Scatec

Fra Fossil til Fornybar Satsning

Balansert utbygging og omlegging

Øyvind Engelstad, SVP Projects Hydropower, Scatec ASA

Scatec in brief

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Develop, build, own and operate renewable energy

3.5 GW in operation and under construction

More than 500 employees in 24 countries

Latin America

383 MW

Europe & Central Asia

506 MW

Africa & Middle East

1,175 MW

Rest of Asia

1,450 MW

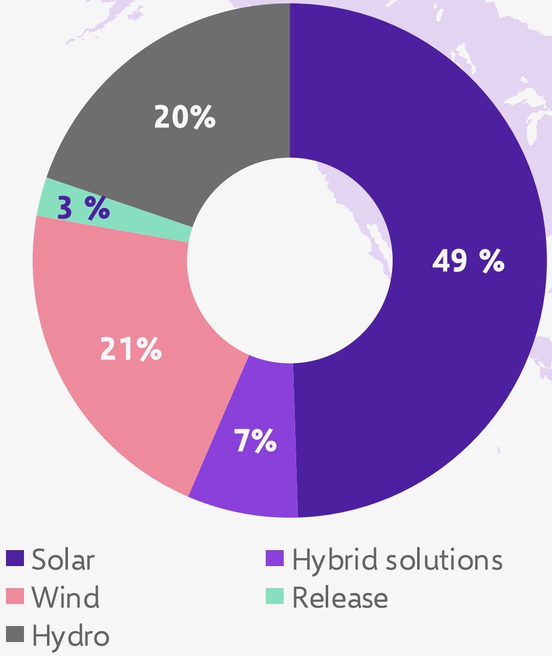
2,053 MW

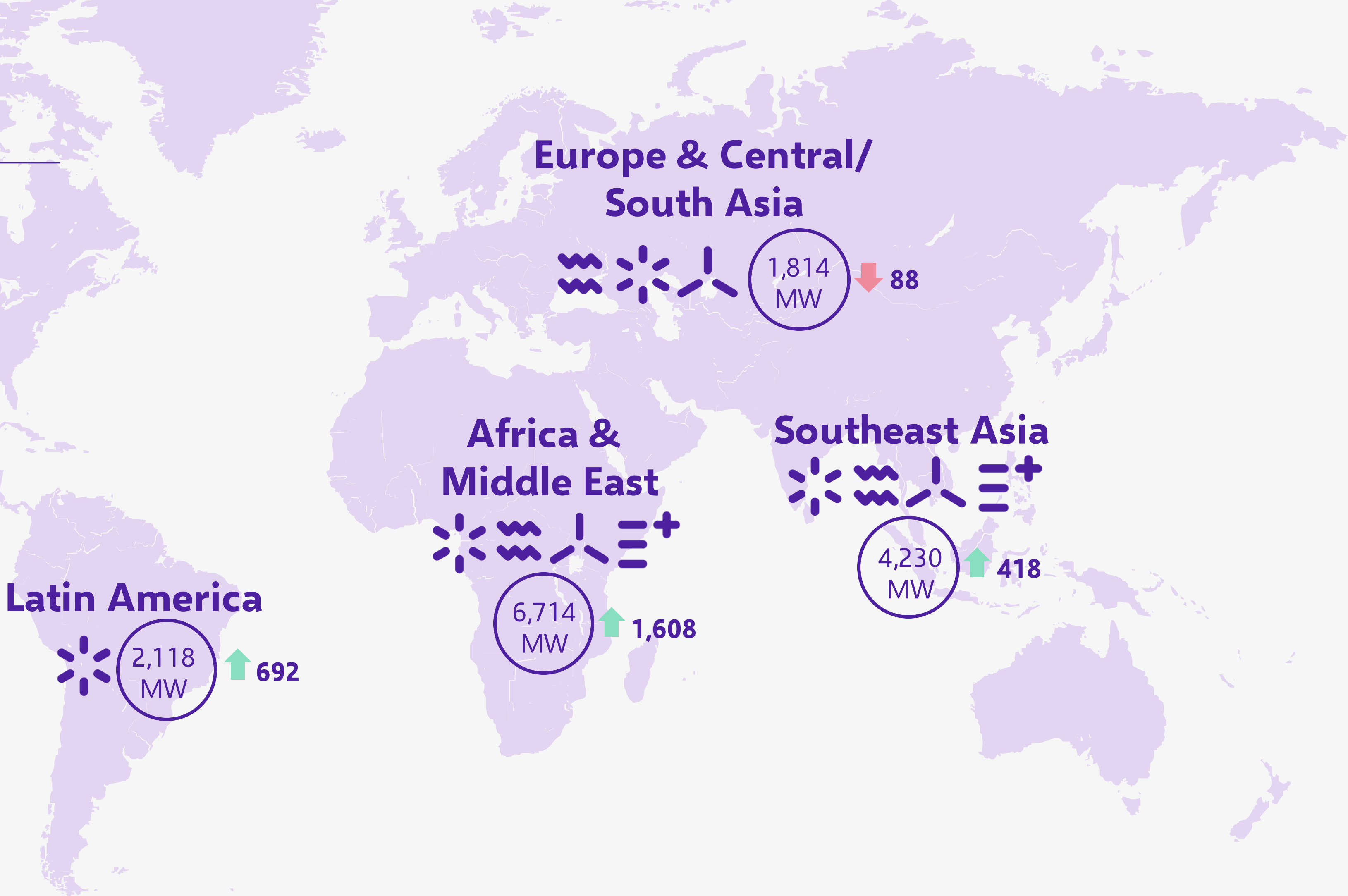
1,422 MW

39 MW

Project backlog & pipeline of more than 14 GW

Pipeline





All figures are as of Q2 2021 reporting date.

On the road to 15 GW in 2025

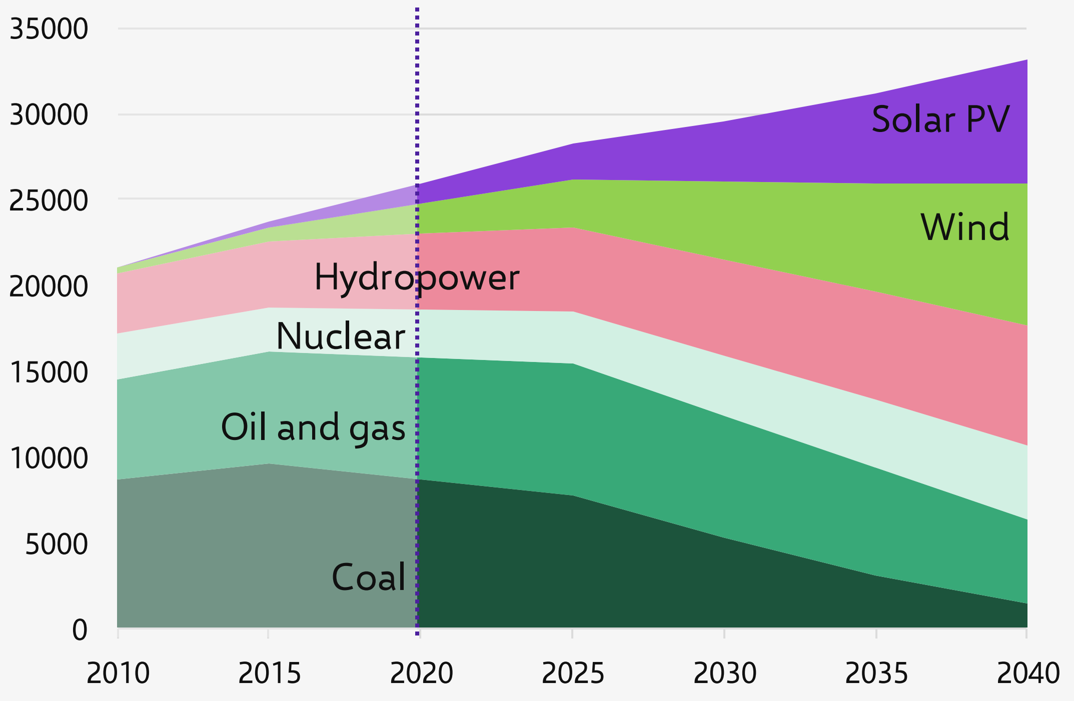
Some highlight projects in backlog and construction:

- 206 MW Ruzizi III HPP – Rwanda, DRC, Burundi
- 350 MW Mpatamanga - Malawi
- 125 MW Volobe HPP - Madagascar
- RMIPPP 560 MW PV + 225 MW (1142 MWh) BESS, South Africa
- 900 MW ACME PV, India
- Sukkur 150 MW PV, Pakistan
- 120 MW Kinguélé + Tchimberle HPP, Gabon

With large amounts of new RES entering the future energy systems, what will be the role of hydropower?

New renewables are expected replace fossil fuel generation and meet new demand

Generation mix in IEA's Sustainable Development Scenario (TWh)



Sources: IEA (2019), World Energy Outlook

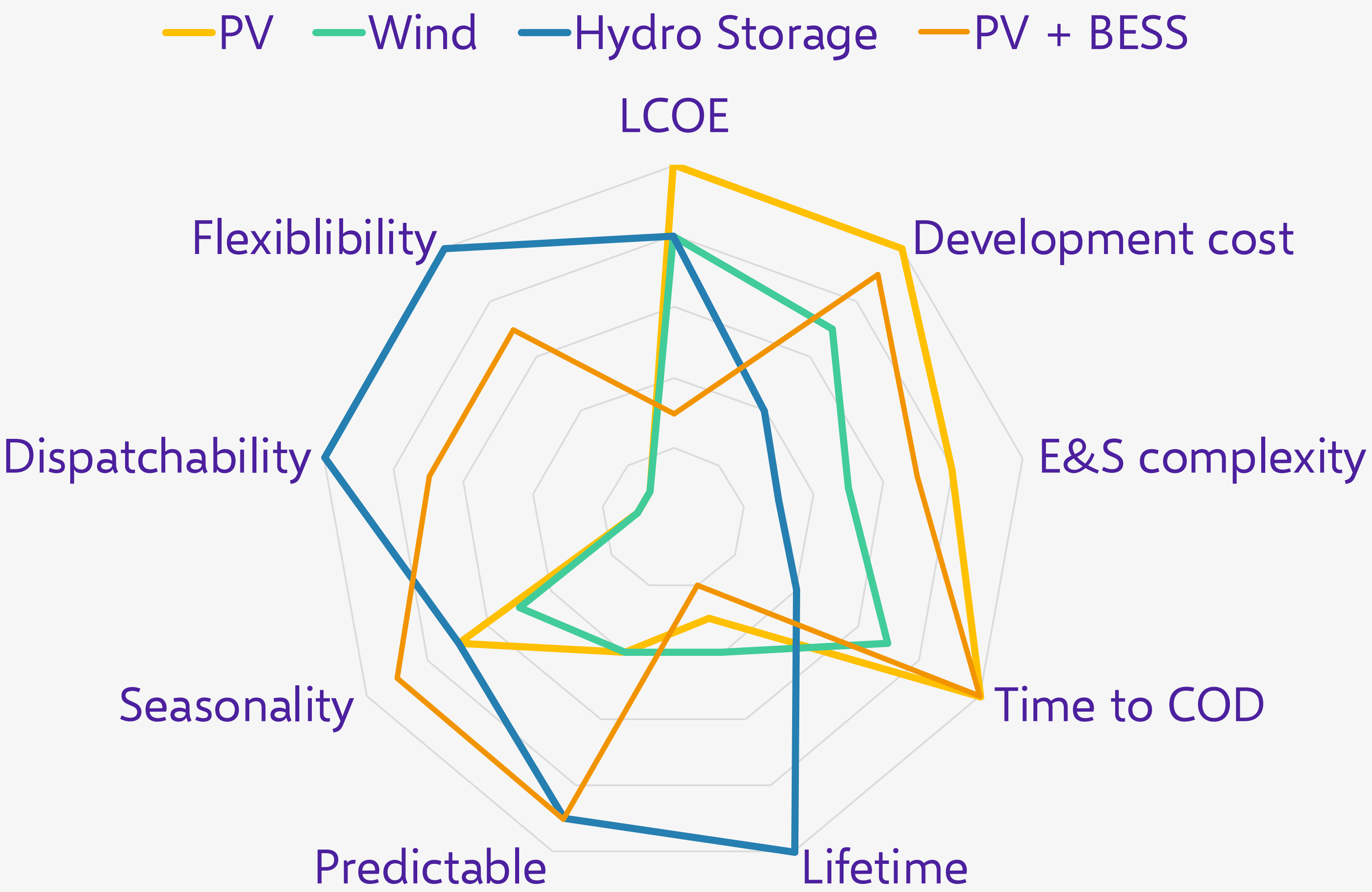
Higher shares of VRE generation will increase the demand for flexible generation

Time scale	Role of flexibility	Product
Seconds Minutes	Maintaining grid stability by adjusting power output in response to unforeseen events	Reserved capacity
Hours Days Weeks ++	Maintaining the supply-demand balance by scheduling energy generation to meet expected demand	Flexible energy

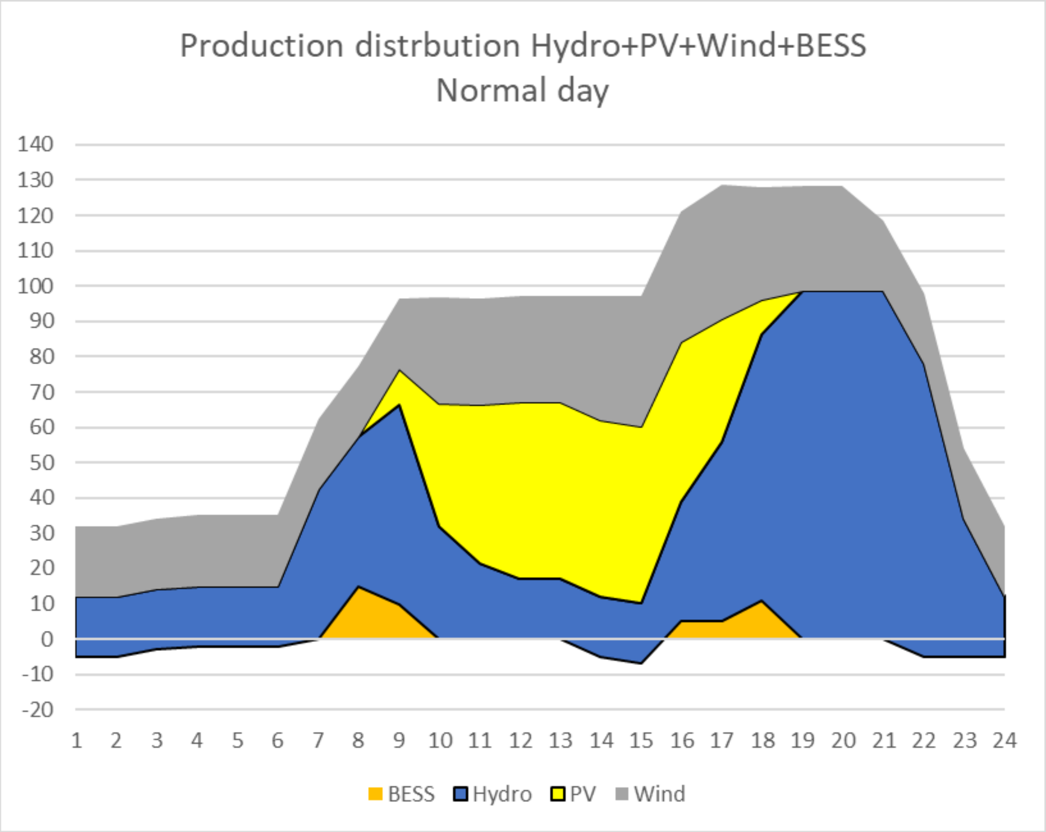
As the dispatchable oil and gas portion of the market decreases and intermittent energy increases, hydropower will play a more important role in securing sustainable energy supply and

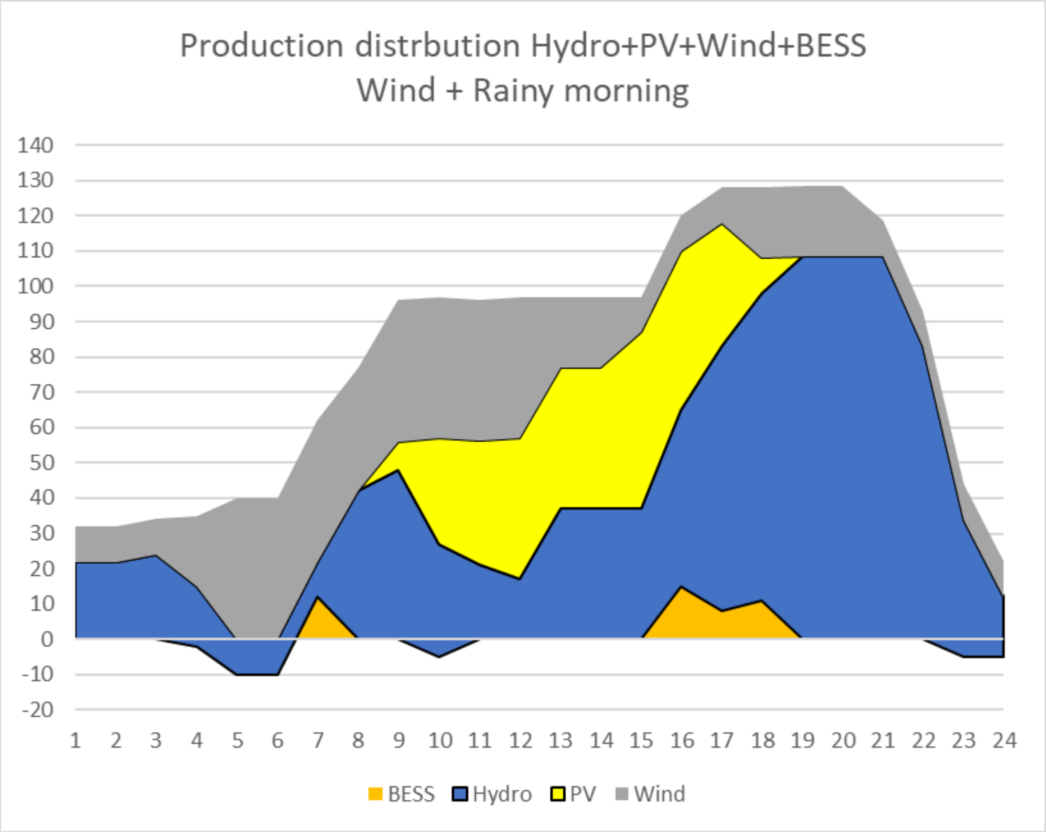

release

Comparing characteristics of renewables



Hydro + Battery + Solar + Wind



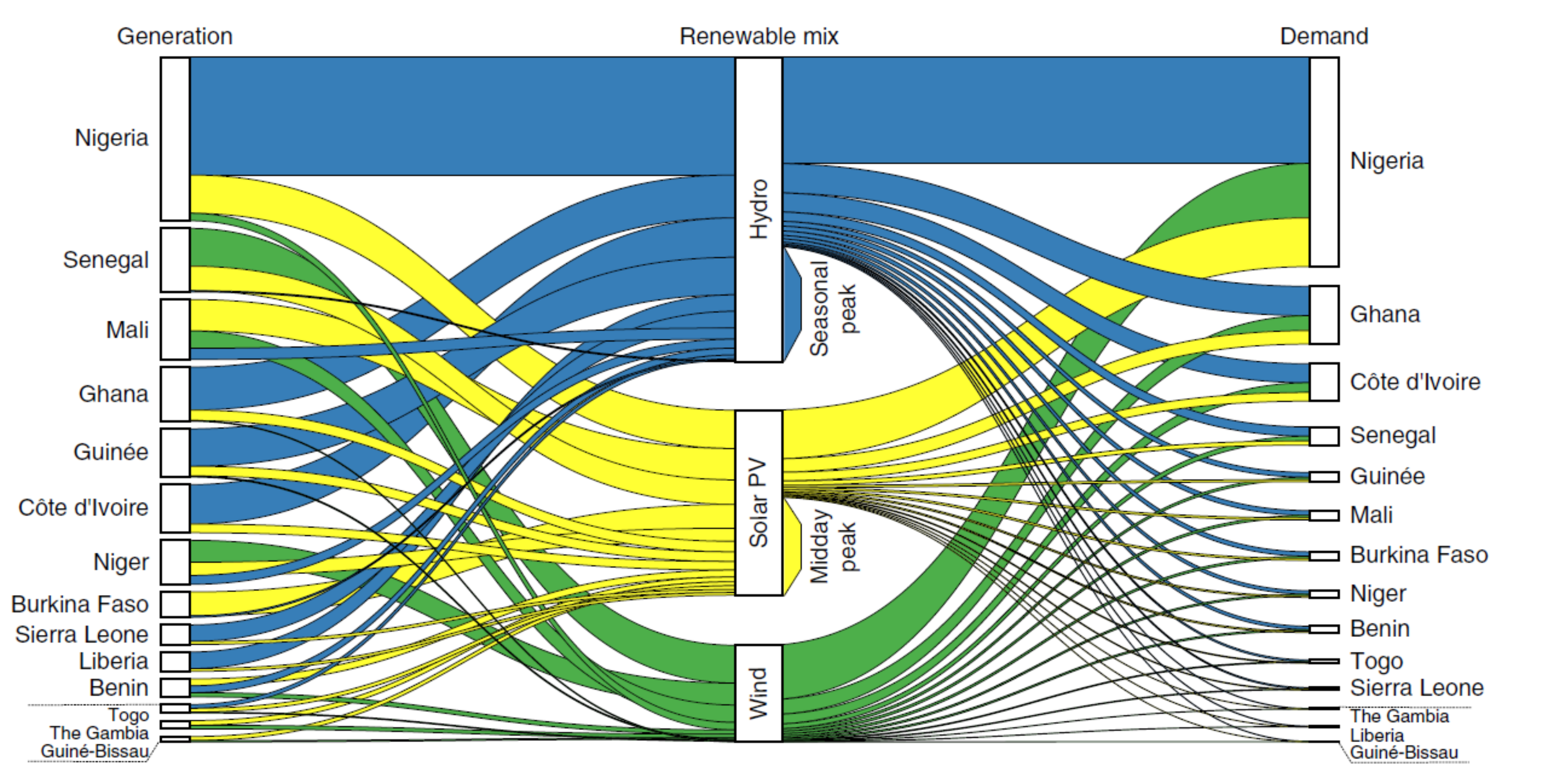


Optimisation of hybrid systems requires good forecasting of intermittent energy and optimisation of dispatch within the technical constraints of the resources in the grid

Regional balancing Example West African

- Hydro is the dominant part of the energy mix in West Africa with solar and wind providing the remainder.
- Smart management of hydropower plants in West Africa can support substantial grid integration of solar and wind power
- Potential may be higher in the CAPP and SAPP
- Source: Sterl et al, 2020, Nature Sustainability

To achieve a transition from a largely fossil based energy supply situation to a sustainable renewable energy future, regional interconnection and a balanced and optimised development of various technologies working in collaboration (hybridization) is essential.



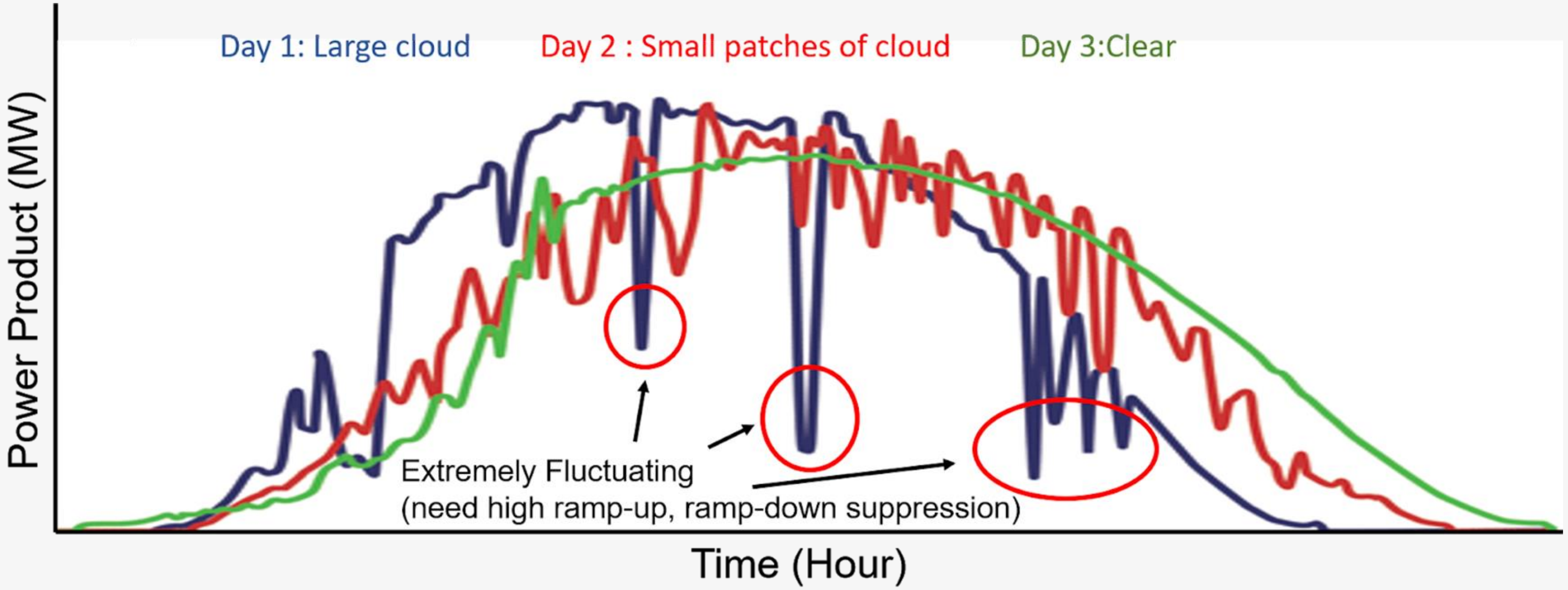
Challenges with high RE penetration

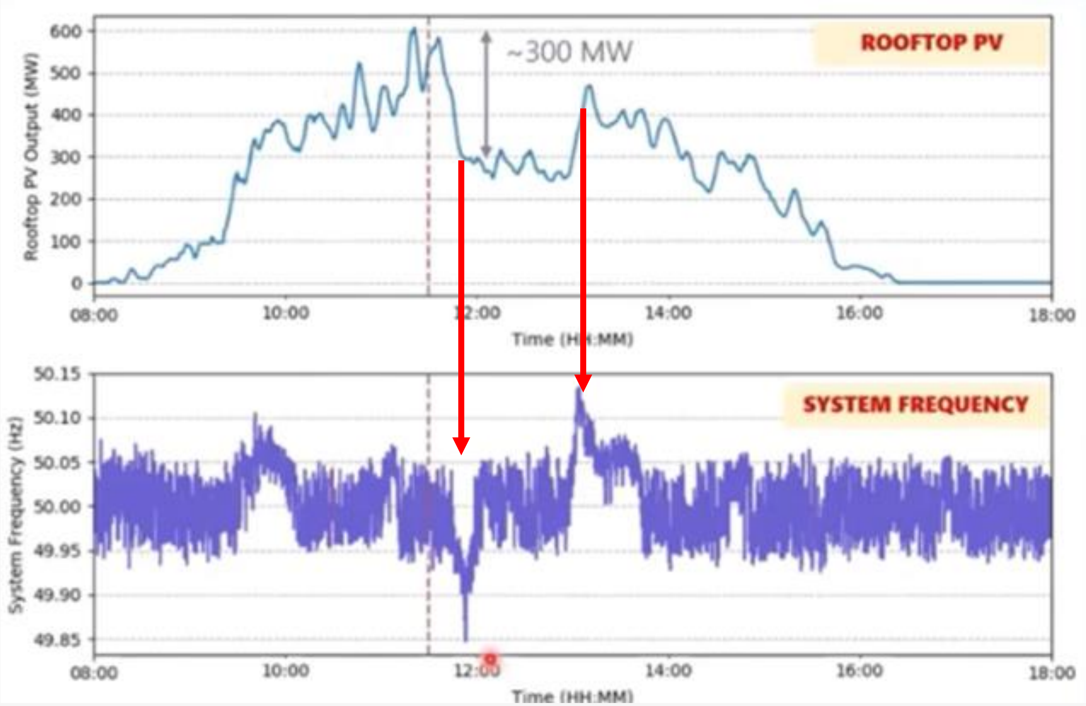
Challenges:

- Frequency and voltage anomalies
- Overloading of existing transmission lines
- Demand and supply mismatch

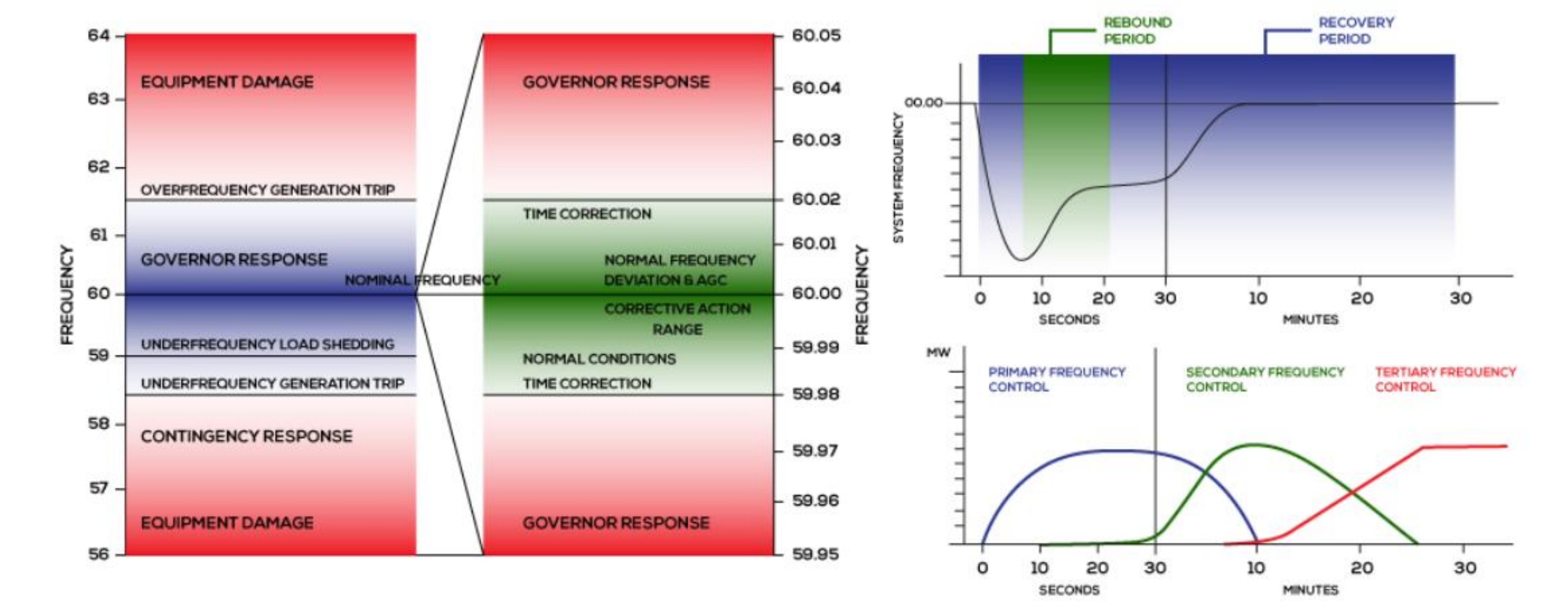
Solutions:

- Central storage and rapid dispatch / load response (PSHP, BESS, Hydrogen)
- Distributed storage (Home BESS, EV discharge,...)
- Smart grid load control (delay in loading of non critical components)



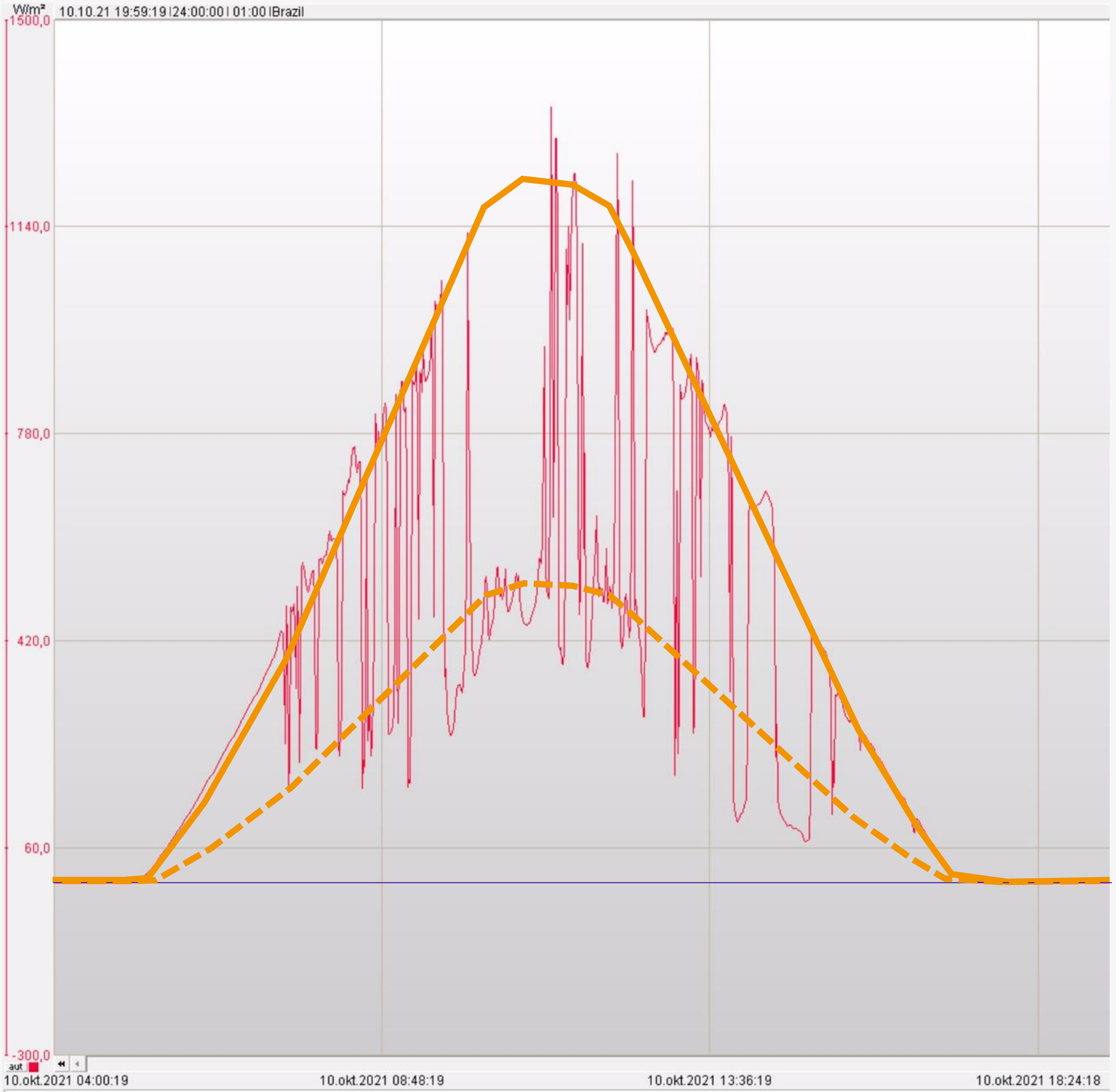


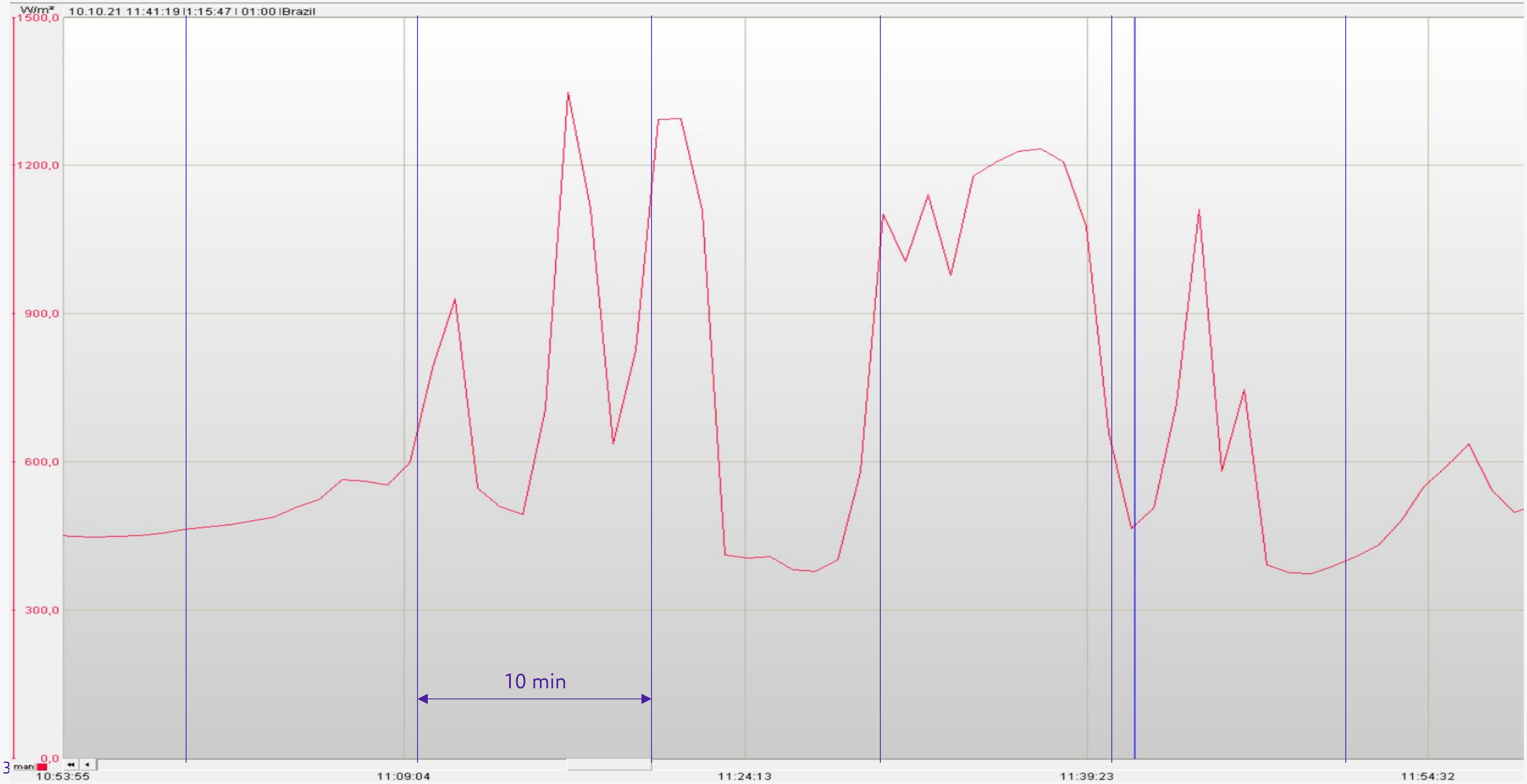
Frequency response (60 Hz nominal)



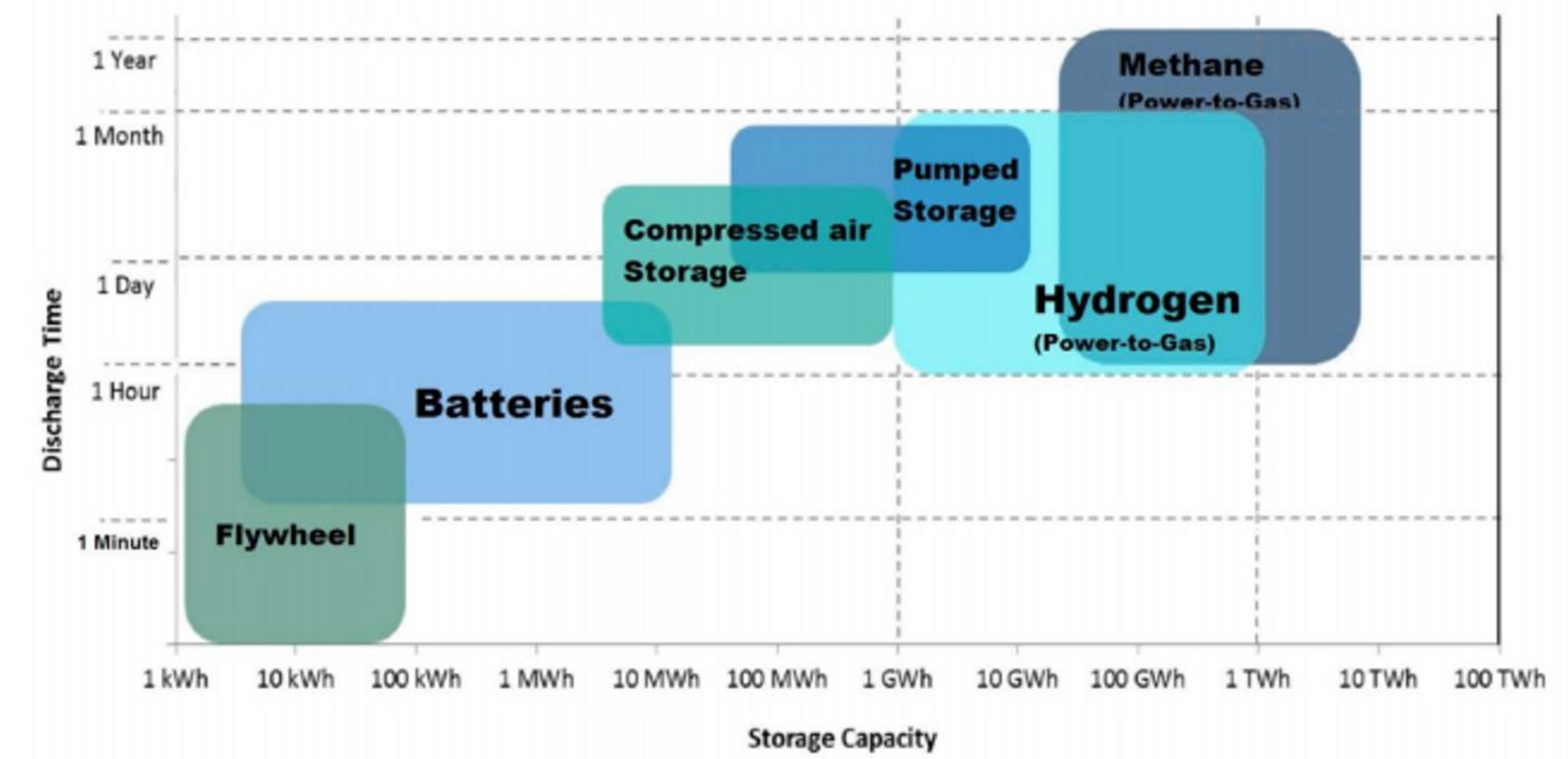
The PV challenge

- Cloudy day volatility in irradiation leads to rapid drops and spikes in voltage and frequency.
- Ramp up can be dampened by inverters
- Rapid drop must be compensated by inertia in the grid or BESS.

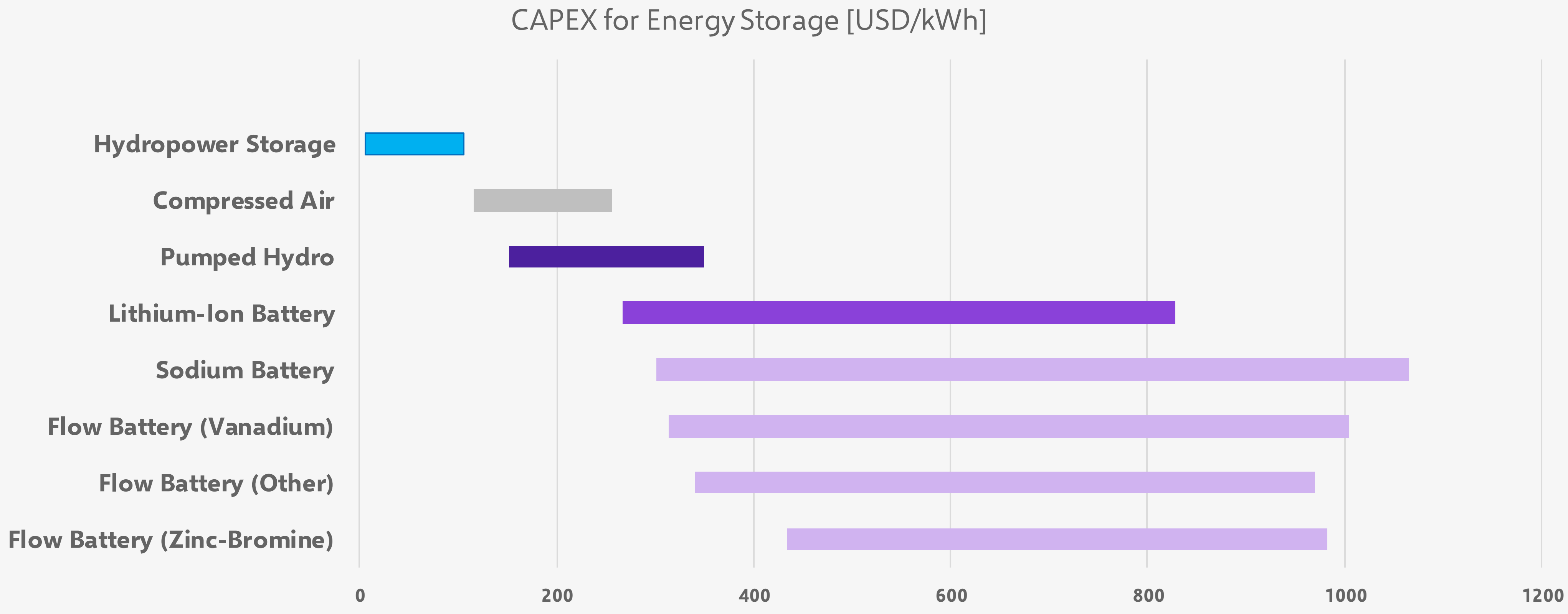



W/m²
10.10.21 11:41:19 11:15:47 I 01:00 IBrazil
1500,0
1200,0
900,0
600,0
300,0
0,0
10 min
man
10:53:55
11:09:04
11:24:13
11:39:23
11:54:32

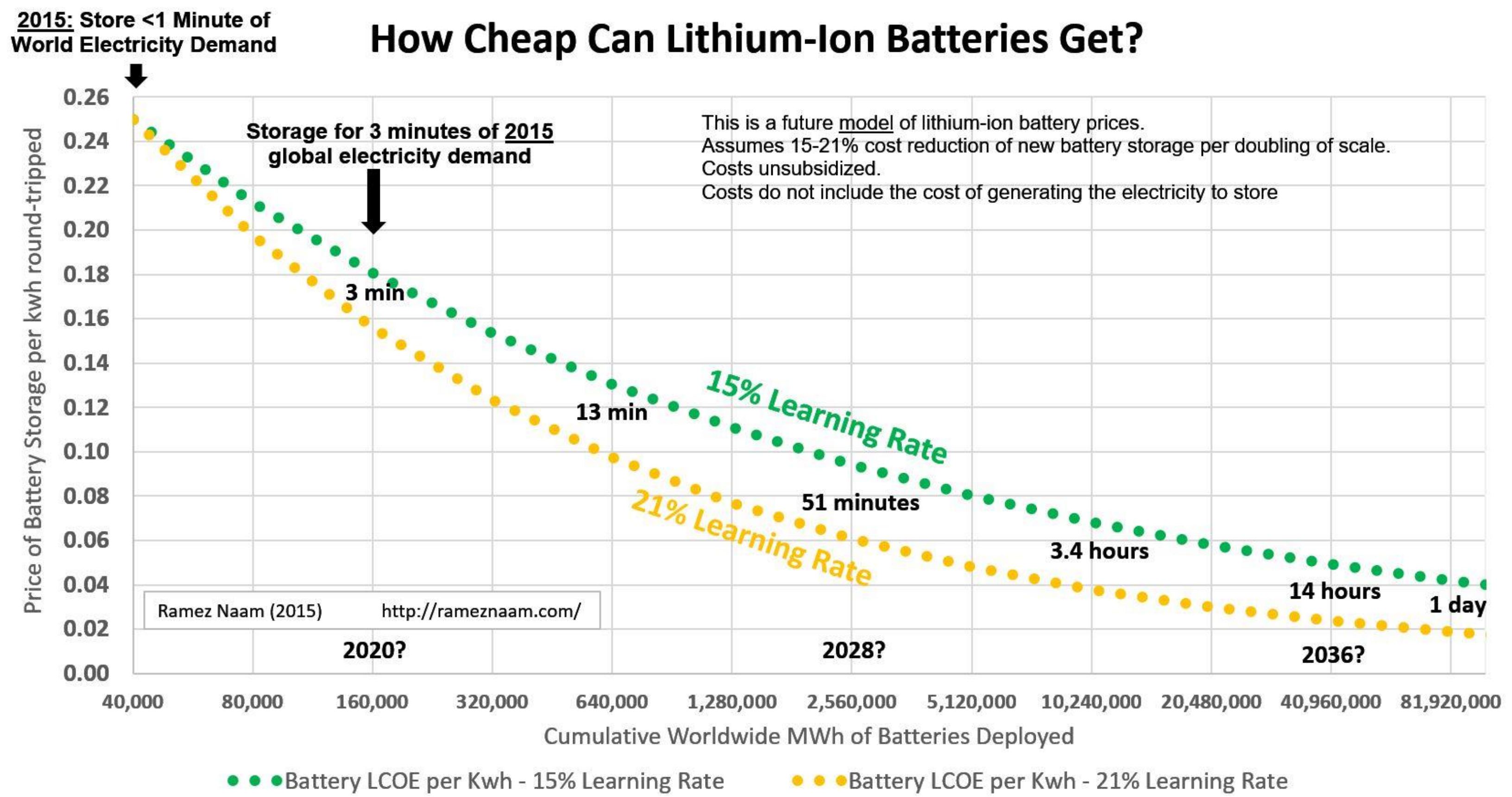
Storage will be an essential component in the future renewable energy mix



Cost of Energy Storage Solutions



Source: https://www.c2es.org/content/electric-energy-storage/



2015: Store <1 Minute of World Electricity Demand
How Cheap Can Lithium-Ion Batteries Get?
Storage for 3 minutes of 2015 global electricity demand
This is a future model of lithium-ion battery prices.
Assumes 15-21% cost reduction of new battery storage per doubling of scale.
Costs unsubsidized.
Costs do not include the cost of generating the electricity to store
3 min
13 min
51 minutes
3.4 hours
14 hours
1 day
15% Learning Rate
21% Learning Rate
Ramez Naam (2015)
http://rameznaam.com/
2020?
2028?
2036?
Price of Battery Storage per kwh round-tripped
0.26
0.24
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
40,000
80,000
160,000
320,000
640,000
1,280,000
2,560,000
5,120,000
10,240,000
20,480,000
40,960,000
81,920,000
Cumulative Worldwide MWh of Batteries Deployed
Battery LCOE per Kwh - 15% Learning Rate
Battery LCOE per Kwh - 21% Learning Rate

Project organization

Scatec

Grønn platform program

Support: 79 mill. NOK
Equity Contribution: ≈ 50 mill. NOK
Total: ≈ 130 mill. NOK

Competence project ("KPN")

Industry project (IPN)

DP0 - Project Management and Communication
Owner: Scatec, Partners: Prediktor, Ocean Sun, IFE og SINTEF Energi

Hybrid hydro-FPV power plants (HydroSun)

- Owner: IFE
- PM: Josefine Selj
- Partners:Sintef Energi, UiO, NTNU, NIVA, Scatec, Prediktor, Ocean Sun, Statkraft, Multiconsult, Hydro

DP1 - Hybrid solar and hydro power plant

- Owner: Scatec
- PM: Øyvind Engelstad
- Parners: Prediktor, Ocean Sun, Sintef Energi, IFE

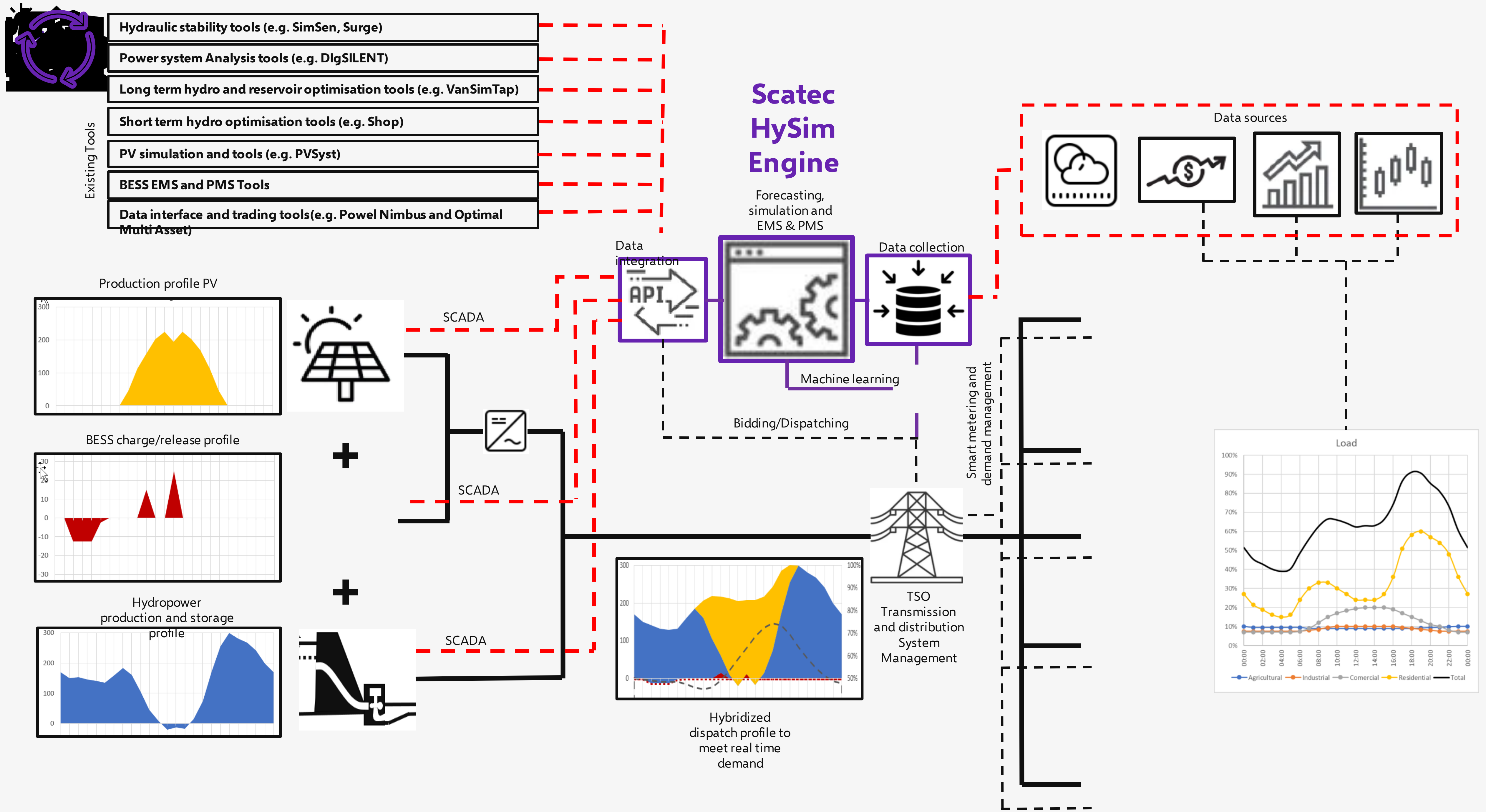
DP2 –Digital tools and control systems for hybrid power plants

- Owner: Prediktor
- PM: Thomas Pettersen
- Partnere: Scatec, Ocean Sun, Sintef Energi, IFE

DP3: Technologies for large scale FPV plants

- Owner: Ocean Sun
- PM: Børge Bjørneklett
- Partners: Scatec, Prediktor, IFE

IFE Scatec prediktor Ocean Sun


Hydraulic stability tools (e.g. SimSen, Surge)
Power system Analysis tools (e.g. DIgSILENT)
Long term hydro and reservoir optimisation tools (e.g. VanSimTap)
Short term hydro optimisation tools (e.g. Shop)
PV simulation and tools (e.g. PVSyst)
BESS EMS and PMS Tools
Data interface and trading tools(e.g. Powel Nimbus and Optimal Multi Asset)
Existing Tools
Scatec HySim Engine
Forecasting, simulation and EMS & PMS
Data integration
API
Data collection
Machine learning
Bidding/Dispatching
Data sources
Production profile PV
BESS charge/release profile
Hydropower production and storage profile
SCADA
SCADA
SCADA
Smart metering and demand management
TSO Transmission and distribution System Management
Hybridized dispatch profile to meet real time demand
Load
Agricultural
Industrial
Comercial
Residential
Total

Scatec