Cool-Data

Innovation Fund Denmark

DATA CENTERS AND INTEGRATED ENERGY SYSTEMS: ON-SITE INTEGRATION

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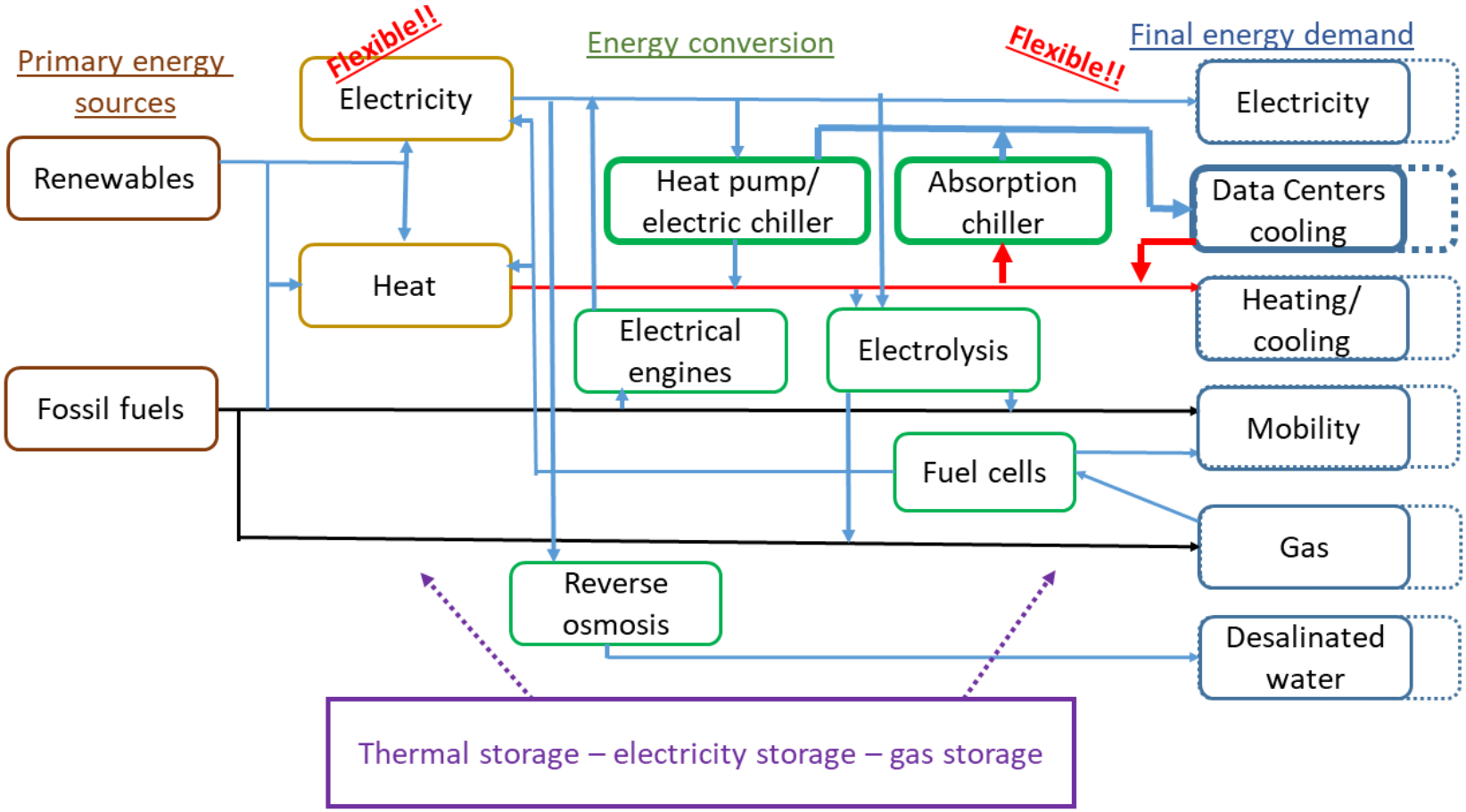
**presenter*

DTU

Outline

- Intro:
  - data centers in the energy system
- About the project: Cool-Data
- Optimization method and case study description
- Future work
- Take-home messages

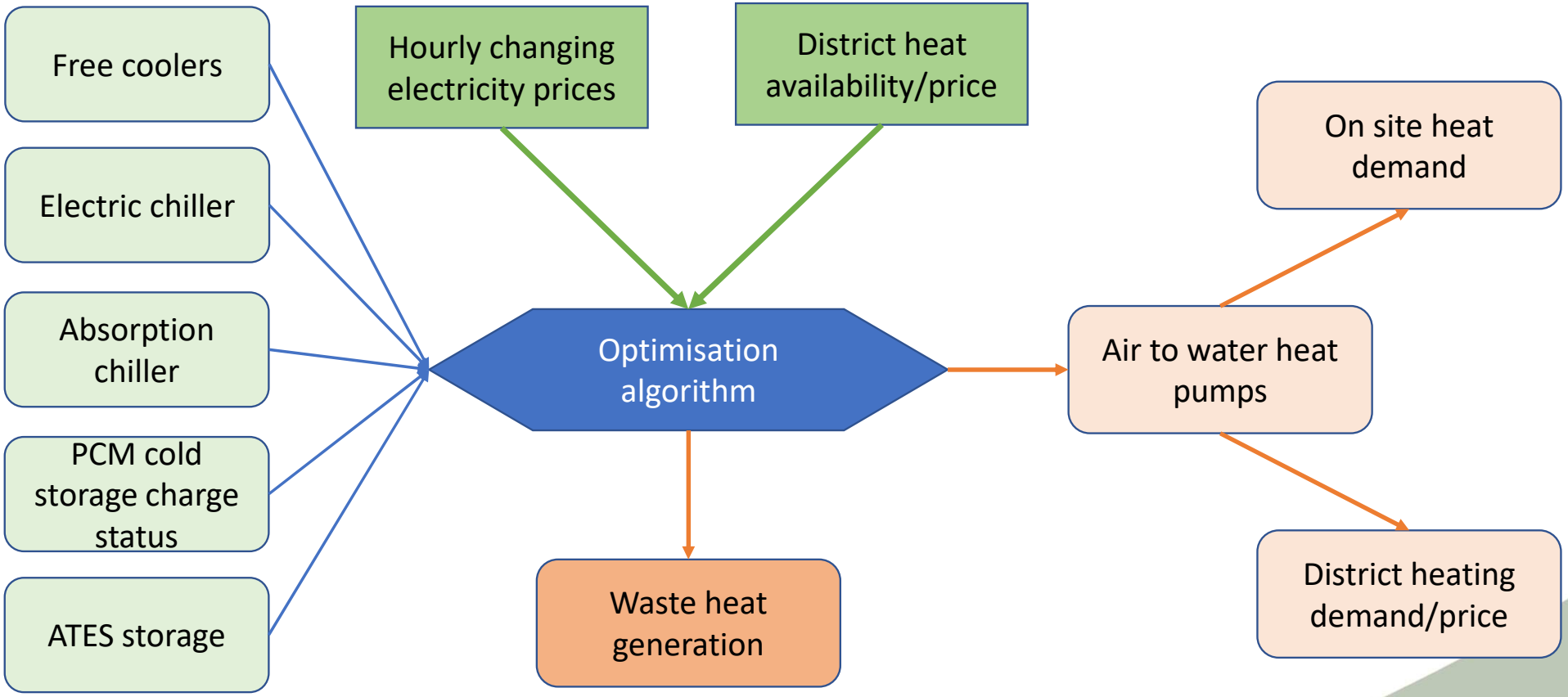
Data centers in energy systems – no silo thinking



Cool-data project

- 2.5 MEUR Danish national project
- Focusing on small and medium-sized data centres
- Integrating data centres to energy systems
- https://cool-data.dtu.dk/
  https://www.linkedin.com/company/cool-data

What needs to be taken into account?

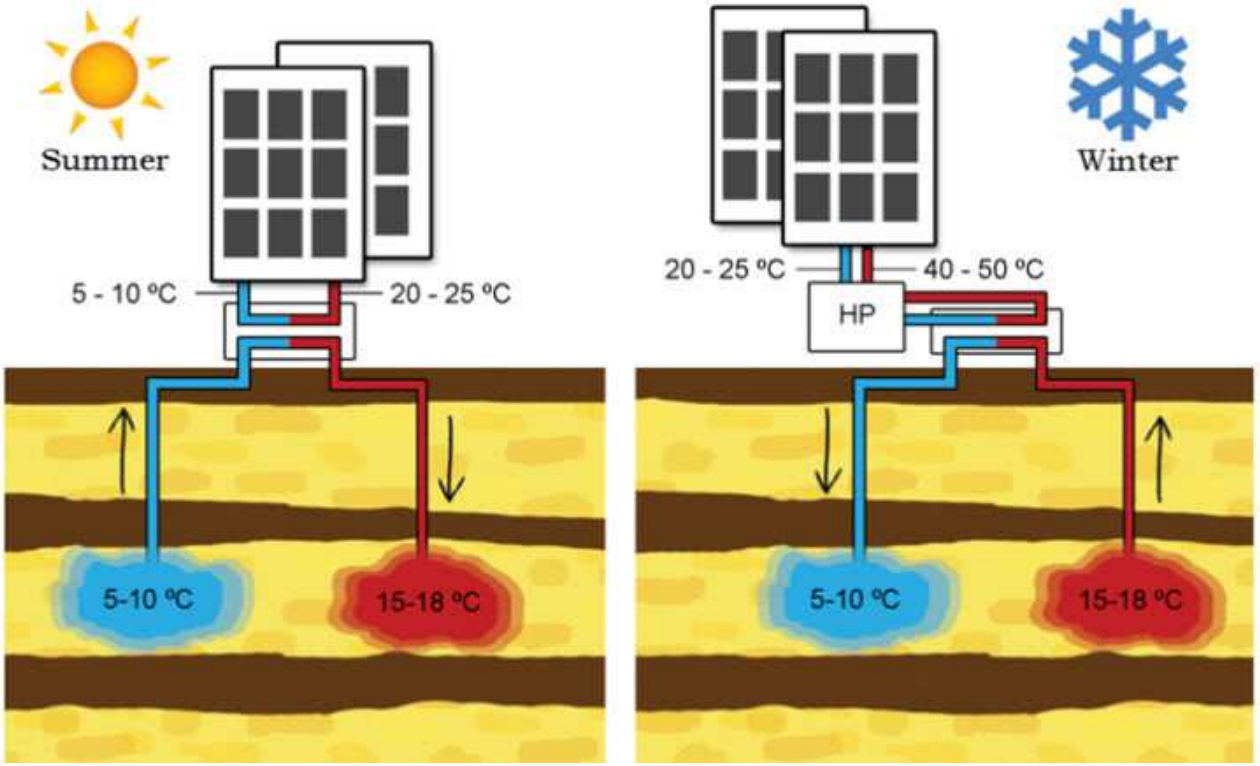


+ Capacity expansion / investments!

Naviair

- A complex system
- 4 chillers, 4 free coolers, **2 ATES (aquifer thermal energy storage) systems**
- Approx. 2 GWh of yearly cooling demand
- 2.7 GWh of yearly heating demand
- PV on site
- Average cooling demand: 228 kW
- Waste heat currently rejected to the environment

ATES system



- Source: deltares.nl

Optimization approach: MILP

- Goal: to minimize the total energy costs
  - Both heating and cooling

- Constraints:
  - to meet hourly energy demand
  - To balance the usage of the ATES storage

- Decision variable:
  - Optimal investment in heat pumps in blocks 4 and 5

The system

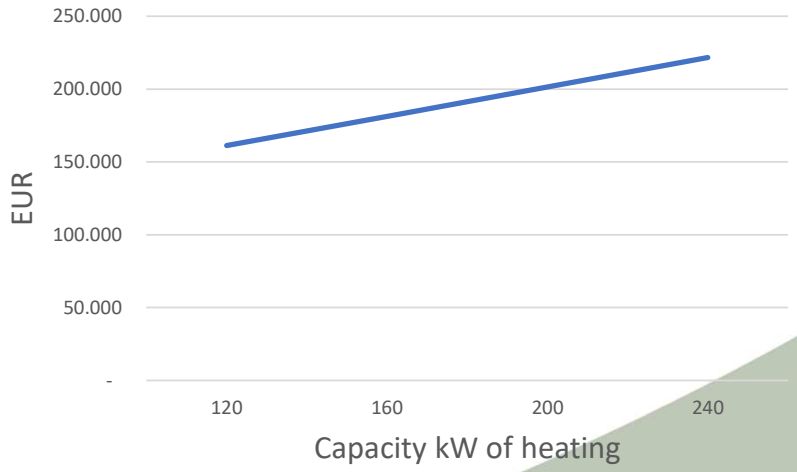
- 2 x 230 kW free coolers
- 2 x 250 kW electric chillers
- 230 kW ATES system

Block 4 and block 5

- District heating (gas) covering the heat demand

Optimization of the capacity in a heat pump:

	Option 1	Option 2	Option 3	Option 4
capacity (kW)	120	160	200	240
Heat pump cost	500,000	650,000	800,000	950,000
Installation cost (fixed)	700,000	700,000	700,000	700,000
Total (DKK)	1,200,000	1,350,000	1,500,000	1,650,000
DKK/kW	10,001	8,439	7,501	6,876
Heat pump CAPEX per year DKK	48,171	62,622	77,074	91,525



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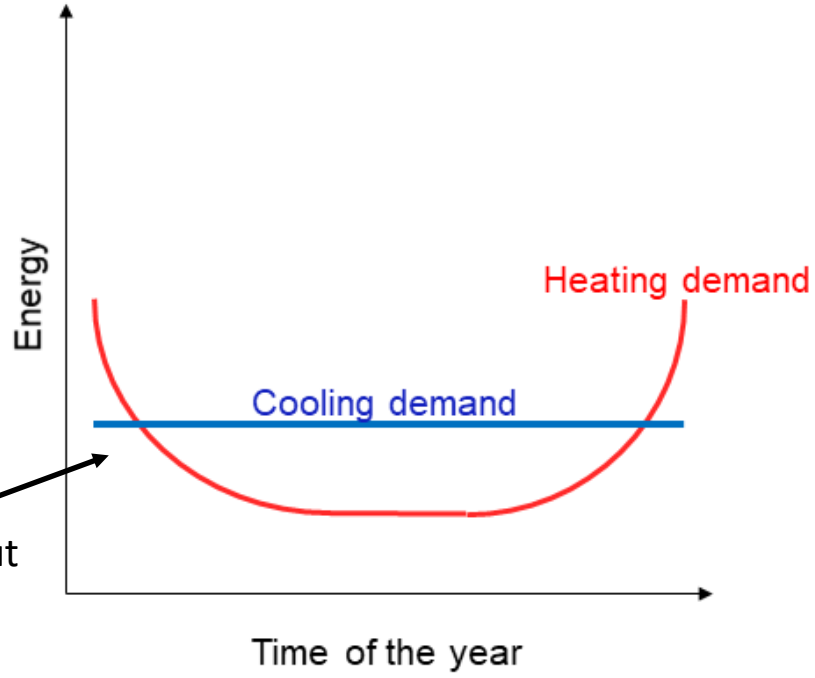
Naviair recommendation

- Coupling different energy systems on site!
- Recommended installation of 2 heat pumps: 200 and 240 kW
  - Covering 75% of the heating needs
- Payback period: 6.5 years
- NPV: 262 kEUR, IRR: 13%
- Yearly savings: 28.6 kEUR

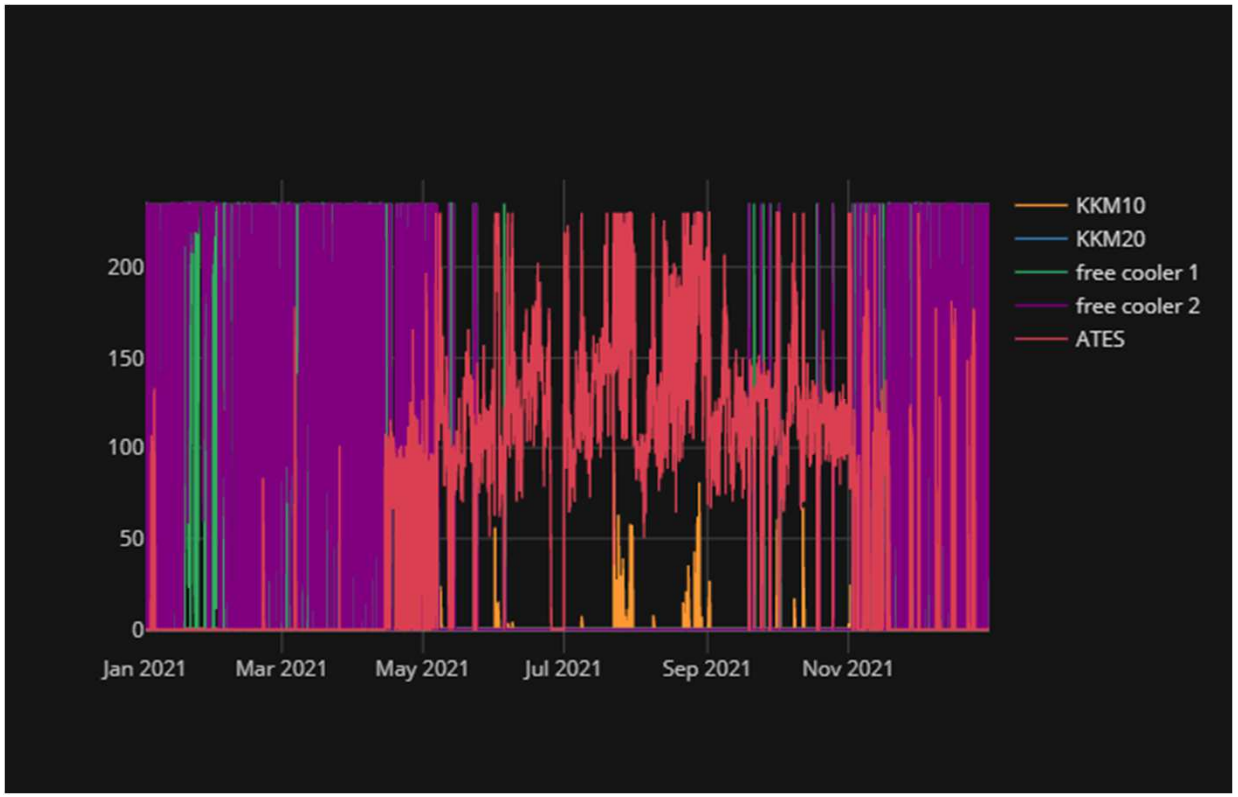
To successfully utilize ATES, heat and cooling extracted during the year need to be balanced out



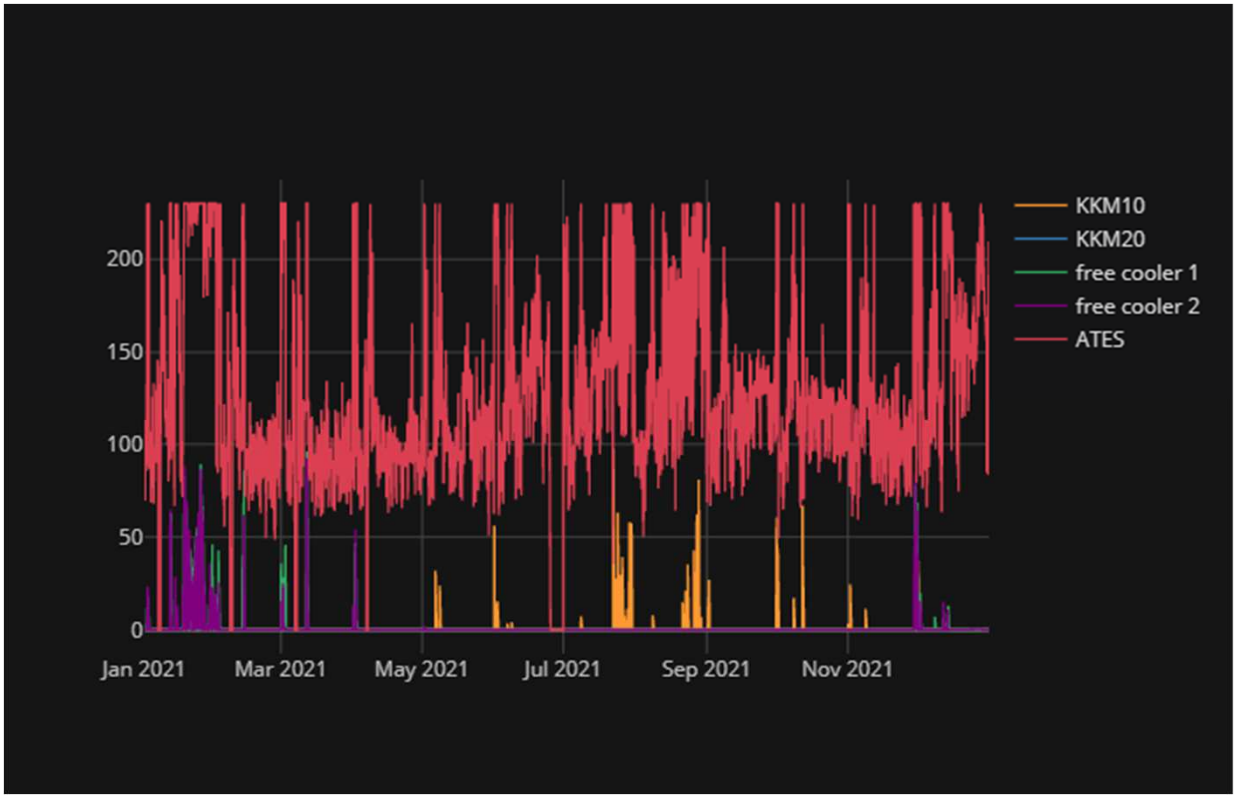
More on results

- Gas consumpion reduction of 76% (3.1 GWh to 0.75 GWh)
- CO2 emissions reduction by 50% (658 to 331 tons)
- electricity consumption: 347 to 847 MWh (+ 2.4 times)

Cooling operation – before HPs



Cooling operation – after HPs



- Heat pumps allow for larger utilization of ATES storage – yearly balance!

KPIs report is free to download

Cool-Data Innovation Fund Denmark

New performance indicators for fully integrated and decarbonized data centres

https://doi.org/10.11581/DTU:00000112

TABLE OF CONTENTS

Future work

- Stochastic optimization
  - Uncertainty from different possible climate scenarios: heating demand and PV generation
  - Electricity prices
- Developing optimal controllers
- Searching for advanced cooling strategies based on reinforcement learning

Take home messages

- Holistic integration of data centers to energy systems
- If integration of heating and cooling load is possible: very efficient solutions possible
- Waste heat should be reused first on site and only then in district heating

COOL-DATA DEVELOPS, ASSESSES AND IMPLEMENTS AN AI-BASED MODULAR, FLEXIBLE, SECURE AND RELIABLE INTEGRATED COOLING ENERGY SYSTEM FOR DATA CENTRES.

1) THE PROJECT RECEIVED FUNDING FROM INNOVATION FUND DENMARK, COOL-DATA: FLEXIBLE COOLING OF DATA CENTERS

2) THE WORK WAS ALSO FUNDED BY THE IEA TS4: DIGITALIZATION OF DISTRICT HEATING PROJECT, FUNDED BY THE EUDP IN DENMARK

https://cool-data.dtu.dk/

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