ECONOMIC CASE FOR BATTERY ENERGY STORAGE SYSTEMS (BESS) FOR FREQUENCY REGULATION IN SINGAPORE

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Overview

Regulation service is an ancillary service that corrects imbalances between load and supply in seconds to minutes time scale. Traditionally, this service is provided by hydro or thermal generators that allow the power system operator to vary the generator's output through Automatic Generation Control (AGC). Especially for thermal generators that provide this service, they have to operate at part-loads, must be dispatched out of order, and undergo wear and tear due to the continuous change in output; leading to an economically inefficient situation.

Battery Energy Storage Systems (BESS) can provide regulation service more effectively than conventional generators as they can ramp from minimum to maximum output in a matter of mili-seconds. Studies have also found that out of the various possible applications of storage systems in a power system, frequency regulation offers the most value to the system. However, the amount of regulation that can be offered depends on the BESS' power capacity and energy capacity, both of which are important factors that determine the cost of the system.

This study first considers the benefits of BESS as a viable provider of regulation services, compared to traditional sources of regulation providers and then explores the financial viability of using BESS of different power and energy capacities to provide regulation services in the Singapore electricity markets. Results show that under the current electricity market rules in Singapore, BESS has no cost competitiveness against traditional generators as regulation service providers. For BESS to enter the market, supportive mechanisms such as higher compensation for BESS for their quicker response in providing fast frequency regulation (which is present in a number of electricity market in the United States) could be considered.

Methods

A discounted cash flow (DCF) model was created to analyse the financial viability of BESS using traditional profitability metrics such as Net Present Value (NPV), Internal Rate of Return (IRR) among other metrics. Current and projected costs of various battery chemistries are taken from literature (Brinsmead et. al., 2015). The wholesale market price for the Regulation service is available from the Energy Market Company website.

Taking into the potential cost reductions, the paper incorporates a range of values for trends for BESS prices.

Furthermore, this paper also considers the potential interactions between regulation requirements, regulation prices and further incorporation of variable renewable energy sources. With increased deployment of intermittent renewable resources, such as solar photovoltaics (Solar PV) in Singapore, regulation requirements are expected to increase and regulation prices should reflect the increased demand.

This study then attempts to determine the conditions and prices that will finally make it financially viable for BESS' to offer regulation services in Singapore's electricity market.

Results

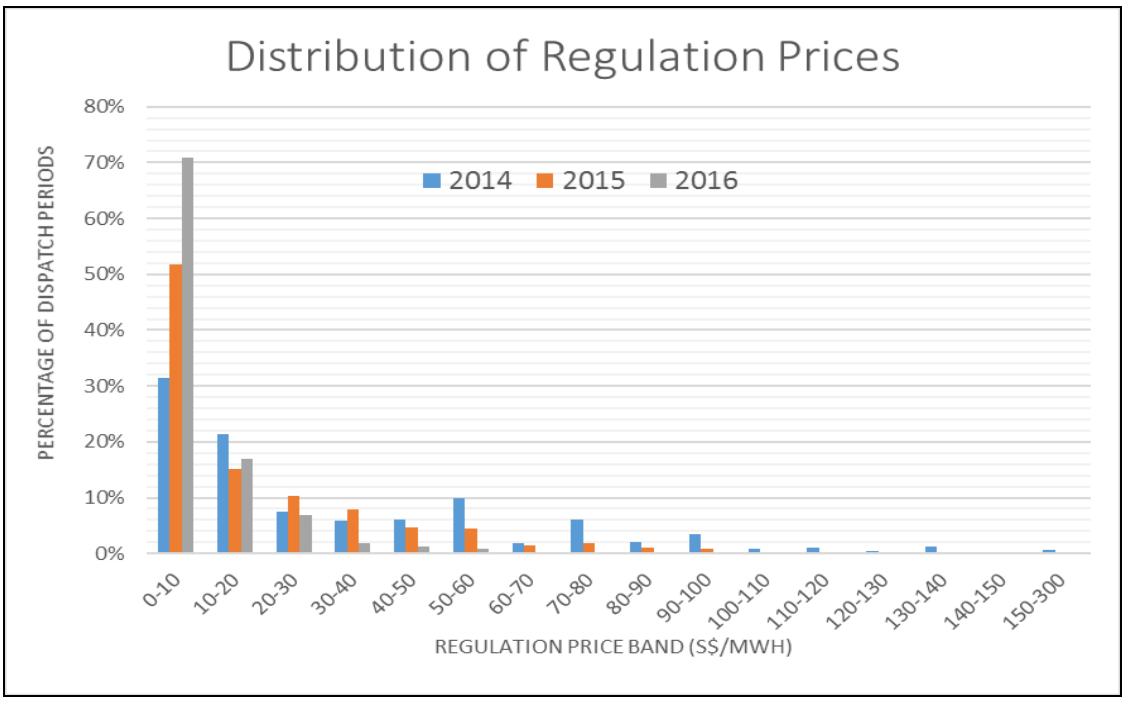

Figure: Distribution of Regulation service prices in Singapore's wholesale electricity market for the years 2014 – 16
Source: Author's calculations based on data from the Energy Market Company

Figure shows the distribution of Regulation price in Singapore's wholesale market for the years 2014 to 2016. Over the years, the market clearing price for regulation has reduced significantly. In 2016, the price lay below S$10/MWh for more than 70 per cent of the dispatch intervals as compared to only 30 per cent of the dispatch intervals in 2014.

At current regulation prices and in the absence of special incentives to reward fast response provided by BESS, these systems have no cost competitiveness against traditional generators as regulation service providers. Second, prices in the energy market also impact the financial model significantly. BESS' have round-trip efficiencies of approximately 80%, thus they incur a significant operating cost to procure net energy.

Conclusions

To enable participation of BESS in Singapore's electricity market, special incentives that reward fast – responding regulation providers may be required.

References

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