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Offshore wind investments – Realism about cost developments is necessary

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ABSTRACT

Data available from the recent boom in European offshore wind investments contradict widely held expectations about a decline in costs per kW. Our review shows that scenario projections for investment costs are systematically flawed by over-optimistic assumptions. Contrasting offshore wind technology with onshore wind and nuclear power, we argue that offshore wind could be a candidate for negative learning since a trend towards more complex OWP (offshore wind parks) exists and uncertainty remains high. We estimate technical uncertainty and input cost uncertainty to calculate whether investments in offshore wind technology are profitable today. Applying a real option model to two reference plants using empirically derived parameter values, we allow for sunk cost and the possibility to abandon the investment. We find that for a large parameter range, investments are not profitable, even with substantial support such as feed-in tariffs under the German Energy Act. Therefore, policy incentives for building larger and more complex offshore wind parks bear a high risk to fail in their aim of bringing down investment costs. Policies that instead incentivize the optimization of offshore wind technology – in particular by increasing the load factor and material efficiency and bringing down decommissioning costs – are more sustainable.

1. Introduction: optimism-biased scenario analysis

Offshore wind energy is expected to be a key technology for future low-carbon electricity generation. Capacities installed or under construction exceeded 11 GW during 2015, of which 75% have been added since 2011. National governments support the development of offshore capacities substantially via feed-in tariffs, direct-marketing subsidies, investment grants or tradable green certificates. A common rationale of these policies is to stimulate the development of the immature technology and to bring down the costs of electricity so that offshore wind becomes competitive with other energy technologies. But what if these expectations are never met? This paper brings forward major doubts about the widespread belief that offshore wind will become a low-cost technology in the near future. On the contrary, we show that complexity and uncertainty related to offshore wind technology are more likely to scale-up and we calculate that the current risk of unprofitable investments is very high.

The starting point of our paper is a clear trend shown in Fig. 1: investment costs of offshore wind power increased substantially with cumulated capacities contradicting widely published expectations of an upcoming decline. Such expectations are based on the assumption that offshore wind capital costs would develop in a similar way to those of photo-voltaic and onshore technologies. Instead it seems that the dynamics of offshore wind power rather resembles those of nuclear technology. The apparent escalation of costs to install an OWP (offshore wind park) underlines the fact that offshore wind is a complex energy technology characterized by high uncertainties. Moreover, as offshore wind is a very capital-intensive technology, sunk costs can be immense if policy strategies and investment decisions are based on assumptions that are over-optimistic or even wrong.

Fig. 2 accentuates the discrepancies between projections and actual development by contrasting observed costs with projected investment costs as commonly found in the literature.[1] To our knowledge almost all scenario projections in the peer-reviewed

[1] Costs are normalized to International Dollars 2010. For details refer to Section 2.1. Note that only a few studies disclosed sufficient information to be included in Fig. 2.

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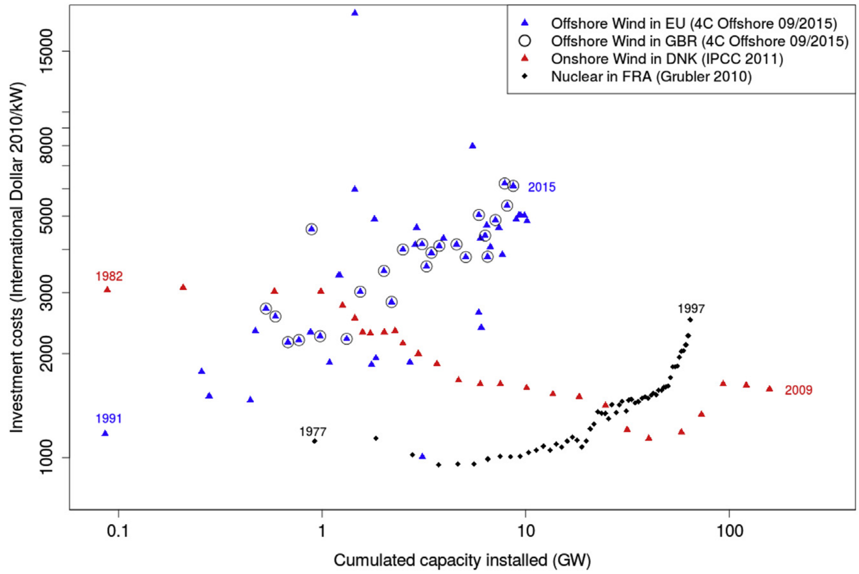

Fig. 1. Specific investment costs over cumulated capacities for offshore wind in the European Union (EU) and Great Britain (GBR) from 1991-06/2015, onshore wind in Denmark (DNK, 1982–2009) and nuclear power in France (FRA, 1977–1997). Data sources are given in the graph's legend.

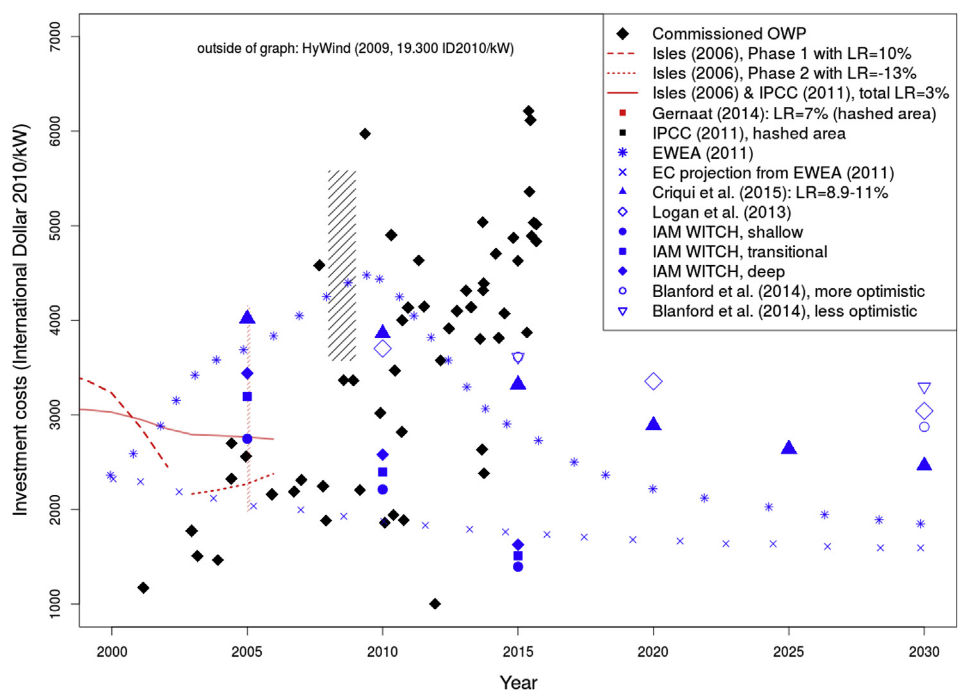

Fig. 2. Actual vs. expected development of investment costs over time. In black: actual data, in red: empirical data, in blue: scenario projections. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

and gray literature have two shortcomings: (1) They are built on scarce data, i.e., on data available before 75% of today's capacities were added; (2) they assume that investment costs will decrease in the near future. In light of today's data (shown in black, Fig. 2) it appears that these cost assumptions are biased by wishful thinking. Furthermore, scenarios with escalating costs have been incorrectly excluded from the scenario space despite the scarcity in data and despite little experience with offshore wind technology. In fact, we would argue that the inclusion of a pessimistic scenario should be a compulsory facet of any modeling study to reveal sensitivities of model results. Would all conclusions made and policy recommendations resulting from such works still hold if this had been the case? Such a test would provide a greater degree of validation and proofing the usefulness of scenarios and model results [34].

Our review finds that many studies refer to Junginger et al. [22] who postulate that a 'moderate' learning rate (LR) of 5–10% would be realistic in upcoming decades in relation to offshore wind technology. An example is Gernaat et al. [14]; who use the IMAGE/TIMER model of PBL Netherlands Environmental Assessment