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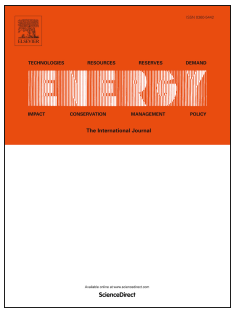

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J. Atherton, R. Sharma, J. Salgado

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Techno-Economic Analysis of Energy Storage Systems for Application in Wind Farms

J. Atherton[1], R. Sharma[1*] and J. Salgado[2]
[1]School of Information Technology and Electrical Engineering,
The University of Queensland, QLD 4072, Australia
[2]Ministry of Energy, Chile
*Corresponding Author:
Rahul Sharma
School of Information Technology and Electrical Engineering
The University of Queensland, Australia
Tel: +61 7 336 57240, Email: rahul.sharma@uq.edu.au

Abstract

The objective of this paper is to analyse reduction in wind power variability through aggregation and use of energy storage systems. A key focus is to evaluate the impact of regulatory framework in addition to the capital expenditure to ascertain techno-economic feasibility of energy storage systems in wind farm applications. A generic techno-economic is developed which takes into account the effects of regulatory framework in addition to the technical and economic features of storage options. Existing wind farms from South Australia are used as test cases. First, a detailed quantitative analysis is performed to establish the variability associated with individual wind farms and the aggregations of their power outputs. Then, the appropriateness of a number of existing energy storage types are evaluated using the developed techno-economic model. Relationships between wind farm sizes, wind farm variability levels, storage capacity requirements, storage costs and storage payback times are determined and discussed for both current and potential future economic and regulatory scenarios. It is found that regulatory framework can be of paramount importance in ascertaining the economic feasibility of energy storage. For example, if the ramp-rate violation penalty (determined to be \$8.89/MW/min) is doubled, then the payback time of energy storage capital investment is found to reduce from 5.32 years to 2.52 years. It is also found that larger wind farms require smaller energy storage capacity and smaller wind farms generally results in a shorter energy storage system payback times.

Keywords: Wind power smoothing, aggregation, storage

1 Introduction

The need for concerted global efforts for decarbonising electricity generation is well recognised. These efforts include setting up of mandatory renewable energy targets and providing incentives for investment in renewable generation. Among various renewable generation options, the wind and solar generation are widely recognised as the key components of future power systems [1]. Wind power generation is estimated to be 40% of all new renewable generation installations from 2013 to 2038 [2]. In China, the wind is predicted to become the third largest energy resource by 2050 after thermal and hydro [3]. Similar