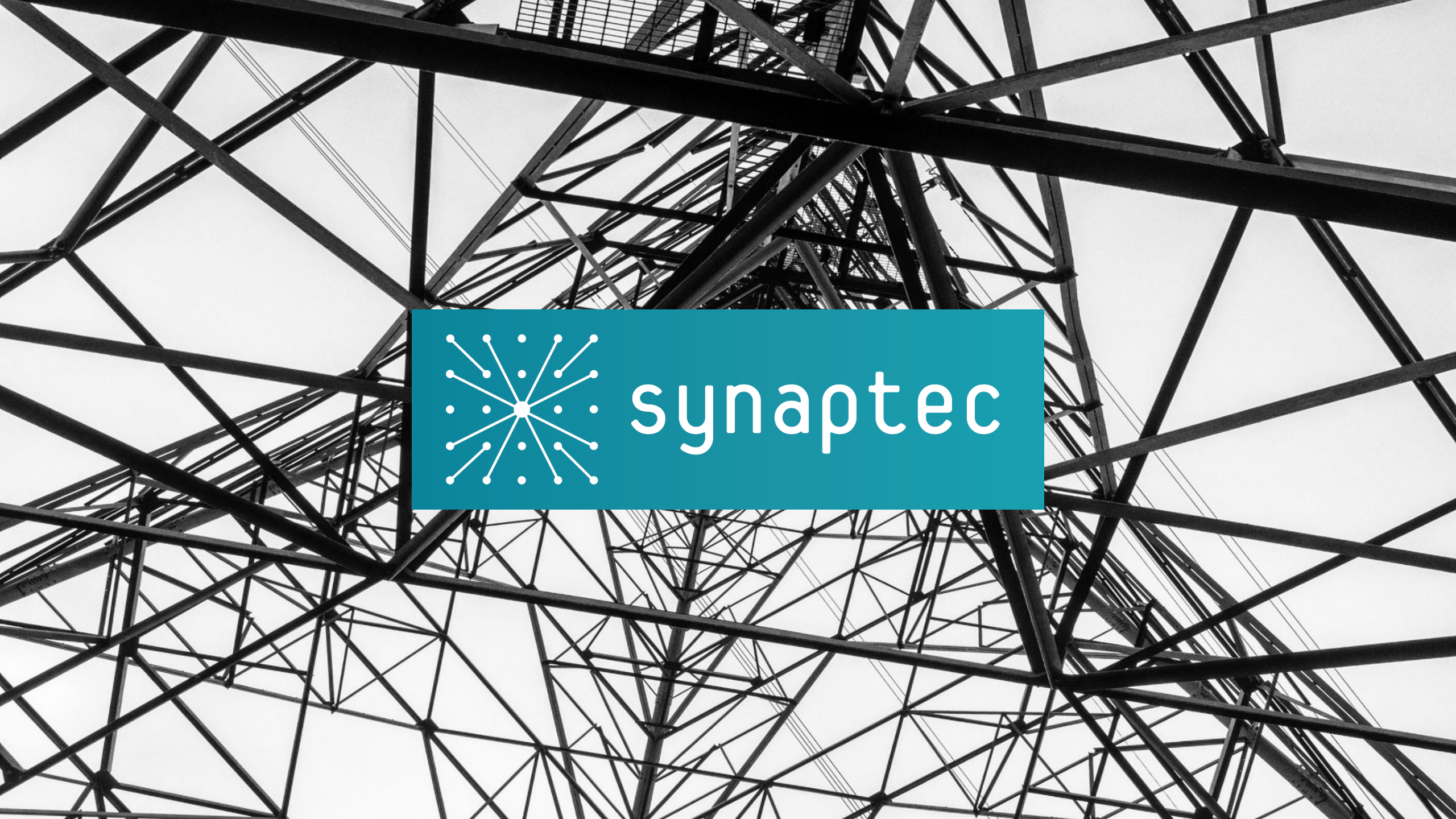

synaptec

Transient and CPOW monitoring for renewable generation connections

Dr Steven Blair

steven.blair@synapt.ec

The good news…

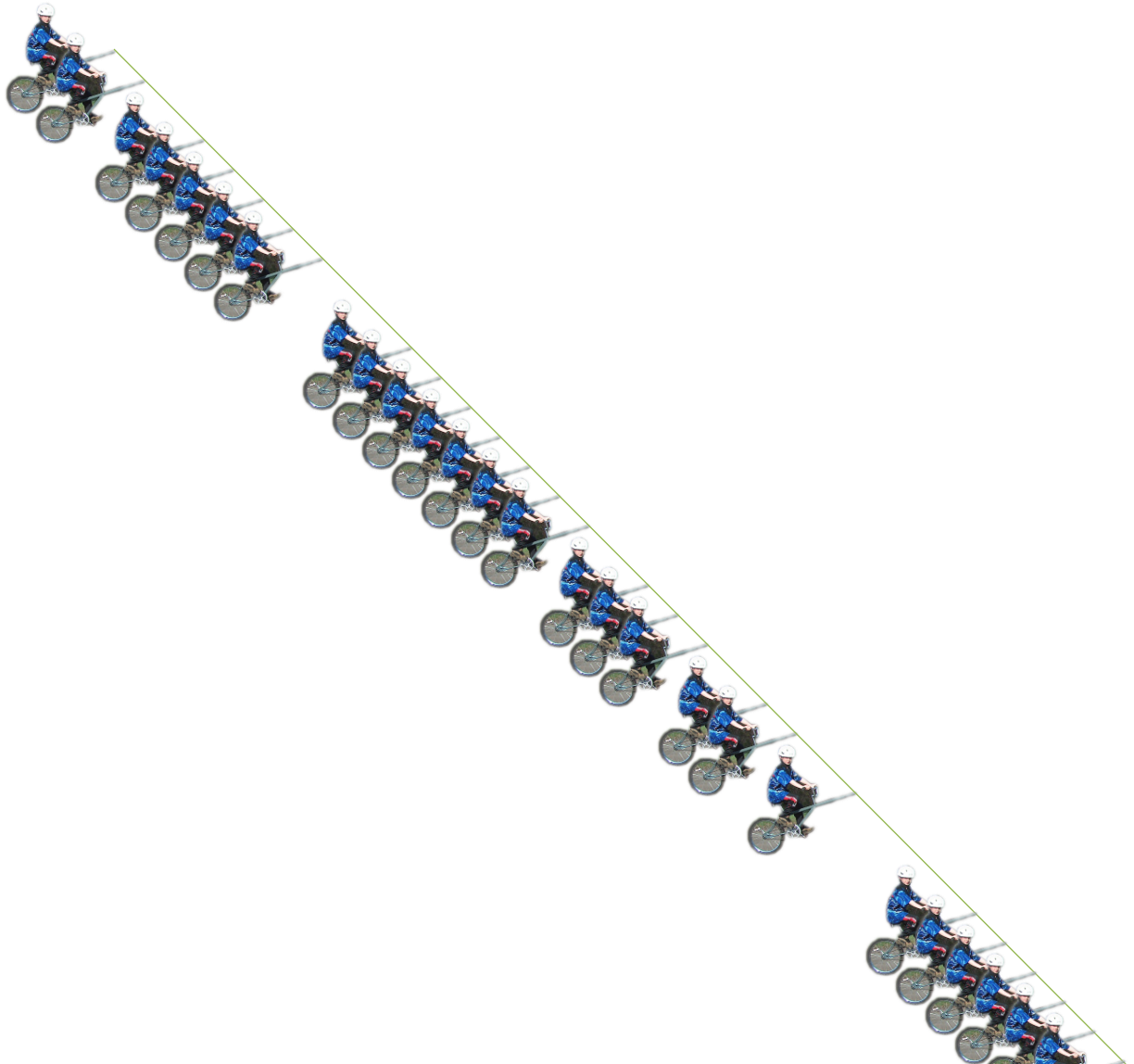
Over 80% of new US generation capacity in 2021 from **renewables**

From: https://www.eia.gov/todayinenergy/detail.php?id=46416

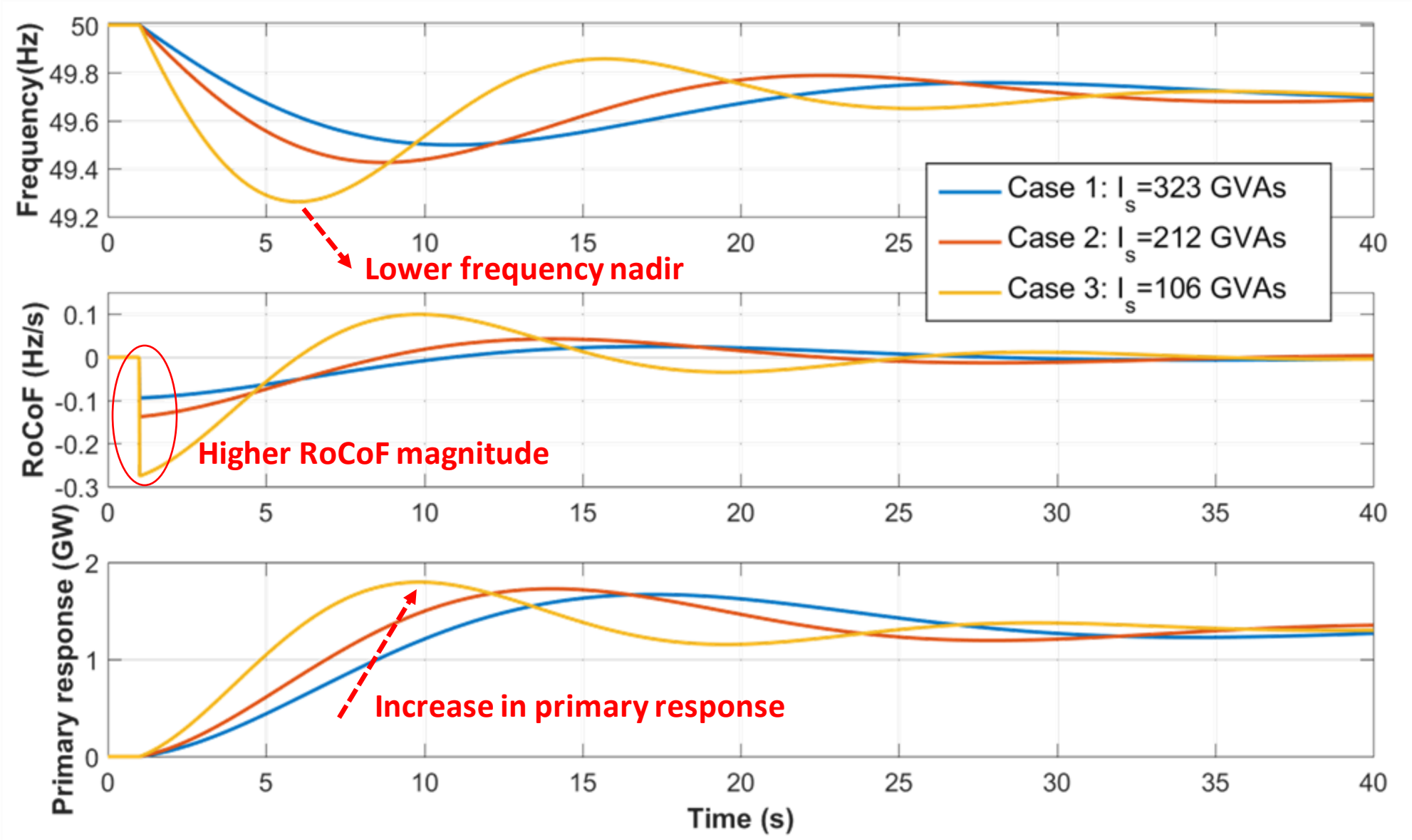
Conventional power system...

Modern power systems

Future power systems…

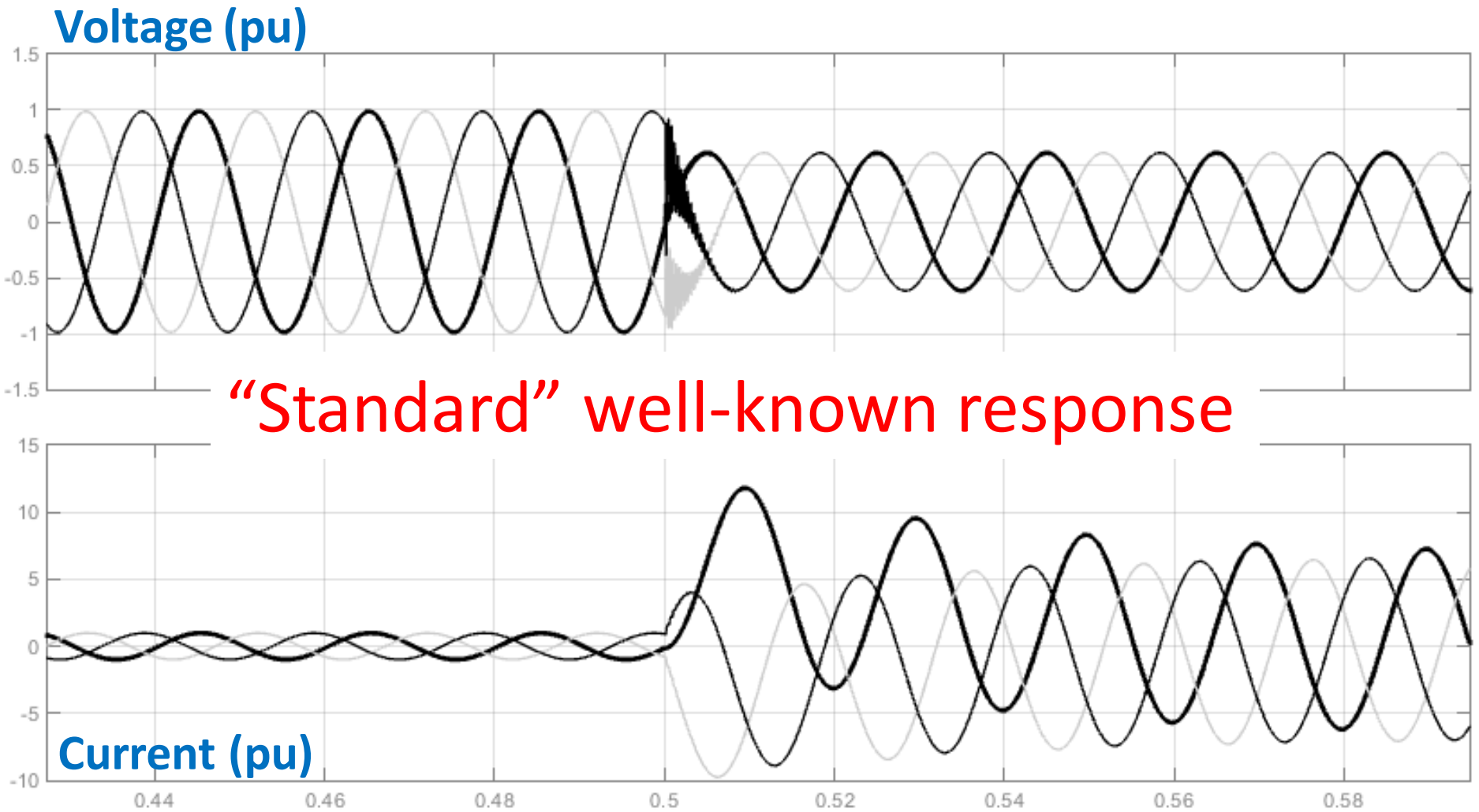


Impact of reduced inertia on frequency control – loss of 1.32 GW generation in Great Britain grid



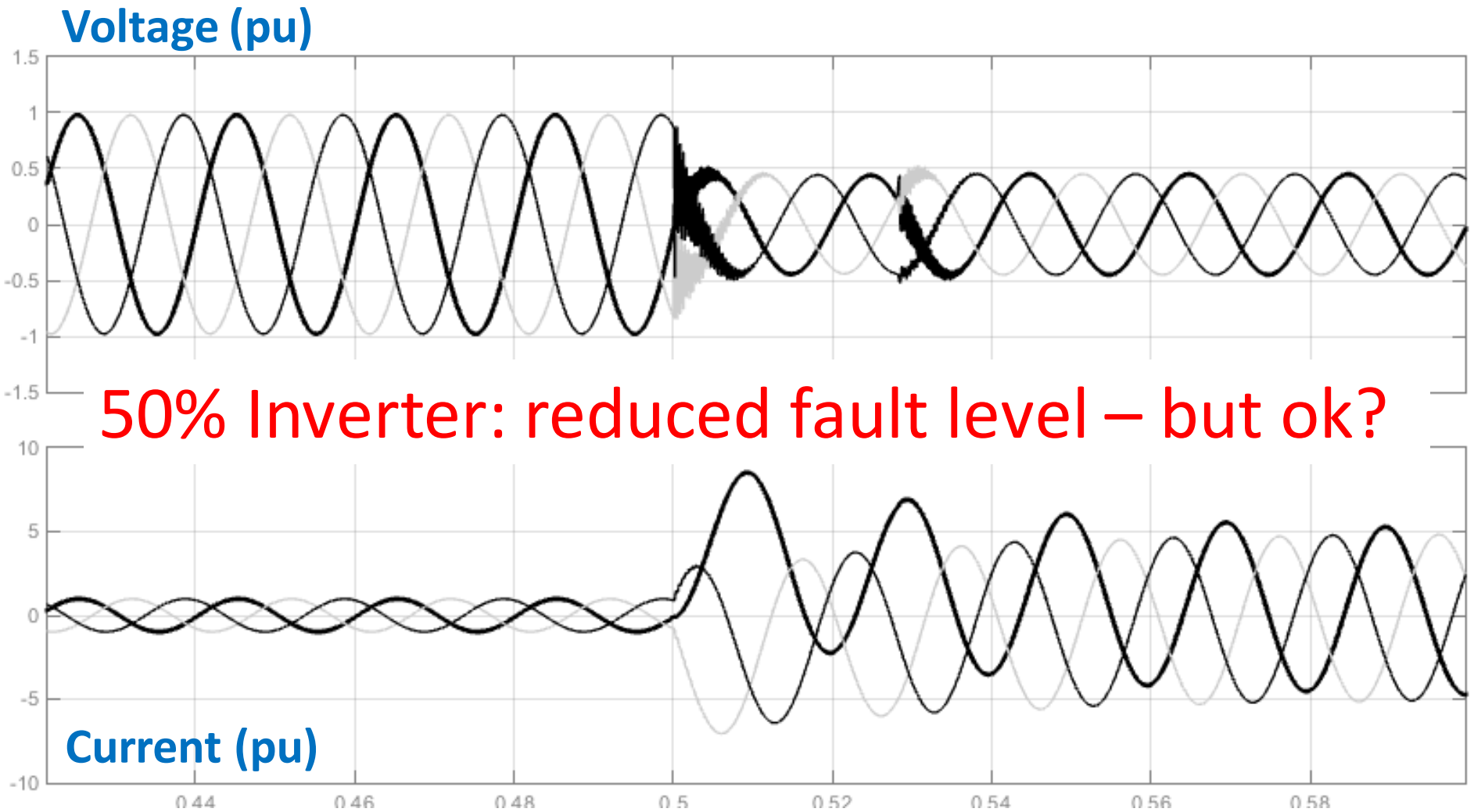
Protection of converter-dominated systems

Three-phase fault: 0% converter penetration level



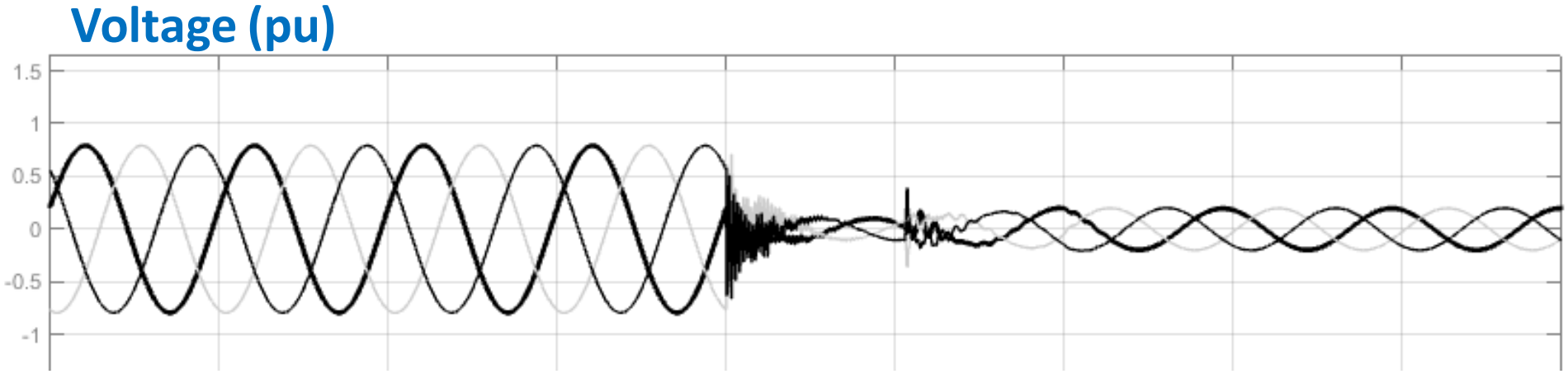
Protection of converter-dominated systems

Three-phase fault: 50% converter penetration level

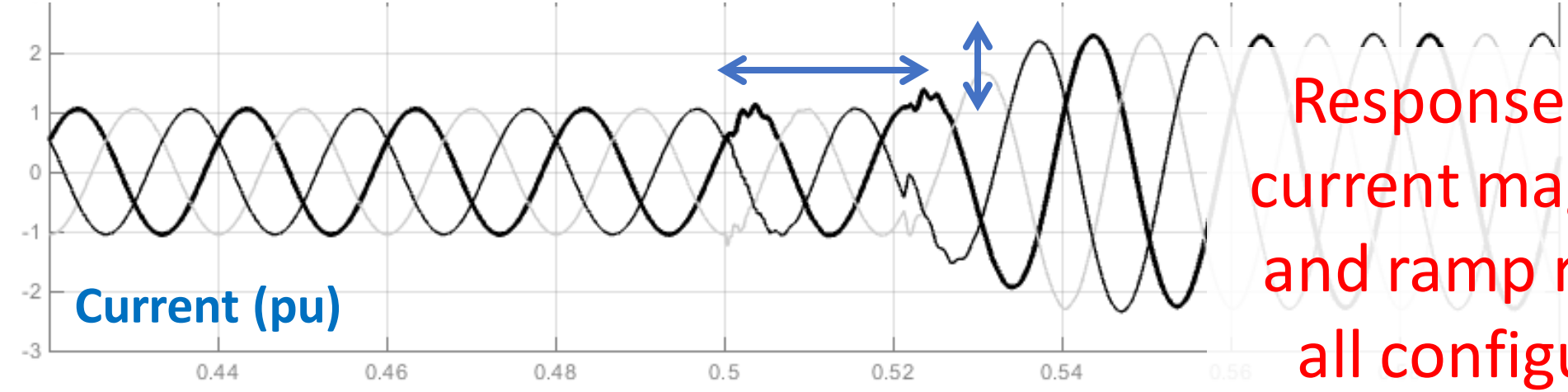


Protection of converter-dominated systems

Three-phase fault: 100% converter penetration level

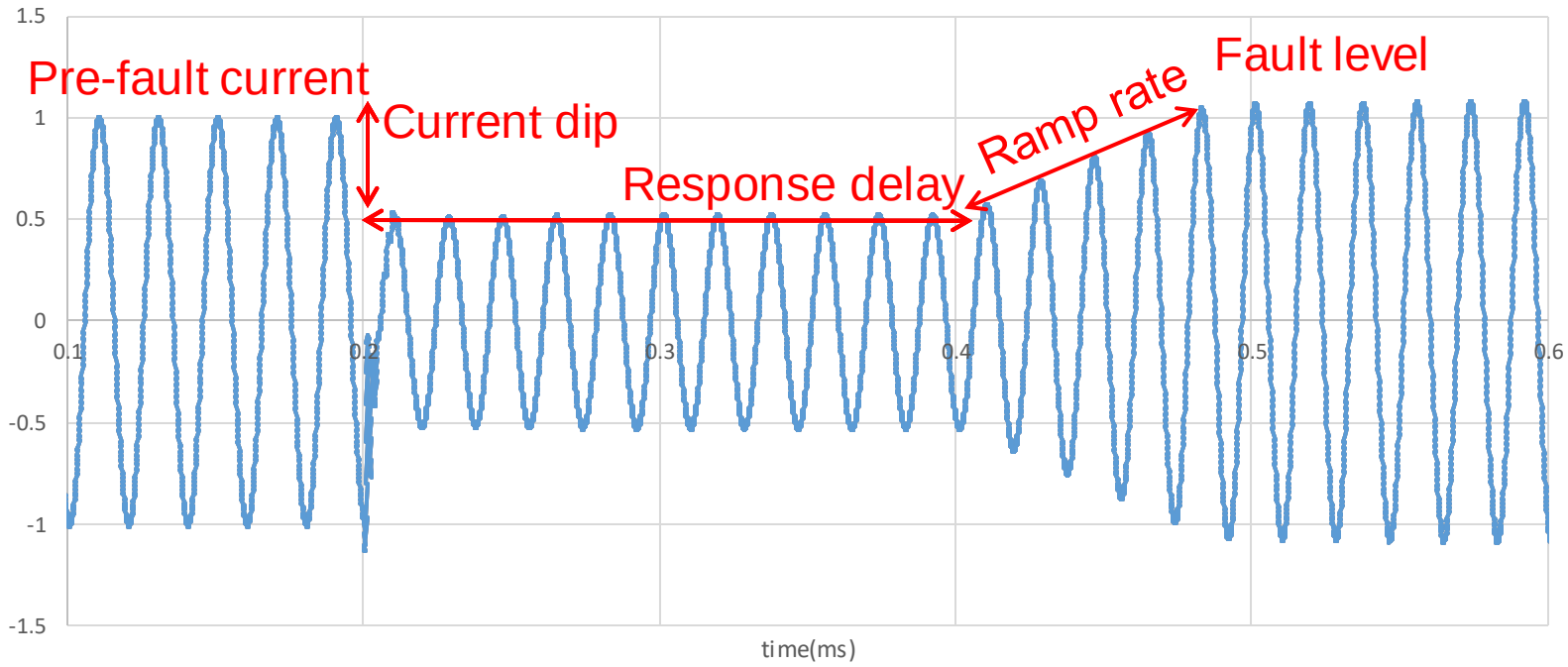


100%: OK? Delay in response, waveform distortion…?

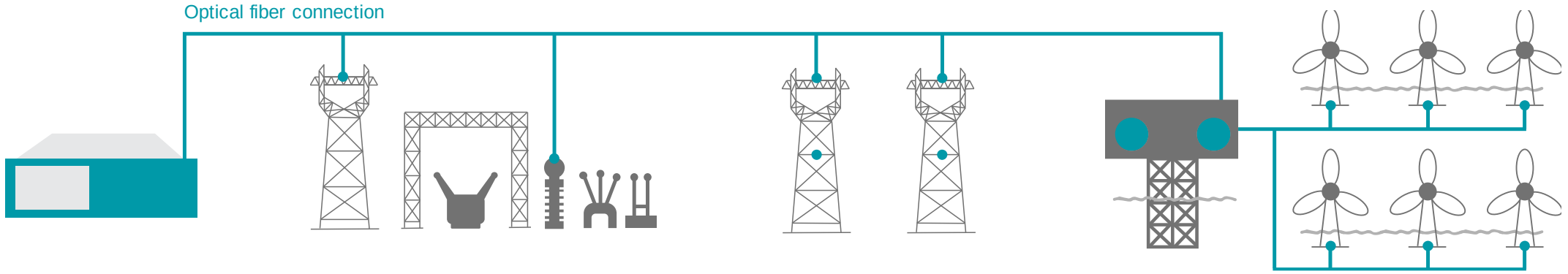


Response delay, current magnitude and ramp rate are all configurable

“Designer” fault currents



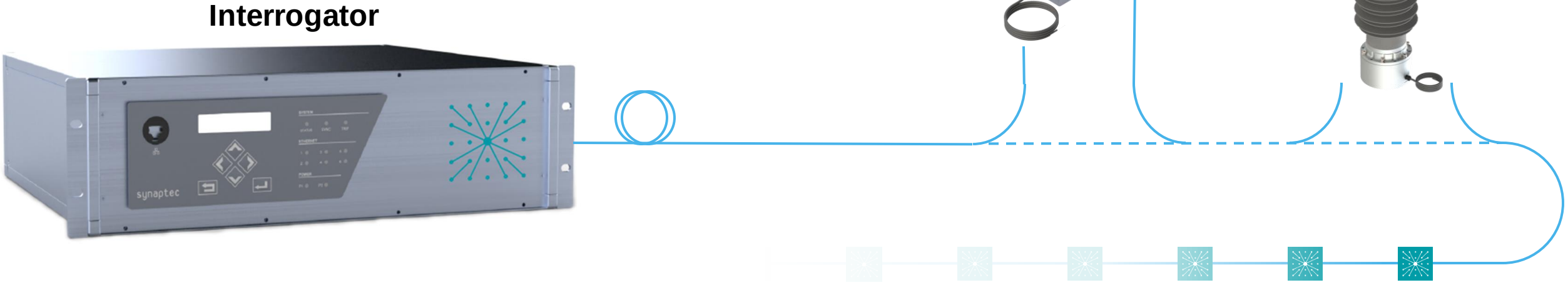
CPOW sensing scheme overview



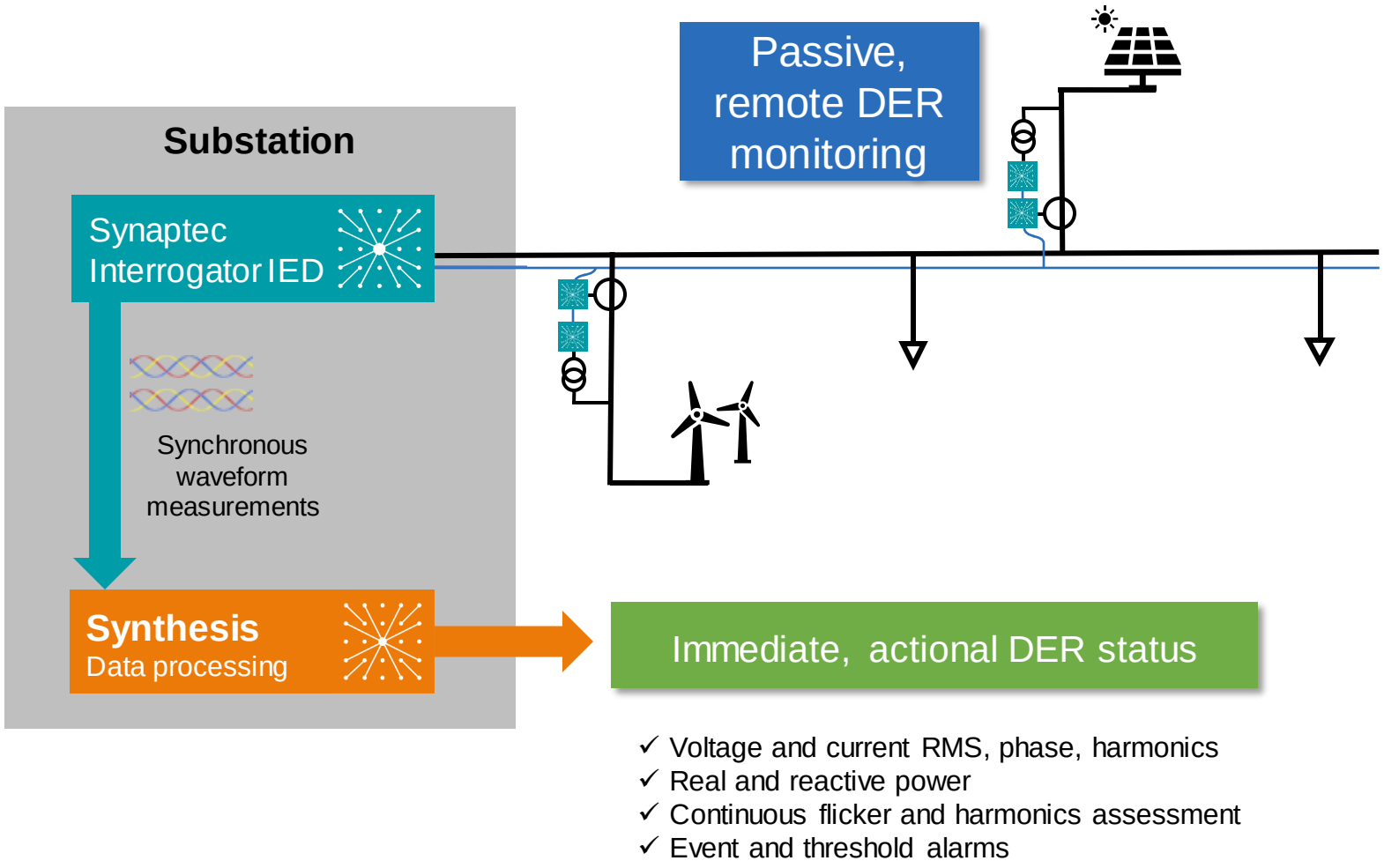
- One powered Interrogator
- Arrays of passive sensors measure **voltage**, **current**, **strain**, **vibration**, **temperature**
- Integrated into existing standard telecoms fiber network
- 5P / 0.2M class electrical measurements
- Microsecond time accuracy on all measurements
- Delivers CPOW data from every sensor

Sensor integration

- Current and voltage sensors are integrated with **standard CTs and VTs**, connected in series through single-mode fiber
- Primary or secondary connected
- No data, power, comms infrastructure or clocks outside substation



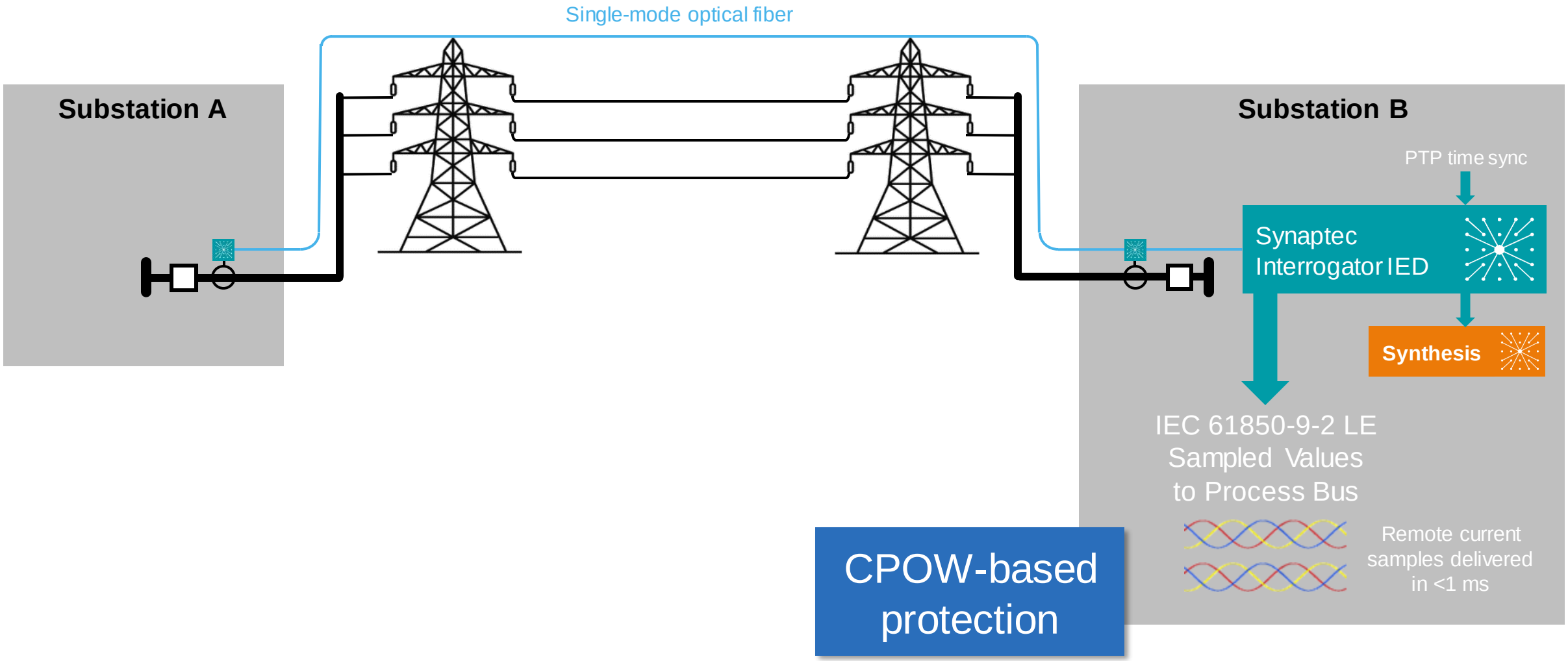
Remote DER monitoring



Summary of value:

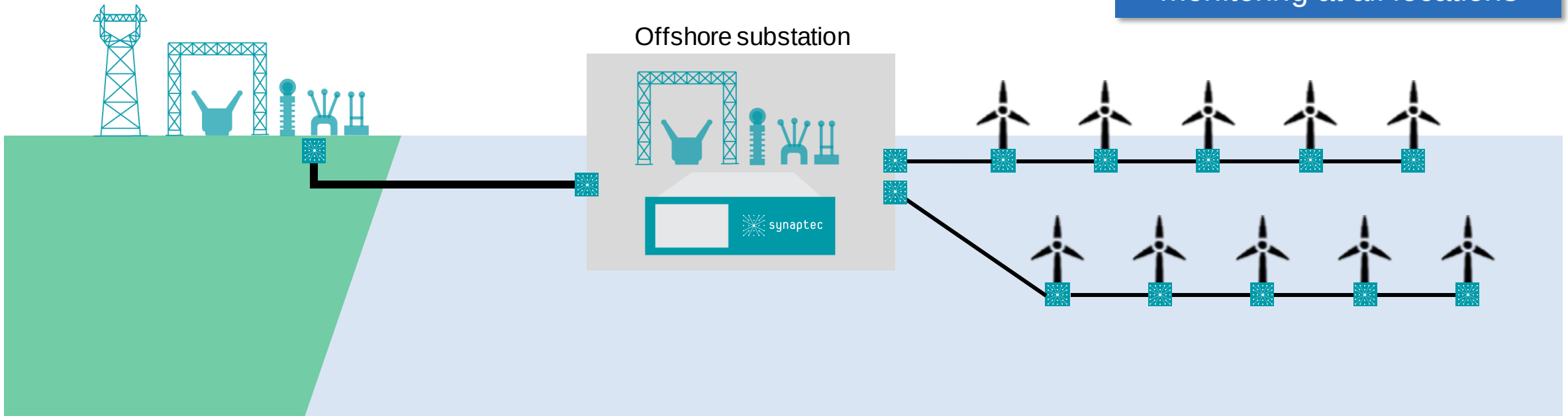
- Visibility of remote DER assets
- Immediate warnings of network PQ violations
- Reduced outages due to PQ-related side-effects of converter control
- Enables more DER connections due to better understanding of constraints

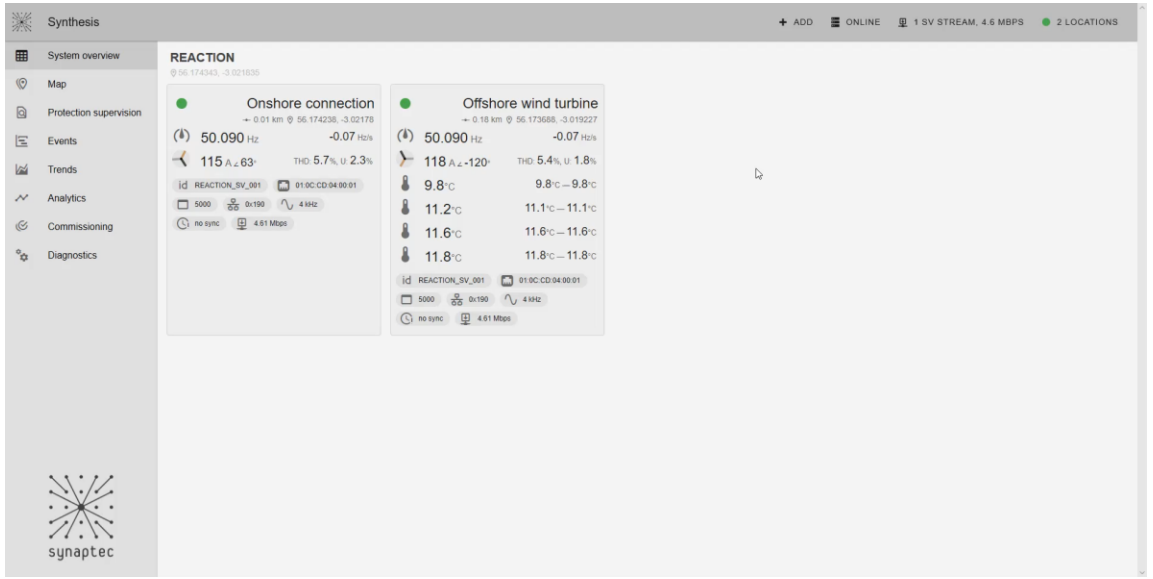
Wide-area line protection

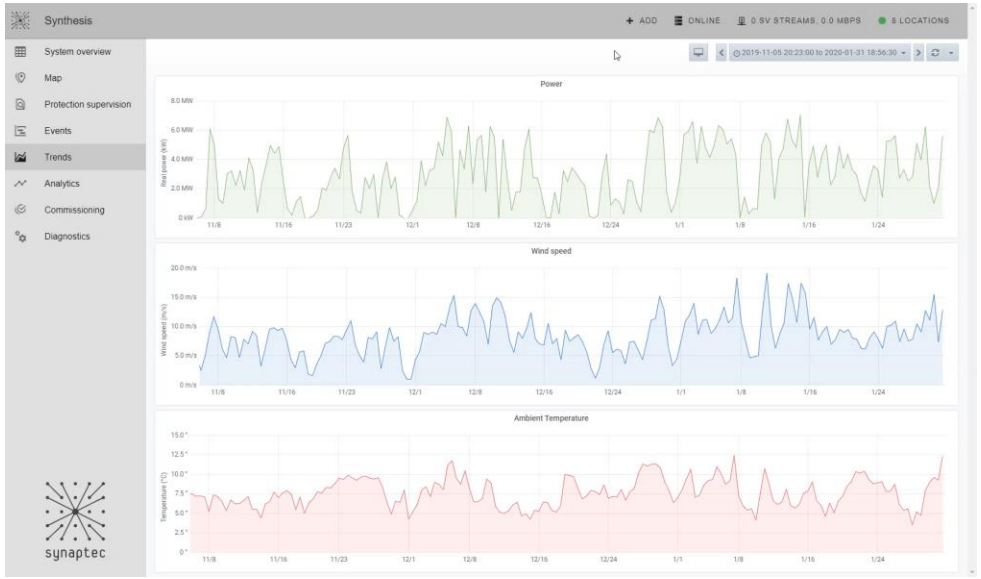


Wind farm monitoring

Synchronous, permanent PQ monitoring at all locations





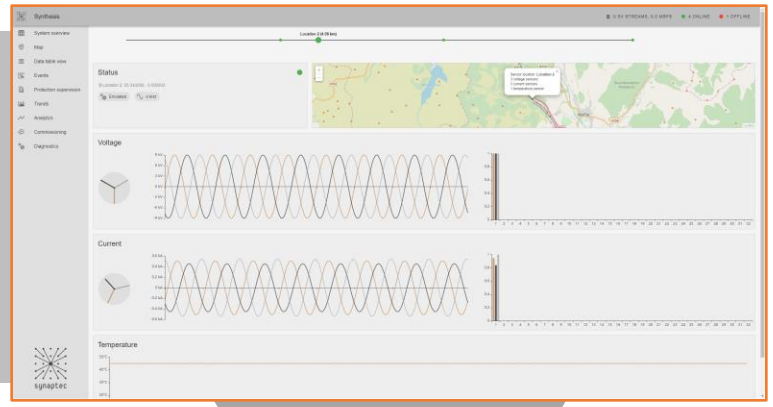


Synthesis – waveform data analysis

Enables:

- Detailed wide-area visibility
- PQ and synchrophasor delivery

- Captures CPOW data – in real-time and for events
- Visualise long-term trends



Secure private access to dashboard

Wide-area sensor networks

Synaptec Interrogator IEDs

Local Process Bus and SCADA integration

Substation

Secure connection

Lossless data compression (e.g. 10 three-phase measurements in 1 Mbps, including TLS)

Synthesis
Data processing & analytics

Local or cloud server and data storage

High-resolution event data (kHz)

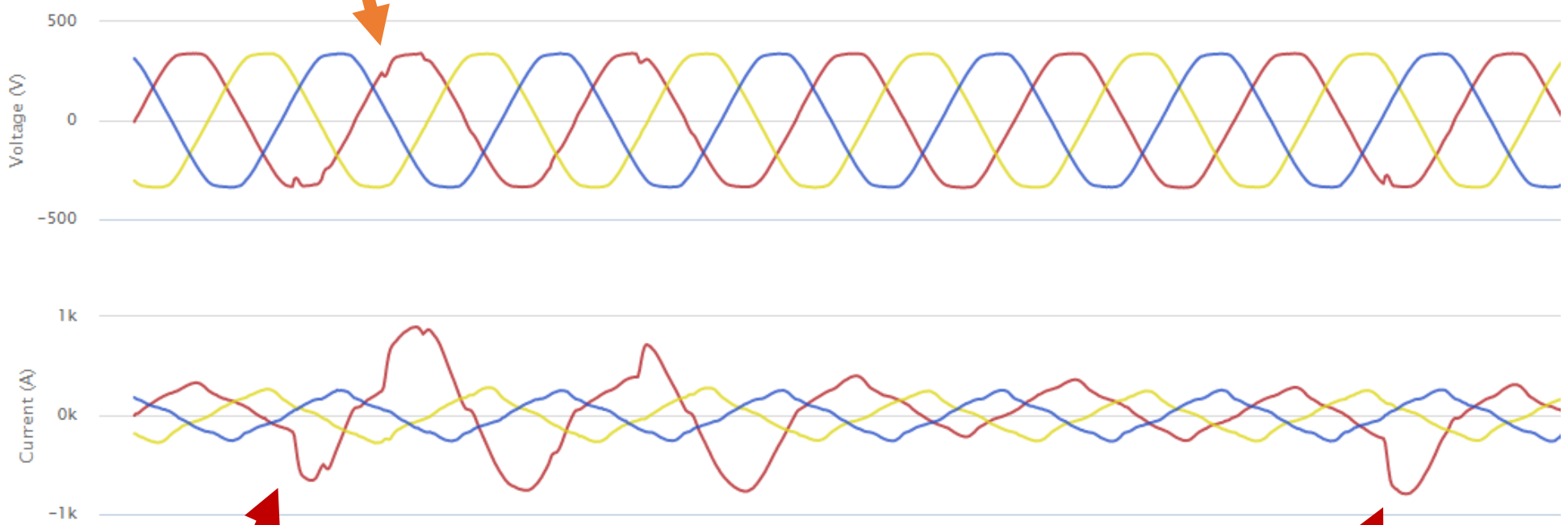
Long-term data trends (Hz)

Event and trend data storage

Synchronised transient detection and archiving

Synchronous measurements: see time-aligned voltage notching

All data available here: http://c2c.eee.strath.ac.uk

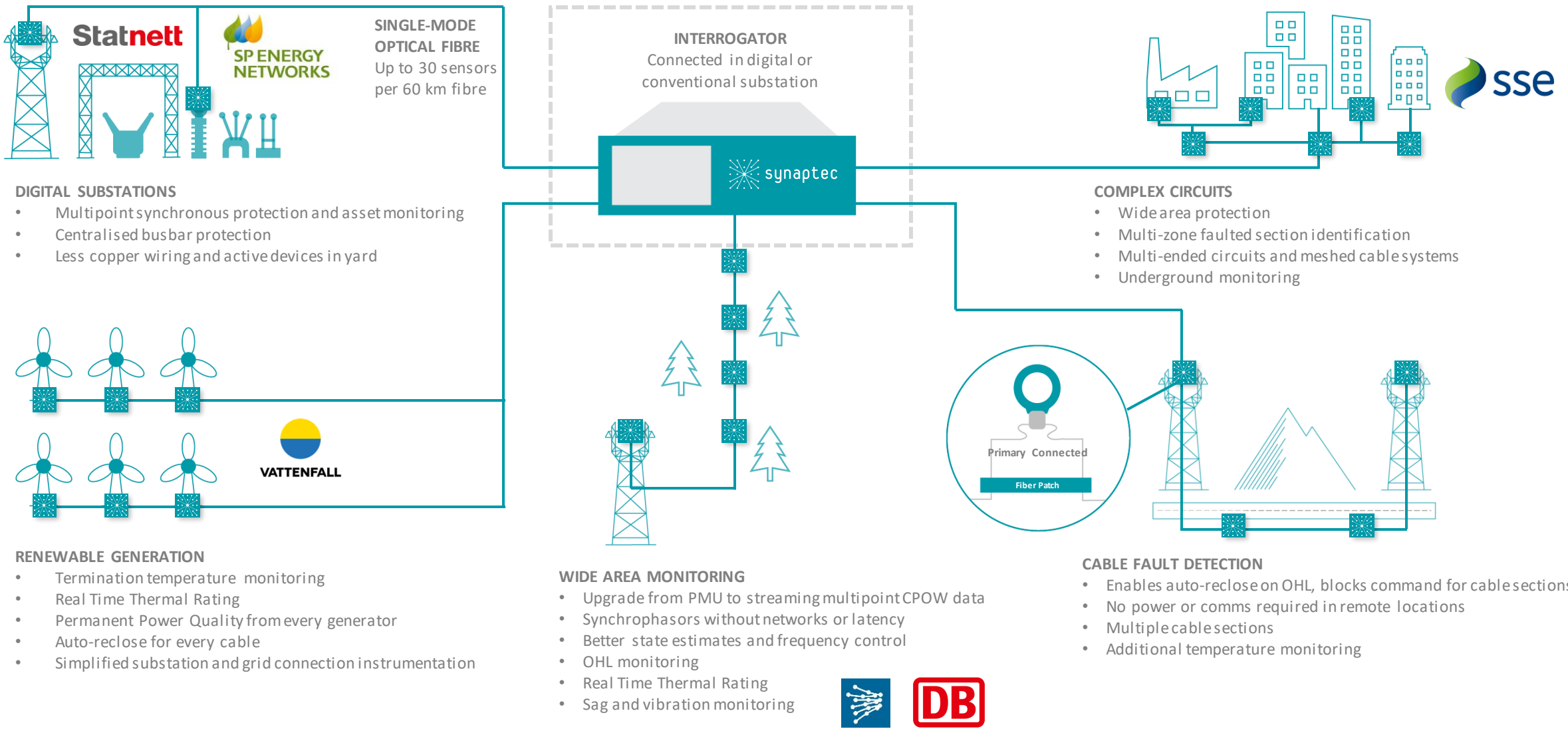


Arcing fault

Re-ignition

Blair, et al, "Automatically Detecting and Correcting Errors in Power Quality Monitoring Data", 2016: https://doi.org/10.1109/TPWRD.2016.2602306
URL for data for this event: http://c2c.eee.strath.ac.uk/#/?eventWaveformTime=1372849063&location=ASHTONPK171032&showEvents=true

Zero-power sensor arrays and unique analytics



DIGITAL SUBSTATIONS

- Multipoint synchronous protection and asset monitoring
- Centralised busbar protection
- Less copper wiring and active devices in yard

COMPLEX CIRCUITS

- Wide area protection
- Multi-zone faulted section identification
- Multi-ended circuits and meshed cable systems
- Underground monitoring

RENEWABLE GENERATION

- Termination temperature monitoring
- Real Time Thermal Rating
- Permanent Power Quality from every generator
- Auto-reclose for every cable
- Simplified substation and grid connection instrumentation

WIDE AREA MONITORING

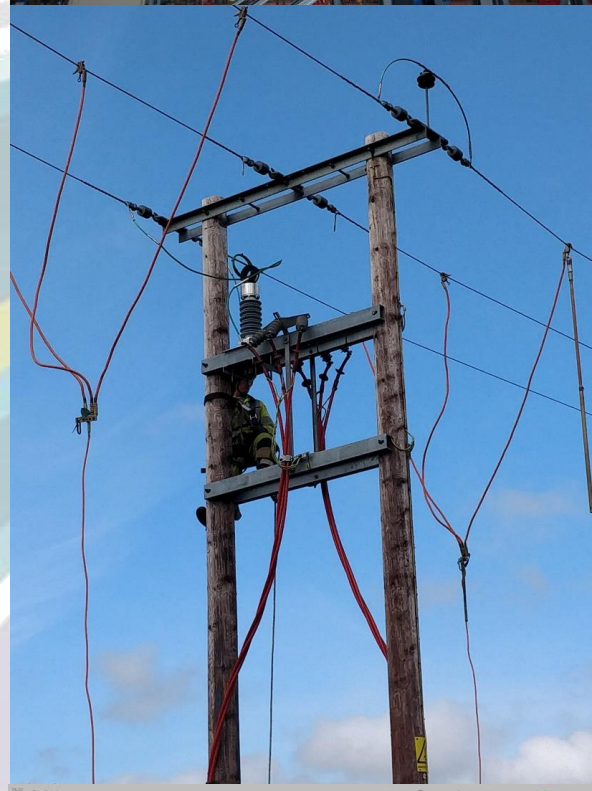
- Upgrade from PMU to streaming multipoint CPOW data
- Synchrophasors without networks or latency
- Better state estimates and frequency control
- OHL monitoring
- Real Time Thermal Rating
- Sag and vibration monitoring

CABLE FAULT DETECTION

- Enables auto-reclose on OHL, blocks command for cable sections
- No power or comms required in remote locations
- Multiple cable sections
- Additional temperature monitoring

Summary

- Secure
- Maintenance-free
- Live, real-time data
- New, integrated data sources
- Supports new CPOW applications



Contact

Dr Steven Blair
Head of Power Systems Technologies

steven.blair@synapt.ec

Synaptec Ltd
204 George Street
Glasgow G1 1XW, UK

t: +44 141 488 3664

w: synapt.ec