Costs and Rate of Return from Off-Shore Wind Farms

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Summary

This paper accompanies the report ***Reposessing the Future: a Common Weal strategy for community and democratic ownership of Scotland's energy resources***. That report outlines the structure of a collectively-owned energy system. This paper contains the calculations on which the energy price saving in that report are based.

A model was constructed which reasonably reflects the government's decision to set the "strike price" for off-shore wind in 2019 at £135 / MWH.

The same model was used to evaluate the cost of producing electricity using the LEC/SEGC model of a publicly owned company returning surpluses to the community and funded by either through Bonds or the equivalent of the Public Sector Loan Board at 3.5%.

The models predict that savings in the cost of electricity production of over 6% will be achieved from inception rising to 15.5% and possibly over 22% at a later stage.

Purpose of analysis

To determine on the basis of published information the rate of return of off-shore wind given the draft "strike price" likely to be in place and to estimate the benefits to the public from a community or Government backed scheme.

Methodology

Appendix A, sets out the various variables which are tested in the spread-sheet model and gives evidence as to their reasonableness. These are:

- Cost of construction for Wind Farms based on Government evidence;
- The market price of electricity in 2034;
- Inflation.

The spread of spend and the "strike price" are taken as fixed and there is assumed to be no residual value after 20 years.

The combination of these variables is used to identify the whole project life range of rates of return (WACC) of the off-shore wind farm projects, for which evidence was supplied to the Government.

These results in turn were compared with what the Government itself estimates to be the "hurdle rate", i.e. the rate of return the energy industry requires to proceed with a given project.

In the model the proposed "strike price" set by the Government i.e. £135 /KWH, would achieve the minimum "hurdle rate" for most projects based on the evidence provided. This gives verification that the model used is similar to that used by the Government in calculating the proposed "strike price".

Each of the project scenarios was then re-evaluated to determine the reduced cost per unit of electricity which would arise were the project carried out by a public body able to borrow at Government rates.

Whole project life rate of return estimates

The Crown Estates lower construction and maintenance prices, give a minimum rate of return of 11.85% based on a 2.0% inflation rate and a £55 market rate after 15 years and a maximum 12.65% rate of return based on a 2.5% inflation rate and a £75 rate after 15 years.

The Crown Estates Higher construction and maintenance prices, give a minimum rate of return of 11.85% based on a 2.0% inflation rate and a £55 market rate after 15 years and a maximum 12.65% rate of return based on a 2.5% inflation rate and a £75 rate after 15 years.

The ROBR lower construction and maintenance prices, give a minimum rate of return of 14.89% based on a 2.0% inflation rate and a £55 market rate after 15 years and a maximum 15.71% rate of return based on a 2.5% inflation rate and a £75 rate after 15 years.

The ROBR higher construction and maintenance prices, give a minimum rate of return of 10.24% based on a 2.0% inflation rate and a £55 market rate after 15 years and a maximum 11.14% rate of return based on a 2.5% inflation rate and a £75 rate after 15 years.

The National Grid lower construction and maintenance prices, give a minimum rate of return of 11.53% based on a 2.0% inflation rate and a £55 market rate after 15 years and a maximum 12.38% rate of return based on a 2.5% inflation rate and a £75 rate after 15 years.

The National Grid medium construction and maintenance prices, give a minimum rate of return of 8.18% based on a 2.0% inflation rate and a £55 market rate after 15 years and a maximum 9.15% rate of return based on a 2.5% inflation rate and a £75 rate after 15 years.

The National Grid higher construction and maintenance prices, give a minimum rate of return of 3.24% based on a 2.0% inflation rate and a £55 market rate after 15 years and a maximum 4.64% rate of return based on a 2.5% inflation rate and a £75 rate after 15 years.

Evidence for the Models Accuracy

The Government estimates of the "hurdle rate" are at least 8.4% for projects using established technologies, which projects coming to production in 2019 would be. All of the scenarios tested except the National Grid's would provide that return even in their highest estimates of construction and maintenance costs.

The National Grid's lower project price estimates would also meet the 8.4% hurdle as would their medium priced projects if either the average inflation rate was above 2% or the "market rate" after 2034 was above £55 (that is in 5 out of 6 of the medium priced scenarios tested). Surprisingly, these 5 scenarios rate of return ranged from 8.41% to 9.15% which is exceptionally

close to Government estimates of the "hurdle rate" of between 8.4% and 9.1% (Appendix A). This gives reassuring evidence that the model used here is similar to that used by the Government.

The National Grid higher cost scenario relates only to the top 10% of projects, although as the sample size was only 7 this must mean 1 project. In the model this project would achieve a return of at most 4.64% so clearly would not proceed. In its evaluation for the Government TNEI concludes

"If a developer respondent suspects that the cost data he provides will be used to set the CfD strike price then he is incentivised to overstate them."

It is clear that the Government has excluded that project from its considerations in setting the "strike price".

All the other projects would pass the "hurdle rate" and therefore proceed at a "strike price" of £135 which is clearly the Government's intention in setting the price.

Comparison with LEC Borrowing at Government rates

Three separate scenarios were tested using the base data reported above (excluding the highest National Grid project). All three assumed Government backed borrowing at 3.5%. In the first scenario both construction and maintenance costs were inflated by 20%. In scenario two construction costs were 10% higher but maintenance costs were 20% up. In scenario three both construction and maintenance were 10% higher.

The cost / MWH was calculated so that the predicted reduction in cost compared to the strike price could be determined.

Scenario 1 all costs plus 20%:

- Crown Estate Minimum from £75 to £86 / MWH
- Crown Estate Maximum from £94 to £104 / MWH
- ROBR Minimum from £82 to £91 / MWH
- ROBR Maximum from £101 to £111 / MWH
- National Grid Minimum from £90 to £99 / MWH
- National Grid Medium from £116 to £126 / MWH

Scenario 2 construction costs plus 10% maintenance costs plus 10%:

- Crown Estate Minimum from £69 to £78 / MWH
- Crown Estate Maximum from £87 to £97 / MWH
- ROBR Minimum from £78 to £86 / MWH
- ROBR Maximum from £95 to £105 / MWH
- National Grid Minimum from £84 to £93 / MWH
- National Grid Medium from £110 to £119 / MWH

Scenario 3 all costs plus 10%:

- Crown Estate Minimum from £67 to £77 / MWH
- Crown Estate Maximum from £84 to £94 / MWH
- ROBR Minimum from £73 to £82 / MWH
- ROBR Maximum from £91 to £100 / MWH
- National Grid Minimum from £80 to £89 / MWH
- National Grid Medium from £105 to £114 / MWH

In all 3 scenarios and for all available project data the cost of producing electricity using the LEC/SEGC model would be considerably less than £135 / MWH. In the most optimistic scenario of £67, it is less than half.

Considering only the National Grid's Medium project costs which is believed to be the basis on which the "strike price" of £135 was set by the Government, then Scenario 1 is between 6.7% and 14% lower; Scenario 2 is between 11.9% and 18.5% lower; Scenario 3 is between 15.5% and 22.2% lower.

These scenarios are in effect timelines, whereby initially Scenario 1 applies i.e. project management and purchasing is hired externally. Then as experience is gained Scenario 2 is achieved i.e. purchasing cost parity is achieve put skilled maintenance and project staff are required. Then once the LEC/SEGC companies have sufficient expertise Scenario 3 is reached with key staff in place and the additional costs relate essentially to risks and overheads.

The models predict that saving in the cost of electricity production of over 6% will be achieved from inception rising to 15.5% and possibly over 22% at a later stage.

As there is no way of knowing whether the prices quoted to the Government in evidence for the National Grid's Medium estimates have in fact been artificially inflated to influence the "strike price" these savings are minimum figures.

The spreadsheet used to model this work is available on request.

Appendix A

Variables used in the Model

Wind Farm costs

The Crown Estates (http://www.thecrownestate.co.uk/media/211144/guide_to_offshore_windfarm.pdf written by BVG Associates in 2011) estimated £1.5B for a 500 MW farm. It is notable that both the Moray Firth and the Firth of Forth projects have been broken down into roughly 500MB chunks, with separate planning submissions for each chunk. This sum was broken down

into £60M for various pre planning submission studies; £600M for turbines; £400-500M for rest of plant including cables and HVDC convertors; £400M for installation and commissioning over a 2 year period; £25M to £40M per year for operation and maintenance over the 25 year life.

This report also notes that major components like turbines will come with a 5 year warranty and feel faults would materialise in that period so a 20 year operational life is reasonable (the DIW report below suggests turbine life may be less than the 20-25 years for on-shore turbines)

Analysing the above into £ / KW gives: Pre construction £120; Construction £2800 - £3000; Maintenance £50 - £80 / year. Turbines alone £1,200 /KW.

Inflating these costs by 5% to 2012 prices gives : Pre construction £126; Construction £2940 - £3150; Maintenance £52 - £84 / year. Turbines alone £1,260 /KW.

A DECC report (https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/223644/TNEI_Offshore_Wind_Generation_Cost_Variations_Review_-_FINAL_for_publication.pdf written by TNEI June 2013) analysed 2 further studies to determine a range of costs. Both these studies distinguished between "near shore" and "far shore" wind farms. The farms most likely to come on stream first fall into their "near shore" category, defined as < 50KM from shore and < 45M water depth. Although Moray is only 13.5 miles from shore, the cable route in Moray is 66 miles exceeds that and later parts of the project have depths > 45M. Nevertheless for maintenance and other purposes it is "near shore" as is stage 1 of the Firth of Forth.

This report costs were in 2012 prices and give expected industry costs for 2016/17 and 2017/18 generation.

The first study (from ROBR) gave a range in £ / KW: Pre construction £46 - £120; Construction £2000 - £2700; Maintenance £126 / year.

The second study based on evidence supplied to National Grid gave a range in £ /KW: Pre construction £70 - £161; Construction £2689 - £3226; Maintenance £103 - £225 / year. The medium prices were £100, £3046 and £143.

In trying to reconcile the variance, it was suggested that the National Grid figures which were obtained later, either more accurately reflected costs from actual projects or on the other hand may be inflated to influence the strike price.

Cost Trajectory

According to the TNEI report , estimates of off-shore wind prices have risen in recent years due to restrictions in the supply chain which is failing to meet demand.

Costs are likely to fall with more efficient turbines and growing the supply chain. However, by 2019 and 2020 the existing 3.6MW to 5MW turbines will be used. Each of the submissions is planning for 7-8 MW for later stages which will reduce the number of turbines required and lower the costs of construction.

A UK Government report (https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/66776/5584-offshore-wind-cost-reduction-task-force-report.pdf published in June 2012) suggests measures whereby off-shore wind costs could be reduced to £100 / MWH by 2020 from what was then estimated as £141 - £191. The main recommendation was to build the supply chain and to build confidence that there would be a steady stream of projects.

Despite this, and largely on the basis of industry feedback, the UK Government proposed "strike price" for 2019 is £135 / MWH. That is the rate which will be paid for 15 years, on all electricity produced from capacity installed and operational in 2019.

When Costs Occur

All published timetables agree a 5 year period from planning approval to live generation. However, construction time is much less than this. Walney wind farm, until recently the worlds largest off-shore wind farm, took 7 months to construct phase 1 but constructed phase 2 in around 5 months. The North Sea farms involve more cabling and somewhat deeper water, however, most material purchase and construction costs will be within 2 years. Construction and purchase costs for modelling purposes are assumed to be spread 5%, 10%, 20%, 35%, 30% over the 5 years to 2019.

Income

The CfD values of £135 in 2019, based on 2012 prices apply for 15 years rising with inflation from 2012 (see https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/223652/emr_consultation_annex_b.pdf p5 note 10).

The remaining 5 years will be at market electricity rates. This is unpredictable in 2034. The current wholesale price varies from £48 to £60 /MWH (http://www.catalyst-commercial.co.uk/wholesale-electricity-prices/) over a year with a mean of around £55. Overall electricity costs are however, expected to rise up to 20% due to the change of energy mix. Furthermore, the UK Government looks set to embrace a new generation of nuclear to supply its base load electricity supply.

The nuclear "strike price" was proposed by the Government as £70 / MWH. The main company interested in building these plants is EDF who are seeking £95 – 100 / MWH for 20 years, although negotiations are on-going (http://www.theguardian.com/politics/2013/jul/05/davey-minister-nuclear-power-hinkley-point 5th July 2013).

Given these expectations it seems plausible that a wholesale energy price of over £70 / MWH in 2034 may be reached, at 2012 prices

The model tests £55, £65 and £75 market rates applying from 2034 to 2039..

Finance Costs

DIW notes that across the EU the energy Industry typically uses a 9% discount figure.

DECC assessment of the reduced costs of CfDs (https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48136/2174-cepa-paper.pdf Cambridge Economic Policy Associates June 2011) gives normal energy sector project stage risk returns expected at 20%-40% nominal IRR up to financial close when it is sold, or 15%-17% across the whole project; full life project returns of 9% to 12% excluding development risk, but including construction risk (some projects 12% to 15%); around 8% from institutional investors once operational.

The cost of finance based on 15 year swops is around 3.5% to 4% plus margin i.e. financial organisations profit. Under the ROC regime this worked out at 6.5% overall for relatively risk free projects e.g. solar and on-shore wind and could be 7.5% pre-tax, 5.4% post tax, for off-shore wind . It is believed the removal of substantial energy market risk under CfDs would enable financial institutions to take on more exposure and hence lower the overall cost of capital. There is also a note that lending is typically in 5 year tranches to encourage refinancing once operational.

Taking account of the operator required rate of return DECC assumed that whilst the technology is emerging the required whole life rate of return (WACC) will be between 9.5% and 11.2% and once established will be between 8.9% and 9.6%. These figures are 0.7% lower than the existing ROC regime.

There is evidence that DECC now assumes the cost of capital will be lower than assessed in 2011. Its impact assessment of May 2013 (https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/68820/3593-estimated-impacts-of-our-policies-on-energy-prices.pdf) states the impact on capital costs "hurdle rates" (page 63) as opposed to ROCs is 1.2% for round 1and 2 farms and 1.1% for round 3. This seems to be 0.4% to 0.5% lower than earlier i.e. WACC of 9.1% to 10.8% for untested and 8.4% to 9.1% for established. The "hurdle rate" is the minimum required rate of return for the project to proceed. In the modelling these rates are used to see if they are achievable over the life of the project given various capital and maintenance costs.

The assumption is if they are not achievable the project will not proceed.

A Local Energy Company (or SEGC) Comparison

Finally, a scenario is examined whereby LECs or the proposed SEGC use Green Bonds backed by the Government to fund the project at 3.5%. This represents current 15 year Government bond rates.

Depending on the company structure, these borrowings could be eligible for tax relief, bringing the real cost down to 3%, which is also the current rate of borrowing by Local Authorities through the Public Sector Loan Board. For comparisons only 3.5% was modelled.

Clearly until some experience was gained, LECS would be required to buy in purchasing and project management expertise, which would raise construction and maintenance costs in comparison with established developers.

On the most pessimistic scenario, it is assumed both capital and maintenance costs would be 20% greater than for private developers.

A second more optimistic scenario assumes purchasing cost parity would be reached and construction would be only 10% greater, to reflect project management, slightly higher costs of constructors and risk factors, with maintenance 20% higher.

A final scenario assumes that technical staff are employed, so that only risk factors are considered and both construction and maintenance are 10% higher.

Consideration was given to incorporating these costs into the overall cost of capital across the project, however, as the LECs/SEGC model is in essence a public enterprise company not issuing dividends, a simple cost basis seemed more appropriate for comparison.

Residual Value

All the models are based on a 20 year operational life to see if extra profit or loss is achieved at the end of the period and calculate either the effective rate of return or the required level of the "strike price". Some assets such as subsea cables will last 40 to 50 years and platforms may last similar periods if Oil platforms are a guide. No estimate is made for these residual values, however, logically they could exceed 10% of the construction cost.

The NPV of cash is calculated at the inflation rate.

Inflation

The Bank of England has a CPI inflation target of 2%, but is predicting that over the next 2 years it will exceed that by at least 0.5%. Historically before 2004 it was below 2%, however, in 2011 it exceeded 4%.

Given the need for a rebalancing of the economy and increased infrastructure investment, most forecasters are anticipating continued inflationary pressure. Indeed over a 2 year horizon the MPC seem relaxed about it staying around 3%. However, a sustained level above 3% would probably result in policy changes. For modelling purposes, it is anticipated that a higher inflation rate results in projects being more profitable as the capital costs have already been incurred. The model will assess average inflation over the 20 year project life of 2% and 2.5%.

Turbine Load Factors

These will vary each year with the wind. Last year Walney Wind Farm achieved 43%. In evidence for the Government the National Grid and ROBR predicted average load factors of between 38% and 44%.

For modelling purposes yearly load factors are assumed to change each year in a cycle from 38% to 41% to 44%.