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Hybrid energy optimized data centers

– Stars of the energy world ecosystem

Antti Hänninen

Data Center Evolution

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2020
Green Data Centers

Standalone (co-location) data centers

- Low PUE/WUE/CUE
- 100% renewable power
- Zero-Carbon / Climate neutral
- Excess heat reuse
- CELL (CECC) Architecture and Multi-Purpose Whitespace

2025
Data Center as a “Power Asset”

Next Generation Data center design –microgrid architecture

- cooling and power distribution facilities with excess heat reuse
- microgrid: MV UPS with BESS, Green(er) Backup power, Onsite Solar PV
- Onsite Power Production
- Simplified computing hall design with Hybrid cooling;

The latest development: Facebook in Denmark, Microsoft/Fortum and Nokia/Partners in Finland

2028
Symbiotic Data Centers - EaaS

HPC/AI DATA center in a mixed asset microgrid

- FROM PaaS to EaaS
- Co-location business model in industry parks (Renewable Energy Zone)
- Sector coupling for shared resources, capex and emissions/ decarbonization
- Excess heat reuse (for cooling and water desalination)

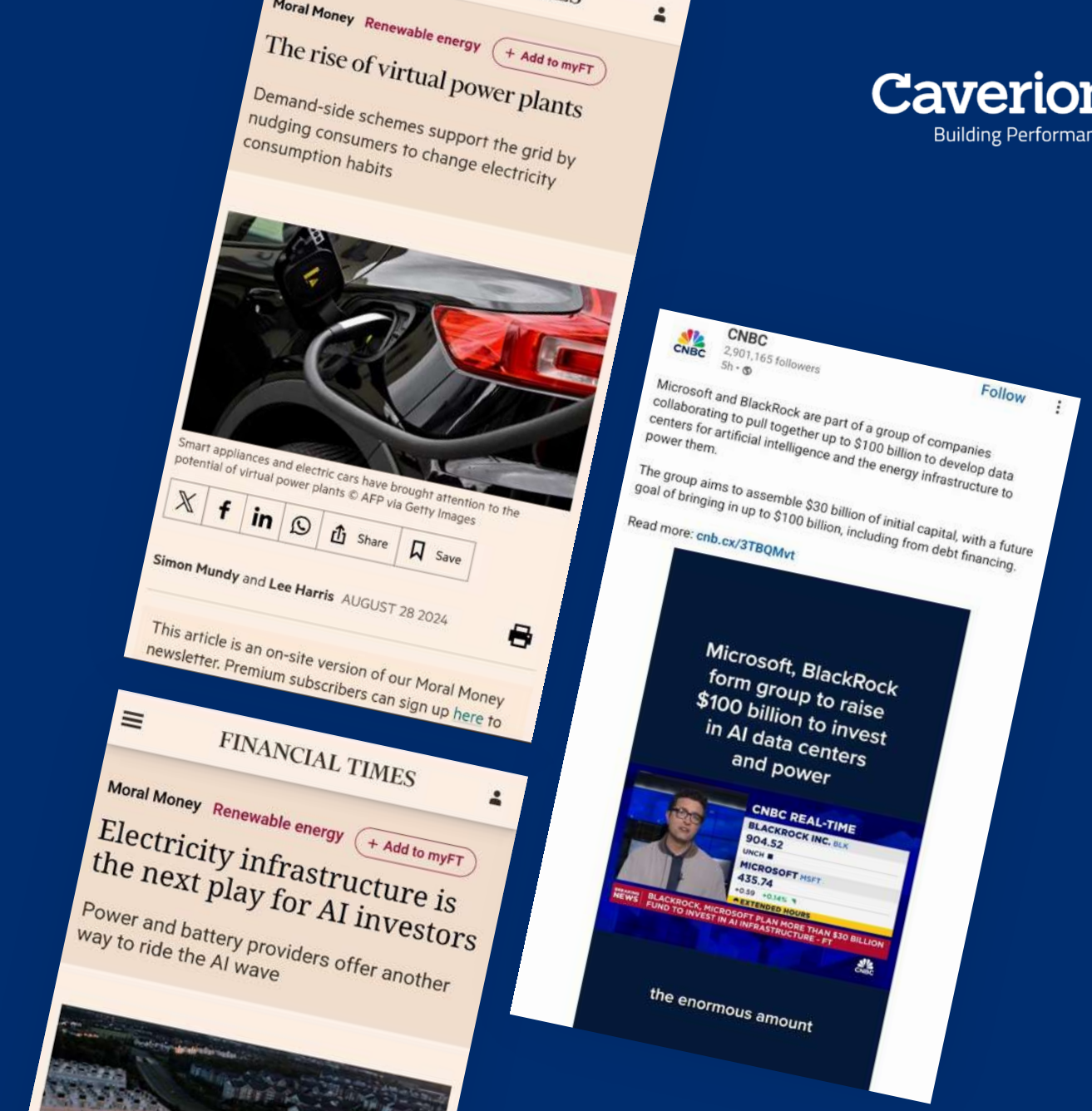
Who will win the AI data center race?

The fastest to deploy zoned, immediately available renewable, resources and partners

The smartest in

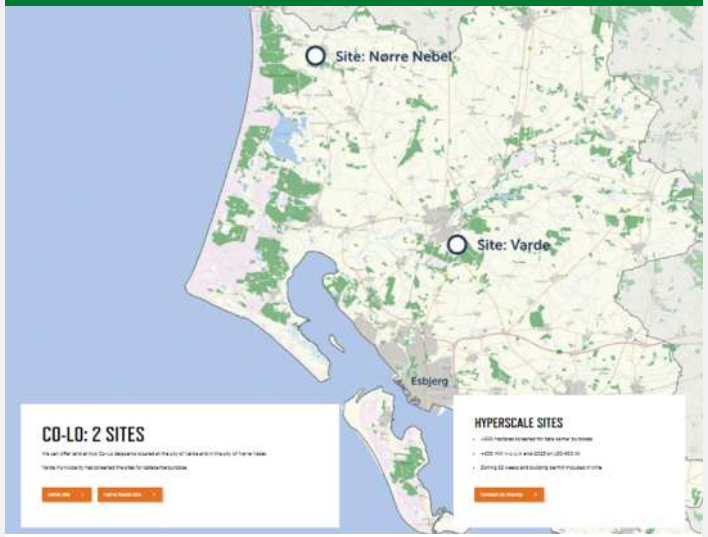
hybrid energy optimization

beyond PPAs, grid support, sector coupling and symbiosis



Example projects that go beyond datacenters

Varde Dataparks



Highlights:
> +200HA of land
> Renewable Energy Available (+2GW→+4GW), heat reuse opportunities with sector coupling
> Partnerships – PaaS example

Microsoft-Fortum (Finland)

Microsoft announces intent to build a new datacenter region in Finland, accelerating sustainable digital transformation and enabling large scale carbon-free district heating

17/03/2022

Highlights:
> Total 650MW (3 sites)
> Cooling (and heat reuse) as a service by external partner
> Critical role municipalities energy portfolio and sustainability targets

Nokia R&D (Finland)

Aurora signs electrification partnership agreement with Nokia at its Oulu smart campus

News - 20/04/2023

The innovative energy solution that is being built will serve the electricity, heating and cooling needs of Nokia's new Oulu campus. The campus will host R&D, office and manufacturing facilities. The multi-optimized energy solution contributes to Nokia's goal of reducing its carbon footprint by over 50% by 2030 across its value chain. The Ministry of Economic Affairs has granted Nokia an RRF-investment grant totaling 12 million euros as part of the funding for the energy solution.

Highlights:
> Extended Campus EaaS with VPP implementation
> CO_2 heat pumps, heat reuse, thermal battery

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Our current value proposition

"Invest in the Nordics – we have cheap electricity and a cold climate”

is outdated because modern high-temperature liquid-cooled racks operate efficiently with free cooling at ambient temperatures of 25–30°C.

The Nordics needs a new value proposition

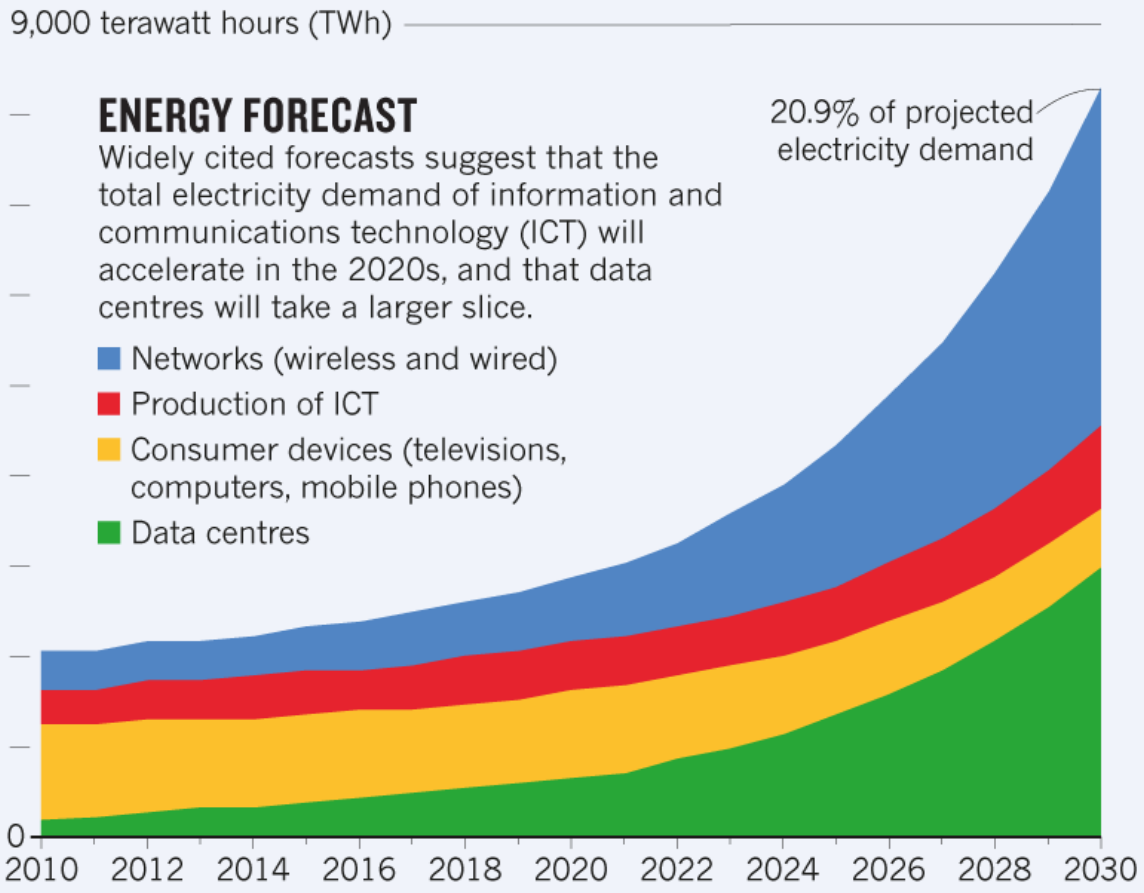
Our climate is no longer a unique advantage for data center cooling

Energy is the limiting factor

Data Centers already consume 3% of the world's energy

With current trends, energy consumption is expected to increase exponentially

Massive changes in data centers are necessary, otherwise the growth rate is unsustainable!



Source: Nature: International Journal of Science, 09/2018

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If you've forecasted energy generation based on a windspeed of 7 m/s, but the actual windspeed is only 5 m/s, your actual wind power generation is only 26% of the forecast.

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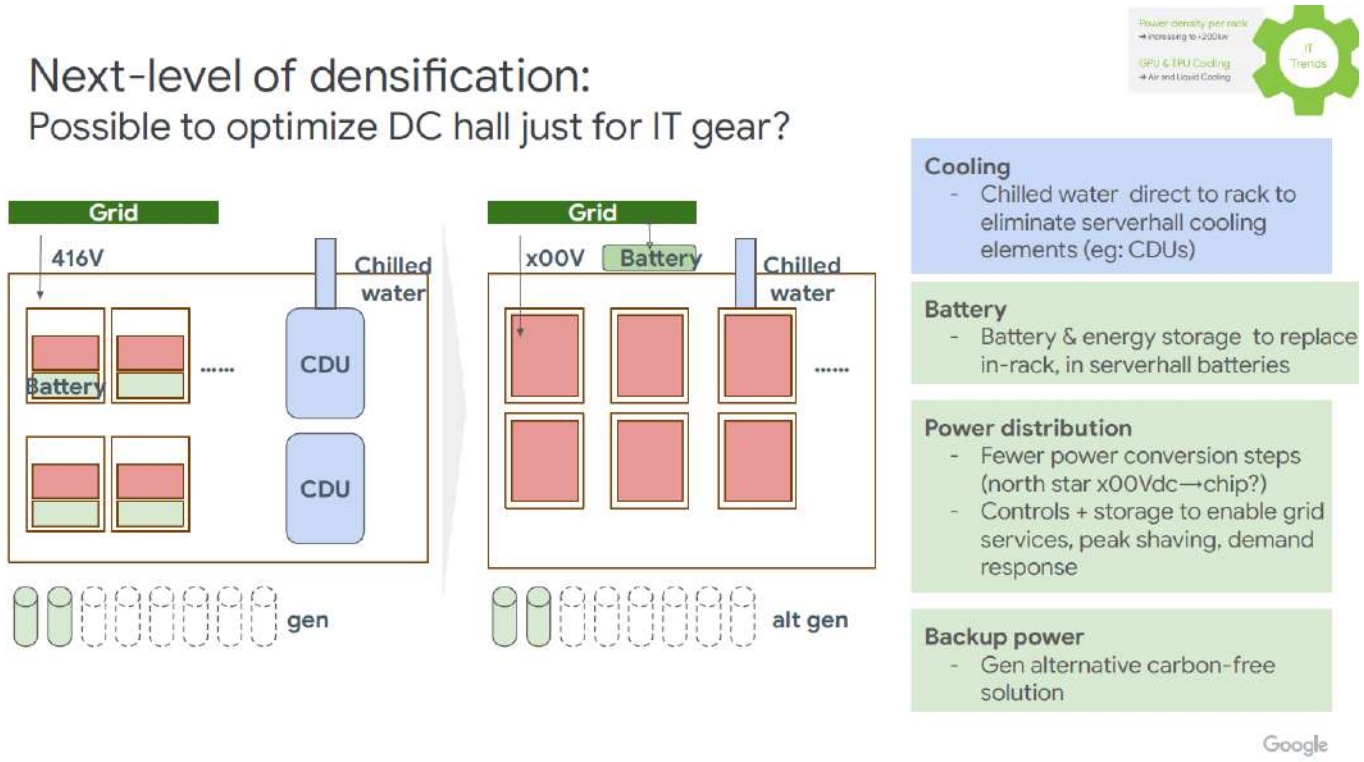
How can **energy** – the limiting factor – be **an asset** for datacenters in the Nordics?

Google: Trends of Future DC Design
OCP Global Summit 2024



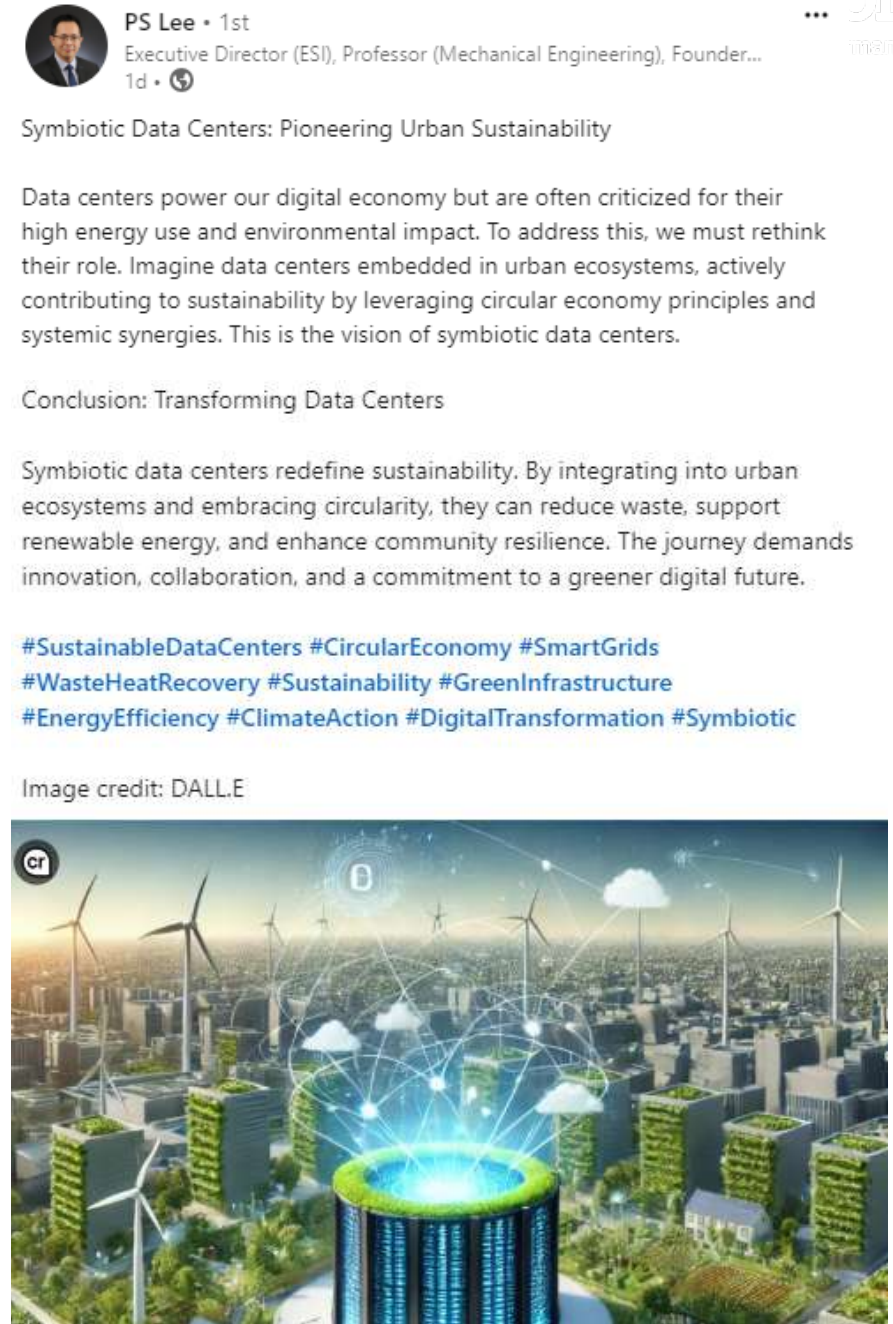
Takeaways:

> Reserve data hall just for computing
> Chilled water development
> Battery & energy storage to replace (in-rack and UPS)
> Controls + storage to enable grid services, peak shaving, demand response
> CO_2 free backup power

Symbiotic Data Center Ecosystems are pioneering urban sustainability

- Local ecosystem - energy communities (optimization, shared utilities, infrastructure and resources)
  - Sector coupling with industrial, commercial and residential partners/townships
- City level ecosystem (cooling and district heating)
- National/regional: as power assets in the energy market

https://www.linkedin.com/posts/leeps_sustainabledatacenters-circulareconomy-smartgrids-activity-7268483327852978177-5JZw



PS Lee • 1st
Executive Director (ESI), Professor (Mechanical Engineering), Founder...
1d •

Symbiotic Data Centers: Pioneering Urban Sustainability

Data centers power our digital economy but are often criticized for their high energy use and environmental impact. To address this, we must rethink their role. Imagine data centers embedded in urban ecosystems, actively contributing to sustainability by leveraging circular economy principles and systemic synergies. This is the vision of symbiotic data centers.

Conclusion: Transforming Data Centers

Symbiotic data centers redefine sustainability. By integrating into urban ecosystems and embracing circularity, they can reduce waste, support renewable energy, and enhance community resilience. The journey demands innovation, collaboration, and a commitment to a greener digital future.

#SustainableDataCenters #CircularEconomy #SmartGrids #WasteHeatRecovery #Sustainability #GreenInfrastructure #EnergyEfficiency #ClimateAction #DigitalTransformation #Symbiotic

Image credit: DALL.E

Symbiotic Data Center Ecosystems create more value than just shelter for computing

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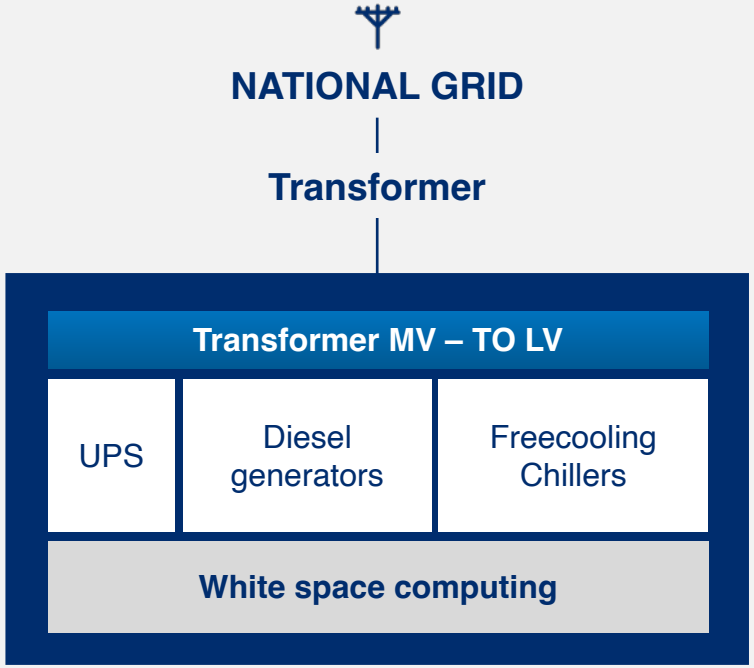
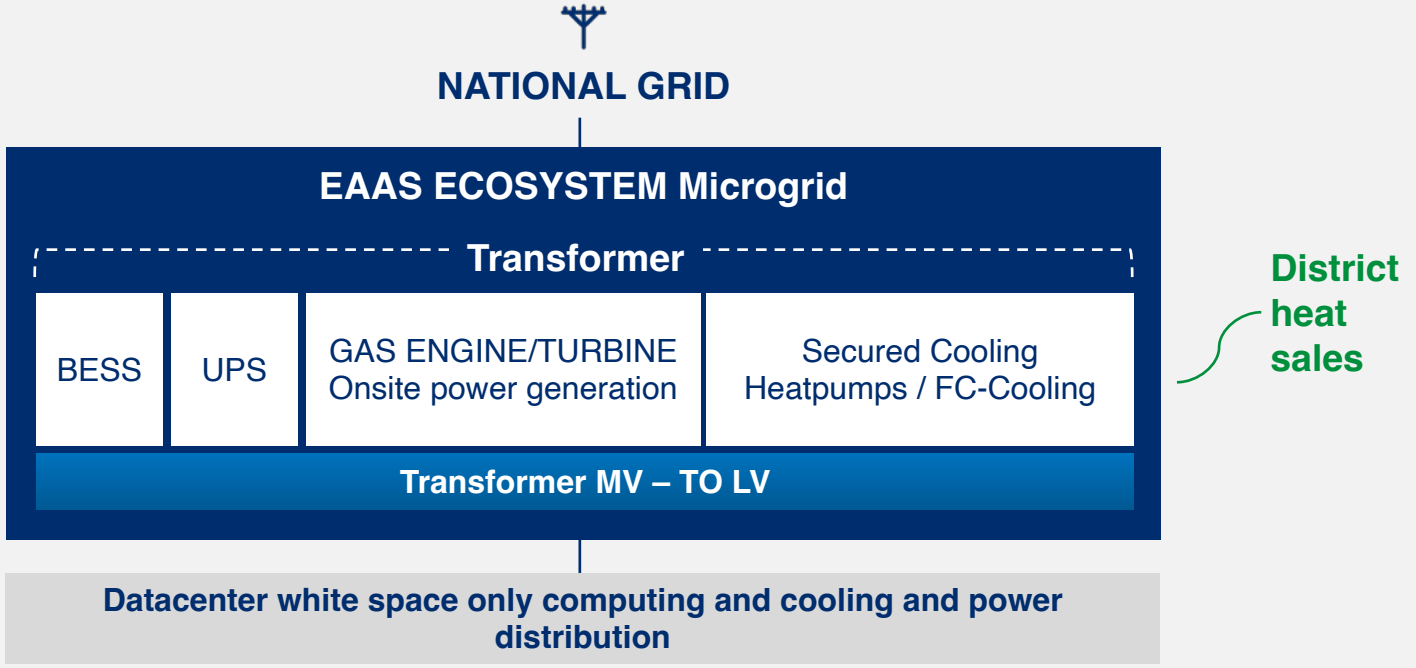




Traditional model ✖

> Massive capex and opex
> 24/7 operations
> Regulations and reporting

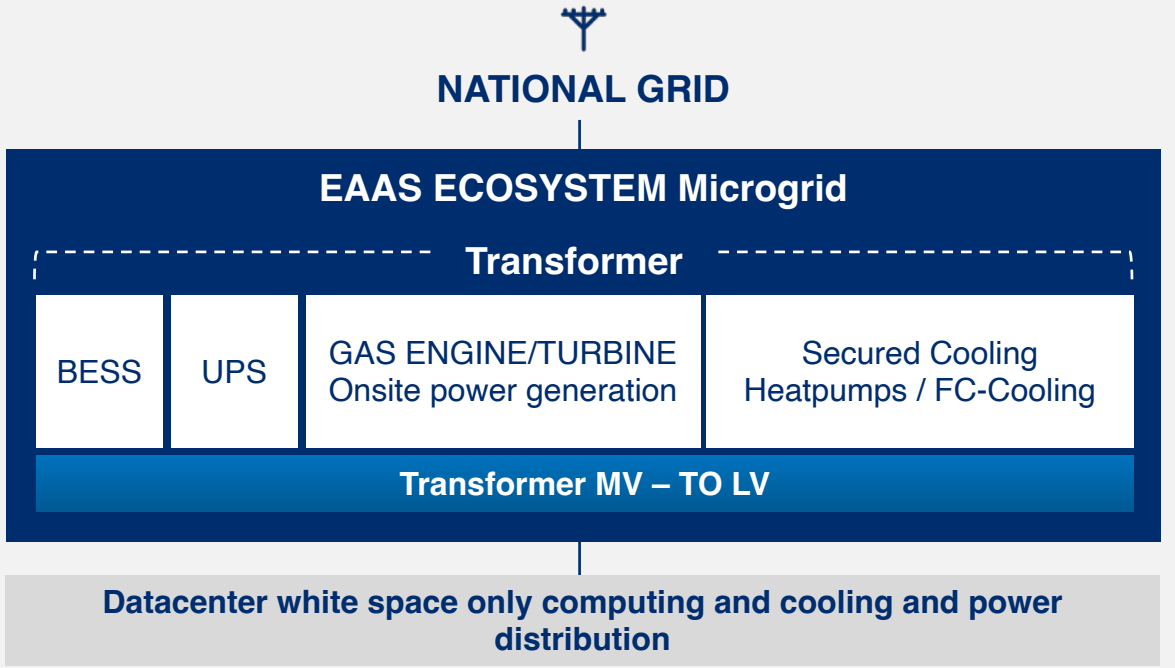
EAAS ecosystem benefits ✚

> Double whitespace
> 50 % capex to EaaS company
> Heat reuse
> Utilizing EaaS assets (Battery storage, FC to replace diesel generators)
> Only commercial and IT operations inhouse

Symbiotic Data Center Ecosystems - "Our Nordic grid needs balancing power – What if there were 10 data centers providing 150 MW each = nuclear power plant"

The need for reserve capacity will increase by 134% in the next 5 years

FINGRID



ONE INVESTMENT – TWO REVENUE STREAMS

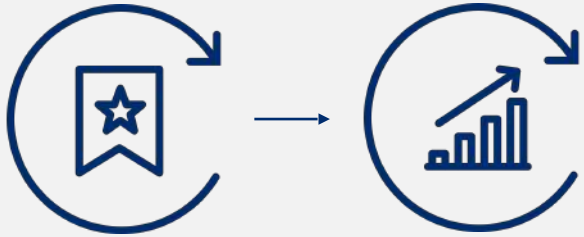
> Significant balancing power capacity
> Cost-effective way to build large amounts of balancing power
> Additional revenue stream for the data center ecosystem

Symbiotic Data Center Ecosystems

- Heat pumps and district heating networks unique

NO ADD ON HEAT PUMPS

Heat pump as ”standard design”



ONE INVESTMENT – TWO REVENUE STREAMS

> Heat pumps are securing cooling
> Revenue from heat sales
> Recovering heat from the process
> Positive carbon handprint
> District heating networks are utilizing heat with efficient way
> (sector coupling like greenhouse are not large scale solutions)

WITH COP 5 we can utilize

> The heat from dc to district heating
> Network 90 degrees outlet

Key takeaways

1
Datacenters can no longer be energy consumers

Needs symbiotic asset sharing or asset producing

2
Traditional approach for power distribution and cooling has to change

An opportunity to rethink secured power more like power plant

3
Energy re-usage (heat pumps + district heating networks)

Around 50TWh of heat is still made by burning something in Finland alone

4
Positive carbon footprint

New datacenters have massive carbon footprints. Integration to district heating creates a positive handprint during its life cycle

5
Virtual power plant

New software business opportunities in energy management

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Thank you!

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