EERA DeepWind conference

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LOWEMISSION

CleanOFF Hub

SINTEF NTNU

Analyzing a grid-forming storage hub for an offshore platform cluster supplied by wind energy

Daniel dos Santos Mota, Hallvar Haugdal, Valentin Chabaud

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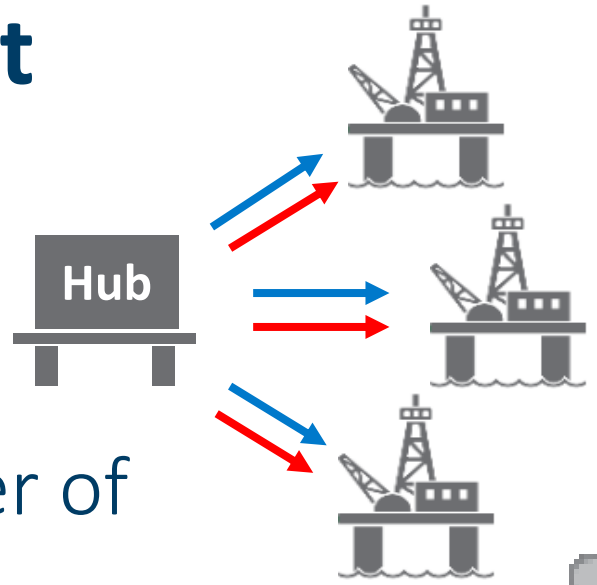
CleanOFF Hub Concept

- Several facilities with both oil and gas production
- Power demand: 50-150 MW per facility at plateau
- Heat demands: 30-70 MW per facility at plateau
- Expected future load profiles: Build-up, plateau, decline, tail
- Expected lifetime: ≥ 30 years
- Distance from shore: ≥ 240 km

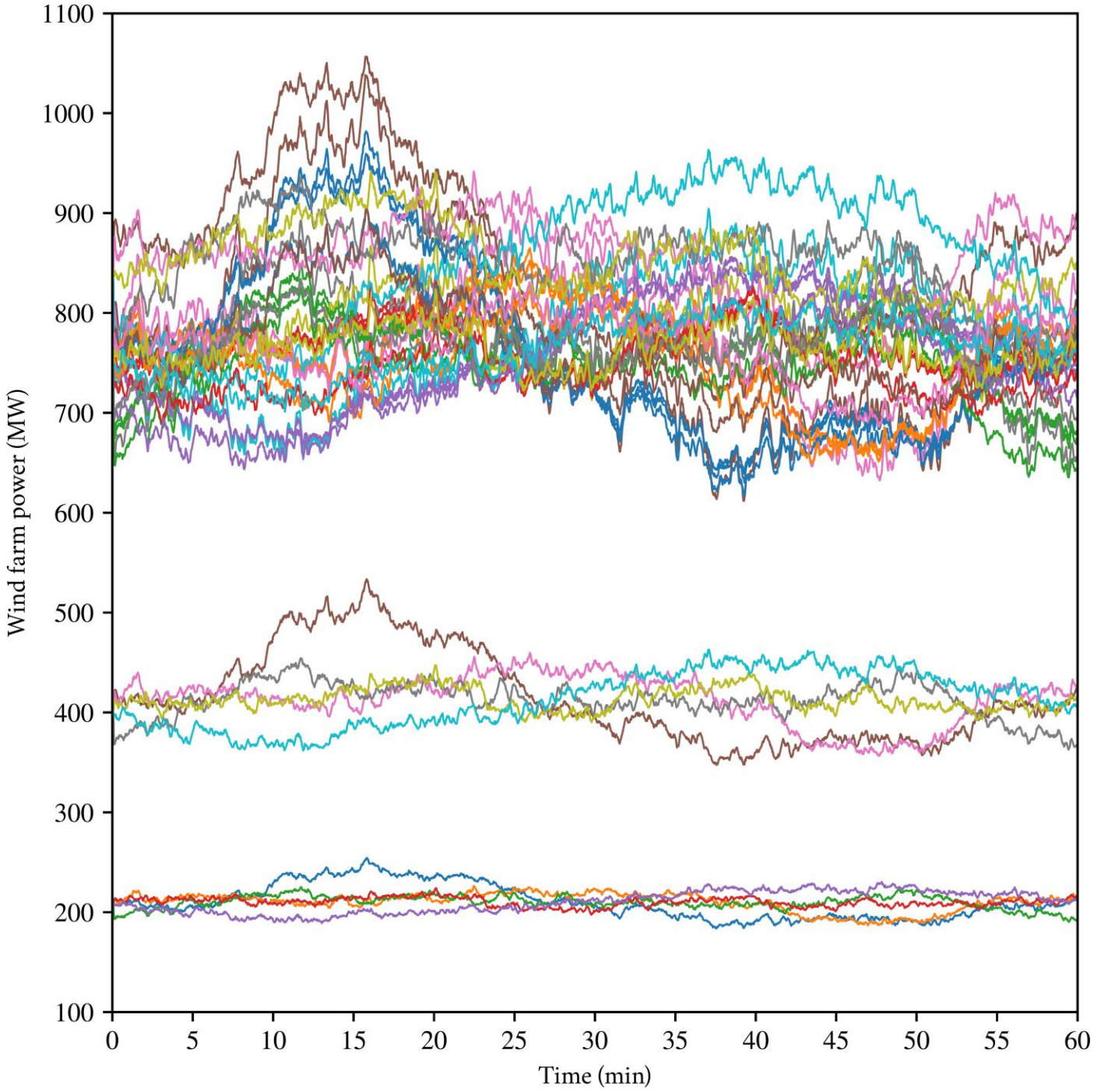
CleanOFF Hub Project
Energy Hub Concept



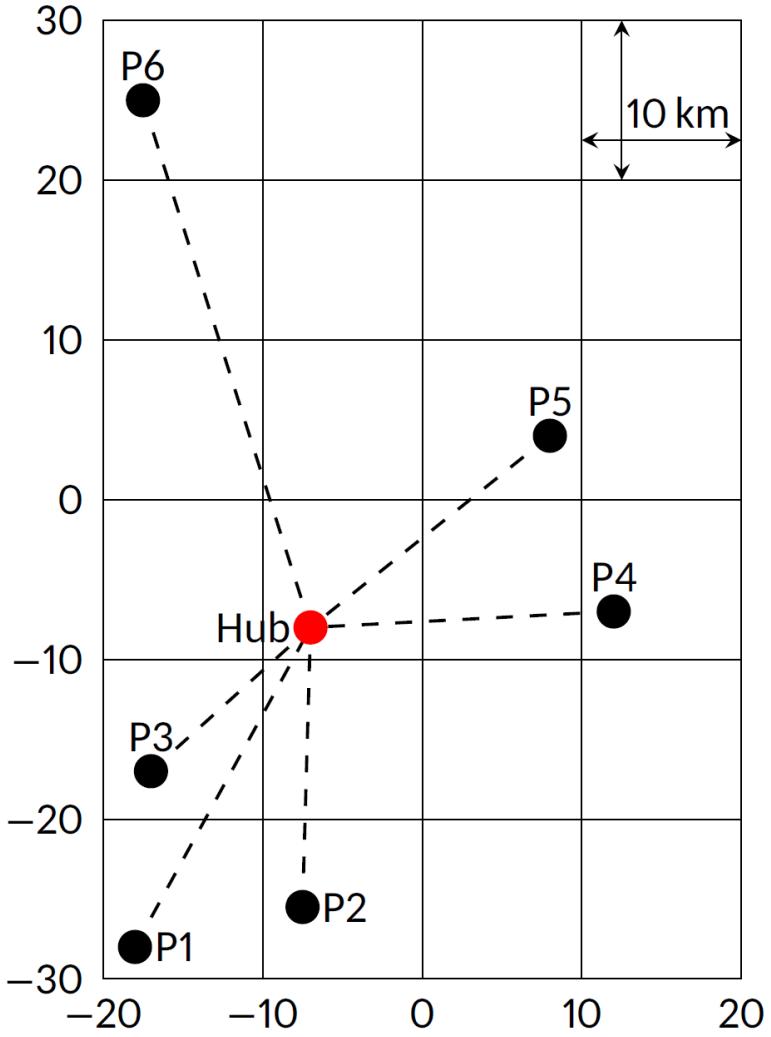
- Offshore power hub for a cluster of platforms
- Offshore wind farm feeding the Hub

Wind Power

- Surrogate model wrapping up data from state-of-the-art aerodynamic simulations
- Encompasses wake losses and power spectral density characterizing correlated wind fluctuations between turbines arising from farm-scale turbulence
- Time series with power output
  - 1 second resolution
  - 1 hour window



Study Case
Oil and Gas Platform Cluster

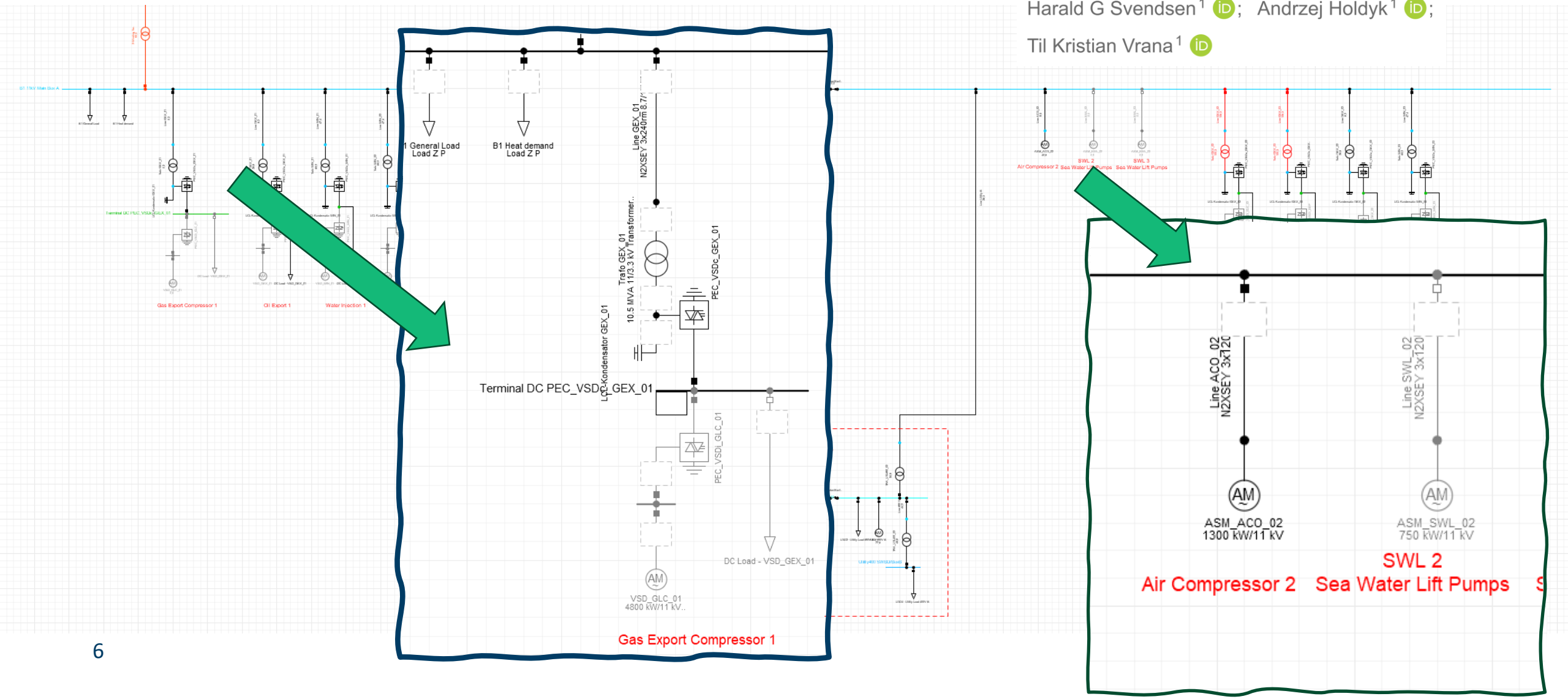


Platform	Load	Model Base
P1	115 MW	LEOGO
P2	115 MW	70% CPL, 30% CZL
P3	80 MW	70% CPL, 30% CZL
P4	80 MW	70% CPL, 30% CZL
P5	80 MW	70% CPL, 30% CZL
P6	80 MW	70% CPL, 30% CZL
Total load	550 MW	

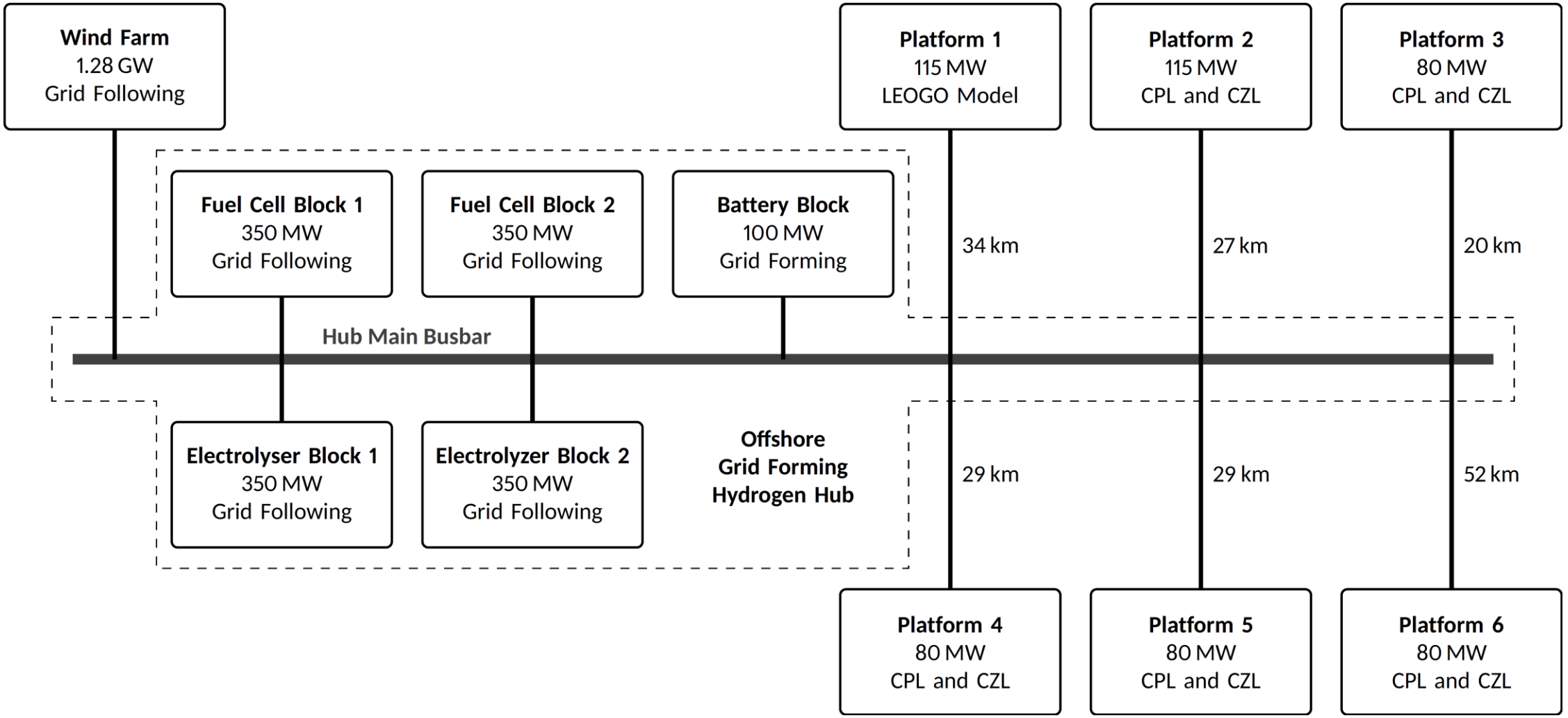
DIgSILENT PowerFactory 2023

Low Emission Oil and Gas Open (LEOGO) platform specification

Harald G Svendsen[1]; Andrzej Holdyk[1];
Til Kristian Vrana[1]



Offshore Grid Forming Hydrogen Hub



Frequency Control

Primary Control

Battery
100MW
Grid Forming

Proportional response to AC frequency variations in the HUB

Secondary Control

HUB AC Frequency → **PI Controller**

Total Secondary Power

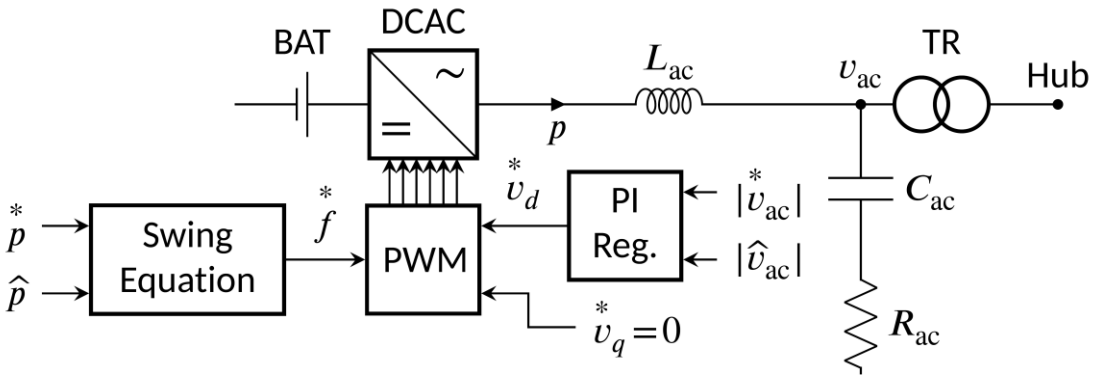
Power Sharing

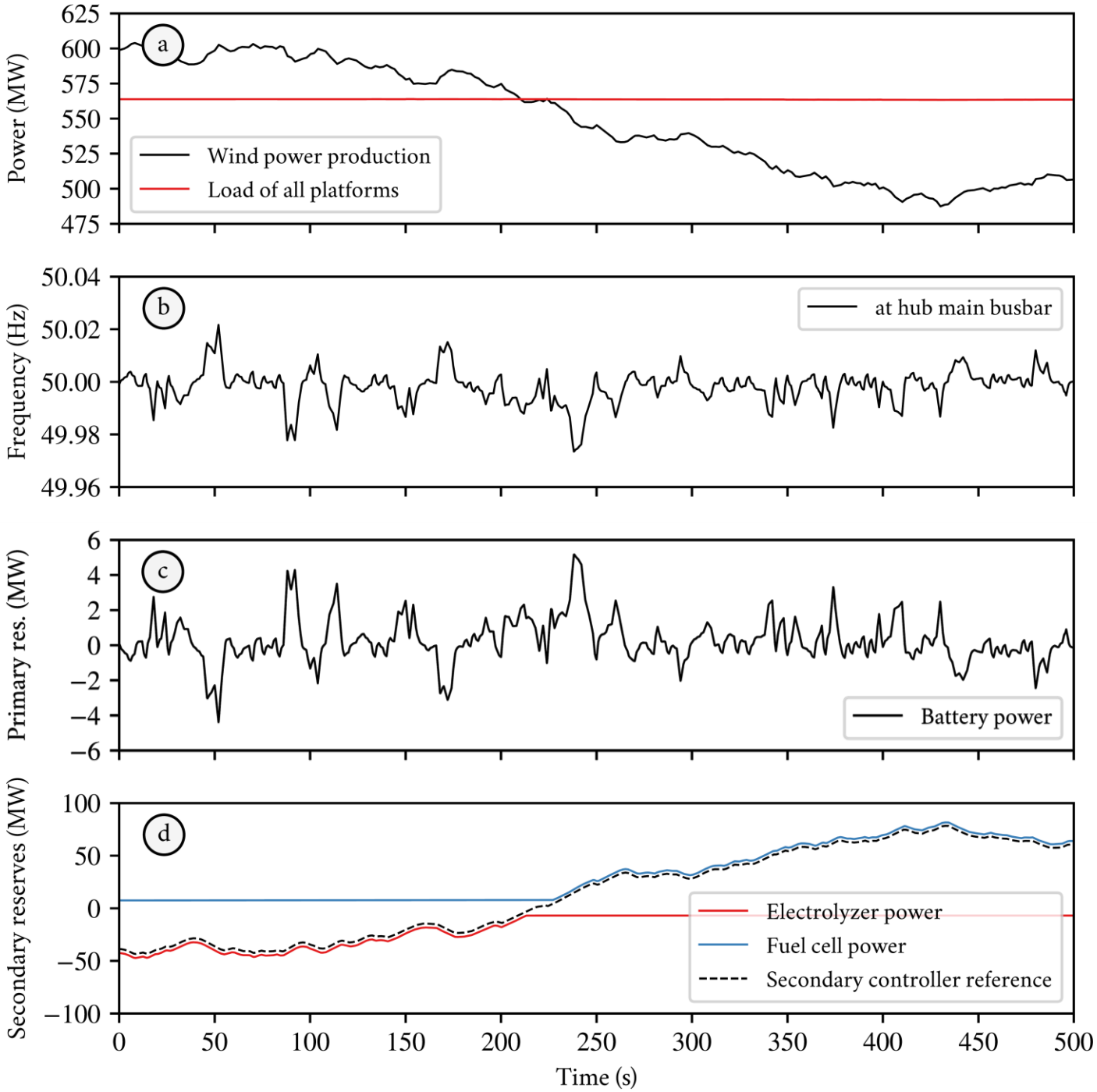
Secondary Power Shares

- **Fuel Cells 350 MW**
- **Fuel Cells 350 MW**
- **Electrolyser 350 MW**
- **Electrolyser 350 MW**

Primary Frequency Controller

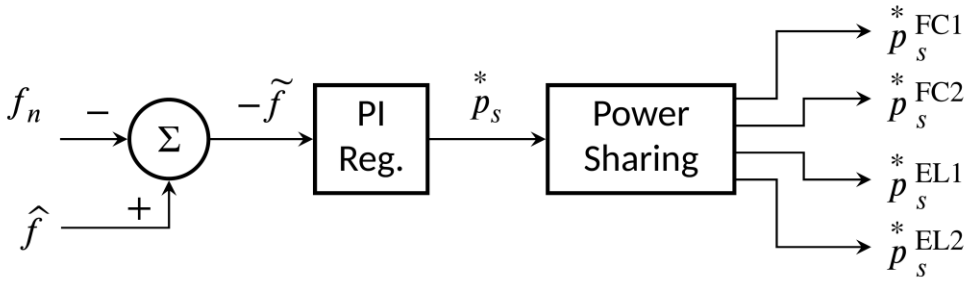
- Grid Forming Battery System
- Virtual Synchronous Machine
  - Proportional response to frequency variations
- Always active

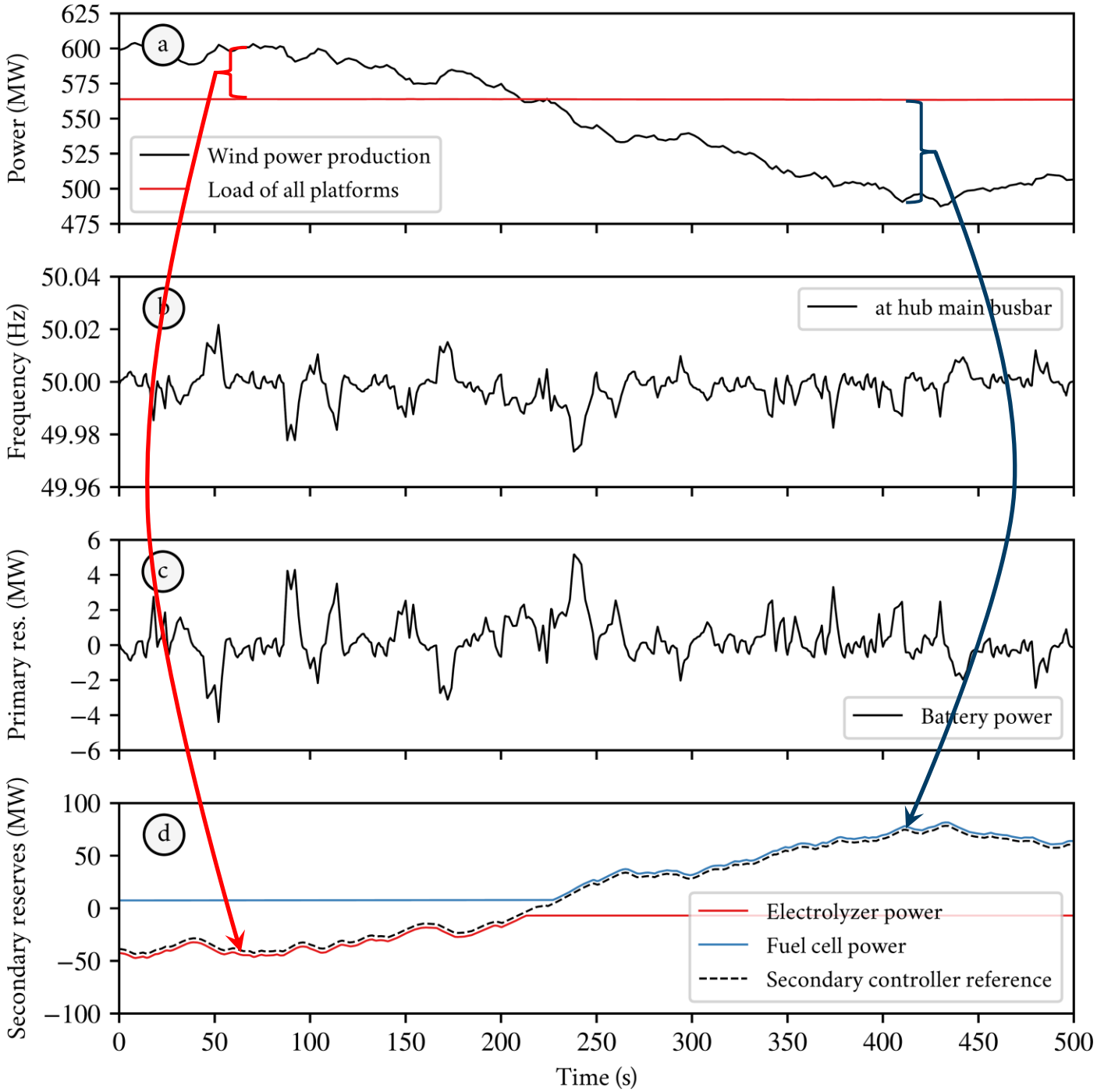




Secondary Frequency Controller

- Centralized PI controller
- Secondary Power Setpoint
- Power Setpoint Sharing
- Always active

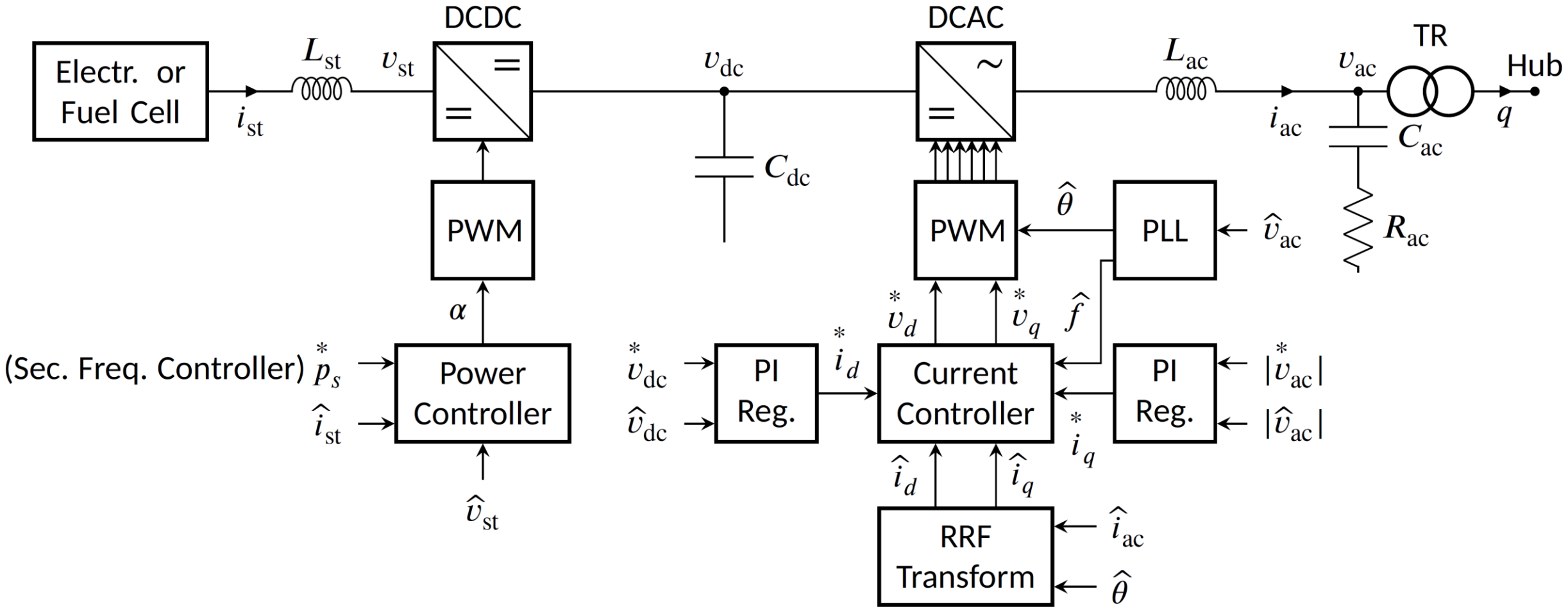




Secondary Frequency Reserves

Table 1. PI regulators of the DCAC converters of the energy storage devices.

DCAC converter	Voltage (v_{ac})	Voltage (v_{dc})
Battery (100 MW)	Active	Not present
Fuel cell block 1 (350 MW)	Active	Active
Fuel cell block 2 (350 MW)	Active	Active
Electrolyser 1 (350 MW)	Disabled	Active
Electrolyser 2 (350 MW)	Disabled	Active

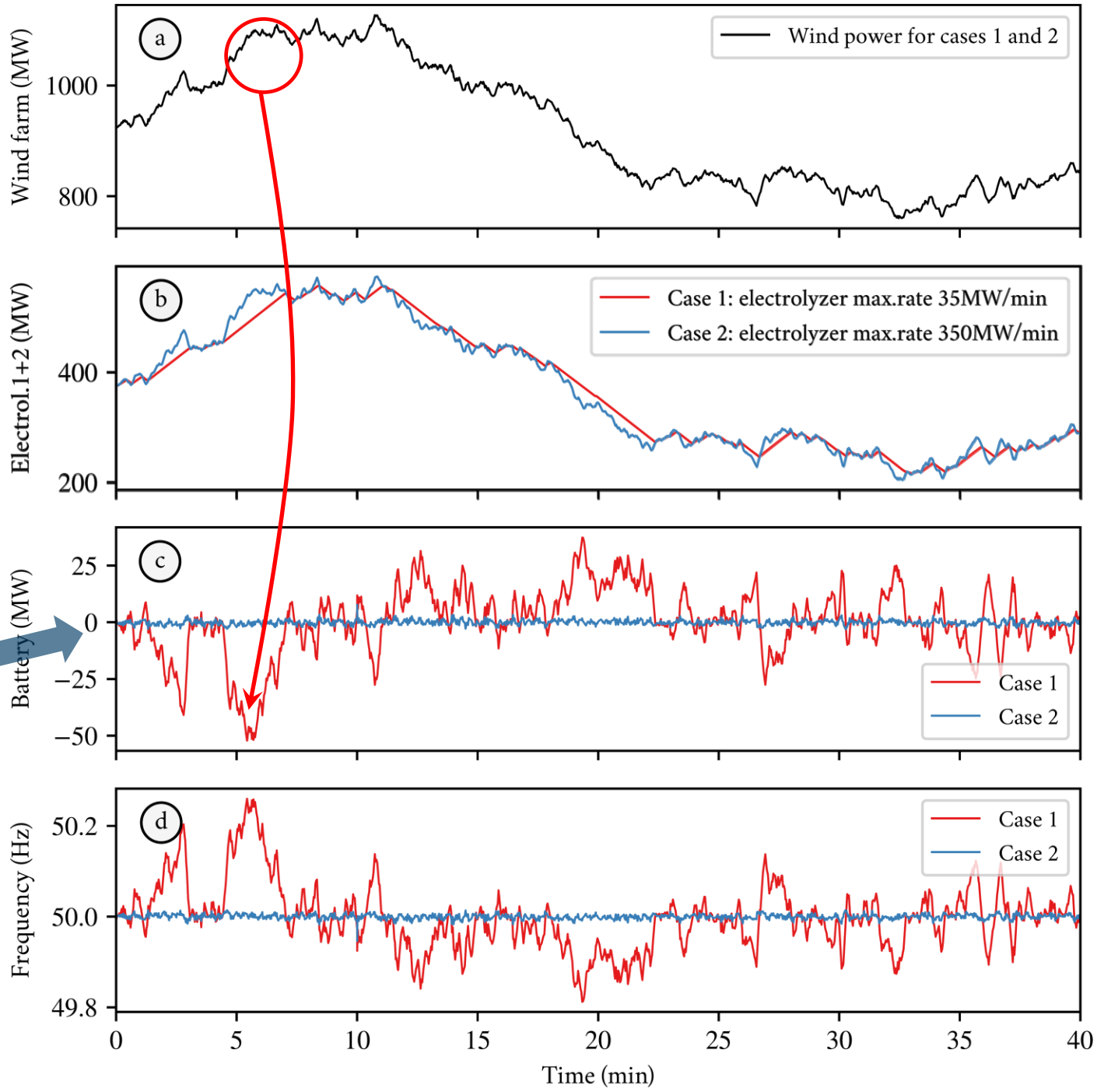


Power Ramping vs Sizing BESS

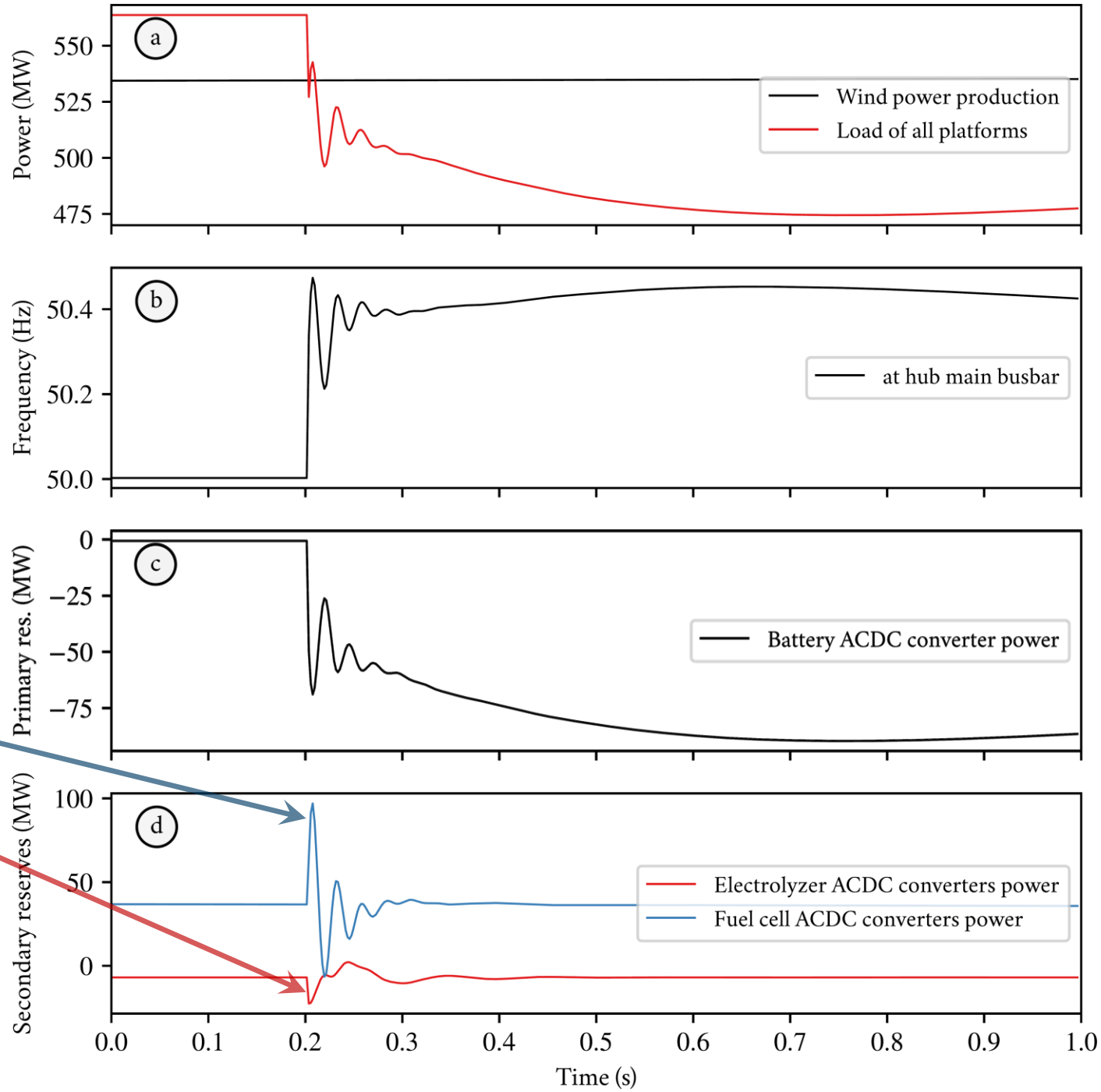
Secondary Reserves
Maximum Ramping Rates

- Case 1
  - Max 35 MW/min
- Case 2
  - Max 350 MW/min

Easier life for the batteries



Fast Transients



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Future Work EMTP Simulations

Thank you!

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