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A Social Cost Benefit Analysis of Grid-Scale Electrical Energy Storage Projects: Evaluating the Smarter Network Storage Project

EPRG Working Paper 1710

Cambridge Working Paper in Economics 1722

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This study focuses on grid-scale electrical energy storage (EES) projects in Great Britain and evaluates them using a social cost benefit analysis framework. Accurately valuing EES projects helps inform system operators, distribution network operators, generators, suppliers, regulators, and policy-makers to make decisions to efficiently allocate resources to modernize the electricity grid. The social cost benefit analysis captures insights into economic development, equity, and efficiency, and answers the fundamental question of whether or not society is better off after making the investment in grid-scale EES.

The Smarter Network Storage Project (the first commercially-deployed and multi-purpose grid-scale battery in Great Britain) was selected as the case study to apply the social cost benefit analysis because its empirical results from years of trials are well documented. The uncertain benefit and cost streams are evaluated through a Monte Carlo simulation and then arranged through a discounted cash flow to provide a net present social value of the investment. Rather than producing deterministic values, a Monte Carlo simulation is a stochastic model that incorporates the risk and uncertainty of future benefit and cost streams of grid-scale EES with many real-world variables that affect the net present value of a project. The various inputs included in the Monte Carlo simulation are explained throughout the paper.

One of the main contributions of this paper is the use of real data through the Smarter Network Storage trials. The social costs of grid-scale EES are analysed in three categories: capital expenditures, operating expenditure, and a degradation analysis. The degradation analysis for the energy capacity of the battery directly impacts the battery lifespan of the EES project. A major insight of this paper discusses that a battery lifespan may be shorter than the lifespan of a conventional distribution system upgrade; therefore, the value of the distribution deferral should be calculated as a fraction of the cost of the conventional distribution upgrade in order to represent its true value.

Furthermore, it is determined that the realistic combination of benefit streams of the Smarter Network Storage project is only a subset of the universe of locational and system-wide benefits emanating from grid-scale EES. Key benefit streams of grid-scale EES projects, such as Capacity Markets, Short-term Operating Reserve (STOR), and Triad Avoidance, were concluded to be either not social benefits or un-economical to perform. The true social benefits for the Smarter Network Storage project include frequency response, energy arbitrage, distribution deferral, network support, security of supply, reduced distributed generation curtailment, carbon abatement, and the terminal value of the asset. Therefore, both market based and non-market based benefits as well as system-wide and location-specific benefits are distinctly calculated in the techno-economic project evaluation and provide focus for future EES investments and policy reforms.

The results prove that social welfare generated from EES continues to increase as the capital costs decline, performance and lifespan improves, and electricity markets reform to become more favourable to grid-scale EES technologies. Ultimately, the analysis shows how society can cost-effectively invest in EES as a grid modernization asset to facilitate the transition to a reliable, affordable, and clean power system in Great Britain.

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Publication June 2017
Financial Support