Paris Session 2022

Validation and application of the methodology to compute resilience indicators in the Italian EHV transmission system

Study Committee C1

Preferential Subject 1

Question 1.1.3: Have others identified ways to integrate power electronic control or fast restoration, to improve resilience?

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Power electronics for resilience enhancement (I)

- **Power Electronics (PE)** plays a more and more **important** role in power systems due to **increasing penetration of converter-interfaced generation** (mostly renewable)
  - EU target: up to 300 GW of offshore wind power to be installed by 2050
- Its role is also important to enhance PS resilience
  - Intended as «the ability to limit the extent, severity and duration of system degradation following an extreme event »
- How can PE improve PS resilience?

1. control flexibility + suitable tuning of protection schemes -> **fault-tolerant control schemes** for the converters: no disconnection of generation also during transient large deviations of operating quantities from nominal values (e.g. during multiple contingencies due to extreme events). **Active Fault Tolerant Control System (AFTCS)** adjusts its control law to unexpected disturbances (e.g. out-of-design contingencies tackled by resilience studies!) → enabler of microgrids' operation
2. **DC grids to integrate offshore wind power** and to connect asynchronous AC areas

Hybrid DC/AC grids: issues and perspectives for resilience enhancement

- **DC (also multiterminal) grids imply large power flows over long distances** and can bring issues to resilience (e.g. faults on DC cables, loss of large power injections into AC grids)
- However, **DC converters with advanced control and protection schemes** can compensate the abovementioned issues and **bring benefits to overall ybrid system resilience**
- **Many EU projects** (Best Paths, Twenties and Promotion) to evaluate the behaviour of hybrid AC/DC systems during faults and in the restoration phase
- **VSC technology based converter controls can help** operators face **resilience** issues:
  - **Speeding up the recovery process**, by using the DCG as a black start source for the AC system (f/Vac control scheme on VSC)
  - **Helping the** hybrid **system survive severe disturbances** (e.g. multiple contingencies triggered by extreme events) **thanks to** converters' **FRT** (Fault Ride Through) capability established by ENTSO-e codes

How can Power Electronics support hybrid AC/DC grid resilience

- In **Best Paths** project RSE **developed and protection schemes for a «VSC-based version» of the tri-terminal SACOI DC link** between Sardinia and the continent
- In the restoration studies two VSC controls were simulated (**VSC as a black start source** with continental grid in service and Sardinia to be re-energized, and **VSC as a STATCOM** in a conventional restoration path)
  - VSC used as a black start source leads to many benefits, e.g. **faster pick up of ballast loads**, and a **lower amount of ballast loads** thanks to VSC power inversion capability)
- Design of **resilience-oriented control schemes**: in TWENTIES project RSE proposed a **risk-based control of the injections of a MTDC grid** for the integration of offshore wind power: this control exploits the redispatch of both dispatchable generators and grid side VSC injections of the DCG **to reduce the risk of branch overloads** in case of severe contingencies on AC grid system
- A **recently approved EU project**, called **HVDC WISE**, intends to i**nvestigate** more in depth the **benefits of DC grids with a specific focus on the reliability and resilience** of the integrated AC/DC system