






BESS Optimization and Trading in the Nordics

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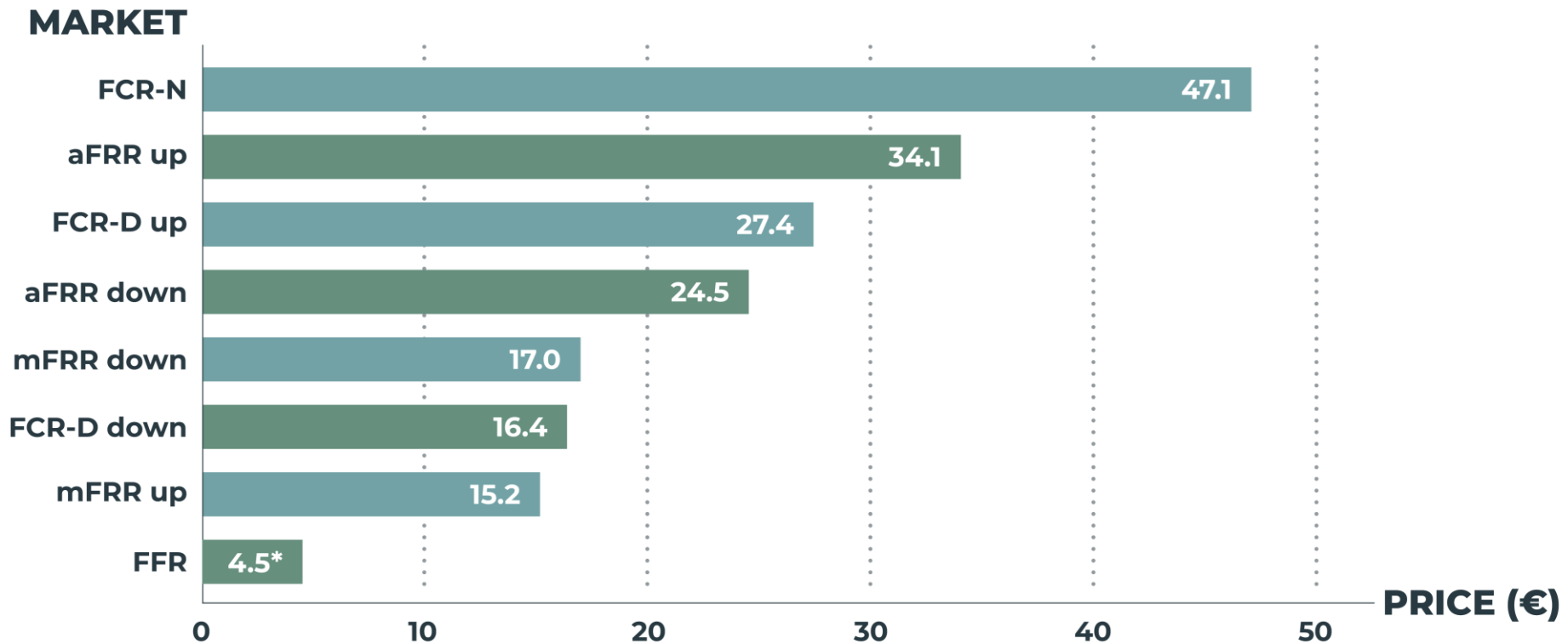
Ancillary Markets in Finland

	FFR	FCR-D	FCR-N	aFRR	mFRR
	Fast Frequency Reserve, Finland 20%, Nordic countries comb. 0 – 300 MW (estimate)	Frequency Containment Reserve for Disturbances, Finland 290 MW, Nordic countries 1 450 MW	Frequency Containment Reserve for Normal Operation, Finland 120 MW, Nordic countries 600 MW	Automatic Frequency Restoration Reserve, Finland 60 – 80 MW, Nordic countries 300 – 400 MW	Manual Frequency Restoration Reserve Dimensioning fault + balance responsible party's (BRP) imbalance
ACTIVATION	Used in large frequency deviations in situations of low inertia	Used in large frequency deviations	In constant use	In use during assigned hours	If necessary
SPEED	In a second 	In seconds 	In a couple of minutes 	In five minutes 	In a quarter of an hour 

Average Ancillary Market Prices in 2023 (FI)



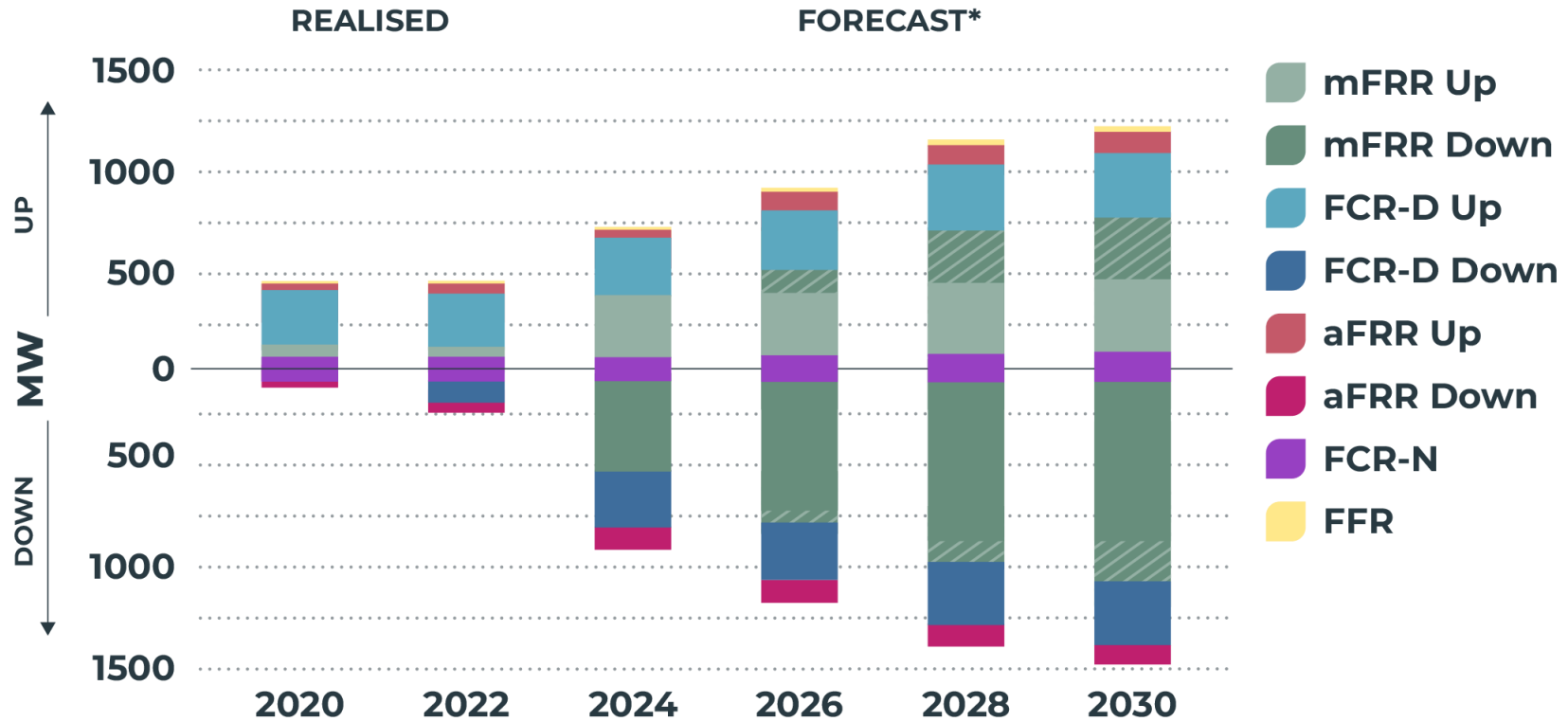
BESS's most significant revenue sources in Finland are frequency containment reserves.



Fingrid Reserve Capacity Procurement 2020 – 2030



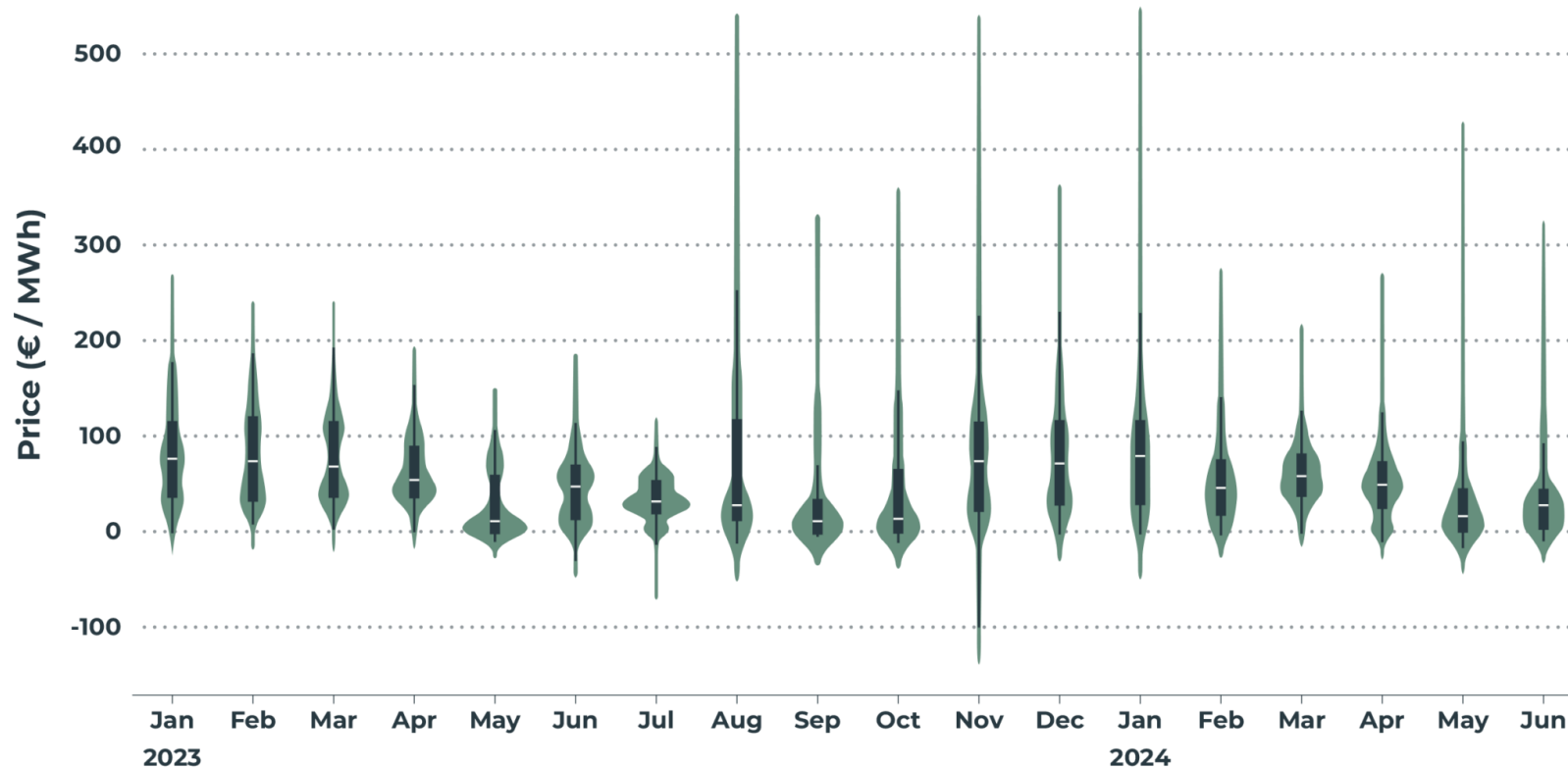
The need for reserve capacities is expected to **grow 134% within the next five years**



Spot Prices by Month (FI)



Spot prices have been highly volatile, making the market favorable for BESS.



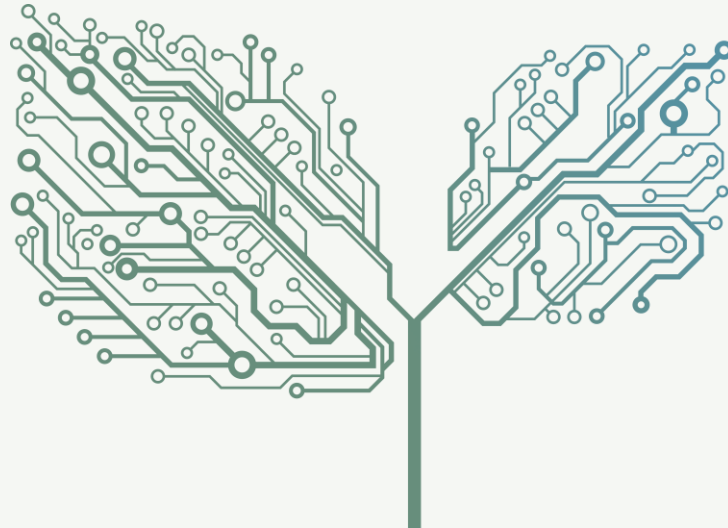
Intraday Market



- Continuous, fast-paced trading of energy.
- Supports the balancing of the power system and brings extra earning opportunities for batteries.
- Trading algorithms must be extremely fast to realize these transactions.
- **Will be more and more important in the revenue stack.**



How we maximize the earnings of BESS from these markets?

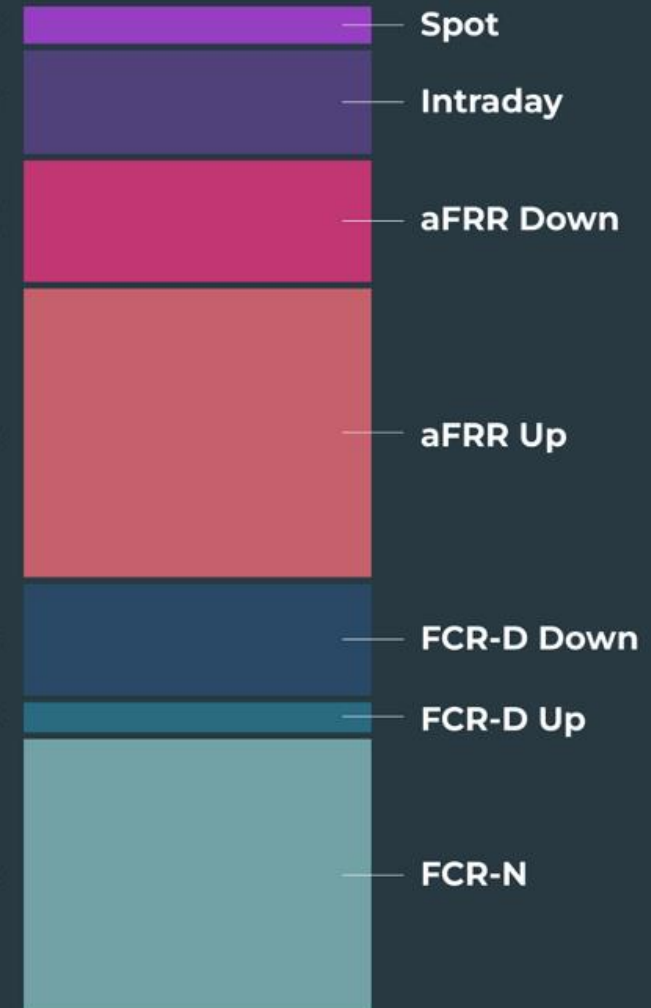


BESS Revenue Streams



- Ancillary markets
 - FFR, FCR-D, FCR-N, aFRR, mFRR
- Wholesale markets
 - Spot and Intraday
- Earnings are maximized by optimizing the BESS "revenue stack" every moment of every day
 - Multi-market optimization

PROFIT BY MARKET



Multi-Market Optimization



The AI models form an optimal weighting of different revenue streams to maximize the returns.

The models use the following for bid formulation:

- Price Forecasts
- Weather Forecast
- Grid-Status Forecasts
- Energy storage characteristics (power, energy capacity, warranty terms)

The trading models are **self-learning**.



The AI Models



1. Optimize the price obtained between ancillary markets and energy arbitrage.
2. Maximize revenues across different ancillary markets by utilizing our price forecasts.
3. Minimize battery wear and reduces cycle count while maximizing revenue from ancillary markets.
 - Warranty terms are always considered



Product Feature Differentiation

Capalo Zeus VPP

Traditional Aggregator or Trader

ANCILLARY MARKETS:

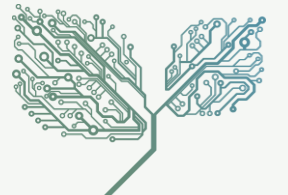
FFR	✓	✓
FCR-D	✓	✓
FCR-N	✓	✓
aFRR	✓	✗
mFRR	✓	✗

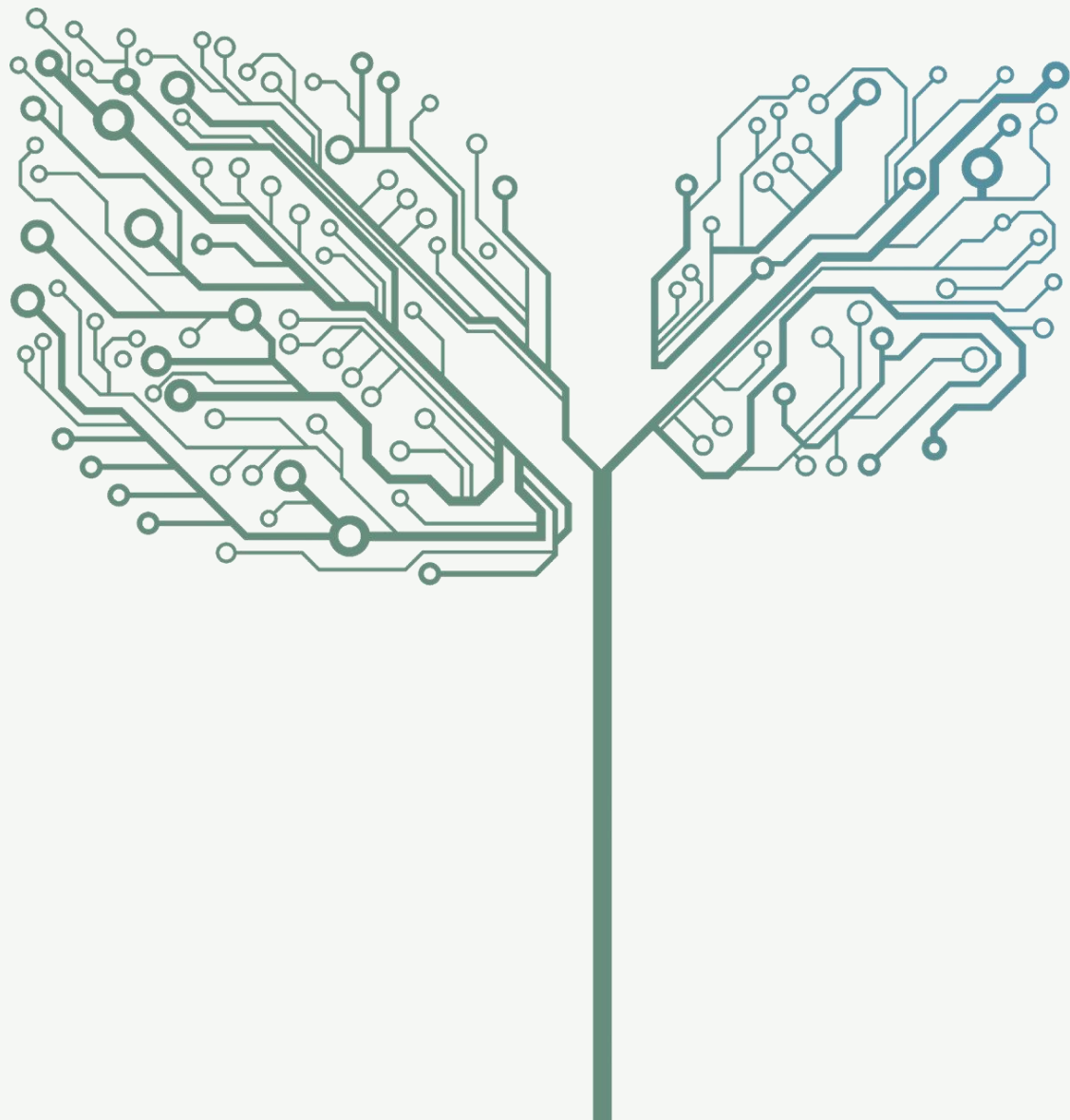
WHOLESALE MARKETS:

Spot	✓	?
Intraday	✓	✗

KEY FEATURES:

Multi-Market Optimization across all markets	✓	✗
Forecasts for all markets	✓	✗
Self-learning trading strategies	✓	✗
Pooling of the batteries to maximize profits	✓	✗
Considering the effects of own bids (saturation)	✓	✗





BESS Revenues in Finland



- **40,700 €/MW/month under our optimization, H2 2023**
([see. Exilion's case study](#))
 - 6 MW/6,6 MWh battery
- Revenues remained similar in 2024



HENRI TASKINEN
Chief Executive Officer



RIKU KUKKONEN
Chief Sales Officer



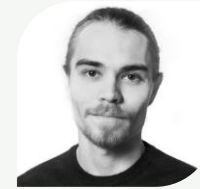
EERIK JAUHIAINEN
Chief Technology Officer



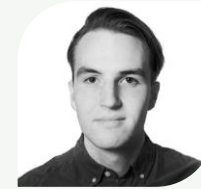
TEEMU LAPPALAINEN
Chief Operating Officer



CHRISTINA BRESTER
Lead AI Scientist



ELIAS VÄNSKÄ
Lead Data Scientist



TONI TERVANEN
ML Engineer



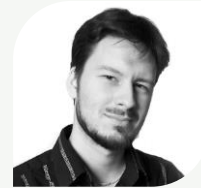
LAURI HIMANEN
ML Engineer



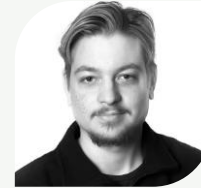
VESA MÄKITALO
Cloud Solution Architect



HIEU PHAM NGOC
ML Engineer



TEO KORHONEN
AI Scientist



AATU TUOMISTO
ML Engineer



JOONA SAVELA
RL Engineer



PANU MATILAINEN
Business Development



TAM NGUYEN
ML Engineer



IREN NAARITS
Head of People & Regulation



KHOA LAI
Cloud Solution Architect



SAMULI SUMMALA
Cloud Solution Architect



MIMI LOUNIO
Head of Marketing



TOMMI LEHTIHULTA
Business Development Executive



FRANS HIETARANTA
Operations Associate



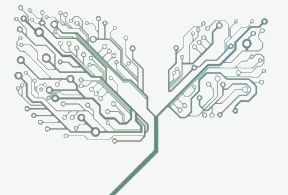
DANIEL WOHLRATH
Trading Engineer



VILJAMI MERILÄINEN
Operations Associate



KRISTIINA SIILIN
Key Account Manager



TAALERI
Energia



“ Renewable energy is the only sustainable way to achieve global climate targets. Storage facilities are needed in order to increase the share of renewable energy in the electricity grid further. This trading agreement with Capalo AI ensures our BESS investment will be utilized optimally on an hour-to-hour basis to help achieve these targets. ”

ALEKSI NORDLUND

Director Power Markets at Taaleri Energia

30 MW / 36 MWh

enordic



“ Battery energy storage systems are essential in enabling the clean energy transition and securing the resilience of the Finnish grid. With multiple markets and increased volatility, the optimization and trading of the battery becomes a key competitive advantage. We're happy to partner with Capalo AI to maximize the profitability and impact of the 38MWh asset. ”

EERO AURANNE

Chairman of the Board of eNordic, Ardian's operating partner in the Nordics

38.5 MW / 38 MWh

exilion

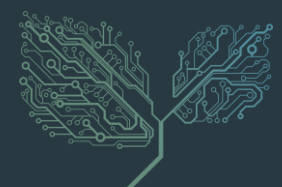


“ As one of Capalo AI's first customers, we are happy to use AI-powered optimization services. With Capalo AI's platform solution, we have managed to significantly increase the profitability of flexible assets in a complex operating environment. ”

TOMMI RISKI

Investment Manager at Exilion

6 MW / 6.6 MWh



CAPALO_{AI}

