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Application of Energy Storage System

Introduction

In the race to reduce carbon emission, there is increasing penetration of distributed generations such as wind, solar and fuel cells in the electrical grid. The stochastic nature of the distributed generator (DG) impacts their power output, causing imbalance in supply and demand across the power system. Both supply and demand imbalance will continuously grow in coming decades, altering the natural inertia of the electrical network. This in turn will cause the grid's frequency to become less stable and deviate from its target more rapidly than in the present day. Energy Storage System (ESS) can buffer the differences between the demand and supply. Additionally, it can improve network operation by acting as uninterruptible power source to provide ride through capabilities.

Benefits of Energy Storage System

Advancements in energy storage technologies offers a wide range of technology to choose from for different applications. However, improper size and placement of ESS leads to undesired power system cost as well as the risk of voltage stability, especially in the case of high renewable energy penetration. Planning the best locations and sizes of an ESS in a power system can achieve significant benefits as follows: 1) enhance power system reliability and power quality; 2) reduce the power system cost and control high-cost energy imbalance charges; 3) minimize the potential for power loss and improve the voltage profiles; 4) serve the demand for peak load and correct the power factor. The ultimate goal is to maximize the benefits for both the DG owner and the utility by sizing the ESS to accommodate all amounts of excess generation capacity and by allocating it within the system in order to minimize the annual cost of the electricity. In addition, a cost/benefit analysis must verify the feasibility of installing an ESS from the perspective of both the utility and the DG owner.

ESS Application

There are many well developed procedures to allow proper sizing of ESS to mitigate the problems associated with the uncertainty of renewable DG units. However, successful integration of ESS with distributed generation in grid-connected applications involves much more than selecting an adequately sized system based on one of the many commercially available technologies. The optimal integration of ESS requires a thorough understanding of the following:

1) application for which the storage is being used and benefit provided to the application
2) available ESS technologies and their suitability for the application
3) requirements and constraints of integrating an ESS

Finally, an effective control strategy for ESSs is required to be developed to achieve attractive energy management.

ESS Control

ESS control strategy depends on the application and constraints of the system. As an example, ESS has potential to perform energy management and network support in standalone or grid-connected electricity distribution system. Control scheme will ensure optimal use of ESS while providing voltage support services. ESS intended for demand side management will shift energy usage in time. This energy shifting strategy can be viewed as equivalent to energy storage: the energy usage by a controllable load is managed with an aim to minimize the impact on the network (e.g., supply unbalance, frequency regulation, or network support) while maintaining the required function of the load for the benefit of the consumer.

ESS can also be deployed at grid level for frequency control. Excess power generation allows the speed of rotating machines (e.g., steam turbines on coal and gas power plants) to increase, which in turn increases the grid frequency. Similarly, lack of supply leads to a decrease in frequency. ESS intended for frequency regulation at grid level needs to coordinate operation of ESS to assist with maintaining the frequency within the nominal range.

Conclusion

As supply and demand imbalance grows, the need for applications of ESS will continuously grow. ESS must be properly sized to act as buffer between the demand and supply imbalance. Additionally, ESS technology and control must be suited for the applications.

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