OCTOBER 02
COPENHAGEN 2025

Research Lessons in Thermal Energy Storage: How research turns infrastructure into innovation

Jorge Salgado Beceiro

Research Manager
SINTEF Energy Research

SINTEF | 75 år

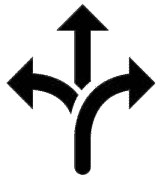
DATACENTER FORUM

Why is Energy the Bottleneck?

- AI & Energy Crunch → Growth limited by power.

- Grid Dependence → Energy markets are unpredictable.

- Flexibility = Value → Lower OPEX and unlock new revenue.



Why is Energy the Bottleneck?

- AI & Energy Crunch → Growth limited by power.

Expected demand 2026

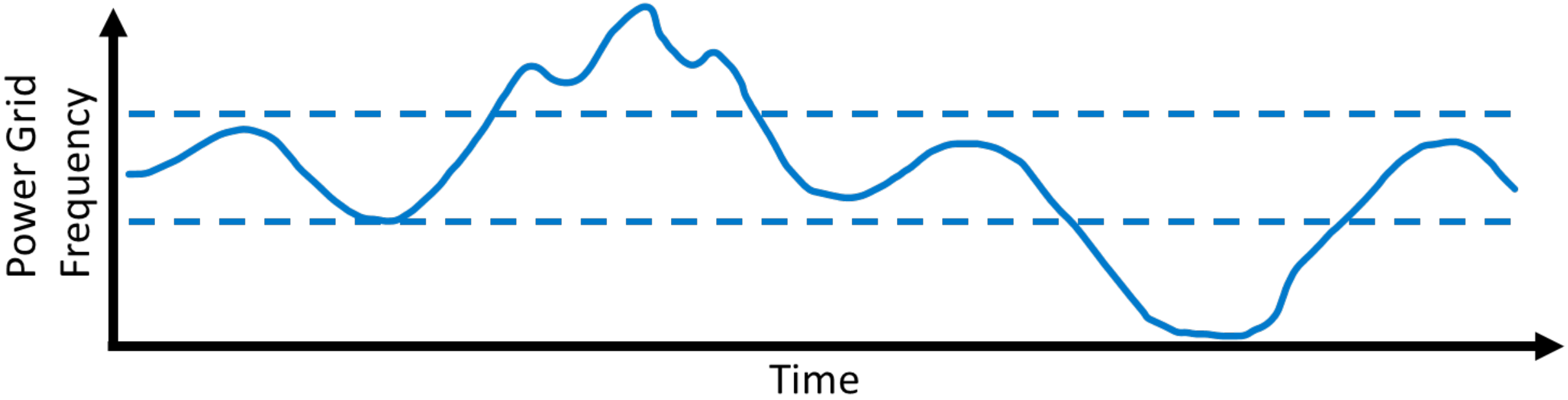
>1,000 TWh

> Japan Electricity Consumption

International Energy Agency (2025). *Electricity 2025*
International Energy Agency (2024). World Energy Outlook 2024

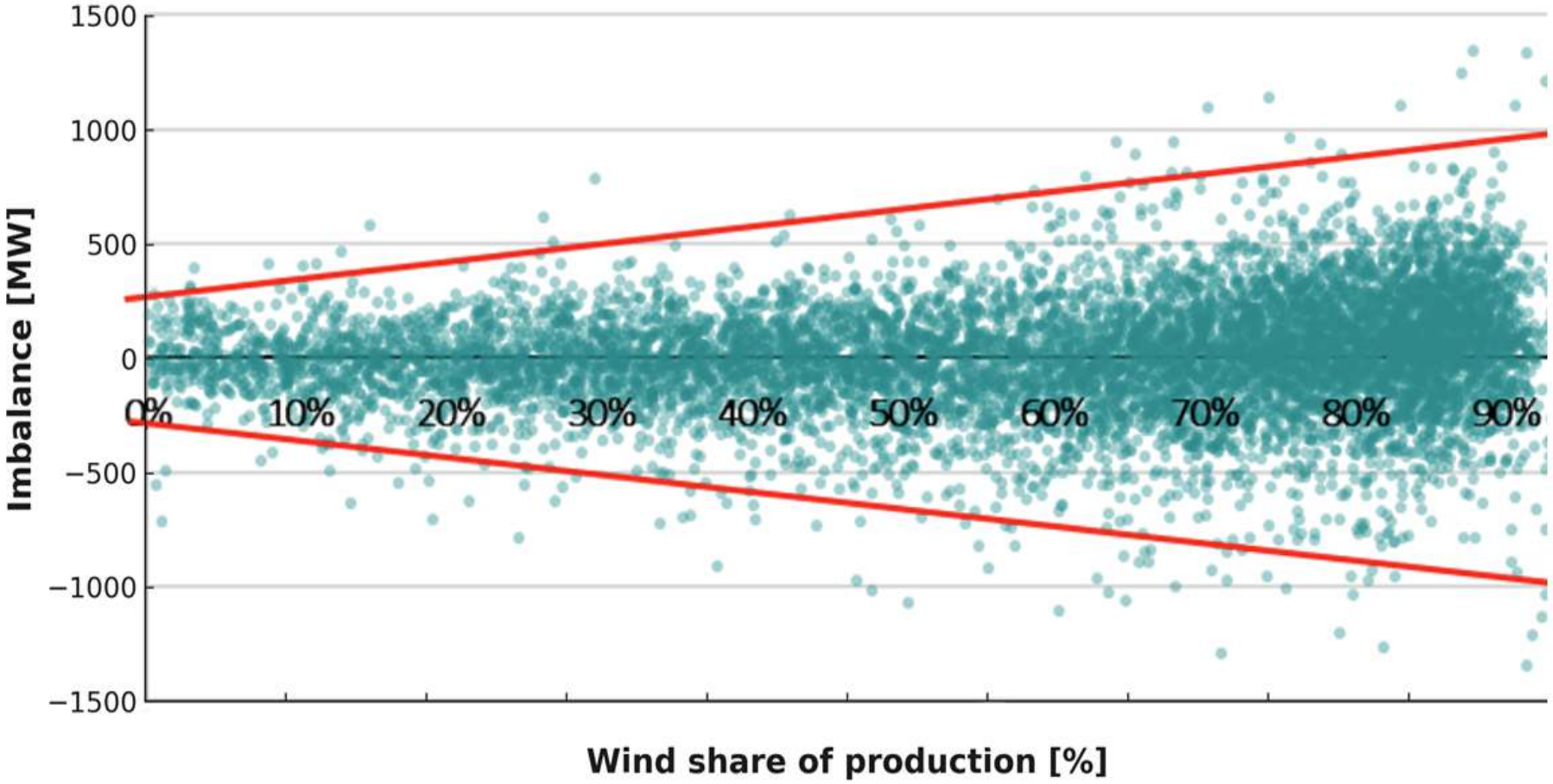
Why is Energy the Bottleneck?

- Grid Dependence → Energy markets are unpredictable.



Why is Energy the Bottleneck?

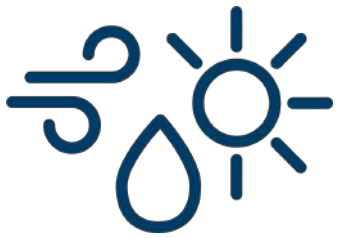
- Grid Dependence → Energy markets are unpredictable.

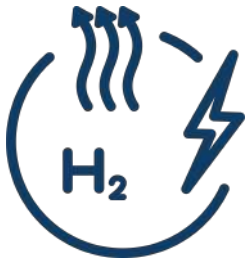


DK1

Why is Energy the Bottleneck?

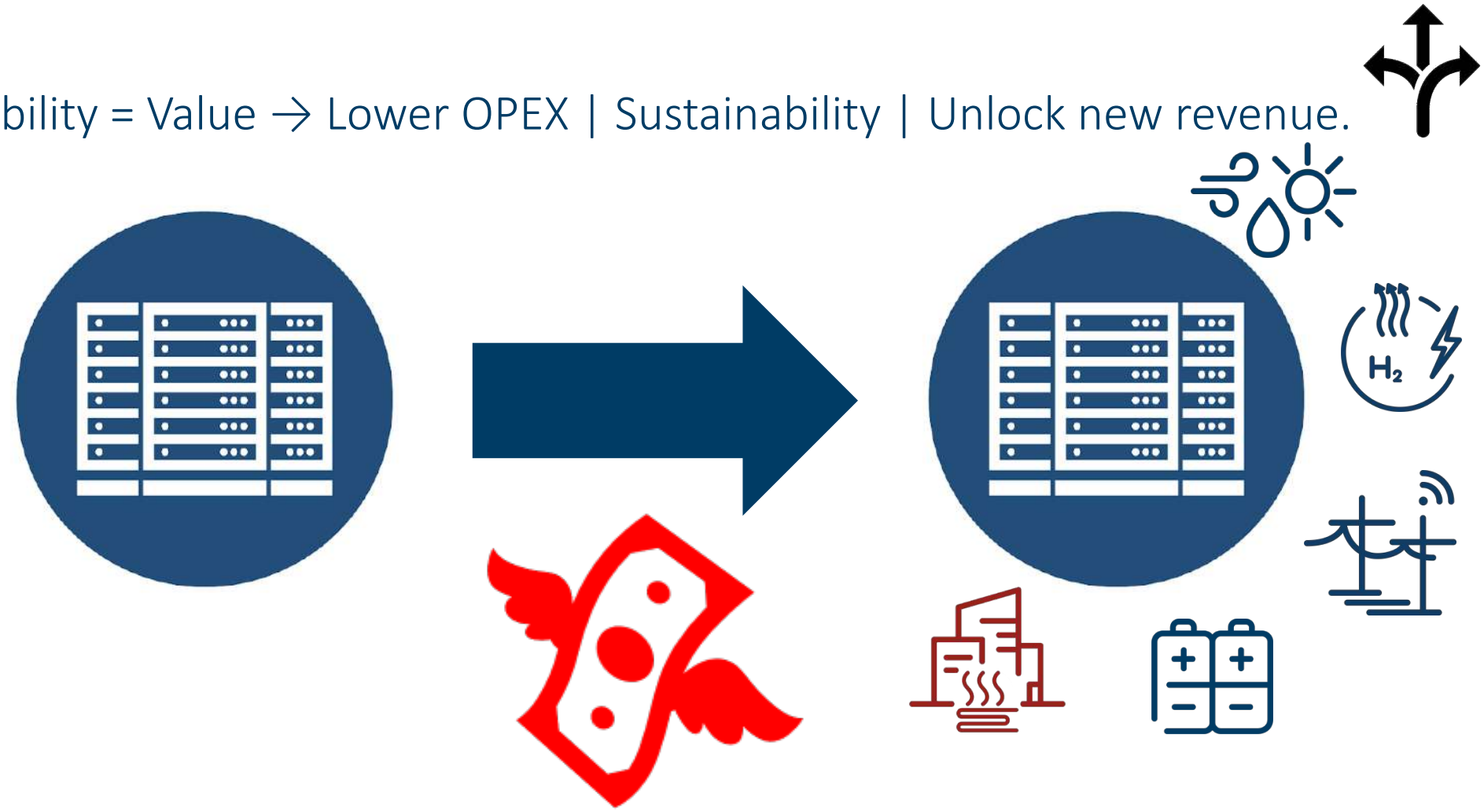
- Flexibility = Value → Lower OPEX | Sustainability | Unlock new revenue.





Why is Energy the Bottleneck?

- Flexibility = Value → Lower OPEX | Sustainability | Unlock new revenue.

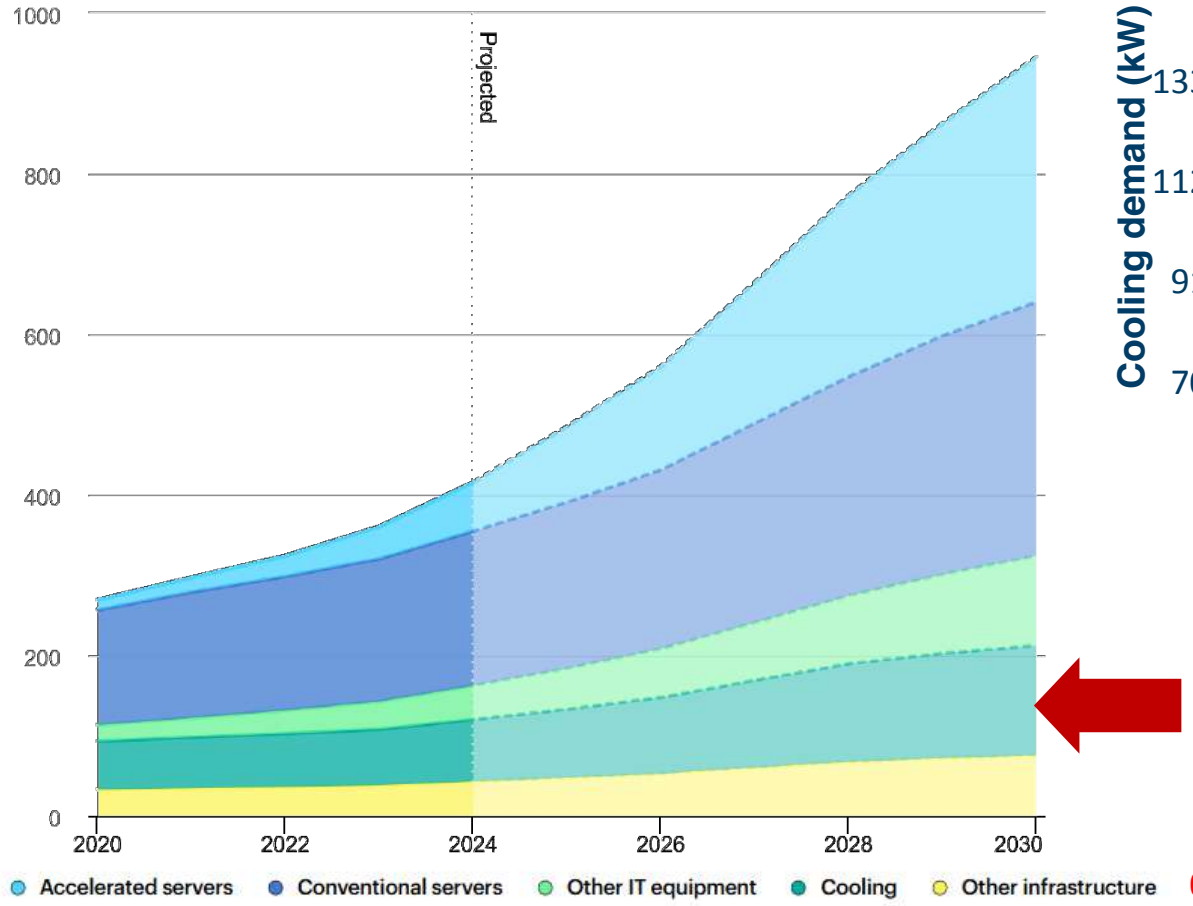


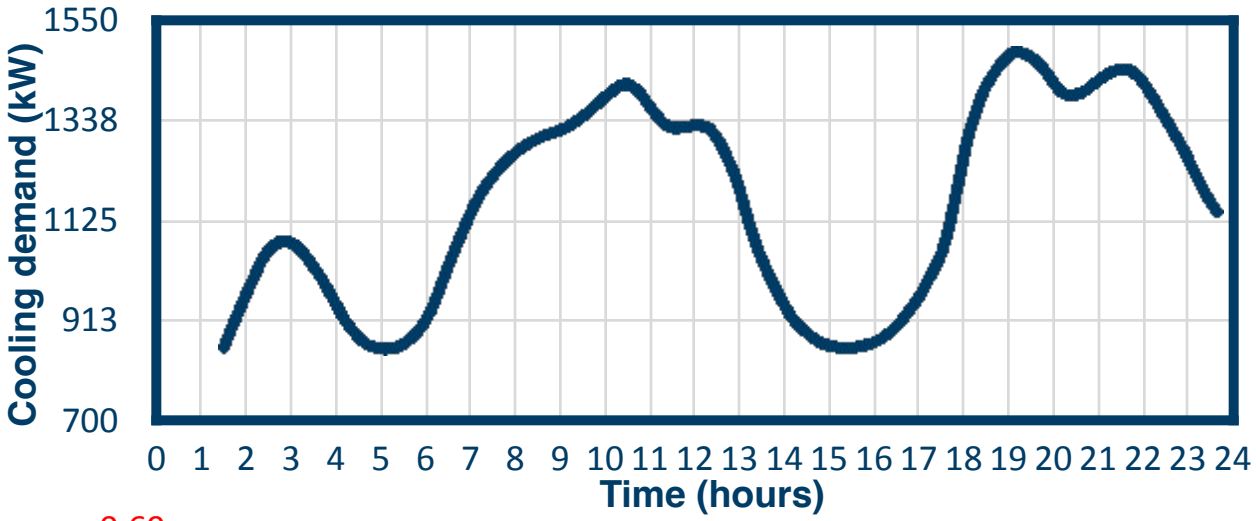
The Problem in 3 Dimensions

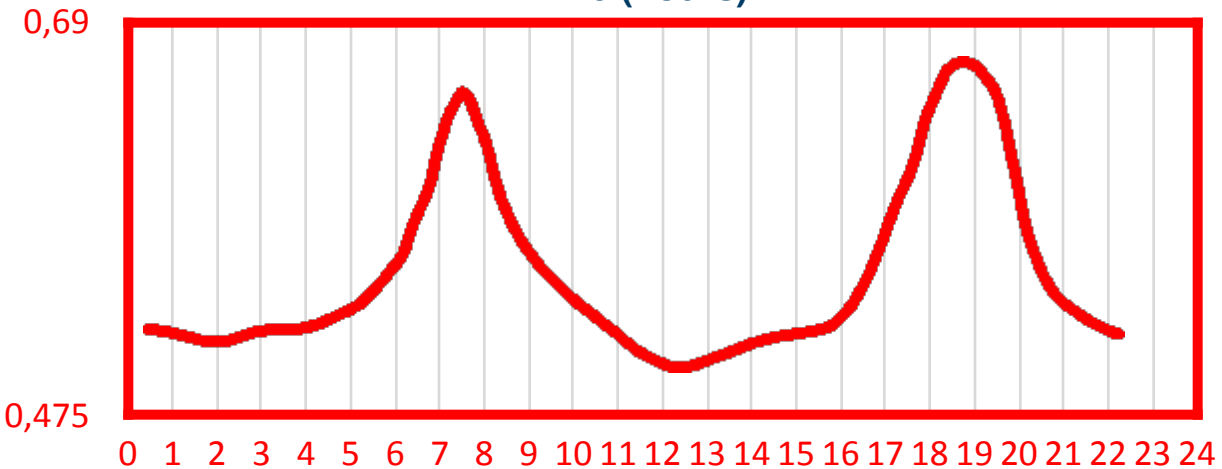
- Cooling = Big Load (up to 30% of electricity). 
- Waste Heat = Untapped Value (and Regulatory Pressure). 
- Location can be a trap: far from cities and waste heat users. 

The Problem in 3 Dimensions

- Cooling = Big Load (up to 30% of electricity on average).







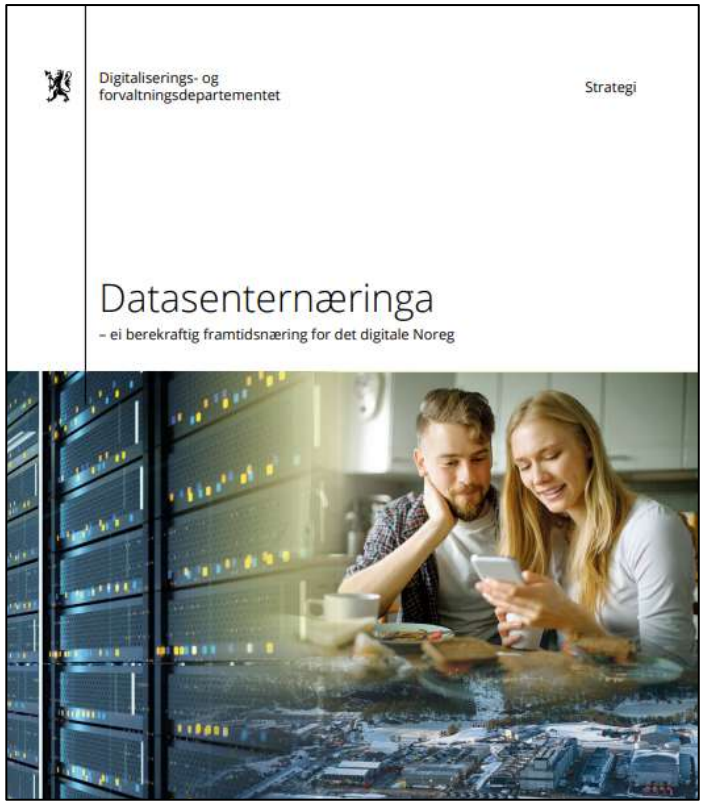
International Energy Agency (2025). *Energy use in data centres and artificial intelligence*.

*Nord Pool data for NO1 (17/03/2025)

The Problem in 3 Dimensions

- Waste Heat = Untapped Value (and Regulatory Pressure).

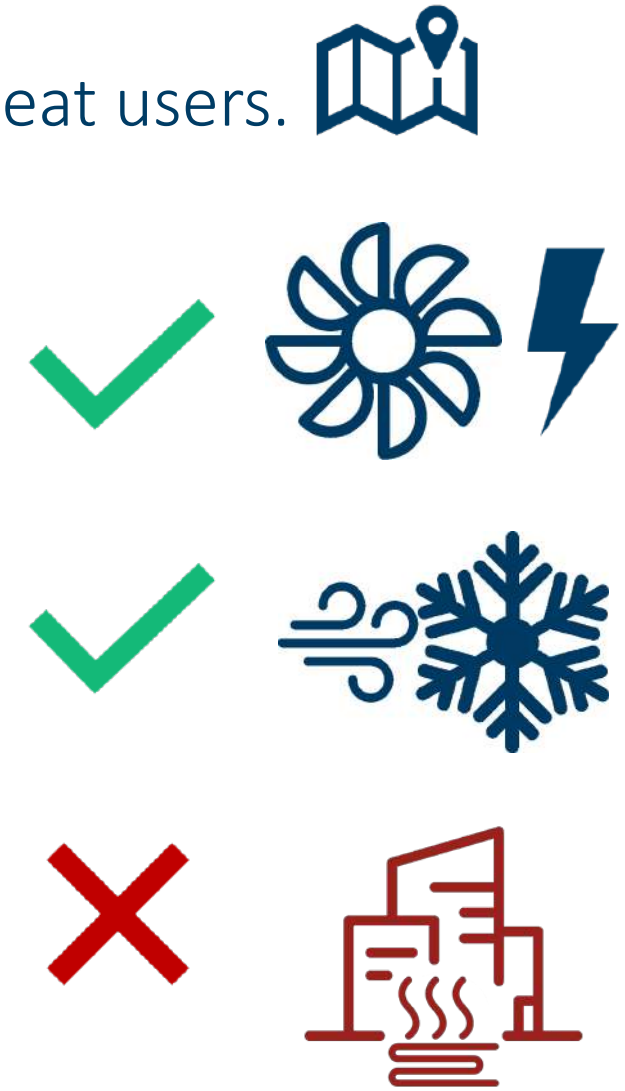
Mandatory to assess, plan,
and report use of waste heat



Energidepartementet (2024). *Høringsnotat: forslag til endringer i energiloven om utnyttelse av overskuddsvarme*. Oslo: Regjeringen.
Nærings- og fiskeridepartementet (2021). *Nasjonal strategi for datasentre*. Oslo: Regjeringen.

The Problem in 3 Dimensions

- Location can be a trap: far from cities and waste heat users.

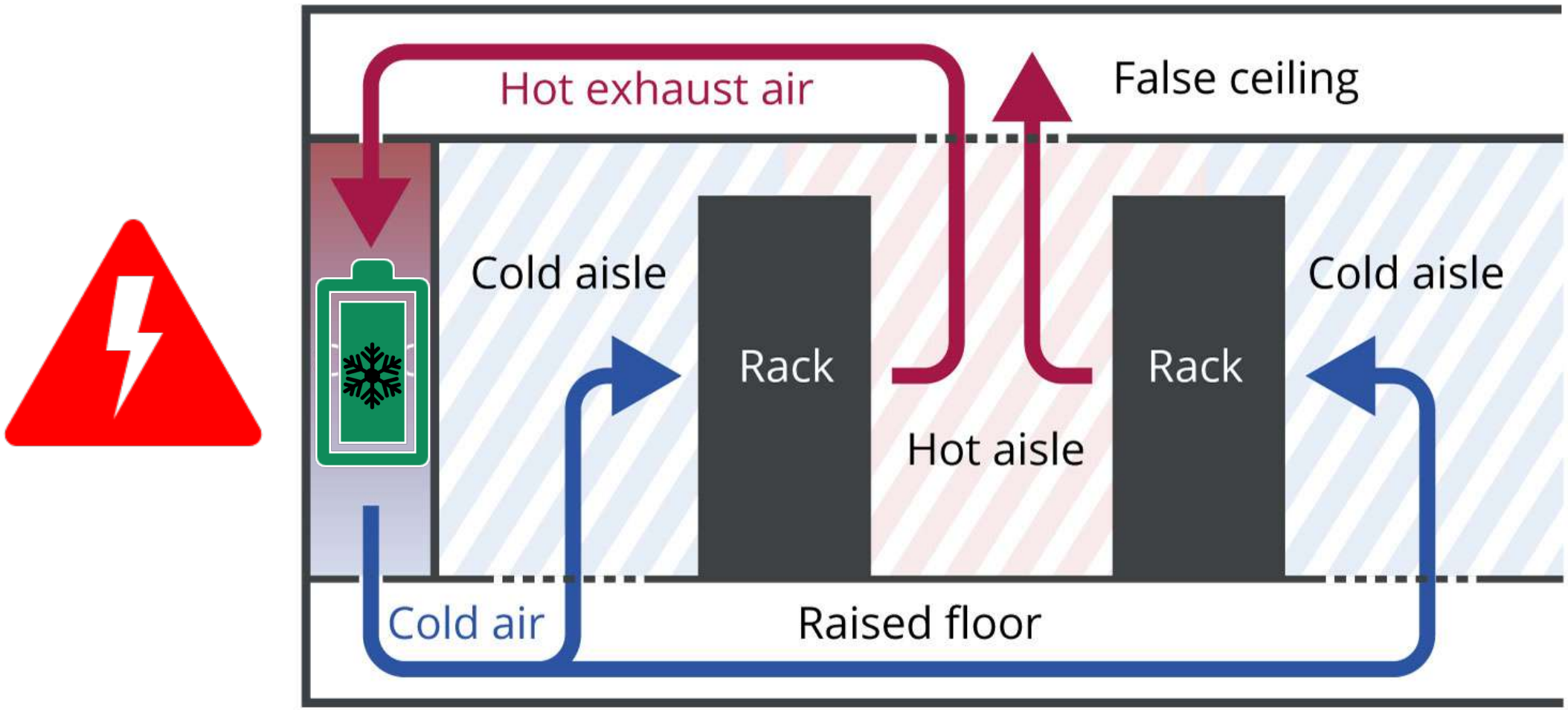


Solutions with Flexibility Assets:
Cold Storage

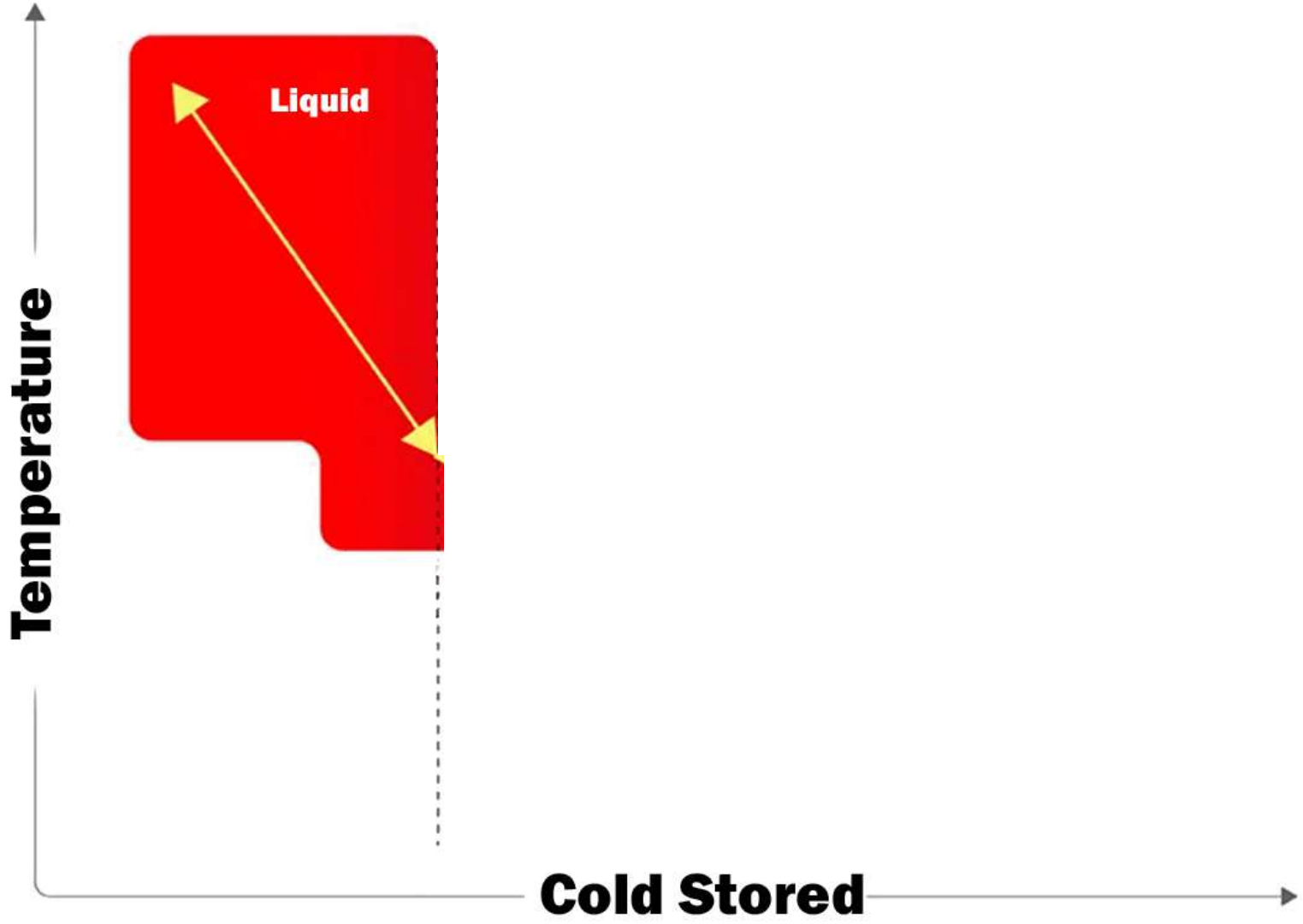
- Cheaper → Shift cooling loads to off-peak hours.
- More Profitable → Enable participation in reserve markets.
- More Freedom → Location not constrained by proximity to power source.

Solutions with Flexibility Assets: Cold Storage

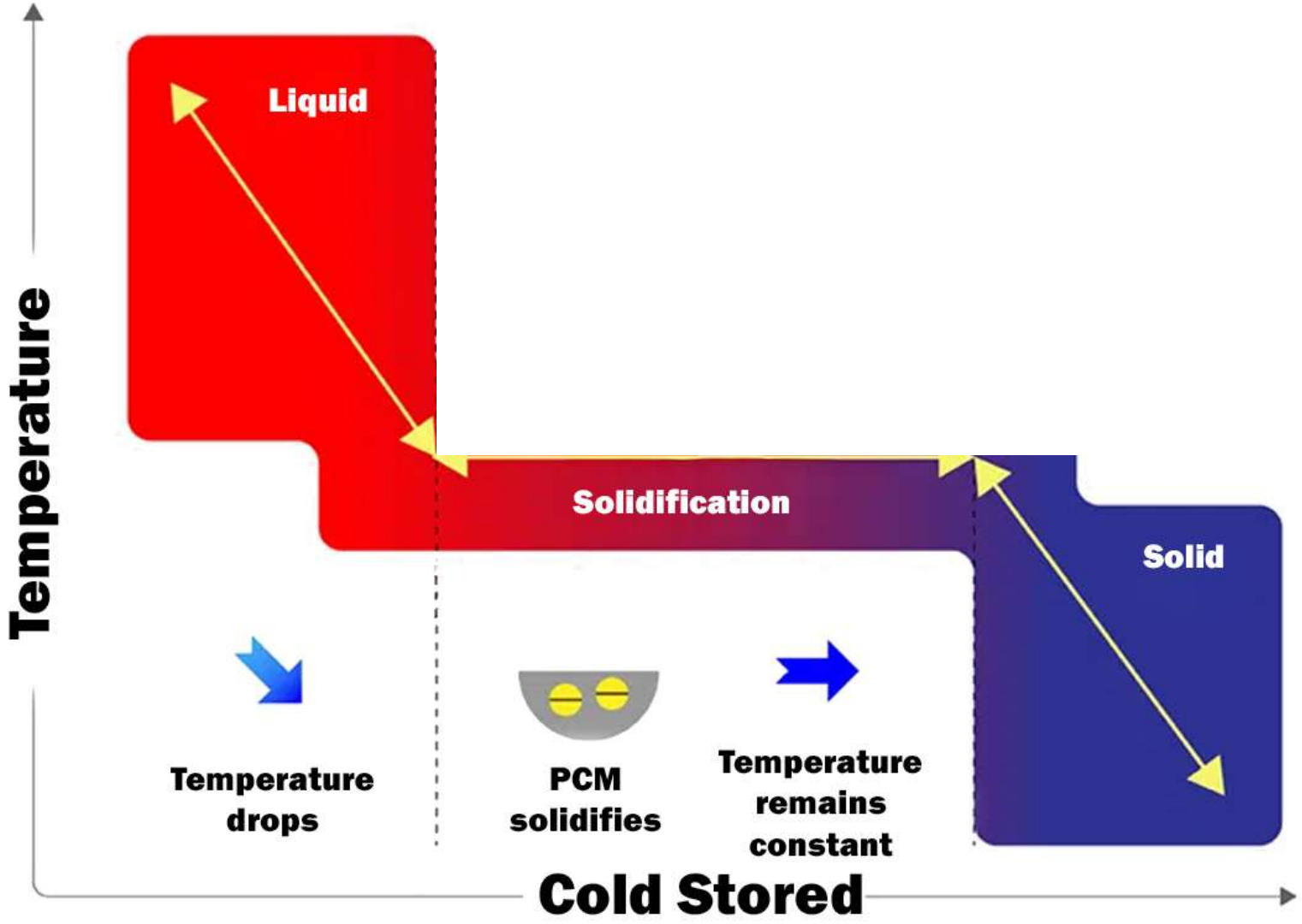
Cooling system:



Solutions with Flexibility Assets:
Cold Storage with Phase Change Materials



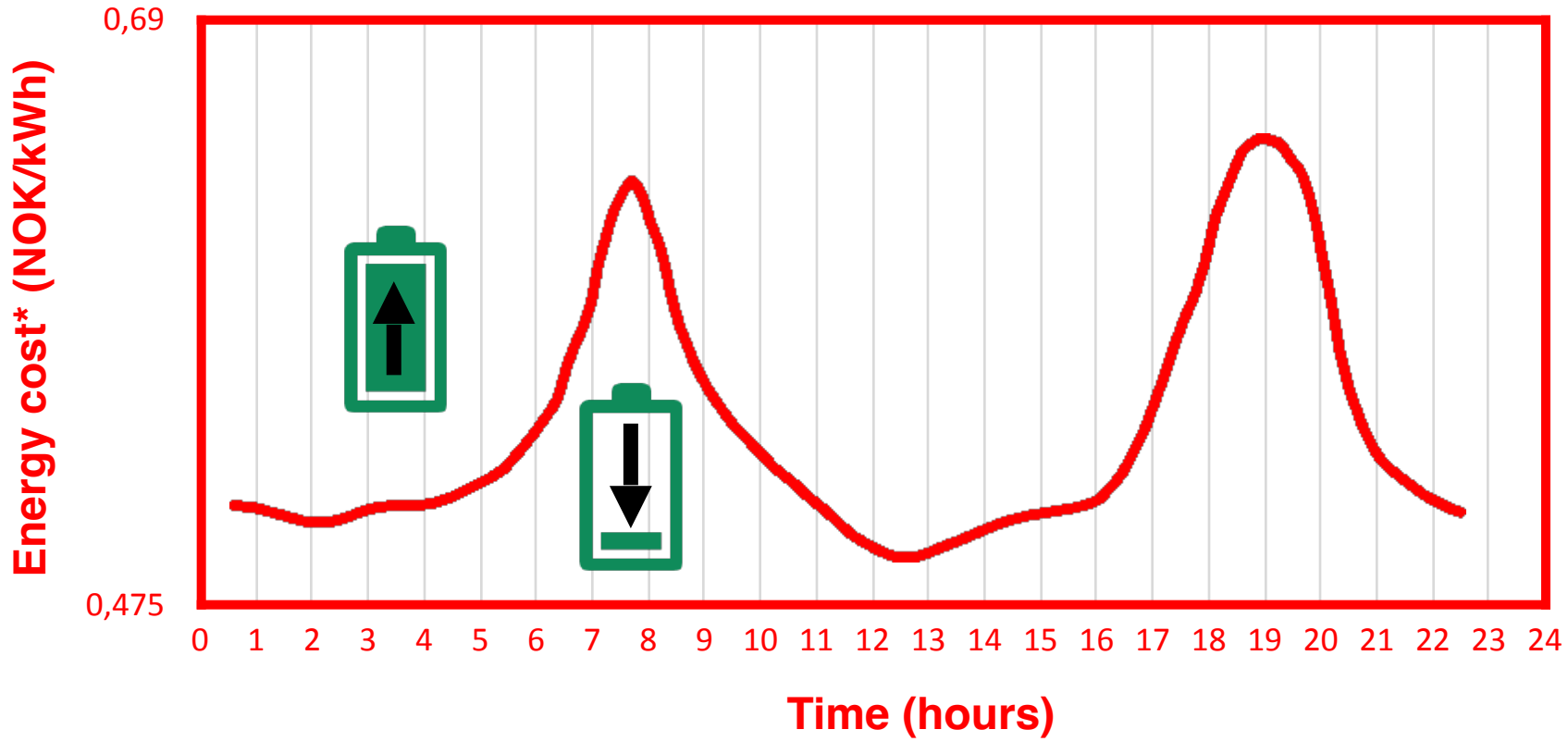
Solutions with Flexibility Assets:
Cold Storage with Phase Change Materials



Solutions with Flexibility Assets: Cold Storage

- Cheaper → Shift cooling loads to off-peak hours.

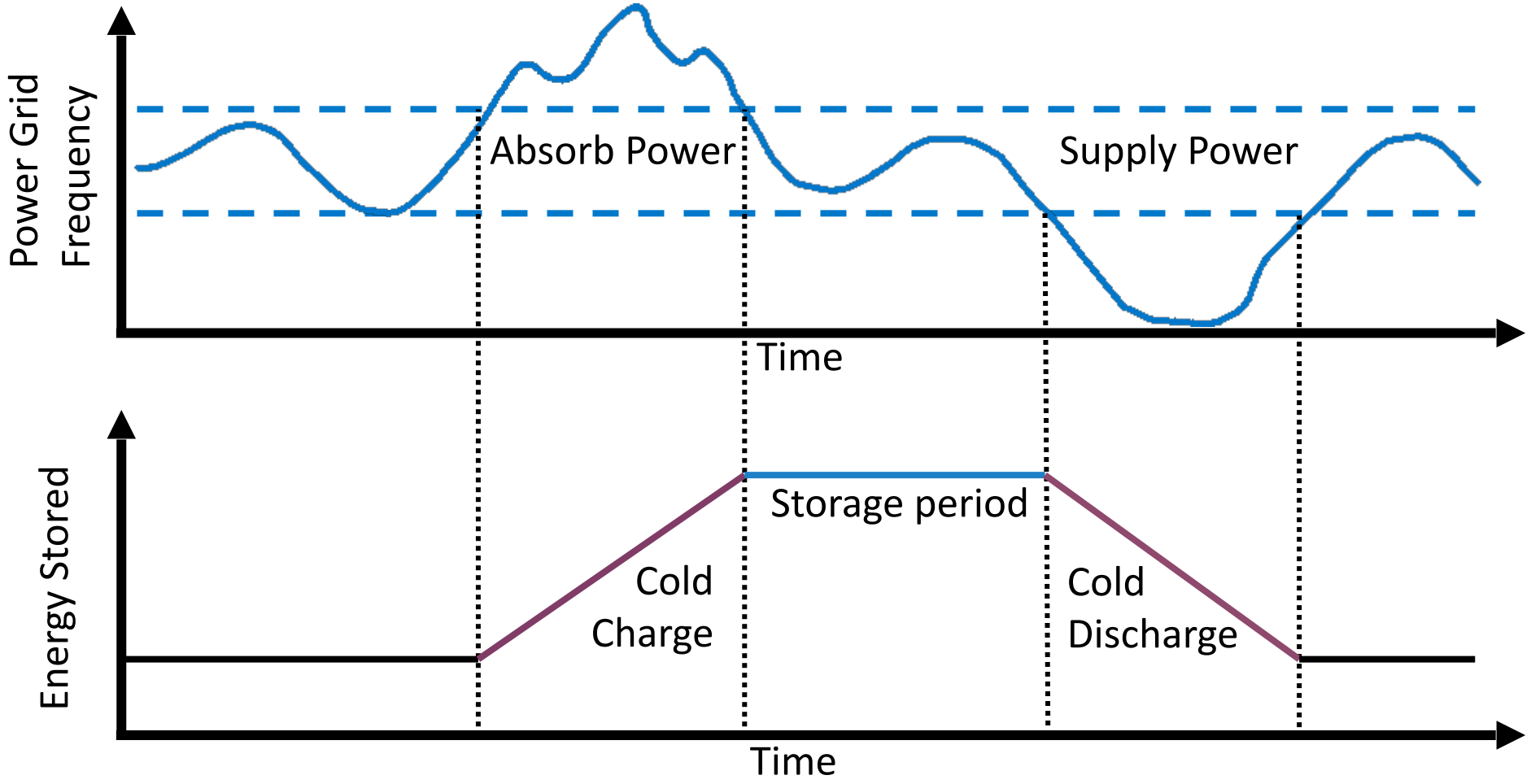
Storage Schedule



*Nord Pool data for NO1 (17/03/2025)

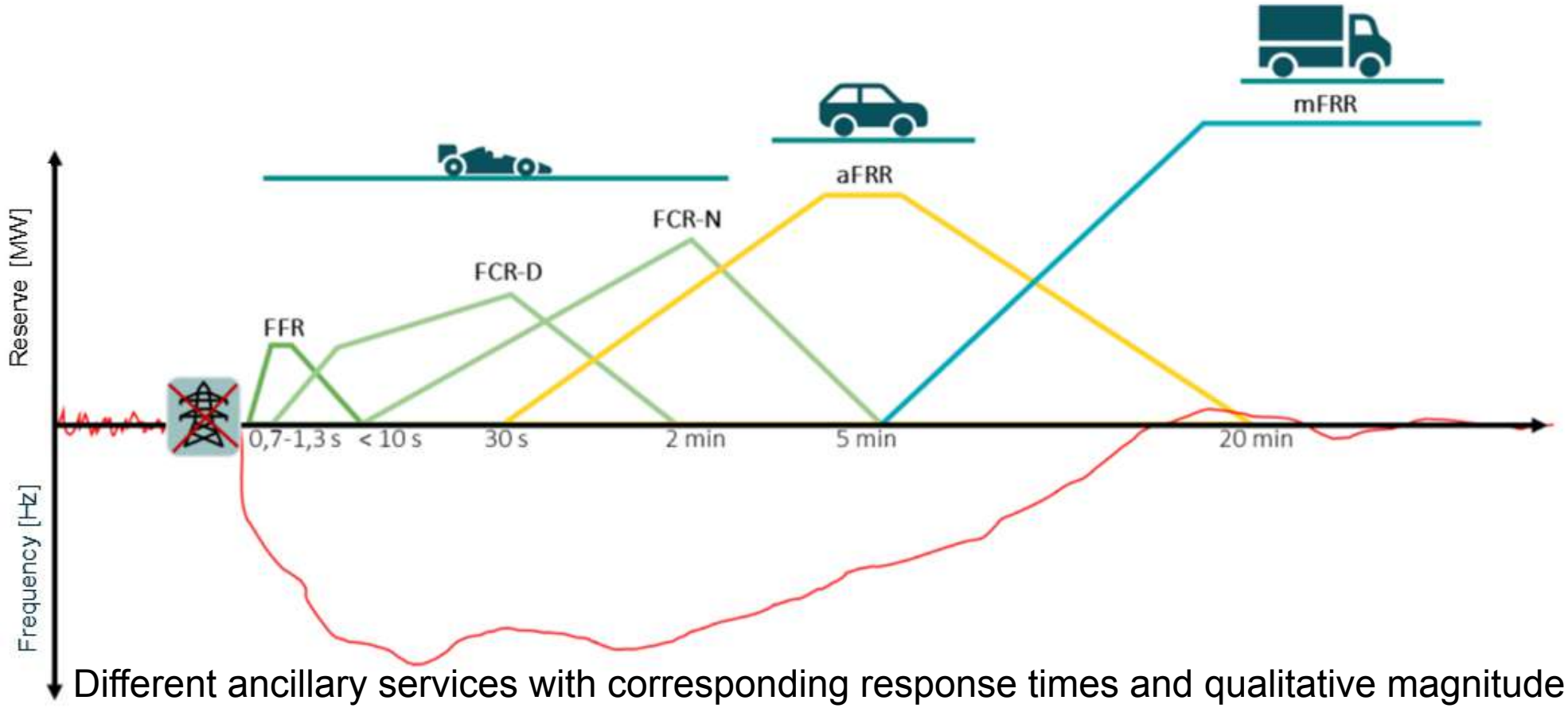
Solutions with Flexibility Assets: Cold Storage

- More Profitable → Enable participation in reserve markets.



Solutions with Flexibility Assets: Cold Storage

- More Profitable → Enable participation in reserve markets.



Different ancillary services with corresponding response times and qualitative magnitude.

Energinet (2022). *Scenarierapport 2022–2032*. Fredericia: Energinet.

Solutions with Flexibility Assets: Cold Storage

- More Profitable → Enable participation in reserve markets.

Market	Response time	Duration	Bid size	Av. profit 2024	Notes
FFR-Profil	1.3s	5s	1 to 50 MW	115 NOK/MW/h	Only up-regulation. (Apr to Oct. 1350 h)
FFR-Flex	1.3s	5s	5 MW	419 NOK/MW/h	Only up-regulation. (Apr to Oct. 400 h)
FCR-D opp	7.5s	15m	0.1 MW	55 NOK/MW/h	Only up-regulation (May to Sep.)
FCR-N	3m	15m	0.1 MW	185 NOK/MW/h	Up- and down-regulation
aFRR opp	5m	60m	1 MW	214 NOK/MW/h	Only up-regulation
aFRR ned	5m	60m	1 MW	186 NOK/MW/h	Only down-regulation
mFRR opp	15m	60m	5/10 MW	80 NOK/MW/h	Only up-regulation
mFRR opp	15m	60m	5/10 MW	191 NOK/MW/h	Only down-regulation

Potential for Cold Storage

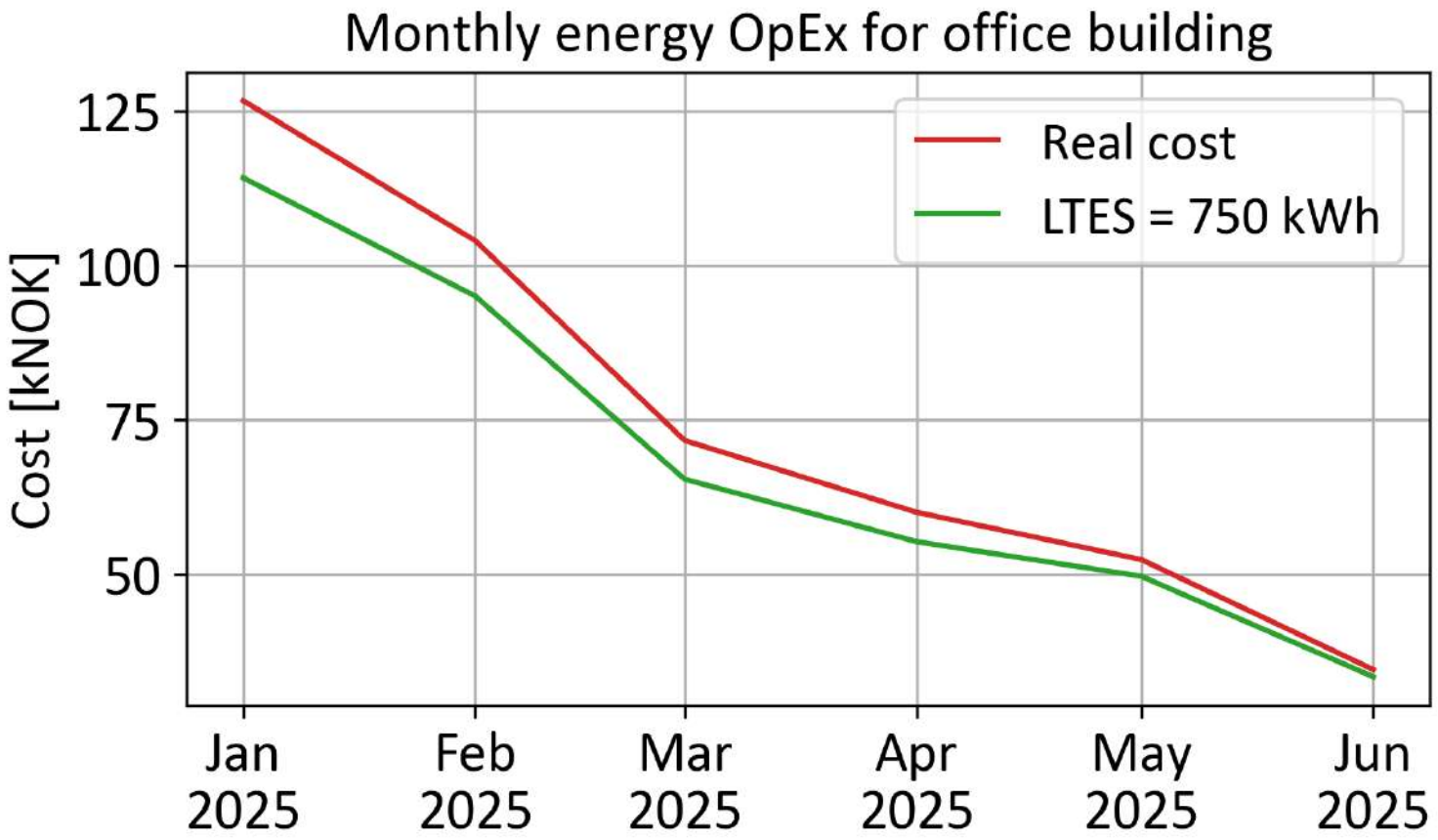
Up-regulation: Discharge to grid to increase frequency

Down-regulation: Charge from grid to reduce frequency

Statnett (2024). *Reservemarkedskalkulator*. Oslo: Statnett.

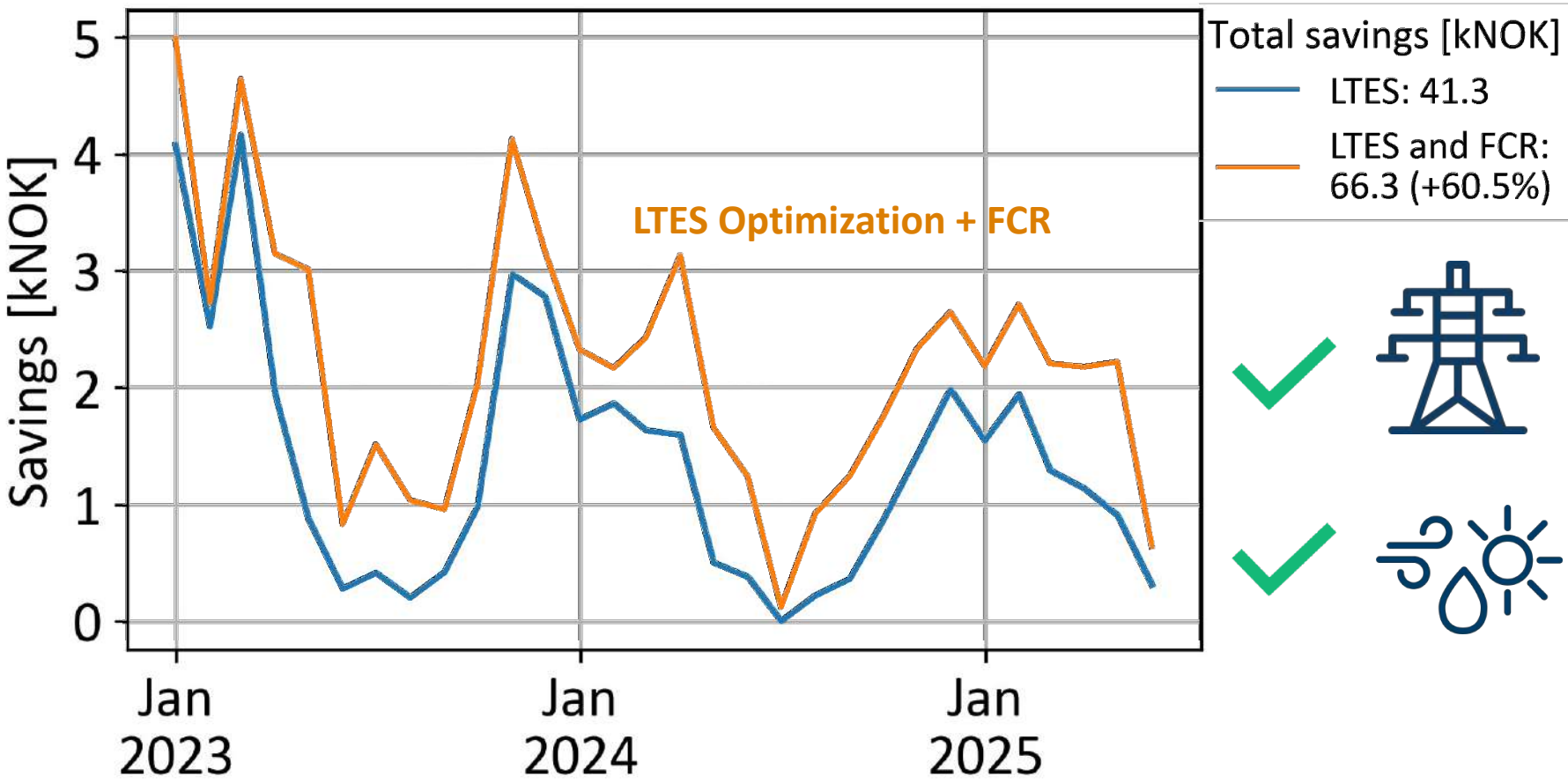
Evidence from Research → How do we know this?

- Demo in a Building

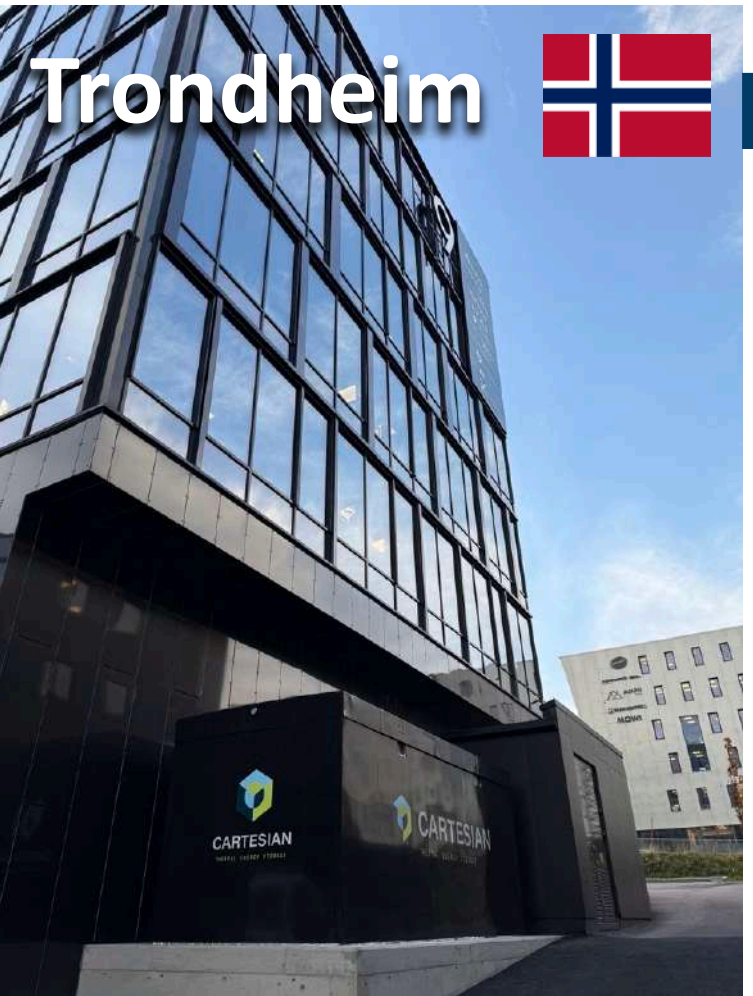


Evidence from Research → How do we know this?

- Demo in a Building → Optimized schedule with thermal storage (LTES)



Evidence from Research → Next Steps



Trondheim

2025-2026

Lyngby

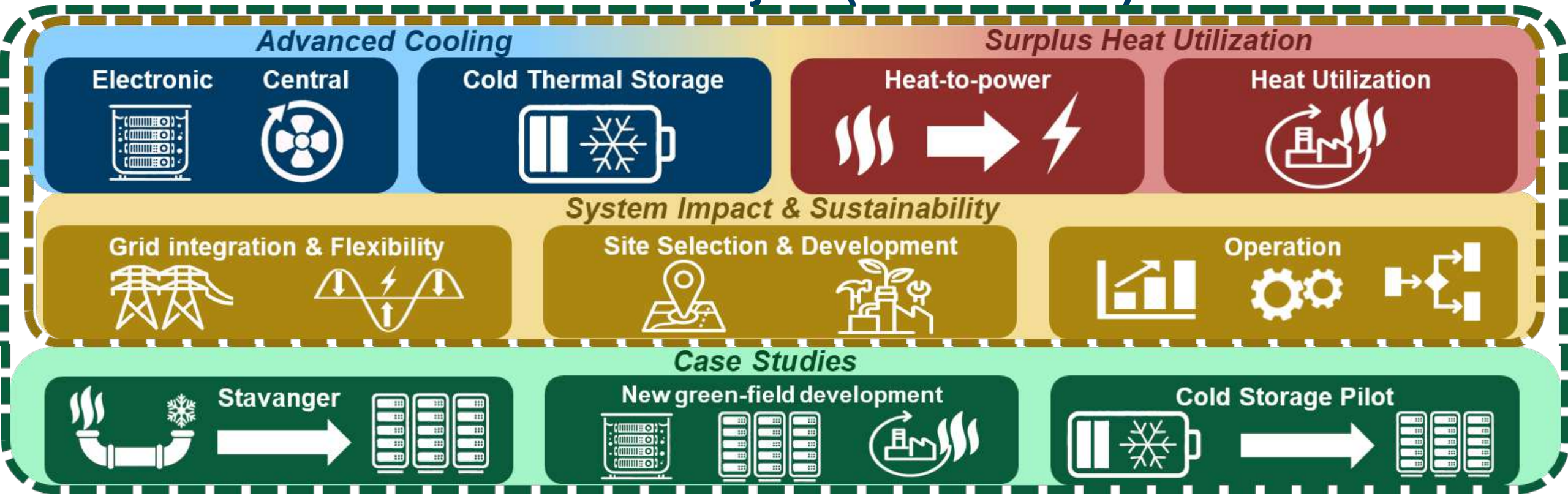
Office building	Data Center
Heat Storage (37°C)	Cold Storage (16°C)
No optimization for reserve market participation	Optimization for reserve market participation

La-Flex

SINTEF · CARTESIAN · klp · AI-ENERGY · DTU · thws Technical University of Applied Sciences Würzburg-Schweinfurt

Evidence from Research → Next Steps

GreenDC Project (2025 – 2029)



The Research Council of Norway

SINTEF RI.SE UiA NTNU

NORWEGIAN DATACENTER INDUSTRY Green Mountain Schneider Electric Ernströmgruppen

VERNE AQ COMPUTE CARTESIAN TENSIO


SINTEF
75 år
Oxygen
Water

SINTEF

75 år

Adapt on time
Store the cold
Own the future

Contact: Jorge Salgado Beceiro