

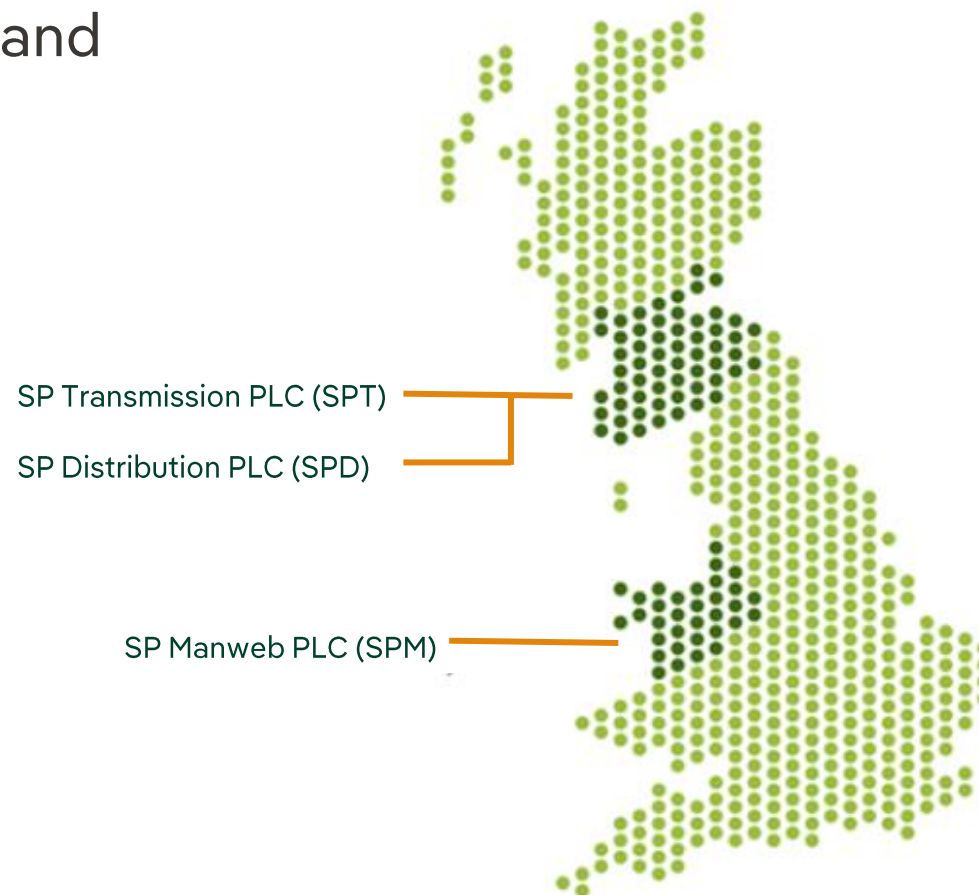


Synergy

Ian MacPherson – Senior Innovation Manager

Future Networks

- TNO and DNO for Southern and Central Scotland
- DNO for Merseyside and North Wales
- 44,000km Overhead Lines
- 65,000km Underground Cables
- Over 3000 substations
- A Total of 3.5 Million Customers



The Future Networks team are delivering our innovation strategy through;

- Industry leading expertise
- Concentrating on creating a positive and lasting impact on the future of distribution and transmission
- Two major fields of focus – black start and power electronics

Black Start

Black Start since 2015

Range of partners

Built expertise and capabilities

Power Electronics

Implementation across voltages on transmission and distribution networks

Phoenix

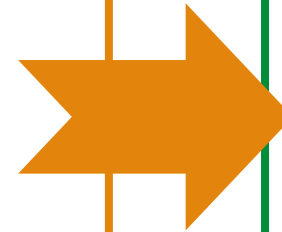
Synchronous condensers + static compensator technologies - **manage reduced inertia** and **voltage control** on Transmission Network.

Angle-DC

Medium Voltage DC (**MVDC**) link to **Anglesey**, increased **renewable generation** integration.

LV Engine

Trial of innovative **Smart Transformers** for the connection of **LCTs**



£120m investment in **RIIO-2** Business plan - implementation of **synchronous condensers** at **Eccles**

3 further sites planned to roll out **LV Engine Technology** within **RIIO-ED2**

VISOR

Greater visibility of network state and assets

FITNESS

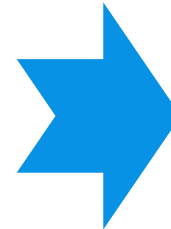
Efficient and effective digital substation

Distributed Restart

DERs supporting the network and restoring power

Synthesis

Advanced analytics and real-time control enabling rapid response to system disturbances



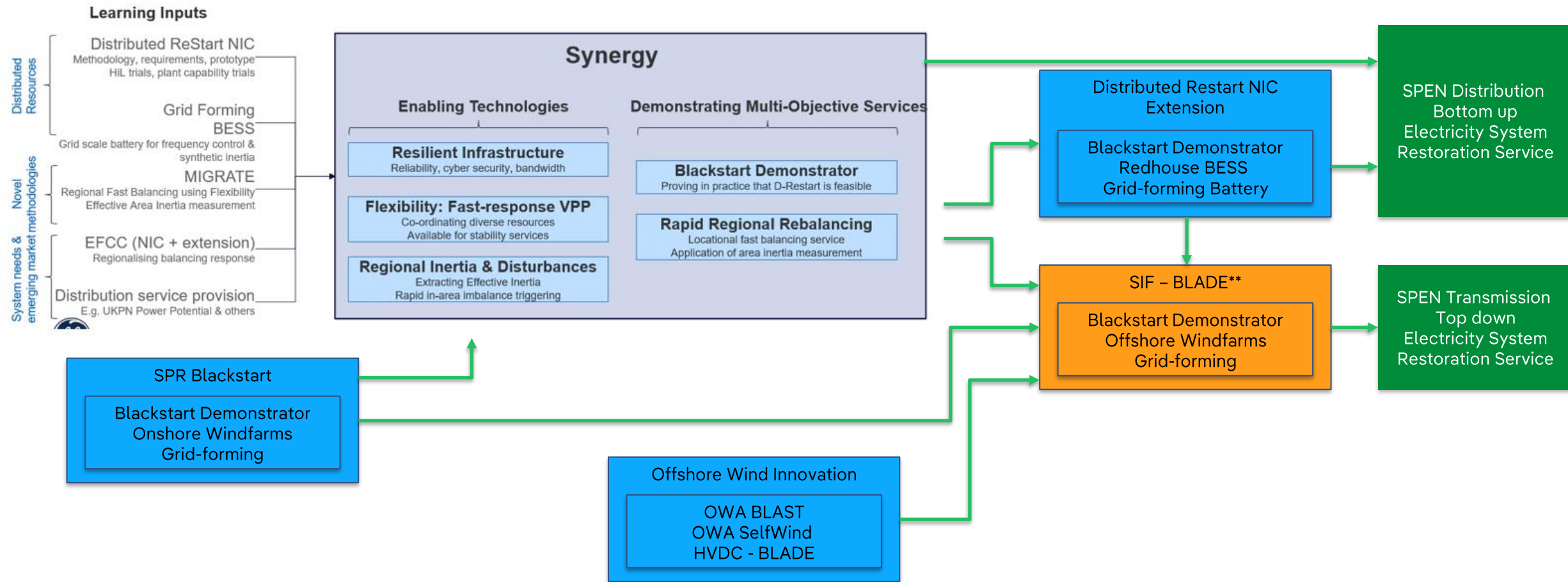
£13.59m further **investment** for **SPT**, estimated **£40m** for other GB Transmission business

£54m investment in RIIO-2
Business plan - digital substations - Westfield and Hunterston

£5m Green Recovery Fund:
Synergy

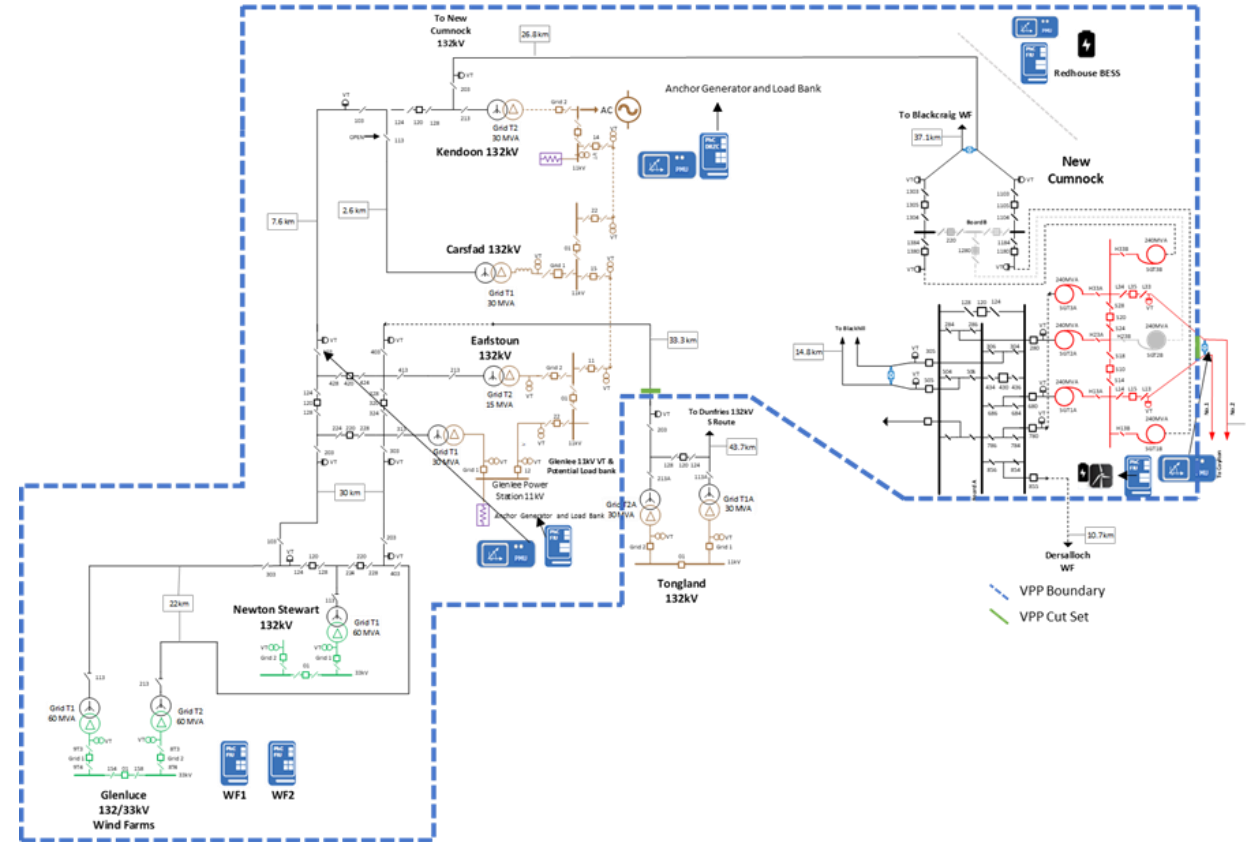
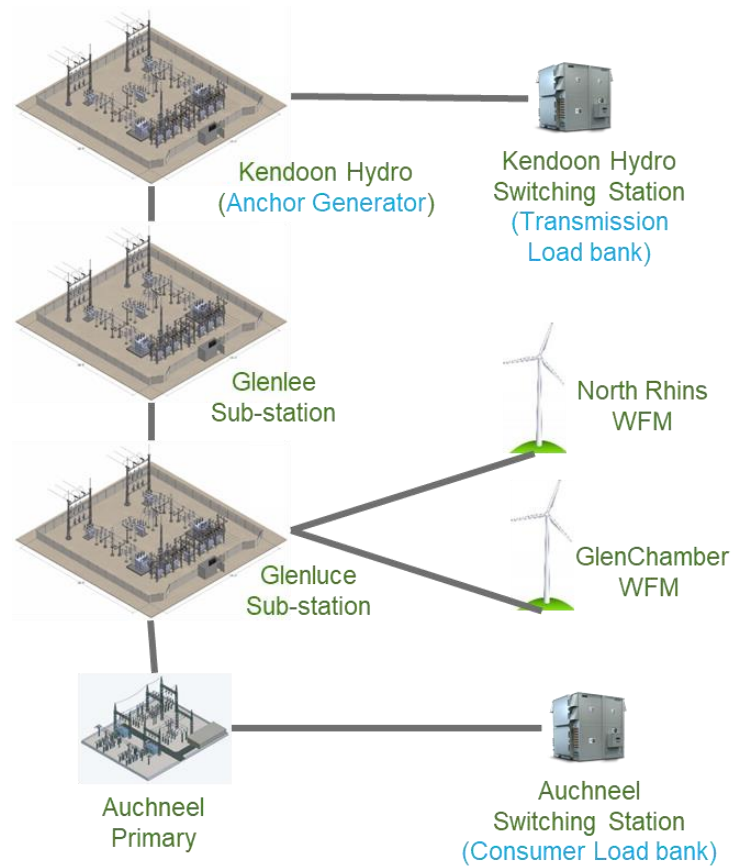
2023-SIF: Black-start from the offshore

Electricity System Restoration Service – SPEN Pathway to Delivery



Demonstration in a live environment that the same infrastructure and set of resources can be used for ***Blackstart, Frequency Response and Constraint***. This will comprise of the installation of advanced monitoring equipment, communication infrastructure and resource control technology in two SP Energy Network Regions.

Electricity System Restoration Service – Dumfries & Galloway

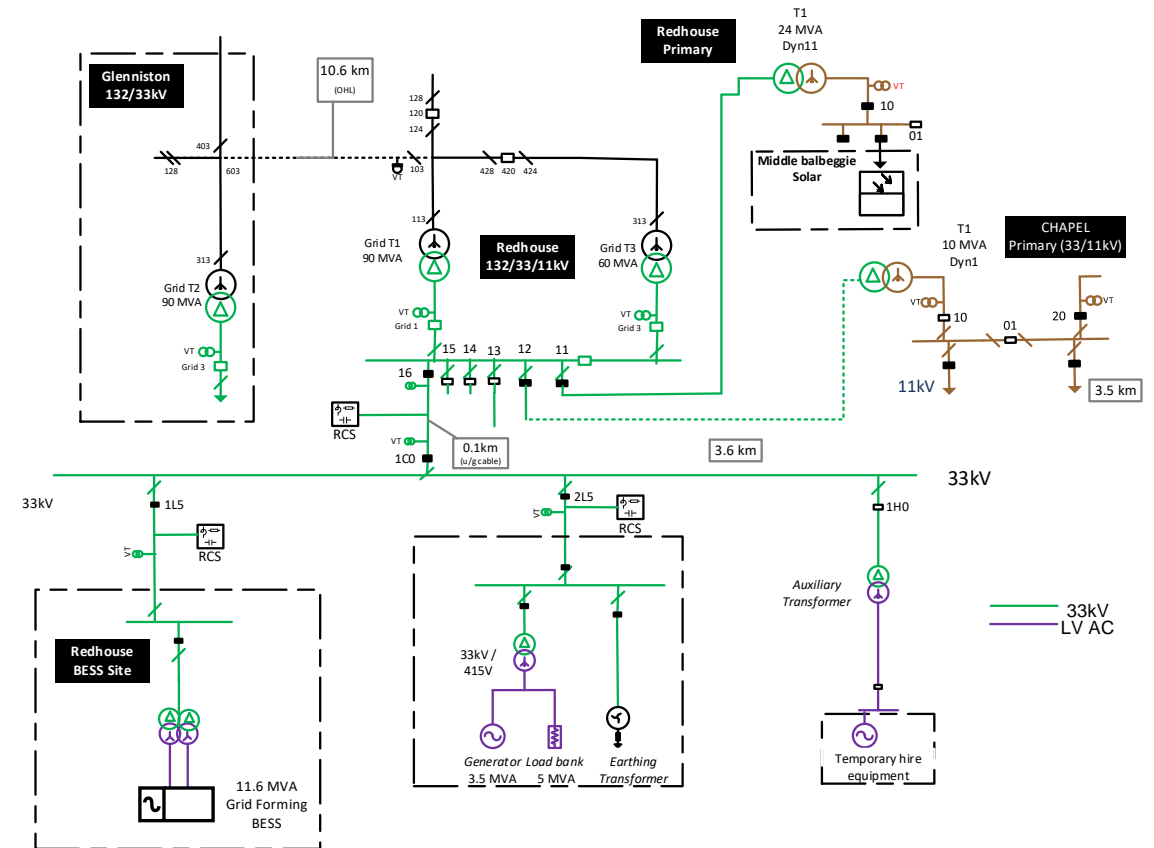
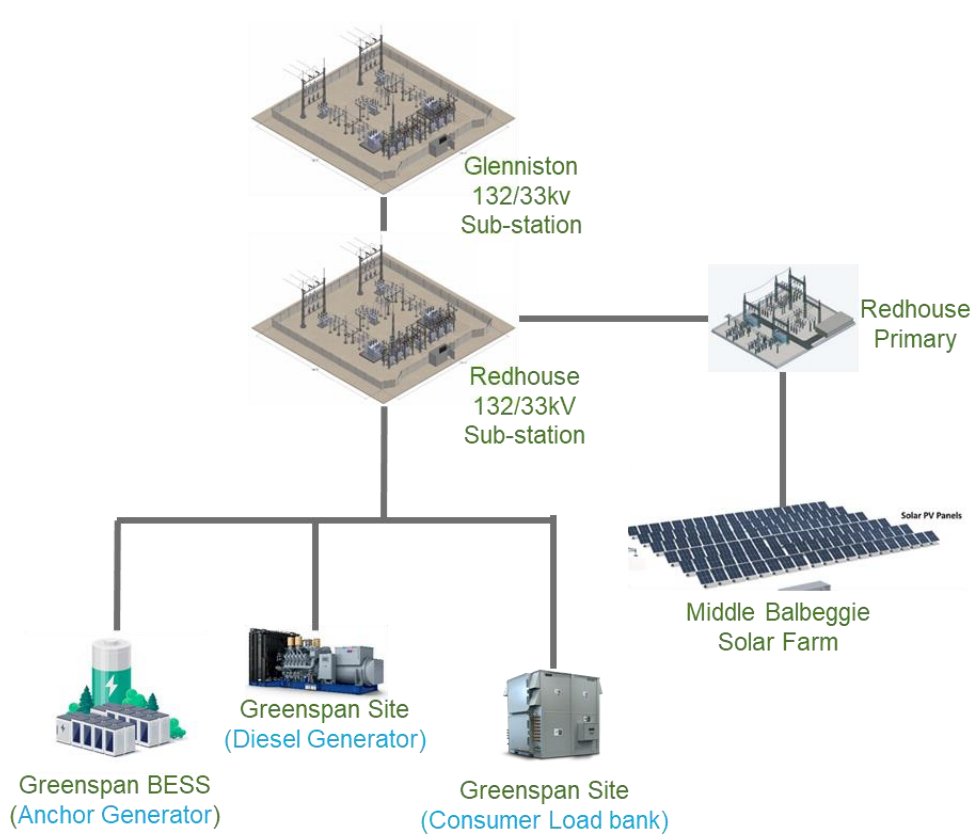


Establish Electricity System Restoration Zone

- Live testing to prove BaU solution for future Electricity System Restoration Service

Island Merge within the Galloway Region

Electricity System Restoration Service & WACS – Central & Fife

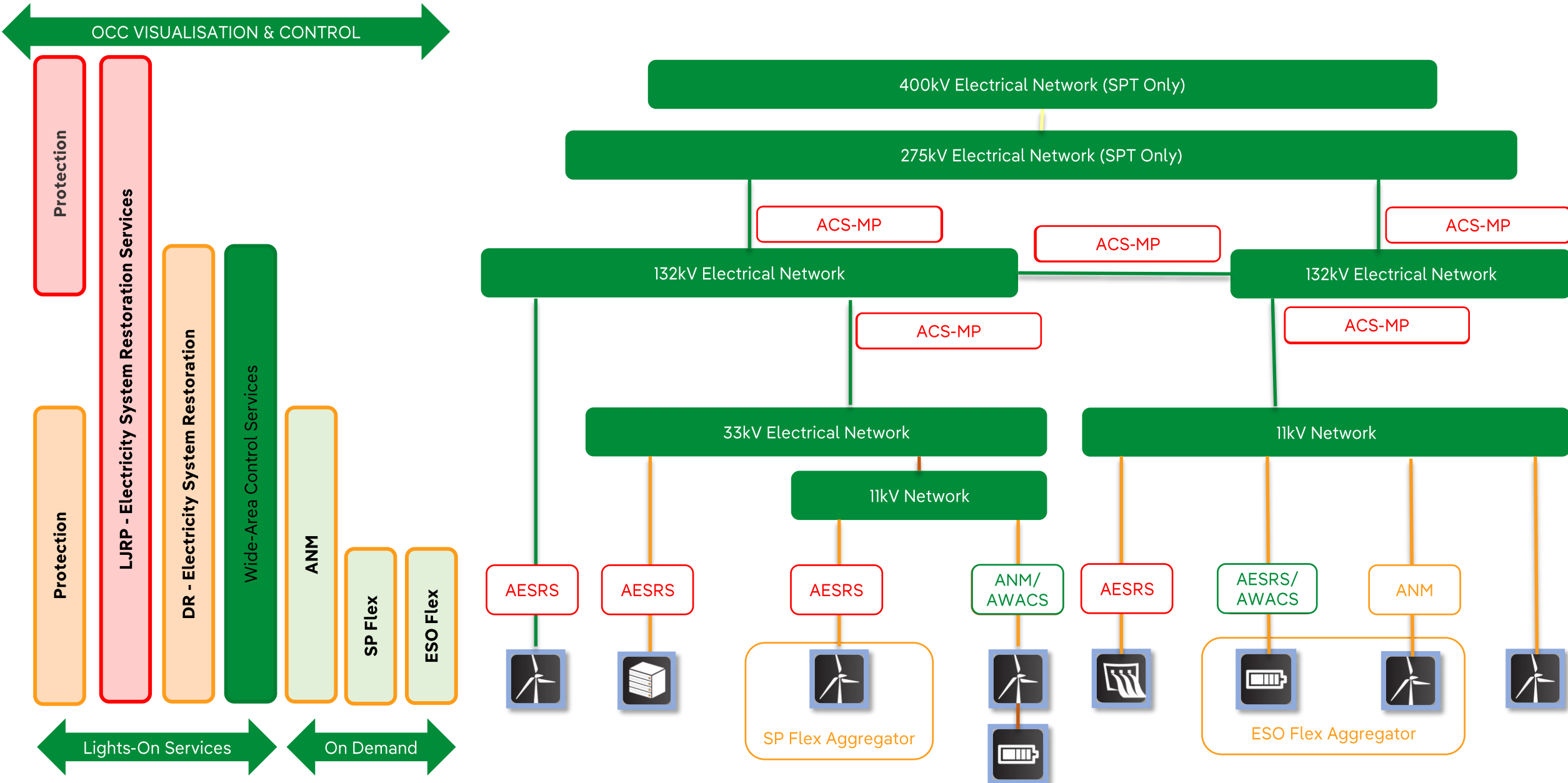


Establish Electricity System Restoration Zone

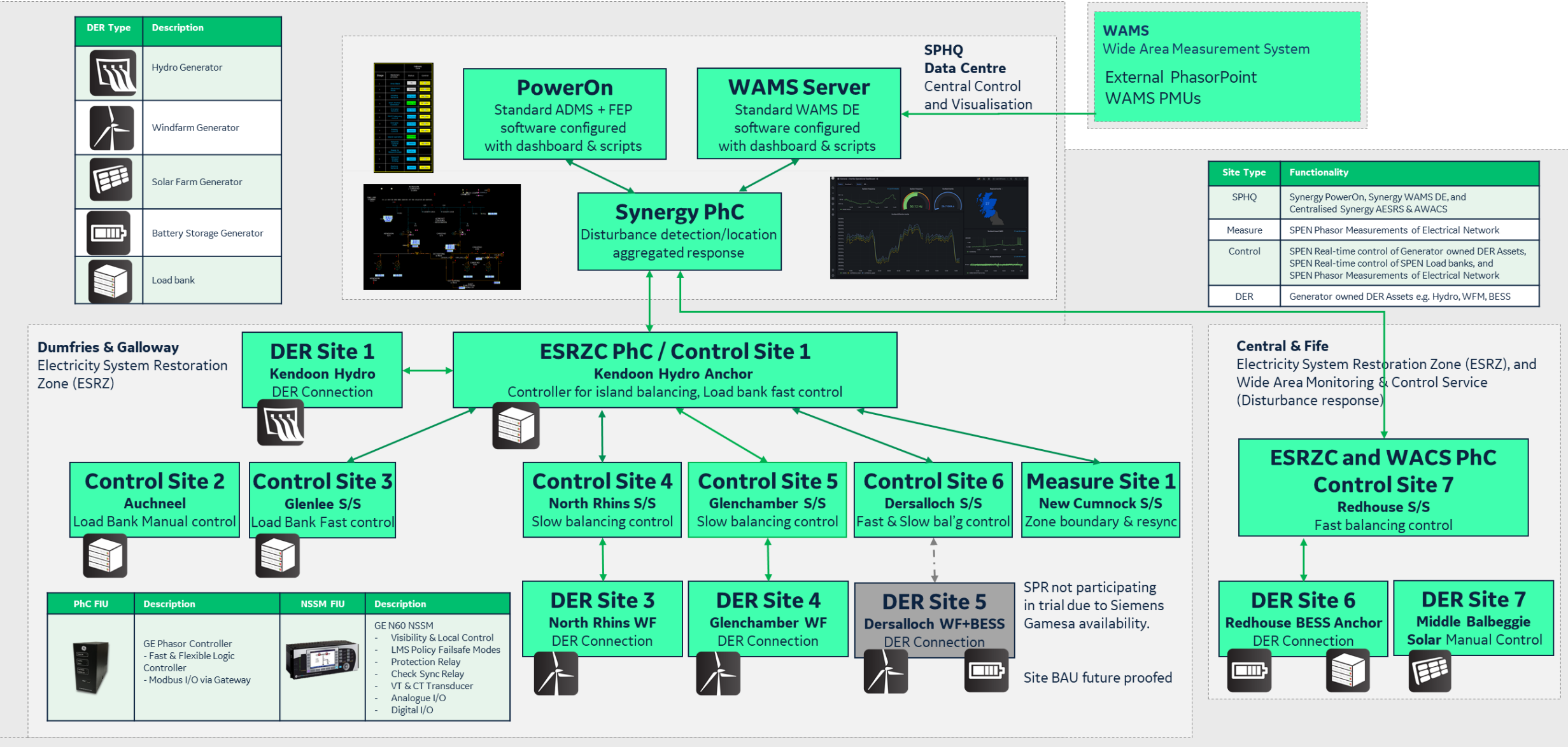
- Live testing to prove BaU solution for future Electricity System Restoration Service

Wide area fast VPP – Scotland fast balancing service using BESS

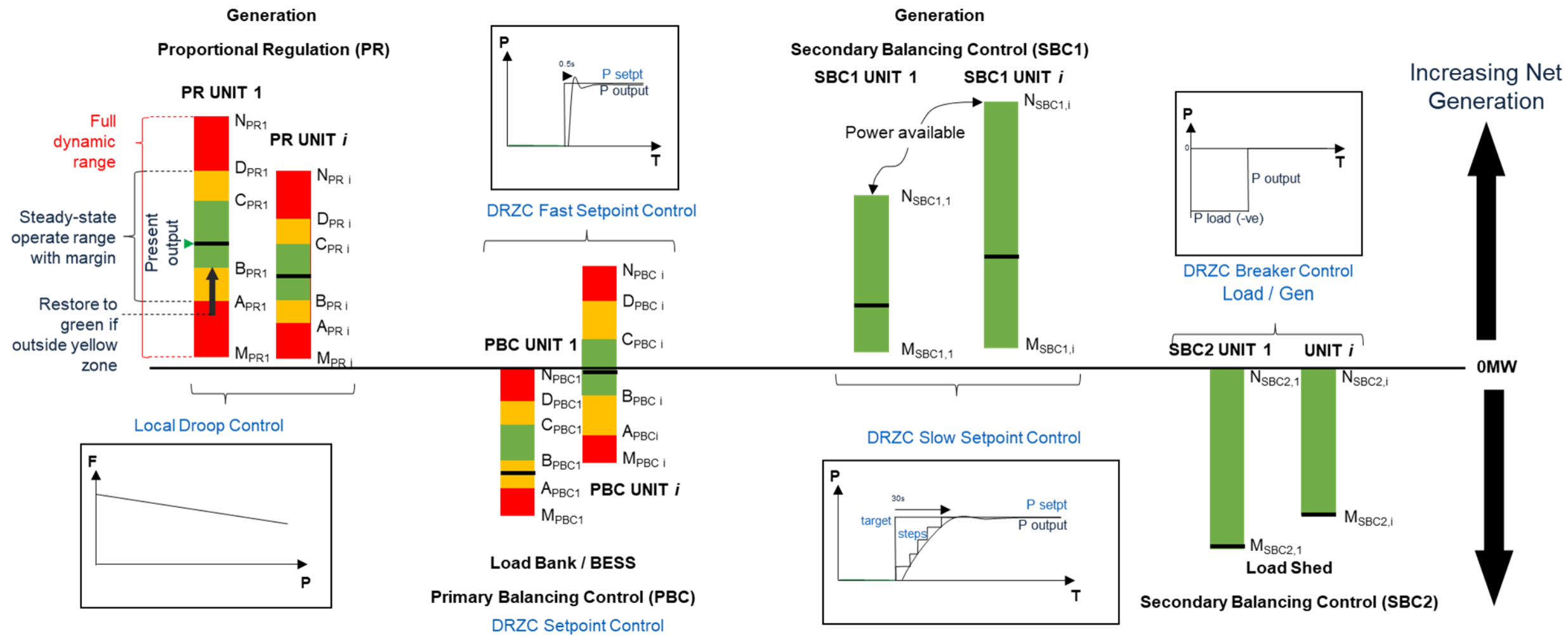
Protection and Control Systems - Tiered Hierarchy of Control



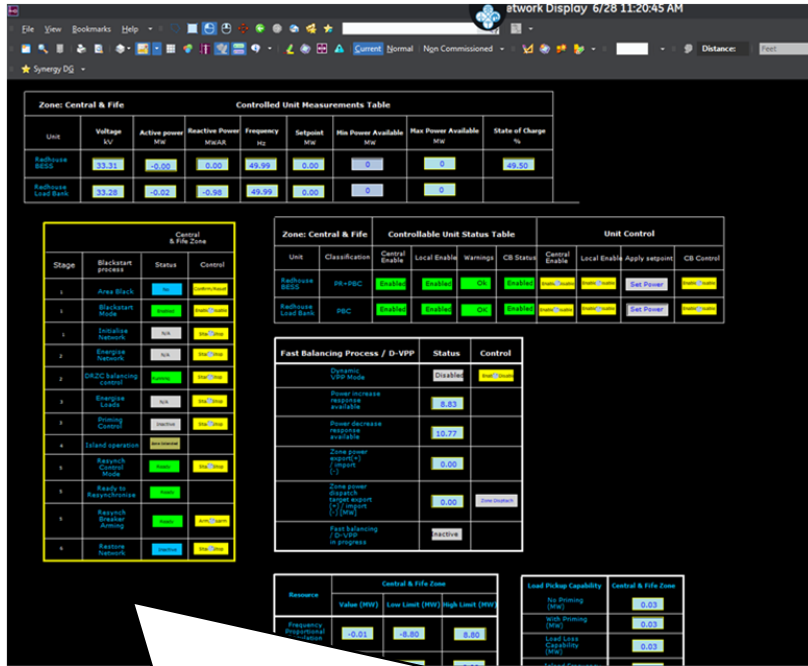
Advanced Energy Management Systems - Tiered Hierarchy of Control



Advanced Energy Management Systems – Balancing Controls



Active Electricity System Restoration Service



ADMS Dashboard

- Controlled unit measurements PQV, setpoints, min/max available
- Control status and user interaction
- Workflow including DRZC zone automation processes



WAMS Dashboard

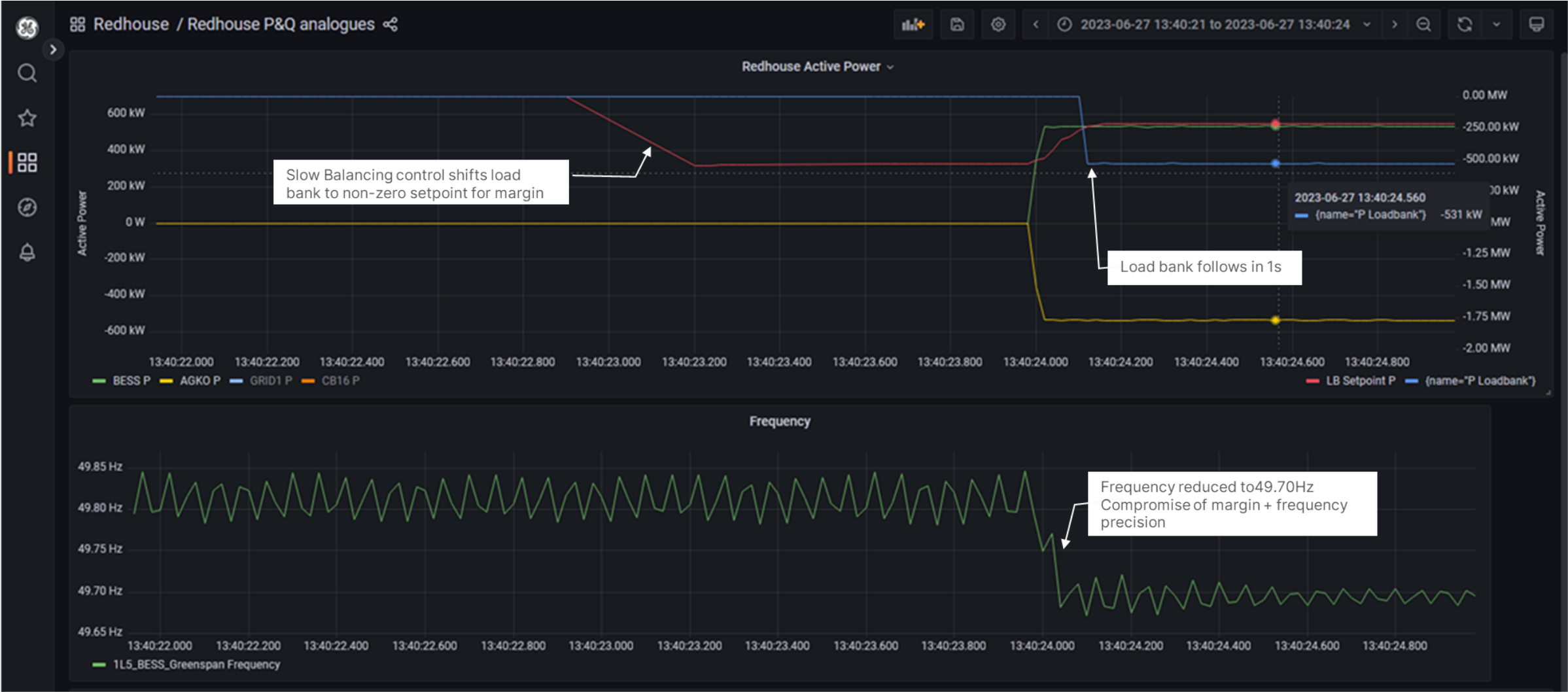
- Dynamic trend charts
- Controlled unit PQV, frequency
- Resync boundary $V\delta$ differences to align
- Zone control activity status



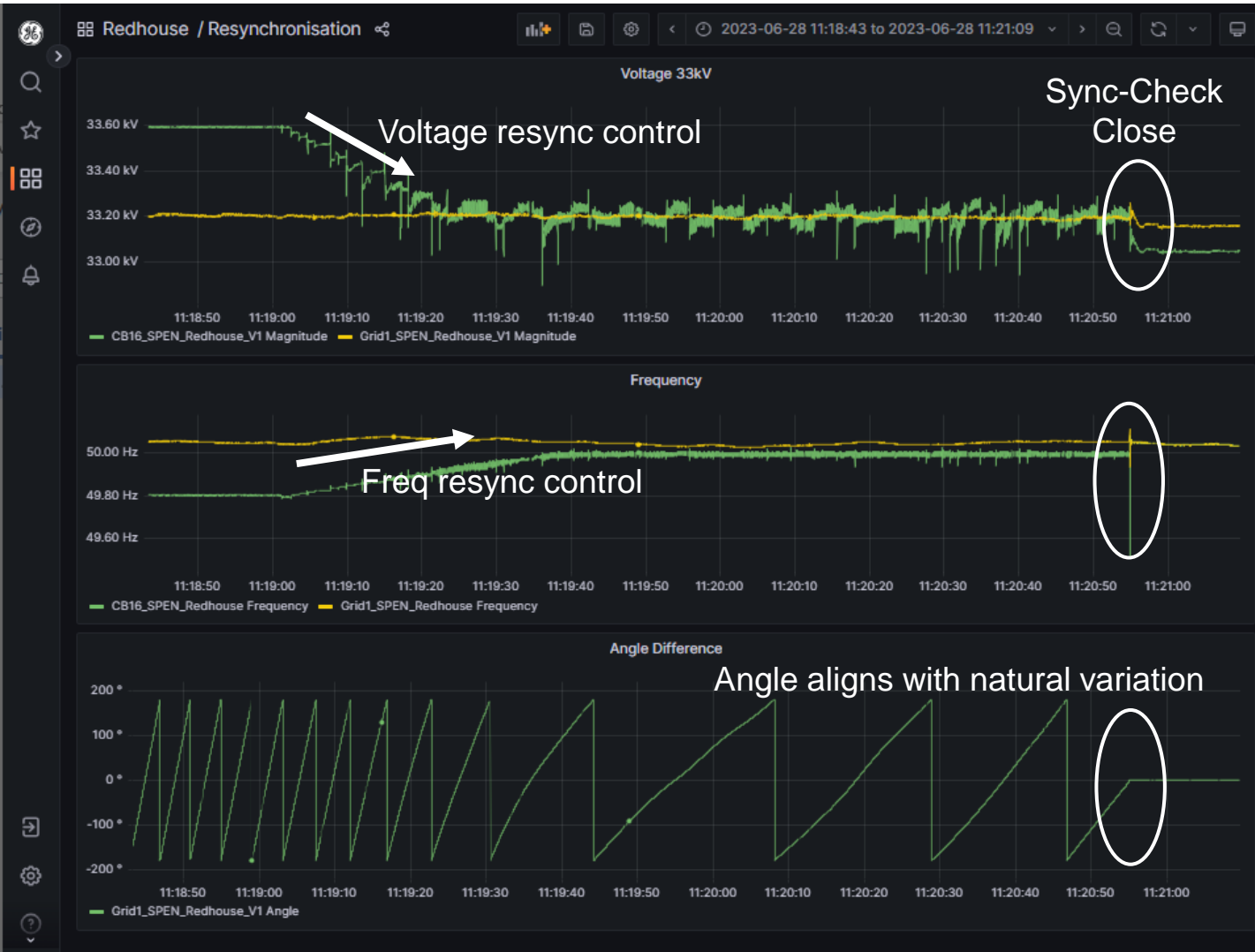
Fast Balancing Response to D-GEN 1.5MW trip Redhouse



Slow Balancing Response after D-GEN trip Redhouse



Resynchronisation Control and Relay Closure



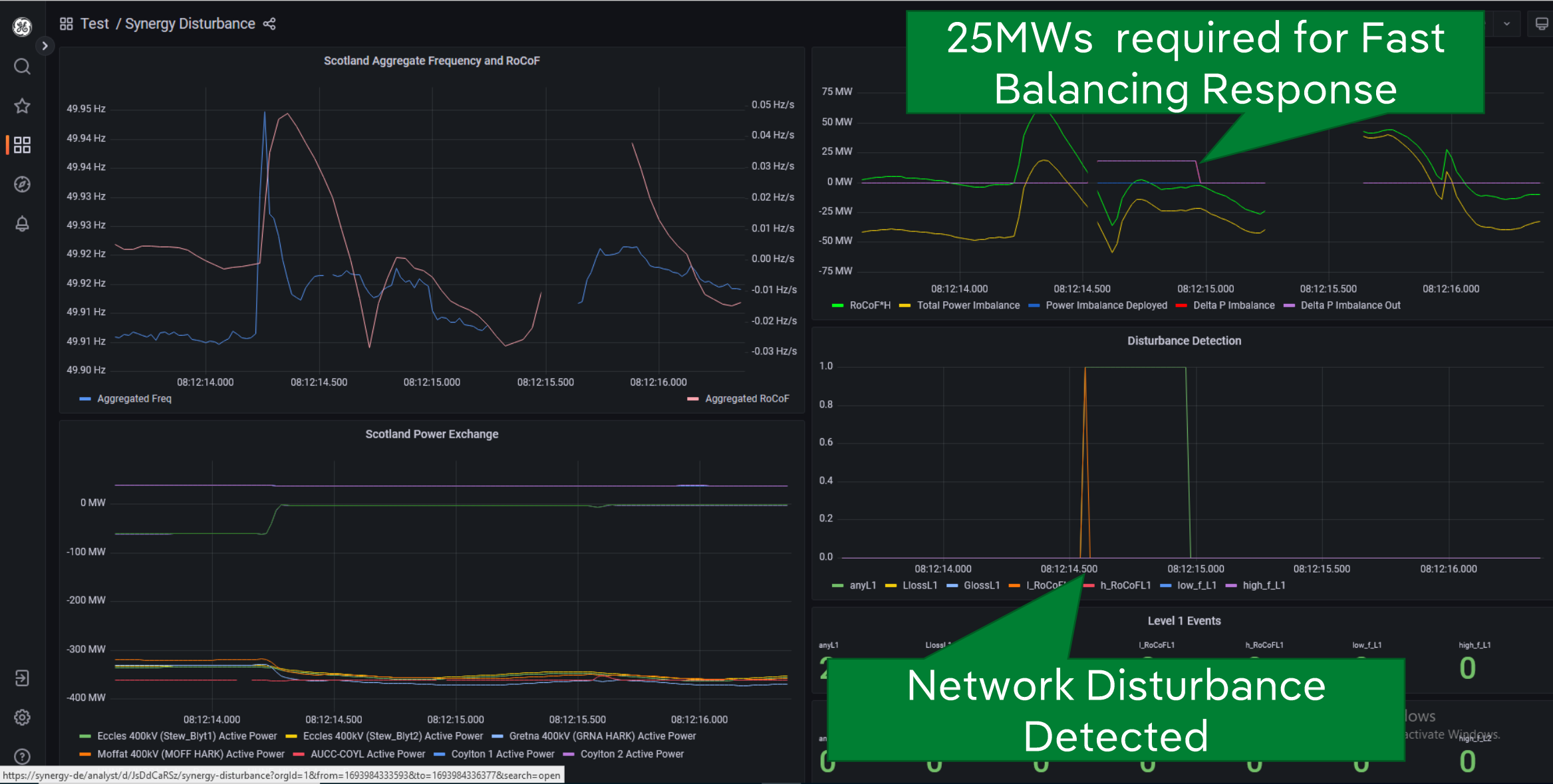
Resync Control Mode brings zone voltage and frequency into alignment with external grid through P&Q setpoint control, shifting position on droop line.

Resync Boundary can be remote from anchor generator.

Sync-Check Relay function on N60 PMU armed from ADMS

Process view & success observed by WAMS, next actions can be initiated (automated if required) e.g. back to grid-following, frequency droop control off, local earth removed

Active Wide Area Control Services – Network Disturbances



Real-time co-ordinated zone control is proven; next steps for BAU services:

- | | | |
|---|---|---|
| 1. Track and forecast generation + stored energy reserve sufficiency to deliver service when called | } | Zone Outlook Manager Project |
| 2. Confirm that zone has sufficient fast disturbance response capability | | |
| 3. Dispatcher training environment with dynamic hardware-in-the-loop simulator | } | HiL Simulation Project |
| 4. Wide Area Monitoring to enable multiple vertical services e.g. AESRS, FCM, CRM, and Digital Twin | } | Further PMU deployments |
| 5. System Integrity Detection Schemes and Protection Schemes | } | Oscillation Stability Management, Effective Inertia, Frequency & Voltage Control |

Questions

