/SOW2023

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Fostering the renewable resources penetration with Battery Energy Storage Systems.

In the last decade the number of Renewable Energy Resources (RES) plant installations into the power system increases exponentially thanks to the green energy politics adopted by many countries in the world. This allows on the one hand to reduce the greenhouse gas emission but, on the other hand, introduces some new problems on the electrical power system.

The main two RES technologies, wind and solar, are in fact in part predictable but not fully controllable. This, together with the phase-out of many traditional fossil fuel power plants brings the power system to a critical condition which could lead to a black-out if not properly managed. In fact, in every moment the electrical load of the power system must be balanced with the power production, so the uncertainty of the RES power production must be compensated using the remaining traditional power plants connected to the grid or other flexible resources such as demand response and energy storage.

Power system needs

The new ancillary services requested by the Transmission System Operators (TSOs) in the last years give an idea of the present and near future needs of the power system. These needs tackle the recent critical events which are going to affect more often the power system.

There are three main categories of new ancillary services [1]:

- Fast reserve: this service aims to compensate the reduction of the power system inertia that allows to keep the frequency of the grid stable. The goal of this service is to limit the frequency variation. Historically the inertia has been always provided by the fossil fuel plants. RESs power plants are mainly connected through power electronics devices which have not inertia. Anyway, the control of this components can be adapted in order to emulate the inertia behavior of a traditional power plant. The time response of this service is typically lower than few hundreds of milliseconds.
- Mid-term reserve: this service aims to recover the frequency deviation, bringing it back to the nominal value. This kind of services span from seconds to few hours.
- Long-term reserve: this last category facilitates the power flow on the transmission grid, reducing the number of contingencies. The main functionality of this kind of services is the energy shifting from some hours to others of the day/week.

BESSs features

A Battery Energy Storage System (BESS) is an electrochemical energy storage able to store electrical energy in one moment and release it in future.

BESSs applications can span from industrial to grid scale applications. Thanks to their high performance, they can be used for several purposes: energy shifting that makes the RES production predictable and fully controllable, peak curtailment that allows to reduce the power connection of the loads, ancillary services which increase the power quality of the power system.

Due to the modularity of the batteries, the BESS size can be very small (< 1 MW) with a connection to the distribution system or big (> 1 MW) with a connection to the transmission system. The nominal discharge rate, which is the ratio between the nominal power and the nominal energy, of a BESS is typically between 0.25 and 1. Practically, there is not lower bound while the upper bound is limited by the battery.

In the last years the cost of the batteries is decreasing more and more due to the mass production effect for the Electrical Vehicles market [2]. Bloomberg expects the volume-weighted average battery pack price of 152 $/kWh in 2023, with a BESS overall cost above $300/kWh for a turnkey four-hour duration system [3]. This makes BESS more competitive than other energy storage such as pumped hydro power plants.

What is the role of BESSs in the energy transition?

To achieve the challenging target at 2050 of greenhouse gas emission, the RES penetration into the power system must keep growing. In this context BESSs are playing a key role thanks to their modularity, flexibility and competitive cost. Currently BESSs represent a technical and economical solution which allows to facilitate further RES installations keeping a good power quality of the grid.

References

[1] IRENA_Innovative_ancillary_services_2019.pdf (click here)

[2] IEA.https://www.iea.org/reports/global-ev-outlook-2023/trends-in-batteries (click here)

[3] BloombergNEF. https://about.bnef.com/blog/top-10-energy-storage-trends-in-2023 (click here)