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Towards 100% Renewables in the Faroe Islands - Wind and Energy Storage Integration

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Agenda

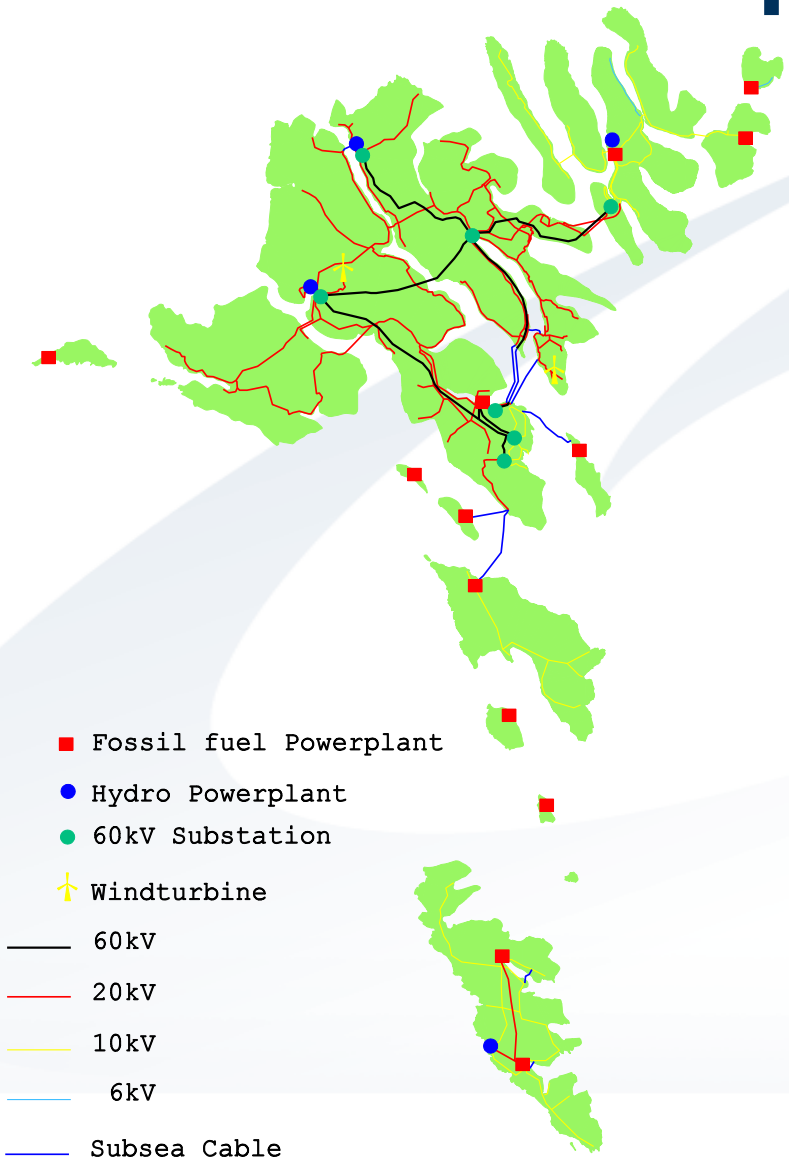
- Introduction
  - General about SEV, 100by2030 vision, Energy mix, projected energy demand, renewable resources
- Battery system in Húsahagi
  - Schematic design, system data, operational experiences
- Economy of the battery system
  - Utilisation of the wind farm, simple payback time

Faroe Islands

Faroe Islands

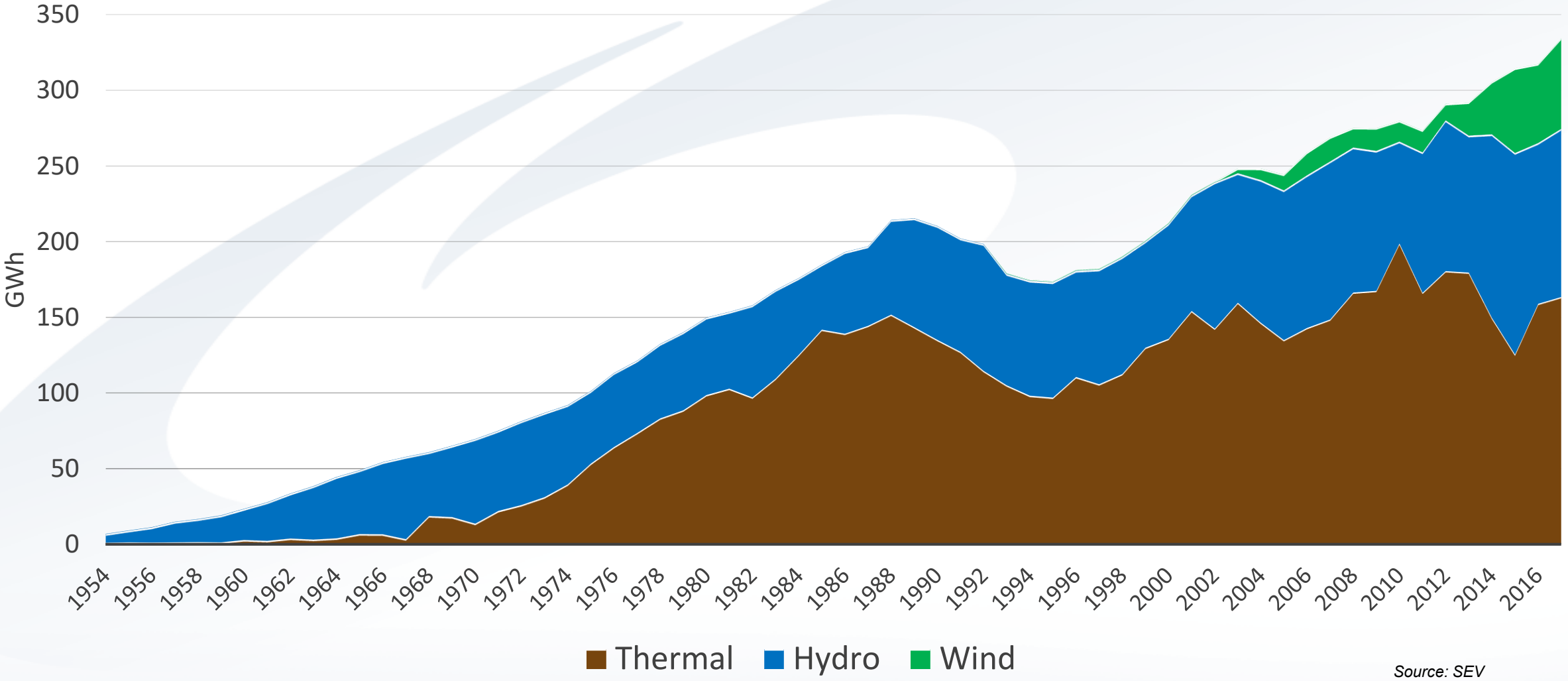
- **General data:**
  - 18 islands (17 are populated), electrically isolated
  - 50.000 inhabitants
  - Area of 1.399 km^2
  - Main export: Fish and fish products

Electrical Company SEV



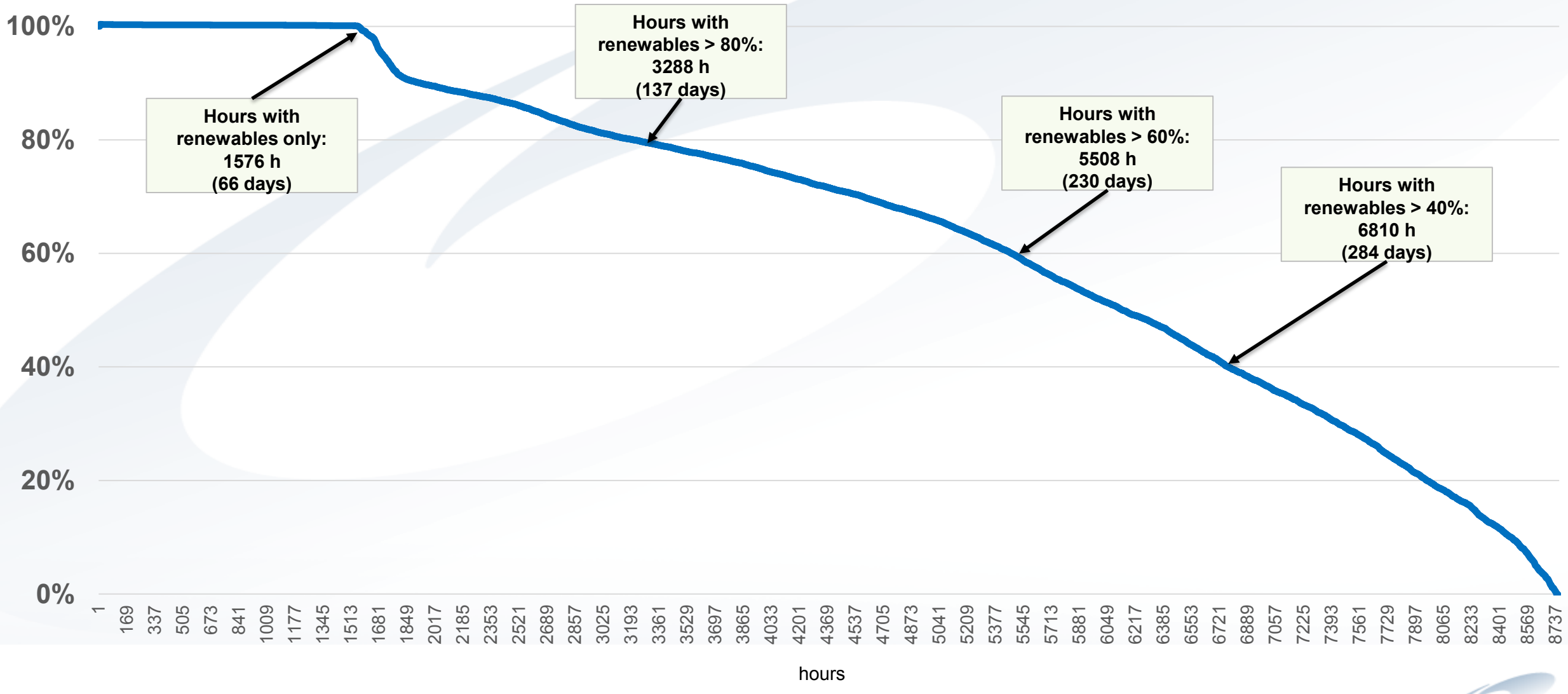
- **General company facts:**
  - Non-profit, founded 1st October 1946
  - 100 % owned by all Faroese municipalities
  - Vertically Integrated Company
  - Joint and several price structure
  - Monopoly on grid operation *(transmission & distribution)*
  - "*De facto*" monopoly on production (98%)
  - *"Micro isolated system" in EU terms (< 500 GWh @ 1996)*
    - *Directive 2009/72*
      - *Derogation from relevant provisions in different chapters about unbundling, third party access etc.*

Energy Mix 1954 - 2017

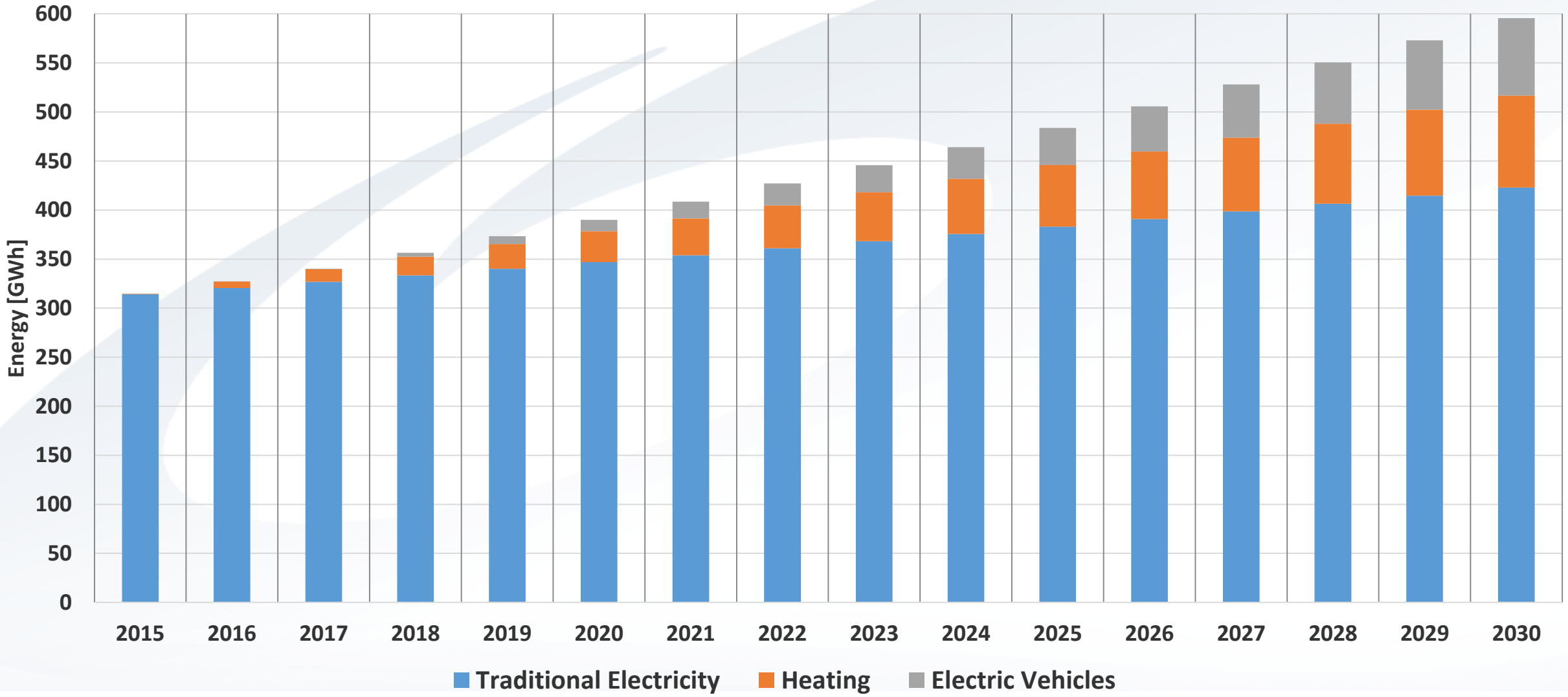


Source: SEV

Renewable energy duration curve 2015



Projected Energy Demand 2015-2030



Renewable resources in the Faroe Islands

Identification of renewable resources

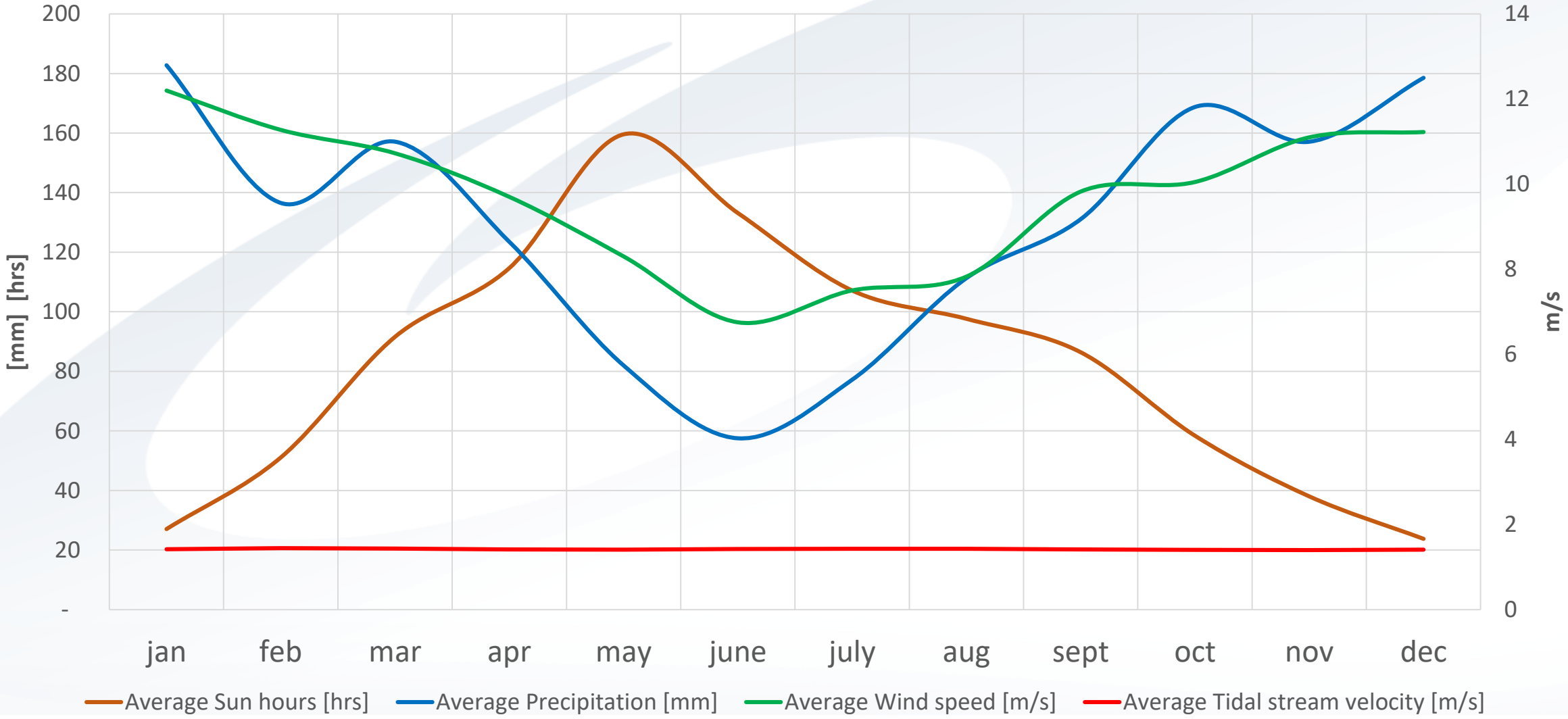
Average wind speed: > 10m/s

Precipitation: > 1300 mm/year *(Tenerife: < 250 mm/year)*

Peak tidal velocities: ~ 3.5 m/s

Average sun hours: ~ 1000 hrs/year (Tenerife: ~3000 hours)

Correlation between the resources

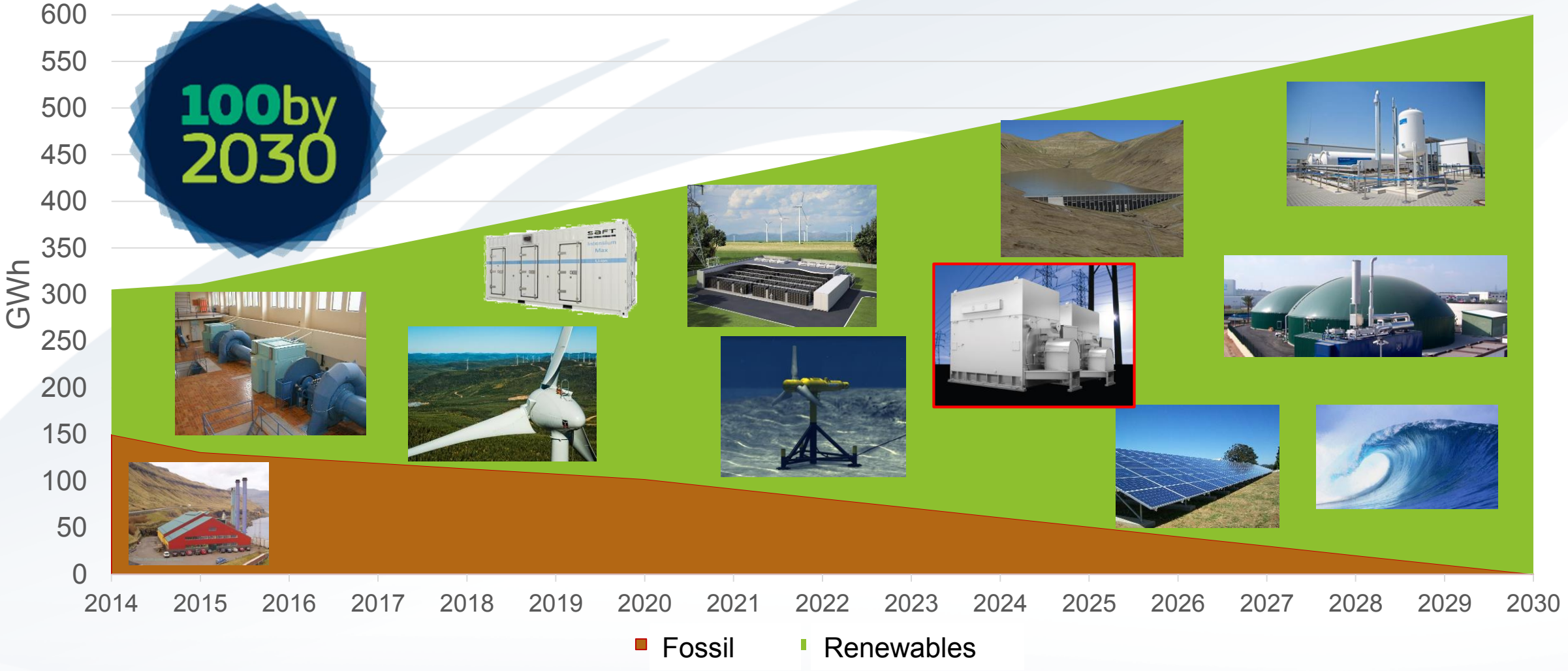


"The engineering is secondary to the vision"

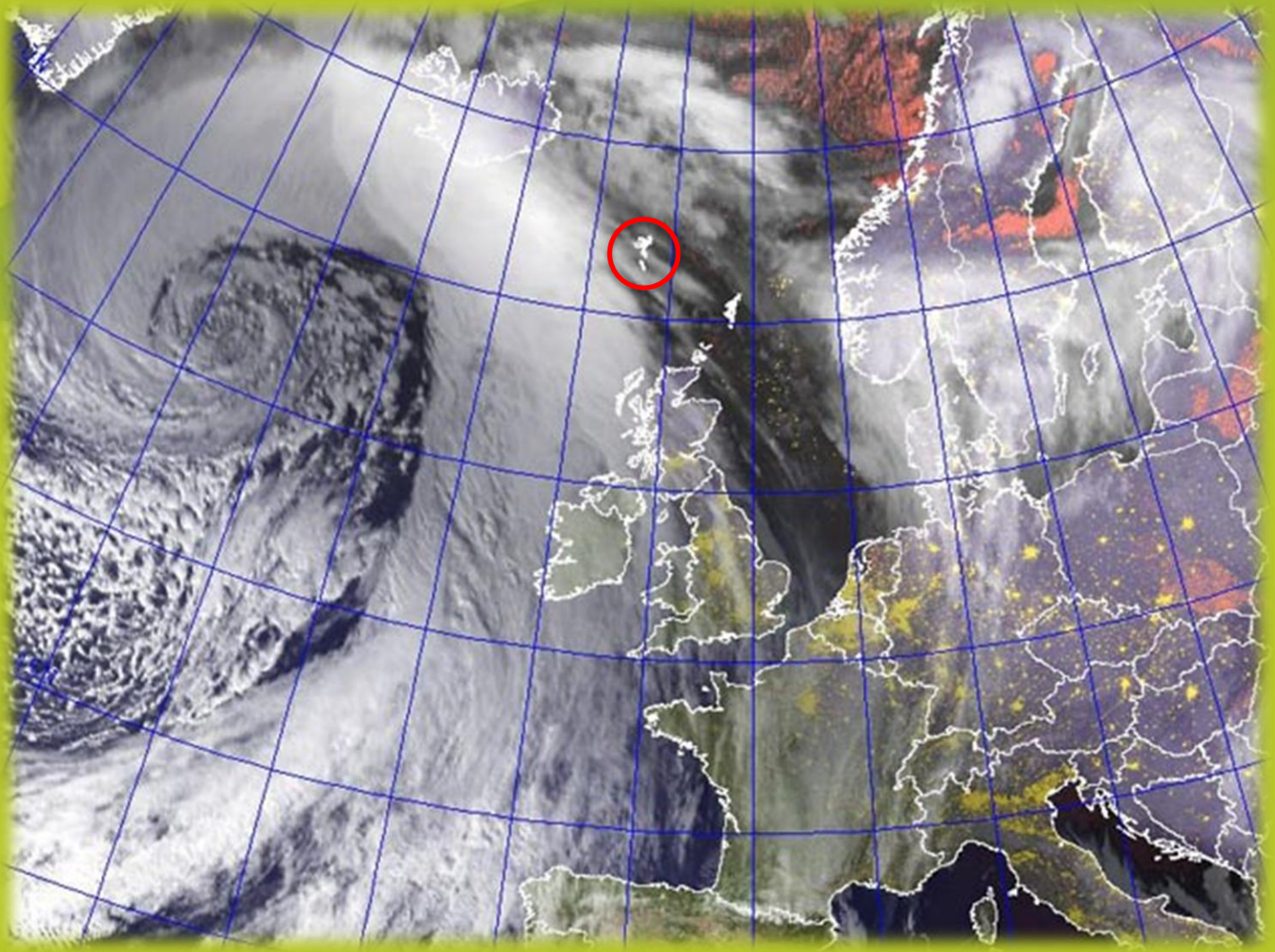
Cynthia Ozick

Our Vision….

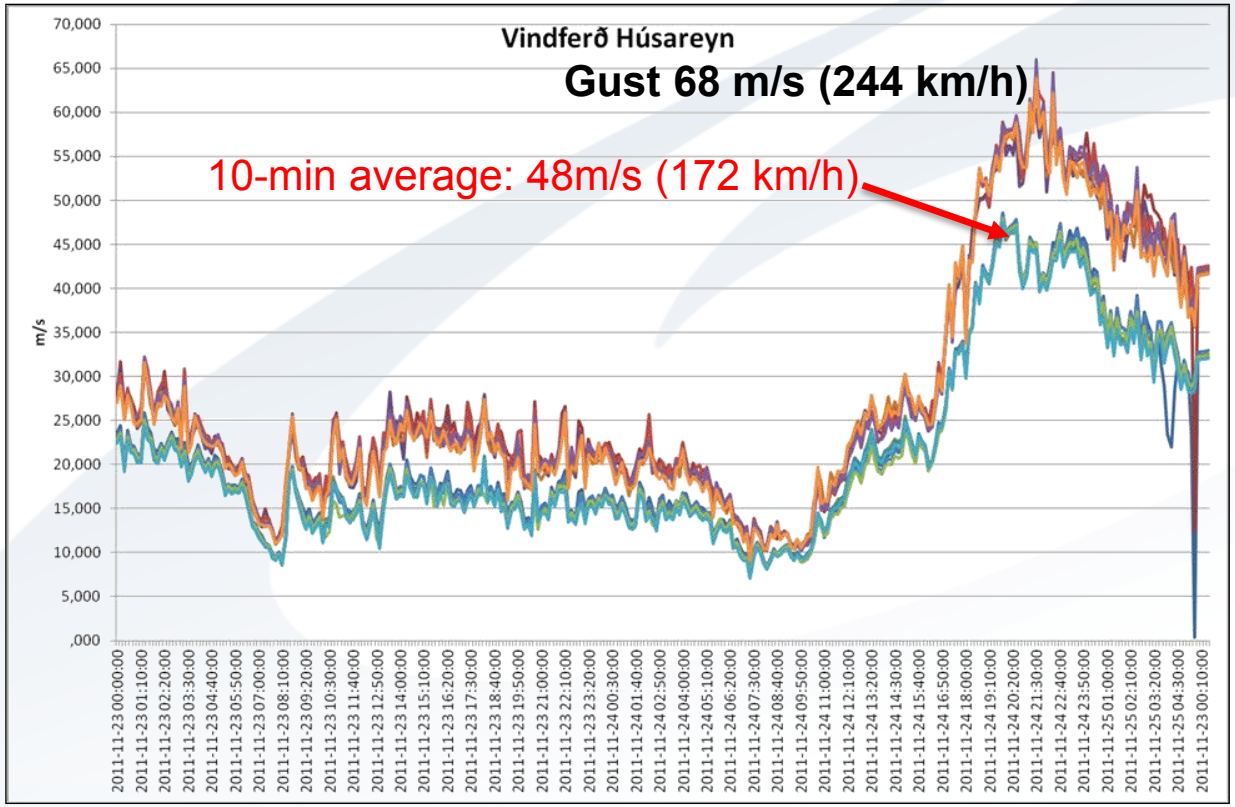
“100by2030”

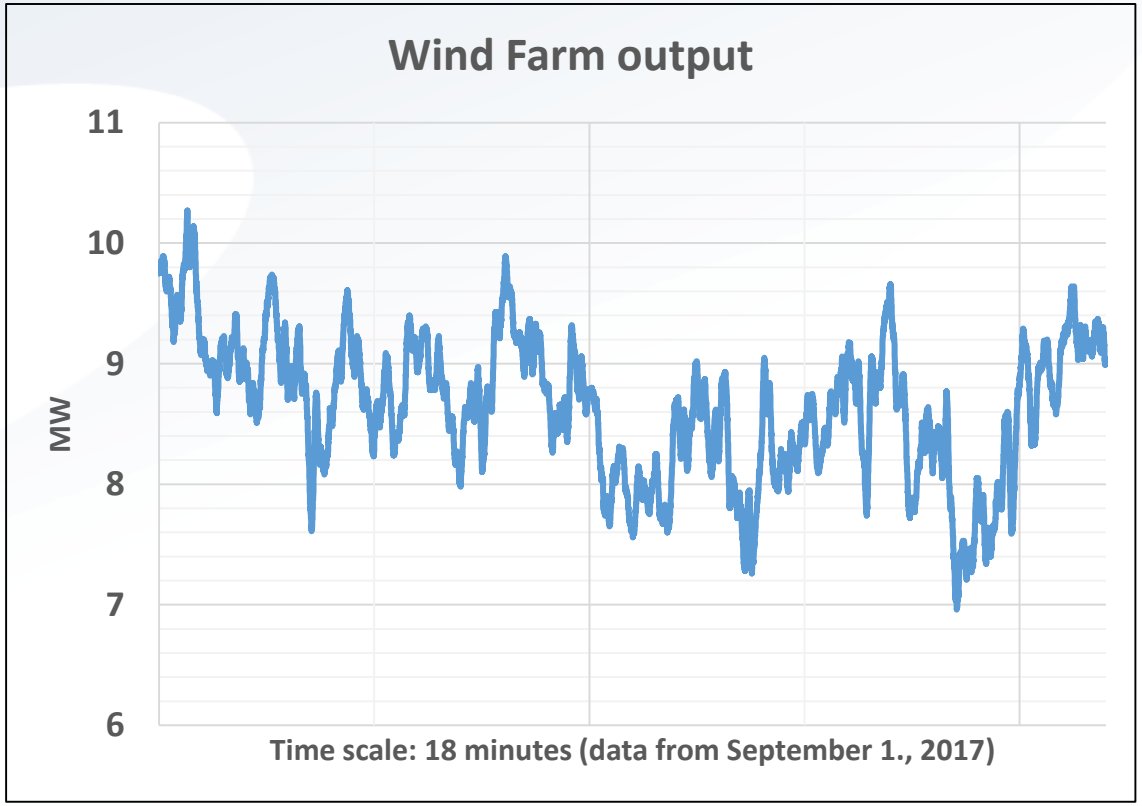

100by 2030
GWh
600
550
500
450
400
350
300
250
200
150
100
50
0
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
Fossil
Renewables

Unstable weather conditions

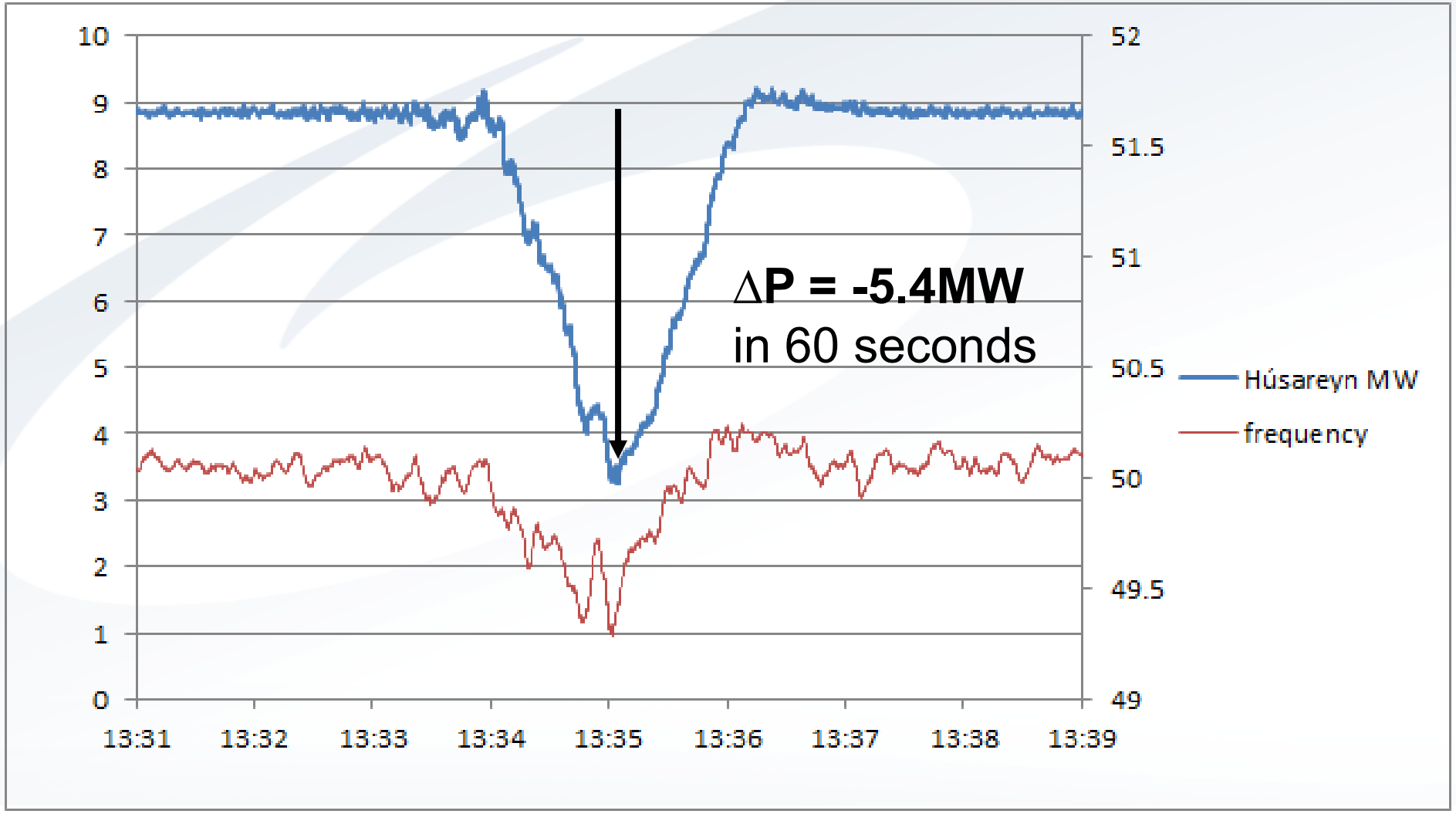


Wind conditions

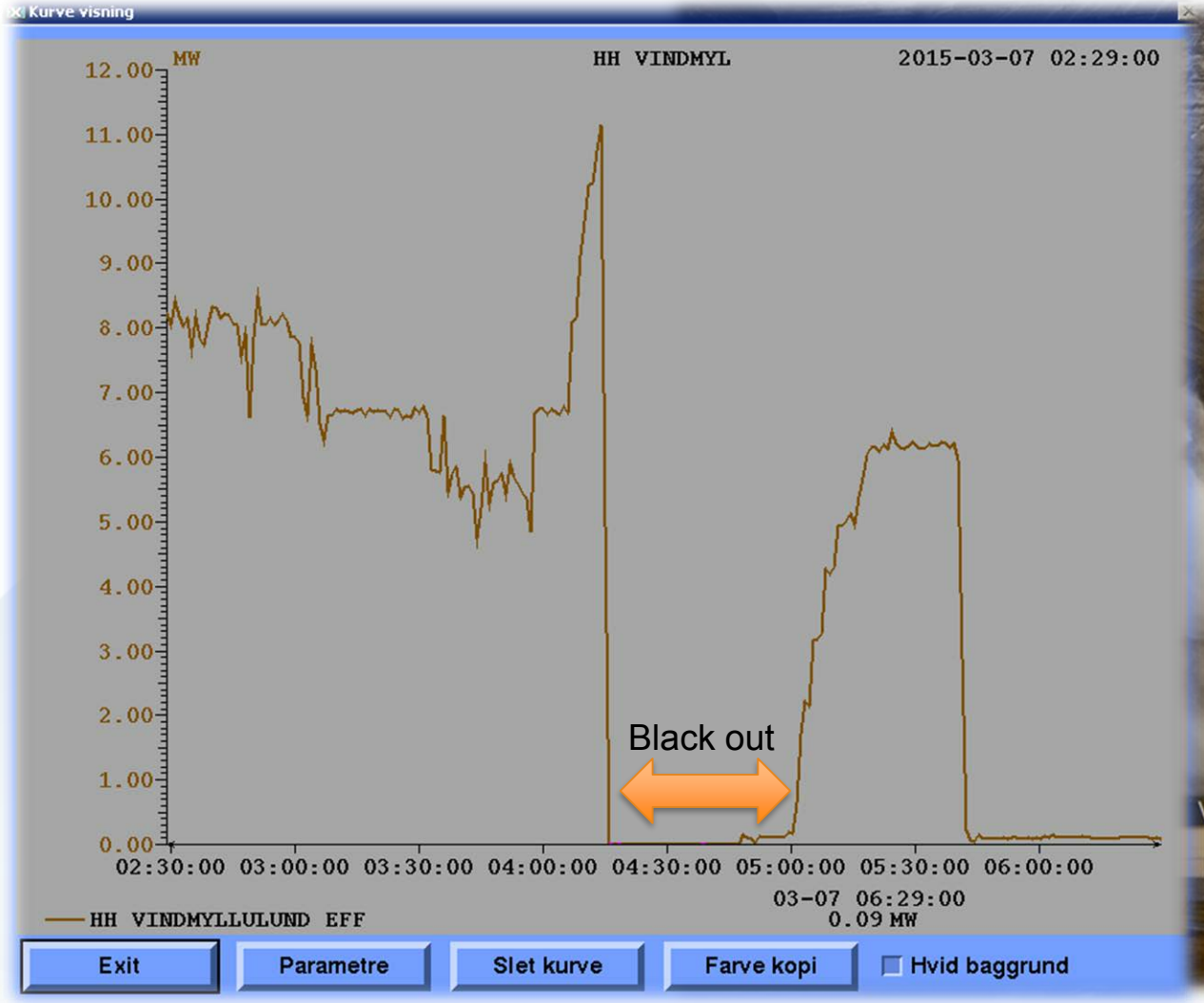




Extreme ramp rates (Húsahagi WF)



Challenging weather

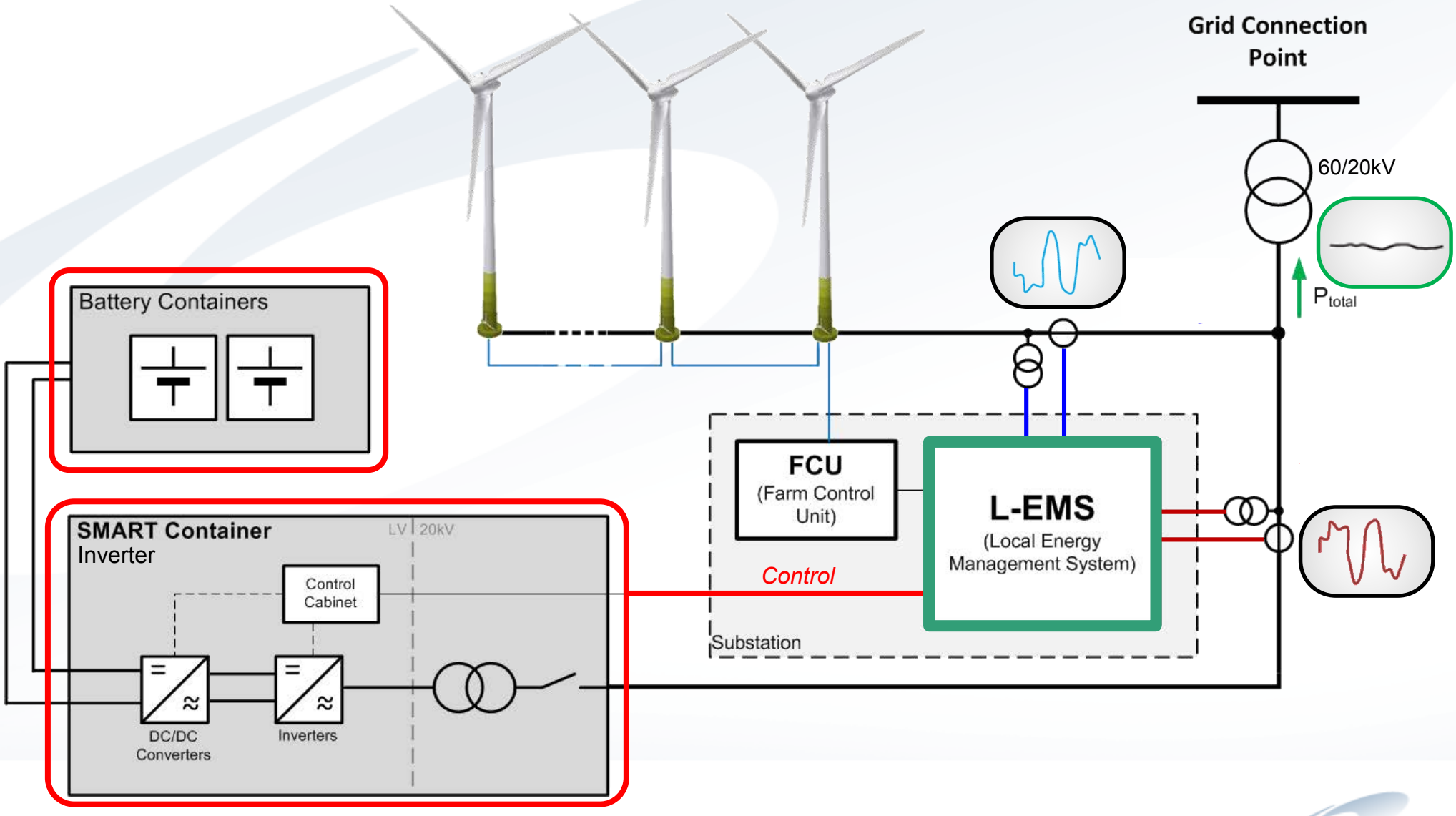


Battery Energy Storage System

Wind farm block diagram

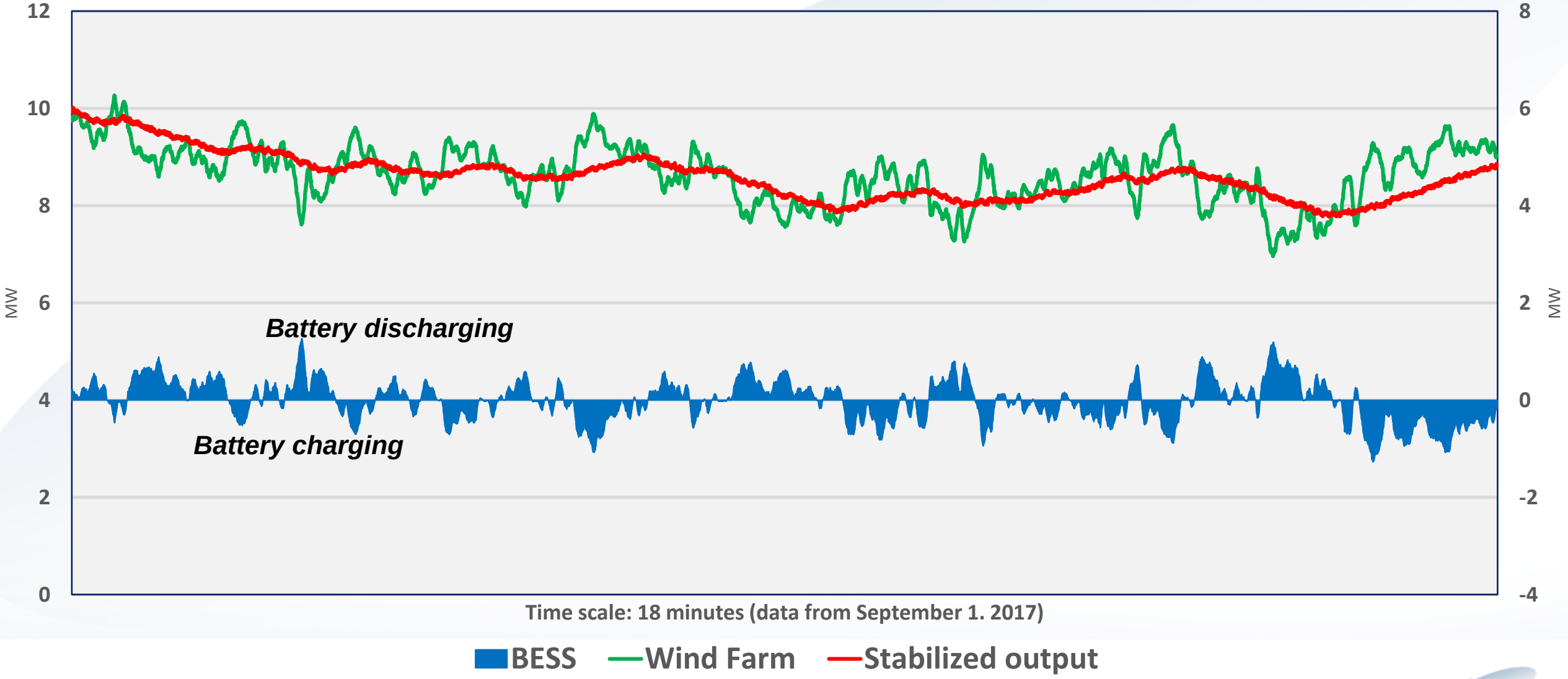
2 Intensium Max 20P	
Energy	707 kWh
Continuous discharge power	2 400 kW
Continuous charge power	1 500 kW
Nominal voltage	623 V
Voltage range	525V – 700V

ENERCON E-Storage 2300	
Apparent power	2300 kVA
AC Voltage	LV: 400V MV: 20 kV
DC Power	2 400 kW
DC Voltage Range	345 – 705 V
DC Current	3325 A

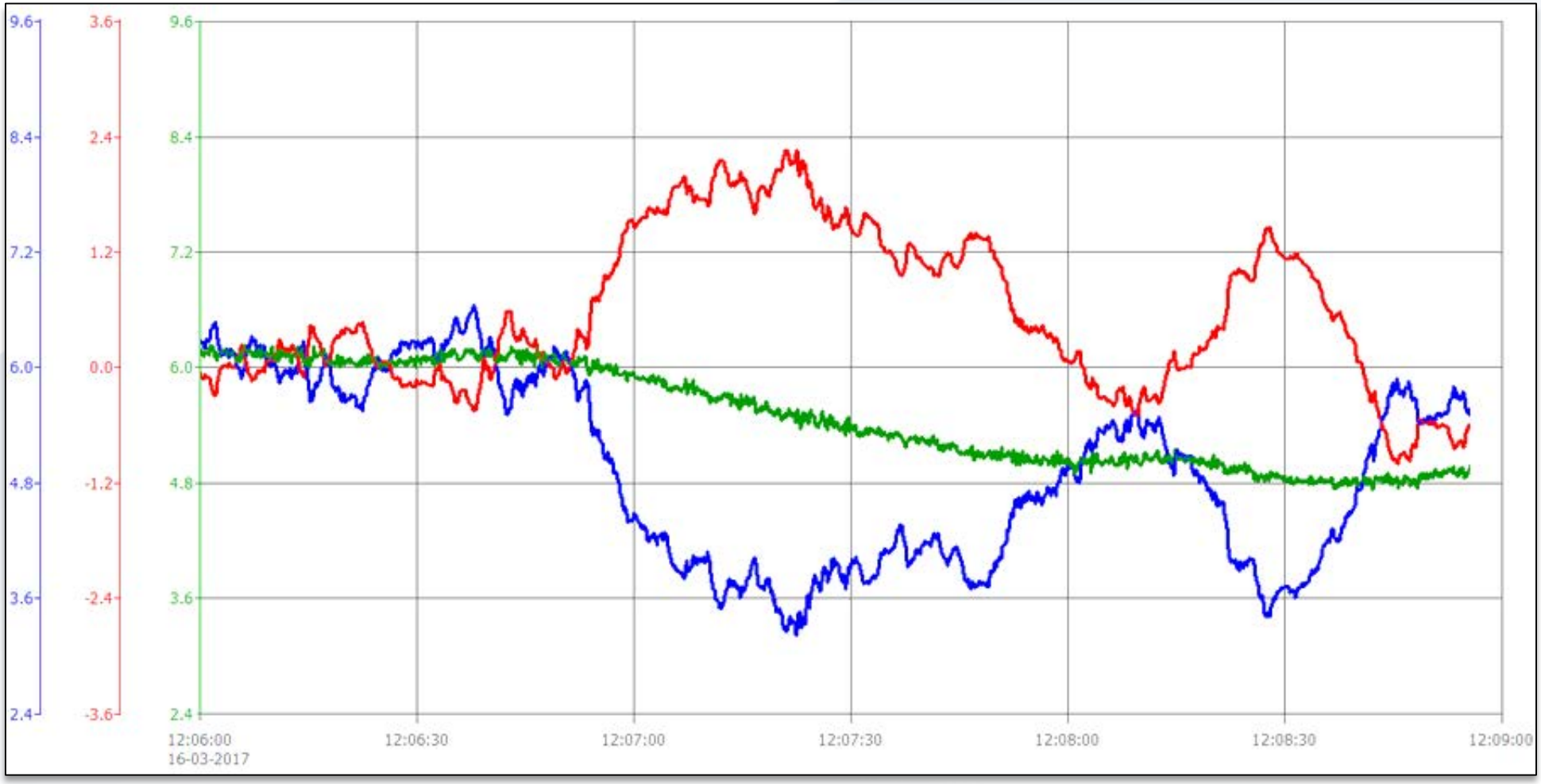


saft
Intensium Max
FKFU 500003

Battery system in operation

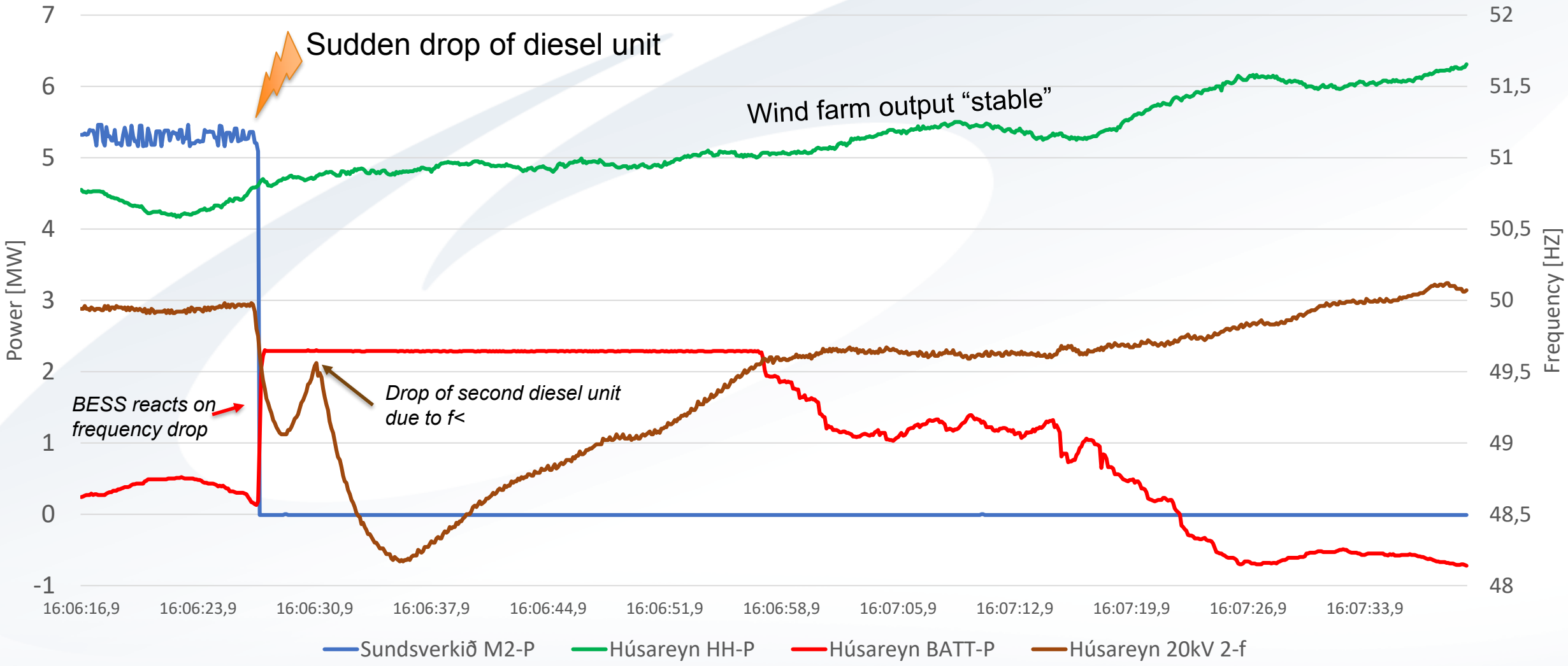


Battery system in operation



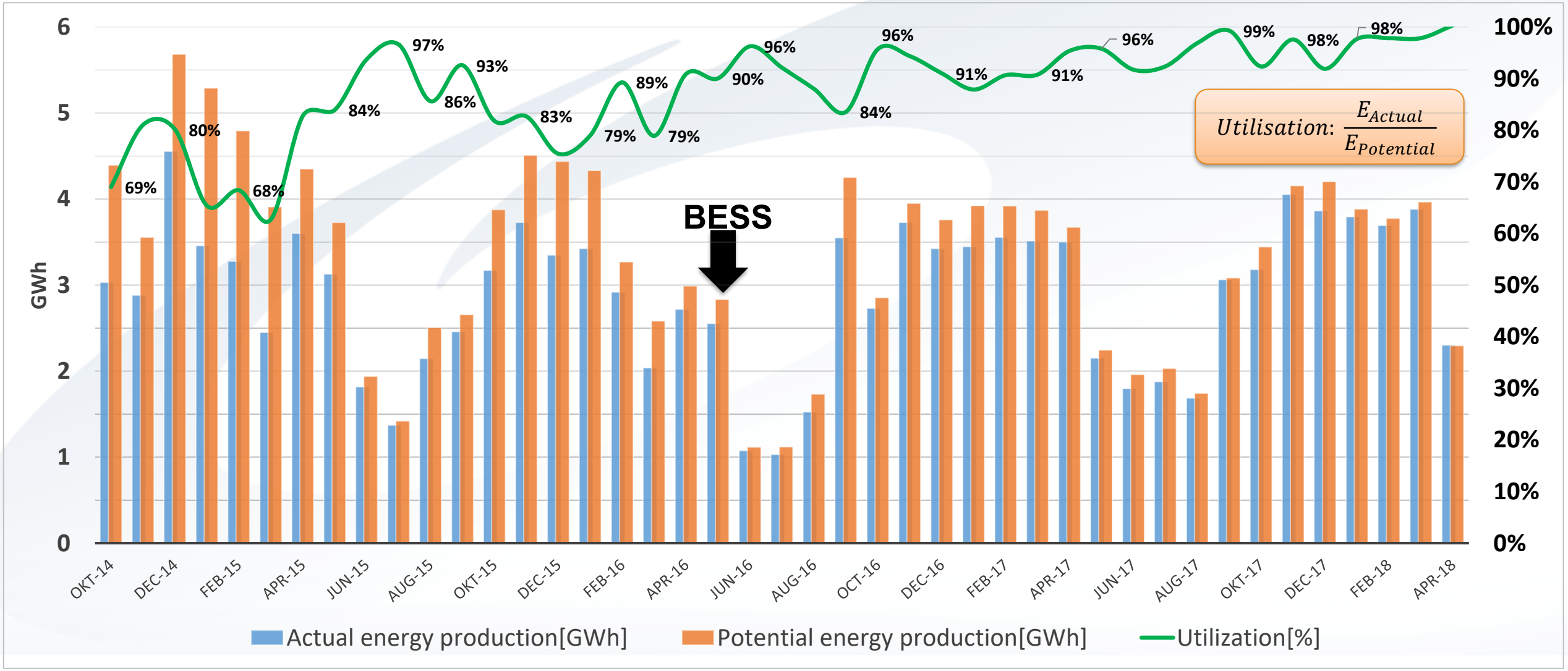
P_{Wind} [MW] P_{BESS} [MW] P_{total} [MW] = P_{Wind} + P_{BESS}

Fast frequency support from the BESS



Utilisation of Húsahagi Wind Farm

Curtailment in 2015: 22%
Curtailment in 2016: 12%
Curtailment in 2017: 6,7%



Business case for the BESS

- Assumptions
  - Increased wind utilisation is displacing oil production
  - Fuel oil cost: 0,09 €/kWh (not including other O&M costs)
  - Energy yield estimation, based on wind measurements: 40 GWh/year
  - Cost of BESS (Batteries, ENERCON E-Storage, L-EMS): approximately 2 M€

- Simple payback time is calculated to 4.5 years.
- Estimated lifetime of batteries is 20 years.

SEV

Special thanks to the contributors to the paper and presentation:

- David McMullin, ENERCON
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- Daniel Gamboa, ENERCON
- Michael Lippert, Saft Batteries

Thank you!

https://www.youtube.com/watch?v=TUa0QAT9KaM

https://www.youtube.com/watch?v=HUMRt9HSzAk

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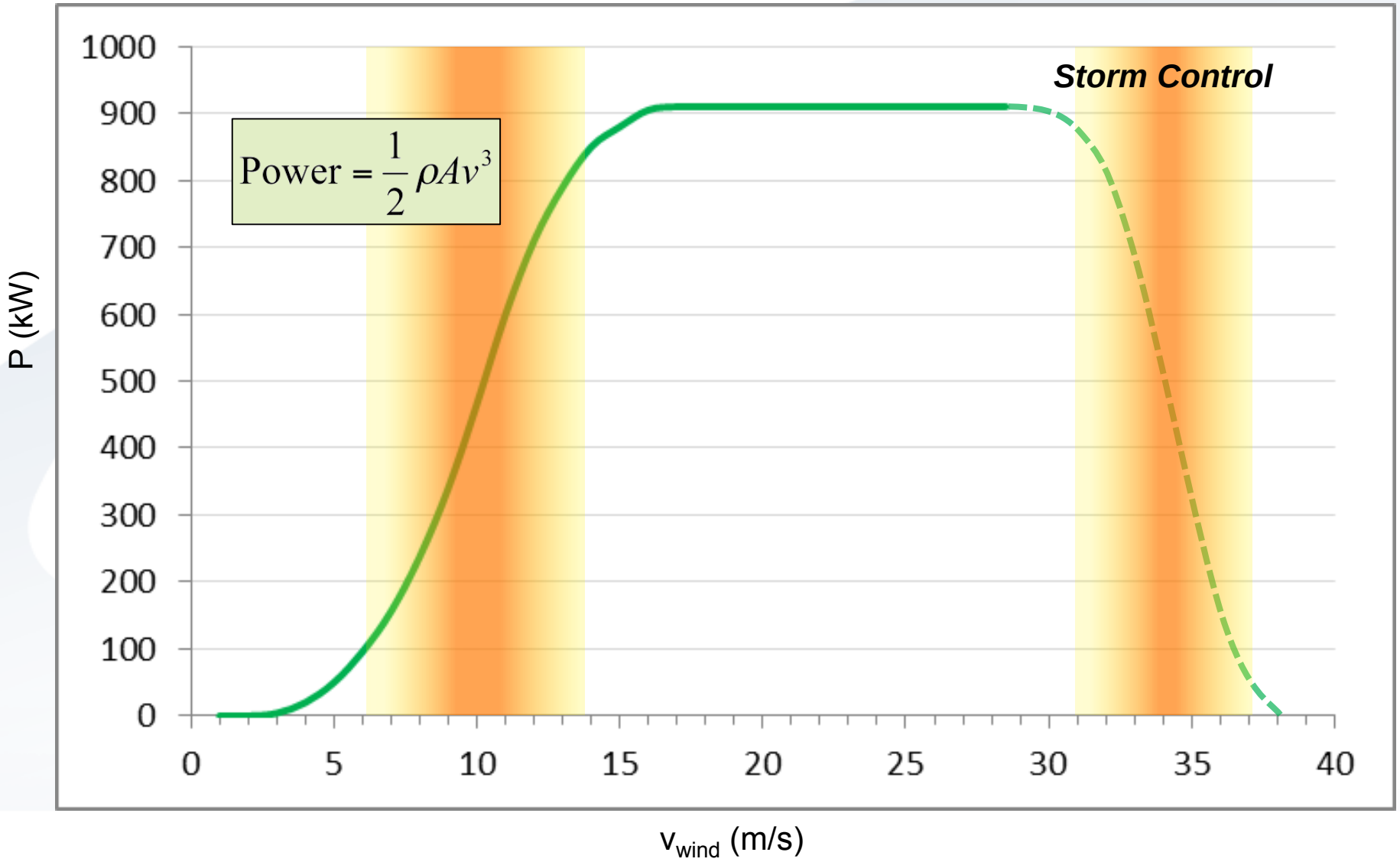
Power curve – ramping “hot spots”