

Cost Reduction Monitoring Framework

Summary Report to
the Offshore Wind Programme Board

February 2015



Foreword

The Offshore Wind Industry Council (OWIC) approved the Cost Reduction Monitoring Framework (CRMF) on 24th February 2014. The OWIC identified the need for the progress being made on cost reduction to be tracked against an agreed schedule of milestones and for an average Levelised Cost of Energy (LCoE) to be published for the most recent projects.

In less than 12 months, the process was designed, agreed and implemented and this document is the first of what we hope will be many annual reports from the CRMF.

Both Government and Industry welcome the publication of this report, providing as it does a strong, evidence-based framework for quantifying the costs of energy from offshore wind. We are pleased and reassured that this first report also demonstrates that cost reduction is genuinely progressing on or ahead of schedule and has the potential to reduce further towards and beyond the target of £100/MWh by 2020.



A handwritten signature in black ink, appearing to read 'Matthew Hancock'.

The Rt Hon Matthew Hancock MP
Minister of State for Business, Enterprise and Energy
Joint Chair of the Offshore Wind Industry Council



A handwritten signature in black ink, appearing to read 'Benj Sykes'.

Benj Sykes
Joint Chair of the Offshore Wind Industry Council



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1 Executive Summary

The Offshore Renewable Energy Catapult was commissioned by the Offshore Wind Programme Board and sponsored by the members of the Offshore Wind Industry Council (OWIC) to develop a Cost Reduction Monitoring Framework (CRMF) for the offshore wind industry. The design of the CRMF was developed jointly by the Offshore Renewable Energy Catapult and The Crown Estate.

Results show that the Levelised Cost of Energy (LCoE) of offshore wind has reduced by 11% during the period 2010-2014. Evidence suggests that the target of £100/MWh by 2020 is achievable; however, challenges remain. This report describes these challenges and provides recommendations.

The evidence supporting this report's findings and recommendations is contained in both a quantitative and a qualitative analysis conducted by Deloitte and DNV GL respectively.

Cost reductions are being achieved largely by progress in the development of larger turbines, XL monopile foundations, improvements in operation & maintenance and extended design life. Progress is also being made in finance (cost of debt, equity and insurance) and across the supply chain (competition, collaboration, contracting).

However, market growth has been lower than considered by The Crown Estate's Offshore Wind Cost Reduction Pathways in 2012 and whilst good progress has been made there are risks to continued cost reduction:

- the supply chain, including turbine manufacturers, does not have sufficient confidence in the size of the market beyond 2020 to justify making the technology investments which will drive cost reduction further.
- solutions expected to be necessary for constructing deeper water further offshore sites, e.g. jacket and/or gravity-based foundations and HVDC connections, are not being developed quickly enough.

Recommendations for the OWPB to ensure that progress continues and the 2020 target is achieved, include:

1. Clarify the Government's future programme, and level of regulatory support for offshore wind, after the February 2015 Contract for Difference (CfD) auction and with respect to the Levy Control Framework beyond 2020.
2. Encourage the demonstration of balance of plant innovations such as novel foundations and optimised electrical networks.
3. Investigate the potential impact of lower than anticipated levels of investment in the jack-up and heavy lift construction vessel fleets, particularly for foundation installation.

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4. Support the capture and sharing of knowledge and best practice through increased collaboration with a view to increasing the predictability of project execution.
 5. Continue to track cost reduction progress in the UK and extend monitoring to include European offshore wind development.
 6. Consider identifying and if required addressing the gaps in skills and expertise required to deliver and operate an offshore wind farm.

Levelised Cost of Energy (LCoE) compared to Strike Price

Levelised Cost of Energy (LCoE) is the cost to produce electricity over the total lifetime (20-25yrs) of the asset based on the expected MWh generated. It includes all costs to construct and to operate the asset, but does not take into account:

- The cost of selling the electricity (including fees/risk margins deducted by the power purchase agreement (PPA) offtaker)
- Working capital costs to reflect the timing delay of revenues

Strike Prices are the amount paid to a generator for each MWh of electricity produced over a 15 year Contract for Difference (CfD) term. Strike Prices are intended to produce a certain level of revenue and a reduced level of market risk, in order to incentivise investment in offshore wind. After the 15 year term, the generator is reliant on the market electricity price only.

Strike prices (over the 15 year term) are therefore expected to be higher than LCoE (over the 20-25 year term) for the following reasons:

- To allow the developer to recover an appropriate level of return over the life of the asset
- To cover the costs of selling the electricity into the market either through a Power Purchase Agreement (PPA) or managing electricity price risk themselves; and
- To cover working capital costs incurred between generating electricity and receiving revenues.



2 Introduction

2.1 Background

The Crown Estate's Offshore Wind Cost Reduction Pathways Study estimated the Levelised Cost of Energy (LCoE) for UK Offshore Wind in 2011 at approximately £140/MWh (real 2011 prices). Through the recommendations of the Cost Reduction Task Force report (June 2012) and the ongoing work of the Offshore Wind Programme Board (OWPB), many companies with a strategic interest in offshore wind are now actively investing in reducing LCoE by introducing new technologies and improved practices.

The Crown Estate and ORE Catapult have jointly developed a standard industry framework for monitoring and reporting industry's progress on reducing LCoE.

2.2 Framework

In November 2013, the Offshore Wind Programme Board Risk Committee¹ (OWPBRC) agreed that the Cost Reduction Monitoring Framework (CRMF) should comprise the following packages:

- A qualitative forecasting approach to track industry progress against a framework of pre-agreed milestones;
- A quantitative tracking approach using standardised project data declared at Final Investment Decision (FID) and works completion to calculate an industry average LCoE, weighted by yield, across as many projects as is necessary to guarantee individual project anonymity in each year.

The output is a series of annual reports for the OWPB to assess how the industry is progressing and where focus is required to make further progress in delivering a lower levelised cost of energy.

¹ The Risk Committee is a sub-committee of the Offshore Wind Programme Board.

2.3 Organisation

A project steering committee consisting of key stakeholders from OWPBRC, The Crown Estate and ORE Catapult directed the project. The CRMF design has been jointly developed by The Crown Estate and ORE Catapult.

Following approval of the process design by the OWPBRC, the management of the CRMF has been conducted by ORE Catapult. The data gathering and analysis of both the Qualitative and Quantitative Workstreams have been contracted to third party consultants, DNV GL and Deloitte respectively.

The key CRMF governance stakeholders are set out in Figure 2, below.

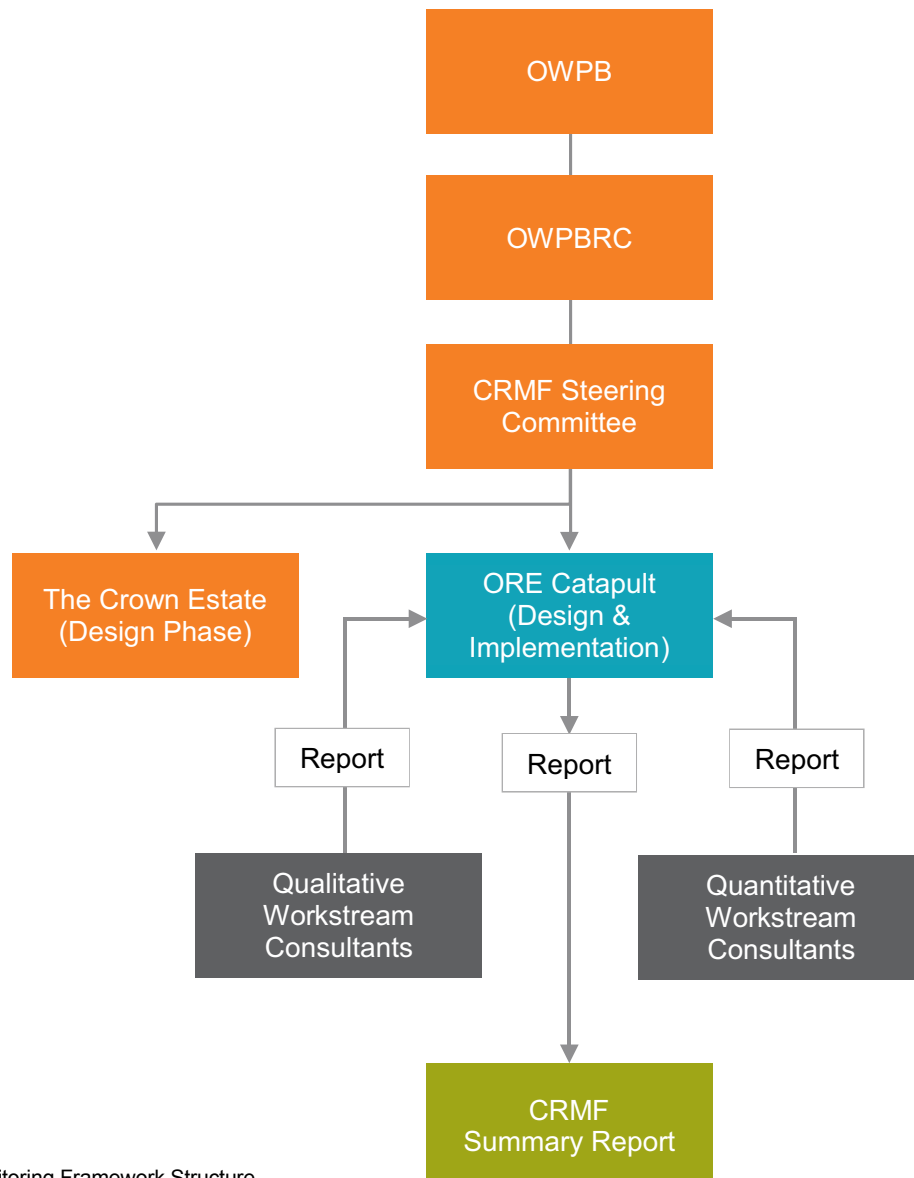


Figure 2: Cost Reduction Monitoring Framework Structure

3 Methodology

3.1 Background and Context

The Crown Estate and ORE Catapult jointly issued Requests for Proposals for qualified parties to design and implement the CRMF process. The Qualitative and Quantitative packages were tendered and awarded as separate contracts. The Qualitative package was awarded to DNV GL, in partnership with PWC, and the Quantitative package to Deloitte LLP.

The full design methodology was approved by the CRMF Steering Group and the OWPBRC.

3.2 Qualitative Assessment

The aim of the qualitative package is to assess the cost reduction progress of the offshore wind industry against the development pathways that were defined in the Offshore Wind Cost Reduction Pathways Study.

A total of 66 indicators were identified and for each indicator a set of milestones was agreed that would demonstrate progress towards the relevant cost reduction pathway.

Primary evidence was gathered from a wide consultation with companies actively engaged in the sector. This was further supported by a literature review and the experience of the assessment teams from DNV GL and PWC.

The indicators were grouped into three areas (technology, supply chain and finance) and were weighted in terms of cost reduction potential. They were then combined to present an overall assessment of progress towards the LCoE target of £100/MWh.

Indicators included:

- Technology indicators for the cost reduction potential of turbines, balance of plant, installation and operation and maintenance.
- Supply chain indicators for competition, growth and scale and the cost reduction benefits of collaboration.
- Finance indicators for cost of debt, cost of equity and insurance.

3.3 Quantitative Assessment

The quantitative assessment employed an LCoE Calculator that the developers used to submit project data to the CRMF. The LCoE Calculator included data entry sections for all inputs required for LCoE calculations, with the calculation and outputs sections password-protected to ensure that LCoE calculations for all projects are consistent.

The Calculator also included built-in checks to identify any inputted or calculated parameters which fall outside of expected ranges and any input sections not completed.

To complement the analytical process, a questionnaire was developed focusing on the qualitative factors that were material for the quantitative assessment of LCoE. Narrative information was requested, which provided insight to the primary drivers of LCoE.

For the 2014 CRMF process, projects reaching either FID or Works Completion in any of the years 2010-2014 (inclusive) were included. In future years, projects reaching FID or Works Completion in the relevant year will be included.

One of the fundamental principles of the methodology employed is that the data for each project should remain confidential to the respective project developer(s). All data has been provided to the CRMF under Non-Disclosure Agreements (NDAs). In order to ensure that no third party can reverse-engineer the LCoE of a single project, three key tests must be satisfied:

1. Three project rule – a minimum of three projects with different owners must be included in the dataset;
2. Ownership history – past ownership of projects will be considered in order to identify any projects where parties other than the current owners have access to the project data;
3. Relative size of projects – the combined contribution of any two projects should not be greater than 80% of that year's LCoE (the 80% hurdle will be considered on a year-by-year basis).

As a result of these requirements, it may not be possible to conduct the quantitative assessment each year and it is likely that this report will instead be compiled bi-annually unless the methodology can be adapted to include projects outside the UK.

4 Implementation

4.1 Qualitative Assessment

Evidence was gathered from over thirty companies through the consultation process. These companies covered the breadth of the sector including developers, financiers and wind turbine and electrical OEMs. In general, there was sufficient evidence to accurately assess the indicators against the milestones and in most cases there was a clear consensus on which milestones had been achieved.

There was limited engagement from Offshore Transmission Owners (OFTOs), fabricators, contractors, array cable manufacturers and vessel operators. As such there is reduced confidence in the related indicators. This could be addressed in future by a longer engagement/implementation phase.

In addition to the assessment against the milestones, the package also delivered a forward looking view on the likelihood that progress would continue at the same rate or whether specific hurdles might prevent the achievement of milestones in 2015 and beyond.

With the exception of the areas of limited engagement, as outlined above, the process worked well and operated in accordance with the design intention. It is recognised that the CRMF process requires time and effort from developers and the supply chain but it is understood that a rigorous approach to cost reduction monitoring is required in order to provide consistent and robust evidence of cost reduction progress. Now that the baseline has been established in this initial implementation it will be possible to refine this for use in future years.

4.2 Quantitative Assessment

The LCoE calculators were completed by participating developers between September 2014 and January 2015. The project team also carried out reviews of the completed calculators to ensure, as far as possible, that information was provided on a like-for-like basis between projects and was free of any identifiable input errors.

During this time, the developers responded to a standard questionnaire in order to identify key factors influencing the resulting LCoE figures. Data was gathered from the following projects:

Works Completion		FID	
Project Name	Capacity (MW)	Project Name	Capacity (MW)
Greater Gabbard	509	Dudgeon	402
Gunfleet Sands 1&2	173	Gwynt y Mor	576
London Array 1	630	Humber Gateway	219
Ormonde	150	Teesside	62
Robin Rigg A&B	180	West of Duddon Sands	389
Sheringham Shoal	317	Westermost Rough	210
Teesside	62		
Thanet	300		
Walney 1&2	368		
West of Duddon Sands	389		

5 Summary of Results

5.1 Quantitative Assessment

For Works Completion projects, LCoE has reduced from £136/MWh for 2010-2011 projects to £131/MWh for 2012-2014 projects. For projects at FID, reported LCoE has reduced to £121/MWh for 2012-2014 FID projects.

This overall reduction from £136/MWh to £121/MWh represents an 11% reduction in LCoE.

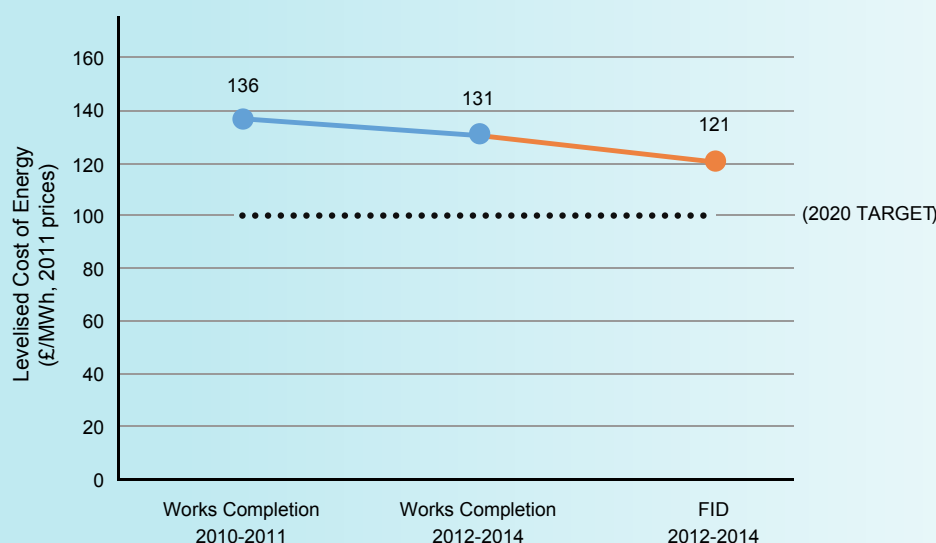


Figure 5.1: Quantitative Assessment Summary

One of the key principles of this process has been preserving the anonymity of developer data and this has put some constraints on the amount of insight that can confidently be drawn from the reduction in average LCoE.

However, one factor that does stand out is that the 2012-2014 FID projects group is dominated by projects using 6MW turbines, whilst the other LCoE figures reflect projects with an average turbine size of 3.4MW – 3.6MW. It may be inferred that the estimated reduction to £121/MWh for these projects is due to some extent (possibly a large extent) to the anticipated capex and O&M reductions from fewer installations and maintainable units plus improvements in output and reliability.

As shown in Figure 5.2, the £121/MWh average for 2012-2014 FID projects is lower than anticipated by The Crown Estate's Offshore Wind Cost Reduction Pathways Study. The Study's Technology Acceleration story anticipated a 50/50 mix of 3MW-5MW and 5MW-7MW turbines for 2014 FID projects; turbines rated at more than 5MW were not anticipated to dominate until FID 2017, at which point LCoE reduction was forecast to be achieved.

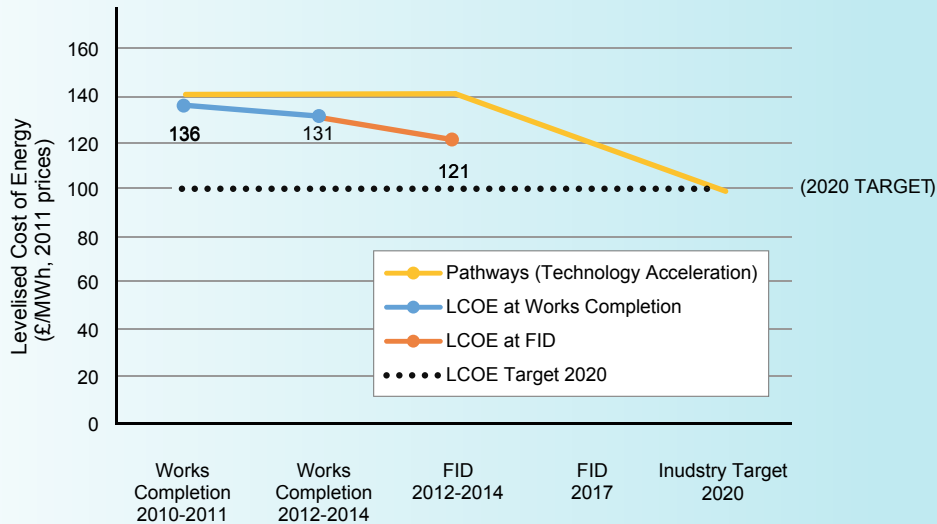


Figure 5.2: Offshore Wind Levelised Costs compared to the Pathways Study (Technology Acceleration)

This reduction being realised early is consistent with the picture emerging from the qualitative assessment that 6MW and larger turbines have become commercially available earlier than anticipated. It is, however, important to note that new turbine development requires a significant investment of time and money. It has been estimated that it can typically take 5 to 6 years from concept design to full commercial implementation. Therefore, the benefit of larger turbines apparently driving the reduction in LCoE to £121/MWh is the result of investment decisions made by turbine manufacturers a number of years ago.

In order to maintain progress in LCoE reduction, it is crucial to ensure that investment in offshore wind continues. Any new technologies that are to be considered for 2017 FID need to be at least at the demonstration stage of maturity by 2014/15.

Whilst the project costs are benefiting from the earlier availability of commercially ready larger turbines, it is also worth recognising that the smaller than anticipated market size is also leading to increased competition for a smaller number of projects and therefore suppressing supply prices. Whilst this is beneficial in the short term, the limited market may restrict the amount of investment, at a time when it is required to continue to develop the technology necessary for further cost reduction.

It should be recognised that, whilst greater than anticipated progress has been made to date, the continuation of the costs reduction journey is dependent on elements of the supply chain which operate in multiple sectors and are less compelled to invest in the longer-term future of offshore wind. Balance of plant supply chain participants are active in oil and gas, electricity networks, conventional power and construction industries. The market opportunity needs to be clearly illustrated to these participants to ensure sufficient investment in the technologies which will drive down cost.

It is uncertain whether the current market conditions will support further long term investment in technology development and supply chain industrialisation. There is limited capacity within the current CfD auction process and little clarity of the market beyond.

The participants in our studies universally supported the need for greater clarity on the future market size and the regulatory support mechanism and availability beyond 2020. Clarity is crucial to illustrating the magnitude of the opportunity for investment: without the vision of a managed market beyond 2020 it will be impossible for the current rate of progress to be sustained.

None of the projects assessed in the 2012-14 FID LCoE average are utilising jacket or gravity based foundations. As such, project costs are benefiting from extended utilisation of XL monopiles on sites previously considered unsuitable. However, this is widely acknowledged to be only an interim solution and, as sites continue to move further from shore into increasing water depths, monopiles will become unsuitable.

Whilst the most economical solution has supported further development of monopiles, it has delayed progress on solutions for deeper water including jacket foundations and gravity base.

Furthermore, whilst some cable development and testing has been started, there is no clear plan for developers to move to 66kV for intra-array cabling or HVDC connections for sites with greater offshore transmission distances.



5.2 Qualitative Assessment

The qualitative workstream concluded that in 2014 the offshore wind industry is on target to achieve an LCoE of £100/MWh for projects reaching FID in 2020.

There has been progress in the development of larger turbines, XL monopiles, O&M improvements and extended design life. Progress has also been achieved in other areas with both the finance and supply chain indicators assessed as on target. Growth and scale is the only indicator assessed as being behind target.

Figure 5.3 provides a visual representation of the results. The size of the area assigned to each indicator is proportional to its contribution to the achievement of the 2020 cost reduction target. The colour of each area shows if the indicator is:



For example, of the detailed metrics comprising the turbines assessment, one indicator, ‘Integrated design of turbine and support structure’, was assessed as being behind target, but this is outweighed by all other turbine indicators being on target or ahead of target, giving turbines an overall assessment of ‘ahead of target’.

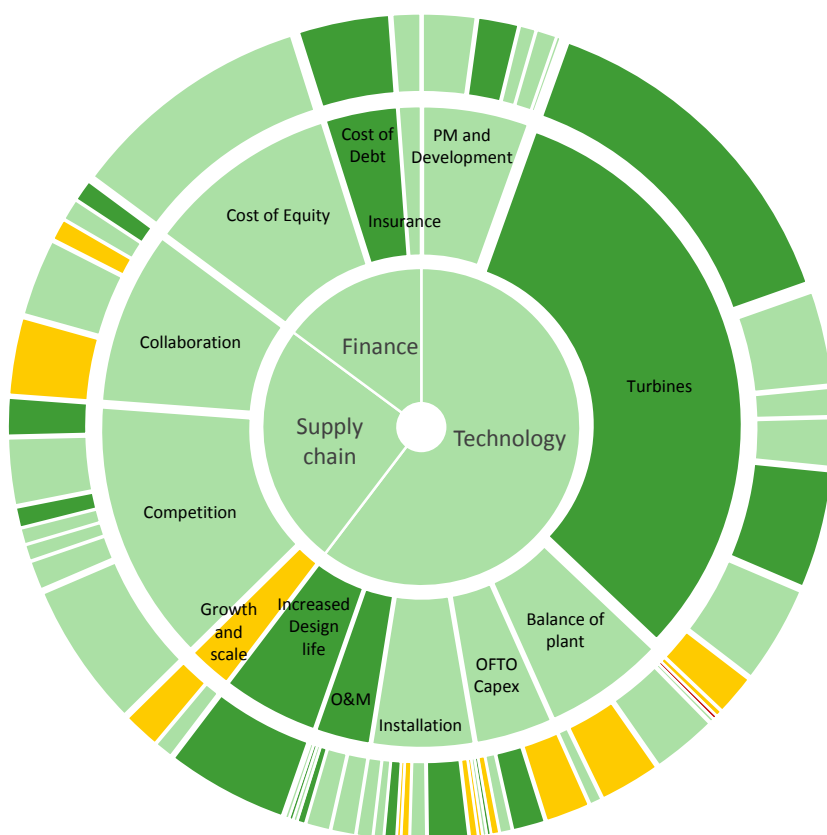


Figure 5.3: Qualitative assessment of key indicator progress against targets
Source: DNV GL

6 Recommendations

Below are the primary recommendations to the OWPB to ensure that progress continues and the target is achieved for projects reaching FID by 2020.

1. Clarify the Government's future programme and level of regulatory support for offshore wind after the current CfD auction, and with respect to the Levy Control Framework beyond 2020. Industry investors and supply chain innovators need the market opportunity to be clearly illustrated such that sufficient investment can be attracted to reduce costs. This message must be clearly and consistently communicated across the industry to administrators and policy makers.
2. Encourage the demonstration of balance of plant innovations such as novel foundations and optimised electrical networks. Technology demonstration remains a major hurdle to commercialisation and electrical networks and foundations innovations must deliver on their cost reduction potential if the overall targets are to be achieved. The industry should collaboratively support these innovations and facilitate efficient knowledge sharing to enable rapid adoption.
3. Investigate the potential impact of lower than anticipated levels of investment in the jack-up and heavy lift construction vessel fleets, particularly for foundation installation. Additionally, the influence of a depressed international oil price should be considered on vessel availability. One of the largest impacts of a smaller market is on fit for purpose vessel development. It should be determined what fleet size and vessel capability is required to support the volumes predicted over the next five to ten years.
4. Support the capture and sharing of knowledge and best practice through increased collaboration with a view to increasing the predictability of project execution. Identifying and promoting best practice in project execution will support the reduction of contingencies. It would be reasonable to expect some reduction to financial contingencies as offshore wind construction activities become more established but there is no clear evidence that contingency levels are decreasing for new projects. It is noted that, due to rapid technology innovation, a significant amount of uncertainty continues to be priced into projects when making investment decisions.
5. Continue to monitor cost reduction progress in the UK and extend to take consideration of European offshore wind development. An annual assessment of progress against key qualitative milestones requires significant industry support to ensure all relevant evidence is gathered. The ongoing assessment of actual project costs requires continued support and engagement from asset owners with the Cost Reduction Monitoring Framework. It is also recommended that the metric used to assess the progress of 'Growth and Scale' is reviewed to ensure that it remains relevant as the target year of 2020 approaches.
6. Further consideration should be given to identifying and, if required and appropriate, addressing the gaps in skills and expertise required to deliver and operate an offshore wind farm.

This report combines and summarises the findings and recommendations of the primary Qualitative and Quantitative assessment reports prepared by DNV GL and Deloitte LLP respectively. Additional recommendations are included in each of these reports and further details can be found on the ORE Catapult website <https://ore.catapult.org.uk/CRMF>.



7 Conclusions

The Cost Reduction Monitoring Framework has been highly successful in drawing together a coherent picture of the costs of recent projects within the UK offshore wind industry and provides an accurate assessment of the associated cost reduction trajectory.

Results show that the Levelised Cost of Energy (LCoE) of offshore wind has reduced by 11% during the period 2010-2014. Evidence suggests that the target of £100/MWh by 2020 is achievable; however, challenges remain.

Cost reductions are being achieved by progress in the development of larger turbines, XL monopiles, improvements in O&M and extended design life. Progress is also being made in finance (cost of debt, equity and insurance) and across the supply chain (competition, collaboration, contracting). However, market growth has been lower than forecast by The Pathways Study and whilst good progress has been made there are risks to continued cost reduction:

- the supply chain, including turbine manufacturers, does not have sufficient confidence in the size of the market up to and beyond 2020 to justify making the technology investments that will drive cost reduction further.
- solutions expected to be necessary for constructing deeper water further offshore sites, e.g. jacket and/or gravity-based foundations and HVDC connections, are not being developed quickly enough.

Whilst this report concludes that good progress is being made towards the LCoE target of £100/MWh by 2020, there is still more work to be done to lock in the cost reductions delivered and ensure the momentum is maintained.

Disclaimer

Whilst the information contained in this report has been prepared and collated in good faith, ORE Catapult makes no representation or warranty (express or implied) as to the accuracy or completeness of the information contained herein nor shall be liable for any loss or damage resultant from reliance on same.

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