Rethinking Cooling: Energy Storage for Air-Cooled Data Centers

Oslo Datacenter Forum 2026

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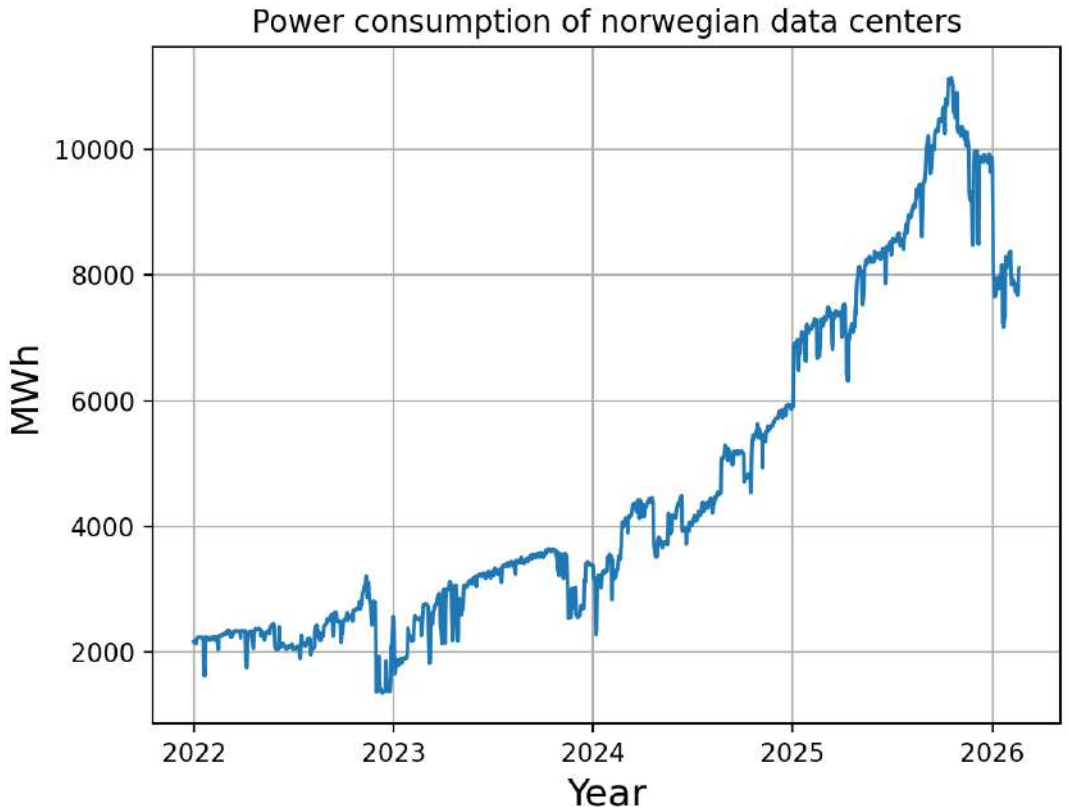
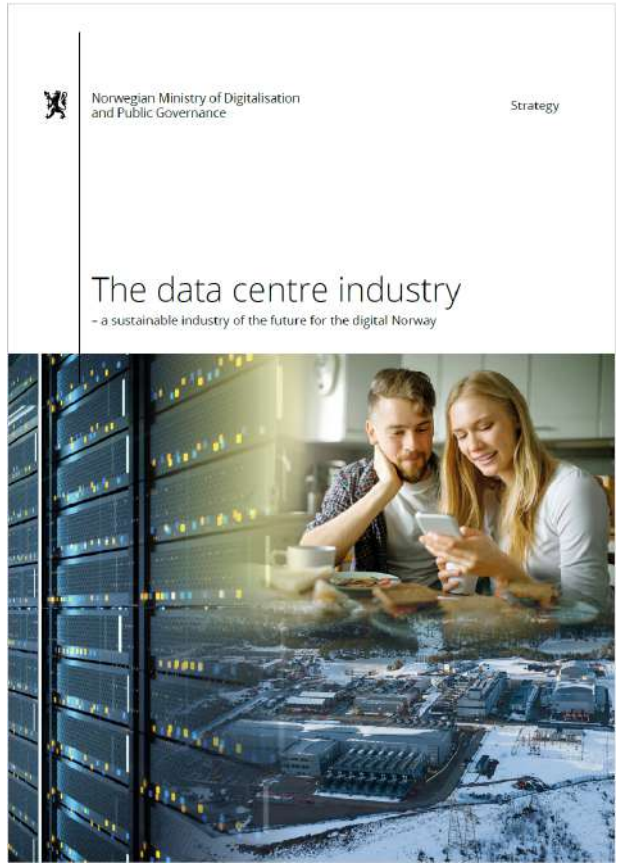
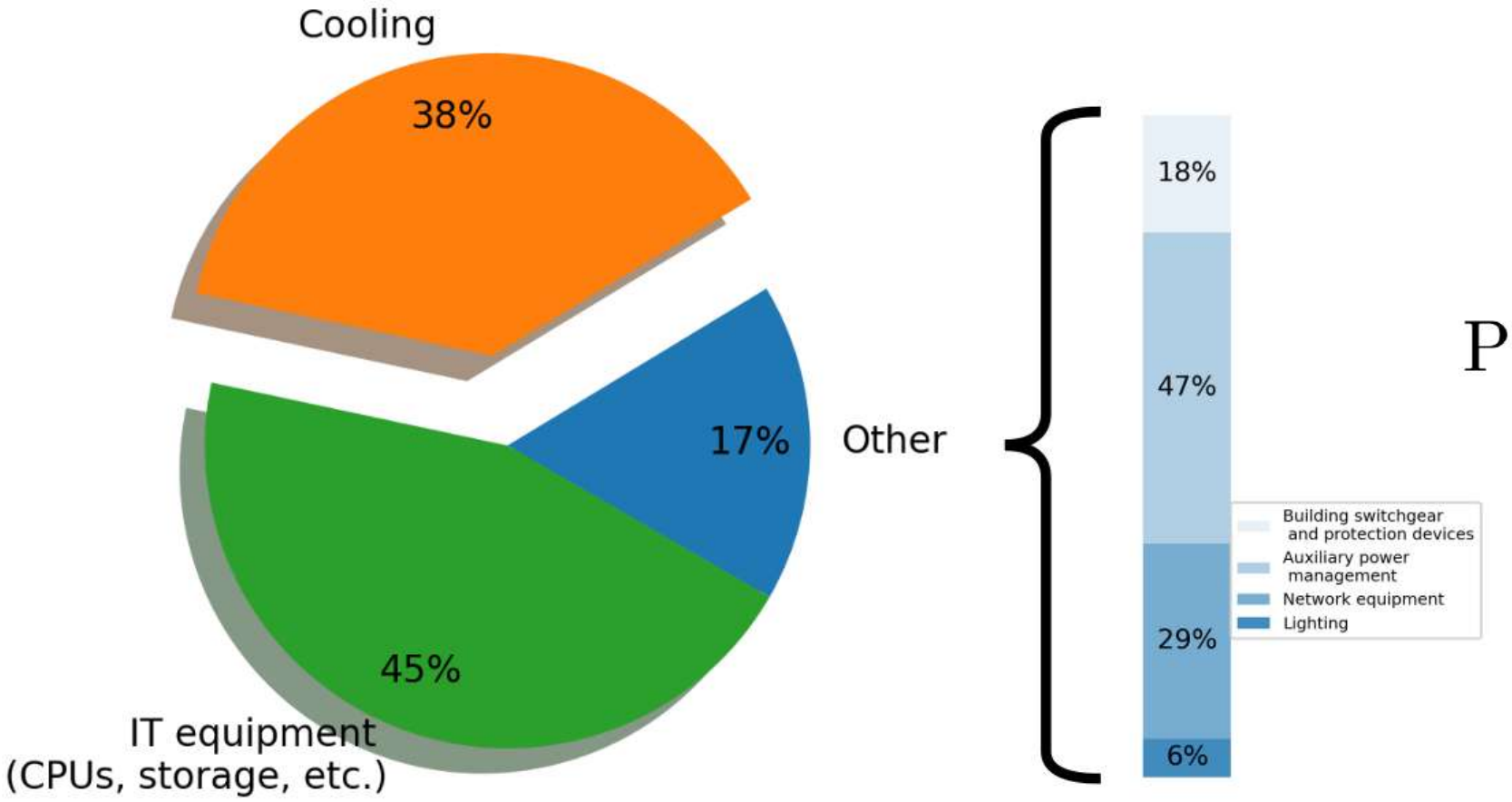
Motivation: pursuing energy efficiency in data centers

- ✓ Ambitious goals from the norwegian government
- ✓ “..implementation plan for beneficial energy measures..”





Data center power consumption



$$\mathrm{PUE} = \frac{\text{Total facility demand}}{\text{IT equipment demand}}$$

Cooling systems

- ✓ Immersion cooling is gaining popularity – future trends
- ✓ Water-to-air: efficient but requires large heat sinks
- ✓ Most data centres are air cooled
  - — “Free cooling” if sufficiently cold

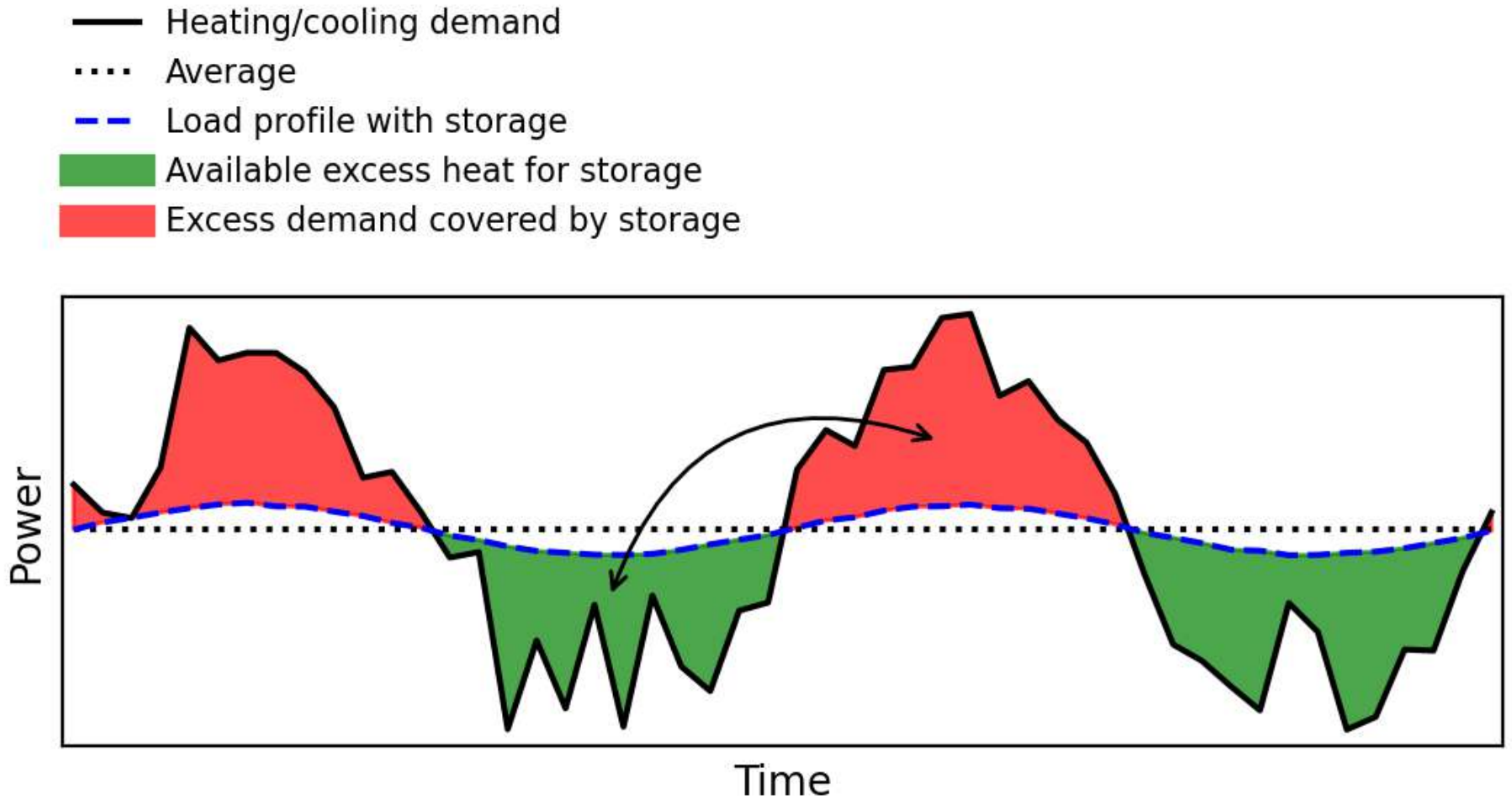
Air cooling – refrigeration heat pumps

- ✓ Fans
- ✓ Compressors
- ✓ Heat exchangers

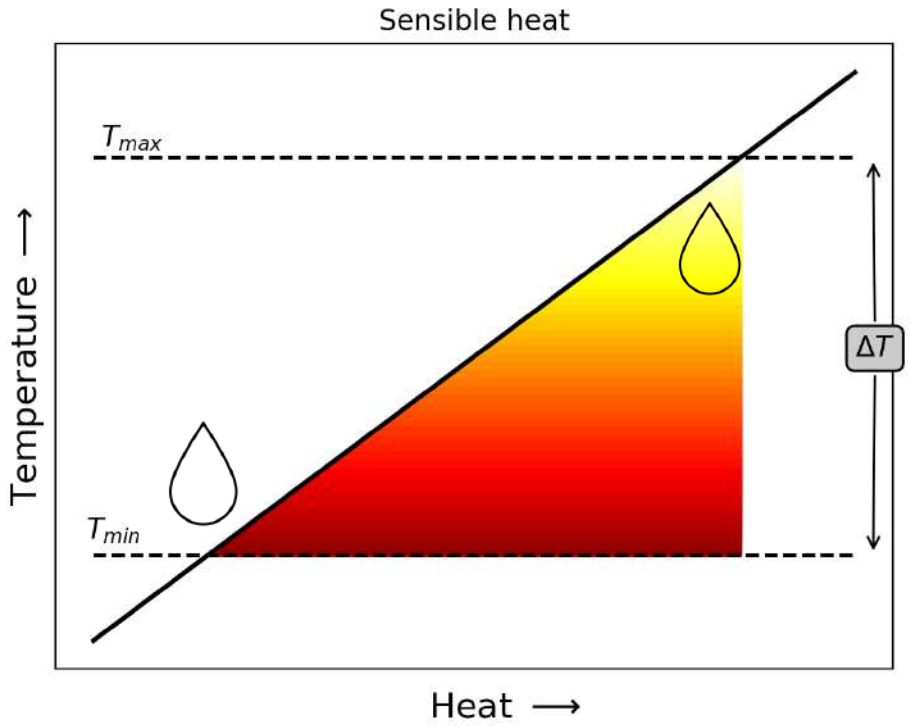
Factors contributing to their efficiencies:

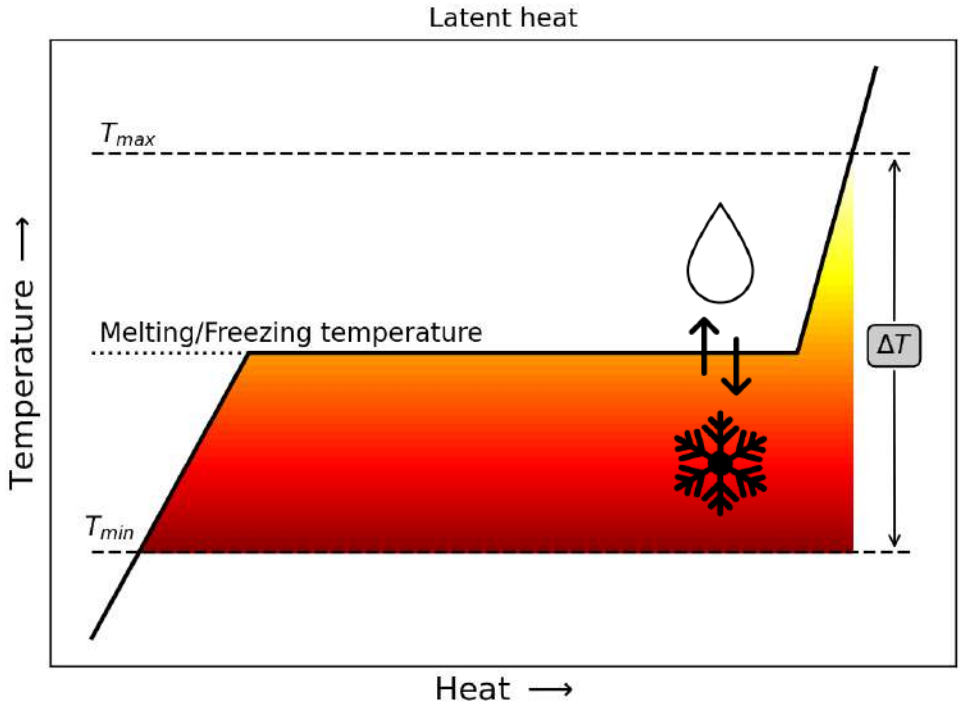
- Temperature difference
- Capacity
- Stability

Thermal energy storage (TES) – buffering excess



Thermal energy storage – main principles





Latent heat thermal storages

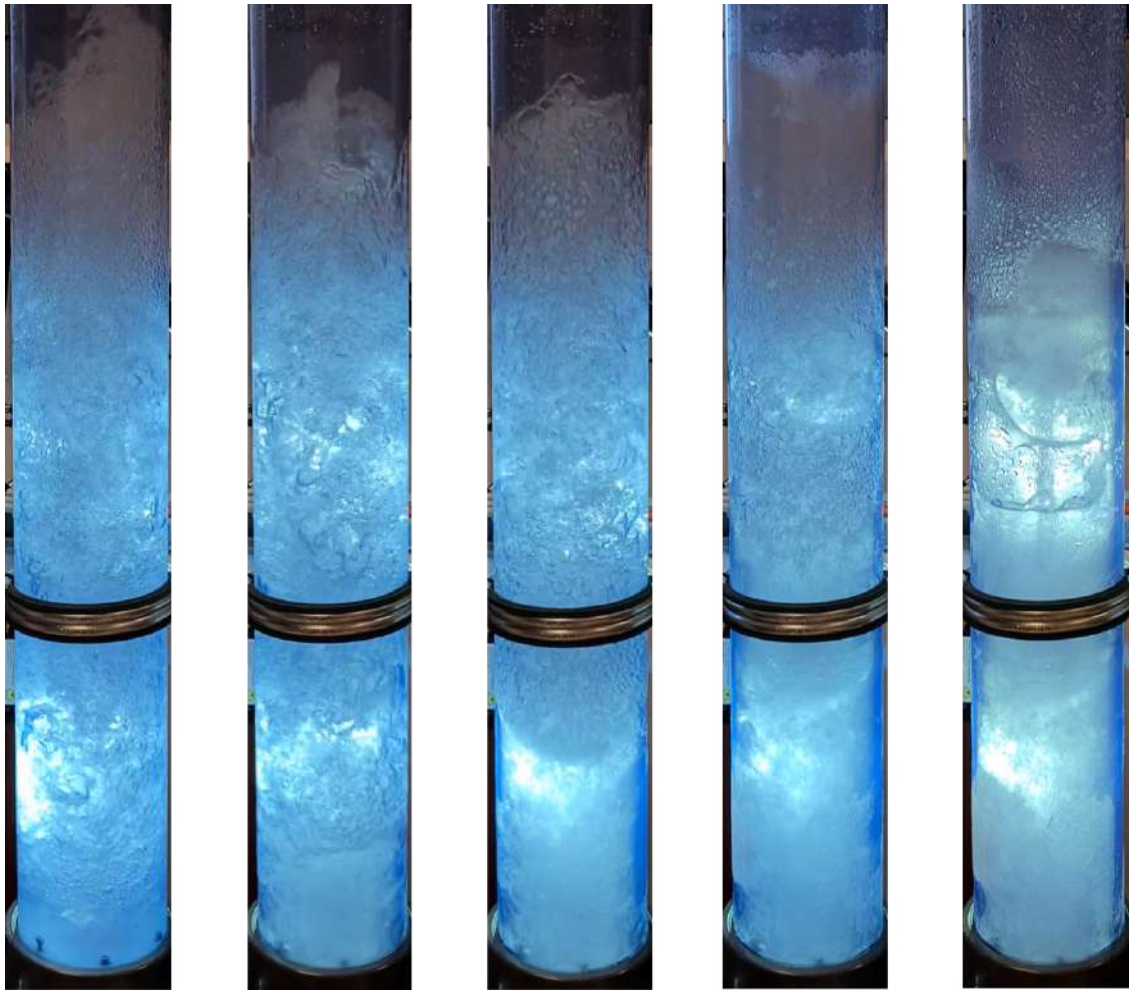
Benefits:

- ✓ Large storage capacity
- ✓ Constant temperature

Disadvantages:

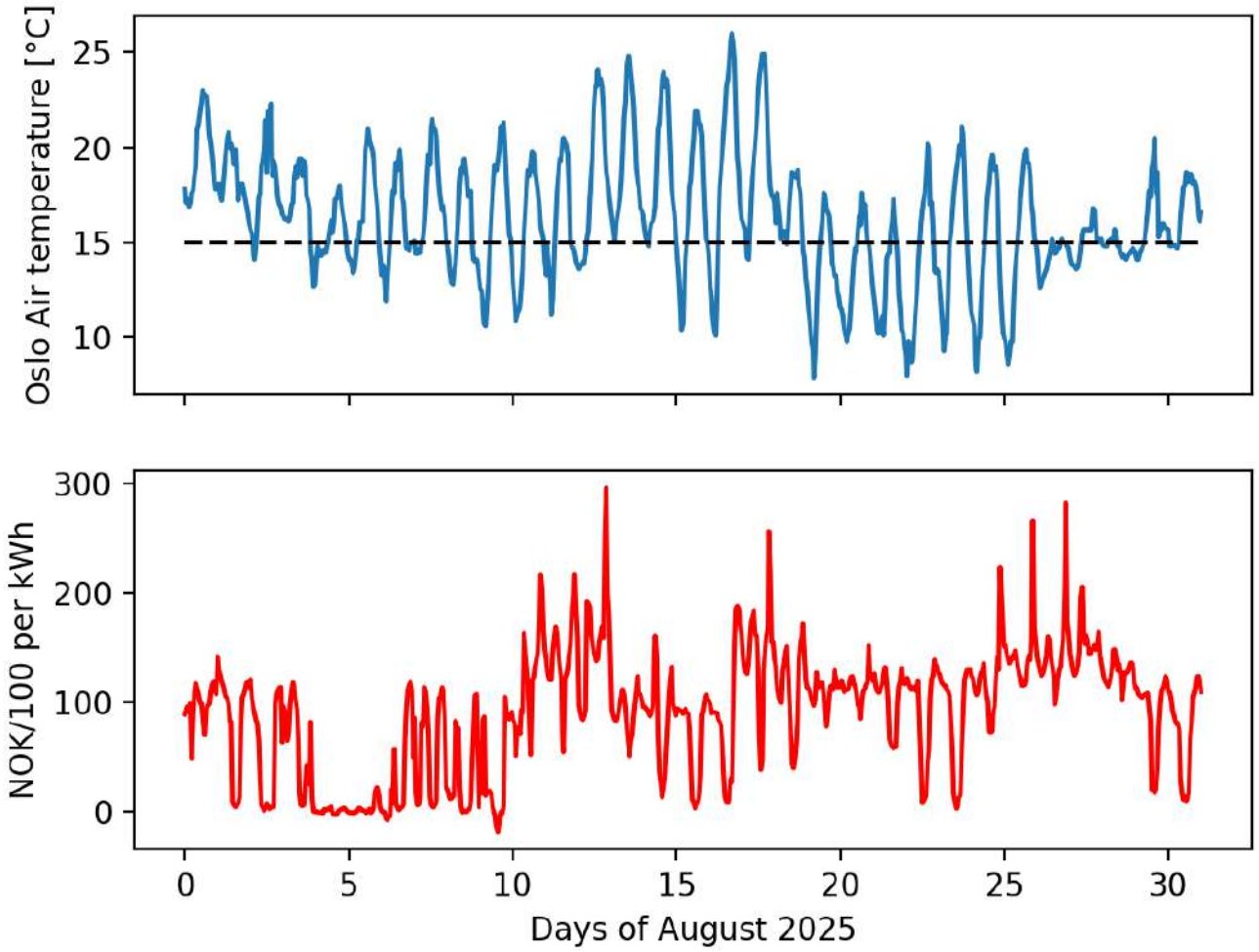
- ✓ Low power output
- ✓ Expensive heat exchangers
- ✓ Not suitable for large gas flows

…until now



Example case

- ✓ A data center located in Oslo
- ✓ Air-cooled
- ✓ A cooling demand of 10MW at 15 degree celcius
- ✓ Uses «free cooling» when outside temperatures are below 15 degree celcius

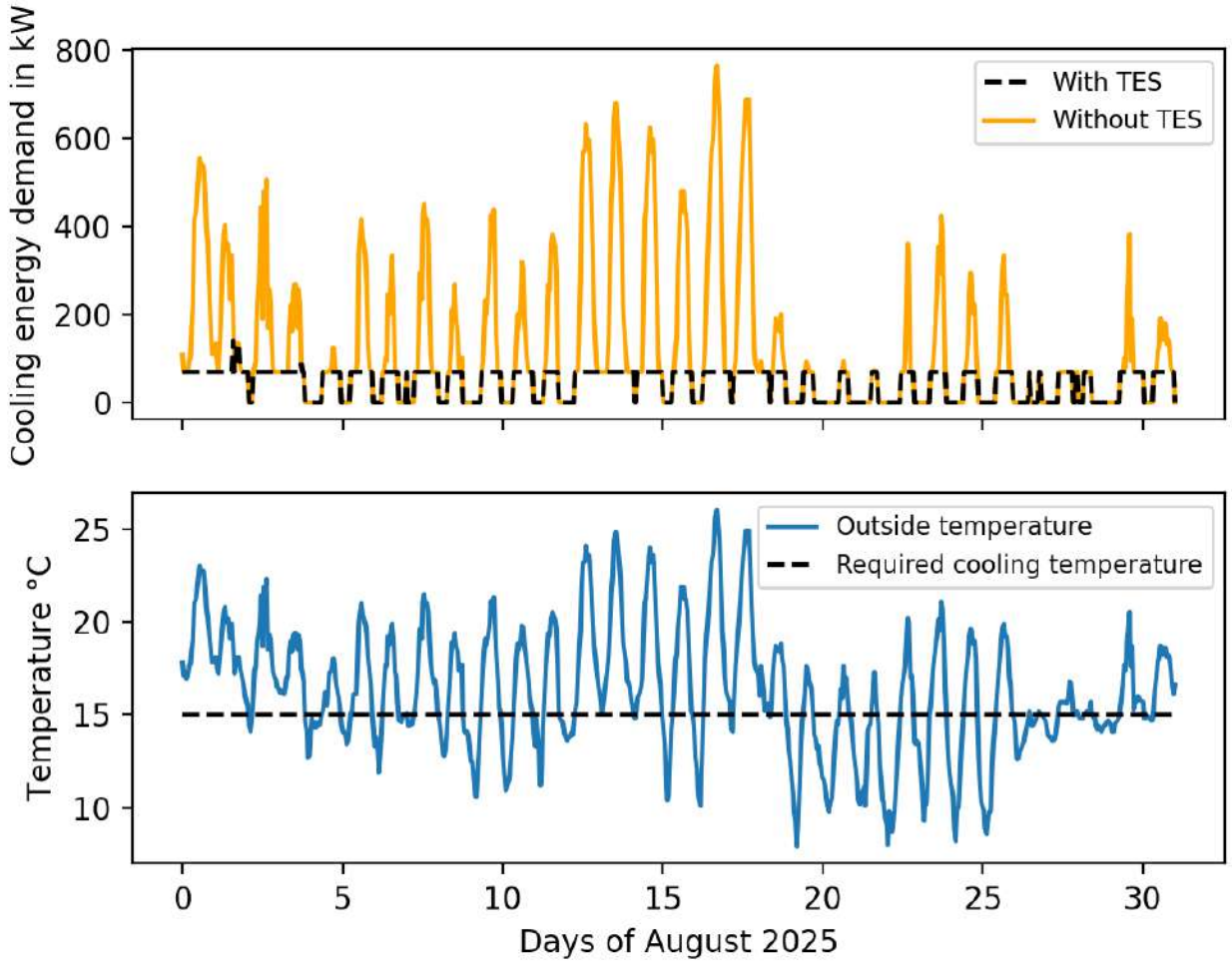


Case I: Energy efficiency

- ✓ Use TES to minimize power consumption
- ✓ More «bang for the buck» cooling power when outside temperatures are low
- ✓ Run cooling system at lowest possible power

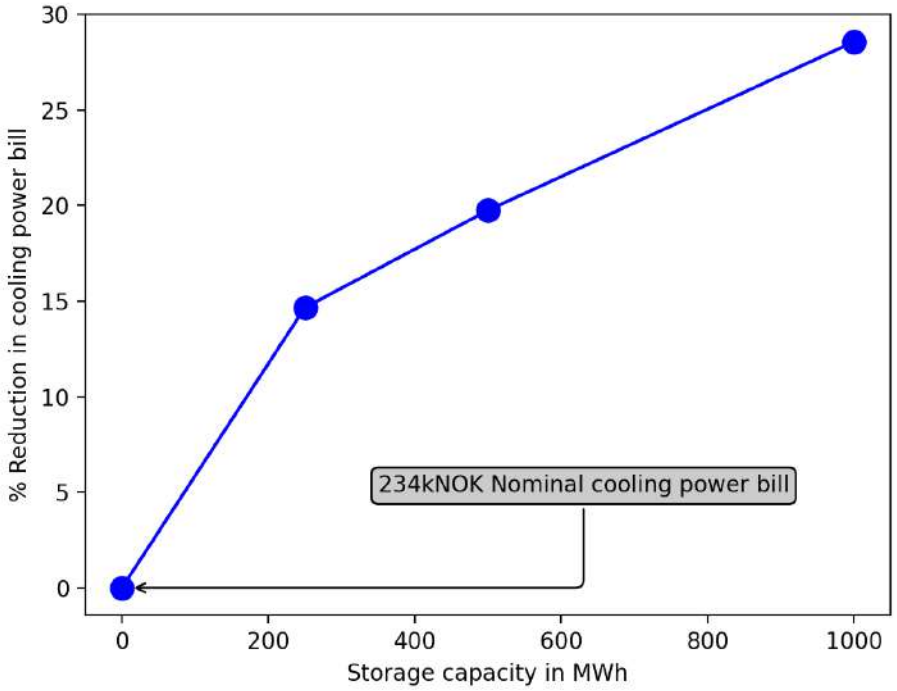
With TES:

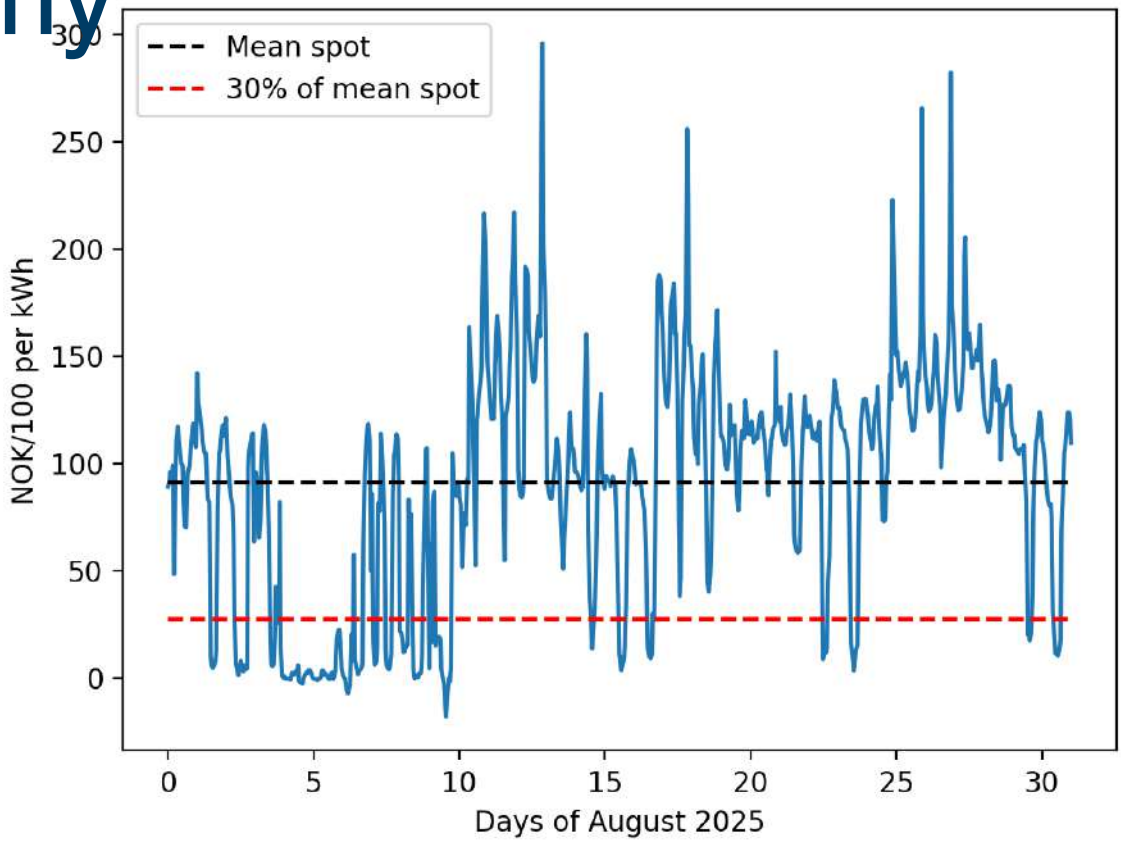
- ❖ **Cooling Power demand reduced by 67%**
- ❖ **Peak power reduced by 81%**
- ❖ **PUE reduced by 25%**



Example case II: Economy

- ✓ Use TES to minimize the power bill
- ✓ Exploit fluctuations in spotprice
- ✓ Maximise cooling power when prices are low – buffer the excess
- ✓ Use storage to avoid price peaks





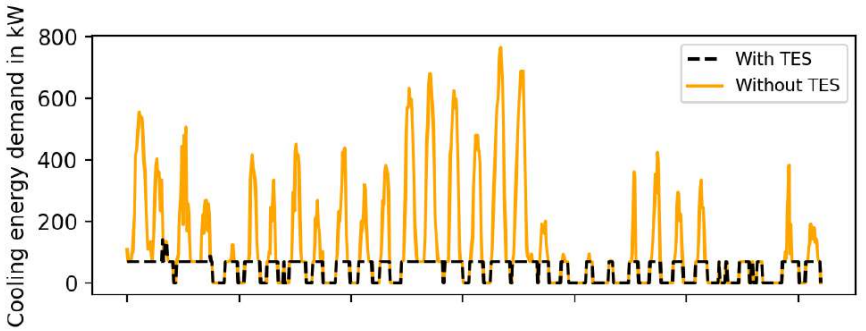
- ✓ Considerable savings possible
- ✓ Increases with storage capacity

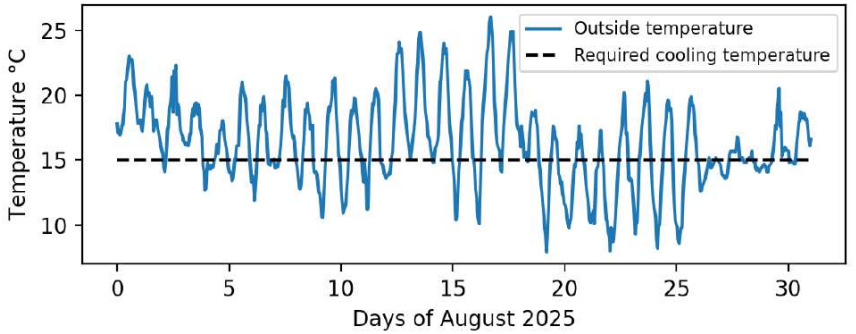
In conclusion

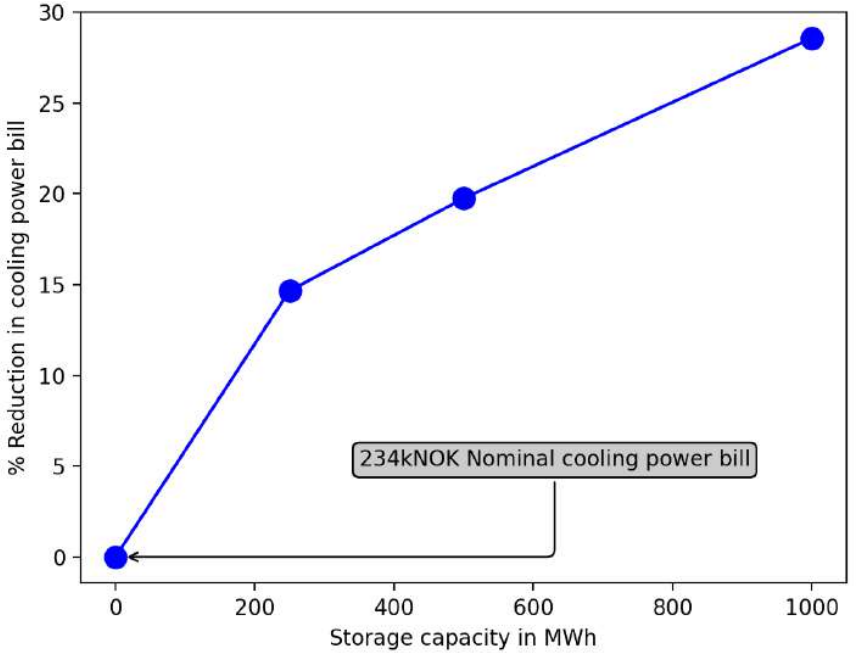
- ✓ **Optimal system operation – a combination of the two examples**

Added benefits:

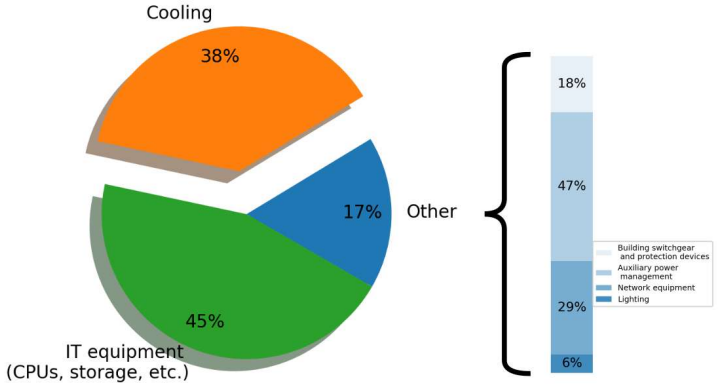
- ✓ Noise reduction
- ✓ Reduction of refrigeration unit CAPEX
- ✓ Flexibility and robustness



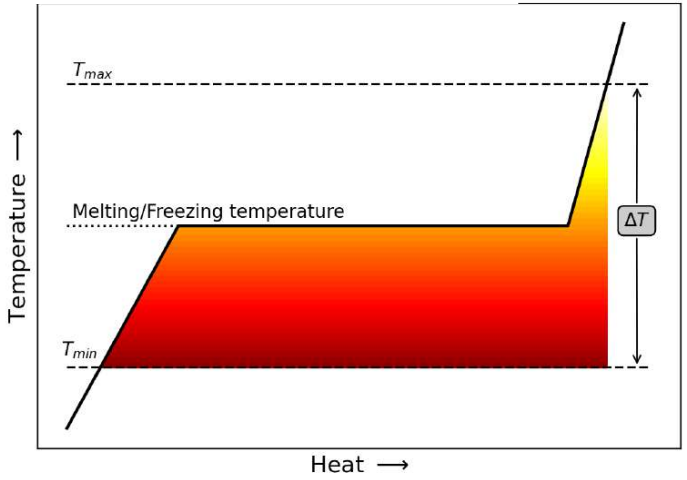


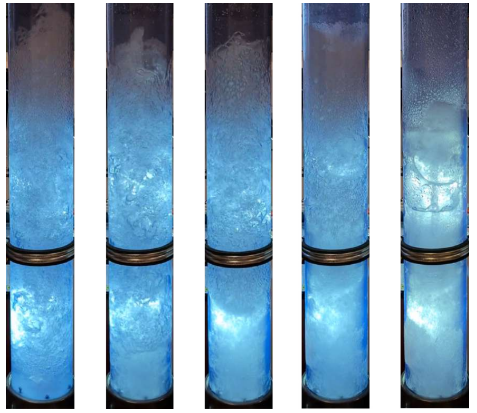


Summary and key takaway



- ✓ Cooling duties constitute large part of energy demand in data centres
- ✓ Thermal energy storage is key to achieve energy efficiency
- ✓ SINTEFs proof of concept unlocks the potential of latent heat storage:
  - ❖ Reduce consumption
  - ❖ Scale down equipment
  - ❖ Improve PUE





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