The driving force of future offshore wind

Achieving market acceptance and cost parity for wind energy

Abstract

Over the last two decades, the offshore wind energy sector has experienced a steady decrease in the average cost of wind power energy, due largely to the increased size of wind turbines. However, to more effectively fill the energy mix gap faced by countries around the world, wind energy must move on from being considered a niche power source.

This white paper addresses the challenges faced by the global offshore wind energy sector and discusses the solutions that will help to drive the industry forward to achieve both mass-market acceptance and a levelised cost of energy that is comparable to traditional power sources.
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About the TÜV SÜD expert

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Nigel has worked on many of the world’s largest and most complex renewable energy projects during their development, construction and operation, including a large number of offshore wind and marine energy projects. He also has experience of working for turbine manufacturers, construction companies, developers and government agencies, with diverse roles in an advisory capacity. His offshore wind energy roles have included WTG Lead, interface manager, QA manager, and foundation lead, on projects including London Array, Princess Amelia, Walney and Cape Wind.
1. Introduction

Global race

The number and pace of development of wind energy programmes across the world continues to grow, with 2013 market statistics from the Global Wind Energy Council (GWEC) showing that cumulative global capacity has reached a total of 318,105 MW (Figure 1), an increase of nearly 200,000 MW in the past five years.

Cost parity

The levelised cost of energy of onshore wind power is now close to reaching that of traditional power sources, with offshore energy following closely behind. Both are likely to remain the cheapest form of low carbon volume generation for the foreseeable future.

Indeed, GWEC’s view\(^2\) is that it is wind’s cost competitiveness that is its greatest advantage in the market place, as in Brazil, South Africa, Turkey, Mexico and elsewhere, wind is competing directly and successfully with heavily subsidized incumbent power sources. Wind is also coming in about 30% cheaper than coal-fired power plants in South Africa. GWEC also predicts that market growth over the next five years will be concentrated in Asia, Latin America and Africa.

Cost reduction is also being experienced in the mature wind market of Europe, with the European Wind Association (EWEA) stating that wind energy offers a valuable alternative to costly fossil fuel imports. It predicts that an increase in wind energy will avoid between €22 bn and €27 bn of fuel costs annually in 2020, increasing to between €47 bn to €51 bn in 2036\(^3\).

The European Commission proposes increasing renewable energy penetration to 27% of consumption in the EU by 2030. EWEA forecasts that this will result in fossil fuel import savings of €190 bn over the 20-year period of 2011-2030\(^3\).

However, while the overall cost of wind energy has steadily decreased by five to 20% per year on a cost per kWh basis, over the last 20 years,

FIGURE 1: TOP 10 CUMULATIVE CAPACITY DEC 2013

<table>
<thead>
<tr>
<th>COUNTRY</th>
<th>MW</th>
<th>% SHARE</th>
</tr>
</thead>
<tbody>
<tr>
<td>PR China</td>
<td>91,412</td>
<td>28.7</td>
</tr>
<tr>
<td>USA</td>
<td>61,091</td>
<td>19.2</td>
</tr>
<tr>
<td>Germany</td>
<td>34,250</td>
<td>10.8</td>
</tr>
<tr>
<td>Spain</td>
<td>22,950</td>
<td>7.2</td>
</tr>
<tr>
<td>India</td>
<td>20,150</td>
<td>6.3</td>
</tr>
<tr>
<td>UK</td>
<td>10,531</td>
<td>3.3</td>
</tr>
<tr>
<td>Italy</td>
<td>8,552</td>
<td>2.7</td>
</tr>
<tr>
<td>France</td>
<td>8,245</td>
<td>2.6</td>
</tr>
<tr>
<td>Canada</td>
<td>7,803</td>
<td>2.5</td>
</tr>
<tr>
<td>Denmark</td>
<td>4,772</td>
<td>1.5</td>
</tr>
<tr>
<td>Rest of the world</td>
<td>48,831</td>
<td>15.2</td>
</tr>
<tr>
<td>Total Top 10</td>
<td>269,773</td>
<td>84.8</td>
</tr>
<tr>
<td>World Total</td>
<td>318,105</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Source: GWEC
The European Commission proposes increasing renewable energy penetration to 27% of consumption in the EU by 2030.

The cost of the technology used to generate it (per kWh) has remained relatively constant. This means the continuous trend in the reduction in the cost of wind energy is driven almost exclusively by the increasing average size of wind turbines. For wind energy to break away from being considered a niche power source, material costs must reduce as the size of turbines increase.

No level playing field

As costs to the state budget can vary widely when supporting renewable energy, so different subsidy wind power regimes exist across the world. Also, many emerging countries, such as China, Japan, Taiwan and Vietnam, are unfamiliar with the policy measures available to accelerate the deployment of wind power. This is compounded by the fact that tariffing policies tried in the past perform differently because of the varying market environments in each country.

Consequently, despite wind power’s obvious environment and cost-saving benefits, the different subsidy regimes within each country do not make the global market an equal playing field, creating different levels and areas of risk for investors in each region.

For example, GWEC believes that the growth in China is a result of the government’s commitment to wind power by raising the official target for 2020 to 200 GW, consequently Chinese industry has responded.

While the wind power industry has grown in excess of 20-fold over the last two decades, this growth has been limited by the subsidy regime available in each global region. By their very nature, subsidies are not orientated to maximising resource and all have particular strengths and weaknesses, resulting in a bias in the capacity installed.

The success of wind energy in any country is therefore defined by its subsidy regime of which there are two main types:

- Feed-in Tariffs (FIT) – governments typically offer a fixed price to energy producers.
- Market-driven tariffs – offer a variable price in line with market fluctuations.

While FITs traditionally bring stability to the market and encourage technology development and manufacture, as well as investment, this regime is now changing in some parts of Europe as governments wrestle with the recession aftermath. For example, countries such as Bulgaria, Spain and Romania are now retrospectively changing prices paid through their FIT schemes. Governments across the globe are also at risk of having schemes oversubscribed as wind power increases in investment appeal.

There are a myriad of different types of market-driven tariffs across the world. However, these do not tend to support manufacturers as price instability creates uncertain future market conditions. If they invest in new plants, they run the risk of being manufacturing-ready when market demand for products has subsequently fallen.

The future is offshore

The majority of turbine manufacturers operate on a global basis and, as the market matures, volume sales deliver them the most profitable solution. While equipment manufacturing benefits economies of scale through multiple production of the same turbine type, this is entirely contrary to the requirements to tailor turbines to meet specific site wind regimes and optimise available resources.

However, over the last twenty years such economies of scale have delivered a steady, significant decrease in the average cost of wind power energy, due largely to the increased size of wind turbines. The physical cost of doubling the blade length of a wind turbine is less than two-times, whilst the output derived from this delivers a potential eight-times increase in potential power. This fundamental size advantage could therefore be used more productively to deliver cheaper energy cost to the end user.

To meet growing demand for wind power, the future therefore lies in offshore as this environment can accommodate significantly larger turbines and is less encumbered by planning and design constraints imposed on onshore wind farms.
2. Market challenges

To meet future global energy demand and see offshore wind power unequivocally accepted as the lowest cost energy source to be produced on a large-scale basis, the market must embrace the challenges of making this a reality.

Controlling the dynamics required for this step change is largely in the hands of the wind power industry. However, when the industry was in its infancy, reliability issues with turbine technology impacted the market’s level of confidence in its potential. Now that significant improvements have been made, with manufacturers offering more extensive warranties on equipment and components, confidence has only just been gained in the capability of turbine technology to deliver.

Technology confidence will in turn encourage investors, governments and the general public to make wind energy their power generation source of choice within the energy mix. However, there still remains several barriers to wind energy’s success:

Investment in equipment not fuel

Investment required for a wind energy project is concentrated at the front-end, when buying equipment. However, for conventional power generation the cost element of fuel is ongoing, right the way through the project’s lifetime.

While the investment approach for wind energy may initially seem advantageous, in terms of cost security, lack of reliance on supply chains etc., the comparatively sizeable investment required when a project commences stresses the financial viability of a wind project substantially.

Likewise, a project utilising the largest turbines, based upon more recent designs, requires this front-ended cost model to be more heavily stressed. While these newer designs carry more sophisticated features, their associated technology risk is less proven and therefore delivers the financing community a more challenging route to investment.

Project risk certainty

For wind projects, risks are largely based on:

- The risk margin of wind measurement
- The reliability of the equipment (driven by an understanding of the wind regime, environment and other site factors).

Generally the finance community is able to come to terms with market-driven risks, which can potentially be managed with supply contracts. However, uncertainty on the variability of the wind is something that is more difficult to incorporate into a financial model, and normally finance can only be achieved on very conservative wind regime values.

This represents an opportunity as well as a challenge, as the methods and understanding of wind modelling and prediction are improving dramatically. Improvements in these estimation accuracies reflect directly on the level of financing that can be introduced into the project and as such the overall profitability. However, any poorly applied measurement techniques undermine the overall reputation of the wind prediction industry and therefore erode the trust between the scientific and financing elements of the industry.

Likewise, the wind industry has historically had a poor reputation for reliability, which has resulted in available finance being limited. A large amount of this inefficiency can be traced back to a root cause of a lack of understanding of the wind regime in which wind turbines are installed, and subsequently their interaction with each other. For example, wind turbines installed in
benign conditions tend to require significantly less maintenance than those in complex, highly stressed wind conditions.

The application of robust wind analysis, which clearly defines the wind regime of the site under consideration, combined with in depth understanding of the technology to be deployed in the design stage, results in projects which have the ability to be managed at levels much higher than those normally achieved.

Local support

For large scale deployment, wind turbines are more viable than any other form of power generation, and will fill the gap in the energy mix that confronts most countries around the world. However, the remaining barrier to effective use of wind energy is public acceptance.

Public and local political acceptance is key to a project’s success. Value must therefore be proven to local stakeholders to garner their support for a project to succeed. This acceptance works hand-in-hand with political support, and is complemented by fundamental local benefit, which normally takes the form of local manufacture and its related employment.

Poor implementation

Wind turbines are very sensitive to two parameters – wind speed and blade diameter. Figure 2 shows how these elements increase exponentially against these parameters, combining to give highly advantageous power generation performance. The power increases as does the square of the rotor diameter, and more significantly as the cube of the wind speed also increases. Therefore, with high wind speed and large blade diameters, energy generation can be significantly increased and costs do not increase in line with this.

However, in addition to the technical challenges detailed above, turbine manufacturers are limited in how they can maximise a project’s implementation by two factors:

- The ability to attract effective finance on turbines using technology which is not considered ‘proven’.
- The limiting effect of public and political acceptance.

Projects implemented five years ago used the best technology available at the time. While this is now considered ‘proven’ technology, it does not reflect the progress of technological development. What is available today could significantly maximise wind energy generation for new projects, but it is difficult to secure finance for such technology that is considered unproven.

Wind projects are also often built in locations and configurations that are constrained in order to satisfy strict limitations imposed by public opinion and strict environmental constraints, such as limits on turbine tip heights, size of wind farms, and site distance from towns/villages. In addition, projects are not sited in the most appropriate location due to the desire to avoid areas where local objection is best mobilised and political influence less willing to support (these generally coincide with areas where jobs are not dependant on the success of the industry).

**FIGURE 2: DELIVERING ADVANTAGEOUS POWER PERFORMANCE**

![Graph showing maximum power vs. wind speed and rotor diameter](source: M. Ragheb - Wind Power Systems. Harvesting the Wind. 2011)
3. Bringing down the barriers

The barriers to appropriate global deployment of wind power are manageable, as the combination of financial and technical challenges are now fully understood. And significant progress is being made in breaking these down.

While great progress is being made towards making wind power considerably more attractive, technology must be advanced faster to more quickly reduce the levelised cost of energy so that it becomes the most cost effective form of generation.

To support the advancement of wind power on a global scale, lessons learnt across the industry must also be incorporated into findings, improvements and structures.

**Investment support**

Conventional project finance does not help with advancing the development of wind energy technology, as it is inherently conservative. What is needed are bold moves at a national or international level, to provide the catalyst for a rapid rate of technology development. This would significantly streamline the connection between the research and development and commercial deployment stages, thereby allowing the deployment of more efficient turbines sooner. This is likely to only come from governments or international non-commercially driven finance organisations.

**Implement lessons learnt**

To support the advancement of wind power on a global scale, lessons learnt across the industry must also be incorporated into findings, improvements and structures. For this to succeed, a shift in risk management and reward in favour of the equipment provider will be required so that they are incentivised to make such improvements.

Currently, the equipment providers are in control of a significant part of the value chain as the cost effectiveness of turbines has increased exponentially against the purchase cost of turbines, which has remained fairly static. As the wind energy market matures, there is significant value in better understanding projects technically, optimising the risk profile of projects on a number of levels and redistributing these to the part of the supply chain best equipped to manage this risk.

**Demonstrate local benefit**

By far the most effective way to demonstrate the benefit that a wind energy project delivers the local area, is through job creation. However, this must be realistic and sustainable, as there are many examples of grant driven or manufacturing tied to consents, which in the long-term turn local support against wind energy.

If manufacturing jobs of a significant number are created this will also drive the creation of a large supporting supply chain, delivering economic community benefit that
helps to garner local support and political drive. This can be seen in all the main manufacturing centres of Germany, Denmark and Spain, where support is much higher than elsewhere. Public acceptance and support is also generally higher in areas which require more governmental economic support as their old industries have died, such as the Outer Hebrides and Orkneys.

**Avoid poor implementation**

Historically, a wind project’s focus was to maintain the levels of output originally committed to within the minimum maintenance cost. Now, improvements in technology allow for in-service upgrades, or maintenance activities being carried out during low wind speed periods.

Long-term planning should therefore allow for this, especially as this more mature industry has a better understanding of the impacts of wind resource, flow and turbine reaction, as well as long-term maintenance needs.

Wind energy projects should therefore benefit from an ongoing learning curve during operation so that they can be improved beyond expectations as technology evolves throughout the project’s lifetime.

**Harness offshore advantages**

To fully benefit from high wind speed and large blade diameters, in order to maximise energy generation and reduce associated costs, offshore implementations offer a solution. Implementing larger turbines offshore is less logistically challenging and the higher wind speeds experienced offshore exponentially exaggerate the benefits afforded by the larger blades. Additionally, the lower turbulence experienced offshore makes it easier to deploy larger blade to generator ratios.

If confidence can be increased, that the new larger turbines will perform, then the increased financial performance of larger turbines cannot be ignored by the industry.
4. Pragmatic expertise to navigate complexity

TÜV SÜD has an unparalleled 20-year track record in supporting more than 3,000 wind energy programmes, developing, constructing, operating and carrying out due diligence on a wide range of projects.

Our areas of specific expertise for due diligence commissions includes:

- Turbine Supply Contract Review
- Balance of Plant Contract Review
- Grid Connection Offer / Agreement Review
- Operations and Maintenance Agreement Review
- Resource and SCADA Analysis
- PPA Review and Negotiation
- Capital and Operating Expenditure Review
- Planning Obligations and Permit Review
- Property Agreement Review
- Risk Management and Interface Management
- Quality Assurance
- Lender’s Engineer
- Operational Performance Assessments
- Supplier Evaluation and Supply Chain Services
- End of Warranty Assessments
- Feasibility Studies
- Market Analysis

5. Business benefits

We work closely with our clients to understand their drivers and goals in order to deliver professional and efficient due diligence services that enable you to:

- **Understand risks and gain certainty** – from the early stages of decision-making, ensuring reliable development and operation of your wind energy project.
- **Increase asset value** – by partnering with a globally renowned service provider that has a proven track record in supporting the entire project lifecycle.
- **Maximise return on investment** – through effective risk management for the economic optimisation of facilities that achieve long-term profitability.
- **Increase confidence** – through accurate assessment and mitigation of project risk provided by our highly qualified and experienced wind energy specialists.

**Increase stakeholder confidence** - TÜV SÜD’s multi-lingual experts apply their knowledge of the global marketplace in a local context to minimise risk and costs.

As a global consulting firm with an unparalleled record in supporting offshore wind project Projects, TÜV SÜD provides organisations with the necessary expertise to identify, evaluate and enhance projects, portfolios and businesses through strategic and pragmatic technical due diligence.
6. Conclusion

As global demand for electricity grows apace, wind turbines represent the most viable option for large scale energy generation. However, the offshore industry faces several key challenges in its quest to achieve cost parity with other energy sources, through the development of wind power as the undisputed global leader in large-scale, low-cost power generation projects.

This maturation of the offshore wind energy market will only be realised by increasing the pace of technological development and acceptance, with risk and reward more equitably distributed across the supply chain in order to galvanise all players into positive action.

A more insightful understanding of key project implementation factors will also make the difference between the long-term success and failure of individual projects, as well as the industry as a whole. But, even if these challenges are addressed, without public and political support the full realisation of wind as the future of power generation will not be achieved.

**Pragmatic support optimizes returns**

TÜV SÜD is currently actively engaged on projects, so our pragmatic approach delivers solutions and recommendations that help clients fully understand such challenges from the onset to maximise their return on investment.

Through our strategic support, we provide clients with the technical expertise to identify and evaluate risks to implement effective management strategies that enhance the value of projects throughout the entire lifecycle, from planning to operation.

TÜV SÜD’s advisory service delivers independent reviews of companies, projects and technologies to fully validate decision making. Our experts have the expertise, strategic support management and analytical skills required to successfully navigate complex issues and to maximise the successful implementation of the offshore wind energy projects of the future.
GLOSSARY OF ACRONYMS

GWEC - Global Wind Energy Council  
EWEA - European Wind Energy Association  
kWh - kilowatt-hour  
FIT - Feed-in Tariffs

FOOTNOTES


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