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Never mind the technology - feel the WACC

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What is WACC and why is it important for LCOE?

Offshore wind is a relatively capital-intensive business. The major costs are incurred in the three years leading up to start of operation of a wind farm in purchasing components and constructing the wind farm.

If we consider a typical 600MW wind farm and assume a capital cost of €3.8 million per MW, the total capital is €2.3 billion. If money was available to borrow at zero interest cost, then paying-off the capital would cost just over €92 million per year for a 25 year project life. This is already more than the annual operational cost, estimated at around €60 million per year. Figure 1 shows (in a simplified form) the cumulative cash position and annual costs for a wind farm if it could be financed this way.

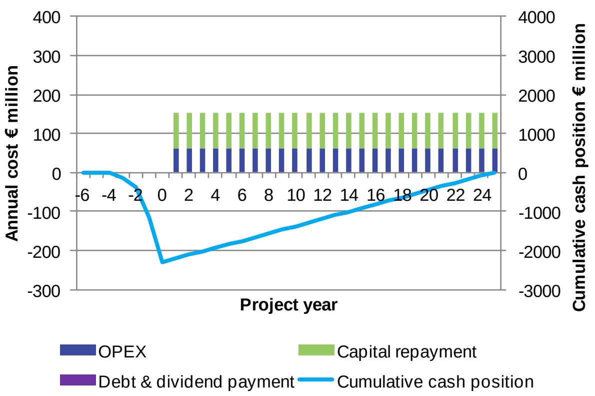

Figure 1: Cumulative cash and annual costs at 0% WACC

In reality, of course, money is not available at zero interest cost. Finance for wind farms comes from a variety of sources, and is now usually a mixture of equity and debt. Annual costs for the wind farm therefore need to include paying the interest costs of the finance as well as paying off the initial capital.

The average cost of the finance (weighted average cost of capital, WACC) is calculated from the capital being provided and the rate associated with source, and is a convenient way to use a single, through-life equivalent value in cost calculations. If the rates used are the actual rates, then WACC is said to be 'nominal'. If rates exclude the effect of inflation, they are said to be 'real'.

Typical WACC values of 9-11% (real) have been used in the past in calculating levellised cost of energy (LCOE) for balance-sheet financed projects. If we use 10% WACC, then the annual payment required triples to €272 million per year. This is shown in Figure 2, which also shows how the majority of the cost is interest payment in the early years.

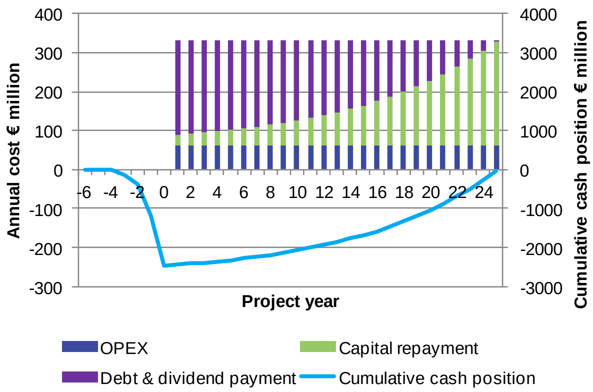

Figure 2: Cumulative cash and annual cost at 10% WACC

Assuming an average net capacity factor of 45%, then a 600MW wind farm will produce 2,367 GWh of energy each year. We can use this with the annual costs outlined above to derive a relationship between WACC and LCOE as shown in Figure 3. We can also see how the contribution of finance cost to LCOE rises from zero at 0% WACC to over 50% above 10% WACC.

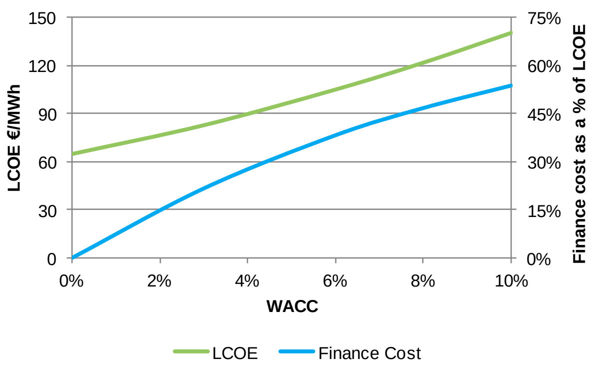

Figure 3: LCOE as a function of WACC, for typical wind farm

We know of projects with FID in 2014 and 2015 with real WACC of around 6%, which gives an LCOE reduction of €35/MWh over projects with 10% WACC, a 25% benefit. Clearly, then, WACC has a big impact on LCOE.

How are projects achieving low WACC?

The best available data for a project with low WACC is for the Gemini offshore wind farm in the Netherlands, which will enter operation in 2017. The project is approximately 74% debt financed (from the start of construction) at a rate of 4.75% (nominal). Assuming a required return on equity of 13% (nominal), then WACC is 6.9% (nominal) or just under 6% (real). This project structure represents a major shift from largely balance sheet (equity) financed projects we have seen in the past.

Providers of debt to a project, who have no right to claim from the equity holders, are called non-recourse finance providers. Their primary focus is on the robustness of the project and its ability to generate revenues to pay-back the debt and interest. These debt providers have no interest in the potential for a project to bring better returns than expected (an 'upside'). They are, however, very focused on the potential risks that the project could produce lower returns than expected ('downside').

Debt providers will investigate a variety of risk areas to the project, including:

- Revenue from electricity sales and support mechanisms
- Wind resources
- Potential component and system failures
- Weather risk in carrying out repairs
- Wind farm availability, and
- Operational costs.

Where debt is being provided from the start of construction, they will also look at risks of construction delay and cost overrun.

Debt providers will undertake detailed project financial modelling and develop realistic scenarios for potential downsides, to arrive at worst-case estimates for the value of energy generated and the operational costs. The difference between these two is the revenue generated that is available to pay the debt providers. Generally the debt providers required this to be at least a factor of 1.2 higher than the debt payment. This is known as the debt-cover ratio.

Case study: 72kV inter-array cables

Array cables make-up about €50m of the capital cost in our example wind farm. Higher voltage, 72kV cables are being developed to reduce cost and transmission losses. If we assume they can save 10% cost and increase the net capacity factor by 0.2%, then the impact on LCOE at constant 8% WACC should be to reduce it from €122.5 to €121.7 per MWh, a 0.7% reduction.

This is a useful improvement, but what if the debt provider takes the view that this is untried and high-risk technology? The debt provider may decide, for example, to allow contingency for a worst case of replacing the higher voltage cables and associated switchgear either before the start of operation or during the life of the project.

In the case where debt is at 5% and equity is at 15%, a ratio of debt to equity of 70 / 30 gives a WACC of 8%. If the debt provider calculates that because of (its view of the) downside risk of new cable technology, the maximum debt to equity ratio he can accept is 67.5 / 32.5, then the WACC rises to 8.25%.

At 8.25% WACC the LCOE rises to €124.2 per MWh, completely negating the benefit of the improved technology.

Discussion

We have seen how an innovation that should offer benefits to LCOE can be viewed as having negative impact on the availability of debt. Replacing this low-cost debt with higher cost equity drives-up the WACC which results in a worsening of LCOE, rather than an improvement. This is one of many potential examples of this type.

There are other innovations (for example which improve certainty on a project) which reduce the downside risk and potentially increase the debt-provider's ability to lend.

There are further innovations being developed that are likely to be viewed by debt providers as having minimal impact on downside risk.

We have categorised innovations as:

- Debt negative innovations
- Debt positive innovations, and
- Debt neutral innovations.

We developed a detailed list of 43 innovations as the most likely to contribute to LCOE reduction in *Future renewable energy costs: offshore wind*, authored by BVGA for KIC InnoEnergy in 2014. We have used this list as the basis for an initial analysis of the categorisation of innovations by their impact on project debt (noting that this list is indicative only and certainly does not capture all possible innovations).

Table 1 shows those innovations we categorised as debt negative, Table 2 shows those we categorised as debt positive and Table 3 shows debt neutral innovations.

From this analysis, we might expect to see accelerated take-up of the debt positive innovations (assuming the continued availability of low-cost project finance).

The concern, though, is if the debt negative innovations are held-back. Achieving low WACC is important in reducing LCOE as we have seen. It is though, a step that can only be taken once. Technology development is still needed to continue to drive down LCOE long-term and obstacles to technology roll-out could ultimately damage the LCOE levels achieved.

As a result, we expect to see providers of potentially debt negative technologies looking at a range of actions to improve their acceptability to project financiers. Not all of these actions will be appropriate in all cases. Key actions include:

- Additional validation testing in realistic environments ahead of first project deployment

- Demonstration as a small part (such as 5%) of an earlier project
- Development of failure mitigation strategies such as system redundancy and pre-planned repair or replacement processes
- Commercial underwriting or warranty provision by the technology supplier.

It is important to note that these actions are likely only to be needed the first times that a technology is deployed at scale in projects. Once its robustness is established, it is then likely to enter the category of established, and hence debt neutral, technologies.

BVGA is working with a range of key industry players in this area:

- For technology holders, we are evaluating and, where necessary helping to revise, product development and validation plans to deliver debt neutral and debt-positive technologies
- For project developers, we are helping define technology demonstration and adoption plans which enable them to take-up the innovations they need to keep reducing LCOE without adverse impact to the cost of capital
- For debt providers, we are helping evaluate innovations that will lower LCOE and develop the understanding needed to model the risk they bring as accurately as possible
- For enablers, we are helping identify any potential market failures that this situation might bring and advising on initiatives that will help ensure the required technology developments are not held-back to any great extent.

Table 1 Innovations with a potentially negative impact on debt in the first project

Innovation from KIC report	Comment
Introduction of reduced cable burial depth requirements	Potential need to remedy cable exposure in operation
Improvements in blade tip speed	Concern over erosion & repair
Introduction of next generation turbines and major new variants	Concern over failure & repair cost for new technology
Introduction of active aero control on blades	
Improvements in mechanical geared high-speed drive trains	
Introduction of mid-speed drive trains	
Introduction of direct-drive superconducting drive trains	
Introduction of continuously variable transmission drive trains	
Introduction of DC power take-off (inc. DC array cables)	
Introduction of suction bucket technology	
Holistic tower design	
Introduction of array cables with higher operating voltages	
Introduction of alternative array cable core materials	
Introduction of buoyant concrete gravity base foundations	
Introduction of float-out-and-sink installation of turbine and support structure	
Improvements in range of lifting conditions for blades	Concern over damage during installation
Introduction of whole turbine installation	Concern over risk in new installation
Improvements in cable installation	

Table 2: Innovations with a likely positive impact on debt

Innovation from KIC report	Comment
Introduction of floating meteorological stations	Greater certainty on conditions
Greater level of geophysical and geotechnical surveying	Reduced uncertainty on site ground conditions
Improvements in blade design standards and process	Better QA & control reduces manufacturing risk
Improvements in blade materials and manufacture	Reduced manufacturing risk
Improvements in workshop verification testing	Reduced failure risk
Improvements in monopile designs and design standards	Better QA & control reduces manufacturing risk
Improvements in jacket design and design standards	
Improvements in jacket manufacturing	
Improvements in array cable standards and client specification	
Improvements in the installation process for space-frames	Better control reduces installation risk
Improvements in weather forecasting	Reduced weather uncertainty
Introduction of turbine condition-based maintenance	Reduced failure risk
Improvements in jacket condition monitoring	
Improvements in OMS strategy for far-from-shore wind farms	
Improvements in personnel transfer from base to turbine location	
Improvements in personnel access from transfer vessel to turbine	

Table 3: Innovations with a likely neutral impact on debt

Innovation from KIC report
Introduction of multi-variable optimisation of array layouts
Greater level of optimisation during FEED
Improvements in blade aerodynamics
Improvements in blade pitch control
Introduction of inflow wind measurement
Improvements in hub assembly components
Introduction of direct-drive drive trains
Improvements in AC power take-off system design
Improvements in inventory management
Improvements in wind-farm wide control

Contact

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