COUNTRY : Greece
REGISTRATION NUMBER : 6996

GROUP REF. : C2
PREF. SUBJECT : PS2
QUESTION N° : 2.2

During the last decades, various power electronic interfaced resources have been integrated to power systems, resulting in a structure, operation and control transformation of the transmission and distribution networks. Power electronic interfaces allow distributed energy resources to provide increased functionality through improved power quality and voltage/volt-ampere reactive and flexibility services. However, power system stability challenges have to be taken into consideration.

In this context, the study presented in paper C2-10711 deals with the integration of storage to support RES penetration produced by a wind park in Northern Greece, that is demonstrated in the field. The demonstration consists of a battery energy storage system (BESS) and a customized controller based on the concept of Active Distribution Node (ADN), improving the share of clean energy unleashed in the grid while maintaining a high level of reliability and stability. Main parts of the BESS are the battery charge converter (it contains two bidirectional converters based on IGBTs technology), the MV transformer, the insulation monitoring device, the EMS-PMS system, the battery bank and the battery management system. The BESS System is connected to a 20kV bar, which is supplied by the secondary of the step-up transformer 40/50MVA. The BESS power converter installed in the WPP active substation has a power of 2 MW and an energy capacity of 2 MWh. The Power Conversion System (PCS) is controlled by an external Controller, including advanced algorithms such as inertial response, predictive algorithms and the demonstration of the convenience of the power firming in WPP. Advanced simulations and real-time platforms are developed, in order to ensure the integration is fully achieved before shipping the System to the site. Advanced algorithms are also implemented in the PCS during the discharging and charging to extend the lifetime of the battery, increasing the reliability of the BESS.

One of its main objectives is to face a series of challenges and benefits related with the transmission and generation energy, i.e.:

- to design and implement an innovative active substation, which integrates a BESS, for a WPP, in order to provide flexible regulation and power management services to the TSO and to improve its interaction with the transmission network, in an effort to enhance its regulation, stability and reliability.
- to enable the usage of energy storage in a WPP active substation to demonstrate reduction of the resource variability impact on the performance of power systems with significant penetration of RES.
- to design and implement a complete demonstration project of WPP controller and BESS in the SEE region.

These challenges are faced by incorporating appropriate virtually synchronous controllers for active substations with energy storage, which are intended to provide a set of advanced ancillary services to the active substation, for stability and reliability of the grid. The dynamic response of these controllers will be virtually synchronous and will set the response of the power converters that process the energy stored in the BESS of the active substation. In this manner, by using some part of the energy stored in the BESS, the active substation will offer a synchronous response, similar to the one of a synchronous generator, in case transient events happen in the grid. This is made by sending the Active and Reactive Power reference (set-points) to the BESS controllers depending on the service demanded by the client. The BESS system will face the inertia emulation, the power oscillations damping and the island mode operation stability.

Taking into consideration the above, the expected benefits and the flexibility services envisioned are summarized as following:

- Grid Code: It is highly important for the demonstrator to show how this type of systems provide a lot of benefits to the grid code and the different operational modes that the plants should provide. According to the European Grid ((UE) 2016/631) code for plants below 50MW the substation is considered of type C.
- Frequency regulation: The system can be connected to the grid although the grid frequency changes. Moreover, the system helps to regulate the frequency by injecting or limiting the active power.
- Reactive control mode: The BESS system is capable of controlling the reactive power in different modes:
  - Cos phi control: Maintain a constant cos phi.
  - Q control: Maintain a constant reactive power.
  - V control: Control the reactive power to maintain a defined voltage constant.
- Low Voltage Ride Through: The system includes a fully dedicated super-capacitor bank connected in parallel with the control system power supply, in order to ensure the BESS is running without interruption according to the grid code voltage dips. All values (thresholds and timers) are parameterized and will be adjusted according to the Utility and Grid Code requirements.