Using Dynamic Simulations to Analyze the Control of an Integrated Thermal Energy System for a Building Complex

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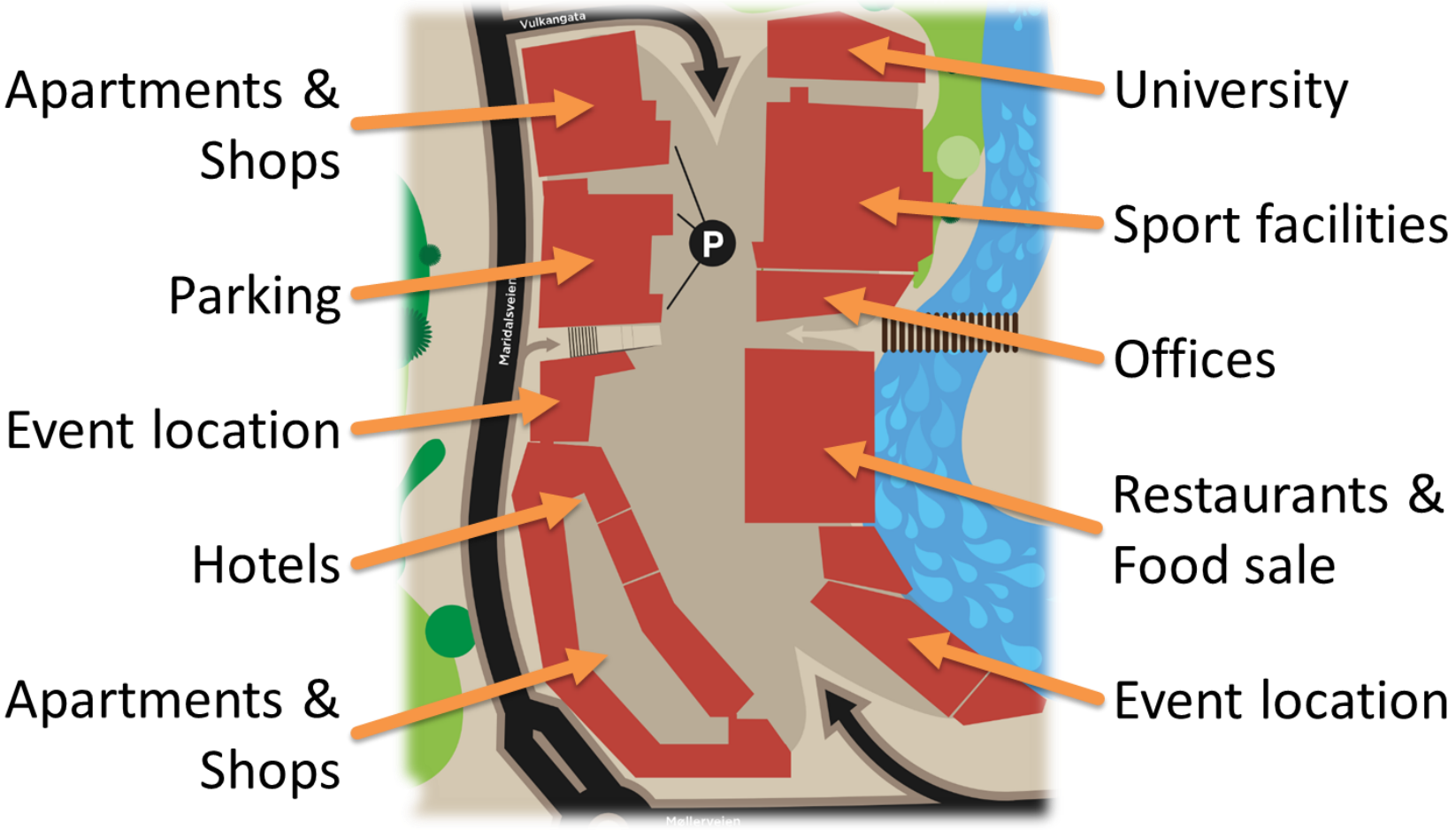
Daniel Rohde, Trond Andresen, Natasa Nord

Norwegian University of Science and Technology

The Buildings



Picture from www.vulkanoslo.no

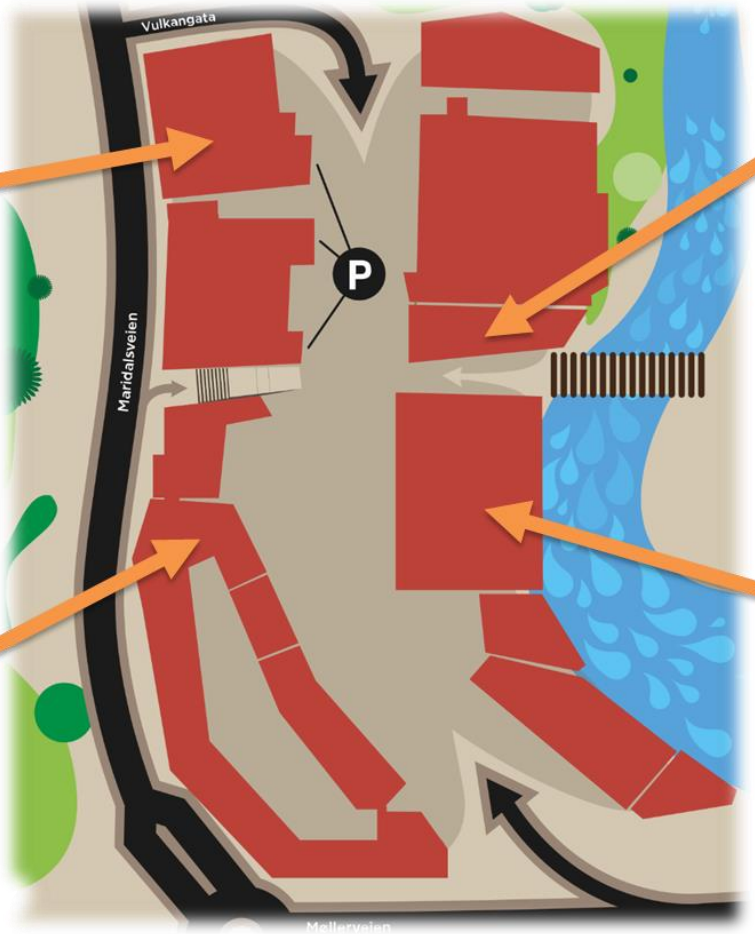
The Energy Supply System

- Covers product cooling, space cooling, space heating and DHW preheating
- District heating used for DHW temperature lift and space heating backup
- Main components
  - Heat pumps
  - Water tanks for short term storage/buffering
  - Boreholes for long term thermal storage
  - Solar collectors

The Energy Supply System

Heat pump
48 boreholes
Water tanks

Heat exchange
station with
district heating
connection

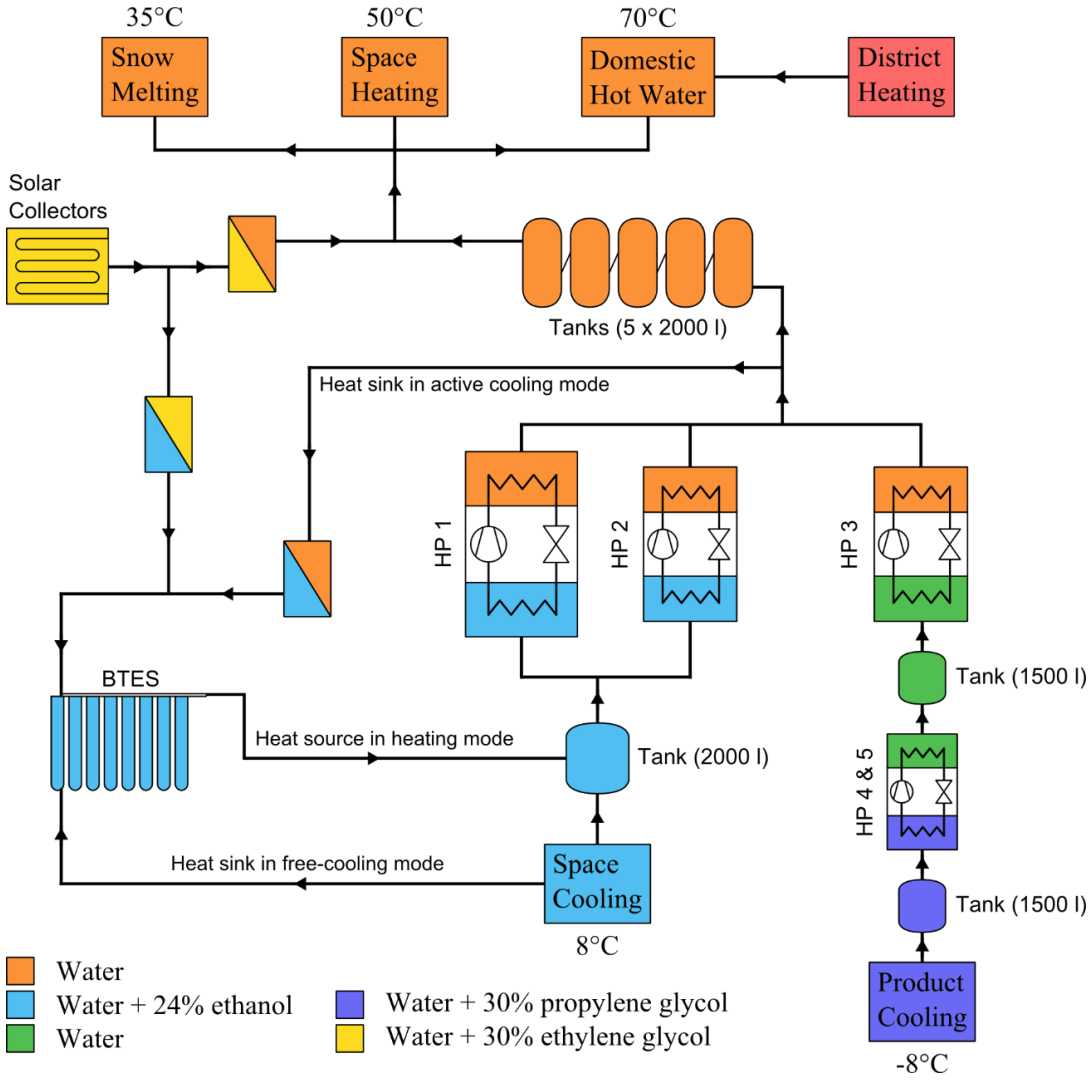


Solar
collectors

4 heat pumps
14 boreholes
Water tanks

Picture from www.vulkanoslo.no

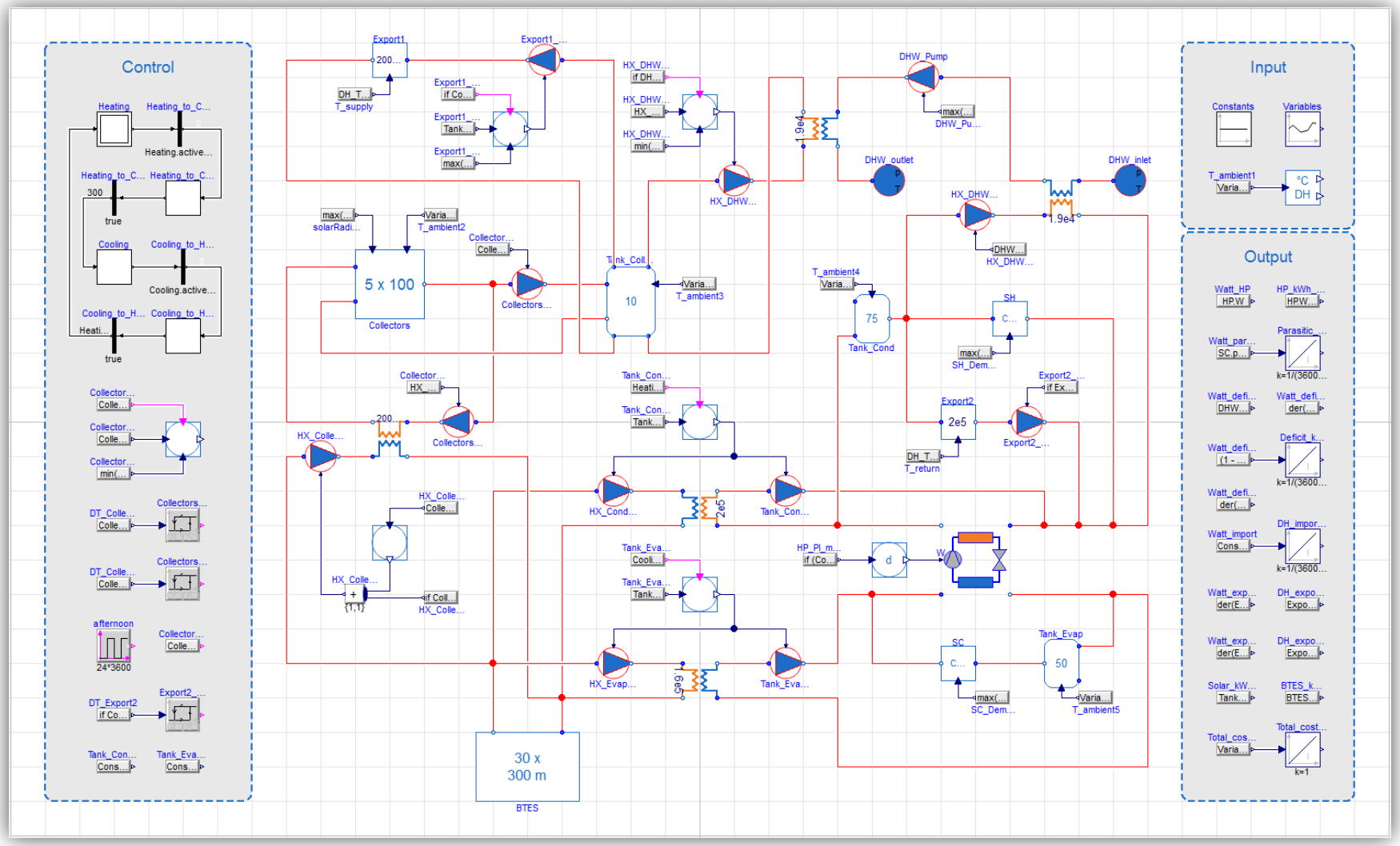
The Energy Supply System



The System Model

- Modelled with Dymola/Modelica
- Goal: Analyze system performance for one year period
- Component models built based on “Thermal” library
- Inputs
  - Measured demand data
  - Ambient temperature and radiation
  - Variable prices for electricity and district heating

The System Model



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Research Case Study

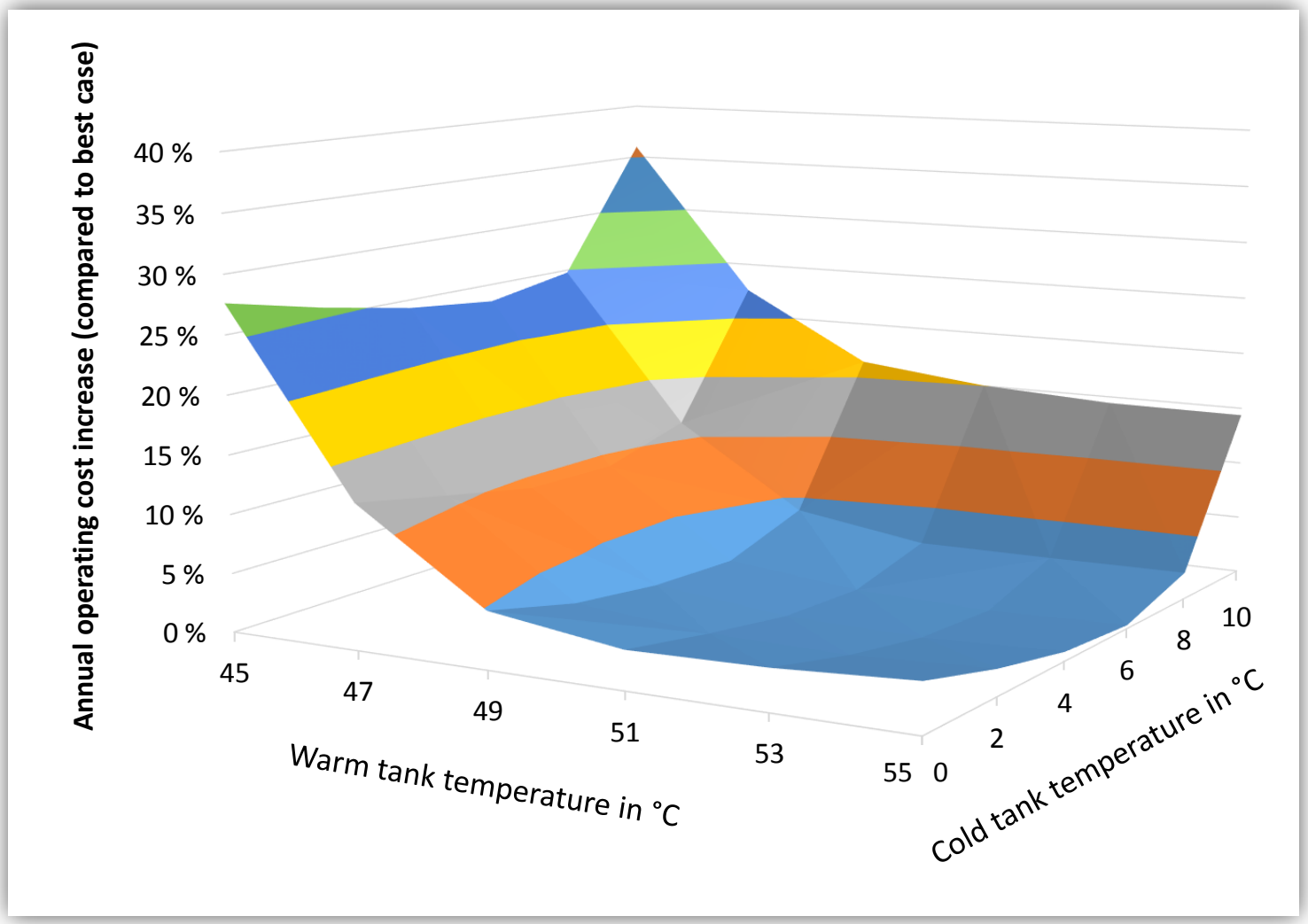
- Improve system design
  - Export to district heating grid
  - Larger solar collector area
  - Bigger water storage tanks

→ What are good component sizes and how should the system be controlled?

First step

- “Reasonable” component sizes
- Parameter study with buffer tank temperatures
  - Warm side: 45…55°C
  - Cold side: 0...10°C
- Effect on heat pump power, parasitic power, thermal losses, district heating import/export, etc.

Results


Annual operating cost increase (compared to best case)
40 %
35 %
30 %
25 %
20 %
15 %
10 %
5 %
0 %
45
47
49
51
53
55
Warm tank temperature in °C
0
2
4
6
8
10
Cold tank temperature in °C

Future Work

- Different tank temperatures for each operation mode
- Use tanks for peak shaving
  - Variable temperatures based on demands and prices
- Optimization of component sizes with “smart” control
  - “Flat” optimum important

Questions?

Thank you for your attention!

daniel.rohde@ntnu.no

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