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ANALYSING THE IMPACT OF ELECTRICITY STORAGE ON WHOLESALE ELECTRICITY PRICES: A CASE STUDY OF IRELAND

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EXTENDED ABSTRACT

Climate change is a global issue and concerns about peak oil and the consequences it could have for fossil fuel dependent societies have created significant pressures on governments and organisations. The European Union has committed to achieve at least a 20% reduction in greenhouse gas emissions by 2020 compared to 1990 level (Commission of European Communities, 2007a), to increase the share of renewable energy in the energy mix to 20% by 2020 (Commission of European Communities, 2007b) and to increase energy efficiency by 20% by 2020 (Commission of European Communities, 2006). Due to the uncertain and intermittent nature of renewable energy resources, the integration of renewable energy onto a power system presents major challenges to power system operators and policy planners. In electricity markets, the demand for electricity must be met by the generation of electricity at all time. When the observed renewable energy output is high, full realisation of the output could be technically infeasible and curtailment of renewable energy may be necessary. Therefore, the integration of large scale electricity storage systems such as pumped hydro, compressed air electricity storage and batteries are of increasing interest due to their unique abilities i.e. their ability to store surplus renewable electricity, to generate electricity at hours of high demand, and to be dispatched at short notice.

Holland (2006) raised the issue of academic literature failing to recognise the role of prices in the allocation of scarce oil. This omission is also present in electricity storage related studies. In the existing literature, storage is mainly studied from the perspective of the electricity system, but rarely from the view point of economic welfare (De Miera et al., 2008; Sioshansi et al., 2009). As a result the benefits needed to justify the cost of building such plant is often underestimated (Commission of European Communities, 2007b). Crampes and Moreaux (2010) showed the social profitability of storage as a net increase in surplus; that is the difference between the cost saved during the peak hours when stored energy is released and loss occurred during the off-peak hours when storage is charging. Therefore, net surplus can add value to storage and should be considered as a means to justify the capital cost of electricity storage.

This work aims to determine the effect of additional storage on the hourly wholesale electricity price, on total system costs and on CO_2 emissions costs under different scenarios of installed wind capacities using the WILMAR model (Wind Power Integration in Liberalized Electricity Market model). This model is widely used in power system analyses with large scale wind generation (AIGS (2006); Tuohy et al. (2009); National Laboratory for Sustainable Energy (2010)) and is currently employed in the European Wind Integration Study (EWIS (2009)).

Ireland is considered as a case study system as it has low levels of interconnection and a high wind penetration (17% of installed capacity) which is expected to grow dramatically in the next decade. Thus issues concerning high levels of variable electricity generation may be seen more clearly than in larger interconnected systems.

The WILMAR model is run for each hour for an entire year with increasing penetrations of both wind and storage capacity. Preliminary results show that the increased use of storage under different wind scenarios reduced the total system costs by 2-3% while CO_2 emissions

costs were reduced by 1.5-2.3% compared to the base case with 6GW of wind. This was mainly due to a reduction in wind curtailment which was reduced by as much as 70% under certain scenarios.

When the effect of storage on the average electricity price was considered, preliminary results found that storage generation reduced the price at the peak hours more than it increased the price at the off-peak hours. As a result up to 2.5% of savings were made on the total cost of electricity for the consumers as the consumptions at the peak hours are significantly higher than the consumptions at the off-peak hours. This paper uses econometric tools to evaluate the significance of these results.

Preliminary results show that the reduction in total system costs and CO_2 emissions costs is not sufficient to cover the storage capital costs. Thus this work also includes an analysis of the social benefit of a reduction in prices as a further means to justify the capital cost of storage.

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