246

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WIND POWER INTEGRATION IMPROVEMENT IN AN ISLAND BY INSTALLING BATTERY ENERGY STORAGE SYSTEMS. CASE STUDY OF LANZAROTE-FUERTEVENTURA

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INTRODUCTION

In this study is analyzed, in the first instance, the difficulties presented by small isolated power systems for integrating an appreciable amount of wind power generation. After that, a solution for the improvement of this type of power is examined. The increase in renewable generation and the incoporation of Battery Energy Storage Systems (BESS) is considered as an option towards a stable energy model.

The renewable power integration, based on wind turbines, and the effects of the BESS have been evaluated by means of Critical Clearing Time (CCT).

CCT: maximum allowed duration of a three-phase short circuit

before:
- loss of system stability
- 10% of load shedding
- instability in the subsequent steady state

taking into account:
- voltage
- frequency
- load shedding

Different study cases of this power system with gradual increase of wind power were studied. This increase of wind power was from 10MW to 150MW in step of 10MW.

RESULTS

As a part of the results, CCTs values obtained and voltage and frequency time evolutions when a three-phase short circuit takes place at different buses are shown in Figure 2 and Figure 3.

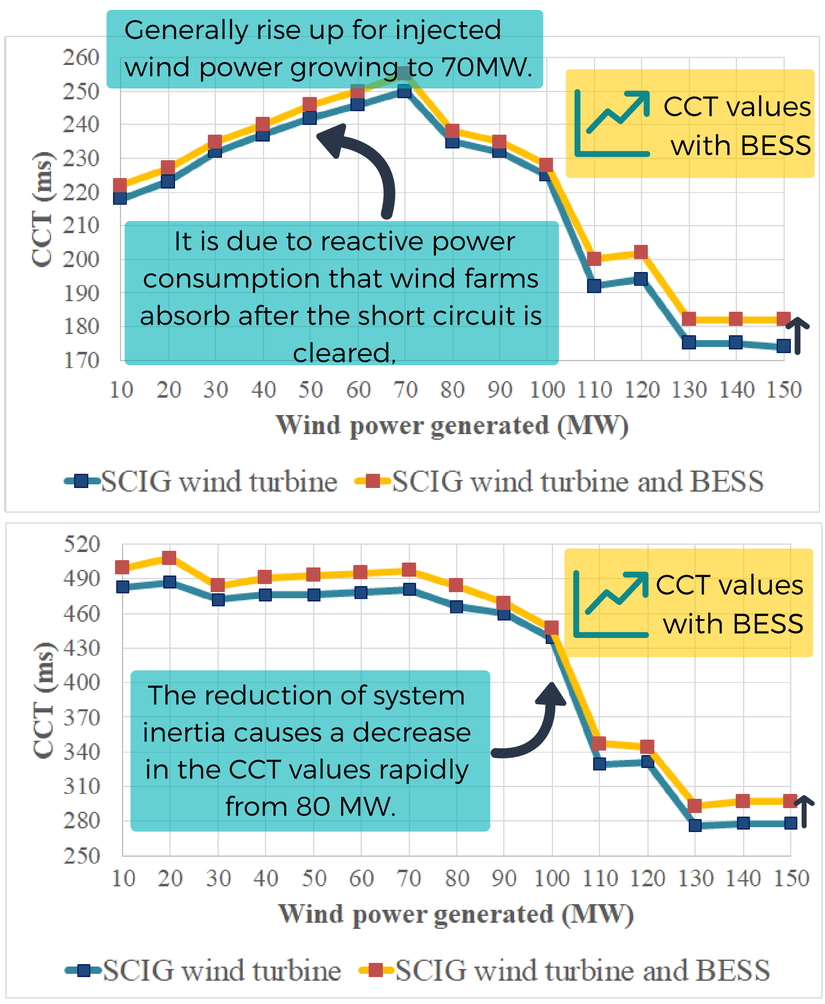


Figure 2. Critical clearing time values obtained in Punta Grande and Corralejo buses.

Lanzarote-Fuerteventura power system expected by 2020 is used in order to study the wind power integration using CCT.

3MW/9MWh BESS have been modeled using the generic dynamic models

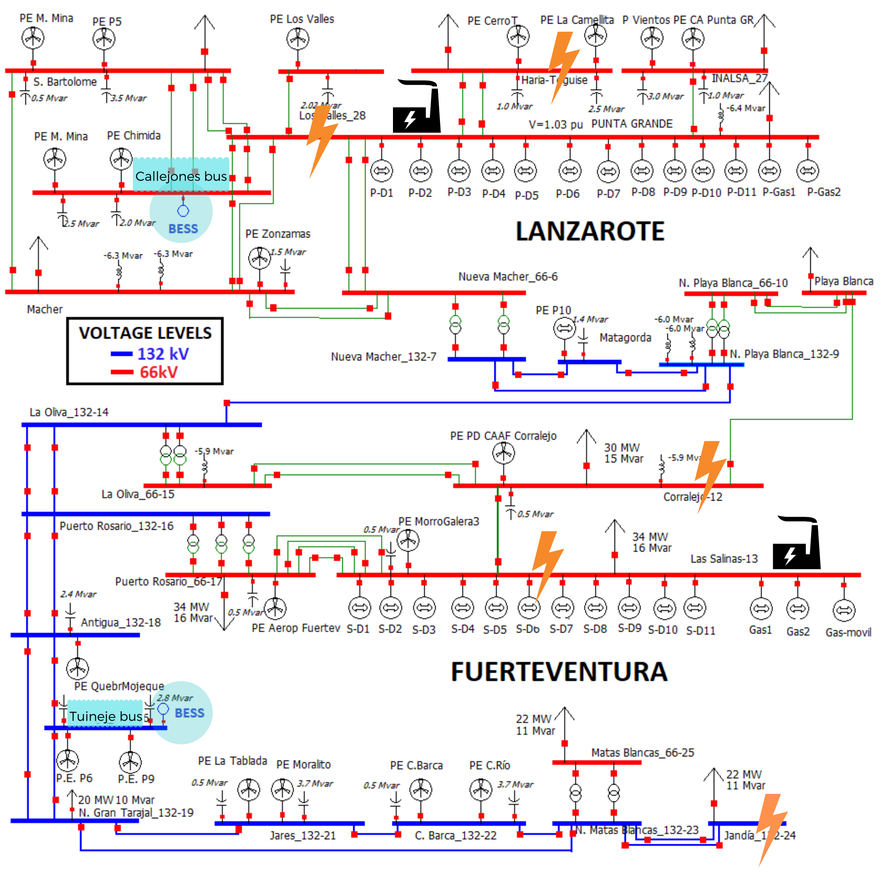


Figure 1. Lanzarote-Fuerteventura power system expected by 2020. BESS have been added to the power system.

Three-phase short circuit with specific durations were studied at different selected buses

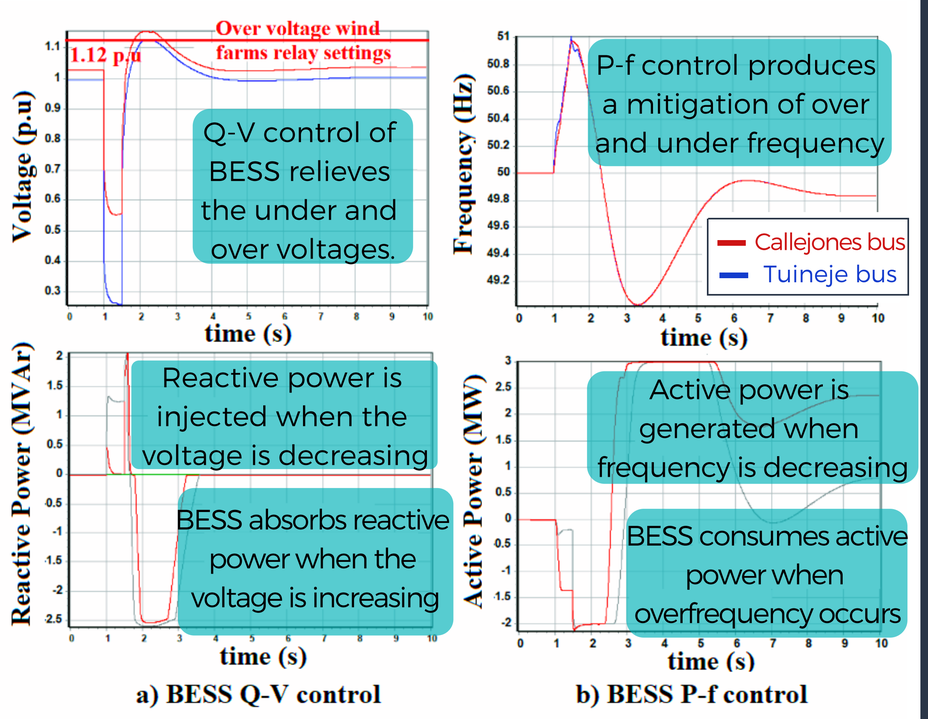


Figure 3. Time evolution of voltage, system frequency and active and reactive power of BESS when a three-phase short circuit takes place in Corralejo bus.

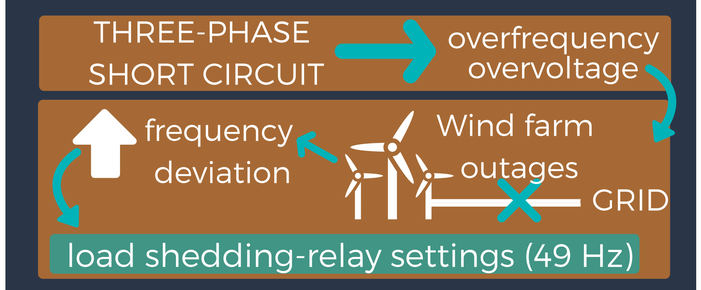
BESS controls of P-f and Q-V have entailed a decrease in the disconnection of wind farms in the cases analyzed.

DISCUSSION

A three-phase short circuit causes a voltage dip and system frequency rises. When the short circuit is cleared, an overvoltage takes place and the frequency value drops below the rated value. Because of this kind of small and isolated power system, overall voltage dip and subsequent overvoltage occur due to its weakly meshed infrastructure. This means that stability is seriously influenced when a large amount of renewable energy is connected along of the power system.

Wind farm outages are observed in several cases. These outages are caused by trip of over frequency and overvoltage protection relays of the wind farms. Wind farm outages are followed by a greater frequency deviation and it causes load shedding.

As more wind power integration, a smaller number of conventional generators are connected. Therefore, inertia constant of power system is also smaller. As a result, CCT also dimishes due to these smaller power system inertia values.



The system frequency and voltage deviations caused by the three-phase short circuit is diminished by the installation of BESS.

As a result, disconnection of wind power and load shedding events are reduced. For this reason, CCT values are higher, as it can be seen in Figure 2, which means that wind power integration is improved.

CONCLUSIONS

To sum up, BESS can be an essential element for a maximum integration of renewable energy sources into the power system due to their capabilities.

Furthermore, BESS could help to fulfill the grid codes in cases of high integration of renewable sources into isolated power systems.

MORE WIND GENERATORS CAN BE ADDED TO THE POWER SYSTEM