Securing and restoring offshore grids: how to make offshore Renewable Energy Solutiosn (RES) ready to participate in power system restoration?

Technical requirements and economic impact

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The problem: The recent Iberian blackout caused an enormous chaos in Spain and Portugal with an economic impact estimated with billions of euros. This indicates the importance of building grids that are resilient to failures, increasing risks due to weather extremities and security threats (physical or cyber-attacks), while also capable of restoring quickly after partial or complete blackouts. *(it is possible obtain up to 18% gains in the restoration time thanks to RES participation as black-start (BS) units [Calik et al., 2024]).* . It will require several innovations with respect to offshore and distributed energy resources participation (including grid codes, grid forming capability, ...), for which restoration is much more difficult to organize.

The solution: In this project we aim to exploit the potential of decision-support algorithms for (1) **faster restoration**, (2) **dynamic restoration**, and (3) **restoration under damage to grid components**, and related valuable innovations in the domain of converter control (grid forming), AI-based forecasting and remote digital control.

These algorithms will provide:

- Faster restoration plans by accurately incorporating novel technologies such as BESS and HVDC as well as the RES uncertainty through stochastic optimization frameworks;
- They will additionally determine how fast the system can be restored under different outage scenarios with seasonal RES participation and potential damage to grid components;
- Efficient decision-support tools that deliver (near-)optimal solutions **within seconds** enable dynamic restoration and prevent cascading events by adjusting to unexpected system behavior during outages and restoration.

Industry relevance: Restoration-conscious grid planning and optimal strategic, tactical and operational decision making are of critical importance for **RES and BESS technology providers, RES and grid operators**, **TSOs** and **society overall.**

- Strategic decisions for **grid infrastructure planning**
    - Types of Black start resources (RES, **batteries**, HVDC converter control) to install/dedicate;
    - Location and sizing (capacity) of the Black start units;
    - Network design: **Cable** connections, lengths and types;
    - Off-grid communication systems during blackouts.
- Tactical and operational decisions with view on restoration
    - Seasonal battery reserves for restoration (annual planning);

- Optimized converter control;
- Static and dynamic rules/plans for restoration strategies under different risk and outage scenarios (variable RES output and grid damage);
- Islanding strategies;
- Maintenance strategies for BS and non-BS units considering potential blackouts.

We welcome all interested parties to participate in the dedicated break-out session in order to work out a ICON proposal along the above conceptual outline.

Duration: 3 years
Budget: 1 - 3M overall

Reference:

Çalık, H., Ergun, H., Yurtseven, K. and Van Hertem, D., 2024, June. A bi-objective approach to power system restoration with renewable participation. In *2024 18th International Conference on Probabilistic Methods Applied to Power Systems (PMAPS)* (pp. 1-6). IEEE. https://doi.org/10.1109/PMAPS61648.2024.10667142
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