Montel Finnish Energy Day 2023

Batteries to support frequency and balance rising wind and solar output



Disclaimer: Bodecker Partners is part owner of Scandinavian Capacity Reserve AB, a battery project developer Lets start where we finished the last time...

Conference programme 9.00 - 9.30 Registration and coffee

9.30 - 9.45 Welcoming words Marja Salonen and Olav Vilnes, Montel

9.45 - 10.15 Finnish power sector in transition Jukka Leskelä, CEO, Finnish Energy Industries

10.15 - 10.45 Key issues in the clean energy package Matti Supponen, Policy Co-ordinator, European Commission, DG Energy

10.45 - 11.15 Coffee

11.15 - 11.45 Utilities need to change to stay in the game Hando Sutter, CEO, Eesti Energia

11.45 - 12.00 Case 1: Batteries to provide market flexibility Ilari Alaperä, Business Development Manager, Fortum

12.00 - 12.15 Case 2: New market place to trade flexibility Marianne Wergeland Jenssen, Markets Director, Nord Pool & Board Member NODES

Q&A session

12.45 - 14.00 Lunch

14.00 - 14.30 Global commodities outlook Trevor Sikorski, Head of Natural Gas and Carbon, **Energy Aspects**

14.30 - 15.00 Will the Nordic power surplus disappear? Olav Johan Botnen, Senior Analyst, Wattsight

15.00 - 15.30 Coffee

15.30 - 16.00 Will PPAs replace subsidies for renewables? Jesper Düring Lausen, Regional Manager, NEAS Energy

16.00 - 16.30 The future of power trading Fredrik Bodecker, CEO, Bodecker Partners

16.30 - 17.00 Panel discussion

Participants: Juha-Pekka Paunu, Category Manager Energy at Hansel, Sami Oksanen, Director Nordic & Baltic at Nord Pool, Fredrik Bodecker and Jesper Düring Lausen

17.00 - 17.10 Montel AI - Modelling using machine learning

Sigfred Sørensen, Software Developer Montel U

17.10 - 18.00 Drinks on Fredrik Bodecker to celebrate his 60th Birthday



8.30 - 22.30 Dinner cruise on MS Emr

#MontelEnergyDays

FINNISH ENERGY DAY

Helsinki, 7 June 2028

9.30-10.15 Update on short term trading algoritms



16:45-17.10 Fredrik Bodecker tells memories of the good old days.

Grid scale batteries

Global grid-scale battery storage has more than doubled in three years

Countries by electrochemical grid-scale battery storage over time (GW)



Source: GlobalData

Wright's law **O**r **Experience** curve effects



Pioneered by Theodore Wright in 1936, Wright's Law aims to provide a reliable framework for forecasting cost declines as a function of cumulative production. Specifically, it states that <u>for every cumulative doubling of units produced, costs</u> <u>will fall by a constant percentage.</u>

Laptops => Mobile phones => Electric Cars => Grid scale batteries

Large Volumes drives Wright's Law!

A challenge for nuclear, even SMRs...and electrolyzers



Source: IRENA 2020 for all data on renewable sources; Lazard for the price of electricity from nuclear and coal - IAEA for nuclear capacity and Global Energy Monitor for coal capacity. Gas is not shown because the price between gas peaker and combined cycles differs significantly, and global data on the capacity of each of these sources is not available. The price of electricity from gas has fallen over this decade, but over the longer run it is not following a learning curve. Licensed under CC-BY by the author Max Roser

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Prices are adjusted for inflation and given in 2018 US-\$ per kilowatt-hour (kWh). Source: Micah Ziegler and Jessika Trancik (2021). Re-examining rates of lithium-ion battery technology improvement and cost decline. Licensed under CC-BY by the author Hannah Ritchie. OurWorldinData.org - Research and data to make progress against the world's largest problems.

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Electricity from renewables became cheaper as we increased Our World in Data





15-21% COST REDUCTION AT EVERY DOUBLING OF VOLUME!

Where are we?



• • • Battery LCOE per Kwh - 15% Learning Rate • • • Battery LCOE per Kwh - 21% Learning Rate • • • Hypothetical Flow or CAES Storage

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2030

The challenge for electrification with renewables – from variable to (near) base load



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The answer: hybrid parks!

Wind + solar + batteries

Why Hybrid parks?

Get closer to baseload. Solar+wind 4800 hours (Spain)

Reduce cannibalization (increase capture rates)



Improve performance of PPAs



Create plannable production (become a trader!)



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The Finnish Wind Wonder





SE2 change in capture rate and production

Capture rate development SE2

	Wind prod. (GWh)	Share of SE2 prod.	Captured price	Avr Spot price	Diff price	Capture rate
2017	5 624,860	13%	29,50	30,86	- 1,36	96%
2018	5 859,252	15%	42,21	44,20	- 1,99	96%
2019	6 320,783	15%	36,81	37,97	- 1,15	97%
2020	10 572,492	20%	12,63	14,37	- 1,74	88%
2021	10 796,539	21%	33,78	42,53	- 8,75	79%
2022	13 941,806	26%	36,83	61,95	- 25,13	59%
2023	5 686,182	32%	41,92	54,72	- 12,81	77%

From 5 to 14 GW in four years just like Finland!

Solar even worse!

Experience from other areas: Capture rates down towards 60% at a 15% market penetration of solar pv!

Example: 15% in SE4 in summer is 300-350 MW solar pv:s



or

Batteries!



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"Summer is coming!"

MONTEL

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Solar drives European power prices below zero on Sunday

(Montel) Power prices in several European nations plunged below zero during some hours on Sunday – the fourth consecutive weekend with negative prices – amid robust solar output and low demand.

In Germany, Europe's biggest power market, prices dropped to as low as EUR -34.99/MWh in the hours between 11:00-17:00 CET.

Solar power generation reached 37.8 GW at 13:00 CET, when power prices were the lowest, while wind power generation contributed 8.6 GW, according to Montel Energy Quantified (EQ). Demand stood at only 48.2 GW at the same time.

Elsewhere, the Netherlands saw the lowest hourly prices on Sunday, with prices dropping to as low as EUR -66.67/MWh. Prices in the Nordic region also sank below zero.

Analysts expect a greater frequency of hourly power prices falling <u>below zero</u> in some European nations due to a growing capacity of intermittent renewable energy, especially during periods of low demand, Montel reported last week.

Reporting by: Christian Driessen <u>christian.driessen@montelnews.com</u> 08:50, Monday, 12 June 2023

Editing by: Jeff Coelho



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Decreasing capture rates

Battery hybrid parks

Hybrid ratios

X-Links (Morocco):

Wind + Solar 10,5 GW

Battery 5 GW / 25 GWh

=> 3,6 GW for 20 hours

NextEra (Oregon):

Wind 300 MW

Solar 50 MW

Battery 30 MW / 120 MWh

Haringvliet (The Netherlands):

Wind 22 MW

Solar 38 MW

Battery 12 MW

Portland (Australia):

Wind 40 MW

Solar 20 MW

Battery 2 MW

Alajärvi (Ilmatar):

Wind 218 MW

Solar 150 MW

Battery 25 MW / 50 MWh

Conclusion:

Local conditions results in very different hybrid ratios.

However...



Reduce canibalization. => Batteries still (just) too expensive, but soon

Improve performance of PPAs. => Partly, but as a side-effect. Better to optimize for energy arbitrage.

> But wait!...

Why Hybrid parks?

Get closer to baseload. Solar+wind 4800 hour (Spain)

Get a hybrid park for free-through frequency support (and capacity) markets! *Reduce cannibalization (increase capture rates)* Improve performance of PPAs

Reserve markets in Finland

- involving both generation and consumption

	FFR	Ð	FCR-N	PRR	FRR
	Fast frequency reserve	Frequency Containment Reserve for Disturbances, 220–265 MW Nordic region total 1,200 MW	Frequency Containment Reserve for Normal Operation, 138 MW Nordic region total 600 MW	Automatic Frequency Restoration Reserve, 70 MW Nordic region total 300 MW	Total Nordic balancing power markets
Activation	In the event of major frequency deviations, in use in the event of low inertia	In the event of major frequency deviations	In use constantly	In use at specific times of day	If required
Speed -	One second	A few seconds	A couple of minutes	Five minutes	15 minutes

Sammanställning utfall samt förväntade kostnader

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Learnings from UK, Australia, USA =>

We tend to forget our hangovers...

Revenues from frequency markets will be replaced by energy arbitrage from more variable production.

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Saved by electrolyzers? (=> no need for batteries)

"This is the way"

"Hydrogen is the way"



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The Hydrogen Hallelujah

Electrolyzers, electrolyzers, everywhere electrolyzers!

The European Commission's REPowerEU program seeks to double the EU's 2020 domestic renewable hydrogen production target to 10 million mt/year, requiring in the region 80 GW of electrolysis, with an additional 10 million mt/year in imports. REPowerEU is designed to make the EU independent from Russian fossil fuels well before 2030, in response to Russia's Feb. 24 invasion of Ukraine.

The UK has followed suit, doubling its low-carbon hydrogen production target to 10 GW by 2030, v ith half of this from electrolysis.

Public money is starting to flow. The EU has approved the first 13 billion euros (\$13.7 billion) of the 430 billion euros (\$450 billion) promised under its 2020 Hydrogen Strategy and is now working to launch a "Hydrogen Bank". The US Inflation Reduction Act (IRA) provides a ten-year tax rebate per kilogram of green hydrogen worth \$3, which will soon be more than the production cost itself. Free hydrogen anyone?

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90+ GW electrolyzers in 2030....

1. Where will all the power come from?



2. => Variable power from wind and solar no longer a problem! (Or?)



First comes low prices!

"The best cure for low prices is low prices"

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We overestimate the learning curves for electrolyzers!

Lower volume More BOP More compressors, pipes, valves etc.



Michael Liebreich • Following Speaker, analyst, writer, advisor, investor in the future ec... 4h • 🚱

"Here are my 2023 predictions for hydrogen: one-third of the projects promoted during the year will make sense; two-thirds will be dumb as a rock; 90% of both will never see the light of day. Happy New Year!" Large scale wind (and solar) power will come several years before the demand catches up

The laws of thermodynamics



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The electrolyzer hallelujah choir will be much slower than the renewables buildout



Where will the Finnish prices be in 2030 with another 30 GW renewables a windy sunny day?



James Cameron at the Mariana trench, 11 000 meters deep.

Conclusion...and a forecast

Conclusions

Large-scale battery parks will, sooner than we think, create firm power. Electrolyzers will come, but not save the producers until after 2035. Prices will drop (hard) but eventually batteries will give back producer control

Fredrik Bodecker's longterm forecast for Finland



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German wholesale power prices, 2008–15, €/MWh





"Leading" energy consultants predicting German power prices

Långtidsprognoser elcertifikat 2011–2016



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So, here is the Finnish power price forecast for the next 20 years!

Finnish power prices 2023-2050



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For last, some culture...





Write a limerick about the FInnish power market



In Finland, so brisk and so stark, The power flows light in the dark. Nuclear thrives, And wind power drives, A dance of electrons, a spark.





There once was a firm, Montel grand,

Tracking energy prices in the land.

In the Finnish domain,

They mastered the game,

With data at their command, so well planned!

Thank you!