

Analysing the potential economic value of energy storage

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Executive Summary

The process of substituting renewable generating sources for fossil fuels in order to reduce carbon emissions has led to new and substantial challenges to the electrical systems of all countries. These are not widely appreciated by the green lobby, the public more generally, or economists. Yet they are of vital importance to the maintenance of readily available electricity supply which is a cornerstone of economic activity as we know it. Most renewable resources, for example wind and solar power, are intermittent rather than firm and are not biddable in response to price. Enhanced interconnection provides a partial solution as do demand management and storage. The traditional method of storage is via pumped hydro facilities, but these require geological features that are not easily replicated. Thus, alternative approaches that are scalable involving compressed air, heat or battery storage have been raised as possible solutions.

The main purpose of this paper is to examine whether there are sufficient economic incentives in place for such storage to operate profitably by exploiting intra-day arbitrage opportunities in the British wholesale market. Given the relatively small size of existing storage facilities in Great Britain compared to the size of the electricity system it would be unrealistic to presume that storage facilities currently operating in the wholesale market would be able to affect the market price. For this reason the paper focuses on the identification of an optimal intra-day strategy for operating a price-taking storage facility.

There are broadly two economic approaches that can be taken in evaluating the optimal level of storage in an electrical network, in particular in the context of significant intermittent generation. One is to evaluate the social benefits and costs of storage; the other is to examine the private benefits and costs of its operation.

The approach we take here is to focus on the private ongoing benefits and costs, on the assumption that storage will be operated commercially by considering stores capable of holding hours' rather than minutes' worth of power. More precisely our simulation results are based on technical parameters and operating costs associated with Compressed Air Energy Storage (CAES) technology and on the plant and pump size of the Hunthorf plant in Germany, this first CAES plant in the world and the only one currently operating in Europe.

The questions we examine are: (i) whether there is a clear requirement for storage, (ii) what will be the focus of commercially-provided storage and (iii) whether this focus appears sufficient to tackle the issues the system faces. The aim of the paper is to explain the requirement through considering briefly the characteristics of wind power, the prime source of renewable energy in Britain. We explain why interconnection and demand management, as currently operated and planned, are a limited solution. We then move on to examining the characteristics of prices, which determine the nature of likely arbitrage activity, so in turn the likely characteristics of a store. Stores of different efficiencies and sizes are discussed. Finally, we move on to considering whether foreseeable future changes in the market will have an influence.

The results of our analysis show that, given the current differences in peak and off-peak power prices, it is possible to profitably operate a store over a limited number of periods during the day, if we ignore the store's initial construction costs. Moreover, our analysis of the impact of wind output forecast on power prices indicates that at the current time there are insufficient profitability incentives to store power over more than one day in order to help balance supply and demand over protracted periods of wind calm. As a result we come to the conclusion that additional incentives may need to be put into place in order to render storage over relatively longer periods more attractive and to deliver broader social benefits which are unlikely to be generated and captured as a result of purely commercial considerations.