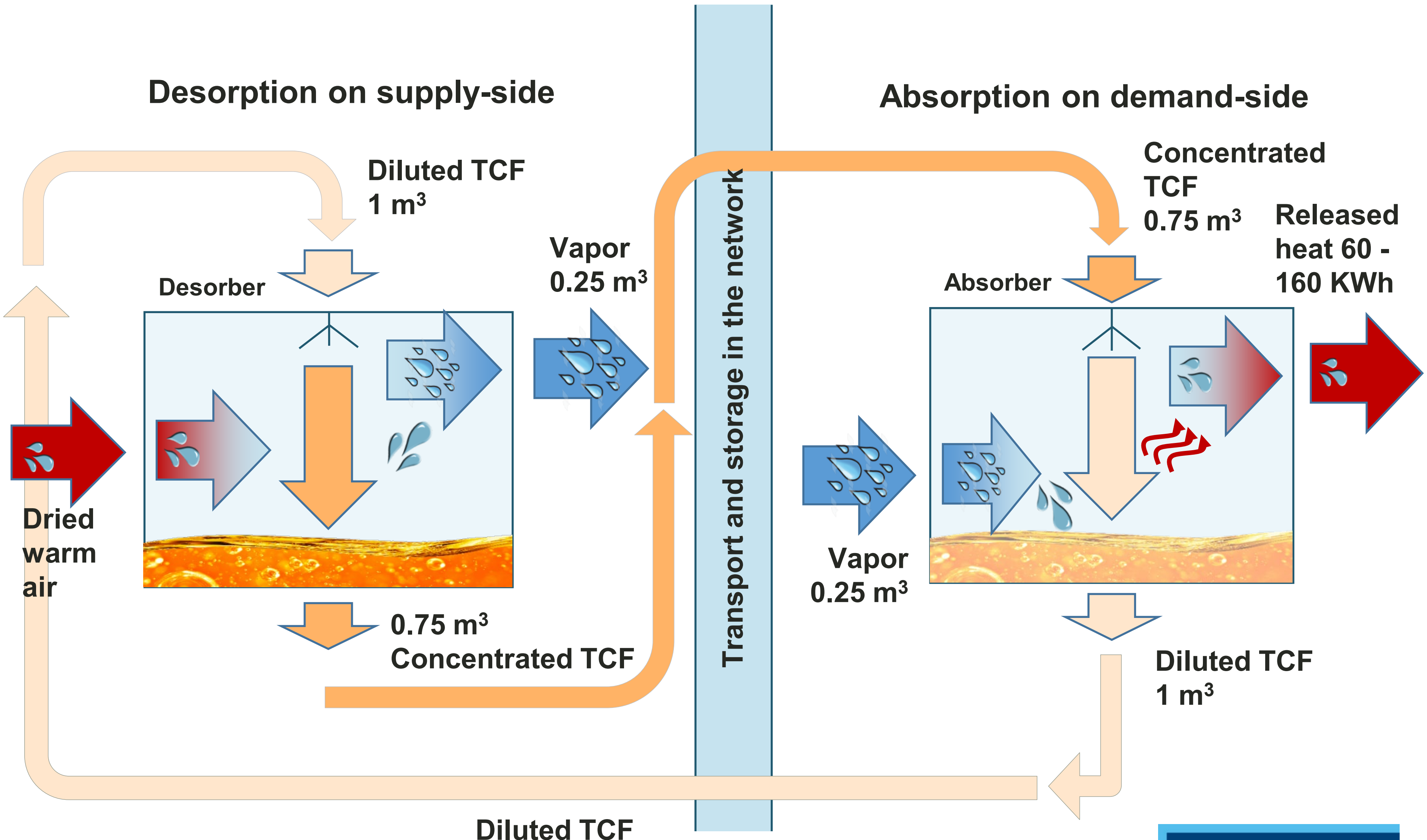
Thermo-chemical processes in a network



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Modeling & Simulation strategy for Hasselt City (sector)

* MODELICA

Modeling

Integrated Dynamic Space heating model for 3 building clusters
TCF system ←→ Heat Pump system

Simulation

- Heating demand profile
- TCF flow demand & (profile)
- Supplied heat of both system

Analysis

Data model for 3 building clusters

Integrated DH model of a Hasselt city sector

Simulation

- Total Pumping energy
- Total TCF mass
- Total supplied heat of both systems

Main objectives

Feasibility of the TCF technology & Energy consumption?!!

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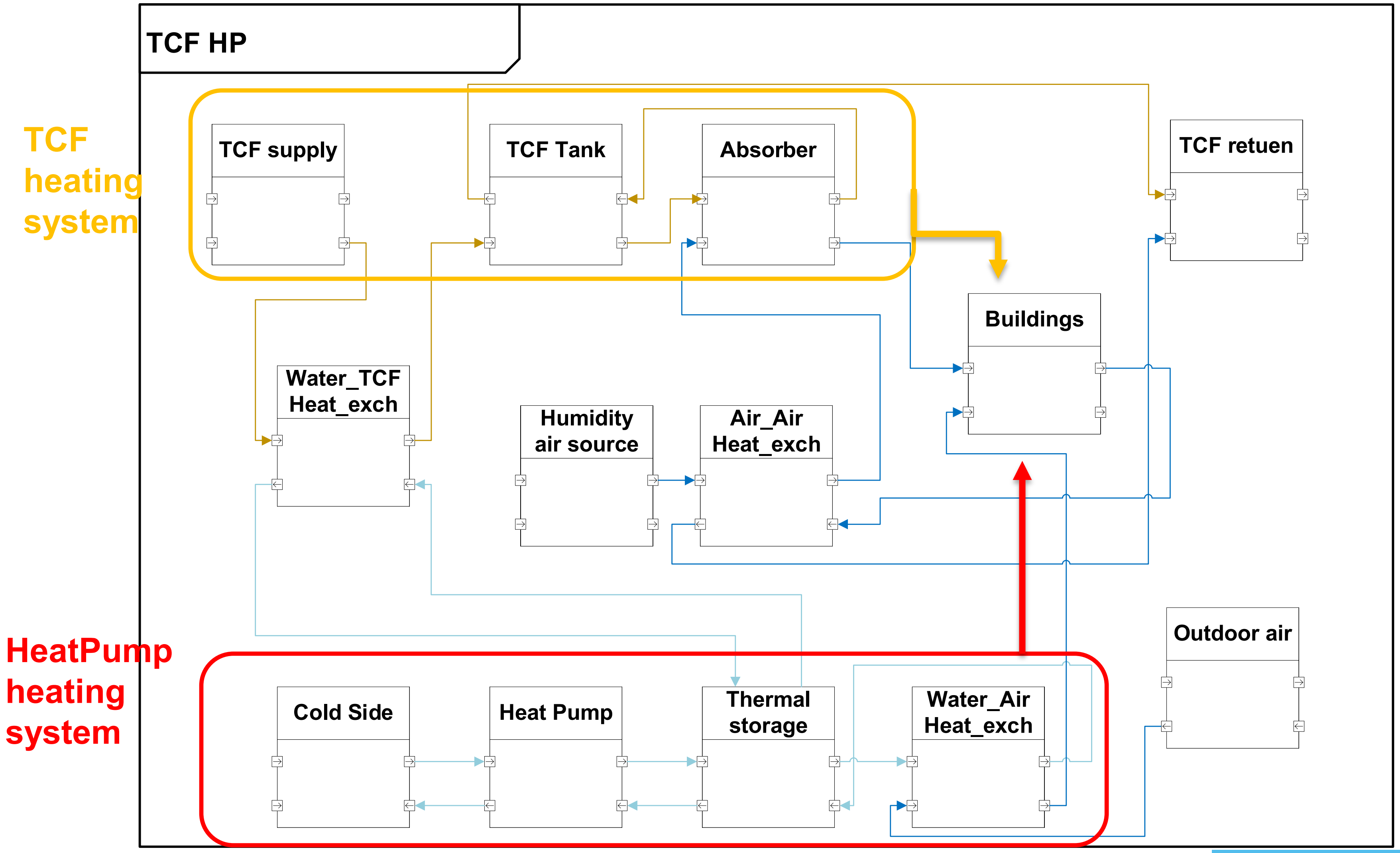
* Modelica library, IDEAS library, BRINE library

Modeling scheme of Integrated system of Space heating



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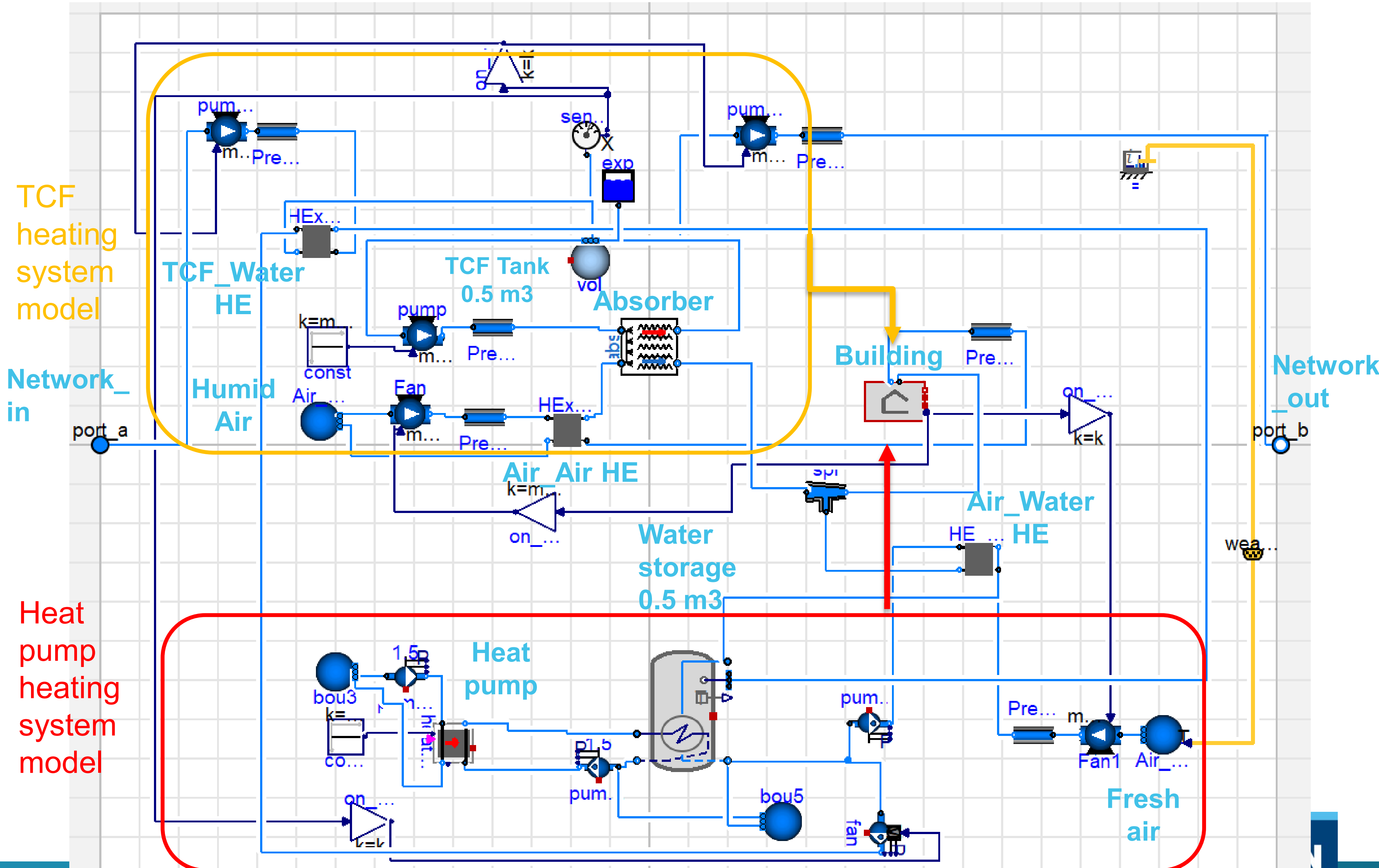
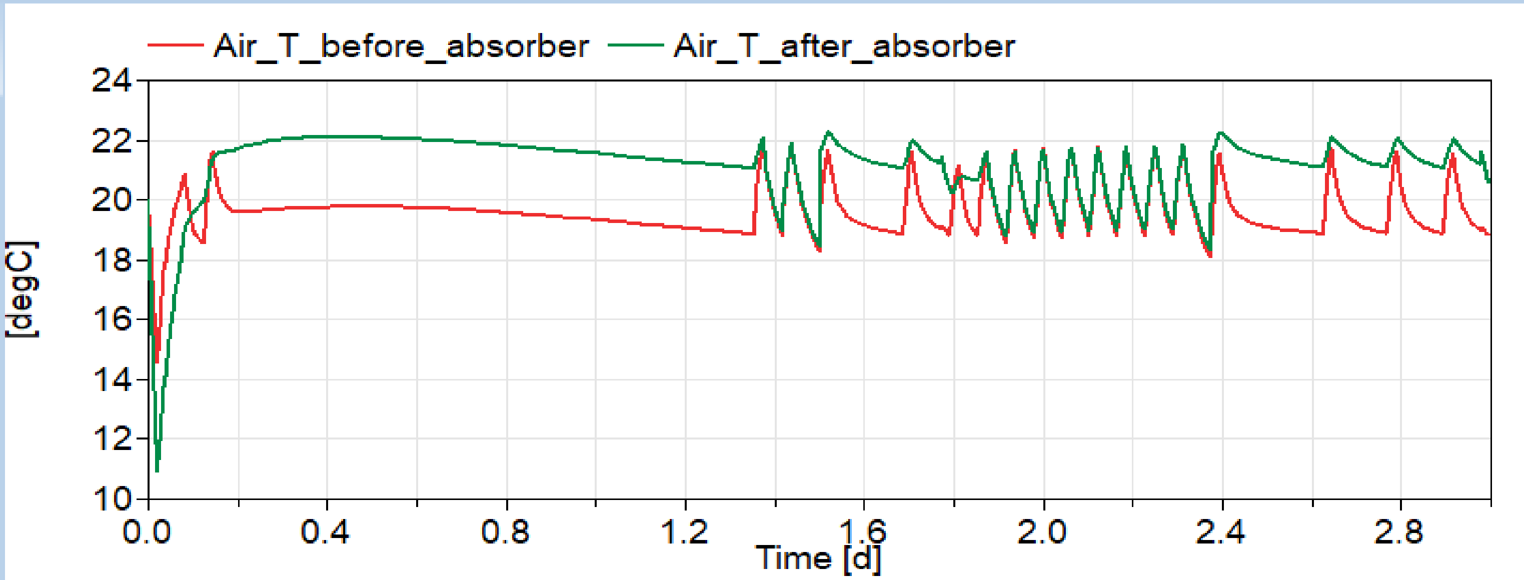
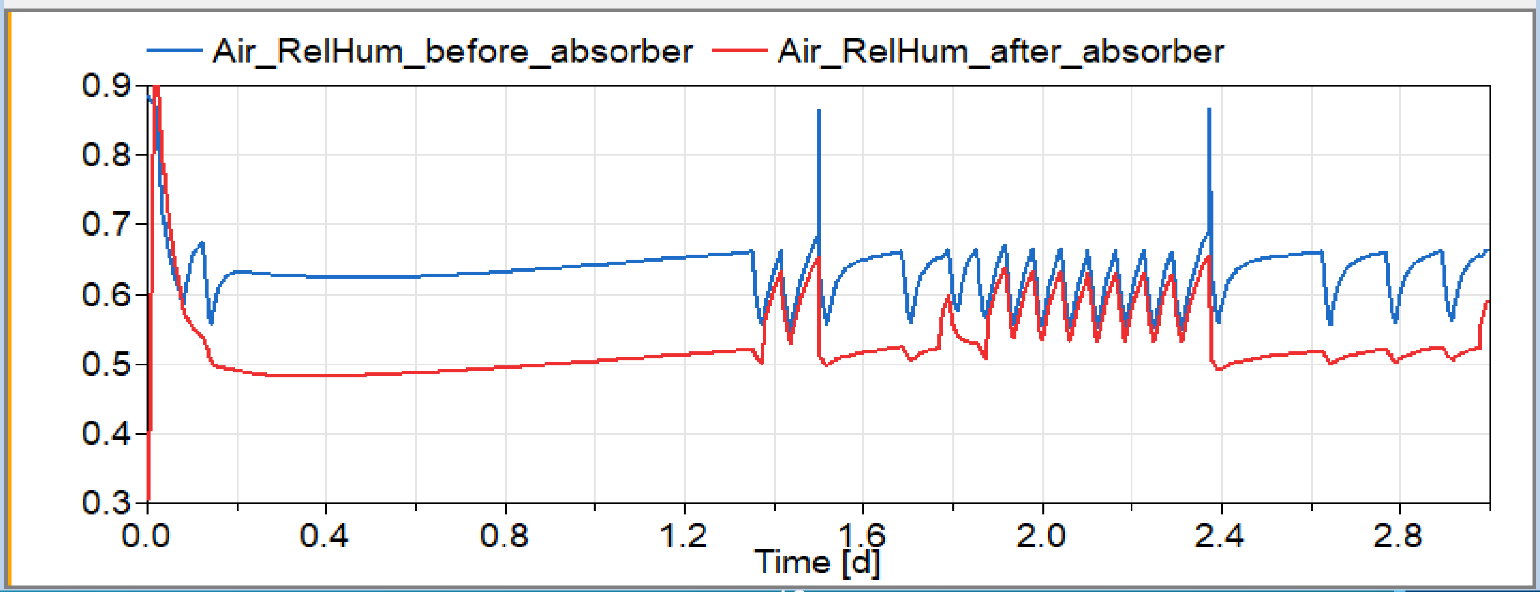
Modelica Integrated system of space heating model



Simulation results of Integrated space heating





Suppl … e than
for 3 … er control

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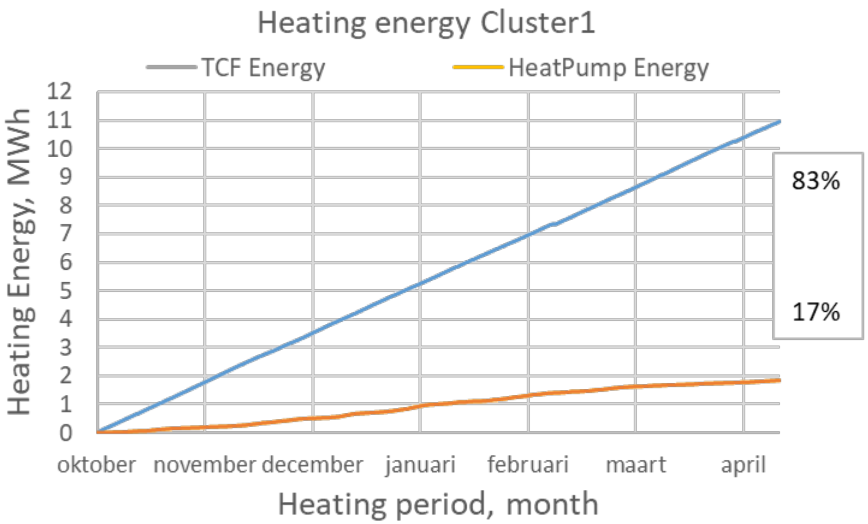
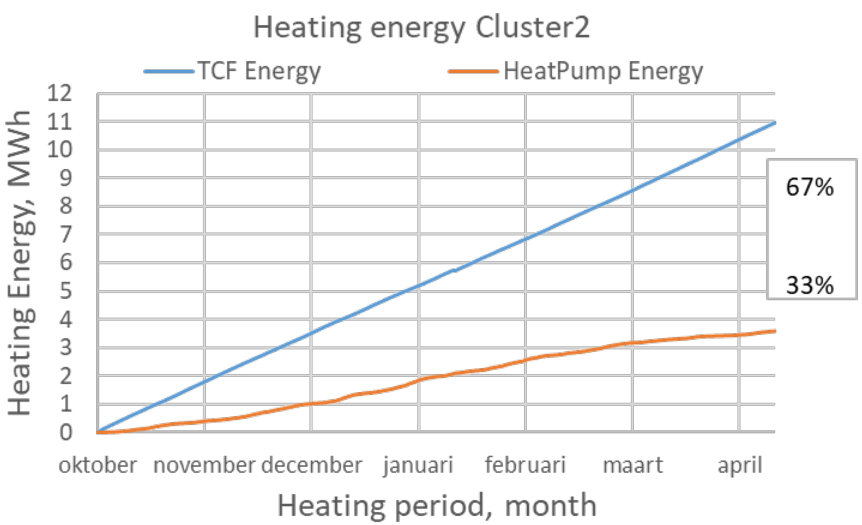
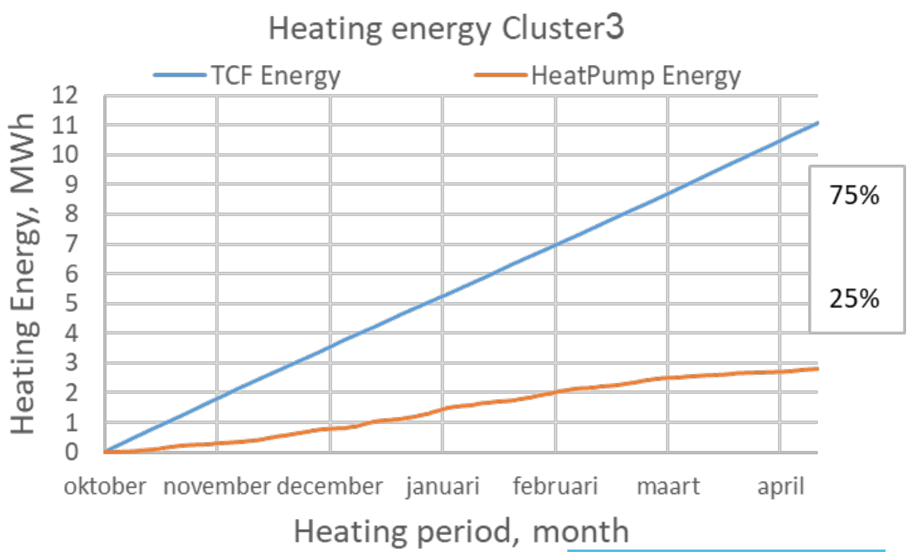
Simulation results of Integrated heating space

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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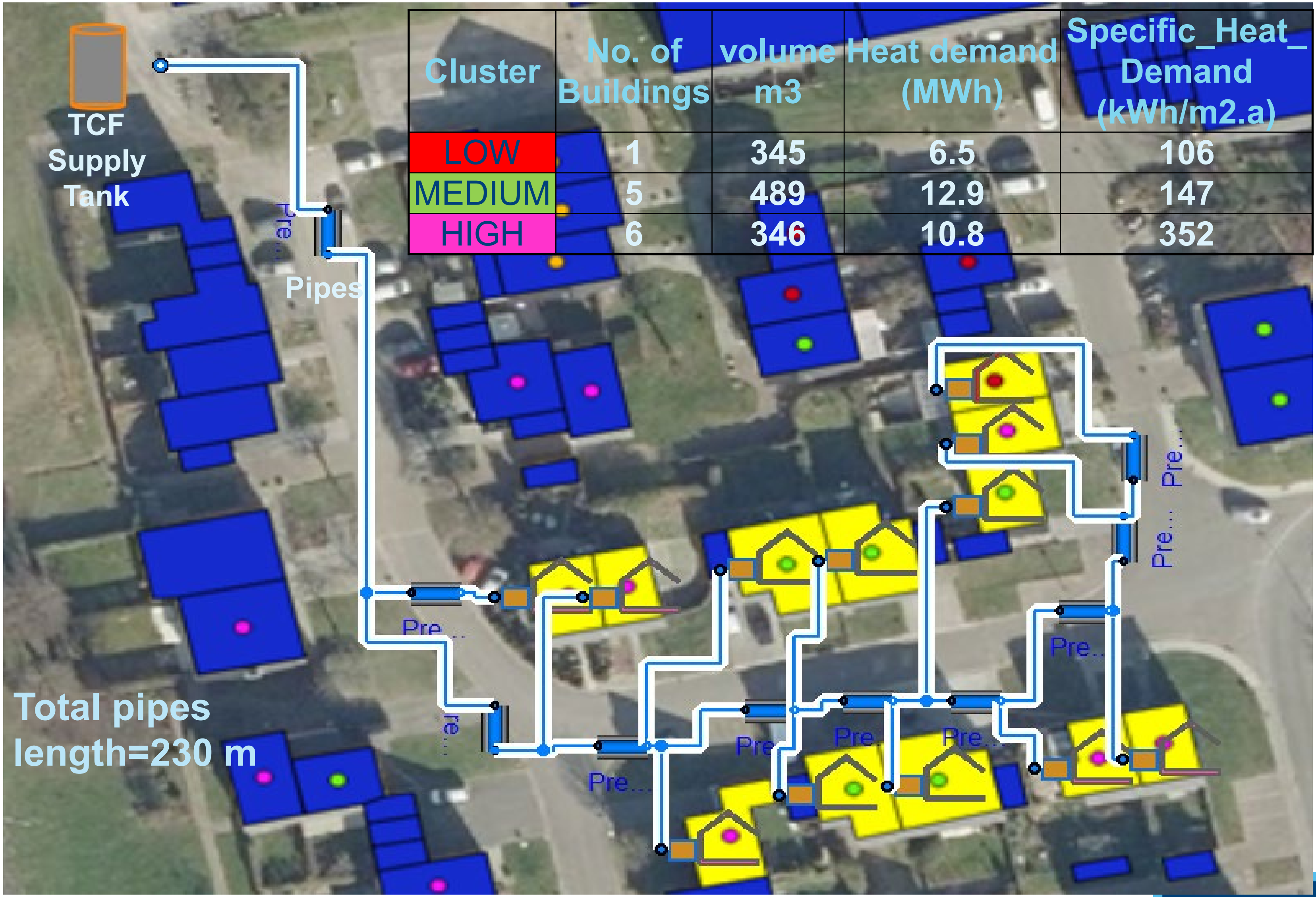
Integrated DH model of a Hasselt city sector

Cluster	No. of Buildings	volume m3	Heat demand (MWh)	Specific_Heat_Demand (kWh/m2.a)
LOW	1	345	6.5	106
MEDIUM	5	489	12.9	147
HIGH	6	346	10.8	352



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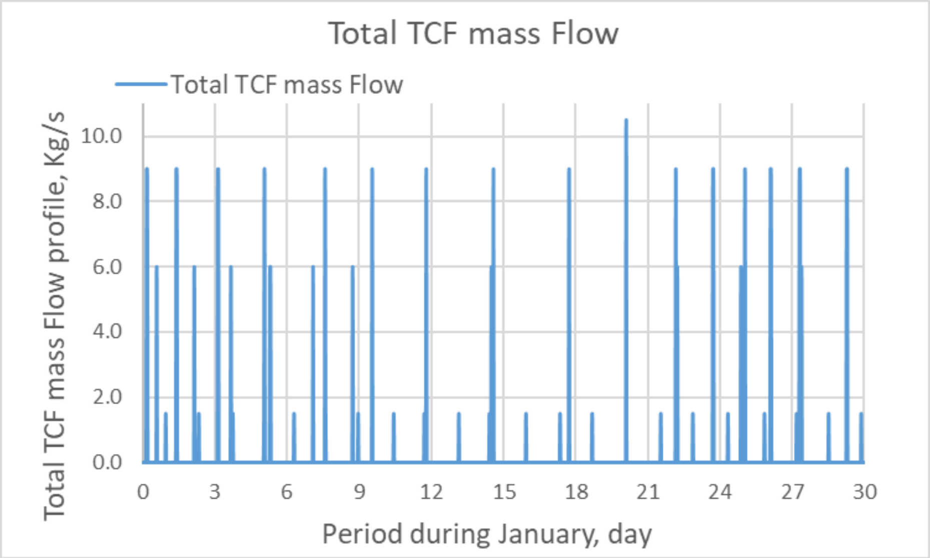
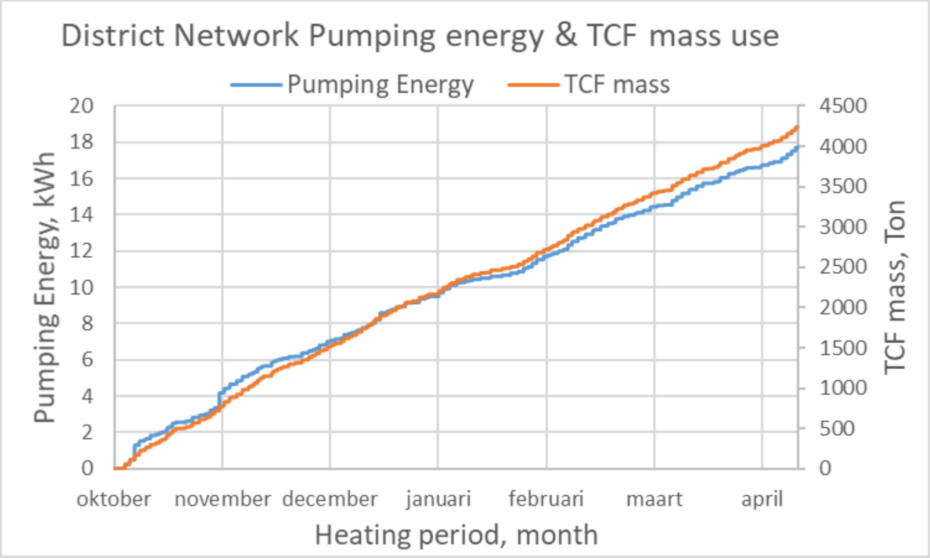
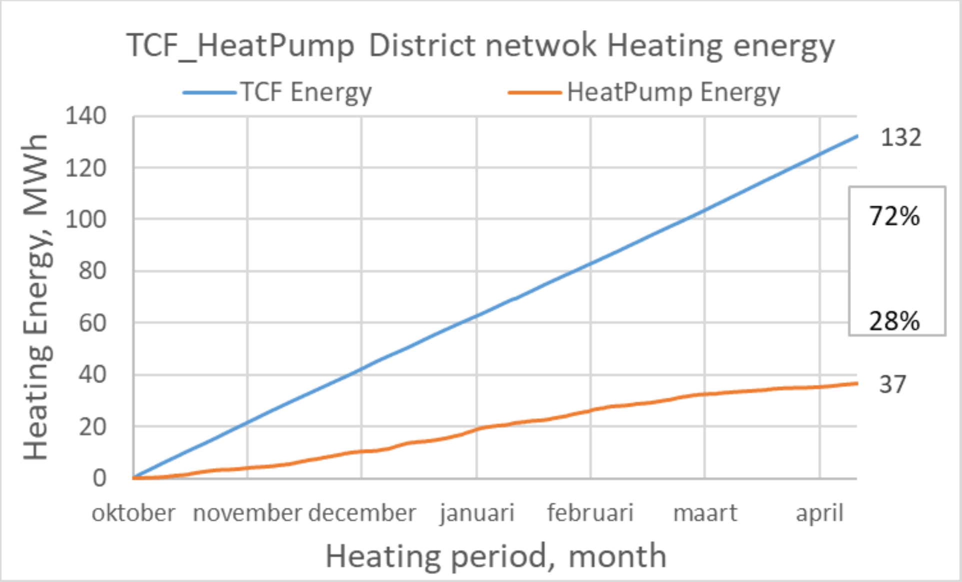
Simulation results of Integrated District Network







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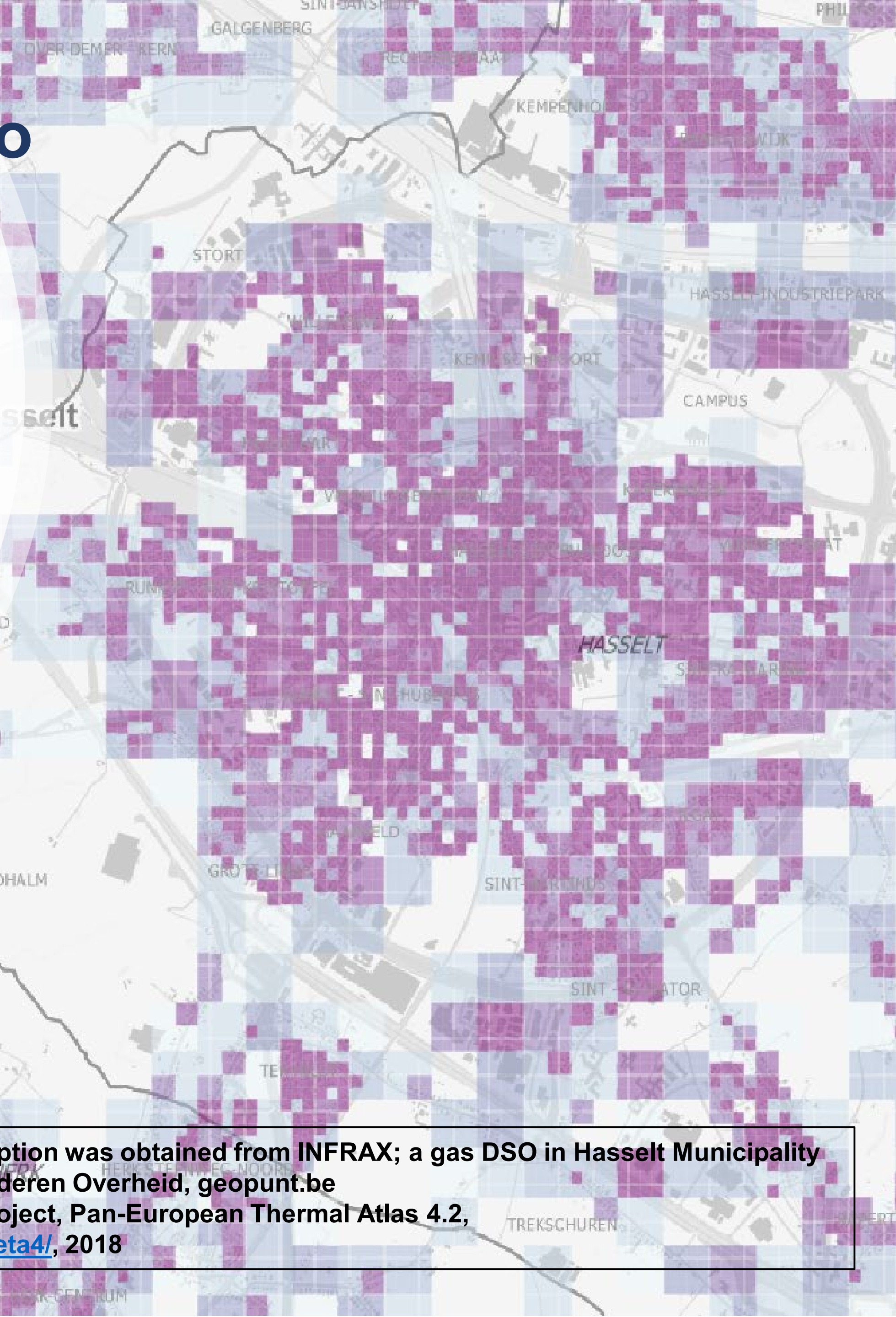
Hasselt Case Study: Intro

- Medium-size Town (~70k Inhabitants)
- Approx. 54,000 Buildings (all types)
- PETA 4.2 Category:

Very High Energy Synergy Region

- Excess Heat Sources from Industry & Power Generation
- **Available Data**
  - ➢ GIS Data for 50x50m Cells for Yearly Gas Consumption
  - ➢ GIS Data for Individual Buildings Heights and Footprints



- GIS data for gas comsumption was obtained from INFRAX; a gas DSO in Hasselt Municipality
- Data obtained from Vlaanderen Overheid, geopunt.be
- Heat Roadmap Europe Project, Pan-European Thermal Atlas 4.2, https://heatroadmap.eu/peta4/, 2018

Hasselt Case Study: Objectives

1. **to explore** the potential and feasibility for a city-level TCF network in a real-life scenario

2. **to present** potential H-DisNet advantages over alternative technologies at district level

3. **to investigate** under which scenario(s) H-DisNet will be economically competitive/attractive

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Hasselt Case Study

Methods

- from input 50x50m gas cons. data to individual heat demand
- Buildings **Clustering** acc. to Specific Heat Demand (kWh/m^2) for MODELICA Simulations
- Integrated System:
  TCF + Heat Pump
- Calculate Annualized Project Costs – Compare to Alternative Technologies

to be applied for?

- Target 13,846 Average-EU Residential Buildings
- Average Heat Demand of ~12 MWh/a (**Result**)

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Hasselt Case Study: Results

- **Serving 155 GWh/a of Heat Demand (42% City Coverage)**
- **3 Building Clusters acc. to Specific Heat Demand**
  a. **Low**
  b. **Medium**
  c. **High**
- **H-DisNet (Integr**

	CO_2 Er	nnualized oject Costs
Gas Boilers	-7	+57%
Standalone Heat Pumps	-2	-5.5%

- **Clear Advantage for Conv. DH over H-DisNet, *BUT* Long Distance Transport?!!**

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Hasselt Case Study: Reflections

- There are some challenges:

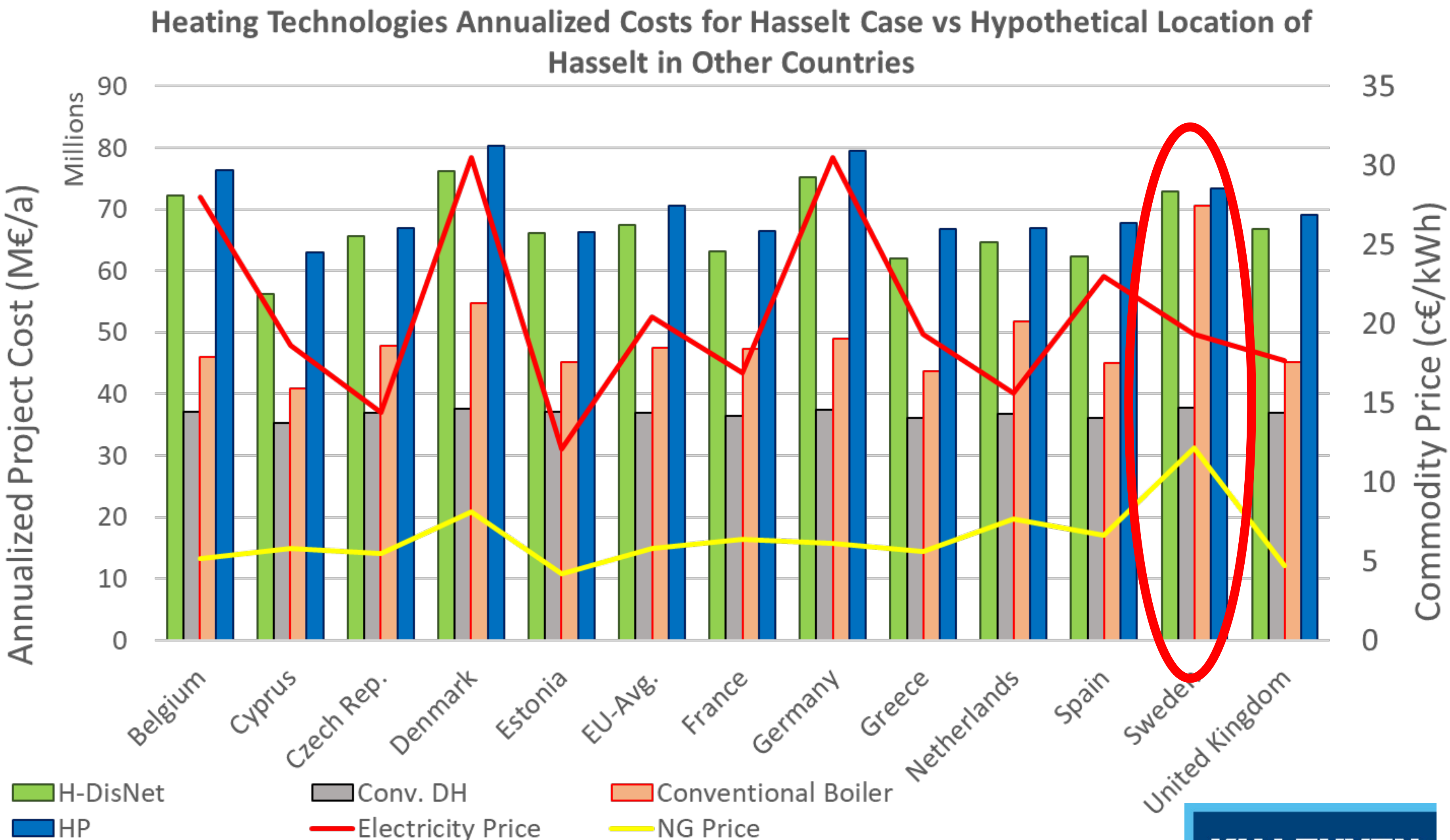
  1. **Urban Sprawl**: CAPEX and OPEX
  2. **Complexity** of in-house Systems
  3. **Heat Pump Operation** within Proposed System marginalizes Benefits
  4. **Economic Competition** with Carbon-Intensive Technologies & Conventional District Heating

- But light at the end of the tunnel?

Long-Distance Transport of Excess Heat to Energy-dense Area	Correct Government or EU Incentives

Is H-DisNet A Solution?

- High Natural Gas Price
- Low CO_2 emissions in Power Mix



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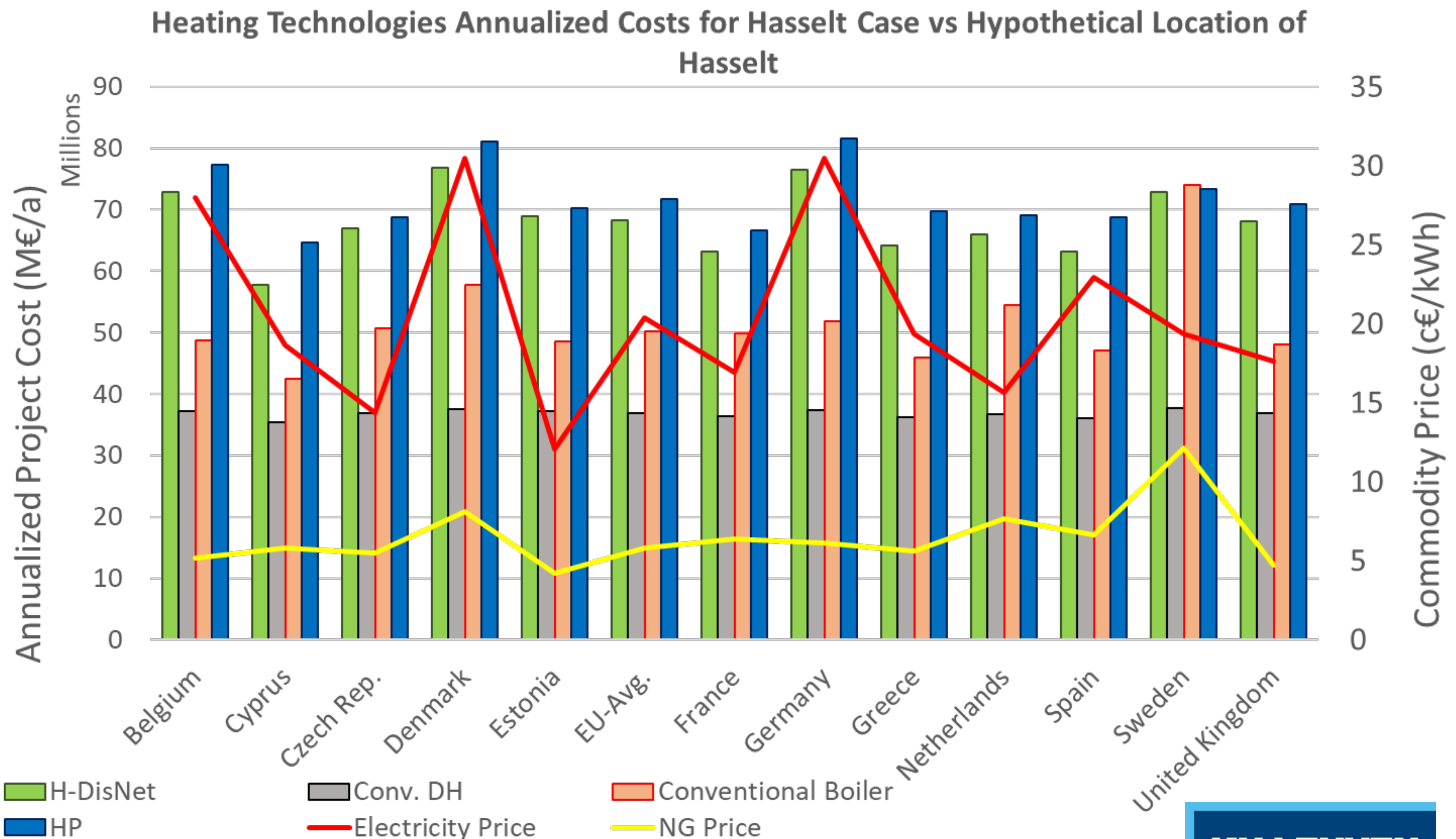
Is H-DisNet A Solution? (Future Scenario)



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Conclusion

- H-DisNet presents a clear environmental advantage for long-distance transport of excess heat to energy-dense areas.
- Economic Incentives needed for better competitiveness of H-DisNet.
- The integrated TCF system with HeatPump system in space heating case is feasible.
- Reduce the use of Heat Pump system to ~ 28% of total supplied heat
- Heating energy of integrated district network is significantly high, comparing with TCF pumping energy, which is 0.01% of the total energy.

Future work

- Explore economics for H-DisNet energy-dense areas rather than whole cities.
- Include cooling application in the integrated district network study & simulation.
- Optimize the integrated system with better control.
- Full scale dynamic simulation for larger district network.

Questions?

Thank you

H-DisNet

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