Application of Cost-Effective Grid-Scale Battery Storage as an Enabler of Network Integration of Renewable Energy

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Abstract

Electric power networks were designed and constructed when bulk energy could not be stored in large-scale capacity. It was required of system operators to match generation with demand while maintaining voltage and frequency within statutory limits. In the last few decades, economic, environmental and regulatory challenges, as well as changing public perception have contributed to the profound changes or reform been embarked upon by electric utilities. The push for clean energy technologies and reduction in greenhouse emissions have had an adverse effect on traditional generation sources while promoting renewable energy generation. Government subsidies are serving as incentives for consumers to significantly invest in new and emerging renewable energy technologies. Governments continue to set renewable energy target which pressure electric utilities and power asset owners to accept renewable energy to essentially reduce greenhouse emissions. Solar-PV and wind energy are emerging as the most competitive and environmental friendly renewable energy options for generating electricity but these are intermittent sources. Wind farms are often likely to be located far from the load centres, requiring the generated power to be transmitted over long distances using preferably high voltage direct current transmission system. Energy storage technologies have been in use for several years. The most common is pump storage hydroelectricity. Grid-scale battery storage holds promise for greater flexibility, control and utilization of electrical power. As the amount of renewable energy injected into transmission and distribution grids increases and the rapid uptake of rooftop solar photo-voltaic installations in households, energy storage is unlocking a new market in renewable energy and enabling new opportunity. Some benefits energy storage devices include: smart grid applications where use of PV, wind and biomass can be supplemented with the use of energy storage devices which will enhance bi-directional power flow. Energy storage will enhance the use of renewable energy thereby achieving emission targets posed by Government. Other significant benefits are demand side management and deferring capital investment for augmentation; off grid or isolated grid applications in rural areas and islands; providing peaking power and reducing the need for fossil fueled peaking plant. Energy storage can lead to power quality improvement as well as voltage stability and frequency regulation. Emerging energy storage technologies on the transmission and distribution networks include: large-scale battery storage, flywheels, compressed air and hydrogen. The introduction and application of cost effective grid-scale battery storage will be a game-changer for the distribution and control of electrical energy. This paper discusses the energy storage devices which will transform the way the world's utilities, control and dispatch electrical energy in the near future, with proven case studies.