Arthur D Little

Energy & Utilities

All at Sea

The Future of Offshore Wind in Europe

Contents

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Executive Summary

The future of offshore wind is in doubt

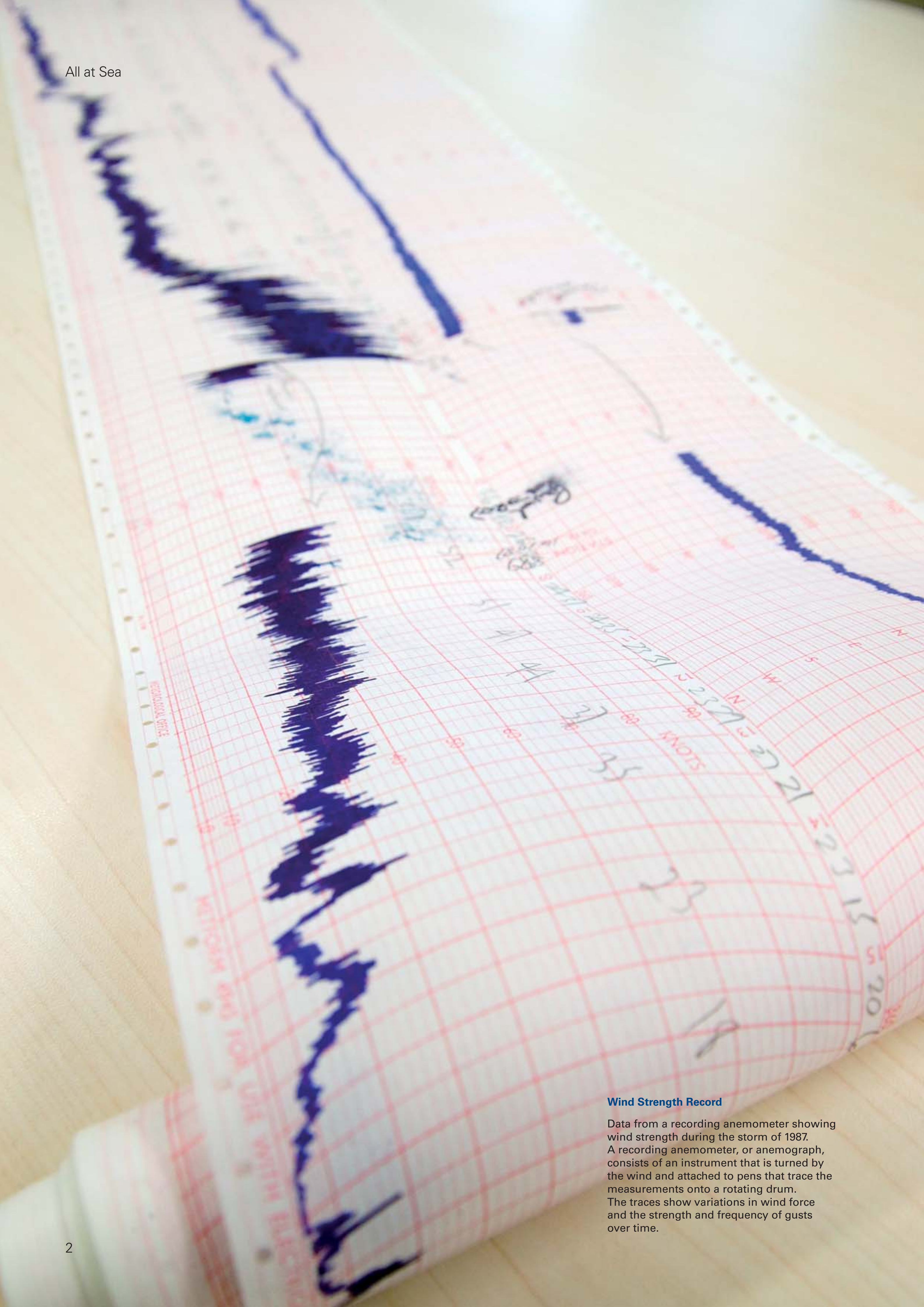
Offshore wind is, in many ways, an ideal form of green energy. It is clean and renewable, and can be deployed well away from public view. It is well supported, especially in Europe, by the public and governments as a way of meeting their renewables targets.

However, despite this positive climate, the future of offshore wind is by no means assured. Supply constraints, logistical difficulties and technical concerns present significant obstacles to the expansion of the sector. The first two barriers are well known, and in some ways easier to overcome. The technical challenges are less widely recognized but present the biggest barrier to long-term growth.

The figures are stark. Onshore, wind turbines can achieve availability levels of 97%. Offshore, technical problems mean that number can be as low as 60%. This problem is exacerbated by the remote nature of the installations, which makes repair times much longer than for onshore facilities.

If the offshore wind industry is to become a major player in the energy sector, it will need to address this high technical failure rate and find ways of developing equipment that is robust and reliable in an offshore environment. No one part of the industry is going to be able to achieve that step change in the technology. It will require collaboration and a willingness to share resources and knowledge. That collaboration will need to be driven by smarter customers and by governments providing research funding and direct financial incentives.

In this paper we examine in more detail the nature of the current challenges facing the offshore wind industry, and highlight what action needs to be taken to overcome those challenges.



Wind Strength Record

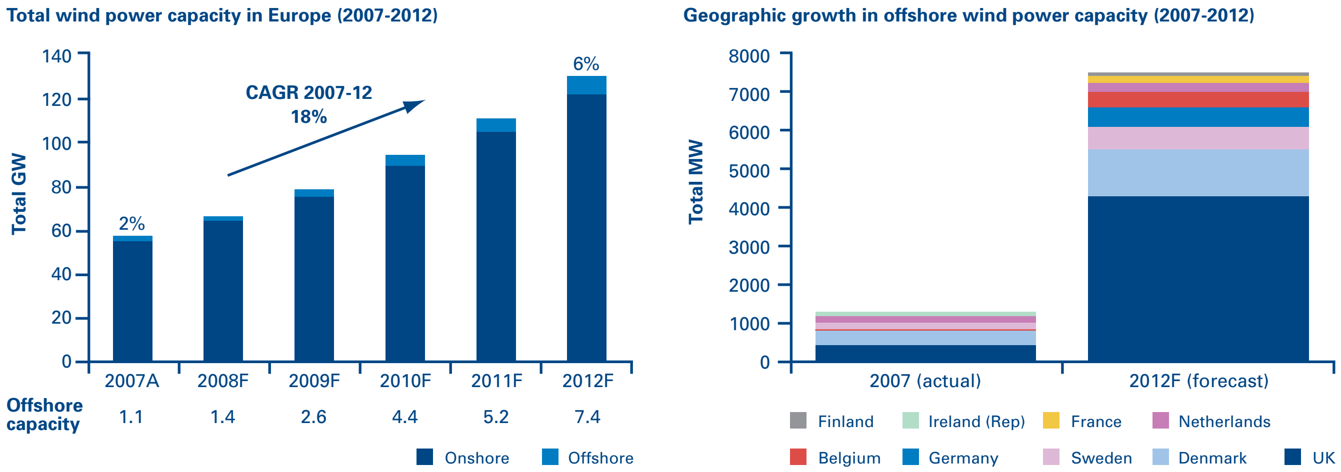
Data from a recording anemometer showing wind strength during the storm of 1987. A recording anemometer, or anemograph, consists of an instrument that is turned by the wind and attached to pens that trace the measurements onto a rotating drum. The traces show variations in wind force and the strength and frequency of gusts over time.

Introduction

The offshore wind market is a small but growing part of the world energy market. Total capacity reached 1GW in 2007 (around 0.01% of global energy capacity) and is set to increase sevenfold over the next five years. Although efforts are being made to stimulate offshore developments in the US and Asia, activity is currently confined to Europe, with the majority of future growth expected to come from the UK, which is predicted to have 20GW of capacity by 2020.

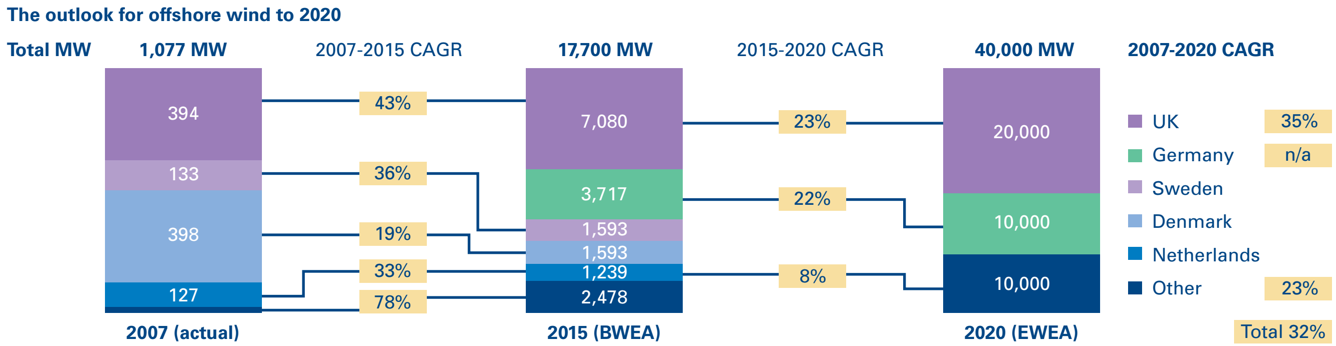
This growth is supported by the UK Government, which has recently affirmed its commitment to offshore wind as a key contributor to its goal of generating 15% of the country's energy needs from renewable sources by 2020. Currently there are only 149 offshore turbines operating in the UK. According to the government's calculations, an extra 3,000 turbines are required (compared to an extra 4,000 onshore) to meet the 2020 target, which represents an enormous challenge to the industry.

Figure 1. The Forecast for Offshore Wind Growth in Europe – Overall growth in European wind power capacity over the next five years is expected to be 18%. Offshore is set to rise to 6% of total capacity, with the UK as the focus



Source: BTM Consult, World Market Update 2007, Arthur D. Little industry analysis

Figure 2. The Outlook for Offshore Wind to 2020 – The target of 40GW for Europe by 2020, of which roughly three quarters are expected to come from the UK and Germany, looks ambitious



Note: BWEA prediction assumes no supply constraints. EWEA is not confident to predict geographic breakdown beyond UK and Germany

Source: BWEA, EWEA, BTM Consult, Management, Arthur D. Little analysis

The Problem

However, despite public and governmental enthusiasm for these projects, the offshore wind industry's ability to meet these ambitious targets is far from assured.

The challenge begins with the need to convince investors to finance the high upfront costs. From the outset, offshore projects need to offer the prospect of a strong return to reduce the payback time. The business case then depends on building as many turbines as possible and, in order to maximize power yield per turbine, those turbines have to push the limits on size.

Delivering projects of this scale and scope successfully means overcoming three obstacles: **supply constraints**, **logistical difficulties** and **technical challenges**.

Supply constraints

Supply constraints are affecting the entire wind industry, both onshore and offshore. The primary factor stretching capacity is the combination of consolidation following the last period of cyclical oversupply, and sharply increasing demand.

Furthermore, suppliers are adopting risk-averse strategies where offshore wind is concerned, and many are unconvinced that the risks of offshore technology justify investment in production facilities. As a result, there are only two major offshore turbine manufacturers: Vestas and Siemens. The sector is unattractive to smaller suppliers, such as the German firm Enercon, for whom risk is not as easy to diversify away. While there are some new players prepared to take the gamble, such as REpower and Clipper, who are developing offshore-specific models, lead times on these models of up to three years mean that these supply constraints are unlikely to ease in the short term.

The situation is further complicated by the fact that offshore production is in direct competition with onshore across its supply chain and, for certain components, there is competition with other industries as well, with bearings (delays of 1-2 years) and blades (delays of 18 months), which are currently key areas of shortage.

However, in the medium term, as new players enter the market, these constraints will subside. Indeed, some manufacturers are convinced that a period of oversupply is possible and imminent, prompted in some parts of the world by a swing in favor of nuclear power.

Logistical difficulties

Clearly offshore wind facilities present major logistical challenges in both their installation and in maintenance. There are difficulties right from the start, as UK ports in particular are often poorly adapted to manage the size of offshore turbines.

As in manufacturing, the offshore wind industry also faces competition from other industries. High levels of offshore oil and gas activity and fully booked shipyards mean the supply of installation and maintenance vessels is constrained.

Here again, however, supply and demand will in time adjust, and these constraints will be overcome.

Technical problems

It is the third barrier, technical problems, that presents the biggest potential risk to the future of the industry. Technical failure rates in offshore wind can be high compared to onshore, reducing availability to 60%. Offshore failures are difficult and expensive to fix. This is underlined by an analysis of maintenance records, which shows that while service teams for offshore wind farms are supposed to make two scheduled maintenance visits every year, unscheduled visits to many installations are made 20 times a year.

Onshore, serious technical failures are high-profile events, because they have the potential to cost lives as well as money. Most notable in the past year was the disintegration of the Vestas turbine, near Arhus in Denmark, due to 'lack of maintenance'. Several incidents in the UK and Germany, including loose blades crashing into roofs of houses, have some questioning the viability of onshore turbines in inhabited areas of the country.

This, in one sense, would strengthen the case for offshore turbines. Given, however, that 'lack of maintenance' is likely to be unavoidable for remote offshore turbines, that they are likely to be much larger than the turbines and therefore more prone to failure than onshore machines, and that they will be subjected to even more extreme conditions, the prevalence of failures onshore highlights the crucial need for current offshore designs to be radically improved.

Why do turbines fail?

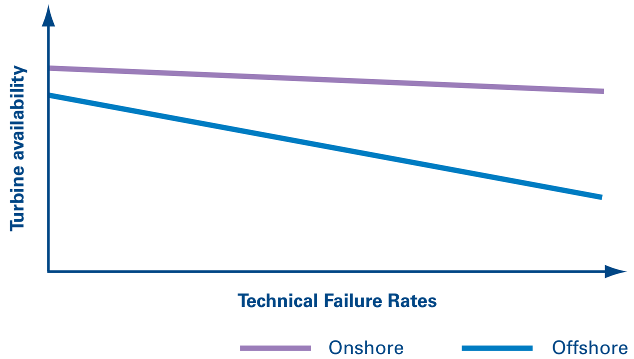
The heart of the problem is that the technology being used offshore is generally onshore technology that has not been modified sufficiently to meet the different demands of an offshore environment. Failures are also harder to repair because they tend to happen in stormy conditions, and are often not dealt with when they happen, but on an aggregated basis at intervals. That means it can be as long as three months before a turbine failure is repaired. The contrast is dramatic with onshore reliability, where availability levels of 97% are regularly achieved.

"A leading industry figure in the German market informed Arthur D. Little that offshore has 10 years in which to prove itself, after which it may be partially or wholly curtailed in German waters."

As sites move further offshore, this problem is likely to get worse. That could mean offshore developments in deepwater areas will be seen as unviable. We are already seeing evidence of caution in this area. All the potential sites in the German North Sea have been allocated, but it is uncertain as to whether investment will follow. A leading industry figure in the German market informed Arthur D. Little that offshore has 10 years in which to prove itself, after which it may be partially or wholly curtailed in German waters.

Figure 3. The Effect of Technical Failures Offshore – Failure rates in current wind turbine technology are high. While this is manageable onshore, offshore it leads to greater downtimes and significantly lower availability

Technical failures offshore have greater impact on availability



- Technical failures are common onshore and offshore
- They are harder to repair offshore, and lead to longer downtimes
- This has a greater effect on availability

Source: Arthur D. Little interviews and analysis

What is Needed

The change needed for the industry to secure its long-term future is for its technology to become more robust and reliable.

Arthur D. Little sees three areas that need attention:

- Better design of individual components (e.g. smaller, two-stage gearboxes), the drive train (smarter integration of key components), and foundations.
- Increased levels of R&D – not only in design, but also access and maintenance methods.
- More thorough certification testing so components really can withstand the offshore environment.

Our analysis shows that testing is probably the crucial element that will stimulate work in the other two areas. To date, testing has clearly been inadequate. Manufacturers have claimed it is possible to test onshore without the expense of offshore testing. However, there is clear evidence that, while it may be possible to test individual components onshore, running a turbine in real offshore conditions for at least a year would bring to light many key problems and save considerable amounts of money.

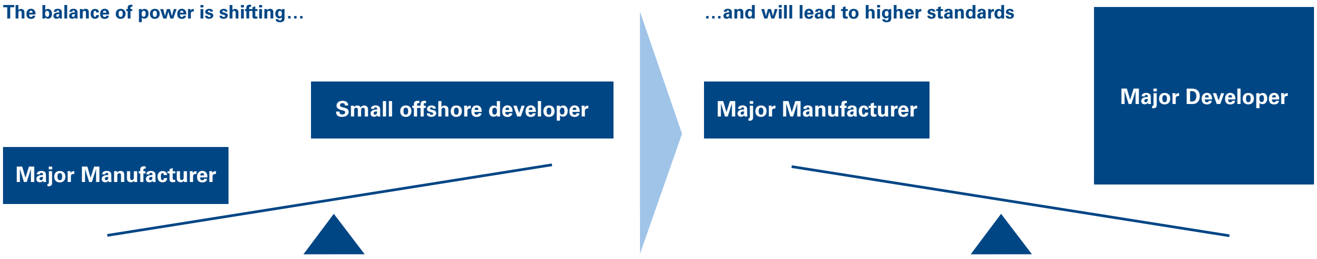
Such testing has already been shown possible, albeit with government support. In Germany, for example, offshore testing is already taking place at Alpha Ventus (albeit on a partly commercial basis).

All this work will need to be underpinned by collaboration. To date, the industry has been characterized by a general atmosphere of secrecy and suspicion and, as a result, there has been fragmentation of knowledge and lack of research progress. Better communication and collaboration between all parts of the industry would stimulate and accelerate work in these areas, allowing knowledge to be shared and costs reduced.

"However, there is clear evidence that, while it may be possible to test individual components onshore, running a turbine in real offshore conditions for at least a year would bring to light many key problems and save considerable amounts of money."

How it will Happen

Figure 4. The Shifting Balance of Power – In the future, as wind farm developers become bigger than the manufacturers and gain experience, standards will need to increase



Source: Arthur D. Little interviews and analysis

The catalyst for change will come from a shift in the balance of power away from the wind turbine manufacturers towards bigger and more experienced customers.

These customers will have the knowledge as well as the muscle to make specific demands for improvements in testing and development, in a way that was impossible for small wind farm owners. These higher standards will filter all the way down the supply chain and are likely to result not only in better design, but also better type testing of components and integrated systems during the production process.

There is already evidence that, as the industry matures, customers are becoming more assertive. This is seen both in the demands they are making in terms of quality, but also in their willingness to walk away from the deal if they are not satisfied with the economics. Shell's recent exit from the London Array is a high-profile illustration of this point.

The customers hand will be strengthened further as the supply constraints begin to ease and growing competition stimulates innovation.

This new environment should encourage turbine suppliers to be more open about their technology. This will, ultimately, work to their advantage. At the moment, individual company research into the causes of mechanical failures or ways of improving access and maintenance may be prohibitively expensive Collaboration can reduce those costs significantly.

In terms of testing, greater openness would facilitate the testing of integrated drive trains. Independent testing facilities – such as the proposed NaREC Centre of Offshore Excellence in Blyth, UK – could be used as a neutral location for such tests to be carried out without compromising secrecy. It is true that such shared schemes have been tried before and not succeeded, but in a changing climate these options will need to be considered again.

This kind of collaboration is not unusual in the energy sector. In offshore oil and gas, for example, E&P companies have collaborated for years on access and maintenance issues, and the results have benefited the entire industry. This shows that there is a clear model to follow.

What should concentrate minds in the offshore wind industry is the clear message that without collaboration, the offshore wind industry will not mature or progress.

Conclusion

If offshore wind is to become a significant player in meeting Europe's energy needs, action will be required from:

- **Offshore wind farm owners and developers** to apply pressure on turbine suppliers to invest in rigorous component testing and robust offshore-specific R&D;
- **Turbine and component manufacturers** to take a long-term view and invest to secure a sustainable future for the offshore wind market;
- **Governments** to free up funding for public R&D centres and projects that can act as catalysts for industry collaboration and 'open research'. The 'Upwind' project, which has produced insights in blade development, is an example of how this can work successfully. Perhaps even more important are direct financial incentives such as the feed-in tariff, which will also be core to allaying investors' financial concerns.

This means all the industry players need to move away from their current risk-averse approach. They need to recognise the distinctive nature of offshore developments and their particular technical requirements. This will take time, but there are some encouraging signs that the offshore turbine market is beginning to recognize the need for a new and distinctive approach.

This trend must continue if offshore wind is to become a significant, sustainable, financially viable source of power.

"Perhaps even more important are direct financial incentives such as the feed-in tariff, which will also be core to allaying investors' financial concerns."

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Offshore Turbines

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