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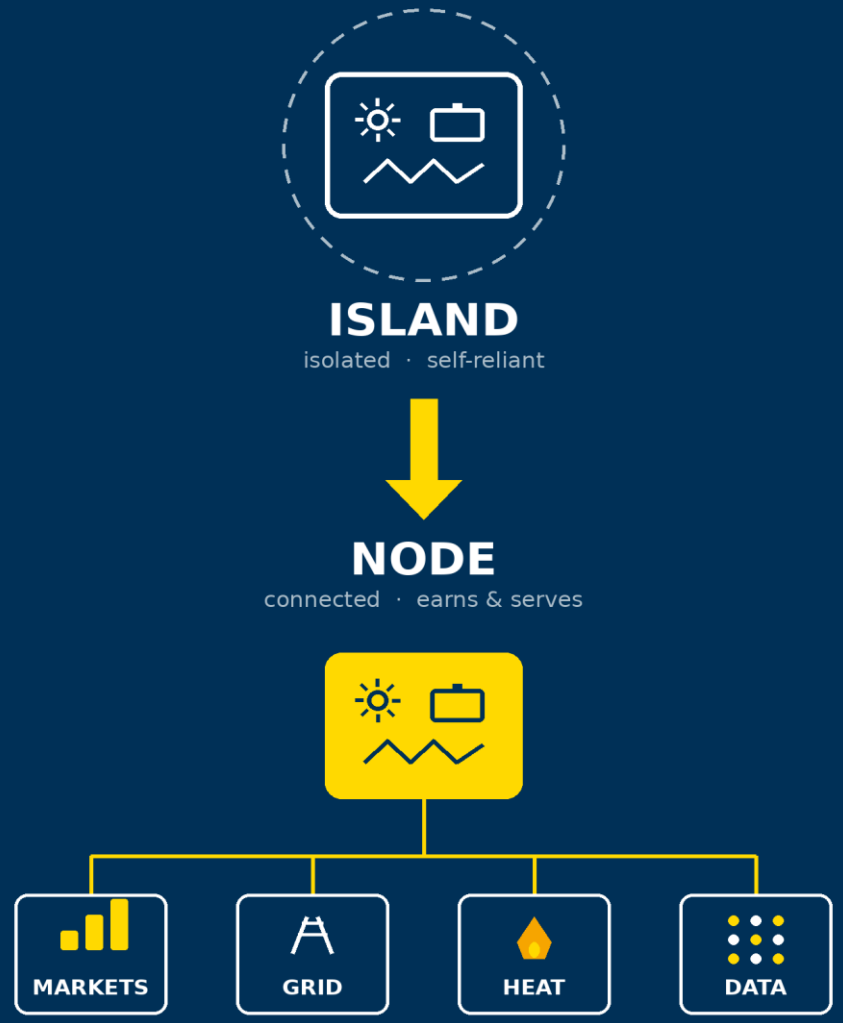
Microgrid — From Island to Node

Operating multi-energy microgrids for better value when the market and data exchange layers are real and live



Jan Segerstam
Director of Research and Development, University of Vaasa

Special Session on Multi-energy Microgrids · Finland 2026 Symposium on Microgrids · LUT University, Lappeenranta · 16 June 2026

The microgrid is changing what it is

Twenty years defined it as an islandable system for local resilience — a second end-state is now live

ISLAND
"Can it disconnect and keep the lights on?"

NODE
"How does it earn and serve at the same time?"



Most real systems sit on the spectrum — and they slide right as data and markets arrive. The operational question flips with them.

Finland is a live preview of the node end

The substrate most of the world is still modelling toward already exists here

2013
universal smart metering, nationwide

1
national data exchange — the Datahub

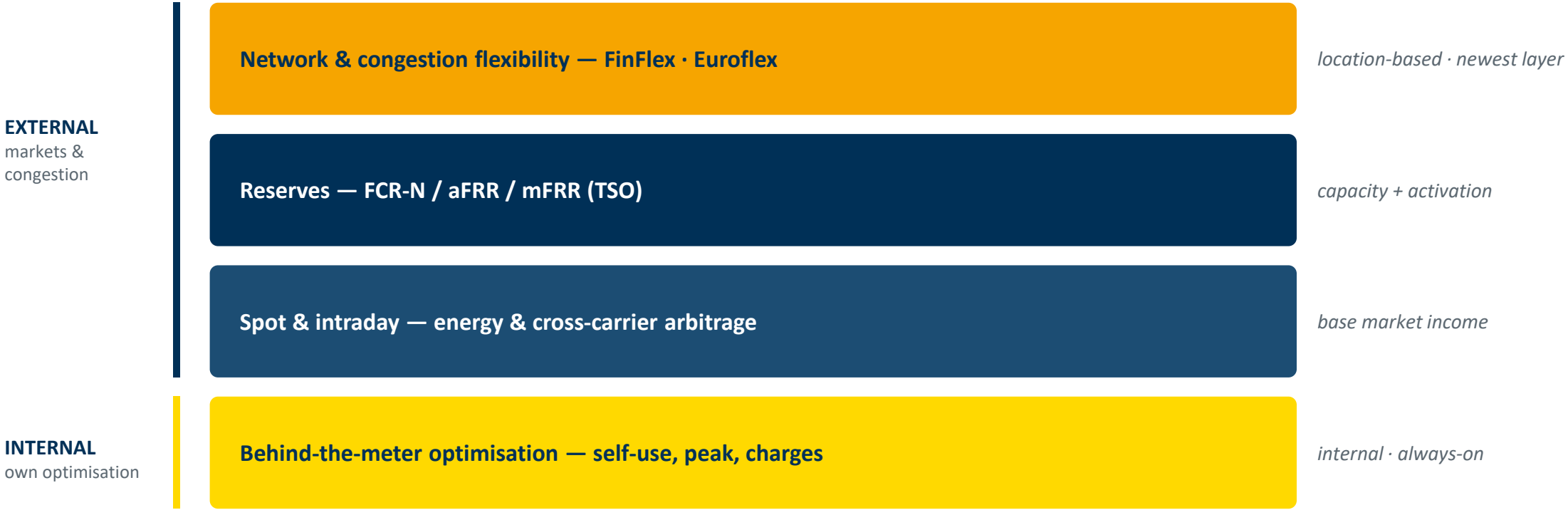
~96%
emission-free generation

- **One price area, one TSO**
  no internal bidding-zone seams to model around.
- **A combined TSO + DSO flexibility market (FinFlex)**
  network value is procured through the same marketplace as system value.
- **Market participation and network control share one signal path**
  the metering and Datahub interface complement and enrich traditional parallel bespoke stacks.

This isn’t a pilot environment — it’s an operating one. It changes what a microgrid can be.

What a node earns: the value stack

When the substrate exists, the same microgrid earns across layers — internal optimisation + external markets



The "value of a microgrid" this community has asked for 20 years — now with real market counterparties, not just avoided cost.

Multi-energy is how a node both earns and serves

Sector coupling and cheap thermal storage give the slack to do both at once

- **Coupling electricity ↔ heat ↔ gas ↔ hydrogen turns one constraint into many options**
  each coupling is a buffer and a market door.
- **Thermal storage is the cheap flexibility:** district heat, process heat, and sand/rock batteries store energy at a fraction of battery CAPEX (you'll see Polar Night Energy's sand battery on Thursday).

- **The carriers that make the system resilient also make its flexibility sellable**
  heat buffers carry the load while electrical capacity earns.
- **An industrial energy community like LEMENE (Thursday's visit) is this in practice:** multiple carriers, storage, and local + market value at the same time.

Multi-energy isn't only efficiency — it's the slack that lets a node serve locally and sell externally.

The hard part: resilience and value compete for the same MW

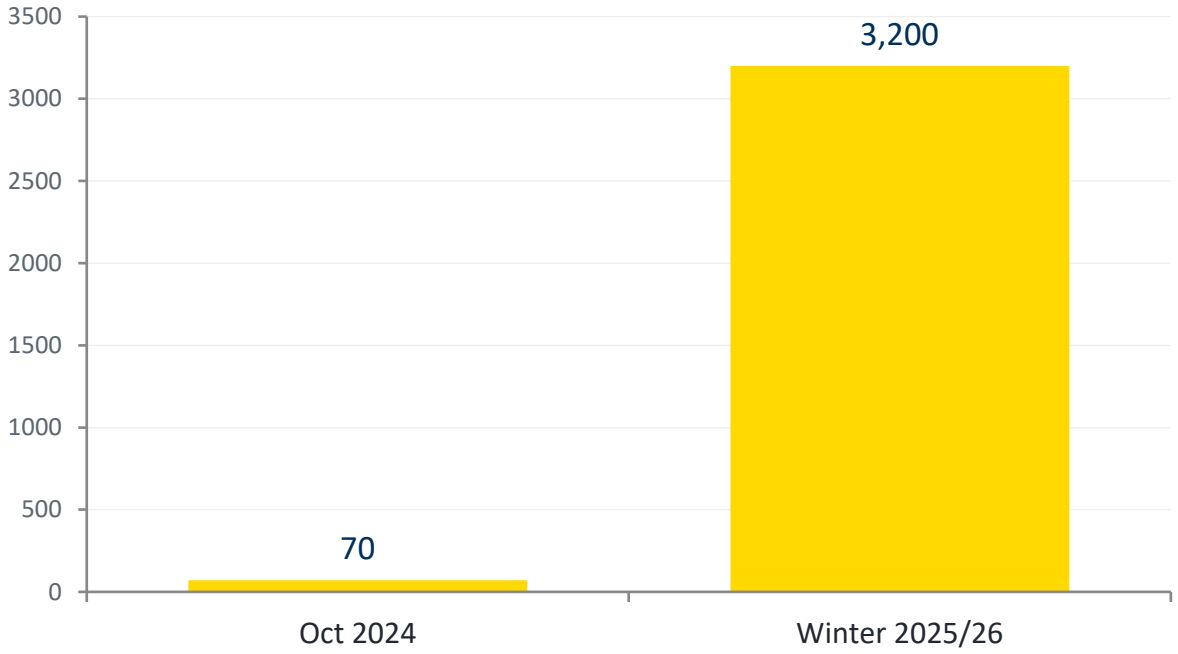
Capacity sold to the market isn't there for the outage — the reservation strategy is the design problem



A pure island over-builds for a rare event; a hollowed-out node fails when it's needed. Multi-energy holds both.

Network value is live, not theoretical

Two Nordic congestion markets on one platform (NODES) — and year-one traction



Norway · monthly traded volume (MWh), driven primarily by MaxUsage

Finland — FinFlex

Combined TSO + DSO market. Live since 2025, first FSP onboarded — and now its **first activations**. The market is moving from standby into real use.

Norway — Euroflex

Split TSO / DSO model · 7 DSOs + Statnett. **~250 MW** across **~1 830 resources**. Capacity market (LongFlex) + activation market (ShortFlex), alongside mFRR.

Same platform, two architectures — the mechanics work, liquidity is building, and the first activations are here.

Capturing the stack is an optimisation problem

Revenue layers don't add — rules and physics constrain them (and that's where this room's methods pay off)

- **Product rules differ:**
  minimum bids, baselining, prequalification and exclusivity cap what one asset can sell at once.

- **Simultaneity:** capacity held for reliability or one market can't be sold to another in the same hour — co-optimise, don't sum.

- **Location:** network value exists only where there is a constraint — it is geographic, not uniform.
  This is where scheduling, VPP aggregation and AI methods turn the substrate into money.

The value stack is the objective function; the methods in this session are how you actually capture it.

The value stack in practice: assets earning today

Most value is created across the market cascade — before network flexibility is even counted

- **Smart battery fleets (e.g. Cactos) —** optimise self-use and peak charges, then stack spot arbitrage and reserves on top.
- **Heat-pump & waste-heat flexibility (e.g. Calefa) —** shift thermal load to chase spot prices and deliver reserves — value across carriers, not just electricity.
- **Grid-scale BESS deployments —** earn primarily from the cascade (spot, intraday, FCR-N / aFRR / mFRR); network flexibility is the newest, additional layer.
- **The cascade pays the bills today —** network value (FinFlex CM/AM) stacks a thinner, location-specific layer on top; it doesn't stand alone.

Real Finnish assets monetise the cascade now — network value adds to it, it doesn't replace it.

What this means for the microgrid community

- **Think island ↔ node spectrum, not a binary —** most systems are sliding right as data and markets arrive.
- **Multi-energy is how a node earns and serves at once —** thermal storage is the cheap flexibility that buys the slack.
- **The real enabler is the substrate (data + markets), not the assets —** Finland shows what becomes possible once it exists.
- **The operational work is the market cascade —** bidding across spot, intraday and reserves first; network flexibility and reliability reservation layer on top.

From island to node — the question shifts from “can it survive alone?” to “how does it earn and serve together?”

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Thank you

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For the panel: *as microgrids slide from island to node — where should reliability stop being self-provided and start being a market service?*