BWEA

Delivering the UK's wind, wave and tidal energy

GARRAD HASSAN

UK Offshore Wind: Charting the Right Course

Scenarios for offshore capital costs for the next five years

Contents

Abbreviations

ACESA	American Climate and Energy Security Act
ARRA	American Recovery and Reinvestment Act 2009
AWEA	American Wind Energy Association
BoP	Balance of Plant
BWEA	British Wind Energy Association
CapEx	Capital Expenditure
DECC	Department of Energy and Climate Change (UK)
EBIT	Earnings Before Interest and Tax
EC	European Commission
EIA	Energy Information Administration (US)
EPC	Engineer-Procure-Construct
EU	European Union
GDP	Gross Domestic Product
GH	Garrad Hassan
GW	Gigawatt
GWEC	Global Wind Energy Council
IEA	International Energy Agency
IMF	International Monetary Fund
IPP	Independent Power Producer
IRR	Internal Rate of Return
LME	London Metal Exchange
MW	Megawatt
OECD	Organisation for Economic Development and Cooperation
OFTO	Offshore Transmission Owner
O&G	Oil & Gas (offshore, unless otherwise stated)
PRC	People's Republic of China
RBS	Royal Bank of Scotland
R&D	Research and Development
REN 21	Renewable Energy Global Policy Network
RO	Renewables Obligation
ROC	Renewables Obligation Certificate
UNEP	United Nations Environment Program
US	United States
VaR	Value at Risk
WTG	Wind Turbine Generator
WTO	World Trade Organization

Executive summary

The offshore wind industry is an important source of future energy supply for the UK, although it is a sector which has yet to fully mature. Project roll-out in the UK has gathered pace with offshore wind build in 2009 expected to be similar to onshore wind build for the first time. Currently, the UK is also the largest global market for offshore wind. This progress has been accompanied by a sharp increase in capital costs which is a concern for continuation of that success story, with economic viability now a major barrier to deployment for offshore wind projects.

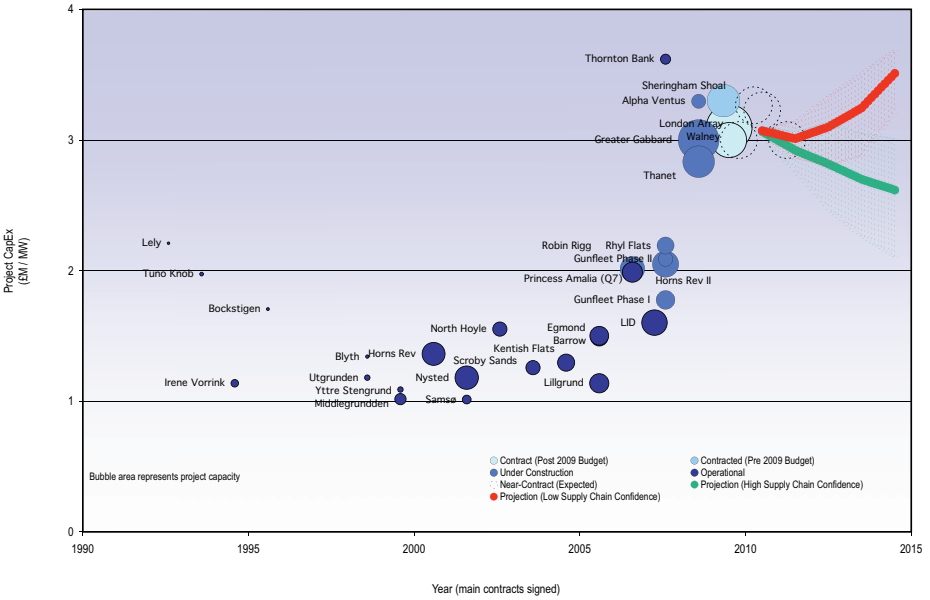
BWEA monitors the offshore wind sector closely and the work reported here has investigated cost trends for the industry, specifically:

- current capital costs levels and the drivers behind historical increases;
- anticipated capital costs for those projects likely to place major contracts by March 2011;
- scenario analysis leading to trends in capital costs extending out to 2015.

The work has been completed in consultation with the industry: project developers, key supply chain contractors and financiers.

The overall picture of capital costs of offshore wind projects, historically and under current market conditions is presented above.

Also shown above are future projections for high and low offshore wind supply chain confidence scenarios. Supply chain confidence is seen as a key factor in future costs and one which can be influenced by policy-makers and developers. In an otherwise neutral environment, projections show that good progress on this front will see capital costs reduced by 15–20% in five years' time and on a strongly-reducing trajectory.



Historical, current and projected future capital costs for offshore wind projects

Other drivers of capital costs tend to be the result of global onshore wind business prosperity or the macro-economic situation, and so less amenable to influence. The confidence limits shown above on the five-year cost trends reflect the potential impact of macro-economics and the influence of the onshore wind industry.

Learning from the past

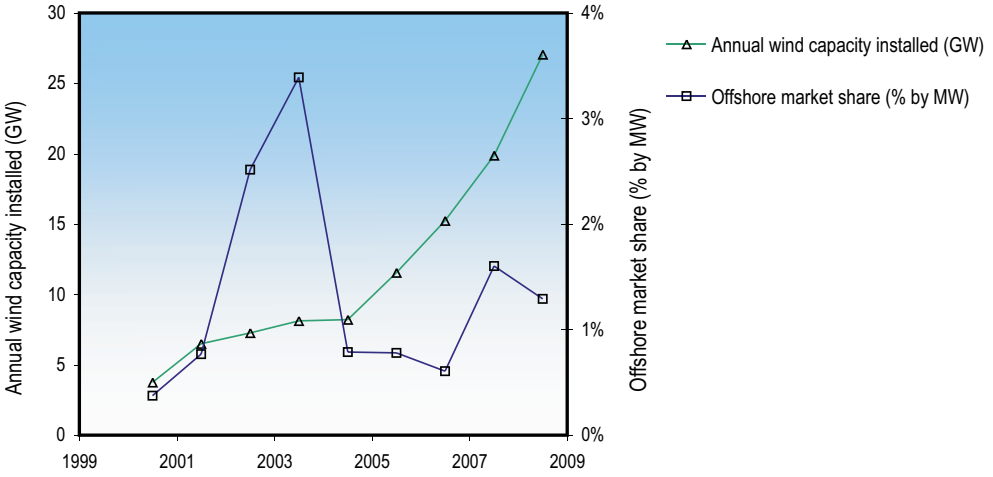
A review of the historical offshore wind capital costs reveals several important influences that have driven an upward spiralling trend from around 2005, which followed a period of relative stability from 2000 to 2004. Most important amongst these are those factors that have served to reduce supply chain competition, namely, the ongoing withdrawal of key contractors and products in combination with increasing demand pressure from industries competing for common supply capacity, in particular onshore wind. To reverse the upward capital cost trend in the long-term, a reversal in supply chain trends is important. Another factor that has had a strong historical influence is the relatively high early competition between suppliers (2000–2004) and subsequent losses as the true cost base and challenge of the technology was established and priced in to future contracts. More recently, currency and commodity markets have played an important role. Over 80% of UK offshore wind project capital value is imported, so the devaluation of sterling since 2007 has forced prices sharply up.

A stable outlook from industry

Consulting key industry players (developers and contractors) gives a picture of current capital costs lying in a range centred on £3.1m per megawatt of capacity installed (for those projects recently contracted and likely to be contracted shortly). The consensus on future trends is for a slight rise in the next two years followed by a slight fall from current levels to 2015. As one expects in such a consultation exercise, dramatic changes are not foreseen and most consultees assume 'environmental' factors will persist at current levels. There was wide acknowledgement that capital cost reduction was needed for a healthy long-term industry. Attitudes towards the UK offshore wind sector are positive – in some cases very positive indeed.

"We take confidence from the ongoing commitment the UK Government shows in developing the offshore wind industry."
DONG Energy

The 2009 Budget proposal for enhanced off-take revenues for pending projects has been mostly well-received with some reservations being expressed on the impact for investor confidence and certainty.



"Positive movements by the Government through the ROC increase in response to a recent decrease in economic viability of UK projects compared to the rest of Europe. This allowed key projects to progress and more importantly sent the signal that the government is serious about offshore wind and will support growth in the industry."
Wind turbine supplier

Consultees also shared their views on the functioning of the market. Developers have responded to the market signal of increasing prices for wind turbines and installation vessels, for example through long-term agreements. Contractors are sending the message that this does not go far enough if the corner is to be turned on capital costs and capacity is to be developed to service Round 3 projects.

Turbine Market – critical mass

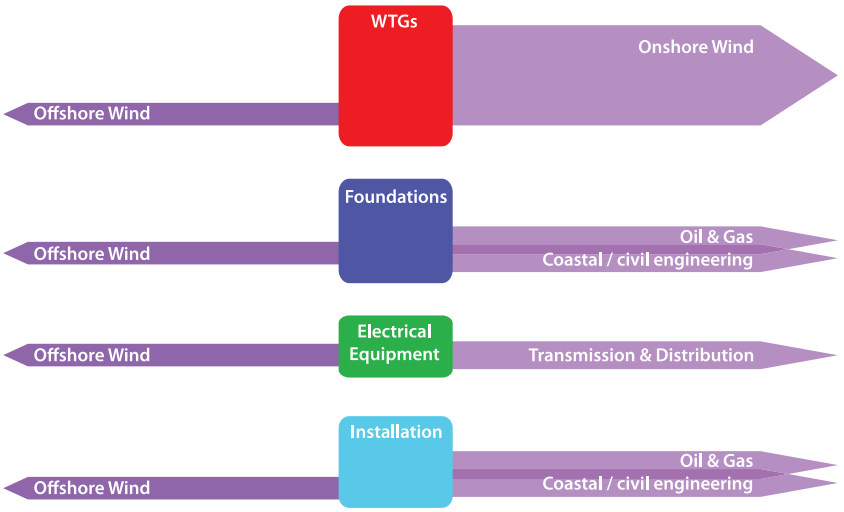
The current global offshore wind installation rate is just under 1 GW per annum, over half in the UK, and growing fast. Discussions with wind turbine suppliers identified that they view offshore sales of around 1 GW per annum as the level which would make them consider the offshore business to be close to mature. At this level on a national basis, suppliers may also start to justify inward investment. As there are three to four turbine suppliers active in the market, that would suggest annual deployment rate of circa 5 GW being required across European offshore markets for maturity in the turbine supply element.

Boosting confidence to extract a decoupled supply chain

The offshore wind supply chain is maturing slowly and the extent to which confidence can develop or be accelerated has a substantial impact on overall capital costs with a five-year horizon, or more importantly, the trajectory which capital costs will be following by 2015. If sufficient confidence is instilled for incumbent and new-entrant suppliers and contractors, a dedicated supply chain could be created for offshore wind for the first time.

"Meeting 2020 targets relies on supply chain companies making huge investment decisions now. That requires a stable industry with a long term future. We welcome recent statements that the Government will take a more strategic approach, especially to grid, and hope to work with them to deliver the UK's targets."
Siemens Transmission and Distribution Ltd

The heavy inter-dependency on other sectors, exemplified by the figure below, continues to be a major capital cost issue. The offshore wind industry has so far ridden on the back of other sectors, and so has been subject to the conditions in those markets.



The analysis presented in this report suggests that measures to accelerate de-coupling of the supply chain have the potential to increase competitive pressures and also to improve the likelihood that industry maturation effects (scale, learning and innovation) will feed through to project capital costs. However, even if effective action is taken by Government and industry now, the benefits are not likely to have a deflationary impact on capital costs until 4-6 years from now due to the substantial lead time required to establish new facilities. The formulation of actions to instigate this shift in the supply base is outside the scope of this study, although it is suggested that a combination of market pull (long-term frame-orders and strong policies) in combination with substantial direct support for new facilities, such as grants and soft-loans will be required. If implemented successfully, these measures have the potential to re-invigorate the industry with real commercial competition driving down contract prices, pushing forward innovation and removing the 'risk-premium' which is currently throttling the sector.

Increasing UK content – a high priority

The very high euro content of offshore wind projects has exposed the industry to massive currency risk and since mid-2007 the precipitous decline in the value of sterling against the euro has had a direct impact on capital costs for UK projects, in the order of 15–20%.

Increasing 'UK produced' content in the value chain has the potential to avoid a repeat of this in the future, whilst generating UK jobs and tax revenues. In addition, the supply chain de-coupling discussed above would be bolstered significantly by such development of domestic supply base, with the potential for the UK plc to become a specialist in offshore wind. This would serve the needs of the domestic market with the potential for substantial future export revenues. This can only happen if developers and government successfully instil the long-term confidence and support required for investment in dedicated supply chain capacity.

"There is a tremendous opportunity coming to the UK manufacturing industry creating thousands of jobs. In some areas industry is further advanced than Government realise. With minimal additional investment we have an opportunity to have sectors of the UK leading in this new industry due to the experience and skills gained from the oil and gas sector. We could create an industry that will last for 20 to 30 years."
Burntisland Fabrications Ltd

Success for UK manufacture relies on the UK providing the base demand for the critical 'mass' mentioned above, and not an erratic component of the wider European demand. However, it is important to recognise that the UK cannot 'go it alone' as contractors require a strong and stable political climate in more than one national market before significant investment decision can be sanctioned. In this respect, a successful UK offshore wind industry is inextricably linked to similar success in other EU markets, despite the additional short-term pressure on the supply chain that this will incur.

Underlying drivers – macro economics and onshore wind

The interactions between the onshore wind market and offshore supply chain against the uncertain macro economic backdrop is found to be central when considering the outlook for offshore wind capital costs. The analysis in this report yields the uncomfortable finding that a prolonged recession and / or the cooling of the global onshore wind market results in a favourable projection of offshore wind capital costs. The UK offshore wind business cannot significantly influence macro economics or indeed the onshore wind market. However, the response of the fragile and contingent offshore wind supply chain to both of these 'environmental' factors can be influenced.

In absence of extreme movements in these factors, capital cost is not expected to alter dramatically over the next 5 years. However, the offshore wind business remains at the mercy of the economic climate, the value of sterling and the pressure put upon it by onshore wind demand. These uncontrollable environmental factors can have just as large an impact on offshore wind capital costs as the measures outlined above.

Delivering Round 3

With a longer timeframe, significant investment decisions need to be made to ensure the capacity exists to deliver Round 3 projects, as well as the capacity planned for other North Sea states. In that context, one perspective is that a steady level of capital costs for the next five years is acceptable, provided it delivers, by 2015, a better-resourced and more efficient industry.

Introduction

In 2007 the BWEA published the report "UK Offshore Wind: Moving Up A Gear" in which future deployment rates were projected for the industry and anticipated future supply chain constraints were identified. The report concluded that the outlook for offshore wind in the UK was generally positive but that specific measures were required in order to ensure that the potential of the industry in contributing substantially towards domestic and EU renewable energy targets would be realised. Specifically, domestic supply chain development, offshore transmission regulation and grid connection availability were identified as areas that required the attention of industry and Government. The high-level picture at the time of publication was that, for well advanced project developments, the additional support afforded through revision of the Renewables Obligation (RO) would yield acceptable project economics, ensuring that the anticipated ramp-up in deployment would become a reality.

Since the publication of Moving Up A Gear, a number of factors have driven capital expenditure (CapEx) for offshore wind projects upwards. Consequently the single biggest barrier to deployment for any offshore wind project approaching deployment currently is once again, project economics. The recent and ongoing dramatic shifts in the macro-economic climate have had and will continue to have a significant impact on the outlook for offshore wind CapEx as the industry moves forwards. Government intervention in the 2009 Budget has provided increased revenue support for projects contracting major works before April 2011 - a measure which is intended to maintain the momentum of the industry in the near-term. Beyond this there remains a question mark over the ability of industry to drive down costs to a economically feasible level.

BWEA has commissioned Garrad Hassan (GH) to undertake a study examining CapEx trends for offshore wind projects to:

1. confirm current CapEx levels for the industry;
2. arrive at estimates of CapEx for those projects likely to contract by March 2011;
3. provide a prognosis for the next five years under various possible scenarios.

Of central importance to this process is a clear understanding of the factors which drive costs and the manner in which these "drivers" are inter-related. In this report, a systematic approach has been adopted to the identification of cost-drivers and associated inter-dependencies to allow the definition of credible future scenarios and CapEx projections. Throughout this process, GH has drawn on in-house industry knowledge, published data and targeted industry consultation to ensure that the most important factors and sensitivities are captured in the findings as well as a broad range of views on the outlook for offshore wind CapEx against an uncertain economic backdrop. Broadly speaking, the overall approach is summarised in Figure 1 below.

The impact on CapEx of unforeseen changes in revenue rates for offshore wind projects, be they shifts in the wholesale electricity market or further revisions to the RO, is specifically excluded from consideration, although such rates are an important driver of CapEx when there are uncompetitive contracting markets.

Section 2 of this report identifies historical cost-trends that have affected offshore wind projects since 2000. Section 3 outlines the key cost-drivers that may be expected to affect costs over a five-year future time frame. Based on industry consultation, Section 4 provides a near-term outlook of costs for projects likely to be contracted before 2012 and specifically those targeting the additional RO support afforded in the 2009 Budget. Section 5 is concerned with projections of offshore wind CapEx to 2015 under various credible macro-economic and supply chain scenarios. Finally, conclusions on the overall outlook for the capital cost of offshore wind projects are presented in Section 6.

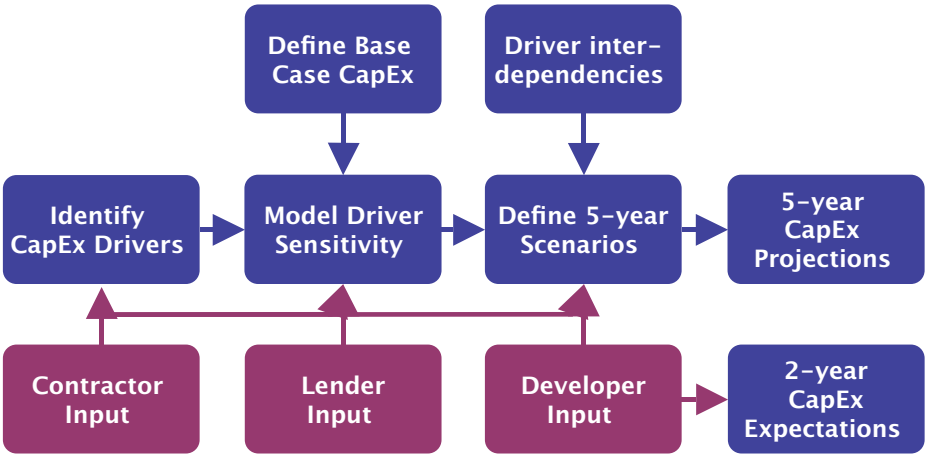
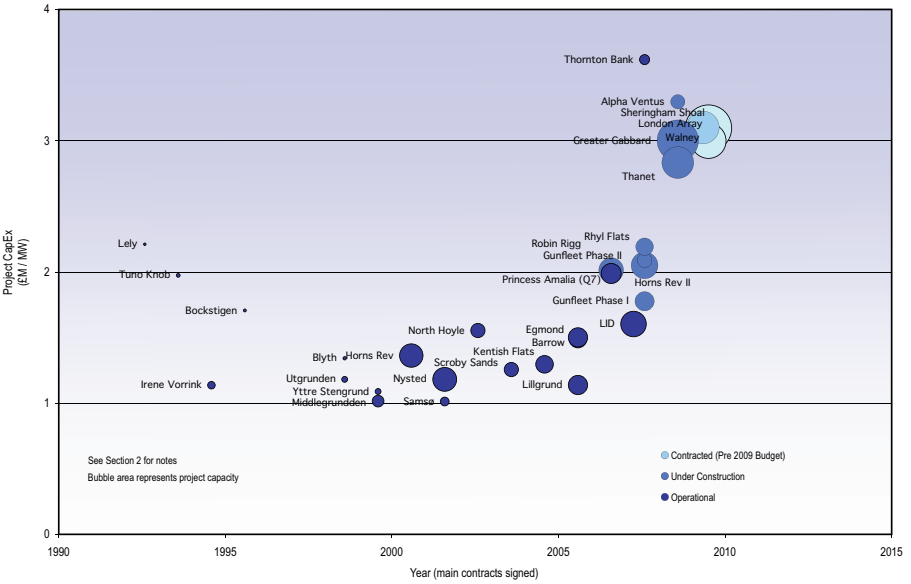


Figure 1: Study approach

Context

Prior to the development of future scenarios for offshore wind CapEx, it is critical that historical trends and sensitivities are well understood. The broad trend since the early days of offshore wind technology in the early 90s is contrary to any expectation of conventional industrial maturation. That is to say, learning or experience curve theory would predict reducing costs with time, through the combined impact of innovation, learning effects and economies of scale. The historical reality has been dramatically different as illustrated in Figure 2, with a CapEx increase of approximately 100% in real terms, in the four-year period from 2005 to 2008.

Figure 2: Historical trend – offshore wind CapEx[1]



The total project CapEx values in Figure 2 are based on published data, adjusted for inflation (2009 prices) and differences in contractual scope (including adding allowances for those projects which have grid connection works provided by a third-party – see footnote). The two projects signing major construction contracts following the announcement of additional short-term support through the RO in the 2009 Budget are discussed further, along with other projects near to contracting, in Section 4. CapEx in this study is taken to include all project-specific transmission assets.

Projects contracted before 2000 were typically supported through national or EC capital subsidy and had a strong R&D focus with significant academic involvement. To that extent, these early deployments, whilst of substantial technical value, have been disregarded for the purposes of the current study which is concerned with cost-trends for commercial projects.

The most important drivers or events which have influenced the CapEx trend since 2000 are discussed below.

1. High early competition and losses (2000 – 2004)

The initial high degree of optimism over the long-term prospects for offshore wind led to fierce competition between contractors for the early demonstration projects. In an attempt to establish a good market position, optimistically low EPC contract prices were offered. Be it due to a deliberate policy of 'loss-leading' or inadvertent cost optimism, it is considered unlikely that the principal contractors turned a profit on these early engagements. Evidence for this is demonstrated through the subsequent insolvency or buy-outs of several key second tier contractors - notable examples including Dutch Sea Cable[2], CNS Renewables[3] and Mayflower Energy[4]. This early negative experience led to the withdrawal of EPC contract offerings by the leading wind turbine suppliers for future projects in 2004, as the full extent of the offshore construction risks were recognised as being outside of core competencies. Despite the passing of certain key risks to project owners, that the transition to multi-contracting landscape has instigated, subsequent market readjustment has actually put upward pressure on prices, as contractors attempt to ensure that the earlier losses are not repeated.

2. The onshore wind boom (2005 – 2008)

The rapid acceleration of onshore wind energy deployment, fuelled by particularly strong growth in North America and Asia as well as sustained expansion in Europe, has placed significant upward pressure on wind turbine prices as demand outstrips supply. Turbine production capacity has, to a large degree, been limited by second and third tier supplier constraints. In particular shortages of key components such as gears, large bearings,

[1] Figure 2 presents a chart of Capital Costs for the majority of offshore wind projects contracted since 1990. The values utilised for the chart are based on published information - typically contractor or developer press releases and / or guidance from the relevant project owner through direct consultation. The values have been adjusted for currency, inflation and scope differences. Currency adjustments (principally between sterling, euro and Danish krone) have been made using historical inter-bank data from oanda.com, referenced from the approximate date of financial close or signing of major construction contracts. Inflation adjustments before 1998 have been based on UK Retail Price Index (excluding all housing) using data obtained from the Office for National Statistics. For 1998 onwards, the average of RPI and euro area inflation (Harmonized Indices of Consumer Prices) has been taken - the latter being obtained through the European Commission Eurostat portal. Adjustment for scope differences has been made in cases where grid connection including offshore substation have been provided by a third-party. In these instances, an increase of 15-25% has been added which based on GH experience is a realistic reflection of the cost of such works. In addition, reductions have been made in cases where Warranty, Operational and Maintenance costs have been included in the published value at a rate of €150k per wind turbine per annum which, again is based on GH experience and is broadly representative of current and historical levels.

transformers, castings, forgings and carbon-fibre have contributed to this trend. Currently, the market for offshore wind turbines is largely coincident with that for onshore projects both in terms of players, products and production facilities, as described further in the following section.

Given the additional risks associated with supplying machines offshore and the high demand for turbines in low-risk onshore markets, manufacturers currently have limited incentive to bid competitively for supply contracts to offshore wind projects. Indeed there is only limited incentive to invest heavily in ramping up dedicated production facilities for what is considered by some as a high-risk marginal market. The plot below in Figure 3, illustrates the point, showing offshore wind peaking in 2003 with a share of the total wind market of 3.4%, by annual capacity added. By 2008, this has reduced to just 1.3%, largely as a result of spectacular growth in onshore wind in north American and Asian markets.

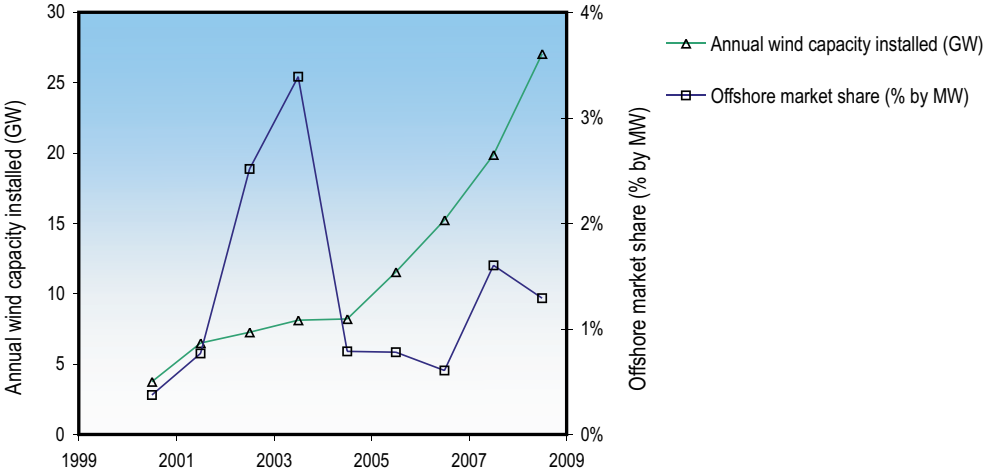


Figure 3: Offshore wind – a fractional market

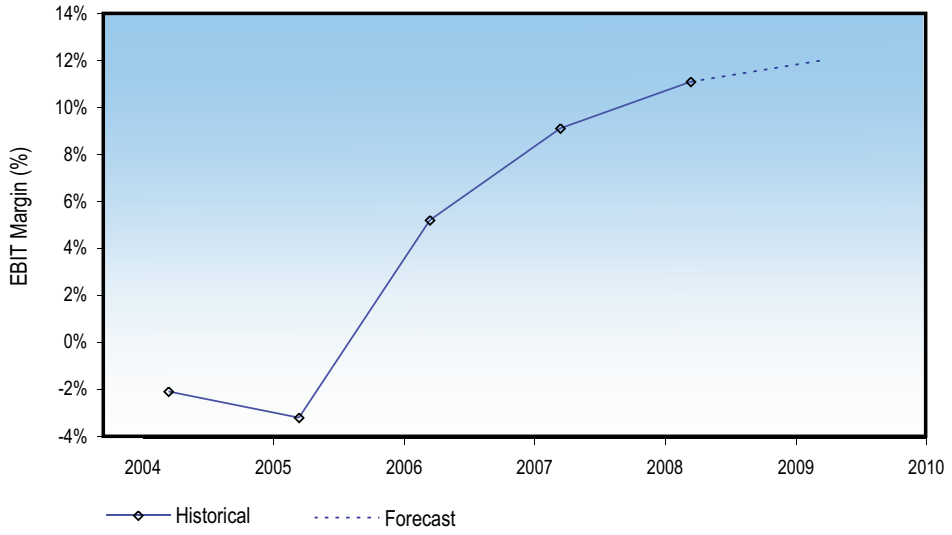


Figure 4: Vestas – move to profitability

3. Turbine suppliers EBIT shift (2006 – 2008)

Super-imposed on the worsening supply-demand imbalance has been a general trend towards greater profitability for the established European-based wind turbine manufacturers. Historically, corporate pricing strategies have focused on expanding (and in reality, defending) market share. As the wind business has matured, the transition towards greater margins is perhaps inevitable, especially in light of the historically low levels of return experienced.

4. Reducing turbine supplier participation (2004 – 2008)

Three key industry events have reduced competitive pressure within the offshore wind turbine supply market. Firstly, the merger of NEG Micon with Vestas in late 2003 which ultimately eliminated the offshore-specific product line of the former, given the obvious overlap with Vestas' own product development programme. Secondly, the absence of GE Wind Energy from the turbine supply market since 2004 has removed the world's second largest supplier of wind turbines from the game. In 2007, the temporary withdrawal from the market of Vestas' principal offering for offshore projects (the V90 model) due to technical difficulties relating to the gearbox[5] reduced supply competition to an all-time low in the period from mid-2007 to mid-2008. The industry was effectively reduced to a single supplier for commercial scale projects wishing to contract during this period (Siemens Wind Power).

5. Vessels and Balance of Plant Crunch (2007 – 2009)

Over the last two years the scarce availability of suitable main installation vessels for the deployment of foundations and erection of wind turbines, has caused significant upward pressure on day rates. Competition for supply chain resource from the O&G sectors has been a factor here as has the changing nature of project demands, with increasing water depths and lift capacities narrowing the field of plant suitable for each project. In addition, key electrical plant, most notably transformers and high voltage subsea

2 Press Release, announcing formation of Dutch Sea Cable-Oceanteam BV, 20 February 2004.

3 "Cns Subsea calls in the administrators" reNews 20 May 2005.

4 "Mayflower installation ship sold for just £12m" Daily Telegraph 22 April 2004.

5 Vestas Wind Systems A/S Company Announcement No. 11 / 2008 "V90-3.0MW offshore wind turbine back on the market again".

cables, have been in short supply. This has primarily impacted on lead times rather than pricing, although inevitably some upward price pressure has fed through from balance of plant suppliers.

6. Raw materials and sterling (2008 – 2009)

Shifts in key commodities markets feed through the supply chain and following some lag will have an impact on CapEx for those elements of the project where the value-content of raw material is substantial. For offshore wind, persistent increases in steel prices since early 2007 through to a sharp peak in mid-2008 has impacted on foundation and wind turbine costs. Changes in copper markets impact the cost of electrical plant including wind turbine sub-components, but overall it is a substantially less important commodity for offshore wind projects (as demonstrated in the following section). More recently, the precipitous decline of sterling against the euro since mid-2008 has had a substantial and immediate impact on prices for UK projects approaching agreement on major construction contracts during this period, with typically ~80% of the project value charged in euro (or Danish krone - the value of which is pegged to the euro).

7. Increased incentives (2007 & 2009)

Arguably, CapEx has also responded to increases in off-take values, for example through the 2007 announcement of enhanced ROC levels for UK offshore projects. Overall, this has been assumed manifest through Points 3 and 5 above.

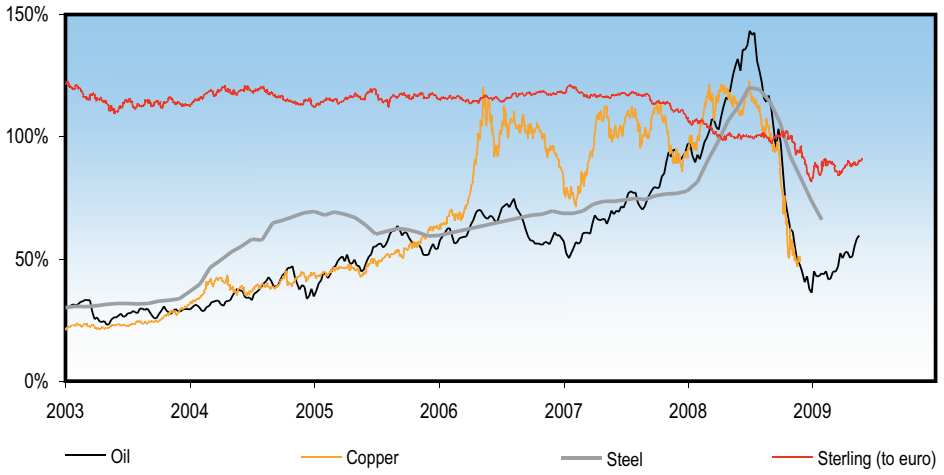


Figure 5: Key Commodities and Sterling

CapEx Drivers

In this section, the underlying Cost-Drivers influencing Offshore Wind CapEx over the next five years are identified and discussed. Analyses have been implemented on the basis of industry evidence and consultation to allow the relative importance of the identified Drivers to be established and to define the most crucial inter-dependencies that exist between them. This has been implemented in order to inform the development of credible future cost scenarios which is presented in Section 5. In this way the study has been implemented as a two phase process - dissection of the problem into constituent *Drivers* before reassembly into credible *Scenarios.*

At this stage, some working definitions are defined:

Driver:
Any factor affecting the capital cost of an offshore wind project.

Scenario:
A future projection of CapEx based on changes to one or more Drivers.

Figure 6 depicts a 'mind-map' of what are considered to be the most significant Drivers both historically and moving forward. It is noted that consideration of Drivers associated with project revenue or operational costs for offshore wind in the UK are outside of the scope of the current study.

As can be seen in Figure 6, Drivers having a direct impact on CapEx have been identified in each of three major categories; Supply Chain, Commodities and Technical Development. The inter-dependencies between the identified Drivers are not shown in Figure 6 but play a key role when considering the outlook for CapEx. Macro economic effects influence most if not all of these Drivers to a varying extent. The most important

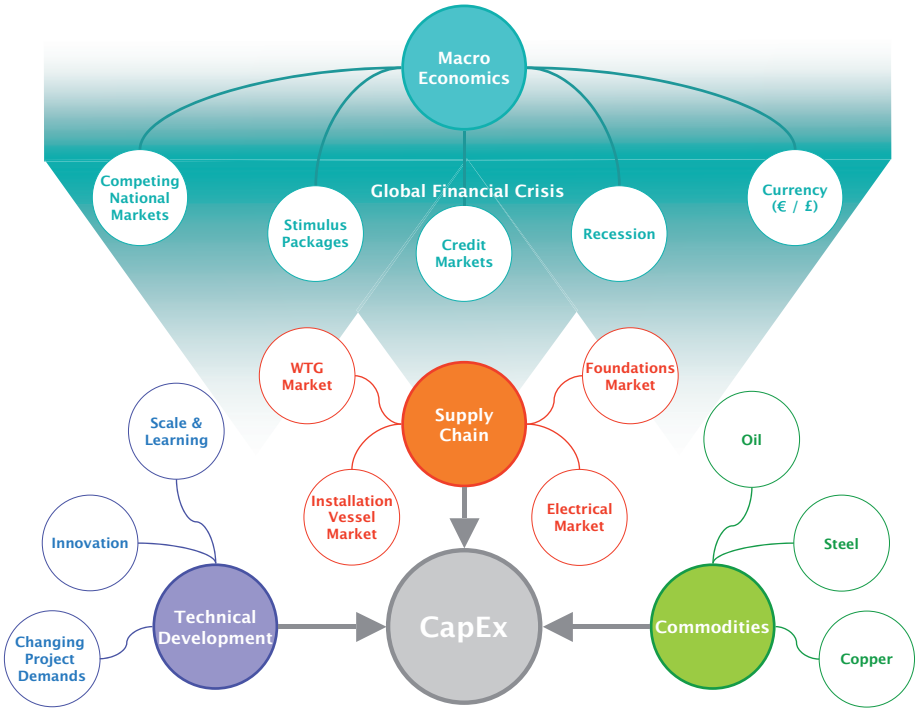


Figure 6: CapEx Drivers – Mind Map

inter-dependencies are catalogued and discussed in this section before application in the five year Scenario projections described in Section 5.
A 'base case' CapEx, model has been derived on the basis of GH commercial and technical experience in the industry - assumed to broadly represent the cost structure of a typical Round 2 UK offshore wind project.

Whilst project-specific factors will inevitably mean that the profile above will not fully reflect individual cases, the broad contractual and value-content breakdown assumed is considered to be a reasonably representative, simplified base case.

In order to assess the relative importance of each Driver, a characterisation of 'sensitivity' has been formulated. This captures the combined impact of both the value-content at risk to changes in the Driver and the inherent likelihood of a systematic shift in that Driver over a five- year period – in other words, volatility.

The Value-at-Risk (VaR) for each of the Drivers has been estimated through the definition of a high level value content breakdown for a typical offshore project, based on industry experience to date and the expected technical demands of projects being contracted in the next five years.

The inherent Volatility for each Driver has been characterised through the definition of five-year high and low cases based on historical evidence, industry consultation and third party published outlooks.

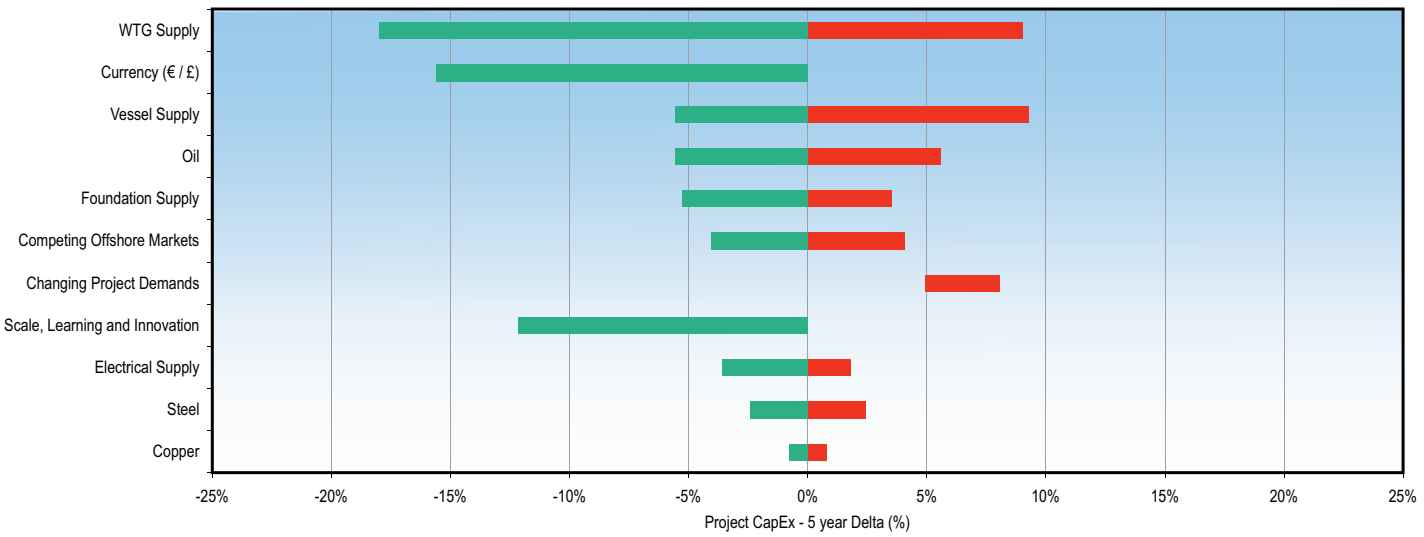
The magnitude of VaR, Volatility and the resultant Sensitivity have been categorised into four broad levels of total project CapEx to aid the assessment of each Driver, as outlined on the next page.

The overall results of the sensitivity analysis are presented in Figure 7 on the next page, which ranks the identified Drivers in approximate order of importance from most to least.

Contract / Category	Total Share	Value Content			
		Install	Steel	Copper	Euro
WTG Supply & Install	50%	10%	10%	2%	95%
Foundation Supply & Install	25%	30%	25%	0%	80%
Electrical Supply & Install	15%	40%	5%	10%	70%
Project Management	5%	0%	0%	0%	0%
Miscellaneous	5%	0%	0%	0%	0%
Total (value-weighted)	**100%**	**19%**	**12%**	**3%**	**78%**

Magnitude	VaR	Volatility	Sensitivity
Low	< 10%	< 10%	< 5%
Moderate	10–40%	10–25%	5–12.5%
High	40–60%	25–50%	12.5–20%
Very High	> 60%	> 50%	> 20%

Figure 7: Driver Sensitivity Analysis



Certain Drivers are considered to have asymmetric sensitivity profiles and this is reflected in the analysis. The overall range between the high and low cases is considered to be of most importance.

There follows a discussion of each Driver in which background evidence is presented for these sensitivity results and the key inter-Driver relationships are identified.

Global financial crisis

In light of the global financial crisis, macro-economic factors will have an increasingly significant effect on the development of the offshore wind industry and in particular on capital costs. In this section, the impact of the crisis has been considered as three strongly related Drivers:

- the ongoing credit freeze;
- the subsequent impact of this on the global economy;
- the response of governments in the form of stimulus measures.

Credit markets – freeze or thaw ?

The financial crisis that started in 2008 with the collapse of a number of large banks and investment corporations in the USA led to a "domino effect" that rapidly spread through global credit markets. The speed and extent of the crisis were related to the highly interconnected nature of the financial system, and the situation has subsequently developed into the largest global financial crisis since the 1930s. The consequence of this severe crisis is the instability of the whole financial sector and a loss of confidence that the capacity is available to "fuel" the economy as liquidity dries up. The danger of a vicious circle developing is well documented, whereby shrinking economies exert further pressure on financial markets in which lenders are embroiled leading to a secondary squeeze on credit.
Consequently, the so called 'credit crunch' has impacted the whole economy and forced governments of all major countries to react. Since the height of the crisis in mid-2008 where even inter-bank lending was limited and expensive, there have been some early indications that credit markets have eased somewhat. It is understood that corporate debt for the larger utilities and other multi-nationals is by and large available. Margins over bank base rates have increased although reductions in base rates have has a compensating effect. Internal investment criteria have clearly tightened, reducing the range of parties with whom utilities are willing to contract. Corporate debt also appears to be available for major supply chain players - the recent €600 million finance package for REpower Systems being evidence of this. However, nonrecourse project finance remains to a great extent off-limits, not only to renewable energy developments but also to broader construction and infrastructure projects within the energy sector and beyond. The IEA predicts that energy investment will drop sharply in 2009, with many major projects either cancelled or delayed by at least 18 months, primarily because of the continued hiatus in nonrecourse lending.

According to the United Nations Environment Program (UNEP) and the Renewable Energy Global Policy Network (REN 21) renewable energy initially weathered the financial crisis better than other sectors but certainly did not escape the general flight of lending due to the credit crunch. According to REN 21, investment in clean energy decreased in the second half of 2008 by 23% from the same period in 2007. UNEP contends that a commonly held view is that a proportion of 2008/09 projects will be funded with money set aside before the crisis, and because of this the real impact of the credit freeze on the renewable energy sector will not be fully understood until mid-2009. The consultation work carried out as part of this study on behalf of the BWEA confirmed this. The IEA estimates that in 2009 total investment in renewable energy could drop by 38% with government support provided through targeted financial assistance offsetting a small part of that decline. The recovery of credit markets depends on whether confidence in the financial institutions can be restored through measures taken by the banks, by individual governments together with the banks, but also the international community as a whole (G8 and G20). Even before the credit crisis, lender appetite for offshore wind projects has been historically weak due to the higher risk-profile involved, with the vast majority of operational assets being balance-sheet funded by major European utilities. Whilst there are some signs, even in the current climate, of a limited role for pre-construction project finance for the most advanced offshore wind developments, balance-sheet funding for the UK at least is expected to continue to dominate within the five-year reference period of the current study. This is very much a 'business as usual' outlook and whilst utility balance-sheets are finite, sufficient funds for construction are likely to be made available provided project economics 'stack-up' and other investment criteria are met. Many of the utility-developers involved in offshore wind now have aggressive internal targets and budgets to pursue that sector.

Should there be a significant easing of credit markets in the next 18 months with project finance back on the table for the wind industry, CapEx for UK offshore wind projects is likely to increase because of the additional supply chain demands that this would instigate. Such additional demands are likely to come from a booming onshore wind sector in the USA and certain European markets. In addition, competing national markets for *offshore wind* (most notably, Germany) are likely to exert increased demand pressure under a credit-thaw scenario. This is because preconstruction finance has to date been a barrier to deployment since many of the most advanced projects outside of the UK are owned by independents, who lack the financial muscle to countenance balance-sheet financing.

Global Recession – sink or swim ?

The slowdown in economic activity since the end of 2008 stemming from the credit crisis earlier in that year has resulted in the current global recession. In major western economies, this was preceded by a decade of strong economic growth, with particularly dynamic development of large emerging

markets in Asia, but also in other parts of the world (for example Brazil, Mexico, South Africa). Such development led to increased production, trade and consumption of goods and services.

According to the OECD, annual growth of GDP within the group of member countries averaged 2.6% between 1994 and 2007. The Chinese economy has been growing since the early 80s, many of these years at double-digit rates. Over the last decade China clearly has been a strong driver of the world economy, supplying many regions of the world (particularly USA and the EU) with consumer goods.

This period of sustained growth came to a halt and was then reversed by Q1 2009 when according to the WTO, exports sharply dropped from Q4 2008. World trade currently has fallen to 2006/2007 levels and it is not clear how far it will drop by the end of 2009. This constitutes the strongest and fastest economic decline in 80 years, affecting almost every country in the world.

The IMF in its World Economic Outlook 2009, presents the view that the current global recession is likely to be severe and long lasting due to two main factors. Firstly, it is associated with a deep financial crisis – historically, recessions that have a financial origin are longer and more severe than those fuelled by other shocks. Secondly, and as a result of Globalisation, it appears to be a highly synchronised phenomenon across all major economies. Historically, recessions that are limited to specific regions do not last as long, as trade plays a less important role. In terms of recovery, the IMF promotes the use of aggressive fiscal stimulus as the most effective measure to support demand in the short term, referring to historic evidence that demonstrates that monetary policy plays an important role in the ending recessions and strengthening recovery, particularly when related to a financial shock.

The OECD is somewhat optimistic about the possible impact of the stimulus packages during the first two years. In its "Road to Recovery – Update on the OECD's Strategic Response to the Financial and Economic Crisis" it is mentioned though that only in a few countries are support measures likely to contribute more than 1% to the level of GDP by 2010. This view is broadly supported by the EIA's findings in their 2009 International Energy Outlook. In the economic projections presented by the UK Treasury an even more positive view is put forward (for the UK at least) where GDP growth is forecast to turn positive in late 2009, gathering momentum through 2010.

The impact of rapid recovery or prolonged recession scenarios for offshore wind CapEx in the UK is likely to be most prevalent to the extent that supply chain pressures are affected, on both supply and demand sides of the equation.

Stimulus Measures – cavalry arriving too late ?

Governments of all major economies have taken action in the form of fiscal counter-measures (economic stimulus packages) since Q4 2008 in an attempt to inject capital into the real economy and to stave off the worst impacts of the ongoing global recession. The most significant of these packages by volume being those undergoing implementation in the USA, China and the EU, each consisting of a mixture of tax relief and public spending.

The stimulus packages address the economy as a whole although most governments have allocated funds specifically dedicated for investment in low carbon technologies. According to HSBC, around 16% of the global 'stimulus pot' of $2.8 trillion is dedicated to green technologies, constituting $438 billion with around 8% of this directed at renewables ($38 billion).

The US package is the largest in absolute terms for renewables (pending clarification of the exact content of the recently reported Chinese package on 'new energy'), with the European countries and South Korea accounting for most of the rest.

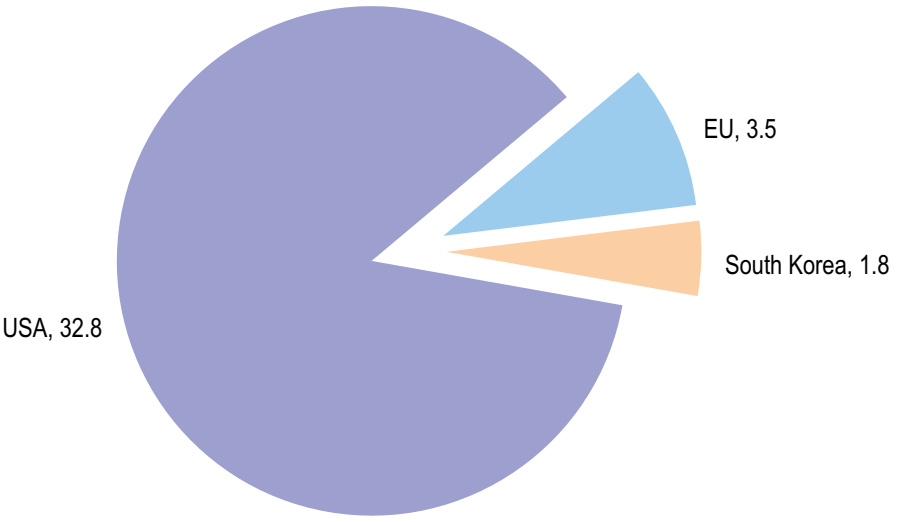


Figure 8: Major stimulus funds committed to investment in renewables (excl. China)

China has dedicated 38% of its $584 billion package to support green technologies, although it is unclear at this point how this will be distributed to the different sectors. However, it can be assumed that due to the impressive scale of the Chinese package, it will have a significant impact on the energy sector and specifically renewables. However, at the time of writing there are early indications that the Chinese authorities are about to announce a major additional package of $439 billion for 'new energy' with a substantial proportion likely to be committed to wind energy in support of a raised national target of 15% electricity generation from renewables by 2020 . The timing of deployment for this second wave of stimulus is unclear but it appears to be aimed at instigating new economic growth in a three year time frame following the stabilising effect of the first-tranche. The overall volume of the fund is likely to send shock-waves through the wind industry, with strong signs that this market alongside the US will dominate growth in both project deployment and supply chain development for the foreseeable future.

Due to the strong political support voiced by the new US administration and the ongoing turnaround in climate policy, the measures announced by the US government are expected to give the strongest signal to the renewable energy industry, alongside that of China, in the concerto of national responses to the financial and economic crisis. The American Recovery and Reinvestment Act 2009 (ARRA), in conjunction with other stimulus measures, provides $787 billion to stimulate the economy, of which over $30 billion is reserved specifically for renewable energies. HSBC anticipates that 70% of this investment is expected to be spent over the next 18 months with the remainder spent over the following decade. Other financial measures including $6 billion for loan guarantees[7] are likely to reinvigorate lending to renewable energy projects which have suffered significantly since mid-2008 at the onset of the credit crisis.

The IEA estimates that about 10% of the $350 billion in funds committed by EU member states are dedicated to clean energy. There has been some surprise at the limited sums allocated to renewable energy – only 6% of the total EU climate related stimulus package according to HSBC. The EU has allocated €565m for offshore wind and these funds have already been allocated to specific projects with a strong R&D or demonstration focus.

It is difficult to calculate the exact overall size of the stimulus packages as they are developed through a number of financial incentives, however, it is clear that they are insufficient to replace the private finance which would have been invested if the crisis had not erupted. New Energy Finance estimates a total global drop in clean energy investment of 25–40 percent, with only $20–30 billion from stimulus packages being spent during 2009. So not only is the volume of public investment decisive but the speed of stimulus package implementation is also crucial. If effectively implemented, the planned financial counter-measures can provide a strong political signal to industry of the longer-term commitment and security for low carbon and renewables industries, which is sorely needed in the current volatile financial and energy context.

In fact, the swift and successful roll-out of the major stimulus packages is likely to *adversely* affect the offshore wind industry in the UK, with supply chain bottlenecks forming as the back-log of delayed infrastructure and onshore wind projects is cleared during 2011–2012. The likely scale of support for onshore wind deployment in the States is of greatest concern when considering the impact of previous US boom years on the global supply imbalance for, in particular, wind turbines.

On the other hand, with the more modest allocation of stimulus funds to renewables industries in Europe, wind energy and other related supply chains may have sufficient capacity to soak-up the additional demands of stimulus spending and therefore upward pressure on pricing is not an inevitability. There is also potential for slow deployment of stimulus spend, diluting the impact on the supply chain and commodity markets. Both possibilities are explored further in the future cost trend scenarios presented in Section 5.

6 "New energy seen new growth engine" China Daily 3rd June 2009.

7 "The winds of change" KPMG May 2009.

Supply chain markets

The dynamics of key supply chain sectors are discussed briefly below with reference to the overall importance (or sensitivity) of each Driver in determining future changes to offshore wind CapEx. It is noted that a detailed supply chain analysis is outside of the scope of the current study and only the key trends and interdependencies are included.

Driver	Sensitivity (5-year)	Interdependencies
Wind Turbine Supply For several years, demand for wind turbines has significantly outstripped supply causing consistent upward pressure on commercial prices for the wind energy industry generally. In addition, there has been a general drive towards increased profitability for the wind turbine suppliers who have historically suffered low margins.	VaR: High [45%] Volatility: High [+20% / -40%] Overall: Very High [+9% / -19%]	Driver impacted by: • Currency [V. High] • Project Demands [High] • Credit Markets [High] • Recession [High] • Learning / Scale [Moderate] • Steel [Moderate] • Vessel Market [Low] • Innovation [Low]

Whilst it is considered likely that the latter of these two factors has already been largely accounted for in recent turbine pricing shifts, there is no sign that the former issue (demand>>supply) will improve significantly in the near-term, even in the face of the worsening conditions for the pre-construction financing of projects (onshore and offshore).

Offshore Wind currently represents a small segment of the broader wind turbine supply market. This is one of the reasons that there currently exist few offshore-specific wind turbine products and even fewer dedicated offshore wind turbine manufacturers.

For products that can be sold with only minor differences in the detail of design and manufacture, both onshore and offshore, there has been evidence of a manufacturer preference for sales to onshore projects which have lower associated liability risks. When offered to offshore projects, this elevated level of risk is reflected in the supply unit price, even if the scope of supply excludes offshore installation activity, noting that the main offshore risk which almost always resides with the turbine supplier is the defects and availability warranties. There are also higher barriers to entry in offshore than in onshore wind, including requirements for contractors to be both technically and financially strong, with suitable, proven products.

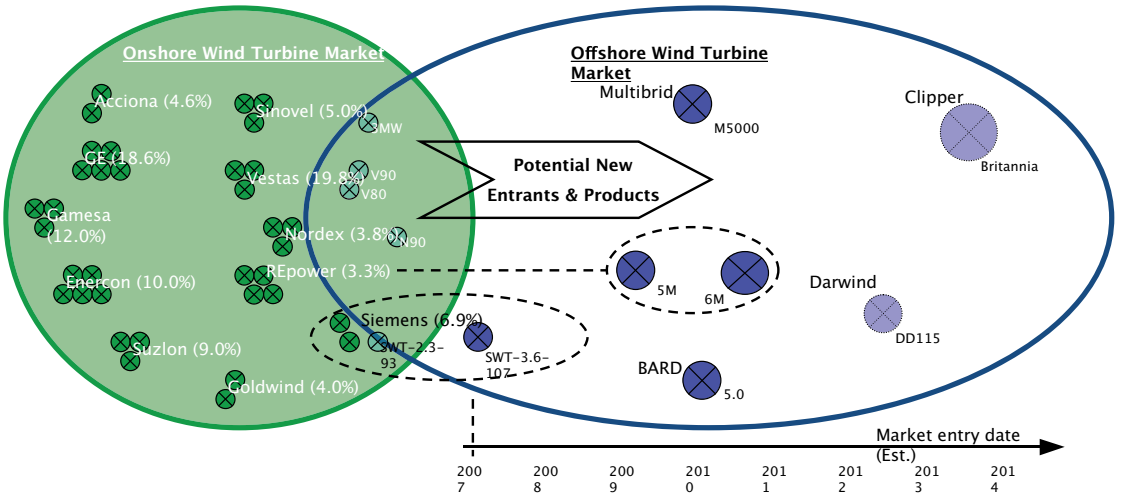


Figure 9: Onshore-Offshore WTG market overlap and bifurcation

- Circles represent product offerings
- Bracketed percentages represent global market share in 2008 (Source: BTM Consult)
- Top 10 global suppliers (by market share) included only for onshore wind supply market, plus REpower

The general lack of wind turbine manufacturers who are prepared to develop and/or offer products to be deployed offshore has the general effect of reducing the options open to owners – reducing competition and adding to the upward pressure on prices.

Figure 9 illustrates the historical and ongoing overlap between onshore and offshore wind turbine supply markets when considering both players and products. Of the 1.5GW of offshore wind in operation at the time of writing, 86% of turbine units are primarily or wholly onshore specific products. This supply coupling is also evidenced in Figure 10, which shows the strong correlation between capacity weighted average CapEx for offshore wind projects and US onshore wind deployment in the period 2005 to 2009.

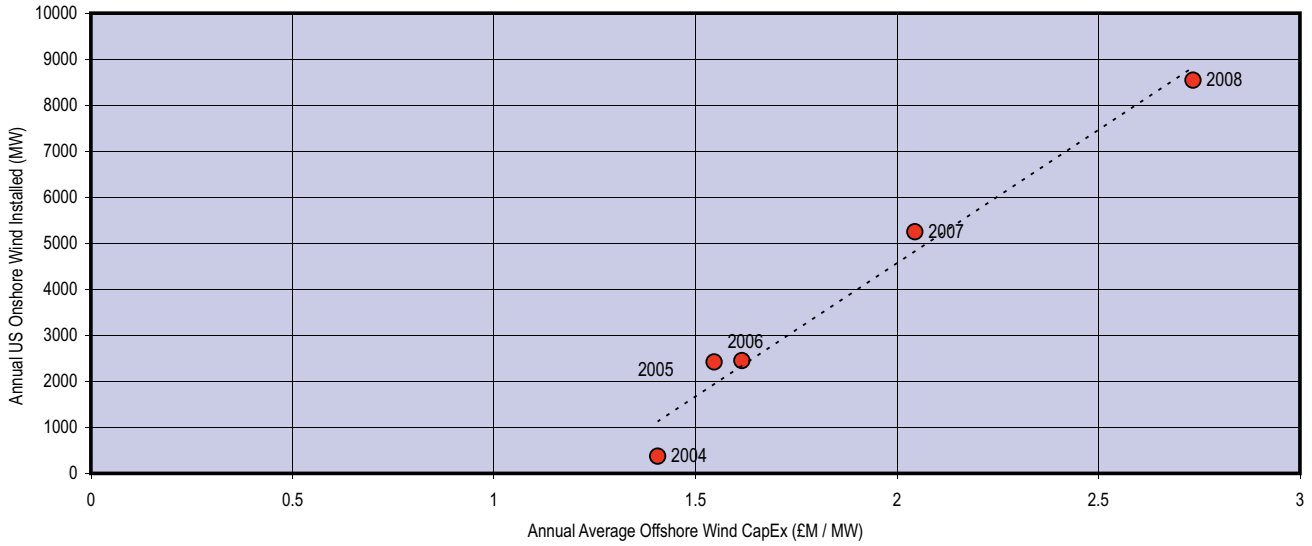


Figure 10: US entanglement

Whilst the old adage "correlation does not imply causation" is relevant here, the trend above is certainly no co-incidence and is indicative of the entanglement at the heart of the turbine supply chain imbalance for offshore projects.

Figure 9 also illustrates the anticipated future trend of a bifurcation or decoupling of the supply market, with offshore specific products and eventually, suppliers becoming increasingly prevalent. Such a trend should mitigate the historical 'resource diversion' suffered by the offshore wind industry, particularly as suppliers commit to significant investment in bespoke production facilities. There is some evidence for this with all three suppliers with near-market products in the 5–6 MW range commissioning substantial production facilities in the last two years. Whilst production is yet to ramp-up to serial levels at these sites (all in northern Germany), the development signals that this critical part of the supply chain now has the confidence in long-term sustainable markets.

However, the bifurcation discussed above, which is considered to be an important future trend, will not entirely mitigate the broader impacts of continued high levels of demand from the global onshore wind business, since second and third tier sub-suppliers are likely to remain largely common to both onshore and offshore products and players. Recent announcements have indicated a scaling-back of new production capacity from previous plans for certain key sub-suppliers which on the surface would suggest a further tightening of supply. In reality it is considered that this development is in anticipation of cooling demand from onshore wind against the backdrop of the global financial crisis and in this respect may not impact the offshore market directly.

The asymmetric assessment of Volatility [+20% / -40%] is a reflection of a general expectation from industry that the upward price trend is expected to ease in the next few years.

Driver	Sensitivity (5-year)	Interdependencies
Foundation Supply Market To date foundations for offshore wind projects have been dominated by monopile solutions. Whilst there are currently only 2-3 established suppliers of monopiles of the diameter required, active in the offshore wind market, the general industry consensus is the levels of capacity dedicated to offshore wind is currently of the order 1 GW with reasonable potential for expansion or redeployment of production resource at existing facilities.	VaR: Moderate [18%] Volatility: V. High [+20% / -30%] Overall: Moderate [+4% / -5%]	Driver impacted by: • Currency [V. High] • Steel [V. High] • Project Demands [High] • Recession [High] • Learning / Scale [High] • WTG Market [High] • Innovation [Moderate] • Vessel Market [Low]

As projects located in deeper water (beyond 20-25m) approach deployment, monopiles start to become less economically attractive, especially when larger wind turbines are under consideration. Multi-member structures (such as jackets and tri-pods) become important here and in some instances concrete based structures are under consideration. For these alternative concepts, the supply chain is at an early stage although there is evidence to suggest that contractors with substantial capacity and experience from other industries are targeting the offshore wind market as demand ramps-up.

For UK offshore projects to be contracted within the 5-year timeframe of the current study, it is considered likely that monopiles will continue to dominate but with increasing penetration from jacket structures likely for projects contracted in 2013-2015. In both instances the cost base of supply is massively exposed to the vagaries of commodity and currency markets. The latter may be mitigated to a reasonable extent for jackets (and to a more limited degree for monopiles) through the further development of the supply chain in the UK. Commodity risk may be reduced through the adoption of concrete foundation solutions, although substantial investment in UK port facilities may be required to facilitate this.

The overall sensitivity of the foundation supply market as a CapEx Driver is considered to be low, which reflects the historical and anticipated future levels of healthy competition and production capacity in this area.

Driver	Sensitivity (5-year)	Interdependencies
Electrical Equipment Supply Market Transformers and subsea cables are the principal electrical items that have been in short supply for the offshore wind industry in the recent past and this trend is anticipated to continue in the near-term. For these elements and the other electrical components required for collection, transmission and grid connection, the offshore industry is drawing on a much larger supply base, principally serving the utilities and network operators.	VaR: Low [9%] Volatility: V. high [+20% / -40%] Overall: Moderate [+2% / -4%]	Driver impacted by: • Currency [V. High] • Project Demands [High] • Recession [High] • Stimulus Packages [High] • Innovation [Moderate] • Learning / Scale [Low • WTG Market [Low]

Whilst the limited supply of these components has significantly extended lead times, historical shifts in pricing have been less dramatic which is largely the result of a mature and broader supply chain being in place. Future deployment plans for offshore wind will make this sector the dominant market for subsea high voltage cable which will alter this situation.

Driver	Sensitivity (5-year)	Interdependencies
Installation Vessel Market A number of different classes of vessel are required to construct an offshore wind project but the majority of the costs are associated with the lease of the main installation vessel for foundation deployment and turbine erection. Historically, the market for suitable vessels for such operations has been highly volatile for a number of reasons relating to the supply-demand balance.	VaR: Moderate [19%] Volatility: Very High [+50% / -30%] Overall: High [+9% / -6%]	Driver impacted by: • Project Demands [V. High] • Oil [V. High] • Currency [High] • Recession [High] • Innovation [High] • WTG Market [High] • Foundation Market [High] • Learning / Scale [Moderate]

Prior to 2003, early offshore wind deployments were reliant on vessels from other industries with varying degrees of conversion and refitting required. In the period 2003–2005, the first two main installation vessels purpose built for the offshore wind market ("Resolution" and "Jumping Jack" - later renamed, "Sea Jack") came into full operation just at a time when project demand was waning. This ultimately led to financial difficulties for the vessel owners during the lean period and to the sale of the major assets and associated equipment, in both cases (twice in one instance). The surge in project demand from 2007 onwards has led to substantial upward pressure on day-rates for these and other suitable options which have been converted for use in the wind industry since. This is evidenced by the use of expensive floating shearleg vessels for monopile installation operations for some projects in the absence of suitable, less expensive alternatives.

This trend has continued for the last year culminating in a 'vessel crunch' for projects deploying in the 2009 and 2010 build seasons. It is estimated that in 2009 there will be 5-6 main installation vessels specifically targeted for use in the offshore wind sector be they new-builds or conversions, but that the degree of construction activity planned demands up to 8 such vessel when factoring in demand from the repair market (see Figure 11). The additional capacity is being found (albeit at a price-premium) from other industries - principally O&G and coastal engineering, which is only possible due to the current lull in construction activity in these sectors.

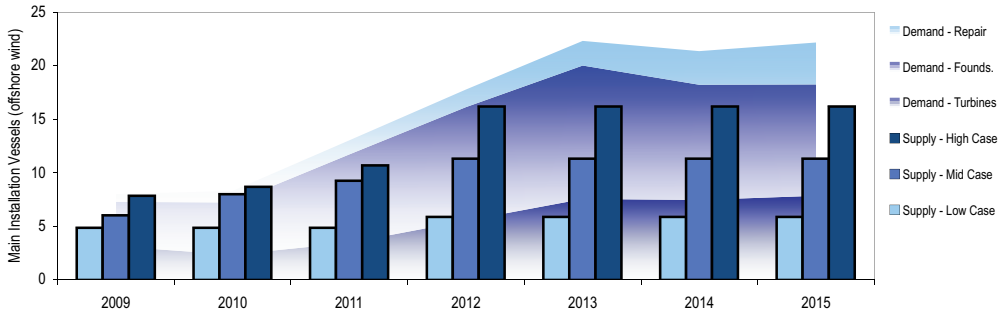


Figure 11: Projected deterioration of supply-demand imbalance for vessels

Looking forward to 2015, it currently appears that the short-fall in vessel supply is likely to worsen unless significant additional capacity is added, as illustrated in Figure 11, above. The supply-demand imbalance outlined above is exacerbated by project specific requirements (mainly water depth, turbine technology and foundation design) which has the impact of narrowing the field substantially for *individual* projects - hence reducing competition and placing further upward pressure on pricing.

Whilst there are many bespoke vessels targeting the offshore wind sector on the drawing board, investment decisions on risky ventures such as offshore construction plant are likely to be delayed in the current financial climate (as in 'Supply - Low Case' in Figure 11). On the other hand, recently the supply chain has demonstrated a greater degree of responsiveness as confidence increases that a viable long-term business is up for grabs (as in 'Supply - High Case' in Figure 11). Currently, nine additional main installation vessels are under construction or on order and whilst there is significant potential for cancellation or at least delay, the current trend proves that contractor appetite is reasonably strong.

The influence of the offshore O&G sector upon vessel availability and costs is dealt with as a separate Driver (Section 3.2) being strongly linked to trends in global oil prices.

Commodities

Movements in certain key global commodity markets are clearly of relevance for offshore wind project CapEx. For the purposes of the current study, the principal commodities of relevance are considered to be steel, copper and oil. Steel and copper have a reasonably direct impact as raw materials drawn from a global market are the basis of a significant proportion of the supply chain. In the case of oil, whilst oil derivatives clearly form part of the raw material utilised during fabrication throughout the supply chain, the single biggest impact of shifts in oil markets is the secondary impact on the marine contracting market and it is in this secondary sense which oil has been considered, as outlined below.

Perhaps the most significant other 'commodity' that will some level of direct or indirect influence on offshore wind CapEx is labour. Whilst the total labour-content of the value chain, in particular for wind turbines is relatively high, significant recent and ongoing upward pricing shifts have predominantly affected project-delivery content - where there is acute skills shortage. The remaining content comprises skilled and semi-skilled industrial labour and in a broader recessionary climate, it is assumed that such content is unlikely to be subject to substantial upward shifts and there remains a strong possibility of downward cost pressure for such content.

Driver	Sensitivity (5-year)	Interdependencies
Steel Much has been made of the impact of soaring steel prices throughout 2008 on the overall cost of offshore wind projects. Whilst the value of steel is certainly the most influential commodity when considered as raw material content of the project and this value content is certainly subject to global market shifts, its overall importance has often been misrepresented.	VaR: Moderate [12%] Volatility: Moderate [+20% / -20%] Overall: Low [+2.5% / -2.5%]	Driver impacted by: • Currency [V. High] • Recession [High] • Stimulus Packages [High] • Foundations Market [Low]

As presented in Section 3 above, the overall value-content for a typical offshore wind project which is subject to variations in wholesale steel prices is estimated to be approximately 12%. The volatility of global spot markets for steel is in general subject to some degree of lagging when considering the plate material required for fabrication of wind turbine towers and foundations, since materials are purchased by the supply chain well in advance of fabrication and assembly. In addition to the 'delayed reaction' effect, such lagging is generally also anticipated to smooth-out the greatest fluctuations of the commodity market. Figure 12 presents historical and project future trends for steel.

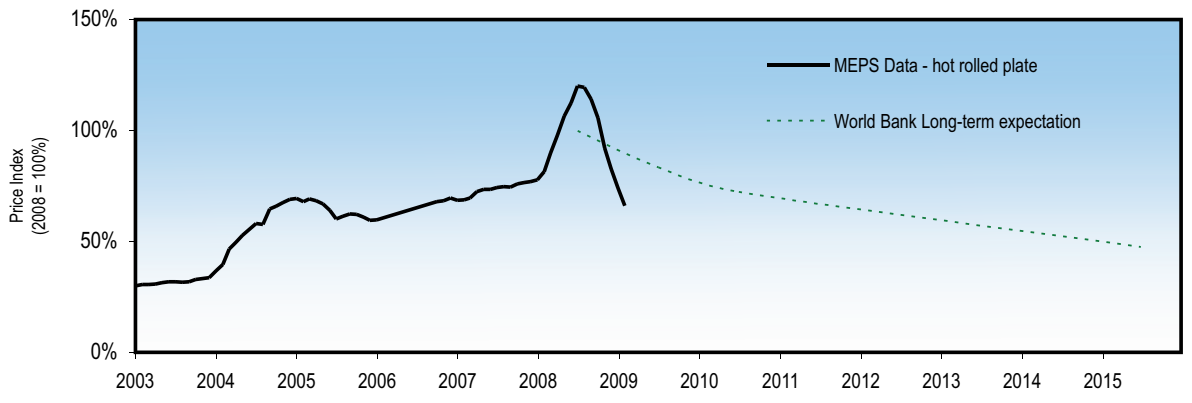


Figure 12: Steel – symmetric about 2008 peak ?

The World Bank projection above reflects the overall long-term expectation to 2015 with the general downward trend largely a reflection of the substantial reduction in demand throughout the global recession. A positive economic recovery scenario would suggest stabilisation or indeed reversal of this trend as global demand reboots, especially as a result of significant spending on infrastructure through stimulus measures.

Added to these global considerations are sector-specific factors and in particular issues relating to the steel grade required by industry standards for deployment of foundations which has limited the number of potential second- or third-tier suppliers of plate material, thus reducing competition. As with several other Drivers examined in this study, without improved levels of competition within the offshore wind supply chain, the potential benefit of current and future reductions in the wholesale price of steel is unlikely to feed through to project CapEx.

Driver	Sensitivity (5-year)	Interdependencies
Copper Also considered by some to have significant impact on the cost of offshore wind projects is copper as a commodity. Copper is present in considerable quantities in electrical cables and other components such as transformers. However, the raw material value-content of such components is surprisingly small, with the majority of costs incurred during the manufacturing process.	VaR: Low [3%] Volatility: High [+30% / -30%] Overall: Low [+0.8% / -0.8%]	Driver impacted by: • Currency [V. High] • Recession [High] • Stimulus Packages [High]

As illustrated in Figure 13, historical data demonstrates this high degree of volatility inherent in the copper market. As with steel, the World Bank expectation to 2015 is for a gradual downward decline.

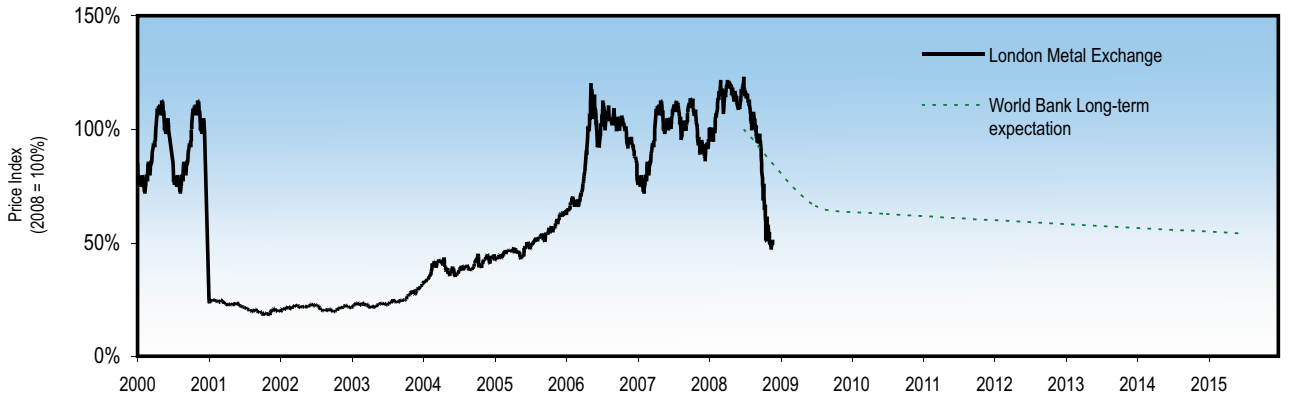


Figure 13: Copper – historically volatile

As demonstrated by the calculation of driver sensitivity for the current study, fluctuations in the copper market can be characterised as something of a 'red herring' in the context of offshore wind CapEx.

Driver	Sensitivity (5-year)	Interdependencies
Oil (secondary impact thereof) Oil has been considered in the current study to the extent that its market price affects the level of offshore marine exploration and construction activity, which has the potential to divert scarce vessel resources away from offshore wind. The flip side being the potential for the widening of the vessel supply market for offshore wind in a low oil price scenario - increasing competition and driving down costs.	VaR: Moderate [19%] Volatility: High [+30% / -30%] Overall: Moderate-High [+6% / -6%]	Driver impacted by: • Currency [V. High] • Recession [High] • Stimulus Packages [High] • Credit Markets [Moderate]

Figure 14 presents historical spot market data for oil normalised to the average for 2008 along side World Bank and Energy Information Administration (EIA) projections to 2015.

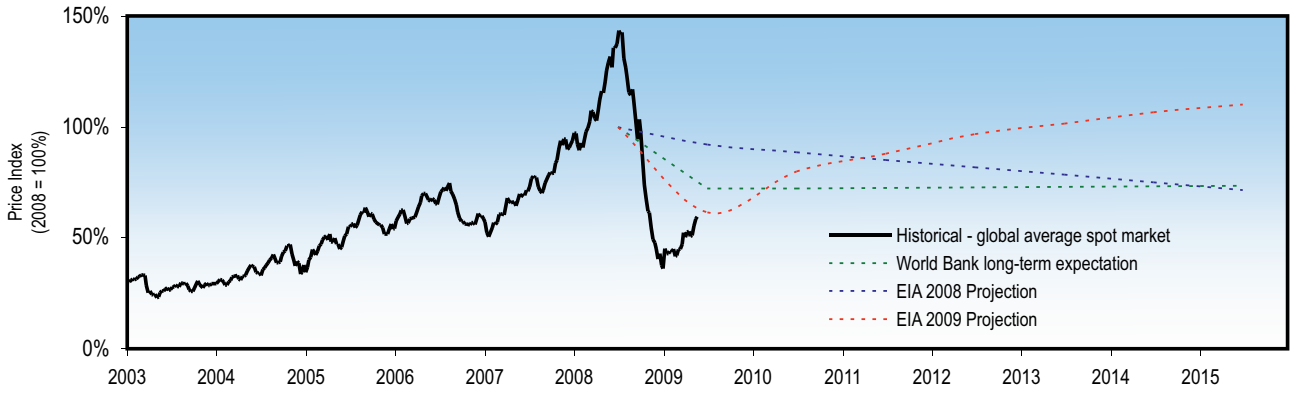


Figure 14: Diverging opinions on crude

Since peaking in July 2008 at just under $150 / barrel, oil prices have collapsed, with the beginnings of a recovery towards historical levels evident in Q2 2009. The World Bank and 2008 EIA projections show reasonable overall agreement – predicting the market to converge towards ~$70 / barrel (in 2009 prices). In contrast the later EIA projection implies a strong sustained recovery in oil prices beginning in the middle of 2009 and trend towards ~$100 / barrel at 2015.

It is difficult to make credible quantitative predictions of the secondary impact of such projections on the level of competition in the vessel supply market for offshore wind construction activity. Essentially, the future price of oil is likely to bias vessel prices towards the high or low cases outlined for the installation vessel market, as described in Section 3.1.

It could be reasonably postulated that in a high oil price scenario such as the EIA 2009 projection, the supply of new vessels specifically targeted at the offshore wind sector remains low and furthermore, that further conversion / utilisation of vessels from O&G into offshore wind do not materialise. On the other hand, under the depressed price projections for oil to 2015 (EIA 2008 and World Bank), it is reasonable to assume that as a minimum, existing and planned vessel capacity for offshore wind, remains by and large reserved for the industry intended use. With a slightly more optimistic outlook, it may be possible that low future oil prices would lead to some conversion or additional 'entrainment' of existing O&G vessels for offshore wind construction jobs. Whilst such plant may in many cases be over-specified for the tasks required, the elasticity of pricing in the marine contracting sector should ensure that the increased levels of competition implied will drive down day rates and hence CapEx. Clearly the price of oil also has a more direct impact because of the relatively intense use of fuels in the manufacture, fabrication and installation activities, but for the purposes of the current study, considering oil as a driver in this sense has been neglected because of its lesser importance.

Technological factors

Driver	Sensitivity (5-year)	Interdependencies
Project Characteristics CapEx is clearly affected by the changing nature of project sites. There are three historical and ongoing trends in this regard. 1. Deeper water leading to a switch in foundation concept, consequent increase in turbine capacity and additional installation demands.	VaR: Moderate [19%] Volatility: High [+30% / -30%] Overall: Moderate-High [+6% / -6%]	Driver impacted by: • Currency [V. High] • Recession [High] • Stimulus Packages [High] • Credit Markets [Moderate]

2. Sites further from shore leading primarily to additional electrical system requirements.
3. Larger projects leading to longer build durations and additional infrastructure demands.

Figure 15 presents these historical and anticipated future trends for UK projects.

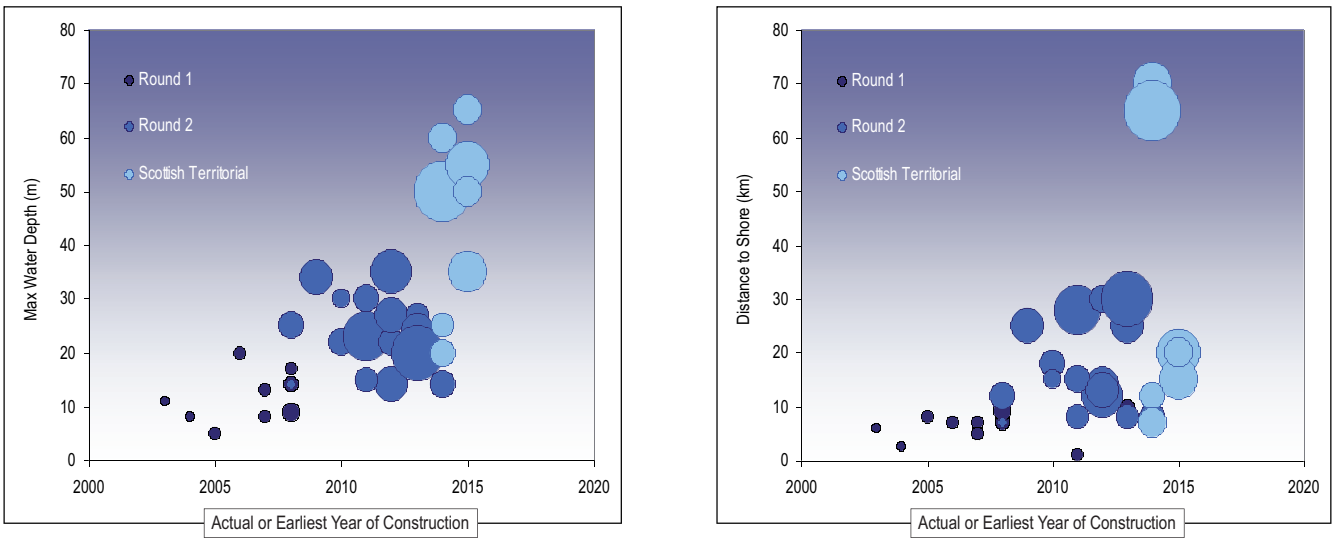


Figure 15: Into the blue
Bubble area represents project capacity

The following table compares UK project averages for the periods 2005-2009 and 2010-2014.

Period	Max Depth	Dist. to Shore	Capacity
2005 - 2009	15.6 m	9.1 km	155 MW
2010 - 2014	27.1 m	19.8 km	482 MW
Delta	+73%	+118%	+211%

It is inescapable that trends in both water depth and distance from shore clearly point towards increasing CapEx for all major project elements; wind turbines, foundations, electrical plant and installation. This is likely be offset to a limited degree through project-specific scale-effects implied by the average tripling of project capacity between the two 5 year periods. This Driver is a special case amongst those considered in this study, since in both optimistic and pessimistic scenarios, the impact can only be upward pressure on CapEx.

Driver	Sensitivity (5-year)	Interdependencies
Scale, Learning and Innovation As any industry matures, all other things being equal, effects of scale, learning and innovation should lead to cost reductions with time. As outlined in Section 2, this has clearly not become manifest in the offshore wind sector to date.	VaR: Moderate [36%] Volatility: Moderate [+0% / -15%] Overall: Moderate [+0% / -12%]	Driver impacted by: • All Supply Chain [V. High] • Project Demands [High] • Recession [High] • Stimulus Packages [High]

The potential for future CapEx 'benefits' be they cost reductions or mitigation of cost increases, is assessed below in Figure 16 against the themes of Scale, Learning and Innovation for each of the key technological areas for offshore wind.

	Technology	Relevance to Study	CapEx Benefit Potential		
			Scale	Learning	Innovation
WTGs	2 - 4 MW	High	Low	Moderate	Low
	4 - 6 MW	High	Moderate	Moderate	Low
Foundations	Monopiles	High	Low	Low	Low
	Multi-Member	Moderate	High	High	High
	Concrete	Low	High	High	High
	Elec. Design / Supply	High	Low	Low	Moderate
Installation	Depth < 15 m	Low	Low	Moderate	Moderate
	15 - 30 m	High	Low	High	High
	Depth > 30	Low	Low	High	High

Figure 16: Scale, Learning and Innovation – limited 5 year potential

In contrast to recent studies, the assessment presented above suggests relatively limited opportunities for CapEx savings through industry maturation, at least within a five-year timeframe. Two exceptions to this are highlighted above; design, fabrication and serial production of multi-member foundations as well as installation operations in moderate to deep waters. Both of these drivers have the potential to mitigate the anticipated cost increases associated with the move towards construction in deeper waters. In addition some CapEx reduction through learning effects is considered to be reasonably likely for wind turbines through a reduction in the 'risk-premium' that has been evident in contract prices since contractor-losses on early projects became manifest. However, this is likely to be offset to some extent by the general trend towards, larger, heavier machines. A strong 'market-pull' from developers, in the form of substantial framework agreements with key suppliers is considered important in engendering the level of confidence required in the supply chain. In all cases, the benefit of scale, learning and innovation will only be passed through to project CapEx in a competitive supply chain environment.

Other key drivers

Driver	Sensitivity (5-year)	Interdependencies
Currency The value of sterling against the euro has had a strong influence on CapEx for offshore wind projects in recent months. This is because the majority of the value-content of offshore wind projects is imported from euro-area suppliers or from Denmark where the krone is pegged to the euro.	VaR: V. High [80%] Volatility: Moderate [0% / -20%] Overall: High [0% / -16%]	Driver impacted by: • Recession [V. High] • Stimulus Packages [High]

Figure 17 provides historical trends and future projections for euro-sterling rates as well as GDP growth forecasts for the UK and euro area.

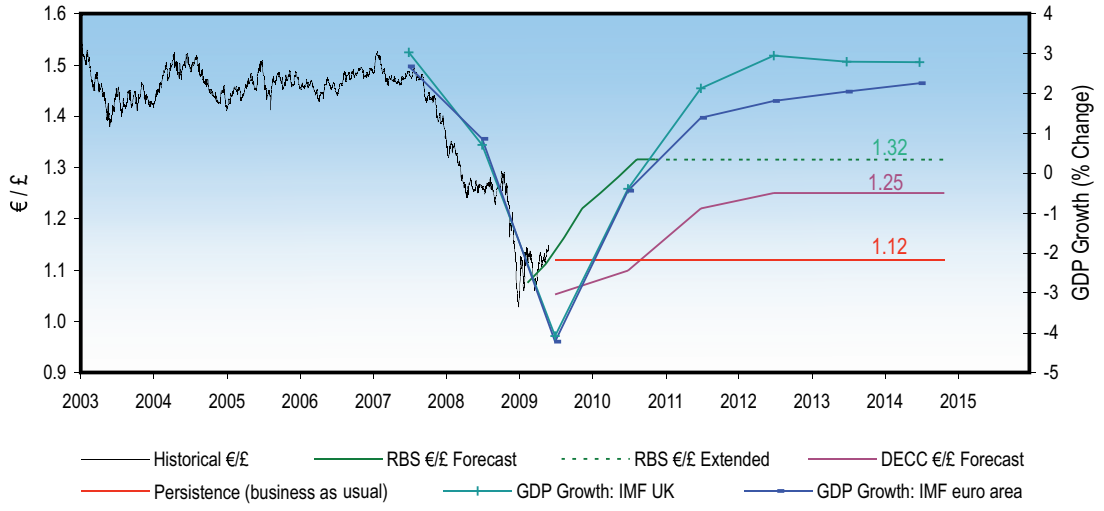


Figure 17: Resurrection of sterling ?

Following a precipitous collapse in late 2008, early Q2 2009 has seen something of a stabilisation. There appears to be a reasonable consensus of opinion within the financial community that in a 2–5 year timeframe, sterling is somewhat more likely to recover value against the euro than to lose further ground, a view supported by IMF projections of GDP growth which indicate that the UK economy is expected to recover from recession somewhat faster than euro area economies as a whole (also shown in Figure 17). However, opinions differ over the speed and ultimate extent of sterling recovery, as illustrated above. The RBS April 2009 projection is of a relatively rapid and strong recovery, with an 18% shift in value of the next 18 months. Recently published assumptions from DECC imply a slower and less dramatic recovery with a 12% upward shift in value over three years. A pessimistic outlook might imply stabilisation at May 2009 levels ("persistence" case in Figure 17).

For the purposes of the current study, the RBS and Persistence currency projections have been characterised as optimistic and pessimistic scenarios, respectively, with the DECC outlook considered as a reasonable central estimate.
Whilst any future recovery of sterling against the euro is clearly good news for UK offshore wind projects, the sensitivity study undertaken here demonstrates the vulnerability of the industry to shifts in currency markets. This industry risk could be mitigated to a significant degree through increasing UK supply content, through successful growth of for those few UK companies who have made some inroads, incentivising participation of existing firms with transferable industry competencies and encouraging relocation of (in particular wind turbine) manufacturing/assembly facilities to the UK.

Driver	Sensitivity (5-year)	Interdependencies
Competing National Markets (Offshore Wind) Given the well documented supply chain difficulties that the offshore wind industry faces, increased demand from other national markets for the same resource required for the UK market will inevitably have an impact on CapEx.	VaR: V. High [81%] Volatility: Low [+5% / -5%] Overall: Low [+4% / -4%]	Driver impacted by: • Credit Markets [V. High] • Stimulus Packages [High] • Recession [Moderate]

The most significant 'competing national market' in the five-year time frame of the current study is considered to be Germany where the government has a stated national aspiration for 25GW of offshore wind capacity to be installed by 2030. The authorities have demonstrated strong commitment to offshore wind with feed-in tariff incentives progressively improved over the past five years (in the context of very successful onshore wind deployment). Despite this, for various reasons deployment has been much slower than anticipated, with the first pilot project (Alpha Ventus) due to come on line in 2010, several years later than originally planned. The majority of development activity is underway in the German Bight region of the North Sea where physical characteristics are by and large considerably more challenging than projects constructed to date elsewhere in northern Europe and indeed somewhat more onerous even than those UK projects due to reach financial close before 2015. This fact mitigates the degree of supply chain overlap between the UK and Germany. Nonetheless, significant competition for wind turbine supply and to a lesser degree foundation and installation resource can be expected.

Whilst less significant in terms of future market size (the Dutch authorities have a target of 6GW offshore wind deployment by 2020), the Netherlands may also be considered as a market that will compete for the finite supply chain resources. In many ways, the physical characteristics of the planned projects are more similar to those in the UK, at least in a five-year timeframe.

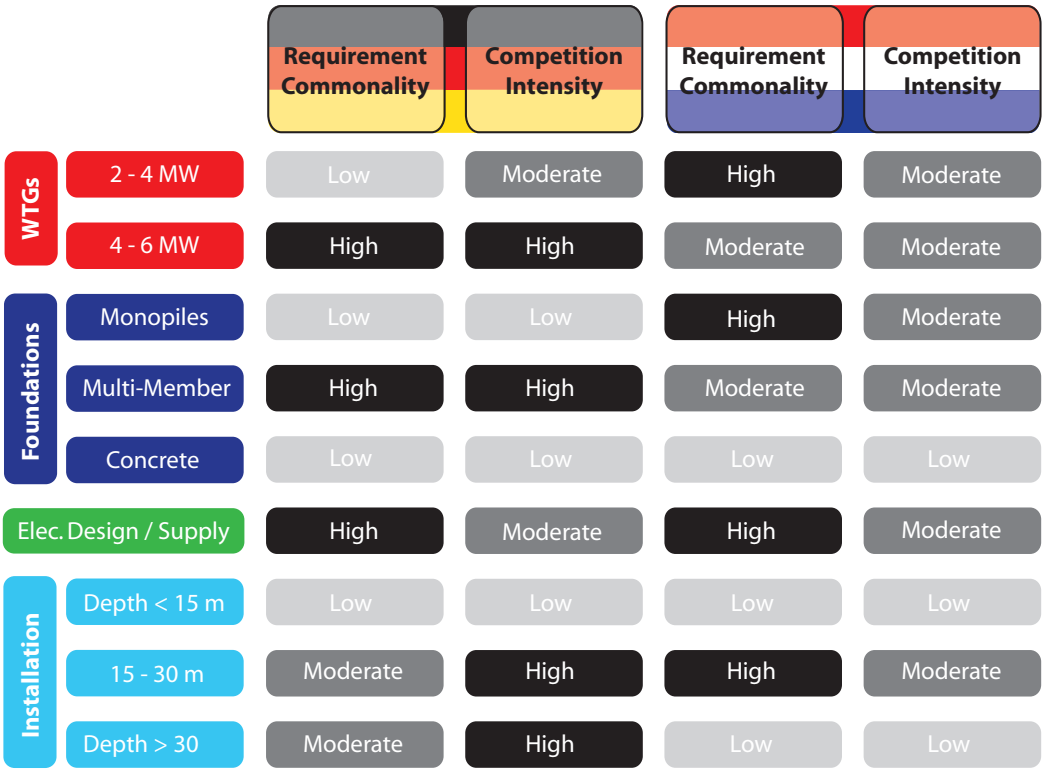


Figure 18: Competing for supply chain resource

The analysis presented in Figure 18, indicates that there is a reasonable degree of technical overlap between the requirements for UK, German and Dutch projects, implying that some level of supply chain resource competition is inevitable.

The UK is currently the market leader in terms of installed capacity for offshore wind, thanks largely to strong and sustained political support, good natural resources and a relatively successful (if at times complex) planning system. There is of course the possibility that German and / or Dutch authorities implement further regulatory revisions which make these markets and the most advanced developments more economically attractive than the UK. In such circumstances, upward pressure on pricing will inevitably befall UK projects as contractors seek to supply where the greatest margins can be accrued. Conversely, in the absence of improved financial support in competing markets, the UK is likely to continue to be regarded by relevant parts of the supply chain as the most attractive national market for offshore wind, all other things being equal. Furthermore, it is noted that the majority of the most well-advanced projects in the German market are currently owned by independent developers or power producers. Without a change of ownership, project finance will be required for these developments and without a substantial improvement in credit markets, it is unlikely that such projects will reach financial close, in the short-term, at least.

Other markets not considered in detail here but which may impact on competition for limited supply chain resource towards the end of the five-year study timeframe include Denmark, Spain, France, Sweden, Belgium and the USA. China also has ambitious plans for offshore wind, but in this case it seems likely that the vast majority of supply will be sourced indigenously, ameliorating any potential resource conflicts for 1st tier supply.

Current and near-term CapEx

Current and near-term market conditions have been assessed primarily through direct consultation with industry. Two projects have announced closing of major construction contracts since the 2009 Budget announcements on increased short-term support through the RO (Walney 1&2 and London Array). These published values have been added to the general CapEx trend in Figure 19. Furthermore, those developers with projects likely to be targeting access to the additional support by signing of major contracts before April 2011 were approached to comment on their CapEx expectations for these projects. Estimates for four further projects were provided and these are included in Figure 19 (with a nominal project capacity / bubble size to preserve anonymity).

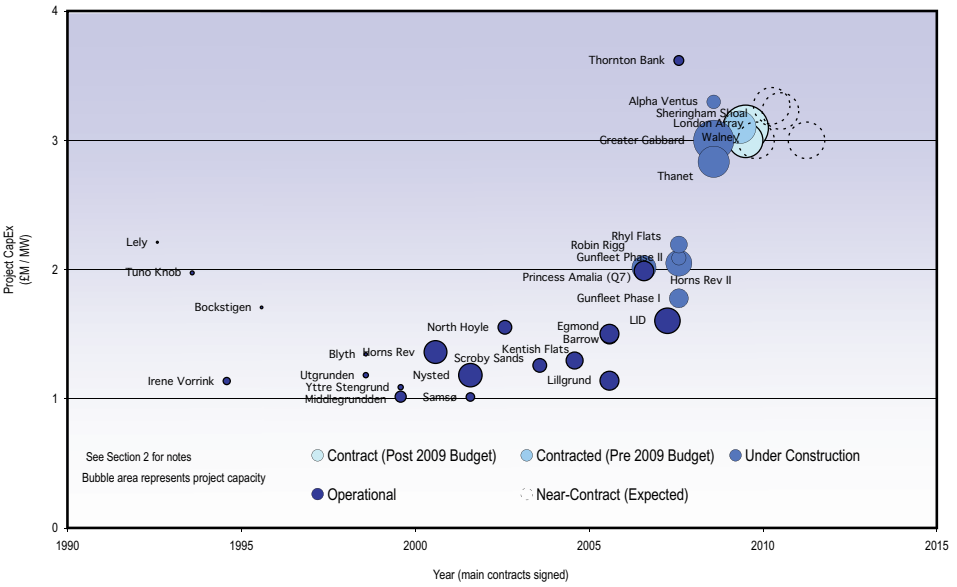


Figure 19: CapEx trend with recent and near contract projects

CapEx values for the recently contracted projects and those expected to be contracted before April 2011 suggests some degree of stabilisation in the short-term - a finding largely supported by the broader results of the consultation. A key findings is the current level of CapEx, which was judged to be in a range centred on £3.1m/MW, with project-specific details dictating where within that range any individual project fell.

Consultation exercise

A central aspect of the study was to consult with those involved in developing, delivering and financing the offshore wind projects on which we were focussed. The consultation included project developers, wind turbine suppliers, other contractors and financiers.

The consultation was conducted by email and telephone between 27 May and 5 June 2009. Aside from the comments quoted below this was on the basis of complete anonymity and preserving confidentiality of project-specific details. As part of the process, a different set of questions was posed to the different parties.

Project developers were asked to provide or comment on:

- CapEx of their recently-contracted offshore wind projects;
- drivers behind historical CapEx trends;
- UK content in recent projects;
- CapEx trends (and drivers) for those of their offshore projects likely to contract by March 2011 (if not already announced);
- CapEx trends (and drivers) for those of their offshore projects likely to contract between 2011 and 2014.

Offshore wind turbine suppliers:

- CapEx of their recently-contracted sales;
- drivers behind historical trend of increasing turbine CapEx;
- turbine CapEx trends (and drivers) over the next 18 months;
- turbine CapEx trends (and drivers) over the next 5 years; and
- supply-side situation (although not of direct relevance to the work here), namely capacity allocation for offshore projects and plans to increase UK content.

Other offshore wind farm contractors:

- historical trend of CapEx for their supply scope (and drivers);
- CapEx trends (and drivers) for their supply scope over the next 18 months;
- CapEx trends (and drivers) for their supply scope over the next 5 years; and
- current proportion of their supply denominated in sterling.

Financiers:

- macroeconomic trends;
- onshore wind supply situation and future scenarios; and
- supply and cost of credit to the industry.

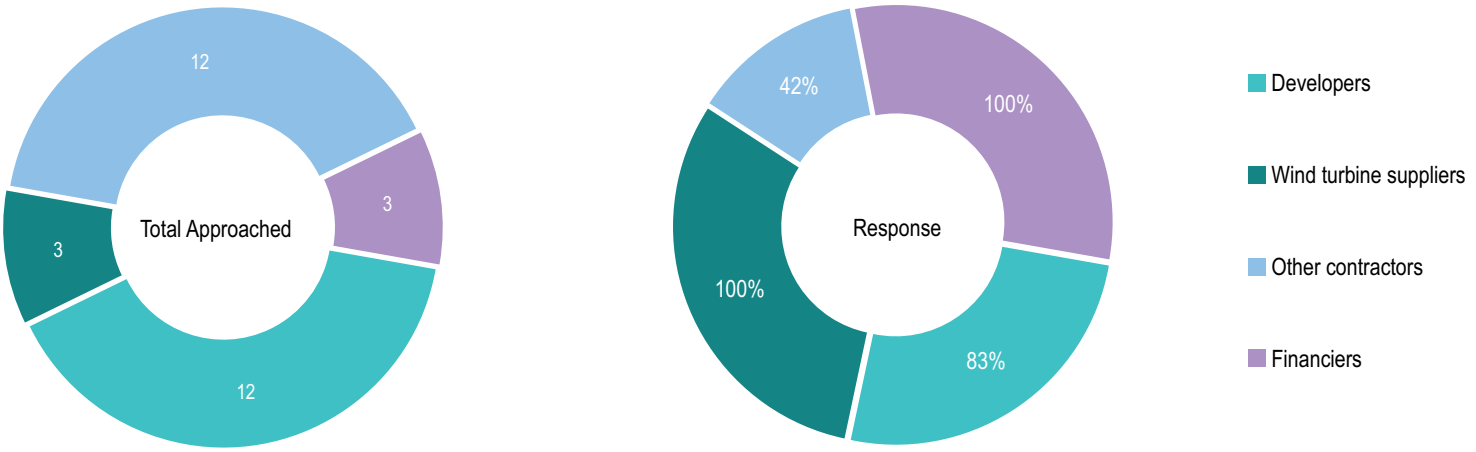


Figure 20: Consultees, approach and response

All parties contacted were asked for their response to the 2009 Budget proposal to place near-term offshore wind projects in higher ROC-bands. In total 30 parties were approached – encompassing all active UK offshore project developers, the leading offshore turbine suppliers, other key offshore contractors and financiers active in the sector. Of those approached, 70% overall provided input to the study.

Main consultation findings

The overall picture of CapEx trend coming through from this consultation exercise is summarised below.

Trend in capital cost 2009–2011

Overall the consensus was of slight increase in CapEx in this timescale with contractors if anything being slightly less of that opinion. The factors cited as drivers on this timescale were:

- Continued pressure on wind turbine supply and some other major cost items;
- More technically-demanding projects; and
- Reduced commodity prices.

Trend in capital cost

With a five year horizon, the consensus is one of slight CapEx reductions, the factors cited being:

- Increased wind turbine supply;
- Longer-term contractual arrangements in place;
- Eased commodity prices;
- General increase in contractor competition;
- Increasing efficiency including standardisation; and against those,
- Increasing project technical demands, especially on foundations and installation activities.

Turbine Market – critical mass

Discussions with wind turbine suppliers identified that they view an installation rate of 1GW per annum as the level of sales which would make them consider the offshore business to be close to mature. At this level on a national basis suppliers may also start to justify inward investment. As there are 3-4 turbine suppliers active in the market, that would suggest annual deployment rate of circa 5GW being required Europe-wide for maturity in the turbine supply element.

Comments

Views on the proposals in the 2009 Budget were mixed but overall pretty positive. These are best summarised by the quotations provided below:

"We take confidence from the ongoing commitment the UK Government shows in developing the offshore wind industry."

"The 2009 Budget proposals will help our project a lot. Shows the Government is willing to make decisions to move the industry forward. Does absolutely nothing to bring certainty to the UK as an environment for investment."

"We see the recent budget announcement as strongly positive for offshore wind. We are, however, concerned over the Government's understanding of the environment necessary to make major investment decisions."

"Good to see "bubble" of R2 projects getting going – even if our project doesn't benefit directly. Some competition from outside UK for later Round 2 seems likely, but hopefully not too serious."

"Very positive – we see the UK as the main driver of offshore wind in the foreseeable future. The ROC system gives business case profitability – but not certainty. The UK still needs to firm up on grid and other delivery issues, including ports."

"Positive movements by the government through the ROC increase in response to a recent decrease in economic viability of UK projects compared to the rest of Europe. This allowed key projects to progress and more importantly sent the signal that the government is serious about offshore wind and will support growth in the industry."

"Budget incentive is available to those who announce (as opposed to negotiate) contracts after Budget day. Seems to penalise those who went ahead in hope and reward some who deliberately delayed their projects, damaging supply chain in the process. Not a good precedent."

"The budget has made some projects move forward, but others remain uncertain. As suppliers we are thankful that the government has given a short term boost. Meeting 2020 targets relies on supply chain companies making huge investment decisions now. That requires a stable industry with a long term future. We welcome recent statements that the Government will take a more strategic approach, especially to grid, and hope to work with them to deliver the UK's targets."

"The financial crisis means that there is an industry focus on keeping costs down and decreasing supply chain risk. There is a need for strategic development of ports and construction/supply chain bases to be used for the offshore renewables market in the UK, and development of fast-tracked demonstration projects (i.e. offshore sites) associated with development of ports and development of supply chain."

"Turbine manufacturers need to demonstrate turbines in UK waters before 2014 to ensure that they can prove turbines to financers. Turbine manufacturers also need confidence in where to invest in development of their UK supply chain. Without demonstration projects, it is hard to see the industry developing new supply chain entrants in time to deliver R3."

"There is a tremendous opportunity coming to the UK manufacturing industry creating thousands of jobs. In some areas industry is further advanced than government realise. With minimal additional investment we have an opportunity to have sectors of the UK leading in this new industry due to the experience and skills gained from the oil and gas sector. We could create an industry that will last for 20 to 30 years."

Five year CapEx scenarios

"There are many methods for predicting the future. For example, you can read horoscopes, tea leaves, tarot cards, or crystal balls. Collectively, these methods are known as 'nutty methods.' Or you can put well-researched facts into sophisticated computer models, more commonly referred to as 'a complete waste of time.'"

Scott Adams

Predicting the future is a notoriously hazardous activity and hence the projections presented in this section should be interpreted with care and in the context of the stated assumptions. The most important historical cost trends have been identified (Section 2), the sensitivity of CapEx to various industry drivers has been examined (Section 3) and a wide range of views have been gathered from key industry actors. All of this intelligence has been integrated in this section in order to project five-year future capital cost trends for the industry under various macro-economic and industry assumptions.

Rationale

The relationship between macro economics and industry supply chains is at the heart of any credible outlook for the offshore wind industry and in particular for capital costs. The 'entanglement' between the supply chain for the offshore wind industry and those of other industries, most notably onshore wind, is also critical. For these reasons and on the basis of the analysis of CapEx Drivers presented in Section 3, future cost trend scenarios have been formulated with reference to three, interrelated themes; the global economic outlook in general, the outlook for *onshore wind* and the overall level of confidence in the supply chain for offshore wind.

- ### Global economic outlook

  Against the current rapidly changing and uncertain global economic backdrop, future macro economic shifts will have a significant impact on all major industries globally. However, when considering the specific effects on the development of both the onshore and offshore wind industries, the predominant influence is considered to be the availability of credit. In combination with the policy outlook for climate change, energy and renewables, access to credit-markets will govern who stays involved and for how long, on both supply and demand sides of the equation.

- ### Onshore wind outlook

  The historical and ongoing reliance of offshore wind on the supply chain for onshore wind, in terms of products, contractors and supply chain capacity, has been one of the key drivers behind upward price pressure in the wind turbine market. Therefore, the future outlook for the onshore wind industry is likely to have a strong influence on the capital cost of offshore wind projects. The wind industry as a whole has averaged an impressive annual growth rate of 25% over the last five years, largely driven by the bullish Chinese and US markets. Figure 21 shows that installation rates in both of these markets have reached the same extent as the historic homeland of wind energy – Europe. This is an important turning point for the industry, as both supply chains and developers evaluate long-term prospects for onshore and offshore wind markets.

- ### Offshore wind supply chain confidence

  The response of those suppliers currently active in offshore wind markets to changes in the macro economic picture and the onshore wind sector will play a crucial role in determining future capital costs and indeed viability of offshore wind projects. Much depends on the long-term perception of contractors who will typically only invest if they can see a stable future industry with a longevity of decades. Even where such a view is

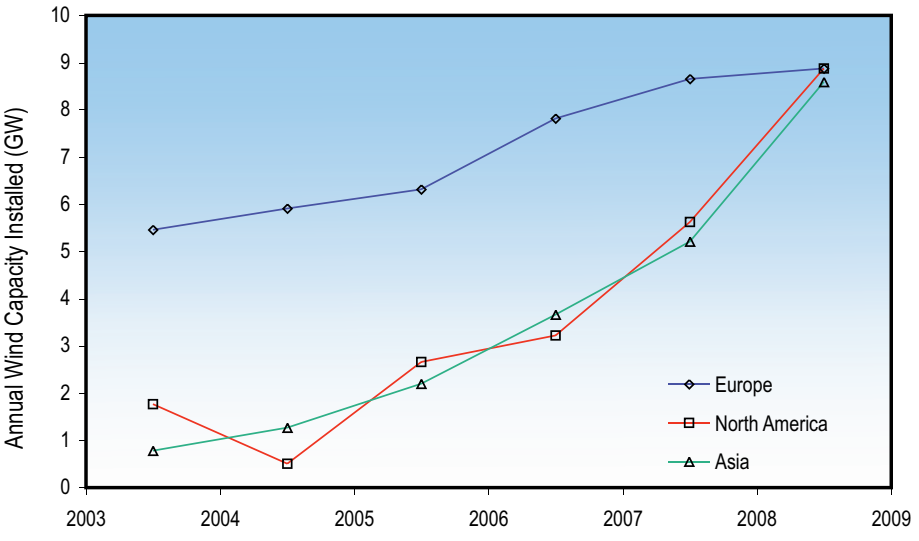


Figure 21: European Plateau

held and an investment decision for a major expansion in production capacity is made, it can take at least three years for that additional capacity to become available in the market. Perhaps the key trend here is whether or not the offshore wind sector is willing to instigate the bifurcation of supply markets necessary to protect the industry from the demands of others. Figure 22 below illustrates (somewhat simplistically) the historical and ongoing supply chain 'borrowing'.

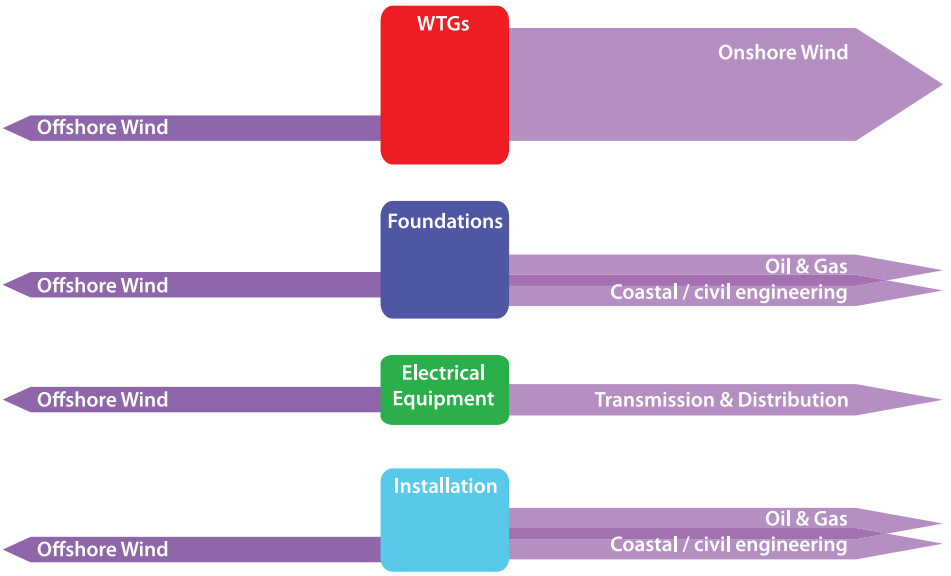
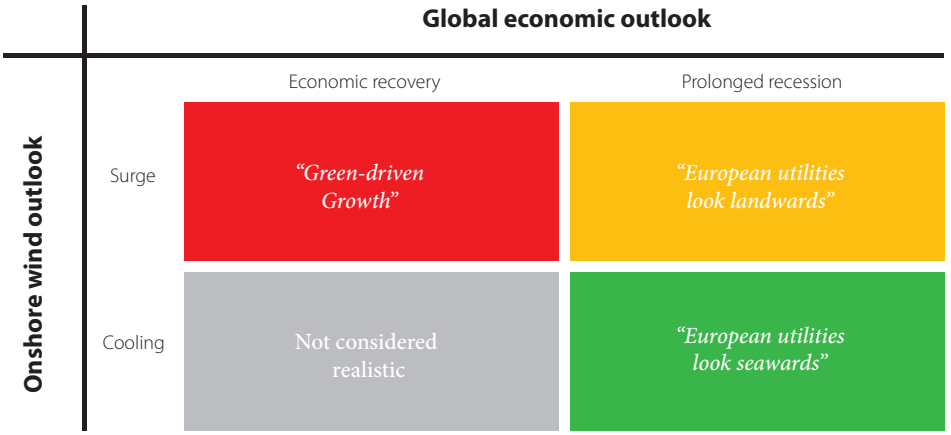


Figure 22: Beg, borrow, steal – industries competing for supply

Whether or not the required supply chain 'decoupling' is possible will depend to a large degree on the health of the competing industries outlined above, the global economic climate and the political backdrop for offshore wind.

The first two of the three themes described above (global economic outlook and onshore wind outlook) have been arranged into a 2x2 matrix, in order to guide the development of credible scenarios for the 'environment' in which the offshore wind business will operate. The combination of rapid economic recovery in the world economy and a cooling onshore wind industry has been deemed unrealistic as the co-incidence of these two circumstances is unlikely and therefore, this combination has been deliberately neglected. For each of the remaining three environmental scenarios, a reasoned narrative has been developed to provide a credible macro economic landscape with potential consequences for the onshore and offshore wind sectors. Following this, both high and low offshore wind supply chain confidence levels have been considered for each thematic combination, leading to a total of six future Scenarios.



On the basis of the Driver analysis presented in Section 3 and the qualitative narrative content, the impact on offshore wind CapEx for each of the six Scenarios has been projected on a year by year basis from 2010 to 2015.

For the findings associated with each of the six Scenarios which follow in Section 5.3, all prices are considered at 2009 levels – that is, general levels of inflation have been neglected.

The influence of the move towards offshore transmission regulation (the OFTO regime) on CapEx has been considered as being neutral for the purposes of the current study, since the outcome of the new licensing arrangements and their impact on how projects are contracted, is currently unclear. In principle, the system should convert capital costs associated with offshore transmission and grid connection works into an operational cost through use of system charges and although there may be a net benefit on IRR as a result of this, the cost of offshore electrical assets will still be inherent in overall project economics.

Section 5.3 provides a description of and key results from each of the six Scenarios.

Scenario-neutral outlook

Two key Drivers for offshore wind CapEx identified and discussed in Section 3 are considered to be reasonably independent of the themes and scenarios described above.

1. Changing Project Demands

Macro economic forces and supply chain dynamics will not alter the fact that in the period to 2015, the offshore projects closing contracts in the UK market will (on average) be located in somewhat deeper waters, further from the coast, with commensurate cost increases. Innovation, scale and learning effects have the potential to mitigate the extent of such increases to some degree, but these have been dealt with separately in the scenario projections since reasonable levels of competition in the supply chain is required before such maturation-benefits are passed through to project CapEx.

2. Currency (€/£)

The importance of the value of sterling against the euro in determining offshore wind CapEx for UK projects has been discussed at length in this report. However, for the purposes of the scenarios under consideration a fixed profile for €/£ forex has been assumed for all cases. As a central estimate, the DECC five-year projection of €/£ forex, as outlined in Section 3.5 has been assumed. The sensitivity of the CapEx projections to more optimistic and pessimistic outlooks for sterling is examined in Section 5.5. The assumed overall impact of these scenario-neutral drivers is presented in Figure 23.

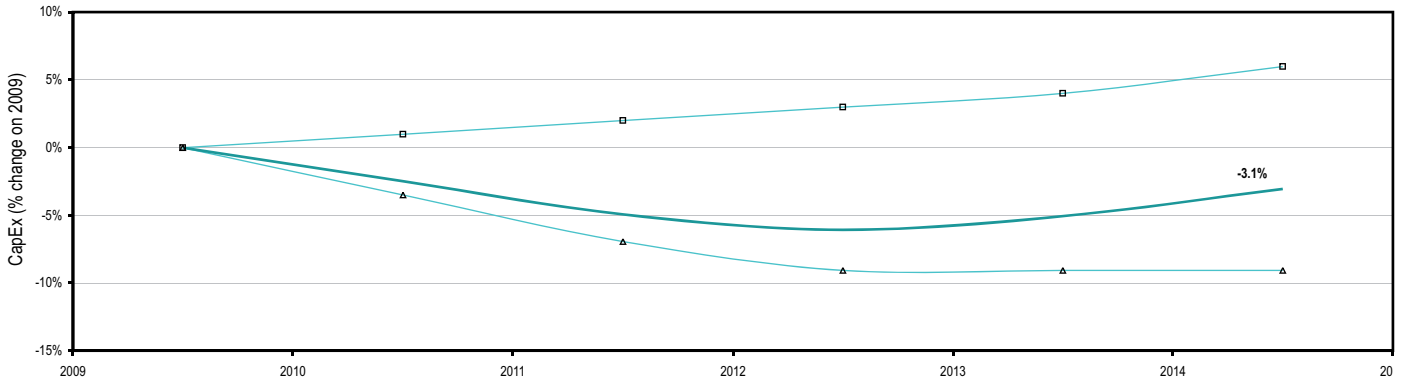


Figure 23: Assumed scenario neutral trends

Scenarios

Economic recovery with onshore wind surge

"Green-driven growth"

Stimulus packages in the US, EU and PRC are spent quickly and to good effect, a high proportion being directed at clean energy infrastructure during 2009 and the first half of 2010. This is coupled with a sea-change in US policy outlook during 2009 with the American Climate and Energy Security Act (ACESA) passing into law by mid 2010. The legislation includes a 20% renewable electricity mandate for 2020 alongside passing of cap and trade legislation, instigating a massive renewables boom in this market, most notably benefiting onshore wind (~50GW added by 2012). In addition to the ensuing pressure on primary wind turbine supply, second and third tier component supply is squeezed further by a surge in wind growth in China (~40GW added by 2012) in combination with sustained demand from onshore projects in Europe (~30GW added by 2012).

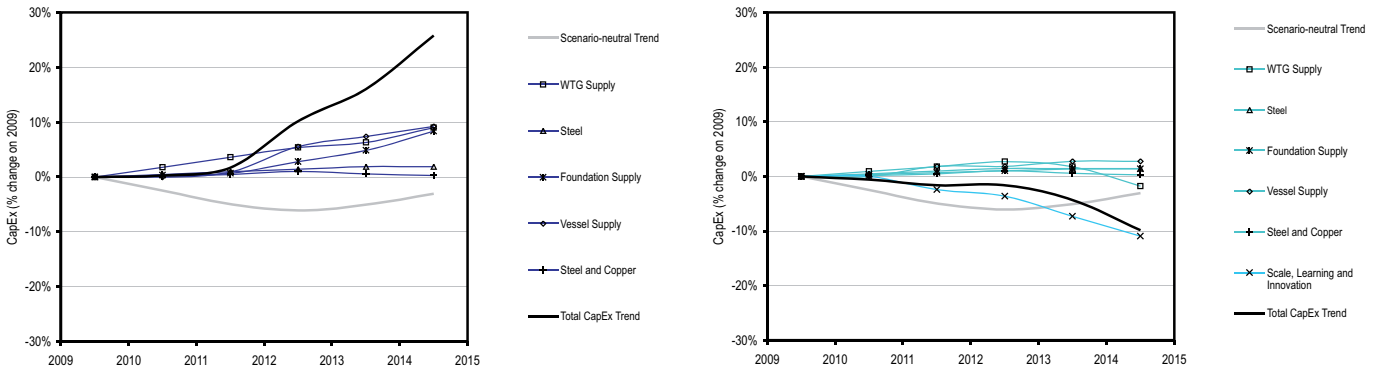
Credit markets ease by Q3 2010 leading to the flood-gates opening on a number of high profile infrastructure projects, most notably in the energy sectors across Europe and the US, in conjunction with sustained infrastructure spending in China, leading to a new spike in commodity markets around 2012. Project finance for wind projects (both onshore and off) returns with a vengeance with lender-appetite surging from 2011 onwards. This reinvigorates IPP activity in onshore wind in the US/Europe and the best-advanced 7–8 large offshore wind projects in Germany and the Netherlands are sanctioned by 2012, following additional incentive support in these markets.

Low offshore wind supply chain confidence

The response of the existing offshore wind supply chain to the above is to divert resources to booming onshore markets, only reserving marginal capacity to keep the offshore sector 'ticking over'. One of the existing wind turbine manufacturers active in offshore wind departs the sector in 2011 to focus on onshore markets and planned offshore specific product offerings are delayed or cancelled. The commodities spike leads to substantial diversion of new-build vessel resource with day-rates soaring from 2012 onwards.

High offshore wind supply chain confidence

The worst effects of the above with respect to supply chain pressures are mitigated through the early decoupling of turbine supply chains and substantial new investment by existing suppliers in dedicated production facilities. Two to three major onshore wind turbine suppliers enter the offshore business although the material impact of this on competition and prices is not felt until 2014. Despite soaring oil prices, sufficient new-build vessel capacity is reserved for offshore wind with minimal resource diversion. Some scale, learning and innovation benefits materialise by 2014.



Results for the reduced supply chain confidence case indicate a substantial upward CapEx trend over five years (+26%), driven primarily by the response of wind turbine and vessel supply markets to the economic recovery and related boom in onshore wind. Should the supply chain respond with greater confidence to the offshore wind sector in the face of significant opportunities elsewhere, increasing levels of competition lead to an overall CapEx reduction (10%) by mid-2014, with a sharp downward trajectory as new turbine supply options become available.

Prolonged recession with onshore wind surge

"European utilities look landwards"

Illiquidity in credit markets remains for much longer than generally anticipated due, for example, to the unexpected failure of a further 1–2 major financial institutions in late 2009. The widespread availability of nonrecourse project finance is firmly off the agenda until 2013 although corporate credit remains available. This prolonged drought for project finance has the effect of removing the majority of independent developers / power producers from wind markets, who sell off their onshore and offshore project pipelines at reduced prices to the major utilities, the only players in the game with deep enough pockets and sufficient access to credit to build in significant volumes.

This consolidation of projects places substantial pipeline volumes in the hands of a relatively low number of utility-developers, leading to a general trend towards prioritisation of those developments in the most attractive offtake markets with the lowest risk profiles. At the same time, the ambitious scale of stimulus package support for onshore wind and transmission infrastructure in the US, coupled with a positive long-term policy outlook and significant supply chain investment, makes this market by far the most attractive for renewables in a five year timeframe. The additional support provided in the 2009 Budget for near-term offshore wind projects in the UK, means that despite increase globally supply chain pressure, these projects are contracted by Q2 2011. However, with the same breaking mechanisms in place, the industry delivers only stuttering deployments in the contracting period 2012–2015.

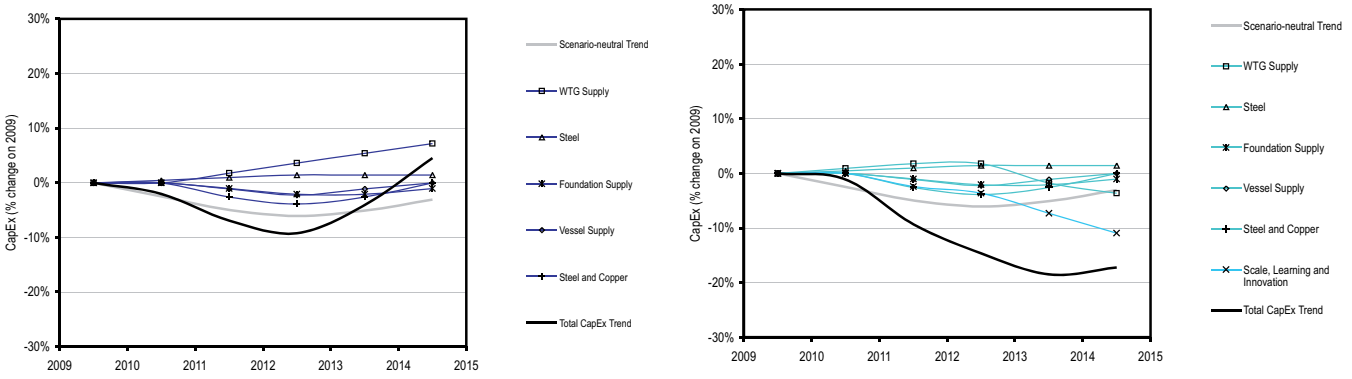
Commodities remain depressed throughout the extended recessionary period, with some signs of a recovery from 2013.

Low offshore wind supply chain confidence

Surging onshore wind markets cause the diversion of limited turbine supply investment funds away from development of capacity for the few offshore product lines towards a rapid ramp-up of onshore facilities. This trend is repeated down the value chain. The situation is exacerbated by the switch in project ownership in the onshore wind market since utilities have a strong preference for the established manufacturers, currently dominating supply to the offshore wind industry.

High offshore wind supply chain confidence

Significant commitments are made by key suppliers to accelerate expansion of production capacity for offshore wind product lines, before the extent of the US wind boom becomes clear. This early commitment, supported by stimulus package support for demonstration schemes, provokes the long sought after decoupling of offshore and onshore supply chains. Whilst cooling of demand prevents entry of new turbine manufacturers, those that remain become focused on the offshore business.



The low supply chain confidence scenario above leads to a CapEx dip in 2012 due to the combined impact of currency and commodity trends, before a strong upward trajectory, reaching a 5% increase on 2009 levels by mid-2014. The high confidence scenario exhibits the same features but with a strong mitigating influence in the wind turbine markets, leading to 17% overall CapEx reduction by the end of the reference period.

Prolonged recession with onshore wind cooling

"European utilities look seawards"

Illiquidity in credit markets remains for much longer than generally anticipated, for example, due to the unexpected failure of a further 1–2 major financial institutions in late 2009. The widespread availability of nonrecourse project finance is firmly off the agenda until 2013 although corporate credit remains available. This prolonged drought for project finance has the effect of removing the majority of independent developers / power producers from wind markets. A relatively protracted roll-out of stimulus measures dilutes their impact on the wind business in the US and the tortuous progress and ultimate failure of ACESA legislation, leads to a substantial curbing of industry enthusiasm for onshore wind in this market. The development of domestic supply chains for the onshore market in China spreads from turbine supply to second and third tier components, easing supply pressure on remaining European manufacturing capacity.

In Europe, the trend towards utility-dominance of wind project ownership continues, fuelled by the prolonged credit-freeze. Continued strong political support for offshore wind in the UK and Germany focuses the attention of the major utilities (who have a preference for deployment at scale and the pockets deep enough to do it) on pushing forward their offshore pipeline. However, the practical limit of balance-sheet financing curbs build-rates to some degree, with no utility committing to the construction of more than a single large offshore wind project in each year.

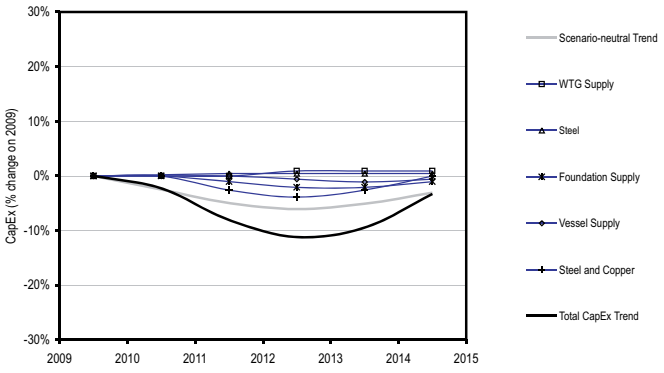
Commodities remain depressed throughout the extended recessionary period, with some signs of a recovery from 2013.

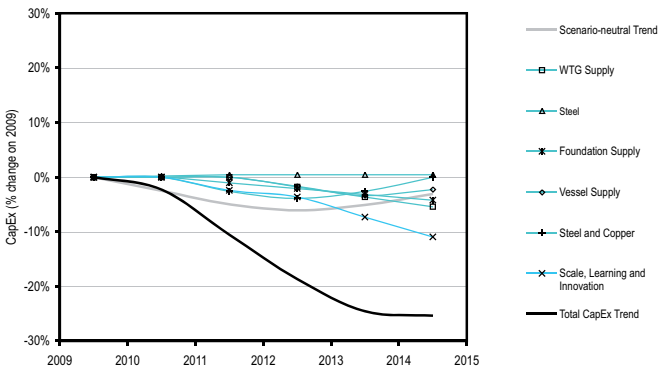
Low offshore wind supply chain confidence

The uninspiring build-rates enforced by the continued credit-freeze does little to foster supply-chain capacity investment and in any case, access to debt for such expansion is very limited. The prolonged recession leads to the failure of at least one key supplier – formerly expected to enter the market with a new product offering in 2013. Several new-build vessels are cancelled as contractor appetite wanes, although the depressed oil price prevents significant resource spillage into Oil & Gas.

High offshore wind supply chain confidence

Offshore wind is viewed by the contracting market as a credible and stable long-term business, perhaps for the first time. The focus of Europe-based turbine / component suppliers shifts towards a high-added-value offshore focus with onshore wind manufacturing increasingly based in developing economies. A reasonable degree of scale, learning and innovation benefit emerges towards 2015 and, in the more competitive contracting environment, is passed through to project CapEx.





In the low supply chain confidence case, something of a stabilisation of CapEx is evident as project demand eases, leading to a marginal reduction by mid-2014 (3%). The high supply chain confidence scenario shows the benefit of introducing significant levels of commercial competition into supply markets and the potential impact of scale, learning and innovation effects, with CapEx projected to reduce by 25% over the five-year period.

Summary and discussion

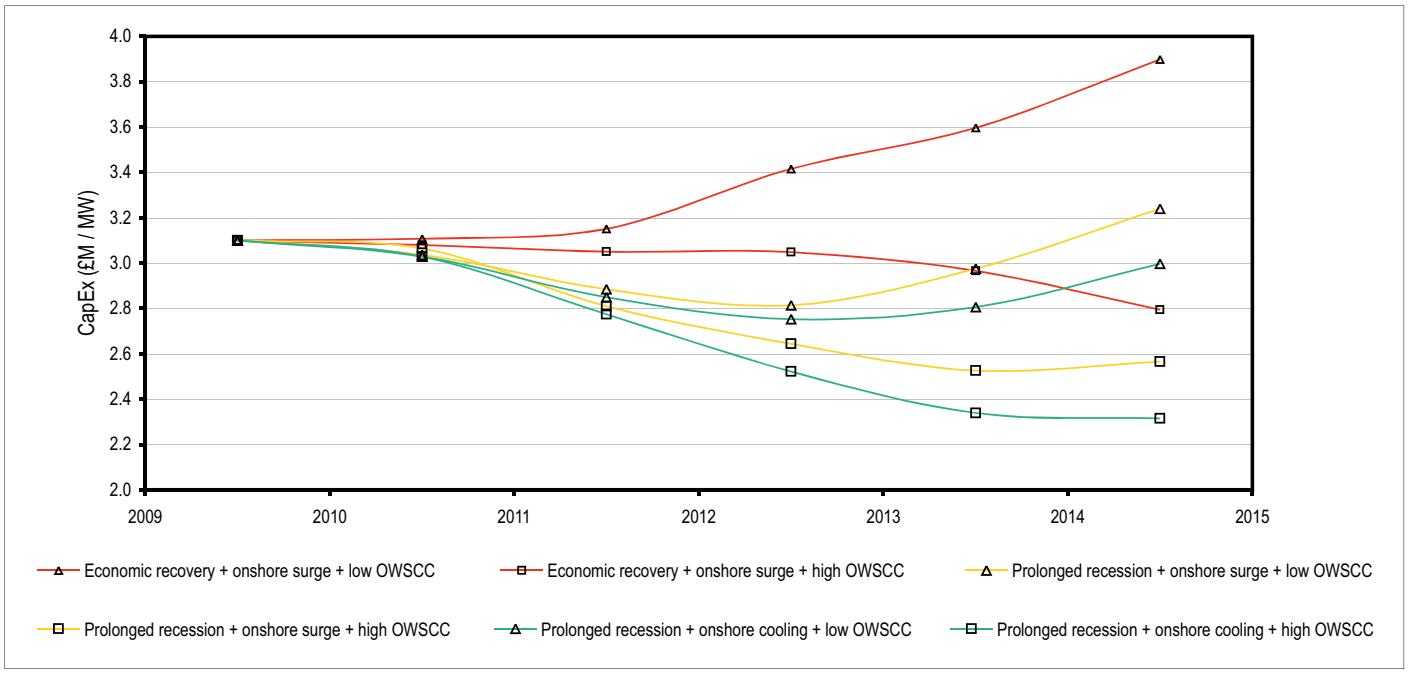


Figure 24: Summary of five year CapEx projections
OWSCC – Offshore Wind Supply Chain Confidence

Results for the six Scenarios are summarised in Figure 24, assuming a base case 2009 CapEx of £3.1M / MW.

As might be expected, there is a significant level of divergence between the various scenarios with the difference between the most optimistic and pessimistic being 51% at mid-2014. This 'spread' is a reflection of both the uncertainty over the outcome of macro economic and industry specific factors as well as the high level of sensitivity to which offshore wind CapEx is subject.

Whilst this work has focussed on CapEx rather than broader project economics, it is clear that scenarios leading to marked increases in CapEx would involve the industry as a whole being under severe economic pressure.

A somewhat uncomfortable finding from the scenario results is that offshore wind CapEx in a very general sense, is inversely proportional to both economic recovery and the growth of onshore wind. The prolonged recession scenarios on average result in a 18% lower CapEx projection at mid-2014 when compared to the economic recovery cases. The equivalent differential when comparing onshore wind 'surge' and 'cooling' scenarios is 15%.

The scenario results also demonstrate the criticality of the offshore wind supply chain response to shifts in macro economics and onshore wind growth trends. The average mitigating effects of high confidence is 24% at mid-2014 with two out of the three high confidence scenarios leading to an overall reduction of CapEx.

Whilst there is little the UK offshore wind sector can do about the global economic climate or indeed, the onshore wind market, measures targeting the boosting of supply chain confidence can have a substantial positive impact. Specifically, 'extraction' of a dedicated supply chain for offshore wind from those currently relied upon from other industries must be a top priority. This will mitigate the probability of continued upward CapEx trends and bring about tangible cost reductions through increased competition and industry maturation (scale, learning and innovation). It is noted that there is a significant time lag between supply chain investment decisions and the resultant new capacity or technology becoming available – typically a minimum of three years. This means that the benefit of any supply chain measures taken now would only have a noticeable impact on project CapEx towards the end of the five-year future period considered in this study, underscoring the urgency of this issue. The 'market pull' created by strong national policy outlook and long-term framework deals from developers may not be enough on its own to achieve this extraction – more direct measures in support of a dedicated supply chain for offshore wind are likely to be necessary.

Environment-neutral projections

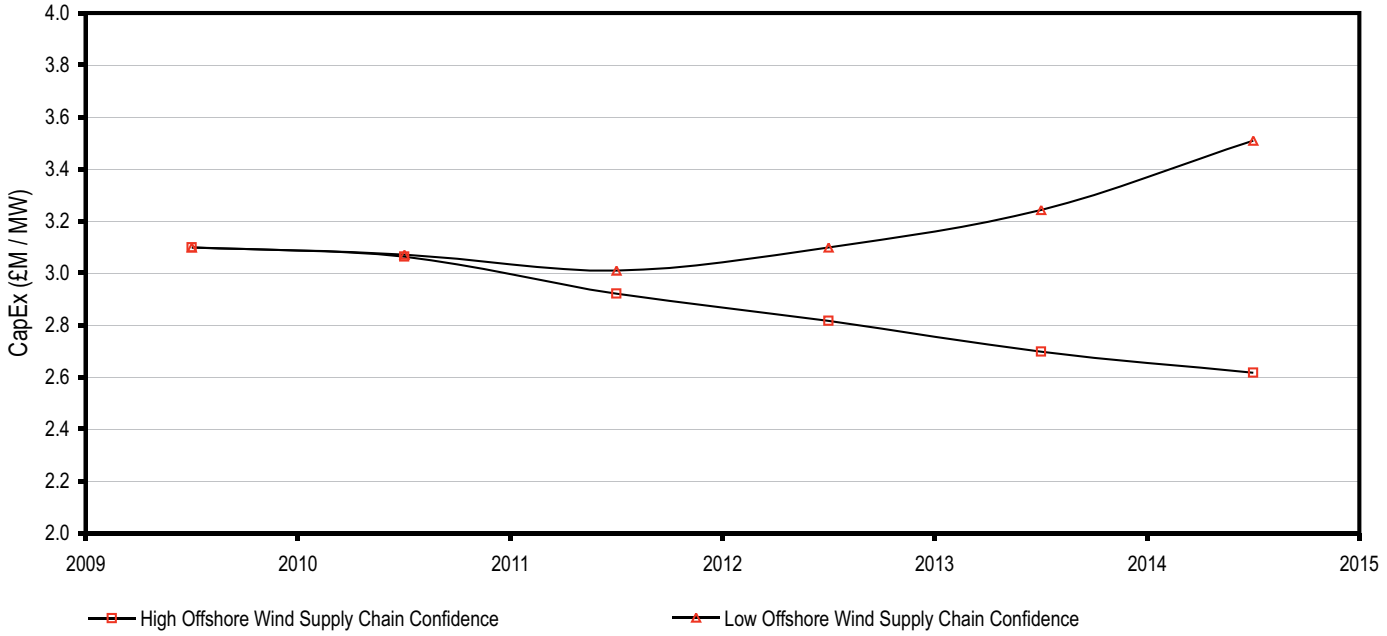


Figure 25: Environment-neutral CapEx projections

Since both macro-economic conditions and the development of the onshore wind industry are to all extents and purposes outside of the control of the offshore wind sector, it is useful to consider the scenario results presented above with a 'neutral' environmental outlook. To achieve this, CapEx projections for both high and low offshore wind supply chain confidence assumptions have been derived assuming an equal weighting between economic recovery and prolonged recession macro-economic outlooks, as presented in Figure 25.

These results illustrate the criticality of supply chain confidence when considering the outlook for offshore wind CapEx. Broadly speaking, the 'high confidence' scenario may be characterised as the beginnings of a successful bifurcation of supply chains - creating a dedicated industrial base for the sector. The projections presented in this study suggest that such a shift in the industry could bring project CapEx to the range £2.3–2.8M / MW in a five year timeframe.

In contrast, if industrial momentum is lost due to the supply chain losing confidence in the viability of the sector, project CapEx is likely to rise over the next five years, with the projections generated in this study suggesting a range of £3.0–3.9M / MW by 2014.

Currency sensitivity

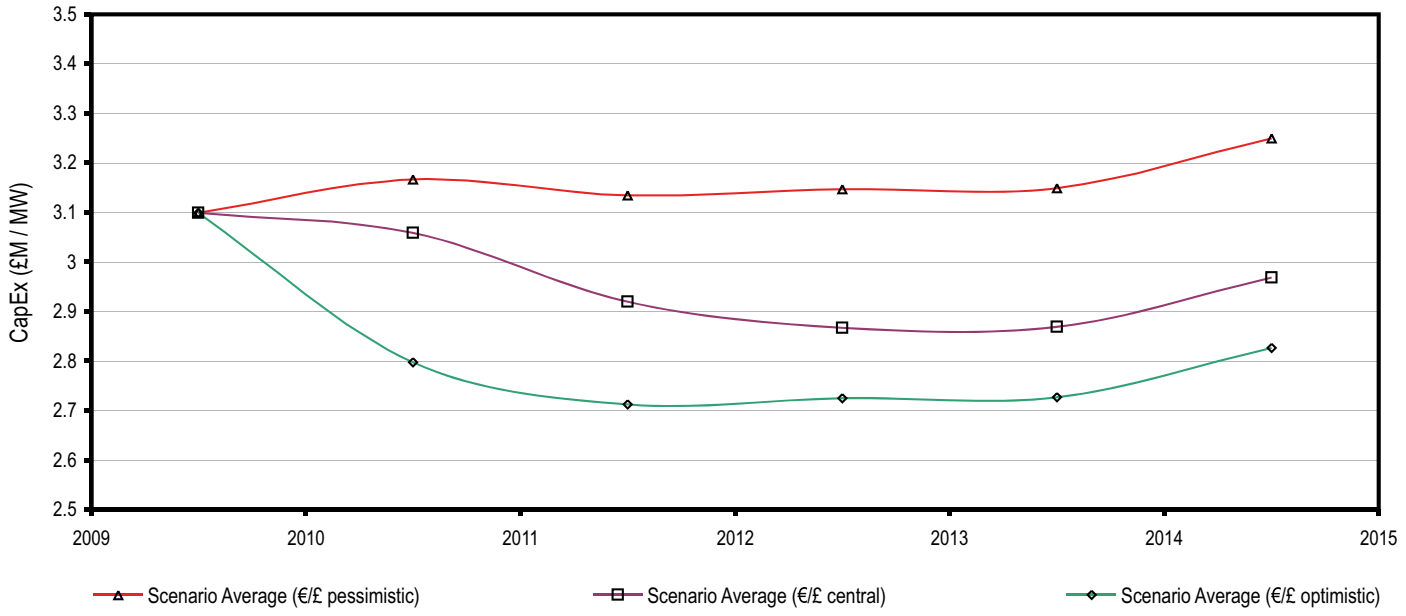


Figure 26: Sensitivity of CapEx projections to currency forecast

The sensitivity of the results presented above to assumptions on the value of sterling against the euro has been investigated through the repetition of the analysis with alternative €/£ forex profiles. As a central assumption for the scenario analyses, the DECC forecast for €/£ was taken, as discussed in Section 3.5. This forecast suggests a sustained but gradual recovery of sterling to €1.25 by mid-2012. A more pessimistic case has been examined by assuming a persistence trend – that is, that €/£ remains stable at Q2 2009 levels (assumed to average at €1.12) for the entire period. An optimistic forecast case may be provided through adoption of RBS April 2009 projections which predict a relatively rapid recovery of sterling to €1.32 by mid 2010 (GH has extended the RBS projection for the remainder of the study period at this level).

The results of this sensitivity study are presented as an average of all six scenarios for pessimistic, central and optimistic currency market assumptions, in Figure 26.

As implied by the high euro value content in the base case assumed for this study (78%), the CapEx scenario projections are relatively sensitive to the currency forecast, with a difference of up to 14% for the optimistic and pessimistic case. The analysis highlights the potential benefit of increasing UK-content in the offshore wind value chain for project CapEx. In addition, the successful establishment of a significant UK supply base, dedicated to offshore wind will have other notable benefits including job creation and contribution towards efforts for a dedicated supply chain for offshore wind, as mentioned previously, encouraging competition and industry maturation effects. Whilst aimed primarily at the servicing the domestic industry, in the medium term there is also substantial export potential to other offshore wind markets in northern Europe.

The BWEA are making efforts towards the establishment of UK offshore wind supply base. The findings of this study serve to underscore the urgency and criticality of such measures in securing a long-term and economically viable industry, able to deliver a substantial contribution towards achievement of 2020 EU commitments on climate change and renewable energy.

Conclusions

The capital cost of offshore wind projects historically and under current market conditions is presented in Figure 27, alongside future projections for high and low offshore wind supply chain confidence scenarios. Error bars reflect the potential impact of macro economics and the influence of the onshore wind industry.

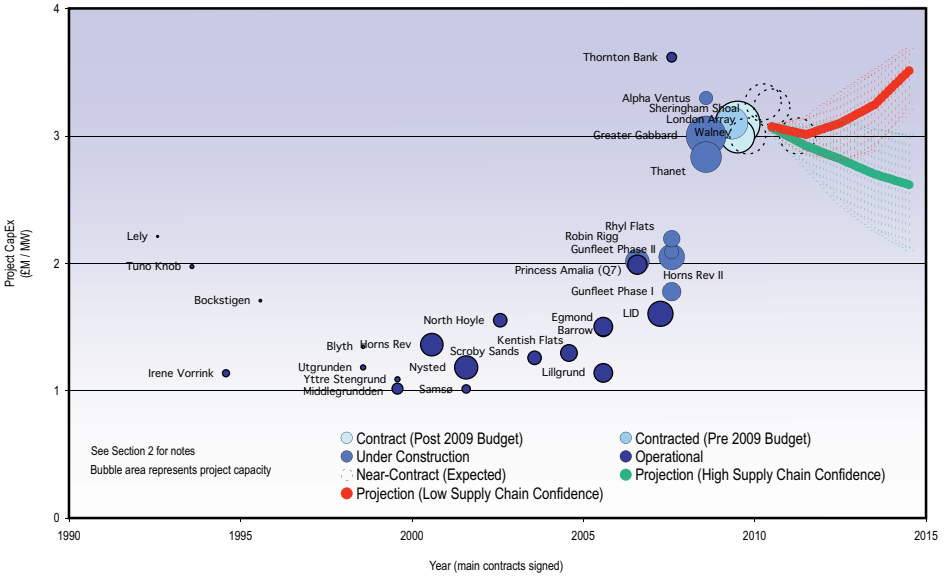


Figure 27: Historical, current and projected future CapEx for offshore wind projects

Learning from the past

A review of the historical offshore wind capital costs reveals several important influences that have driven an upward spiralling trend from around 2005, which followed a period of relative stability from 2000 to 2004. Most important amongst these are those factors that have served to reduce supply chain competition, namely; the ongoing withdrawal of key contractors and products in combination with increasing demand pressure from industries competing for common supply capacity, in particular onshore wind. To reverse the upward CapEx trend in the long-term therefore, a reversal in supply chain trends is important. Another factor that has had a strong historical influence is the relatively high early competition between suppliers (2000–2004) and subsequent losses as the true cost base and challenge of the technology was established and priced in to future contracts. More recently, currency and commodity markets have played an important role.

A stable outlook from industry

Consulting key industry players (developers and contractors) gives a picture of current CapEx lying in a range centred on £3.1m per MW (for those projects recently contracted and likely to be contracted shortly). The consensus in future trends is for a slight rise in the next two years followed by a slight fall out to five-years. As one expects in such a consultation exercise, dramatic changes are not foreseen and most consultees assume current 'environmental' factors will persist at current levels. There was wide acknowledgement that capital cost reduction was needed for a healthy long-term industry. Attitudes towards the UK offshore wind sector are positive – in some cases very positive indeed. The 2009 Budget proposal for enhanced off-take revenues for pending projects has been mostly well-received with some reservations being expressed on the impact for investor confidence and certainty. On the supply chain, developers have acknowledged the market signals on wind turbines and installation vessels, with response, for example through long-term agreements. Contractors are sending the message that this does not go far enough if the corner is to be turned on capital costs and capacity is to be developed to service Round 3 projects.

Boosting confidence to extract a decoupled supply chain

The offshore wind supply chain is maturing slowly and the extent to which confidence can develop or be accelerated has a substantial impact on overall CapEx with a five-year horizon, or more importantly, the trajectory which CapEx will be following by 2015. If sufficient confidence is instilled for incumbent and new-entrant suppliers and contractors, a dedicated supply chain could be created for offshore wind for the first time. The analysis presented in this report suggests that such measures have the potential to increase competitive pressures and the likelihood that industry maturation effects (scale, learning and innovation) will feed through to project CapEx. However, even if effective action is taken by Government and industry now, the benefits are likely to only have a deflationary impact on CapEx in a 4–6 year timeframe due to the substantial lead time required to establish new facilities. The formulation of actions to instigate this shift in the supply base is outside the scope of this study, although it is suggested that a combination of market pull (long-term frame-orders and strong policies) in combination with substantial direct support for new facilities, such as grants and soft-loans will be required. If implemented successfully, these measures have the potential to re-invigorate the industry with real commercial competition driving down contract prices, pushing forward innovation and removing the 'risk-premium' which is currently throttling the sector.

Increasing UK content – a high priority

The very high euro-content of offshore wind projects has exposed the industry to massive currency risk and since mid-2007 the precipitous decline in the value of sterling against the euro has had a direct impact on CapEx for UK projects, in the order of 15–20%. Increasing UK produced content in the value chain has the potential to mitigate similar future trends from occurring in the future, whilst generating UK jobs and tax revenues. In addition, the supply chain decoupling discussed above would be bolstered significantly by such development of domestic supply base, with the potential for the UK plc to become a specialist in offshore wind. This would serve the needs of the domestic market with the potential for substantial future export revenues. This can only happen if developers and government successfully instil the long-term confidence and support required for investment in dedicated supply chain capacity. However, it is important to recognise that the UK cannot 'go it alone' as contractors require a strong and stable political climate in more than one national market before significant investment decision can be sanctioned. In this respect, a successful UK offshore wind industry is inextricably linked to similar success in other EU markets, despite the additional short-term pressure on the supply chain that this will incur.

Underlying drivers – macro economics and onshore wind

The interactions between the onshore wind market and offshore supply chain against the uncertain macro economic backdrop is found to be central when considering the outlook for offshore wind CapEx. The analysis in this report yields the uncomfortable finding that a favourable projection of offshore wind CapEx requires a prolonged recession and / or the cooling of the onshore wind market. The UK offshore wind business cannot significantly influence macro economics or indeed the onshore wind market. However, the response of the fragile and contingent offshore wind supply chain to both of these 'environmental' factors can be influenced. In absence of extreme movements in these factors, CapEx is not expected to alter dramatically over the next five years. However, the offshore wind business remains at the mercy of the economic climate, the value of sterling and the pressure put upon it by onshore wind demand. These uncontrollable environmental factors can have just as large an impact on offshore wind CapEx as the measures outlined above.

Delivering Round 3

With a longer timeframe, it is evident that significant investment decisions need to be made to ensure the capacity exists to deliver Round 3 projects as well as the capacity planned for other North Sea states. In that context, one perspective is that a steady level of CapEx for the next five years is acceptable, provided it delivers, by 2015, a better resourced and more efficient industry.

Garrad Hassan is the world's leading renewable energy consultancy serving the wind, wave, tidal and solar sectors. Headquartered in the UK, with offices across the globe, it offers a full range of engineering consultancy, industry advice, specialist software and training – dedicated to renewables. This report has been led by the company's Offshore Wind Department - a multi-disciplinary team focused on contributing to offshore wind project development.

BWEA is the trade and professional body for the UK wind and marine renewables industries. Formed in 1978, and with over 470 corporate members, BWEA is the leading renewable energy trade association in the UK. Wind has been the world's fastest growing renewable energy source for the last seven years, and this trend is expected to continue with falling costs of wind energy and the urgent international need to tackle CO_2 emissions to prevent climate change.

BWEA

BWEA
Greencoat House
Francis Street
London SW1P 1DH
United Kingdom

Tel: +44 (0)20 7901 3000
Fax: +44 (0)20 7901 3001

www.bwea.com