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The price of rapid offshore wind expansion in the UK: Implications of a profitability assessment

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ABSTRACT

With a total installed capacity of 5.1 GW and an expansion pipeline of 11.9 GW, offshore wind constitutes a story of success in the UK. The necessary foundation for this outstanding attainment is an energy policy that offered entities enough incentive in the form of profit and certainty so that investing in a rather immature technology became attractive. In this article, the profitability of 14 early-stage offshore wind farms (1.7 GW) is assessed with the objective to review at what price this rapid expansion occurred. Within the framework of a developed standardised financial model, the data from the offshore wind farms' original annual reports were extrapolated, which made it possible to simulate their profitability individually. The results reveal a return on capital in the range of more than 15% and a decreasing trend. This implies that the levelised cost of electricity from the first offshore wind farms were underestimated in the past. In addition, a stress test revealed that the operation of some farms might become unprofitable towards the end of their planned lifetimes. The particular reliable data basis and novel modelling approach presented in this article ensure that this study is of high interest for offshore wind stakeholders.

1. Introduction

More than 10 years ago, the first offshore wind farm (OWF), North Hoyle, became operational in UK waters. This marked the start of a rapid expansion that led to the UK being the world leader in offshore wind since 2008 [1]. In June 2015, 27 projects with a total installed capacity of 5.1 GW were operational, an additional 11.9 GW were either in construction or planning approval, and 5.2 GW were in the planning stage [2]. It seems that the target of up to 18 GW in offshore wind capacity by 2020 formulated in the UK Renewable Energy Roadmap [3] is achievable. However, part of this policy paper also describes the aim of reducing the levelised cost of electricity (LCoE) from offshore wind to 100 GBP/MWh by 2020. These two conflicting targets encapsulate the main challenge policymakers are faced with when designing support schemes for the efficient expansion of renewable energy. On the one hand, subsidies must offer enough incentive for entities in terms of remuneration and certainty to ensure the expansion. On the other hand, the profits of these entities should be kept at a minimum because they ultimately must be borne by the electricity consumers. Furthermore, the entities should be forced to develop, build and operate the renewable energy plants as efficiently as possible and to continuously improve the technology in order to reduce the LCoE [4]. The objective of this article is to assess the profitability of OWFs that became operational in the last few years and thus provide a review of the subsidy scheme for offshore wind in the UK that helped to facilitate this remarkable recent expansion.

Since 2002 the support mechanism for large-scale renewable electricity generation in the UK has been a green certificate system known as the Renewables Obligation. It requires electricity suppliers to source a specified proportion (known as the “obligation”) of the electricity they provide to customers from renewable sources. Suppliers demonstrate that they have met their obligation either by presenting Renewables Obligation Certificates (ROCs) or by paying a penalty (known as the “buy-out price”). ROCs are green certificates issued for the production of renewable electricity to operators of renewable generating stations. Hence, the operators sell their ROCs to suppliers (or traders), which allows them to receive a premium in

Abbreviations: OWF, offshore wind farm; LCoE, levelised cost of electricity; ROCs, renewables obligation certificates; CfD, contract for difference; CapEx, capital expenses; OpEx, operating expenses; SPV, special purpose vehicle; LECs, levy exemption certificates; REGO, renewable energy guarantees of origin; IRR, internal rate of return.

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addition to the wholesale electricity price. In this way, the certificates provide an incentive for the deployment of renewable generating stations [5,6]. However, this mechanism also implies risks for operators of renewable generating stations because they are exposed to volatile wholesale prices. The reduction of these risks and the resulting greater certainty and stability of revenues were the main motivation for implementing the Contract for Difference (CfD) scheme as a part of the Electricity Market Reform enacted in 2013. With the CfD, renewable electricity generators are paid the difference between the "strike price" – a price for electricity reflecting the cost of investing in a particular technology – and the "reference price" – a measure of the average market price for electricity [7]. In addition, the CfD equips the generator with clear contractual rights against a government-owned counterparty over a period of 15 years while securing the payments indexed to inflation, which further increases the level of certainty and works towards reducing financing costs [8]. The strike price for each OWF is determined in two ways: 1) using a competitive allocation process through an auction in case the assigned delivery year budget (known as the "pot") is exceeded or 2) using a non-competitive process, which means that all applying OWFs receive the so-called administrative strike price (see Ref. [9] for a detailed description about its setting), i.e., the maximum accepted strike price for bids defined for the delivery year [10,11]. However, electricity generators under the RO scheme will continue to receive its full lifetime of support (20 years) until the scheme closes in 2037 [6].

LCoE, which original notion was to enable the comparison of the unit costs of different technologies over their economic lives, plays a key role in the debate over subsidy levels (e.g., it is one input for setting the administrative strike prices in the CfD scheme [12]) and was therefore also used in this analysis. Hence, it is worth to have a closer look at the definition of LCoE, which is provided and comprehensively discussed in Ref. [13]:

$$LCoE = \frac{\sum_{t=1}^{T} \frac{C_t}{(1+r)^t}}{\sum_{t=1}^{T} \frac{EP_t}{(1+r)^t}} \quad (1)$$

where EP is the energy production in year t, r the interest rate and C_t the (capital, operation and decommissioning) costs in year t. It is remarkable that many studies and reports focus on substantiating the inputs costs and energy production, whereas the interest rate is often assumed to be 5 or 10% and not justified in detail (e.g., [14]). A sensitivity graph provided in Fig. 1 shows that the interest rate, which determines the financing cost, has a significant impact on the LCoE and therefore might lead to incorrect estimations when simplified (see Ref. [15] for a detailed discussion on its importance based on a LCoE study of solar PV systems). In general, the interest rate required by investors depends on the risk inherent to the project. In Ref. [13], it is stated that the assumed interest rates of 5 and 10% (referring to low and high risk scenarios) reflect the return on capital for an investor in the absence of specific market and technology risks. This simplification was made because it would be hard to produce comparable results for different technologies in different national markets otherwise. Thus it is essential when using the concept of LCoE for the evaluation of a specific technology in a specific market that assumptions about the interest rate are well considered.

In the recent report on electricity generation costs in the UK by the Department of Energy & Climate Change (DECC) [12], so-called technology-specific hurdle rates, i.e., the return on capital investors require to proceed with the project, are considered for the interest rate. The study also contains a comprehensive discussion on this topic based on several studies by consulting companies. Studies assessing hurdle rates apply two types of methodologies or a combination of them. The most common method is to employ the capital asset pricing model (CAPM), which determines the return on equity that an investor should expect on a financial asset by comparing its risk to other publicly traded assets [16]. This was, for example, done in Ref. [17] and in Ref. [18], where it was supplemented to account for asymmetric risk and real option values. Other studies rely on information provided in the available literature or gathered from interviews with industry participants, as in Ref. [19–21]. Although these studies differ in regard to the year of publication, the assessment method and the underlying data, they report post-tax hurdle rates in the same range of 10–12% and predict a decreasing trend as the maturity of the technology increases. Interestingly, all of these studies have estimated current and expected future levels of hurdle rates with the aim to provide input for the design of future subsidy schemes, which is also the reason why they are referred to as cost of capital. However, no study has ever assessed on a large scale the actual ex post realised return on capital of OWFs that are already operational. This would enable the real LCoE to be calculated, including the real financing cost based on the remuneration rewarded to the entities. This article closes this gap and is motivated by reviewing the subsidy scheme and evaluating the degree of benevolence so that investment in offshore wind was ensured. An indication of potential over-subsidisation may be seen in the massive expansion of OWFs in the last several years. It could also be apparent in the outcome of the first CfD competitive allocation round [22], where the resulting strike prices of 114.39 and 119.89 GBP_{2012}/MWh (1.16 GW; delivery years 2017–2019) were significantly below the administrative strike price of 140 GBP_{2012}/MWh [11]. This also casts a shadow on the already non-competitive allocated 3.18 GW offshore wind capacity commissioning over the years 2017–2019 for administrative strike prices of 140 and 150 GBP_{2012}/MWh, respectively [23].

However, the use of cost of capital instead of the realised return

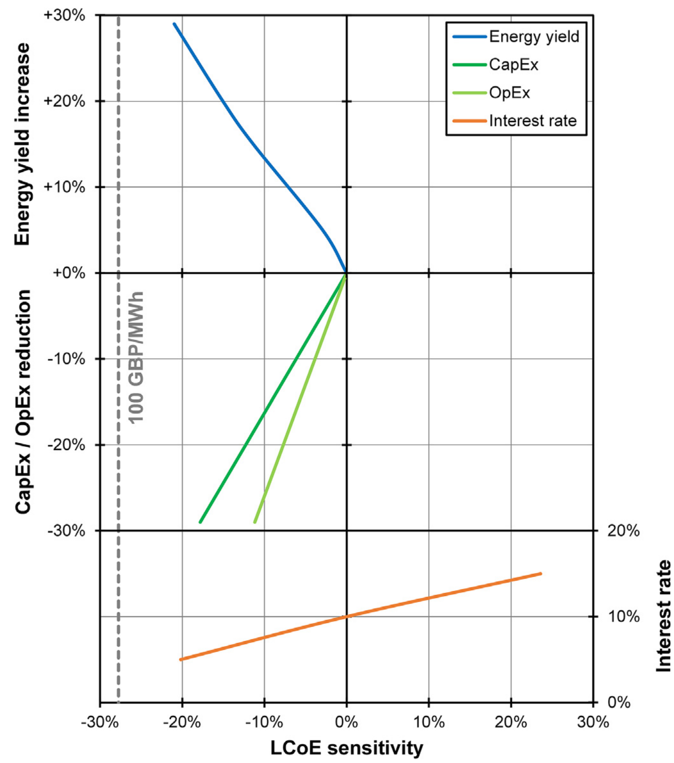

Fig. 1. LCoE sensitivity subject to energy yield increase, capital expenditures (CapEx)/operating expenditures (OpEx) reduction and the interest rate (based on data provided by Ref. [12]).