Unlocking Hydro's Full Green Battery Potential

Green Energy Flexibility in a Dynamic Grid Landscape

Energy Transition Challenges

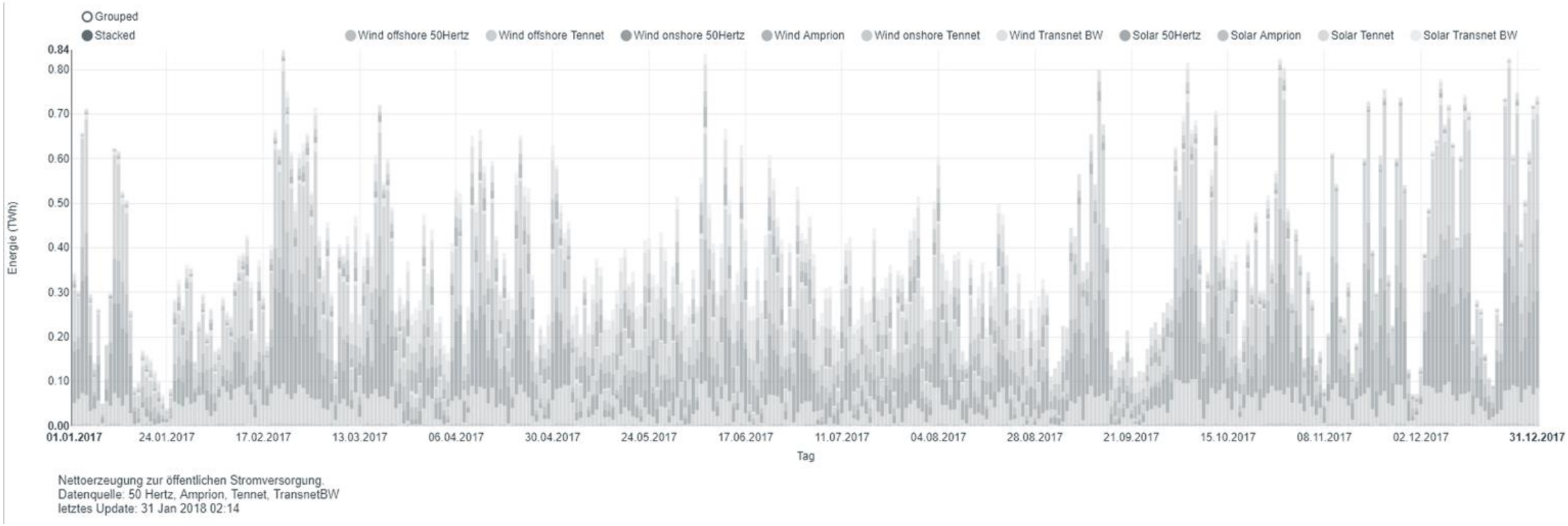
Increased flexible production like wind & solar creates new challenges for energy markets & the grid

GRID CHALLENGES

MARKET VOLATILITY INCREASE

The Intermittent Renewables Challenge

Generation varies over time…



Huge amounts of storage capacity are needed to balance supply and demand in real-time.

Quelle: https://energy-charts.de

The Storage Problem

Energy transition problems and how hydro power is the silent giant hidden hero of the renewables transition

How to Solve the Storage Problem

Intelligent combination of storage mediums will be required to allow full integration of wind and solar

HYDRO STORAGE

+ PREDICTABLE
+ LARGE STORAGE VOLUME
+ RAPID REACTION
- NOT POSSIBLE EVERYWHERE

BATTERIES

+ DE-CENTRAL LOCATIONS
+ RAPID REACTION
- SMALL STORAGE VOLUME
- RARE EARTH MINING

DEMAND RESPONSE

+ DE-CENTRAL LOCATIONS
- LIMITED DISPATCHABILITY
- LIMITED STORAGE CAPACITY

NEW TECHNOLOGIES

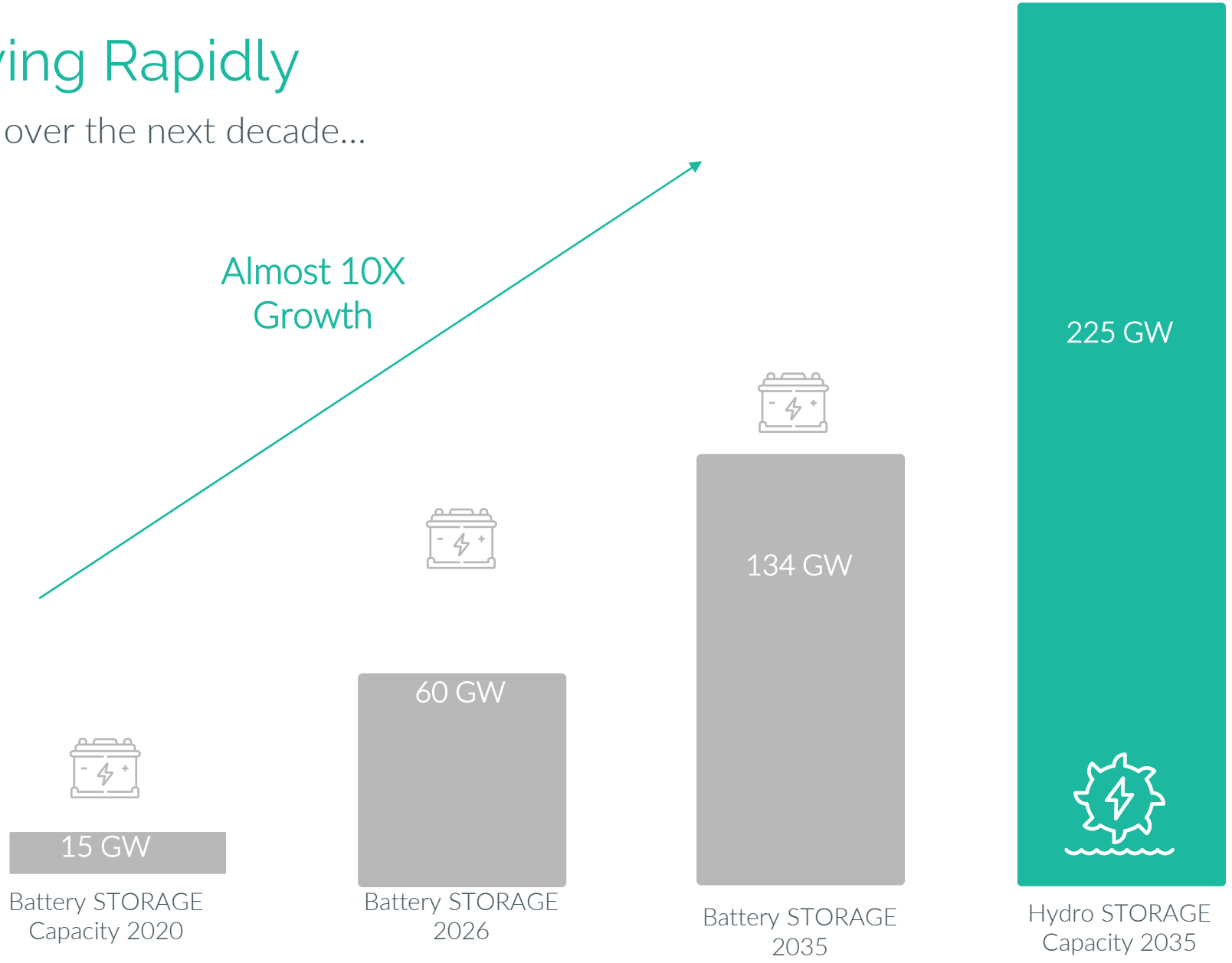
+ LARGE STORAGE VOLUME
- CENTRAL & LARGE INVESTMENT
+ LARGER STORAGE VOLUME & NO RARE EARTHS

Batteries are Growing Rapidly

Batteries will grow almost 10x over the next decade…

… will they become the most important storage medium?

Hydro storage capacity still dwarfs batteries way past 2035



SOURCES: https://www.statista.com/statistics/1307203/world-battery-storage-electricity-generation-capacity/
https://www.iea.org/articles/how-rapidly-will-the-global-electricity-storage-market-grow-by-2026

But viewing data in GW paints a very skewed picture…

Load Factor - Full Load Hours		2020	2026
Pump-Storage Hydro	GWh/GW	53	60
Battery	GWh/GW	1	3

- Average storage capacity of batteries is ~1 hour and will develop towards 3 full load hours with technological advances
- Average hydro storage volume is ~3 DAYS (= 20x larger per GW)

We need minimum 12 HOURS to cover day/night consumption patterns, even longer for periods of no wind ('Dunkelflaute').

→ How does the picture look in GWh = Storage Volume (not Storage Capacity)?

Hydro Power Is & Remains the Green Battery

Hydro power will be the largest source of grid-scale storage for many more years

TODAY

Battery = 0.2%
of Hydro Storage Volume

20 GWh

8.500 GWh

Hydro PUMP-STORAGE Capacity TODAY

2035

350 GWh

12.500 GWh

Hydro PUMP-STORAGE Capacity 2035

Battery = 2.5%

of Hydro Storage Volume

But a significant part of hydro storage potential is not reflected in these figured because it is currently UNUSED.

→ Why does hydro storage potential go unused?

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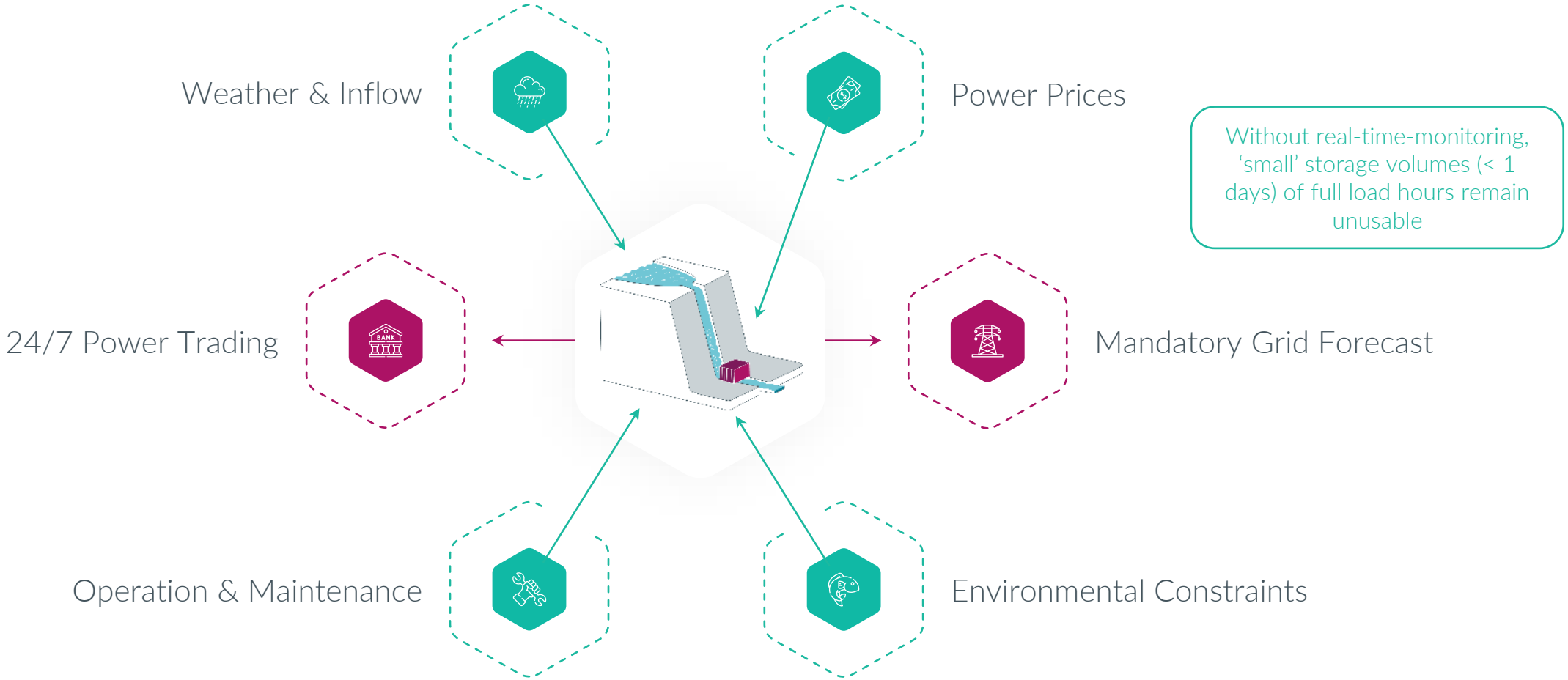
https://www.iea.org/articles/how-rapidly-will-the-global-electricity-storage-market-grow-by-2026

Why is hydro storage potential wasted?

Hydro plant operators have to balance many complex objectives, 24 hours a day - Inflow and reservoir level needs to be monitored continuously based on the weather and in tight interaction with environment.



Without real-time-monitoring, ‘small’ storage volumes (< 1 days) of full load hours remain unusable

What does this mean in practice?

Without real-time process, significant hydro storage potential goes unused

Hydro storage capability ranges from

- SEASONAL → Likely used
- WEEKLY → Mostly used
- DAILY → Rarely used
- HOURLY Storage → currently mostly unused

How can we fix this and lift this potential?

Real-time reaction unlocks hydro storage potential

Predictive production planning in real-time makes also small hydro storage accessible as ‘green battery’ to the grid

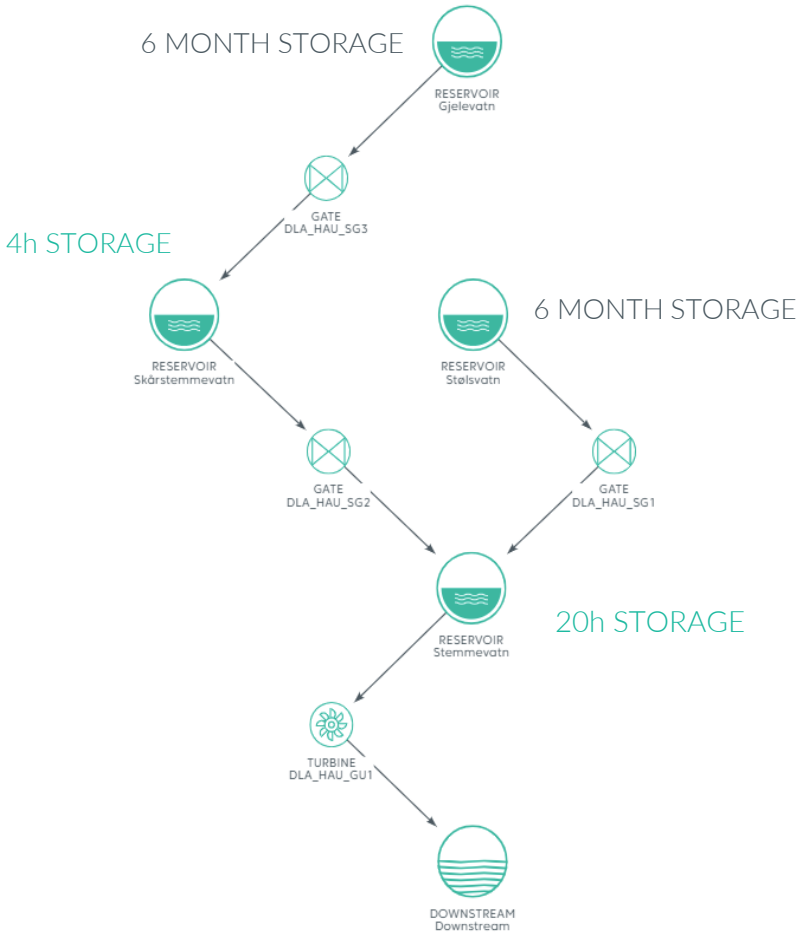
Real-Time
Monitoring & optimal dispatch 365/24/7

Data-Driven
Models continuously learn & recalibrate based on data

Automated
Digitalize your process from water to money and increase profitability

CASE STUDY: Making hydro storage potential usable

Real-time optimisation of water flow in complex cascades is not possible with manual process



DALANE ENERGI

TURBINE	1 Francis
CAPACITY	4.5 MW

HISTORICAL PROCESS

- Fixed profile
- Manual hatch control

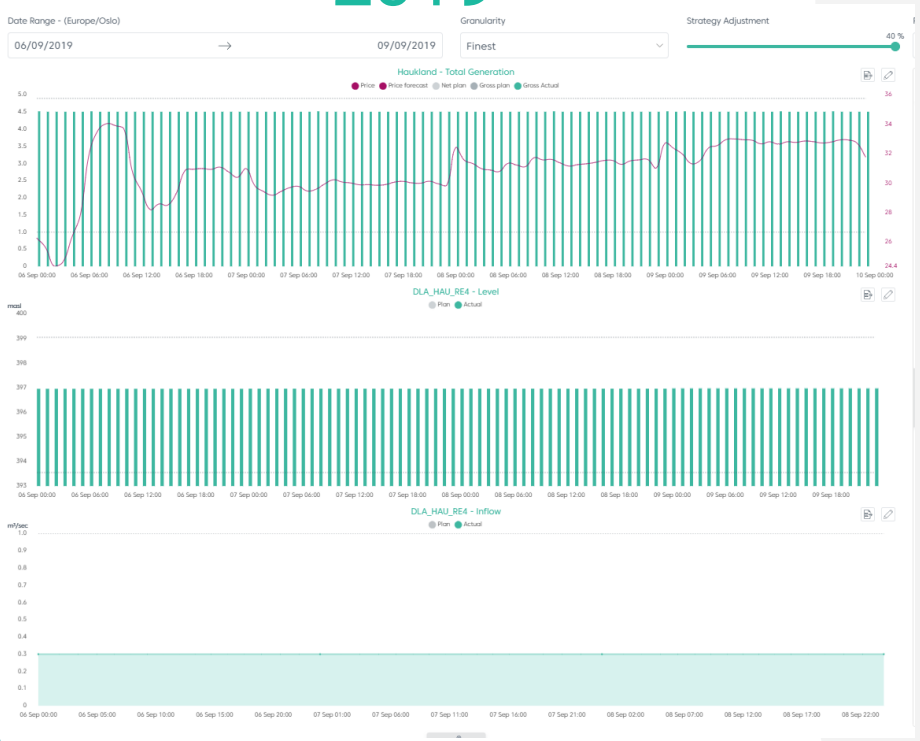
NO FLEXIBLE DISPATCH

→ STORAGE POTENTIAL UNUSED

CASE STUDY: Making hydro storage potential usable

Real-time predictive planning empowers small & medium hydro storage to be available as ‘green battery’ to the grid

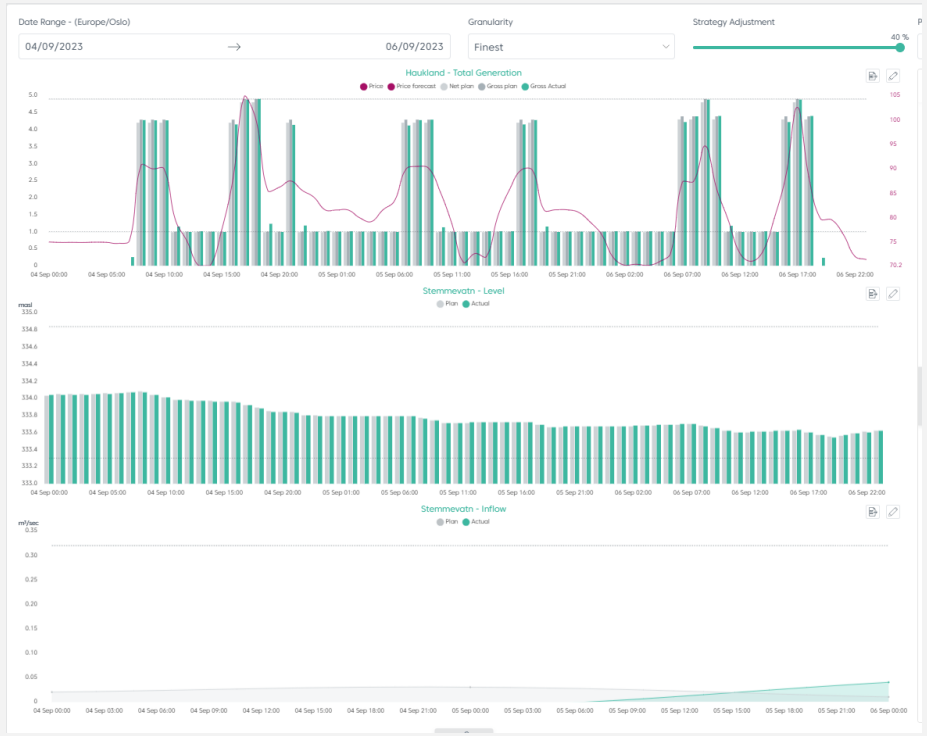
2019



DALANE ENERGI

→ 4.5 MW STORAGE
POTENTIAL WASTED

2023



DALANE ENERGI

→ 4.5 MW STORAGE
POTENTIAL USED
= 20.000 Tesla Power Walls

TODAY THE WORLD BOASTS

100.000 HYDRO PLANTS

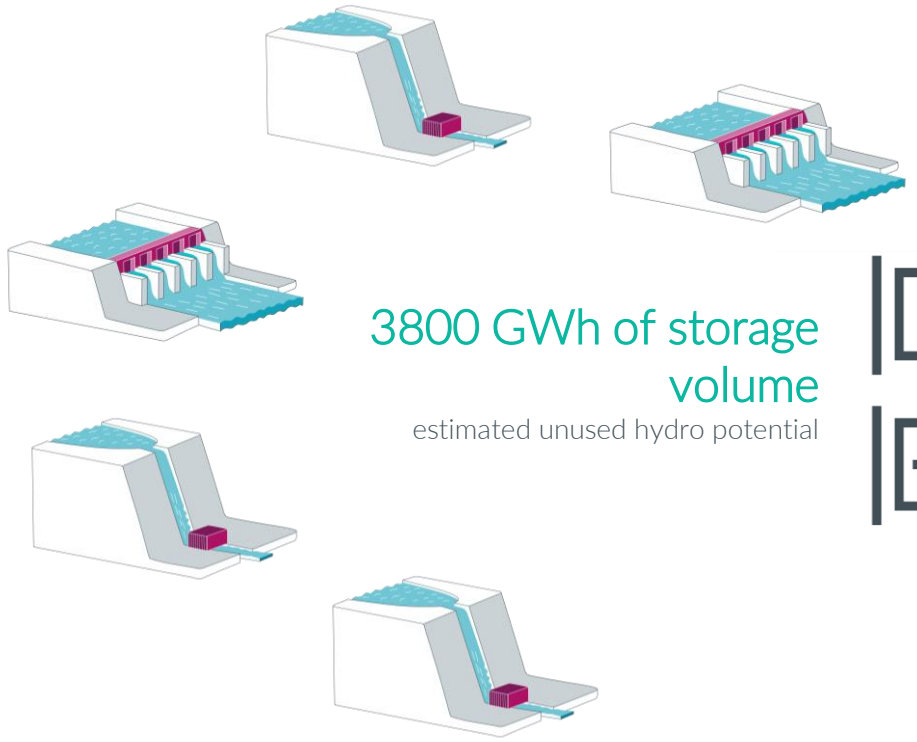
OF WHICH

80.000 SMALL HYDRO PLANTS
& MOSTLY NOT DIGITALIZED

→ ASSUMING ONLY 5% OF THESE HAVE PHYSICAL STORAGE CAPABILITY
→ 3800 GWH OF STORAGE VOLUME POTENTIAL CURRENTLY UNUSED

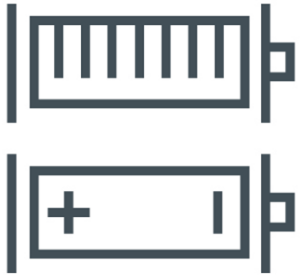
Unlocking a ‘green’ battery to the grid

Making hydro available to the grid in real-time will unlock large storage potential without upfront investment need



3800 GWh of storage volume

estimated unused hydro potential

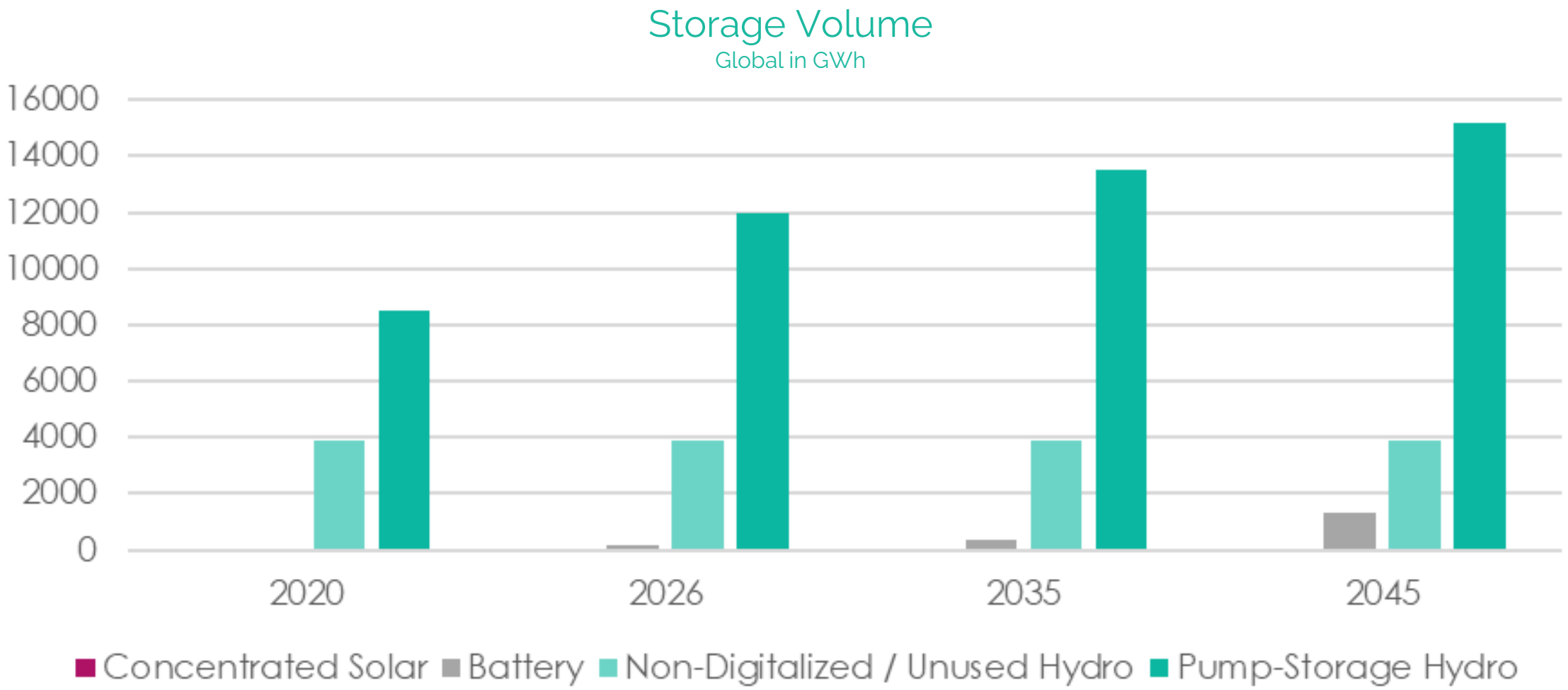


300 million Tesla power walls

@ 13.5 kWh

Let's tap into the unused potential

Enabling hydro storage potential with digitalisation is A huge lever in the energy transition



CONCLUSION

1. Successful energy transition requires combination of multiple storage technologies

2. Use the ‘best option’ for each centralized / non-centralized use case based on physical availability

3. Invest significant resources to…
   - Develop (better) battery technology without rare earths and larger storage volume (‘solid state battery’)
   - Digitalize & financially incentivize hydro power to make huge storage potential available to the grid

HYDROGRID

Make Hydro a Power for The Future

optimize@hydrogrid.ai +43 1 375 3333 30 hydrogrid.ai