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SP Energy Networks

Study Committee C6

Active Distribution Systems and Distributed Energy Resources

11131_2024

TRIALLING DISTRIBUTION-BASED ELECTRICITY SYSTEM RESTORATION AND OTHER SERVICES

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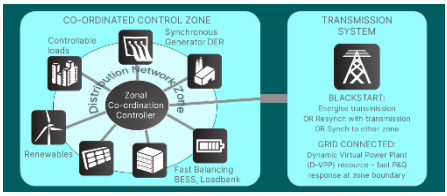
Motivation

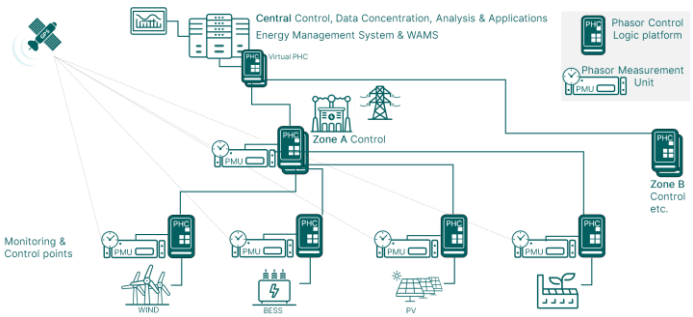
- Centralised blackstart capability is scarce
- Regulatory change in GB requiring 60% of **regional** load restoration within 24h
- DER resources are capable of blackstart; need to co-ordinate many smaller and variable resources
- Automated balancing and network control of a distribution zone harnesses resources to grow, run and synchronise an island.

Zonal Control for Restoration



Electricity System Restoration Service (ESRS) system manages the zonal power balance, frequency, voltage and network topology through the full restoration process.

Structure of Wide Area Control System



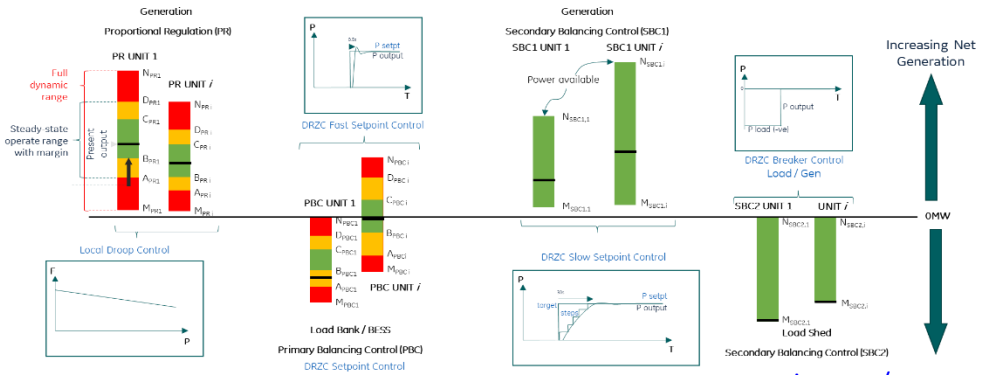
Hierarchical structure of Central, Zonal and Edge control.

Central operator view & supervise, wider region control, analytics.

Zonal fast closed loop control logic

Edge actuation of control at plants, failsafe.

Classification of the Controlled Resources and Limit Levels



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Core **Distribution Restoration Zone Control (DRZC)** real-time processes manage the active and reactive power in the zone to achieve stable near-nominal V & F through the following real-time control functions.

DRZC Process	Description
Proportional Regulation e.g. BESS, hydro	Conventional **local droop frequency & voltage control**; Wide Area Control (WAC) may raise/lower setpoints.
Fast Balancing e.g. BESS	Sub-second **rebalancing load pickup or load/gen trip**. Proportional to power gain/loss, using multiple resources.
Slow Balancing e.g. Wind,PV,load	Re-dispatch slow responses **so balancing units maintain control margins**
Priming	Biasing fast response units to **maximise load pickup**
Resynch Control	**Aligning island's frequency & voltage** across resync boundary. Followed by synchrocheck relay arming.
Dynamic Virtual Power Plant	Once resynchronised, **zonal P & Q setpoints** applied to the total export. Used as manual dispatch or auto trigger.

Network operators have the following **Central supervisory** functions available as a workflow in the distribution management system and dynamic views in WAMS.

SCADA/DMS Process	Description
Network Initialisation	Sets all CBs to known starting point for island
Enable/disable units	Manage which units participate in the zone control
Enable/disable controls	Manage which control processes are active in the zone
Energise network & loads/gen (staged)	Switching sequences to energise network sections, simplifying procedure
Observe zone state	Zone black, zone islanded, operating point vs limits etc.
Initiate resync control	Zone starts follows the frequency and voltage across the resync boundary
Synchrocheck arming	Once F & V aligned, arm checksync relay, observe closing
Dynamic VPP settings	Enable and apply P&Q setpoints to whole zone
Restoration	Restration of normal system operation

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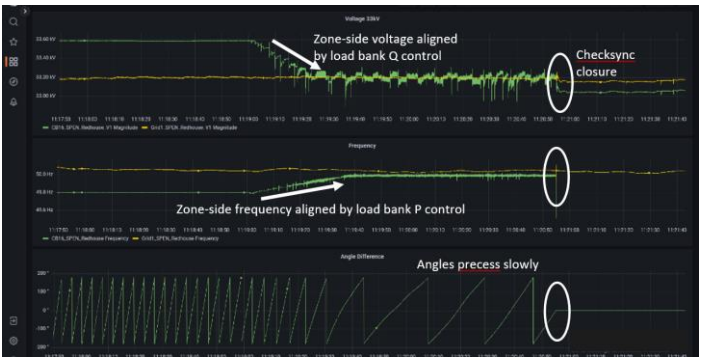
Example Results from Live Trials

Grid-forming BESS performed stable fast-response Proportional Regulation with setpoints provided by ESRS

Fast balancing trigger detected and rebalancing initiated in 180ms. Actuation at load bank takes further 0.8s; much faster actuation possible in BaU with inverter based resource.

Island stability was achieved with fast & slow balancing action.



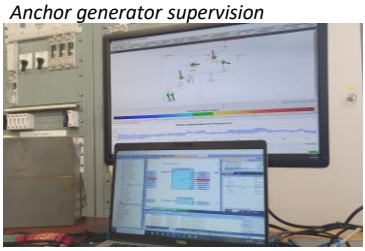
Resync controls the zone to track the grid-side voltage and frequency. Operator is informed when values across the selected boundary match. Checksync relay is armed and closure observed in WAMS as angles align. The zone is then operated in D-VPP mode.

Conclusions

- Zone restoration control approach is proven
- Real-time dynamic HiL is important for testing, demonstration and operator training
- Rollout to larger, more complex zones is intended
- Further work on latency, system resilience, security & fleet management required for BaU
- Forecasting and managing the zone's stored energy is needed
- System can be used with D-VPP to deliver new DSO fast response services

Control room supervision

Anchor generator supervision



Controlled hydro & load bank