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A COST BENEFIT ANALYSIS OF TIDAL GENERATION

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Overview
Concern over global warming has led policy makers worldwide to accept the importance of reducing greenhouse gas emissions. This in turn has led to a large growth in clean renewable generation for electricity production (EU Directive, 2001). Much emphasis has been on wind generation as it is among the most advanced forms of renewable generation, however, its variable and relatively unpredictable nature result in increased challenges for electricity system operators in balancing generation and demand at all times. Tidal generation on the other hand is almost perfectly forecastable within the time frames of interest to power system operators and as such may be a viable alternative to wind generation (Bryans *et al.*, 2005).

Methods
Like other forms of renewable generation, tidal output is reliant on the underlying resource which cannot be controlled i.e. output is high when conditions are favourable and low when unfavourable. The function of power system operators is to supply electricity to customers in a reliable manner at a sustainable cost. This involves ensuring that the generation meets the demand at all times and that any short term gaps between demand and generation are bridged quickly and precisely to maintain the integrity of the power system. Since the output of tidal generation, cannot be actively controlled this balancing of generation and load could become more challenging as tidal penetrations increase. An increase in tidal generation on an electricity system may require the system operator to alter how conventional generation is dispatched since tidal generation may receive priority dispatch (EU Directive, 2001). As such, conventional generation may be obliged to operate at lower operating levels in order to be available to ramp up to accommodate the inherent variability of the tidal generation. There may also be an increase in the number of start-ups and shut-downs of other units as system operators attempt to coordinate the following of the fluctuating demand throughout the day and the variable output of the tidal generation. This can have a knock on effect on power system operation costs (EirGrid, 2004).
The work presented here discusses in detail the costs imposed on the power system by increased tidal generation. The costs included are the capital and operating costs of tidal generation and the costs associated with alterations in the operating patterns of conventional units. However, tidal generation can also produce significant benefits such as fuel and emissions savings from displaced conventional generation and added generating capacity on an electricity system. Thus, the value of the benefits that can accrue from increased tidal generation are also presented here and include the capacity benefit of tidal, the emissions savings and the savings in fuel costs (Denny & O'Malley, 2007).

Result
In order to investigate the costs and benefits of tidal generation, it is necessary to analyse it in the context of the power system within which it is installed. Thus, a case study of a real electricity system is conducted and a thorough model of the power system is developed. This model represents a gross pool electricity market where generators bids consist of their marginal costs and where energy and reserve are cooptimised. This model determines the operating levels of conventional generators as penetrations of tidal generation increase (Denny & O'Malley, 2007). The resulting operating schedules are then analysed to

determine tidal generation's impact on the operation of conventional generators and their resulting cycling costs, emissions and fuel costs.

The costs and benefits are combined to determine the net benefit curves for tidal which show the tidal generation penetrations where the costs exceed the benefits, beyond which no further investment should be made in tidal generation. A sensitivity analysis is also conducted to determine the factors which influence the costs and benefits of tidal generation.

Conclusion

The results show that given its low load factor, the costs of tidal generation exceed the benefits at all installed capacities for the case system under a reasonable set of assumptions. It is found that for tidal generation to produce positive net benefits, the capital costs would have to be less than or equal to €138,547 per MW installed which is an unrealistically low capital cost. Thus it is concluded that tidal generation is not a viable option for the case study at the present time.

The results presented in this work are relevant for the chosen case system, however, the methodology described could be applied to other electricity systems and forms of renewable generation.

References:

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