EUROPEAN UNION

FACILITATING OFFSHORE
WIND IN INDIA

OFFSHORE WIND POLICY AND MARKET ASSESSMENT

A GLOBAL OUTLOOK

The European Union is a unique economic and political partnership between 28 European countries. In 1957, the signature of the Treaties of Rome marked the will of the six founding countries to create a common economic space. Since then, first the Community and then the European Union has continued to enlarge and welcome new countries as members. The Union has developed into a huge single market with the euro as its common currency.

What began as a purely economic union has evolved into an organisation spanning all areas, from development aid to environmental policy. Thanks to the abolition of border controls between EU countries, it is now possible for people to travel freely within most of the EU. It has also become much easier to live and work in another EU country.

The five main institutions of the European Union are the European Parliament, the Council of Ministers, the European Commission, the Court of Justice and the Court of Auditors. The European Union is a major player in international cooperation and development aid. It is also the world's largest humanitarian aid donor. The primary aim of the EU's own development policy, agreed in November 2000, is the eradication of poverty.

http://europa.eu/

OFFSHORE WIND
POLICY AND MARKET ASSESSMENT

A GLOBAL OUTLOOK

DECEMBER 2014

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TABLE OF CONTENTS

7 Case studies

List of figures and tables

FOWIND
focus states
in India
(for illustrative
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FOREWORD

On behalf of the FOWIND consortium, I am pleased to see the publication of the *Offshore Wind Policy and Market Assessment*, which is an integral part of the first year outcomes under our four year project to put together a roadmap for developing a sustainable, commercially viable offshore wind industry in India.

The development of the offshore wind sector, which began in earnest at the beginning of the last decade, has been primarily in the waters off northern Europe. The success of onshore wind has led to a series of unrealistic expectations for the rapid growth of the offshore sector which have run up against hard, cold reality time and time again especially in Europe. The offshore sector is really a different industry altogether from the onshore sector, in terms of scale, capital requirements, and operational and technological challenges.

The last decade and half have also been times of rapid technological and economic change; challenging times for maintaining the policy stability required to build the economies of scale necessary for the establishment of the right machines, the right foundations, the right electrical infrastructure, and the right installation and operation and management practices which are only now leading to the cost reductions necessary to make the sector commercially viable in the long term.

This report seeks to review the experiences to date in the major markets, as well as to put the offshore wind sector in a larger context of the industry as a whole. We try to tease out the lessons that may be useful for Indian policymakers as they piece together the policy, regulatory and financing frameworks which will allow for the development of a sustainable, commercially successful industry; which of course must be adapted to both the unique opportunities and challenges of the Indian financial and energy environments. We hope you find it useful.

S. H. Sawyer

Steve Sawyer

Chair, FOWIND Project Executive Committee
and
CEO, Global Wind Energy Council

ABOUT FOWIND

The **Facilitating Offshore Wind in India** (FOWIND) project is implemented by a consortium led by the **Global Wind Energy Council** (GWEC). Other consortium partners include the Centre for Study of Science, Technology and Policy (CSTEP), DNV GL, the Gujarat Power Corporation Limited (GPCL), and the World Institute of Sustainable Energy (WISE). IL&FS Energy Development Company Limited (IEDCL) joined the consortium as a strategic partner in April 2014.

The project seeks to establish structural collaboration and knowledge sharing between the EU and India on offshore wind technology, policy and regulation and serve as a platform for promoting offshore wind research and development activities. The project focuses on the states of Gujarat and Tamil Nadu for identification of potential zones for development through preliminary resource and feasibility assessments for future offshore wind developments.

This report has been developed as part of Work Package 6 on Knowledge Exchange and Structural Cooperation. Under this package GWEC is working with FOWIND partners to facilitate sharing of relevant regulatory, research and industry experience from Europe. Actions under this work package will support Indian decision makers' efforts towards developing a robust policy and regulatory framework for offshore wind.

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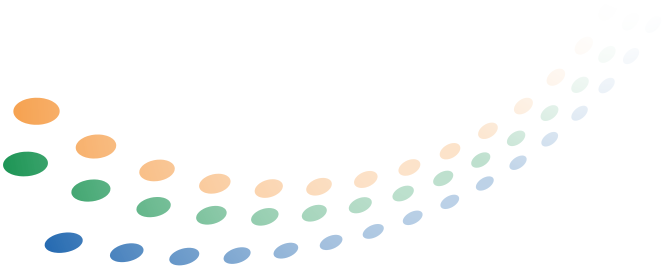
EXECUTIVE SUMMARY



India has a strong need for large-scale, indigenous and clean energy production.

As a rapidly developing nation, India increasingly requires secure access to modern sources of energy: this is essential for reducing poverty and improving health, increasing productivity and competitiveness, and promoting economic growth. Even today about 300 million people in the country lack access to electricity[1]. In addition, rising concerns about climate change, combined with the desire to improve energy independence, is prompting policymakers to consider new energy generation options.

India already has a strong track record in onshore wind, but the rate of capacity addition has fallen in the past couple of years due in part to policy instability, but also state-specific issues linked to land acquisition for projects. As a result, **offshore wind may now have a role to play,** holding the potential for alleviating the land acquisition challenge. Although the costs are greater than its onshore cousin, offshore wind has some inherent advantages such as a large wind resource, higher wind speeds and more clarity over land tenure. Offshore wind can also play a role in meeting the demand from load centres closer to the coastline – for example, Greater Mumbai, Chennai and Surat, as well as other big cities such as Vishakhapatnam and Vadodara, subject to technical and economic feasibility.

Looking globally, offshore wind has come of age. It is well over ten years since the first commercial-scale offshore wind farm, *Horns Rev,* was completed in the Danish North Sea. Although the path to roll-out has not always been smooth, over 7 GW had been installed in Europe and Asia by the end of 2013 – and counting. Policymakers across the world are increasingly recognizing the benefits of generating power from a clean and indigenous energy source, which not only brings industrial development possibilities, but is also starting to demonstrate cost reduction.

Yet **offshore wind represents a significant regulatory, technical and financial challenge.** Deploying wind turbines in the hostile marine environment remains complex and the risks associated with these capex-heavy investments should not be underestimated. A huge amount of regulatory change is required, involving coordination across departments and stakeholders. Experience shows that policymakers have a crucial role to play in creating the right incentive, grid connection and consenting regime that secures industry confidence and catalyzes investment, helping to lower project risk and push technologies towards maturity.

This report has reviewed progress in the sector to date and focused on the regulatory and policy frameworks in seven leading markets. It has drawn out the following **key recommendations for India:**

i. Set a clear offshore wind target and roadmap to convey the vision to industry

Experience shows that a clear, time-bound, quantitative target for offshore wind development, and a roadmap of how to achieve it, is an effective tool to focus minds on the offshore wind opportunity.

ii. Clearly articulate and affirm energy policy objectives to maintain industry confidence

A clear understanding of wider policy objectives helps to provide industry with confidence that the drivers for offshore wind will persist even if the exact milestones do not always go to plan.

iii. Ensure managed progression from demonstration to commercial projects

Demonstration sites are crucial for identifying regulatory issues, testing the local supply chain, understanding specific environmental concerns, helping transfer knowledge and testing new technology. A clear plan for well-managed progress to commercial-scale projects is also required for industry to make the necessary investment in infrastructure.

iv. Provide strong initial public investment and utilise Public-Private partnerships where possible

Public investment is needed not just to reduce project risk and to provide soft loans but also to ensure that the preliminary assessments and necessary supporting infrastructure is developed. The current high cost of offshore wind means that a mix of public and private finance is likely to be required for early projects.

v. Ensure sufficient volume, delivered in a smooth pipeline, and design risk-informed support mechanisms to drive cost reduction

Confidence in sufficient market volume helps industry to maximise local ‘learning by doing’ and benefit from economies of scale – thus pushing down costs. Yet it is important to ensure a smooth pipeline, as rapid increases or decreases in deployment are challenging for the supply chain to manage. A further aid to cost reduction can be designing ‘risk-informed’ financial support mechanisms, which are structured such as to minimise upfront developer risk, and therefore minimise the cost of financing.

vi. Carefully consider the costs and benefits of promoting a local supply chain

Job creation can be a key driver for offshore wind, yet needs careful consideration. It could be beneficial for India to promote investment in this sector with a view towards creating a robust supply chain as part of the country’s industrial development strategy. However the decision to develop a supply chain must be based on whether the potential market is big enough to warrant a local supply chain that is commercially viable, and whether local companies would be able to win export opportunities in the wider global market.

1

INTRODUCTION

The FOWIND project is seeking to establish structural collaboration and knowledge sharing between the EU and India on offshore wind technology, policy and regulation and serve as a platform for promoting offshore wind research and development activities. The project focuses on the states of Gujarat and Tamil Nadu for identification of potential zones for development through preliminary resource and feasibility assessments for future offshore wind developments.

This report has been developed as part of Work Package 6 on Knowledge Exchange and Structural Cooperation. Under this package GWEC is working with DNV GL and other consortium partners to facilitate sharing of relevant regulatory, research and industry experience from Europe. Actions under this work package will support Indian decision makers' efforts towards developing a robust policy and regulatory framework for offshore wind.

WHY INDIA?

India has a strong need for large-scale, indigenous and clean energy generation. As a rapidly developing nation, India increasingly requires for secure access to modern sources of energy: this is essential for reducing poverty and improving health, increasing productivity and competitiveness, and promoting economic growth. Even today about 300 million people in the country lack access to electricity[2]. In addition, rising concerns about climate change, combined with the desire to improve energy independence, is prompting policymakers to consider new energy generation options.

India already has a strong track record in onshore wind. To date onshore wind has been the major contributor of renewable power in India, constituting 66% of installed renewable capacity. However, onshore wind resources in India are concentrated mainly in the five western and southern states of Tamil Nadu, Karnataka, Maharashtra, Andhra Pradesh and Gujarat. The rate of capacity addition has fallen in the past couple of years due to policy instability as well as state-specific issues linked to land acquisition for projects.

Offshore wind may now have a role to play. Offshore wind holds the potential for alleviating the land acquisition challenge. Although the costs are greater, offshore wind has some inherent advantages such as a large wind resource, higher wind speeds than onshore wind and more clarity over land tenure. Offshore wind can also play a role in meeting the demand from load centres closer to the coastline – for example, Greater Mumbai, Chennai and Surat, as well as other big cities such as Vishakhapatnam and Vadodara, subject to technical and economic feasibility.

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OFFSHORE WIND STATUS IN INDIA

The FOWIND project, co-funded by the European Union (EU), is conducting research to inform and support these efforts towards developing a roadmap for a long-term sustainable and economically viable offshore wind industry in India. This in turn may support work towards a first demonstration project in India. Economic feasibility will ultimately depend on whether good wind resources are available in shallow waters and close to shore.

There are not yet any offshore wind turbines installed in India – but the seeds of activity are underway. The Ministry of New and Renewable Energy (MNRE) is developing a draft offshore policy[3], and preliminary efforts are being taken to assess the offshore wind resource by the National Institute for Wind Energy.

THE ROLE OF THIS REPORT

Sound policy design is crucial to offshore wind's success. Deploying wind turbines in the hostile marine environment remains challenging, and the risk associated with these capex-heavy investments should not be underestimated. Experience shows that policymakers have a crucial role to play in creating an incentive and consenting regime that secures industry confidence and catalyzes investment, helping to lower project risk and push technologies towards maturity.

This report summarises the market and policy status of offshore wind globally. In doing so, the FOWIND consortium seeks to share the lessons of offshore wind development in north western Europe and China in order to provide a sound platform to inform policy design in India.

The report is structured as follows:

Markets
- Chapter 2: Market status
- Chapter 3: Market outlook

Trends and challenges
- Chapter 4: Cost trends
- Chapter 5: Financing trends
- Chapter 6: Challenges

Case studies
- Chapter 7: Case studies

Concluding analysis
- Chapter 8: Conclusions for India

By sharing these lessons, and tailoring them to the unique circumstances of the Indian power sector, it is hoped that the report will support India's policymakers in evaluating and/or realising the potential for offshore wind in India.

Footnotes

1 http://www.worldenergyoutlook.org/resources/energydevelopment/energyaccessdatabase/

2 http://www.worldenergyoutlook.org/resources/energydevelopment/energyaccessdatabase/

3 http://mnre.gov.in/file-manager/UserFiles/presentations-offshore-wind-14082013/JS-MNRE.pdf

2 MARKET STATUS

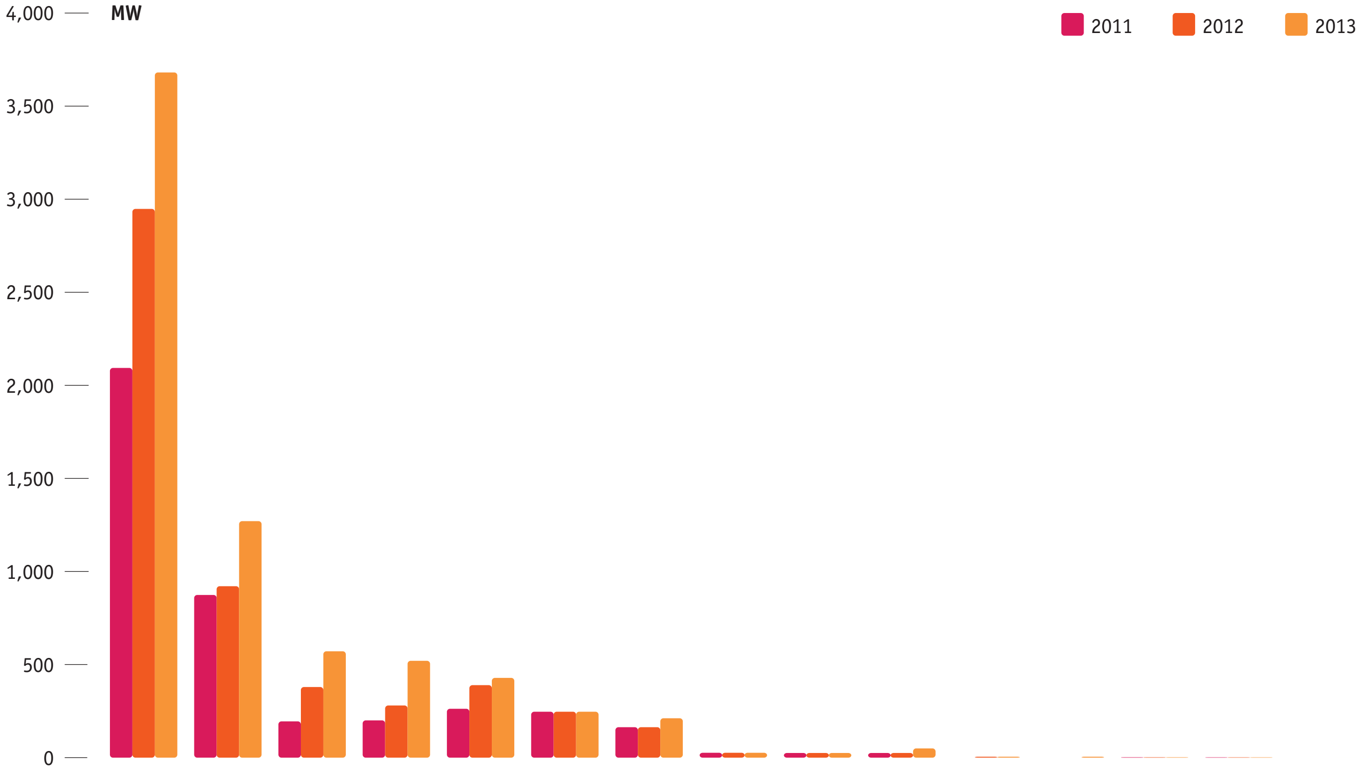
The transformation of the global energy system is well underway. More money was invested in new renewables-based generation capacity than on non-renewables-based generation capacity in 2013. At least 144 countries have renewable energy targets in place. Renewables accounted for more than 56% of net additions to global power capacity in 2013[4].

Offshore wind is already part of this energy transition, and has certainly come a long way since the early days of the first commercial scale offshore wind farm at Horns Rev. By the end of 2013, over 7 GW had been deployed globally. Whilst significant and growing, it is important to retain a sense of context – this represents 2.2% of the total 318 GW wind power capacity[5].

Deployment has largely been in European waters: more than 90% of offshore wind capacity to date has been installed in the North Sea, Baltic Sea, the Irish Sea and in the Atlantic Ocean. This European dominance is clear in *Figure 1*. The only significant offshore wind market outside Europe today is China. However, offshore development has begun in Japan, South Korea, Taiwan, Vietnam and the United States.

Anholt Wind Farm
© Siemens

FIGURE 1: CUMULATIVE INSTALLATIONS IN OFFSHORE WIND MARKETS (2011-2013)



	UK	Denmark	Belgium	Germany	PR China	Netherlands	Sweden	Finland	Irland	Japan	Korea	Spain	Norway	Portugal	US
2011	2,093.6	874	195	200.3	262.6	246.8	163.7	26.3	25.2	25.2	0	0	2.3	2	0
2012	2,947.9	921.1	379.5	280.3	389.6	246.8	163.7	26.3	25.2	25.3	5	0	2.3	2	0
2013	3,680.9	1,270.6	571.5	520.3	428.6	246.8	211.7	26.3	25.2	49.7	5	5	2.3	2	0.02

Source: GWEC

EUROPEAN OFFSHORE MARKET

2013 was a record year for offshore wind installations in the EU: 1,567 MW of new offshore wind capacity was connected to the grid, a 34% rise on the previous year. This represented over 14% of the EU's 2013 wind energy market. According to the European Wind Energy Association (EWEA) Siemens was the leading turbine supplier (69% market share), DONG Energy the leading developer (48% market share), and Bladt the leading substructure supplier (37% market share)[6].

Taking a cumulative perspective, the total installed EU offshore wind capacity reached 6,562 MW, enough to provide 0.7% of the EU's electricity. This consisted of 2,080 offshore wind turbines across 69 offshore wind farms in 11 European countries.

Mid-year update

The latest statistics suggest that between January and June of 2014, Europe fully grid connected 224 offshore wind turbines across 16 commercial wind farms and one offshore demonstration site with a combined capacity of 781 MW. These were installed in five wind farms, namely Gwynt y Môr (UK), Northwind (Belgium), Riffgat (Denmark), West of Duddon Sands (UK) and the Methil Demo at Energy Park Fife (UK). During this period the average size of wind turbines installed was 3.5 MW.

Overall by July 2014, 2,304 offshore wind turbines with a combined capacity of 7,343 MW were fully grid connected, and 310 wind turbines totalling 1,200 MW were awaiting grid connection. As of July 2014, 4.9 GW offshore wind capacity was under construction. This is summarised in *Table 1*.

2014 also witnessed the biggest project finance deal in the history of offshore wind. This was the € 2.8 billion financing of the 600 MW Gemini offshore wind farm off the coast of the Netherlands[7]. 70% of this budget will be provided on the basis of project financing, making it the largest ever project financed offshore wind farm. The project is due to be completed in 2017.

TABLE 1: OFFSHORE WIND INSTALLATIONS IN EUROPEAN WATERS (JANUARY TO JUNE 2014)

	Belgium	Germany	United Kingdom	TOTAL
No. of farms	1	10	5	16
No. of foundations installed	1	159	73	233
No. of turbines installed	30	126	126	282
No. of turbines connected	47	30	147	224
Capacity connected to the grid (MW)	141	108	532	781

Source: EWEA

V-Shape semi-sub floater prototype with 7 MW turbine
© Mitsubishi Heavy Industries, Ltd

CHINA

China installed 39 MW offshore wind in 2013 for a total offshore capacity of 428.6 MW. This made it the fifth largest offshore wind market in 2013.

The offshore sector in China has been slow over the past three years, but it is finally entering a 'mini-boom'. In 2011, the first round of concession tenders awarded tariffs to four projects with a total capacity of 1 GW. Less than half of this capacity was built. However, offshore installations are expected to move at a faster pace in the next couple of years. China has seven offshore projects under construction totalling 1,560 MW, and another 3.5 GW projects in the pipeline. These projects will start construction in 2015.

OTHER EMERGING OFFSHORE WIND MARKETS

By the end of 2013, **Japan** had installed 50 MW of offshore wind capacity, including 4 MW of floating turbines. In keeping with the global trend, some Japanese key players have adopted a partnership approach; for instance, Mitsubishi Heavy Industries has embarked on a joint venture with Vestas to develop an 8 MW offshore turbine. Hitachi Zosen Corp. has partnered with Statoil to pursue floating wind technology.

South Korea had a relatively quiet year in 2013. However the Hyundai Heavy Industries began installation of their 5.5 MW turbine off Jeju Island in 2013. A Government initiative that involves 6 utilities is in the early stages of development. It will see a test field being set up off the coast of Jeollanam and Jeollabuk provinces to test 20 different turbines from a number of Korean manufacturers.

Taiwan is working towards Phase 1 of three offshore wind farms, with completion planned by end 2015.

SUMMARY

- 2013 was a record year for offshore wind installations. 2014 and 2015 will see similar annual numbers come online.
- China is on the verge of take-off, while Japan, Korea, Taiwan and the US are getting underway, but will take some years before achieving the scale and maturity of leading European markets.

In the **United States,** Cape Wind Associates LLP has been planning the country's first offshore wind farm for more than a decade, in Nantucket Sound, along the coast of the state of Massachusetts. The project proposal faced stiff opposition from fisherman and local residents including both the Koch and Kennedy families. With a total planned capacity of 468 MW, the project is now fully permitted and was issued the first commercial offshore wind lease in the US[8].

A handful of other companies are also developing Atlantic Coast wind farms. The U.S. Department of Energy awarded three grants up to $ 46 million (€ 38 million) each for offshore wind demonstration projects in May 2014. These awards will support design and construction of three projects with anticipated completion by the end of 2017. The three projects in New Jersey, Oregon and Virginia are expected to have a total installed capacity of 67 MW[9].

Footnotes

[4] http://www.ren21.net/ren21activities/globalstatusreport.aspx

[5] GWEC 2014: Annual Market Update 2014, Global Wind Energy Council, April 2014

[6] EWEA 2014: European Wind Energy Association

[7] http://www.gemini-wind.eu/

[8] http://www.capewind.org/when

[9] http://energy.gov/articles/energy-department-announces-innovative-offshore-wind-energy-projects

Middelgrunden wind farm, Denmark © Wind Power Works

3

MARKET OUTLOOK

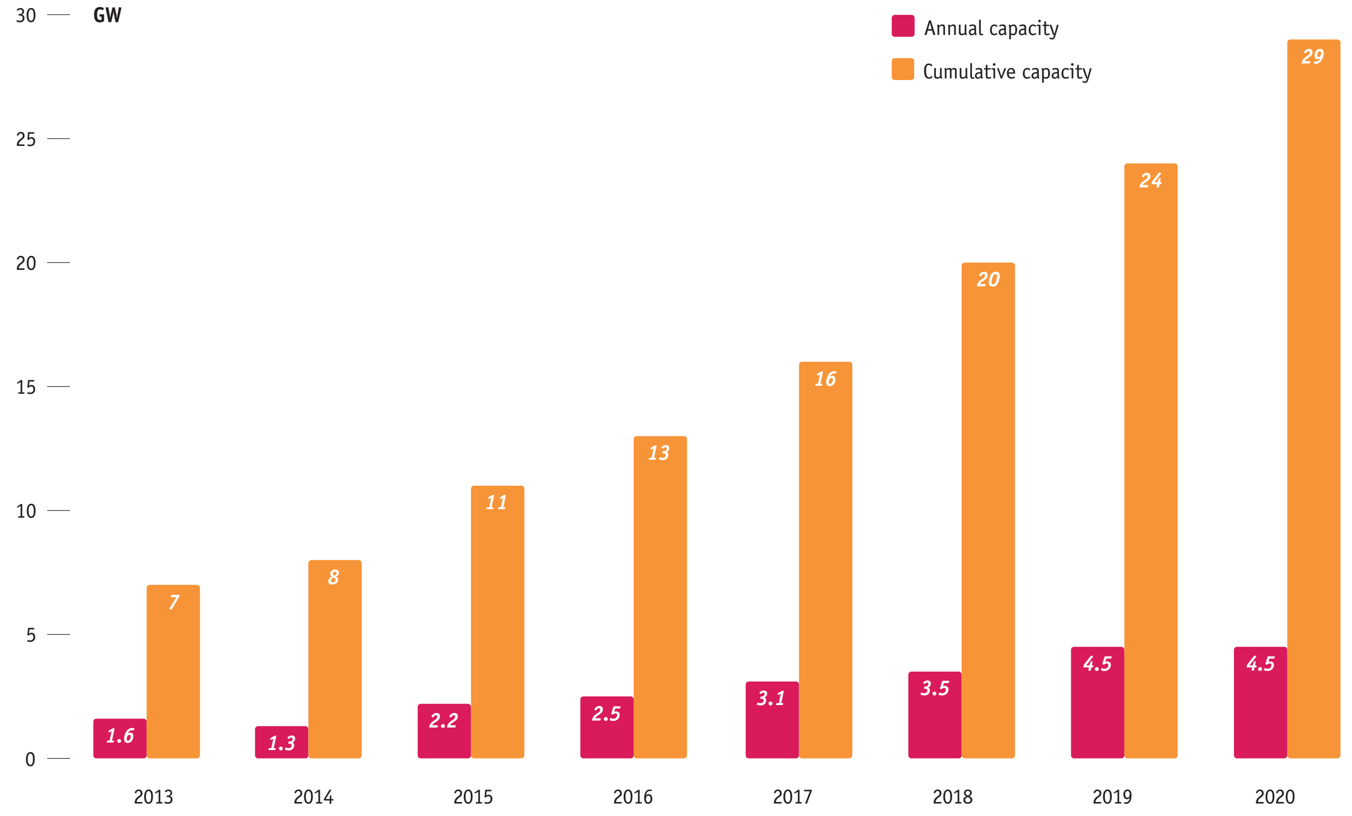
Although global offshore wind deployment is currently small relative to its onshore cousin, it is expected to grow steadily in future years – in Europe and beyond.

GROWTH PROJECTIONS

There are several estimates available today. The IEA expects renewables based capacity to rise from a global total of 1,690 GW in 2013 to 2,555 GW in 2020. As shown in *Figure 2,* it projects global offshore capacity will reach 29 GW by the end of 2020[10]. This is broadly consistent with DNV GL estimates.

An analysis of existing top-down Government targets, along with a consideration of the bottom-up pipeline, helps to show where this capacity will be installed. This is summarised in *Table 2*. It should be noted that today many of these targets are considered ambitious.

FIGURE 2: GLOBAL OFFSHORE WIND PROJECTIONS - ANNUAL AND CUMULATIVE



Source: IEA Mid-term Market Update 2014

TABLE 2: OFFSHORE WIND INSTALLATION TARGETS AND PIPELINE

	Government offshore wind installed capacity targets	Pipeline (as of Q1-2014)	Source
European Union	43.3 GW by 2020 as proposed under the EU National Renewable Energy Action Plans (2009), though some national governments have since suggested downgrades.	22 GW of consented offshore wind farms	EWEA Wind Energy Scenarios for 2020
China	2 GW by 2015 and 10 GW by 2020	7 offshore projects under construction totalling 1,560 MW by 2015. Another 3.5 GW to start construction in 2015.	Rechargenews 'China sees less offshore wind', October 23, 2014
Japan	-	4 projects with 254 MW capacity at the EIA stage	GWEC Annual Market Update 2013
South Korea	900 MW by 2016 and 1.5 GW by 2019	90 MW	GWEC Annual Market Update 2013
Taiwan	4-6 demonstration offshore wind turbines by 2015 600 MW by 2020 and / 3 GW by 2030		GWEC Annual Market Update 2013
United States	54 GW by 2030	498 MW	US Department of Energy National Offshore Wind Strategy | GWEC Annual Market Update 2013

EU: SHORT TERM SLOWDOWN

Globally the EU will continue to account for the bulk of global offshore installations in the coming 5 years. The 12 offshore projects currently under construction in the EU represent 3 GW of capacity, which once completed will bring the cumulative capacity in Europe to 9.4 GW by 2015, assuming no project delays.

According to EWEA, wavering political support for offshore wind energy – particularly in key markets such as UK and Germany – has led to delays to planned projects and fewer new projects being launched. In several other EU offshore markets, such as Belgium, the mid-term outlook for offshore wind is challenging due to delayed grid expansion or connection plans. The National Renewable Energy Action Plan (NREAP) target of 43.3 GW by 2020 is very unlikely to be met, with EWEA suggesting that 23.5 GW would be installed by 2020.

CHINA: MOVING FORWARD AGAIN

Offshore development in China has been relatively slow, with the National Energy Administration (NEA) recently downgrading targets to around 2 GW by 2015 (with 5 GW under construction) and 10 GW by 2020. This slow progress reflects in part the lack of coordination between various administrations around the development and permitting procedure, and the lack of an adequate feed in tariff. It also reflects a more cautious approach by the Chinese Government to offshore wind, with a desire for a greater focus on quality and reliability.

The market has picked up recently with a new national feed in tariff, although at a rate lower than what the industry was hoping for. In 2014, China had seven offshore projects under construction totalling 1,560 MW and a pipeline of another 3.5 GW that will start construction in 2015.

Denmark © GWEC

REST OF ASIA AND NORTH AMERICA: NASCENT

It is difficult to make volume predictions for more nascent offshore wind markets, which are by their nature subject to greater uncertainty, and so the following provides a tentative summary of the expected progression.

In the coming years, **Japan** will continue its transition to a more diverse energy mix, in part motivated by the outcome of the Fukushima disaster, and will slowly liberalise its electricity market. The feed-in tariff for offshore wind announced by the Japanese Government in March 2014 is the most generous in the world at JPY 36/kWh, and this is expected to help catalyse activity to 2020. Nonetheless, the rate of deployment will be constrained by practical considerations that have upward cost implications, particularly a lack of infrastructure such as undersea cables, jack-up vessels and port facilities. Floating wind turbines remain a promising prospect in Japan for the long-term – though it remains to be seen how quickly this technology will be commercialised.

The Government of **South Korea** has made ‘green growth’ one of its national development priorities, putting forward a strategy for offshore wind development with a target of 1.5 GW by 2019. As for the rest of Asia, we expect new large offshore projects to come on line in **Taiwan** from around 2020 onwards.

The likely evolution of energy debates and commercial interest in the **US** is unclear. Despite having tremendous potential for offshore wind, the country is yet to install a MW scale offshore wind turbine and faces ongoing competition from excellent onshore wind and shale gas resources. However, activity is ongoing with the Department of Interior's Bureau of Ocean Energy Management streamlining the permitting process for offshore projects and undertaking lease auctions in Maryland, Rhode Island and South Carolina.

BEYOND 2020

The fundamental drivers for offshore wind – including energy security, decarbonisation and industrial/job-creation benefits – will persist in importance in the future. Nonetheless, the outlook for offshore wind post 2020 is difficult to predict. Two primary sources of uncertainty are cost reduction and policy:

- **Cost reduction:** Deployment of offshore wind is crucially dependent on achieving cost reduction. Looking to the future, strong cost competition may come from utility-scale solar PV in some markets, while in the US gas-fired power generation drawing on the shale gas boom may be a further competitor. The offshore wind industry is responding to this cost pressure: most notably, the UK is targeting £ 100/MWh (€ 124/MWh[11]) by 2020, supported by the Cost Reduction Taskforce. The success of these efforts is crucial to achieving growth – but the rate of cost reduction is subject to some uncertainty.
- **Policy:** There is a general lack of policy and regulatory visibility on renewables beyond 2020. Even where policy signals have been provided, they tend not to be provided on a technology-specific level. For instance, the EU's announced target of renewables supplying 27% of energy used by 2030 provides a signal on overall policy direction, but it remains unclear what proportion of this will come from offshore wind.

Despite these uncertainties, it seems likely that a key trend will be the globalisation of offshore wind, going beyond the historic European dominance of this market.

SUMMARY

- **Fundamental drivers** (energy security, decarbonisation, industrial growth and job-creation) for the growth of offshore wind are expected to persist in the long-term.
- **Offshore wind is going global,** with projects in new markets outside Europe starting to come online. China is likely to be, alongside the UK, the biggest market in the world by 2020.
- **Beyond 2020,** US and Japan are likely to become major markets.

Footnotes

[10] http://www.iea.org/newsroomandevents/speeches/140828_MTREMR_Slides.pdf

[11] Exchange rate used £ 1 = € 1.2406

4

COST TRENDS

Offshore wind costs are typically measured in terms of the levelised cost of energy (LCOE). This is determined by dividing the discounted costs of the wind farm (including financing costs) by the discounted amount of energy generated over the lifetime of the project.

The levelised cost is driven by five factors:

- **Capex** – the discounted capital expenditure required to build the offshore wind farm
- **Opex** – the discounted operational costs associated with running the wind farm
- **Decex** – the discounted decommissioning costs
- **Finance** – the cost of raising the funds to build the project.
- **Net energy production** – the discounted amount of MWh generated taking into account any electrical losses to the grid connection point.

Publically available information on the cost of offshore wind is challenging to obtain, with developers only ever quoting expected Capex figures (at financial close) in the public domain. This Capex figure is often not robust for two reasons:

1. It is the expected costs for the project. Many offshore wind farms have suffered cost overruns in the construction phase, the details of which are not provided publically. The true outturn cost of projects is therefore not known.

2. There is no consistency in reporting of the Capex figure and it is not clear what is included or excluded in the figure. For instance, a developer may include £ 50 million (€ 62 million) to upgrade a port while another may exclude the same works from the publically quoted figure. Different levels of contingency may also be included in the quoted cost.

Opex, finance costs and the annual energy production for specific wind farms are not provided on specific projects in the public domain. This makes it extremely challenging to estimate the LCOE for specific offshore wind farms, particularly given how sensitive LCOE is to wind speed, distance to shore, ground conditions and the depth of water.

This being said, there are various attempts at estimates from both public sector and industry bodies. In the UK, costs are typically assumed to be around £ 135/MWh (€ 167.5 /MWh) (including the transmission infrastructure), in line with the support mechanism in place. In Germany the developer does not have to pay for the transmission infrastructure and so costs are lower, around € 140/MWh. This makes offshore wind an expensive energy generating technology (around 50% more expensive than onshore wind) and so significant effort and focus is being placed on cost reduction.

The rest of the chapter is structured as follows:

- Capex
- Opex
- Annual energy production
- Cost reduction

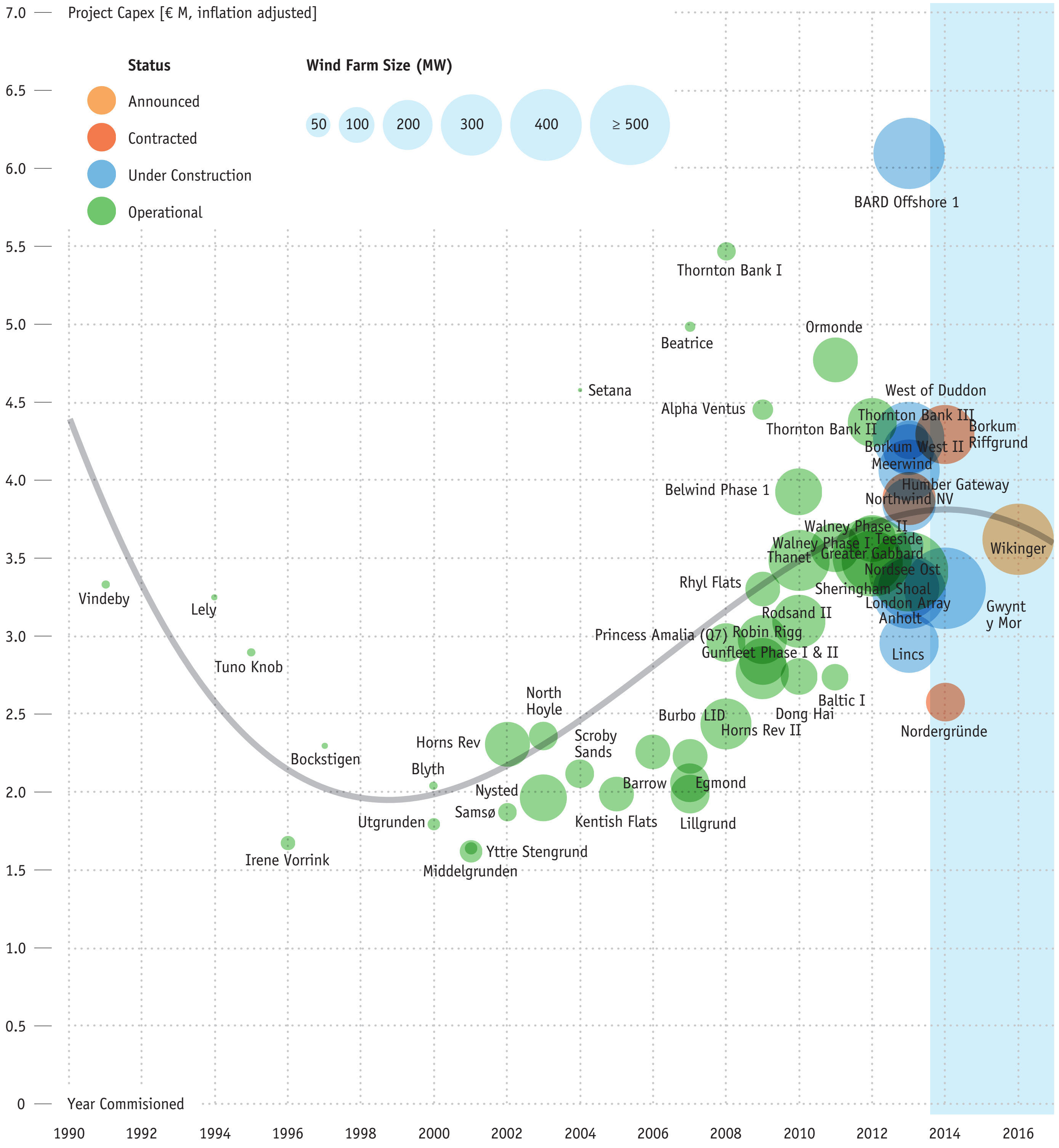
2 MW floating turbines at Kabashima © MOE

CAPEX

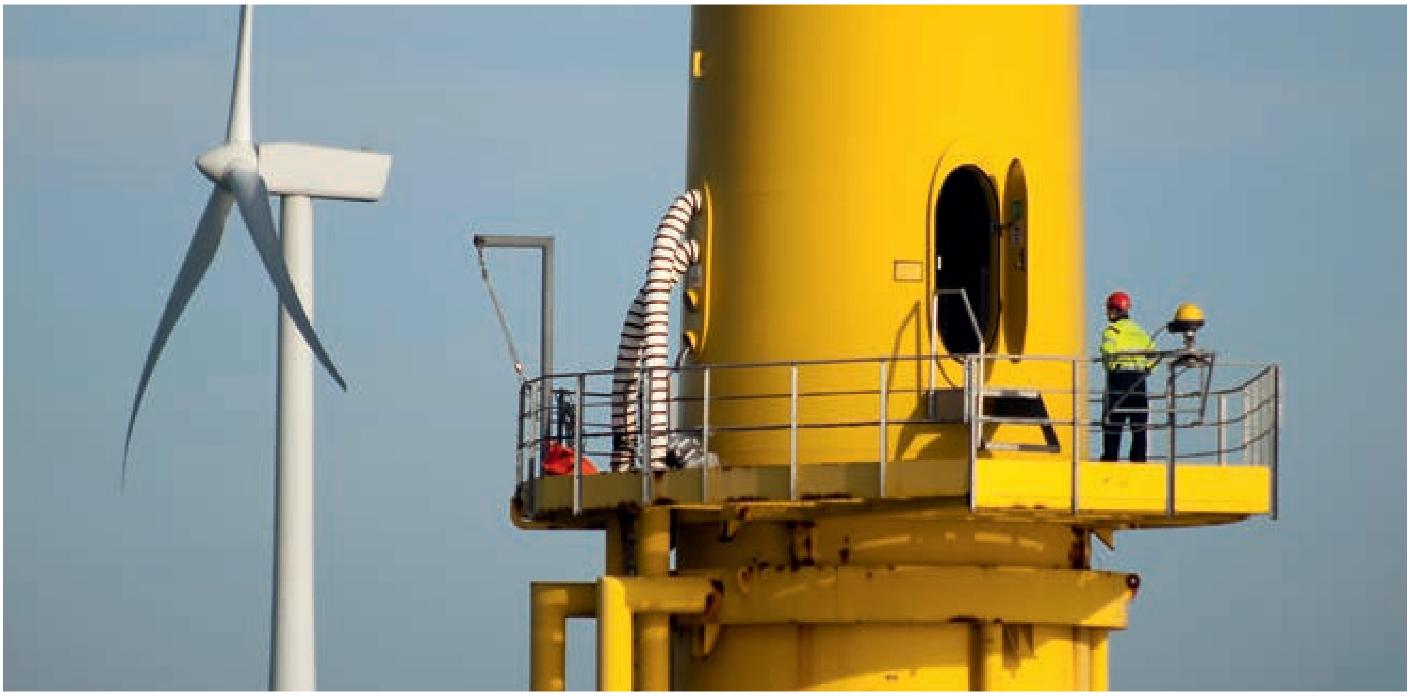
DNV GL records major public domain contract award announcements within the offshore wind industry. The broad trend in the development of Capex since the early days of offshore wind technology in the early 1990s is contrary to any expectation of conventional industrial maturation. Learning or experience 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 3*, with Capex increasing by approximately 100% in real terms, in the 4-year period from 2005 to 2008. A number of factors contributed to this rise including over optimistic early estimates, the boom in onshore wind from 2005 to 2008 constraining supply to the more risky offshore sector, a reduction in turbine suppliers to the offshore wind market, constraints in vessel and balance of plant supply and rapid increases in commodity prices. These phases are explored in more detail on *page 23*.

FIGURE 3: OFFSHORE WIND CAPEX OVER TIME



Source: DNV GL



Scroby Sands offshore wind farm, Great Yarmouth © Ben Alcraft/ RenewableUK

2000 – 2004: High early competition and losses

In the first few years of the century, offshore wind burst onto the European renewables scene as the 'next big thing' in energy. Consequently, the leading wind turbine manufacturers and engineering contractors were scrambling to gain early mover advantage in a new industry with a bright future. The combination of competitive hustle and a shaky understanding of how much building an offshore wind farm really costs proved toxic. Contracts for work on projects underway between 2000 and 2004 were let on terms that, with the benefit of hindsight, were clearly priced far too cheaply.

The inevitable outcome was that a number of significant suppliers, especially in the marine contracting business, went bankrupt. Casualties included Dutch Sea Cable, CNS Renewables and Mayflower Energy.

2004 – 2010: More cautious pricing, supply chain bottlenecks and a commodity boom

The bruising experience of the early contracts left its mark on the industry. The period from 2004 to 2010 not only saw a far more cautious approach to pricing but reduced competition from the contractors remaining in the market. In fact, the offshore wind sector found itself competing with a booming onshore wind market to gain the interest of turbine manufacturers and with the temporary exit of Vestas from the market in 2007, the number of turbine suppliers was constrained to just two (Siemens and Repower). With the booming onshore market, turbine manufacturers took the opportunity to increase profit margins, further putting pressure on price.

Moreover, between 2007 and 2009 the high oil price meant marine contractors turned back towards the oil and gas industry, leading to a chronic shortage of installation vessels for offshore wind. This caused significant upward pressure on day rates.

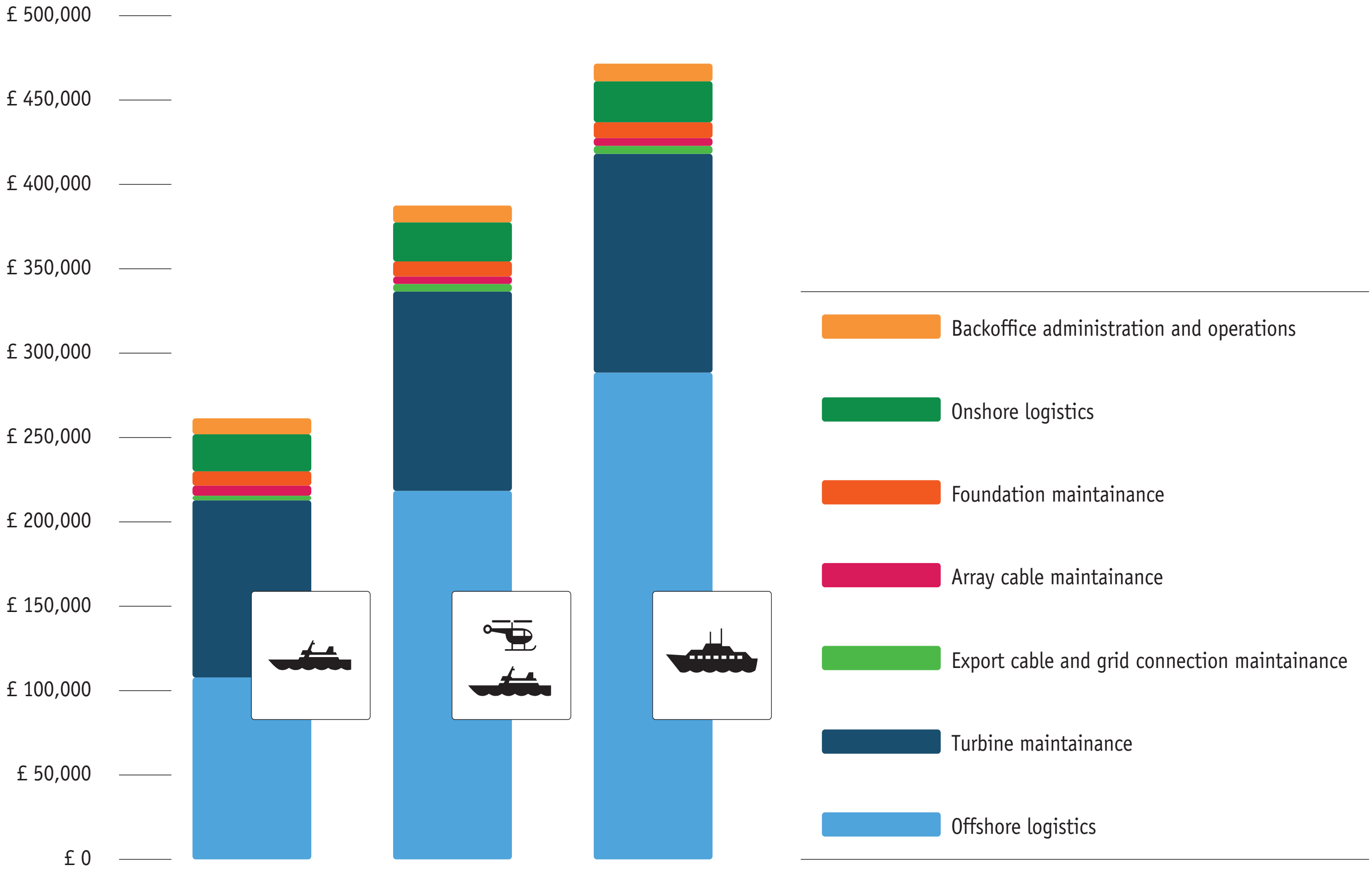
As if this market pressure on prices wasn't enough, projects in UK waters were hit by both a collapse in the value of the pound and surging commodity prices pushing up the cost of key components. The impact of this 'perfect storm' can clearly be seen on capital cost trend data.

2010 – 2014: Ongoing maturation phase

Since 2010, the establishment of a dedicated supply chain and a much clearer understanding of the costs and risks of offshore wind construction have meant that capital costs have stabilised to some extent. Sites are becoming more challenging providing upward pressure on costs but the creation of offshore-specific wind turbines and installation vessels has meant that better, cheaper and safer offshore wind construction techniques are now the standard.

The finance community is showing increasing interest in offshore wind and the sector is becoming global, moving away from the traditional heartland of the North Sea. As a sign of progress, support levels in the UK have begun to be reduced and projects are progressing. However, Capex is only one driver of LCOE and it is important to consider the other elements as well.

FIGURE 4: OPEX ASSOCIATED WITH THREE OPERATIONS AND MAINTENANCE STRATEGIES – WORKBOAT ONLY, WORKBOAT WITH HELI-SUPPORT AND OFFSHORE BASED[12]



OPEX

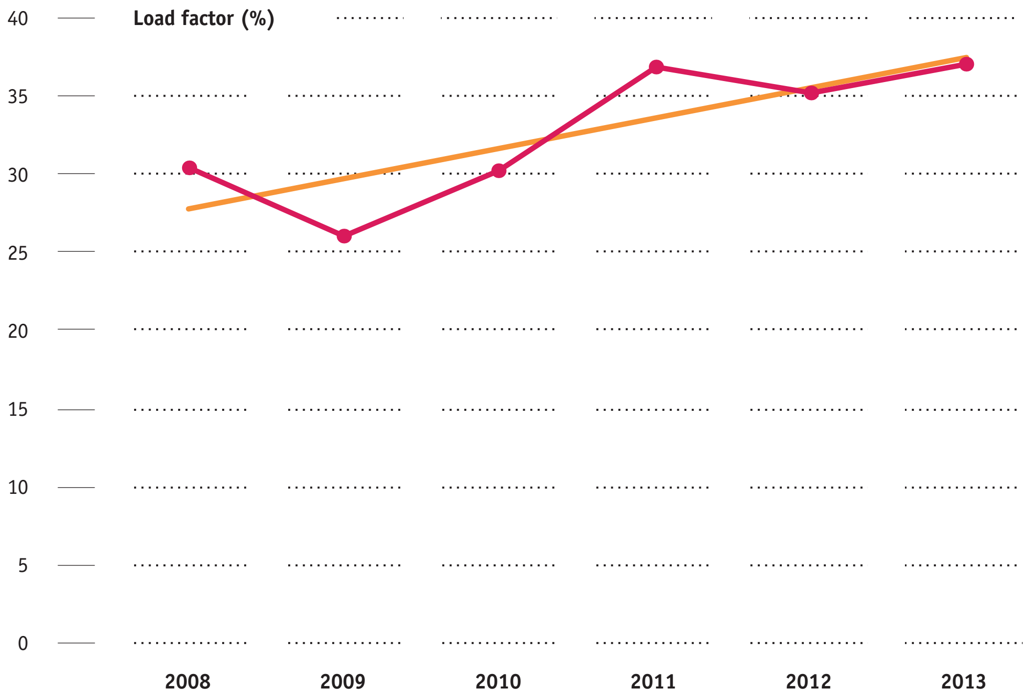
Opex costs are very site and region specific but in general scale most strongly with the number of wind turbine units (assuming similar turbine reliability), rather than the installed capacity of the plant. This is due to the high dependence upon the number of transfers of technicians and parts onto turbines and is one of the main drivers towards larger offshore wind turbines.

The distance from shore is also very important and drives the overall operations and maintenance (O&M) strategy, of which DNV GL identifies three main types. The first uses tried and tested workboats to ferry technicians to and from the wind farm on a daily basis and is suitable for wind farms up to around 12 nautical miles (nm) from shore.

The second strategy involves workboats but complements these through the use of helicopter support for wind farms up to around 40nm offshore. Beyond this offshore-based strategies emerge with technicians living on fixed or floating accommodation platforms or vessels for an extended period of time. Cost estimates for each of the different strategies are provided in *Figure 4* for the UK market, which should be broadly representative of North Sea projects across Europe. Opex costs will be very different in Asian markets, although the principles are likely to remain the same.

As can be seen wind farms further offshore typically have higher O&M costs, which therefore have to be offset by the higher wind speeds found further offshore.

FIGURE 5: LOAD FACTORS FOR THE UK'S OFFSHORE WIND FLEET



Source: Digest of UK Energy Statistics

ANNUAL ENERGY PRODUCTION

Much of the debate around offshore wind costs has focused on the Capex bubble chart shown in *Figure 3,* but this is only one side of the story. In parallel to this increase in capital costs, load factors have increased substantially. This is highlighted in *Figure 5,* which shows load factors for the UK's offshore wind fleet increasing from 26% in 2009 to 37% in 2013[13]. This is in the context of windiness over the past two years trending close to normal.

Although some of this variation can be explained by natural variation in the wind, there is a clear increasing trend and even the 37% masks progress from some of the newer wind farms which DNV GL understand have load factors in the high 40's. A similar pattern has been observed in Denmark, with Anholt achieving over 50% in 2013.

This significant increase in load factors helps offset the increase in capital costs and suggests that LCOE has not increased at the same rate as Capex.

COST REDUCTION

Building on this trend of increasing load factors, there is an emerging consensus that around 30-40% levelised cost reduction is achievable by 2023 through innovations and improvements around technology, supply chain and finance[14]. This includes the following:

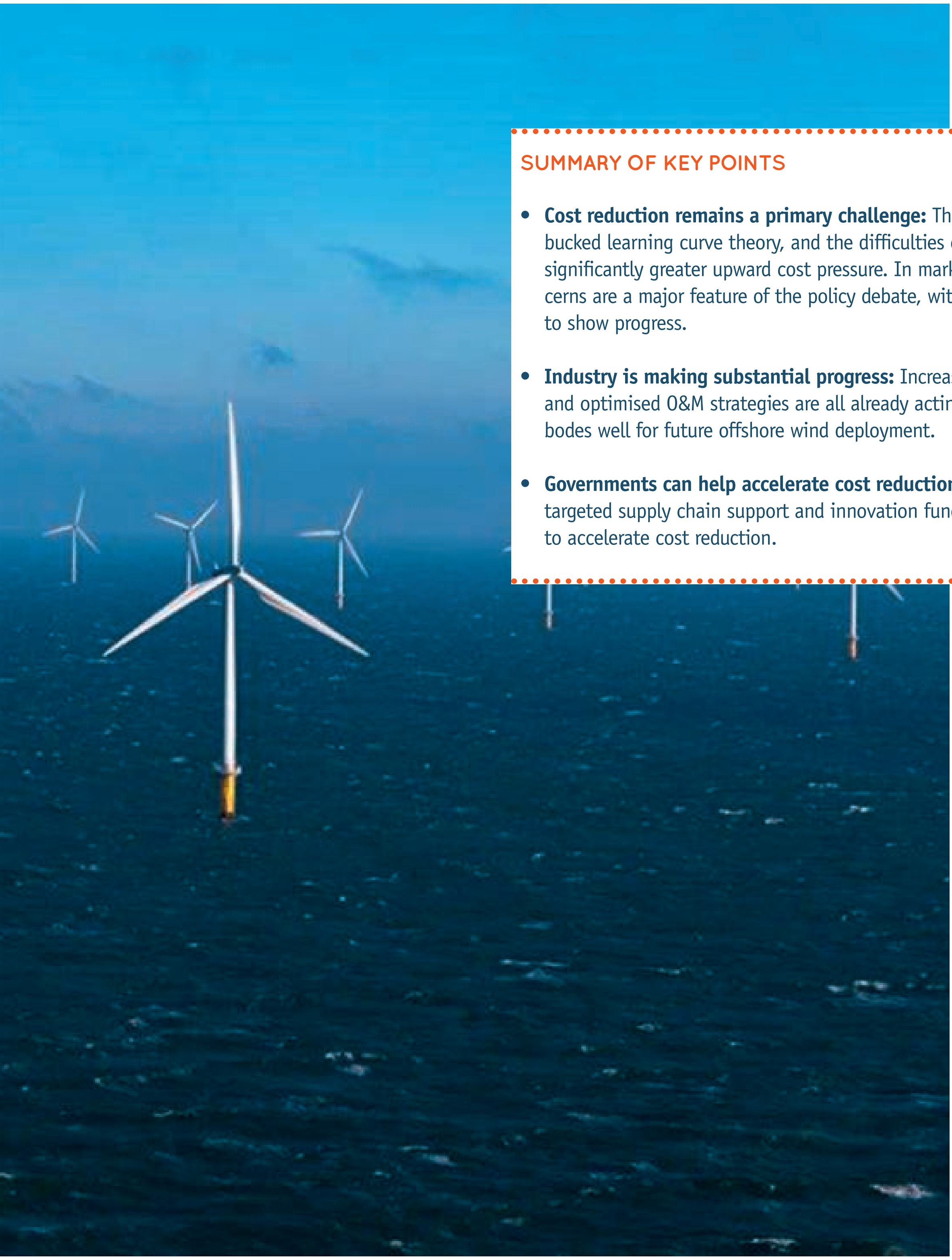
- Upscaling of turbines from 4 MW to 8 MW
- Reductions in Weighted Average Cost of Capital (WACC) through reducing risk, introduction of lower cost sources of finance and increased gearing
- Increased competition in all aspects of the supply chain
- Industrialisation through purpose built factories, vessels and automation of manufacturing process
- Standardisation of elements including the electrical infrastructure
- Design life extension beyond 20 years

In some leading markets, the public and private sector are working closely together to try to accelerate cost reduction, with the UK being a notable example – see Case Study below.

CASE STUDY - UK COST REDUCTION POLICIES AND TARGETS

The UK Government and industry have agreed on £ 100/MWh (€ 124/MWh) as a target for projects reaching financial close in 2020 supported by the Cost Reduction Taskforce and Pathways Project[15]. A range of policies have been put in place to achieve this aim including:

- Electricity Market Reform and move to **Contracts for Difference** (See UK Section in *Chapter 6*)
- Stimulating the local supply chain through enterprise zones, capital grants, etc.
- Various R&D initiatives including the Offshore Wind Accelerator, Offshore Renewable Energy Catapult and test and demonstration site programme
- Launching a Cost Reduction Monitoring Framework
- Establishing a Green Investment Bank and Offshore Wind Investment Organisation
- Skills training



SUMMARY OF KEY POINTS

- **Cost reduction remains a primary challenge:** The early years of offshore wind bucked learning curve theory, and the difficulties of the offshore environment bring significantly greater upward cost pressure. In markets across the world, cost concerns are a major feature of the policy debate, with industry facing strong pressure to show progress.
- **Industry is making substantial progress:** Increasing load factors, larger turbines and optimised O&M strategies are all already acting to reduce levelised costs. This bodes well for future offshore wind deployment.
- **Governments can help accelerate cost reduction:** Through a stable policy regime, targeted supply chain support and innovation funding the public sector can help to accelerate cost reduction.

Denmark © Saylor/GWEC

Footnotes

[12] http://www.sdi.co.uk/~/media/se_2013/renewables/guide_to_offshore_wind_report_interactive_jan%202014.pdf

[13] Collected by the Department for Energy and Climate Change in their Digest of UK Energy Statistics (DUKES)

[14] For instance, a recent study commissioned by the German Offshore Wind Energy Foundation together with the German energy company RWE Innogy found that the cost reduction potentials of offshore wind power over the next ten years could be between 32% and 39%.

[15] Offshore Wind Cost Reduction Taskforce (2012). Offshore Wind Cost Reduction Taskforce report

5

FINANCING TRENDS

Denmark © Bent Nielsen and Danish Wind Industry Association

This section provides a brief overview of the financing of offshore wind farms. Offshore wind is a relatively new class of power generation technology in comparison to traditional power generation options in most countries. Stable, clear and long-term policy and regulatory frameworks and a validated wind resource allow developers and investors to take the necessary risks and finance offshore wind projects.

FINANCING STAGES

The risk profile of an offshore wind farm evolves over the course of a project's life. This is summarised in *Table 3*.

TABLE 3: FINANCING OVER THE KEY STAGES OF AN OFFSHORE WIND PROJECT

Stage	Financing overview	Risk
Development	Funding requirements during this phase are for project development activities, which need to be carried out to achieve regulatory milestones – notably securing planning permits and grid connection agreements. However, capital requirements are surprisingly significant for offshore wind projects during this phase (usually in 10's of million €s) because they should also cover extensive site data gathering (offshore) and accompanying analysis work. This informs both engineering design and the consenting process. The source of funding for this phase is mostly risk equity, provided by either the project developer's balance sheet or via equity partners, such as venture capital investors. The likelihood of a project proceeding to construction will vary by country and further impacts the cost of finance during this stage.	**HIGH** (Up to double-digit cost of capital)
Final Investment Decision (FID)	Following the granting of required licenses, and grid connection agreements, the project sponsor will need to raise the required capital for the major construction contracts which are let typically at or soon after the final investment decision (FID). Sources of capital vary widely – utility balance sheets dominate, although more recently other sources of capital have entered the industry. Government backed banks such as Germany's KfW can play a role at this stage for derisking purposes – although this involvement is expected to discontinue once offshore wind technology is considered fully mature.	↓
Refinancing	Either during the construction phase, or more commonly following 1-2 years of satisfactory operation, several project owners have chosen to refinance projects. The primary driver for this has been to free up stretched utility balance sheets in order to progress other projects in the pipeline. Key sources of capital for this phase are risk averse sources such as pension funds and infrastructure investors, who are looking for long-term de-risked assets, and can accept lower returns.	**LOW** (Single digit cost of capital)

HISTORY OF OFFSHORE WIND PROJECT FUNDING

European finance trends for offshore wind can be broken down as follows:

- 2000s to 2010: Balance sheet funding
- 2011 to 2013: Tentative entry of new sources of capital; and
- 2014 onwards: Greater diversity of funding.

Each of these three phases is discussed further below.

2000s-2010: Balance sheet funding

As with other immature technologies, funding for pre-commercial offshore wind farms was largely drawn from utility balance sheets and capital grants during the early years. Due to the substantial construction and technical risks associated with these pre-commercial offshore wind farms, securing financing from external sources was challenging.

Despite the dominance of balance sheet financing, there were some pioneering examples of a wider mix of funding sources. For instance, C Power secured de-risked project finance for Thornton Bank offshore wind farm in Belgium in November 2010, in a high profile pre-construction deal. At the time, this represented the largest such pot of project finance within the sector.

Some of the key early examples of innovative financing arrangements are provided in *Table 4 and Table 5*.

TABLE 4: CASE STUDY – FINANCING OF NORTH HOYLE OFFSHORE WIND FARM

RWE
The energy to lead

NORTH HOYLE (2004)
The first breakthrough – debt finance for offshore wind

Scale & location	60 MW Round 1, UK
Lifecycle phase	Post-construction
Size	£ 400m (€ 496m) deal
Details	3 partners took equal stakes in £ 100m (€ 124m) equity, with £ 300m (€ 372m) debt facility
	Incorporated into Beaufort Wind portfolio to reduce risk

TABLE 5: CASE STUDY – FINANCING OF PRINCESS AMALIA OFFSHORE WIND FARM

PRINCESS AMALIA (PREVIOUSLY CALLED Q7) (2006)
The first project financed offshore wind farm

Scale & location	120 MW, west of Ijmuiden NL
Lifecycle phase	Pre-construction
Size	€ 400m deal
Details	Dexia bank, Rabobank, BNP Paribas and Danish state-owned enterprise EKF (Eksport Kredit Fonden) provided funding using Vestas 2 MW turbines.

2011-13 – Tentative entry of new sources of capital

The offshore wind sector has recently witnessed the tentative entry of alternative sources of finance, including courtship of institutional investors. This showed that privately financed projects at scale are possible – particularly when partially de-risked through state bank and export credit agency assistance. During this period some of the key deals that attracted headlines included:

TABLE 6: KEY PROJECT FINANCING DEALS (2011-2013)

Timeline	Project Name And Capacity	Country
January 2011	**Walney II** 367 MW Dong sold 24.8% stake to Dutch Ampere Equity Fund and PGGM.	United Kingdom
April 2011	**Anholt** 400 MW PensionDanmark and PKA bought a 50% share. see *Table 7*	Denmark
August 2011	**Meerwind** 288 MW Group of 7 commercial lenders provided € 822mn financing to Blackstone – see *Table 8*	Germany
September 2011	**Gunfleet Sands** 172 MW Japanese Marubeni Corporation bought 50% stake post-construction.	United Kingdom
May 2012	**Borkum Riffgrund 1** 277 MW KIRKBI and Oticon bought 50% stake from DONG.	Germany

La Mata-La Ventosa wind farm
© AMDEE

Of particular interest has been the involvement of North American and Asian players. Japanese institutions like Mitsubishi Corporation, Marubeni and Sumitomo have all made recent, high profile offshore wind investments in several European countries. Meanwhile, capital from private equity players such as Blackstone, pension funds like Caisse de dépôt et placement du Québec and Independent Power Producers (IPPs) like Northland Power are reaching across the Atlantic. This demonstrates that international equity is not waiting for developments in home markets but actively seeking out opportunities in other offshore wind markets.

TABLE 7: CASE STUDY – FINANCING OF ANHOLT OFFSHORE WIND FARM

DONG energy

ANHOLT (2011)
Balance sheet recycling via the pension funds and insurers

Scale & location	400 MW, Denmark
Lifecycle phase	Pre-construction
Size	DKK 10 billion (€ 1.34 billion) deal
Details	April: Dong sold 50% to 2 Danish pension insurance groups. [September 2011: Secured € 240m from the Nordic Investment Bank] To mitigate risks, Dong remains responsible for operations and remains a significant investor

TABLE 8: CASE STUDY – FINANCING OF MEERWIND OFFSHORE WIND FARM

WindMW

MEERWIND (2011)
Private equity and de-risked project finance

Scale & location	288 MW, Germany
Lifecycle phase	Pre-construction
Size	€ 822m deal
Details	US Private equity firm Blackstone secured financing from 7 commercial lenders The first project to close under the KfW Offshore Wind Programme

2014 onwards – greater diversity of funding

More recently, new investor classes and lenders have become increasingly active in the market, leading to the mobilisation of external finance for offshore wind. Lender appetite is strengthening, and equity is no longer limited to utility balance sheets, with a range of alternatives entering at both pre- and post-construction stages.

One recent example has been the 600 MW Gemini project, where a new entrant secured the largest offshore wind debt finance deal, pre-construction – see *Table 9*.

This increasing interest from lenders is a sign of the growing maturity of offshore wind. In fact, on finance indicators, the sector appears to be ahead of where it was expected to be under industry scenarios[16].

TABLE 9: CASE STUDY – FINANCING OF GEMINI OFFSHORE WIND PROJECT

TYPHOON OFFSHORE

GEMINI (2014)
The largest project financing in offshore wind (* till 2014)

Scale & location	600 MW, Netherlands
Lifecycle phase	Pre-construction
Size	€ 2.8 billion of equity and debt raised
Details	The Gemini project is owned by a consortium consisting of Northland Power (60%), Siemens Financial Services (20%), Van Oord Dredging, Marine Contractors BV (10%) and N.V.HVC (10%)
	In May 2014* over 22 parties, including twelve commercial creditors, four public financial institutions, and one pension fund, raised the equity and debt required for the project, representing the largest project financing in the offshore wind sector

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Footnote

[16] http://www.thecrownestate.co.uk/media/5493/ei-offshore-wind-cost-reduction-pathways-study.pdf

Middelgrunden, Denmark
© Gibbon

SUMMARY OF KEY POINTS

- **Early offshore wind projects were funded on balance sheet.** However, even as early as 2004, baby steps were taken towards new forms of finance under North Hoyle offshore wind farm.

- **Towards the end of the 2000s, privately financed projects became possible in Europe,** though they were partially de-risked through state bank and export credit agency assistance.

- **Looking to the future, even greater funding diversity is expected,** which is crucial to ramping up global deployment and reducing financing costs.

- **The availability of capital is shaped to a certain extent by activities over which Government has limited control** – such as the financial markets, global trends in attitudes to risk, and the balance sheets of companies operating in the energy sector. Nonetheless, **Government-backed banks can help** to enable offshore wind deployment in these countries through the provision of de-risked finance. Germany's KfW and Denmark's EKF are examples. However, to have a tangible impact, they must have sufficient resource to make an impact on the market. A initial criticism of the UK-based Green Investment Bank (GIB) has been that its initial capitalization was too low at £ 3billion, although the GIB is taking steps to increase this through a £ 1billion operational investment fund.

6

CHALLENGES

The installed capacity of offshore wind has grown steadily but consistently fallen short of predictions.

In the UK, for example, the Crown Estate has leased around 45 GW of sites, much of which was expected to be built by 2020. However, successive updated projections from the UK Government have downgraded the ambition, first to 18 GW installed by 2020 and, more recently, to a range of 8 to 13 GW. Similarly in Germany, 2020 expectations have been downgraded from 10 GW to 6.5 GW.

There are many reasons for such slower than expected deployment. Key challenges to offshore wind growth are discussed below.

POLITICAL SUPPORT

With lead times of 7-9 years from lease to operation, and costs in the billions, offshore wind projects are long-term, capital-intensive investments. As such, a key challenge facing investors is gaining confidence in the Government's strategic commitment to the sector.

The key success factors for ensuring the Government's long-term commitment to offshore wind are as follows:

- **Decarbonisation or renewable energy target:** A clear target, goal or roadmap from central Government can help to focus and coordinate policy, and give industry confidence in the longevity of the Government's commitment to offshore wind. Without a clear political commitment, offshore wind will struggle to flourish.
- **Stable policy regime, with visibility of any future changes:** Offshore wind investors require that the policy regime is predictable, stable and that changes are signaled in a transparent manner far in advance. A volatile policy environment is a major challenge; for instance, the transition from the Renewables Obligation to the Electricity Market Reform regime in the UK has proved unsettling for industry.

COST OF ENERGY

Energy costs have become highly politicised in many markets. In the UK, the media has pounced on the alleged impact on consumers of offshore wind deployment. In Japan, the emerging offshore industry had to broach the difficult issue of cost differentials between offshore wind and solar PV early in 2014 before Government finally agreed to a tariff at 36JPY/kWh. In the U.S., the first offshore projects must contend with the shale gas revolution. Cost reduction is a significant challenge and vital for the long term sustainability of the industry.

FINANCE

Concerns have been expressed within the industry of a potential 'funding gap' for offshore wind, with fears that a lack of capital may act as a major brake on the deployment of offshore wind in leading markets such as the UK through to 2020. Indeed, compared with other power sector technologies – such as gas-fired power stations – offshore wind has yet to firmly establish a long, robust track record, which limits its bankability.

However, these fears of a 'funding gap' need to be put into perspective. Reductions in 2020 targets in both the UK and Germany has reduced capital requirements and the sector has become better at managing risk, aiding new investor classes and lenders to become active in the market. This has reduced the risk of shortfalls, with 'good' offshore wind projects finding good appetite from investors.

SUPPLY CHAIN

Supply chain bottlenecks have historically been another area of concern. In the early years, offshore wind lacked a dedicated supply chain, meaning that developers had to 'beg and borrow' from other sectors – such as onshore wind and oil and gas. This was a key driver of Capex increases in the period 2006-2010, as demand exceeded supply.

The situation has improved substantially with competition increasing in most areas of the supply chain. However, there remain concerns over potential bottlenecks in high voltage alternating current (HVAC) subsea cables (over 120kV) and high voltage direct current (HVDC) transmission systems – as well as a more general skills shortage in the sector. The sector is also struggling to move towards serial production of jackets. The nature of the supply chain bottleneck depends on the market under consideration; for instance, vessel availability is a particular concern in Japan and Taiwan.

PORTS INFRASTRUCTURE

Ports play a crucial role in the construction and operation of offshore wind farms, with different types of ports acting as the construction port, manufacturing port and O&M port. Requirements for construction and manufacturing ports for offshore wind are generally different to that of other sectors due to the need for long quay sides, high loading limits, large laydown areas and 24 hour unrestricted access. Significant investment is often needed to bring ports up to meet offshore wind requirements, which can be problematic, particularly in countries which have a largely privatised ports industry (like the UK).

Portside requirements for the O&M phase are much less onerous, with proximity to site the most important driver.

SOCIAL-ENVIRONMENTAL CONSTRAINTS

Like any major infrastructure project, offshore wind has impacts on the environment in which it is placed; these impacts need to be assessed and where required mitigated to an acceptable level. Potential impacts include on birds, marine mammals, fishing communities, shipping, seaside communities and those who live close to the onshore grid connection. Impacts can be both positive (e.g. increased employment opportunities) and negative. With over 2000 turbines in the water, the sector now has a much better understanding of potential impacts.

Sweden © GWEC

That being said, assessing the impacts of offshore wind is extremely challenging given the lack of general knowledge of the marine environment. For instance, on one bird survey in the UK, a developer found a greater number of one species of birds in a small wind farm than was understood to exist across the UK. This lack of information poses significant challenges for regulators who have to make choices on the basis of far from perfect information.

The best way of avoiding conflict and planning issues is through good site selection, reducing any risk of impacts well before a project applies for consent. Site selection is best achieved through robust marine spatial planning exercises, which seek to develop a good understanding of the potential environmental constraints, alongside meaningful engagement with key stakeholders (such as fishermen and shipping community) to identify areas best suited to offshore wind. Germany developed a formal Marine Spatial Plan, leading to greater support from shipping and environmental groups, while in contrast in China, sites initially leased to offshore wind developers had to be moved due to overlaps with competing marine interests.

REGULATORY CHALLENGES

Europe has adopted a range of approaches to consenting and licensing, reflecting the historical legacies of the countries involved. Key success factors for consenting and licensing regimes are as follows:

- **Sufficient institutional capacity:** It is crucial that organisations involved with consenting and licensing offshore wind projects have the institutional capacity to do so, both in terms of human capital (skills, knowledge and personnel) and financial capital (access to sufficient finance to perform the tasks that are required).

- **Sympathy to technology development timescales:** Consenting and licensing processes need to adopt a realistic approach to the timescales of development. For instance, the issue of timelines was a key factor in the failure of the Danish Anholt offshore wind single site tender in 2009. Due to a lack of dialogue between the industry and the agency holding the tender, unrealistic build timelines were built into the contract and many developers were deterred from bidding.

- **Clear institutional incentives for offshore wind deployment:** Institutions must be appropriately motivated to promote offshore wind deployment. For instance, an organisation that has a very straightforward area of responsibility and

authority is the UK's Crown Estate. Operating with a purely commercial mandate has allowed it to take decisions and to plan what have been undeniably successful leasing rounds. As a commercial landlord, the Crown Estate has a long-term interest in the viability of the industry and the exploitation of the renewable resources of UK waters, making it a proactive and forward-looking stakeholder as well as administrative body.

SUMMARY OF KEY POINTS

- **Many offshore wind challenges lie largely within policymakers' control:** A key challenge for the offshore wind industry is accommodating the legal and political framework of the sector. Here policymakers have a significant impact. Robust marine spatial planning exercises are crucial for engaging often competing marine users and de-risking the development process. At the same time, a consistent narrative from Government about the role of offshore wind can instil confidence amongst industry players, with a backdrop of positive political noises often more important than elegant regulatory solutions. The public sector can also assist in addressing finance challenges (for instance, see KfW) and infrastructural and supply chain barriers.

- **Other offshore wind challenges require an industry lead:** Overcoming technical challenges is predominantly a challenge for the private sector to lead.

- **Often, a combination of public and private sector intervention is most appropriate:** Bringing down offshore wind costs is a prime example where collaboration can be beneficial.

7

CASE STUDIES: OFFSHORE WIND POLICY

This section assesses the policy regime of the following leading offshore wind markets:

- **United Kingdom:** the largest market at the end of 2013
- **Germany:** the fastest growing market at the end of 2013
- **Denmark:** the oldest market for offshore wind
- **Belgium:** a fast growing market in Europe
- **Netherlands:** a market that has slowed in recent years but is now picking up rapidly
- **China:** the largest non-European market by the end of 2013

For each of the above markets, the following aspects are discussed and later summarised:

- Key policy drivers;
- Land /seabed tenure;
- Development rights;
- Grid connection; and
- Financial support mechanism

Within the policy drivers section a simple assessment of the significance of policy drivers is provided as follows:

● *Minor driver*

●● *Medium driver*

●●● *Strong driver*

UNITED KINGDOM

Current Status

The United Kingdom (UK) is the market leader, with 3.6 GW installed at the end of 2013. All of this capacity has been delivered under the Renewables Obligation – a tradable green certificate system. Industry projections see a total of around 6 GW of capacity installed by 2016 and around 10 GW installed by 2020, by which point offshore wind will supply between 8-10% of the UK's electricity annually[17].

The Government is currently undertaking major policy changes with the introduction of Electricity Market Reform (EMR), in which the Renewables Obligation will be phased out (formally closed in March 2017) and replaced with a form of variable feed-in tariff termed a 'Contract for difference' (CfD)[18].

Policy drivers

Interest in onshore and offshore wind in the UK was primarily driven by legally binding EU 2020 renewable energy targets, which imply that the UK needs to source over 30% of electricity from renewable sources, up from a very low level at the start of the millennium. The UK has also signed into law the Climate Change Act, which mandates an 80% cut in carbon dioxide emissions by 2050. At the same time, North Sea oil and gas is in long term decline, while around a third of the generating capacity in the UK is expected to come offline over the next decade, increasing concerns around energy security. Despite having the best onshore wind resources in Europe, gaining planning permission has been a major challenge, further driving the industry offshore. The large industrial potential and job creation benefits of offshore wind has been another key driver – with the recent announcement by Siemens that it is investing in a turbine assembly and blade manufacturing facility in Hull – an example of how this is beginning to pay off.

TABLE 10: OFFSHORE WIND POLICY DRIVERS IN UK

Energy security	Decarbonisation	Industrial / job creation benefits
●●●	●●●	●●

Land/seabed tenure

The Crown Estate owns almost the entire seabed out to 12nm and has rights to lease the seabed out to the edge of the continental shelf. Leases in the UK have been issued in a number of Rounds, with developers receiving 25 year leases in Round 1 and 2 and 50 year leases in Round 3.

Development rights

Once a developer has obtained a lease, a variety of permits need to be obtained. The type of permit varies across the devolved administrations. In England and Wales, for projects over 100 MW, a one-stop shop exists in the form of the Planning Inspectorate, which grants onshore and offshore environmental consents, electricity generation consents and provides compulsory purchase powers. In Scotland, separate applications are required for the marine and onshore elements. This separation between onshore and offshore elements has proved problematic in the case of Aberdeen Bay wind farm.

It typically takes 3-4 years after receipt of the lease to prepare an application, primarily driven by the requirement for two years of bird surveys. In England and Wales the Planning Inspectorate has a fixed time limit of 15 months to make a decision, while in Scotland there is no fixed time limit[19].

Grid connection

Developers also need to apply separately to the Transmission System Operator for a grid connection agreement. This is National Grid in England and Wales; and either Scottish and Southern Energy, or Scottish Power, in Scotland. To date, generators develop and build the transmission infrastructure and then are required to sell, through a competitive tender, to an Offshore Transmission Owners (OFTOs), who own and operate the asset. OFTOs receive a return on investment by charging transmission fees. The regulator in the UK, Ofgem, is also keen to see 'OFTO build' whereby a third party tenders to build the transmission infrastructure and then operates it once built.

Burbo Bank, Liverpool Bay
© RenewableUK

Financial support mechanism

A generator's current revenue stream is provided under the Renewables Obligation (RO), which is a green certificate scheme, which tops up the wholesale price. The value of a Renewables Obligation Certificate (ROC) varies over time, as does the wholesale price, but an indicative example of the revenue stream for an offshore wind generator commissioning between April 2013 and April 2014 is provided *in Table* 11.

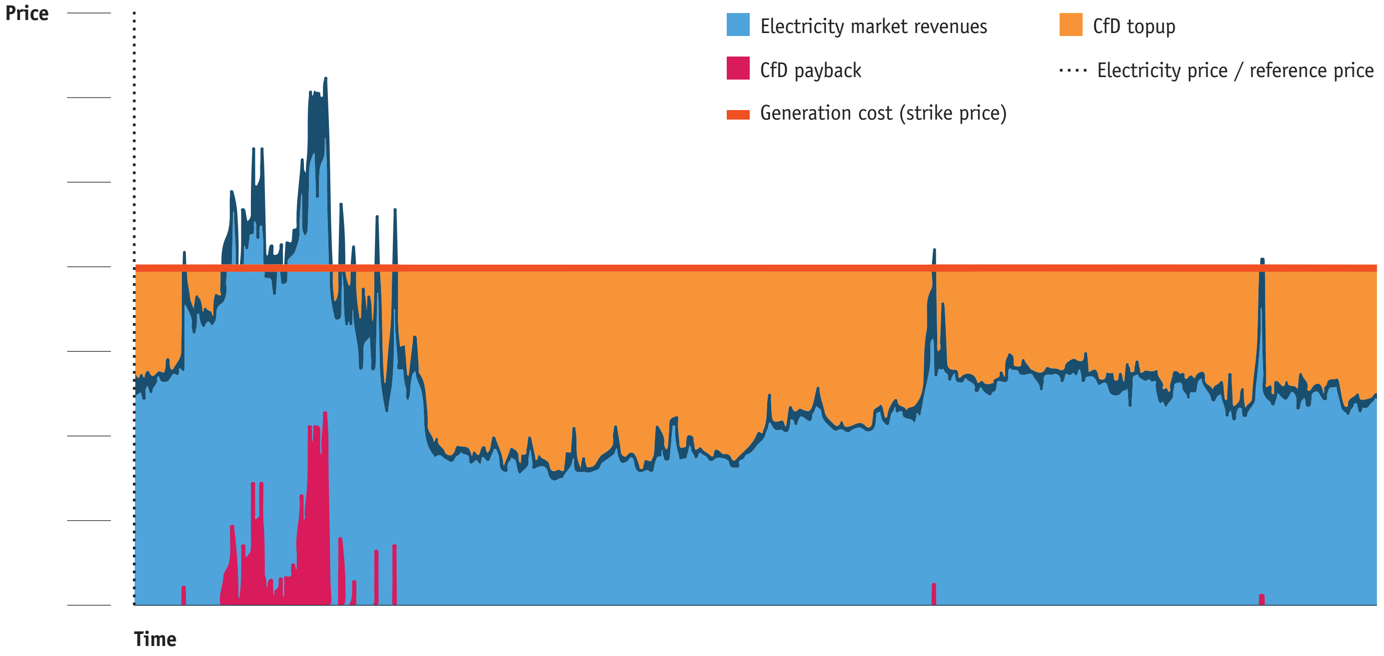
TABLE 11: INDICATIVE OFFSHORE WIND GENERATOR'S REVENUE STREAM IN THE UK FOR PROJECTS COMMISSIONING

Support type	**Support level (MWh)**
2 x Renewables Obligation Certificates (ROC buyout price plus 10%)	£ 89.56 (€ 111)
Climate Change Levy	£ 5.24 (€ 6.50)
Wholesale power price	~ £ 50 (€ 62)
Total	£ 144.80 (€ 179.60)

The UK's support mechanisms for all low carbon generation are undergoing reform. The 2012 Energy Bill[20] states that the Renewables Obligation will be closed to new projects in April 2017. Instead, support will be provided in the form of contracts for differences (CfDs), which is a form of feed-in tariff.

CfDs are long-term contracts between an electricity generator and statutory contract counterparty. Under the CfD system, top up payments are provided to generators when the market price for power is below the intended level of total revenue (strike price). However, unlike other similar arrangements in other countries, when the wholesale price is above the strike price, the wind farm will pay back the difference in order to maintain cost-efficiency. The operation of a CfD mechanism is summarised in *Figure 6*.

FIGURE 6: THE OPERATION OF A CONTRACT FOR DIFFERENCE - UK



Source: DECC

The maximum tariff level under the CfDs is provided below. It is important to note that CfDs will provide support for 15 years, which contrasts the RO's support for 20 years. As a result the tariff level has been increased to compensate for this reduced term.

These prices represent the maximum a generator can receive, as the Government will auction contracts through a competitive tendering process.

TABLE 12: OFFSHORE WIND STRIKE PRICES

Year	2014/15	2015/16	2016/17	2017/18	2018/19
Offshore wind strike price	£ 155	£ 155	£ 150	£ 140	£ 140
in €	€ 192	€ 192	€ 186	€ 174	€ 174

Source: DECC

Offshore wind farm
Liverpool Bay, UK
© blickwinkel Luftbild Bertram

SUMMARY OF KEY POINTS FROM THE UK

- **Structure financial support mechanism to minimise risks:** The structure of the financial support mechanism should be designed where possible to improve the risk-profile of offshore wind investments. A well-designed support mechanism can minimise and/or transfer risks so as to reduce the cost of capital of offshore wind investments. Indeed, the UK Government's intended transition from the Renewables Obligation to CfDs is in part motivated by the belief that the stable revenues provided by strike prices will drive down the cost of capital.

- **Fix decision making timetables and provide a one stop shop for consenting:** Following high profile consenting delays, a new one stop shop planning system was introduced in England and Wales with a fixed 15 month decision making timetable in 2011. This made it comparatively easier for developers to obtain consents and gives certainty on decisions vital for timely progression of the project post consent.

GERMANY

Current status

After a slow start the German offshore wind industry has recently picked up, and with over 3 GW of projects under construction, is the most active market in Europe. As of June 2014, 628 MW of offshore wind capacity was connected to the grid in Germany. By 2030, a capacity of 15 GW is to be connected to the grid according to the plans of the German Federal Government[21].

Policy drivers

The move towards offshore wind is driven in part by the 'Energiewende' or Energy Transition. This will result in Germany shutting down all of its nuclear reactors by 2022, and setting ambitious renewable energy and emission reduction targets. The latest version of this is contained with the new regulation for Renewables (Erneuerbare Energien Gesetz, EEG; August 2014) and stipulates:

- 40-45% of electricity generation from renewables by 2025
- 55-60% of electricity generation from renewables by 2035
- 80% of Germany's electricity consumption shall be generated by renewable sources by 2050.

The German Government has historically taken a relatively interventionist approach to maximising the industrial benefits of wind energy, seeking to build an industry and create domestic jobs. In essence, the Government has sought to take a strategic approach to the power sector, whereby energy policy is aligned with industrial policy. Germany has converted its early lead in onshore wind to the offshore wind sector: it is no coincidence that today many of the dominant players in offshore turbine manufacturing are German (e.g. Siemens, Areva and Senvion).

TABLE 13: OFFSHORE WIND POLICY DRIVERS IN GERMANY

Energy security/Nuclear phase out	Decarbonisation	Industrial / job creation benefits
●●●	●●	●●●

Land/seabed tenure & development rights

In Germany, a thorough Marine Spatial Plan was developed that identified potential zones for offshore wind development, after taking into account constraints such as Nature Reserves and shipping routes. Developers are then able to lodge applications for permission to build marine renewable energy within these zones in an open-door approach.

Once a developer has secured a site, several of the major permits and licences are bundled into a single authorisation process administered by the Federal Maritime and Hydrographic Agency (BSH[22]). This includes land tenure rights, environmental impact assessment and generation license.

Once a complete application is submitted a series of three consultation exercises are carried out involving relevant authorities within Government, the public and interested groups and agencies. The second of these consultations is particularly significant because it is used to determine the scope of the Environmental Impact Assessment (EIA) to be carried out[23].

The outcome of the EIA, along with a final consultation round and final scrutiny by competent authorities inform a decision by the BSH. Should the decision be positive, and the regional authority issues the relevant navigational consents, a conditional consent is awarded. The consent provides the developer a 2.5 year window during which the developer must fulfil the conditions before starting work. Once the conditions are met, the developer is given a lease to the seabed for 25 years, guaranteed grid access and a fixed output tariff.

Robust technical standards have been produced that apply to the EIA and the consent conditions. These standards, available in English from the website of the BSH provide an element of uniformity to the experience of applicants, but are relatively rigid and can lead to higher costs.

Before operation can begin, the Transmission System Operator (TSO) must provide grid services to the project and once operational the owner is required to observe the relevant health and safety legislation.

Once operation of the project has begun, environmental monitoring must be performed and an annual report presented to BSH for at least three years or a maximum of five years in order to validate the assumptions of the EIA submitted as part of the application. A long-term monitoring schedule will be determined by the BSH in light of the results.

Germany © Anja Gerseker/ GWEC

Grid connection

The Transmission System Operators (TSOs) in Germany are required to fund all offshore wind grid connection works up to an offshore connection point, with the developer responsible for connecting to this connection point. Costs are recouped from network users to pass on to consumers.

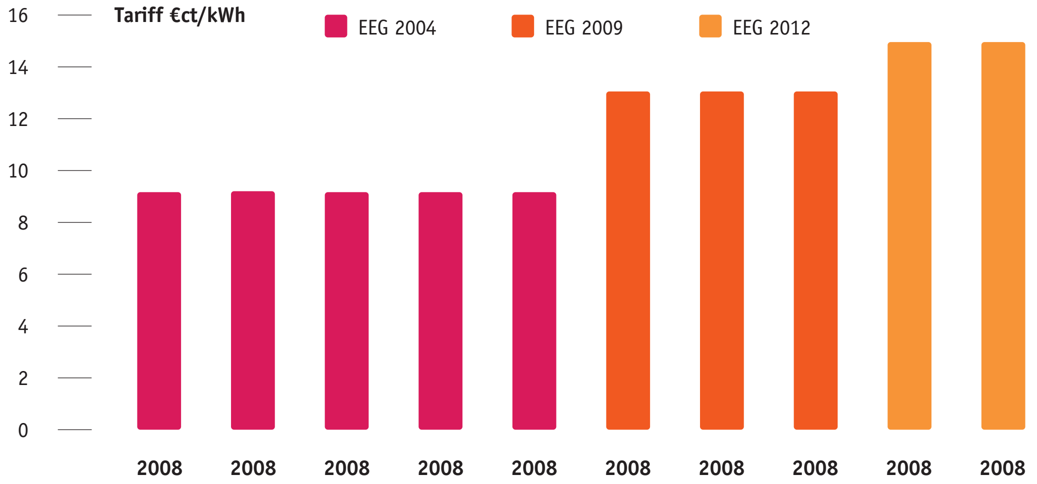
High profile delays in grid connection, due to the significant technical challenges of HVDC systems and a lack of capitalization of the TSOs Tennet and Elia 50Hz, have meant that a number of projects have been built but cannot export power. This has led to developers claiming multi-million Euro damages. This issue has slowed deployment with some developers delaying projects until these issues have been resolved. A regulatory agreement has been reached which should lead to the resolution of these issues but, given long lead times, grid issues remain a concern.

Financial support mechanisms

Introduced in the Renewable Energy Act (Erneuerbare-Energien-Gesetz, EEG 1991), the German feed-in tariff is seen by many as the archetypal renewable support mechanism. However for offshore wind the German Government initially struggled to set the right level with the tariff level being changed a number of times before deployment was stimulated (as shown in *Figure 7*).

Scroby Sands
offshore wind farm,
Great Yarmouth, UK
© RenewableUK

FIGURE 7: CHANGES IN GERMAN EEG LEVEL (2004-2013)



As well as the standard duration feed-in tariff, in 2012 Germany introduced a 'market premium option' of the feed-in tariff. Under this arrangement, generators are able to market their physical output directly and receive as additional revenue the difference between the fixed tariff for which the plant would be eligible and the average market value of the electricity generated. Generators also receive a 'management premium' (currently under review) designed to compensate them for additional costs incurred by direct market participation, such as balancing costs arising from forecast error. This was introduced to encourage renewable electricity generators to accept and manage wholesale power market risks and move towards some degree of market integration of renewables. Generators are able to change freely between the 'classic' fixed feed-in tariff and the market premium option and those marketing their own output still benefit from preferential grid access rules.

In addition, an 'accelerated' tariff model is available in which payments are front loaded with the total support duration reduced to 12 years. In the case of the accelerated model the same tariff as for the 'normal' tariff model is paid for the extension period, calculated using distance from the coast and water depth.

© Siemens

The support term varies with distance to shore and water depth, with the period extended by 5 months for each full nautical mile beyond 12 nautical miles that the installation is located from shore and by 1.7 months for each full metre of water depth over 20 metres.

Generators commissioning in April 2013 – April 2014 can choose between two tariff rates shown in *Table 14*.

TABLE 14: OFFSHORE WIND GENERATORS REVENUE STREAM IN GERMANY FOR PROJECTS COMMISSIONING

Support type	Support level (MWh)
EEG FiT (accelerated model[24])	€ 190 for 8 years (with extensions for depth and distance) € 35 for remainder of term to 20 years
EEG FiT (standard duration)	€ 150 for 12 years (With extensions for depth and distance) € 35 for remainder of term to 20 years

The current tariff level has resulted in significant investment, and conditions in Germany are now some of the most favourable globally at least out until 2017.

Beyond 2017, tariff rates will be reduced as follows:

- **Compression model:** 2017: 19 €ct/kWh; 2018: 18 €ct/kWh; 2019: 17 €ct/kWh

- **Basis model:** 2017: 15 €ct/kWh, yearly 0.5 €ct/kWh degression

In addition to both models there will be 0.4 €ct/kWh extra for direct marketing.

SUMMARY OF KEY POINTS FROM GERMANY

- **Set tariff at an adequate level:** A balance must be found that ensures economic viability without over rewarding projects. In Germany this has resulted in an iterative tariff setting process with each tariff change taking a few years to work through until a level was reached that ignited construction activity.

- **Develop a comprehensive spatial plan (maritime and sectoral) for all competing users of the sea / exclusive economic zone (EEZ) and the national grid** so as to prevent conflict and bottlenecks later on. Germany did so for example by developing the 'Bundesfachplan Offshore' in 2012. This specialized spatial planning is the basis for the network planning of offshore grid connections.

DENMARK

Current status

Building on its world leading onshore wind industry, Denmark installed its first offshore wind farm at Vindeby in 1991 and since then has been at the forefront of the industry, having installed 1.2 GW to date. Although a small market compared to the UK and Germany, it has shown consistent progress and expects to add another 1 GW by 2020 through a combination of Horns Rev 3 and a number of smaller, close to shore 'community' wind farms.

Policy drivers

The Danish Government has set a 2020 target of 35% of all energy consumption to be supplied from renewable sources (including 50% of electricity from wind) and a 34% reduction in greenhouse gas emissions (relative to 1990). By 2050 the Danes hope to have 100% of Danish energy supplied from renewable sources. Many leading offshore wind companies are Danish (DONG, Vestas, LM Windpower, Bladt, Ramboll, etc) or in the case of Siemens Wind, have Danish roots. This has meant a strong symbiosis between energy and industrial policy.

TABLE 15: OFFSHORE WIND POLICY DRIVERS IN DENMARK

Energy security	Decarbonisation	Industrial / job creation benefits
●●	●●●	●●●

Land/seabed tenure & development rights

The Danish Government has the sole right to utilisation of wind energy within Territorial Waters, in the Contiguous Zone and in the EEZ. The conditions for offshore wind farms are outlined in the Danish Electricity Supply Act 2008.

The establishment of offshore wind projects can follow two different procedures:

- Following the Danish Government's action plan for offshore wind development, the Danish Energy Authority will invite bids to tender for pre-specified sites.
- The 'open door principle': implies that independent applications can be made at any time, for any site. The Danish Energy Agency (DEA) will then assess the site, and if the conclusions are positive, an invitation for Expression of Interest will be announced. Successful registrants will then be invited to tender for the site. This helps ensure competition outside of the Government's action plan.

The following licenses are needed to build an offshore wind farm:

1. Licence to conduct preliminary studies, including environmental (EIA) and technical (ground investigation). This

Middelgrunden wind farm, Denmark
© Wind Power Works

is provided either directly after a tender (tender process) or following receipt of the first satisfactory planning documentation (open-door process).

2. Licence to establish the offshore wind farm under certain specified conditions is granted after an application is filed based on the preliminary investigation reports. This is granted after the preliminary investigation reports show that the project is compatible with relevant interests at sea.

3. Permission for energy production must be obtained before commissioning of the farm, typically for 25 years. The application must be followed by a documentary report demonstrating that the conditions given have been followed. When a project is larger than 25 MW, the operator needs obtain a concession for the production of electricity.

Grid connection

The financing of the grid connection for offshore wind farms depends on the route taken to licensing: either through the tendering process or through the ‘open door’ policy. In the first case, the grid operator, Energinet.dk, will finance the connection, including the establishment of a step-up transformer. This effective socialisation of grid costs is a very attractive feature of the Danish system for project developers. Part of the justification for this structure is the possible future use of such cables for future international offshore interconnections.

If the 'open door' route has been taken, however, responsibility falls to the developer to provide the connection to the nearest defined shore connection point, along with the required step-up transformers. Costs of any necessary grid reinforcement may also be expected to be borne by the developer, in this case. The three private offshore wind farms established in Denmark to date (Samsø 23 MW; Rønland 17 MW and Middelgrunden 40) have followed the second procedure, and no notable problems have resulted. These projects are, however, all within about 3km of the coast, and it can be assumed that grid connection costs were not prohibitively expensive.

Financial support mechanism

Offshore wind farms in Denmark are supported through a feed-in tariff, which is set through a competitive auction process. Power off-take in Denmark is largely handled via the DEA, as part of the incentive scheme. There is no power purchase obligation in place in Denmark like for example in France or Germany. However, electrical power from renewable energy enjoys priority access to the grid. In some cases, the owner may choose to sell the electrical power to utilities or other power suppliers through a Power Purchase Agreement (PPA).

If the power price drops to zero or negative (i.e. there is an oversupply of electricity), then renewable projects do not receive any support – hence this acts as a motivation for generators to curtail output and help supply-side grid management.

SUMMARY OF KEY POINTS FROM DENMARK

- **De-risk the development process** – The Danish Government undertakes substantial development work in advance of the site being leased. This includes completing geotechnical studies, wind resource assessment and environmental surveys. The lease areas are then auctioned off to the lowest bidder. The benefit of this approach is that the site is effectively de-risked to the developer, leading to a lower tender price. For instance, if the developers did not know the ground conditions at the site, they would have to include contingency and risk provisions associated with this uncertainty. As the DEA provides this, the developer can price more effectively.
- **Ensure sufficient competition for site leases** – The last site tender in Denmark was for the Anholt site but this was considered somewhat of a failure as only one developer (DONG) ended up bidding, significantly reducing competitive pressures. Various reasons have been identified for this including a lack of publication of the leasing round, high number of opportunities elsewhere (Round 3 in the UK), tight delivery timescales and a perception that non-Danish utilities would not be able to compete with DONG. Since then, the Danish Energy Agency has made various amendments to the process that has resulted in four developers qualifying for the Horns Rev 3 tender.

BELGIUM

Current status

Despite having a relatively small coastal area, Belgium has installed 571.5 MW of offshore wind by the end of 2013. Northwind is due to be commissioned in 2014, while Norther and Belwind 2 are expected to be commissioned in 2015. By the end of 2015, Belgium is expected to have installed 1,236 MW of offshore wind capacity.

Policy drivers

The national renewable energy action plan commits Belgium to source 13% final consumption of energy from renewable sources by 2020. The onshore wind resource is fairly limited, which has helped push forward the offshore wind industry.

Belgium © C-Power

TABLE 16: OFFSHORE WIND POLICY DRIVERS IN BELGIUM

Energy security	Decarbonisation	Industrial / job creation benefits
●●	●●●	●●

Land/seabed tenure & development rights

Belgium's success, despite having only 67 kilometres of coastline, can be attributed to the early establishment of seven zones designated exclusively for offshore wind. Four authorisations are required for the installation of energy generating units located on offshore territory.

1. Lease concession, which typically takes around 1 year
2. Environmental permits and authorisations, which typically takes around 6 months to 1 year
3. 'Sea cable' permits, which typically takes around 6 months to 1 year
4. Authorisations for cable-laying along public roads, which typically takes around 6 months to 1 year

Scroby Sands offshore wind farm, Great Yarmouth
© Ben Alcraft/RenewableUK

The procedure for granting an environmental permit explicitly provides for the cooperation between the competent ministry and the scientific body carrying out the study on the environmental impact (MUMM[25]). This has led to better data on potential environmental impacts being identified in Belgium as opposed to the much larger market of the UK.

Grid connection

Grid connection costs are borne mainly by the plant owner, with the TSO required to contribute one-third of the procurement and construction cost of the export cable and connection equipment, capped at € 25 million. The costs of the expansion of the grid are initially borne by the grid operator. Use of System costs are borne by the consumers through their electricity bill.

Financial support mechanism

In addition to wholesale power, generators can sell one certificate/MWh produced. Offshore wind power stations' receive the minimum certificate price that is:

- € 107 /MWh for electricity generated resulting from first 216 MW of installed capacity;
- € 90 /MWh for electricity produced from an installed capacity exceeding the first 216 MW.

Wind farms are provided balancing support estimated to be worth approximately € 7/ MWh in 2012.

SUMMARY OF KEY POINTS FROM BELGIUM

- **Focus on monitoring of environmental impacts** The procedure for granting an environmental permit explicitly provides for the cooperation between the competent minister and the scientific body carrying out the study on the environmental impact (MUMM). This has led to better data on potential environmental impacts being identified in Belgium as opposed to the much larger market of the UK.

NETHERLANDS

Current status

The Netherlands has had a stop-start history in offshore wind. By the end of 2011, the Netherlands had 247 MW of offshore wind deployed and a strong pipeline of projects. However a change of Government led to a cut in renewable energy support and stagnation in the offshore wind industry. In 2014, the market took a huge leap forward with the signing of the cross industry, Government and civil society Energiakkord that aims to deliver 4.45 GW of offshore wind by 2023. This agreement suggests that the Netherlands will be one of the main secondary markets in Europe, with financial close at Gemini another positive development.

Policy drivers

The Netherlands has set a target of a 30% reduction in CO2 emissions by 2020, compared with 1990, which includes a renewable energy share of 20% in 2020. As part of this a target has been set to reach 6 GW of onshore wind and 4.4 GW of offshore wind capacity by 2023.

The Netherlands has built on its strong marine heritage to develop a strong supply chain in offshore wind, with companies such as Smulders, SIF, VSMC and Van Oord major contractors and fabricators.

TABLE 17: OFFSHORE WIND POLICY DRIVERS IN THE NETHERLANDS

Energy security	Decarbonisation	Industrial / job creation benefits
●	●●●	●●●

Land/seabed tenure & development rights

Spatial planning in the Netherlands is undertaken by the Ministry of Infrastructure and Environment and resulted in the National Water Plan, identifying constraints to offshore wind but providing developers the opportunity to come forward with sites beyond these constraints.

Once a site has been identified the developer must undertake an EIA that includes an assessment of impact on other sea users, and submit plans for construction, operation, decommissioning and safety, together with the request for consent.

To help developers, the Government operates a ‘one-desk’ service, coordinating consultation processes for areas such as fishing and shipping, and permitting requirements from subsidiary and supporting activities such as landing of ships during installation and maintenance and onshore planning. If successful, the developer is issued a construction permit that requires works to commence within 3 years of approval.

Thornton bank, Ostend, Belgium © EWEA

Grid connection

Offshore grid connections need to be applied for separately from the WBR (Wet Beheer Rijkswaterstaatswerken) and SDE (Stimulering Duurzame Energieproductie) processes to the Dutch TSO, TenneT. Previously, the costs of connection to the grid were borne by the plant operator and the costs arising from the expansion of the grid borne by the final consumers. The costs arising from the use of a grid are borne by the customers connected to this grid (users and plant operators).

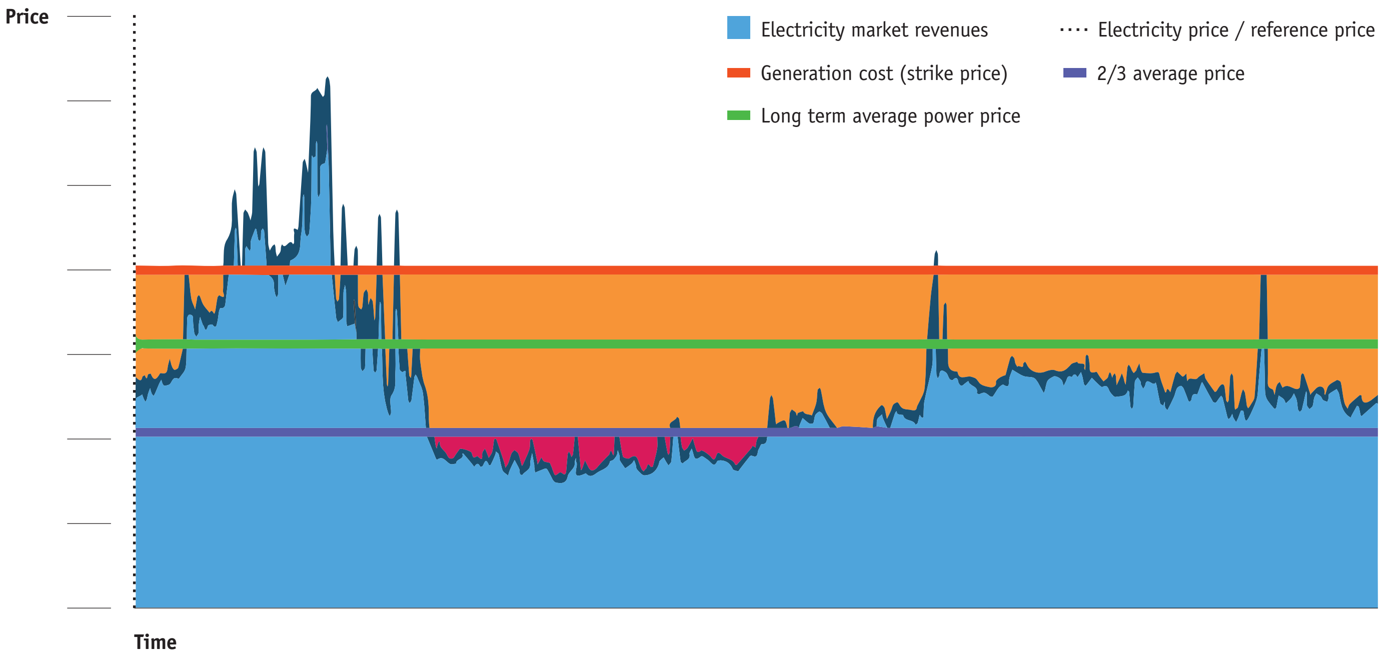
How grid costs will be shared in the new programme is not yet clear but where a coordinated offshore network is the most efficient approach, TenneT will make the required investment.

Financial support mechanism

Offshore wind in the Netherlands is supported by a sliding premium tariff set by competitive auction, with a ceiling price set by the Government. When assessing these bids the Government corrects the price using a formula on the basis of water depths and distance to shore. This produces a ranking of projects and the ones that come within budget get contracts, with the developers receiving the price they bid in with (and not the ranked adjusted price). The tariff level is confidential but concerns have been raised over the correction factors for depth and distance to shore, which appeared to overly favour the more expensive projects that have now struggled to be built. There is also a large tax deduction granted to offshore wind developers.

Tariffs are paid for 15 years but limited each year to a maximum number of full load hours (corresponding to 36% capacity factor) for budgetary purposes. Generators must market their power and an incentive is paid to make up the difference between the wholesale market electricity price and the cost of generation. In calculating the subsidy to be paid by the scheme, top ups are capped at the difference between the generation costs and 2/3 of the long term power price. Generators are not expected to repay subsidies when the wholesale price of electricity is greater than the cost of generation.

FIGURE 8: NETHERLANDS SDE/SDE+ PAYMENT MODEL



SUMMARY OF KEY POINT FROM NETHERLANDS

- **Long-term political support and clear policies necessary** – Changes in Government have led to a stop-start offshore wind industry in the Netherlands. This decreases confidence and makes investment in new manufacturing facilities difficult.

Nue (Silkworm) Island,
Kyonggi-do, West Sea of Korean peninsula.
Unison 750KW x 3 WTG's, Commissioned in 2009
© KWEIA

CHINA

Current Status

China's offshore wind market has developed much slower than anticipated, particularly given the rapid growth rates onshore, and by the end of 2013 the installed capacity had risen to 429 MW. *Table 18* shows that seven offshore projects are under construction (totaling 1.6 GW) with another 3.5 GW projects in the pipeline that will start construction in 2015.

Government targets have now been downgraded to approximately 2 GW of offshore capacity by the end of 2015 and 10 GW by 2020[26]. This represents a challenge but the level of activity on the ground suggests that this is achievable.

TABLE 18: PROJECTS UNDER CONSTRUCTION IN CHINA

Fujian Putian Nanri Island Offshore Project	400 MW	Longyuan	Near shore
Fuji Putian Haiwan Haishangfengdian	300 MW	Fujian Zhongmin	Near shore
Jiangsu Rudong Inter-Tidal Project	200 MW	Longyuan	Inter tidal
Jiangsu Dafeng Concession Tenter project	200 MW	Longyuan	Inter tidal
Jiangsu Rudong Offshore Project	150 MW	China Guangdong Nuclear	Inter-tidal
Shanghai Donghai Bridge Phase II	116 MW	Shanghai Donghai Wind Energy	Near shore
Guangdong Zhuhai Guishan Project	200 MW	China Southern Grid	Near shore

Source: GWEC

Beginning of offshore wind sector

China's first Renewable Energy Law entered into force in 2006. It significantly accelerated the growth of renewable energy. Up until this time renewables had been marginal, but the 2006 Law provided a legal framework for their operation and development. The Law required that grid companies prioritise renewables over other sources of power. Although it did not include targets and tariff bands for different technologies, the law did provide the basis for follow-up supporting regulations for wind power.

A provision for renewable portfolio standards was a key element of the 2006 Law. Other market-enhancing provisions included 'Government-guided' prices for wind power; the obligation for utilities to purchase all generated renewable power, and state guarantees. The 2007 Medium and Long-term Development Plan for Renewable Energy put forward national targets and policy measures for supporting implementation. To further encourage its emerging wind industry, the Government included a 70% local content requirement, which was removed at the end of 2009. China's first offshore wind power demonstration project, and the first offshore wind project outside Europe, is the 102 MW Shanghai Donghai Bridge offshore wind farm. The wind farm started generating power in July 2010.

First tender for offshore wind

In 2010, the Government launched a public tender for the first round of offshore wind concession projects. The intention was to add 1 GW of planned capacity in four projects along the coastline of Jiangsu Province[27], two of which are offshore and two are intertidal. The leases were granted following a concession tender model, in which a competitive tender determined both developers and tariffs.

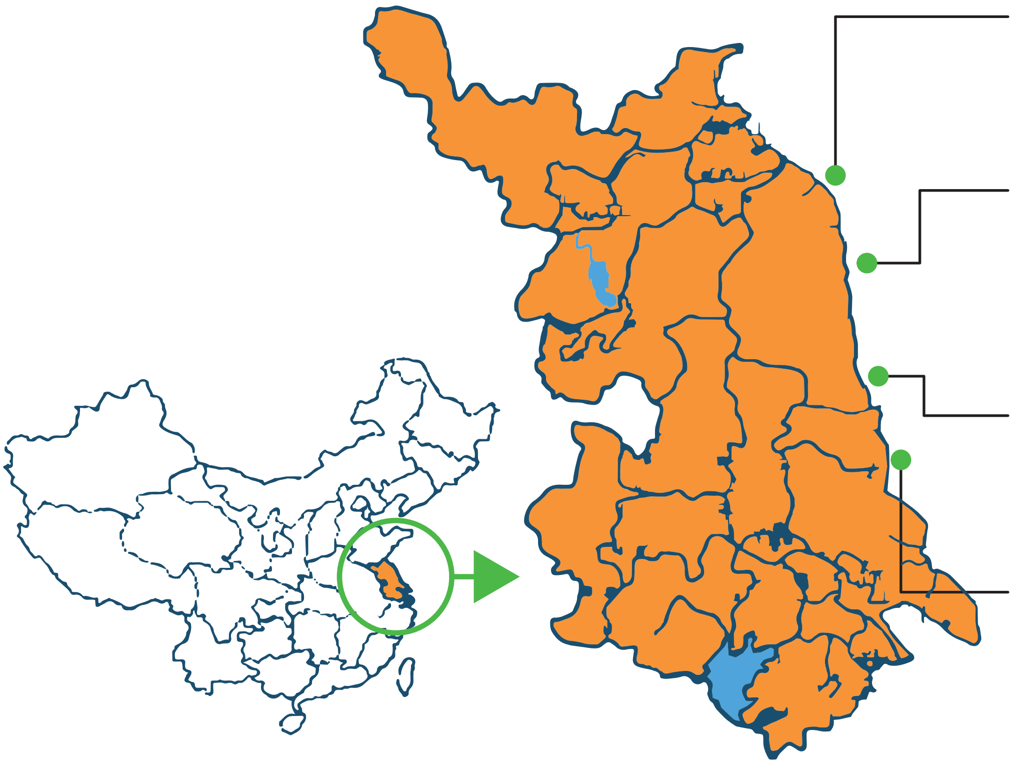
However these projects, although approved by the NEA, led to objections from other Government departments seeking to protect fishing rights and other marine interests. In the meantime, the developers realised that the proposed prices were too low.

Nevertheless, in the meantime, 'demonstration projects' were being approved and built, receiving a more favourable tariff then the concession sites. In the beginning, these demonstration projects were always of small size, consisting of several turbines with a total maximum capacity of 20-30 MW. But, the Jiangsu Rudong (intertidal) project (150 MW) was approved and labeled as a 'demonstration project'. It began full commercial operation by the end of 2012.

TABLE 19: OFFSHORE WIND POLICY DRIVERS IN CHINA

Energy security	Decarbonisation	Industrial / job creation benefits
●●●	●●	●●

FIGURE 9: LOCATION OF CHINA'S OFFSHORE PROJECTS



Binhai Offshore 300 MW
Datang, Sinovel, 0.7370 CNY/kWh

Sheyhang Offshore 300 MW
CPI Sinovel, 0.7047 CNY/kWh

Dafeng Intertidal 200 MW
Longyuan, Goldwind, 0.6396 CNY/kWh

Dongtai Intertidal 200 MW
Luneng, Sewind, 0.6235 CNY/kWh

Source: Chinese Wind Energy Association[28]

Burbo Bank, Liverpool Bay, UK
© Wind Power Works

Policy drivers

The drivers for offshore wind in China are as follows:

- Unprecedented need for new energy generating capacity
- Clear industrial development strategy for wind power, including offshore wind
- Need to improve air quality
- Proximity to load centres – much of China's population lives on the coast
- Large resource – according to the China Wind Energy Development Roadmap 2050 there is approximately 500 GW of potential in areas with water depths of 5 m to 50 m.

Grid connection

In 2009, the Renewable Energy Law was amended to introduce a requirement for grid operators to purchase a fixed amount of renewable energy. The amendment further reiterated that the grid companies should absorb the full amount of renewable energy produced, with the option to apply for subsidies from a new Renewable Energy Fund[29] to cover the extra cost of integration.

Land/seabed tenure & development rights

Chinese power companies invested in a series of demonstration projects[30], as a way of gaining experience in offshore developments and gained experience for the next tenders. The main cause for the delays with China's offshore plans during this stage was a lack of coordination between state administrations.

Offshore wind developments appeared to conflict with some other marine economic activities and two governmental bodies (NEA and State Oceanic Administration) were put in charge of offshore wind power development. A cohesive national plan for the offshore industry was deemed necessary for long-term growth of the offshore wind sector.

In 2010, the NEA and the State Oceanic Administration jointly published a report titled 'Interim Measures for the Administration of Development and Construction of Offshore Wind Power'. These guidelines were set to help accelerate China's offshore wind power development and included detailed provisions for project approval procedures, as well as criteria for project development and construction. Tender procedures were to be the preferred method of selecting the offshore projects, and foreign investors were allowed to hold a minority stake in offshore wind developments.

Financial support mechanism

A national level feed-in tariff was announced in October 2014 at CNY 0.75 per kWh for inter-tidal projects while the nearshore tariff was set at CNY 0.85 per kWh. There are industry concerns as to whether this is sufficient and as a result, some provincial governments have announced additional renewable energy subsidies on top of the feed-in tariff. For instance, in Shanghai offshore wind farms receive a boost of CNY 0.2/kWh for the first five years.

SUMMARY OF KEY POINTS FROM CHINA

- **2006 Renewable Energy Law:** Policy and regulatory support for offshore wind stems from the introduction of the Renewable Energy Law in 2006. This policy provides the long-term framework for other necessary regulatory actions to be taken.

- **First round of tenders could have been better designed:** In 2010, the first round of concession tenders awarded tariffs to four offshore wind projects with a total capacity of 1 GW, and marked a new era for China's wind industry. However, due to the low tariffs and the complexity of securing permission from various Government departments, the offshore developments did not really takeoff and the first four concession projects saw delays in completion.

- **Forward looking industrial development strategy:** Supply chain development and technology cost reductions have historically been strengths of China. Both its domestic onshore wind and solar PV sectors were supported by long-term industrial development strategies. China today is the leading manufacturer and implementer of both these technologies. It is likely that offshore wind deployment will have a similar focus on industrial growth.

- **Demonstration projects were critical, likely to be a significant offshore wind market by 2020:** With almost 5 years of experience on the ground with several demonstration projects, the Government and the offshore wind industry are better placed to take the next step. The offshore sector in China is finally entering a 'mini-boom'. The pipeline of projects is beginning to look attractive to developers and investors.

Horns Rev II, North Sea, Denmark © Wind Power Works

Footnotes

17 http://www.renewableuk.com/en/renewable-energy/wind-energy/offshore-wind/

18 http://www.renewableuk.com/en/renewable-energy/wind-energy/offshore-wind/#sthash.Zfg6r61q.dpuf

19 UK Planning Act 2008 as amended by the Marine and Coastal Access Act 2009, the Localism Act 2011 and the Growth and Infrastructure Act 2013

20 https://www.gov.uk/government/organisations/department-of-energy-climate-change/series/energy-bill

21 http://www.offshore-windenergie.net/en/

22 In the sphere of offshore wind energy, the BSH operates as an authority granting permits and planning permits for offshore wind farms and grid connections in the German exclusive economic zone (EEZ). Moreover, the BSH is responsible for monitoring the operation of the plant and, if the approval conditions are violated, can prohibit the operation of the plant or prescribe other measures. Furthermore, maritime spatial planning falls within the remit of the BSH. The BSH is also responsible for the preparation of the Federal Trade Plan for Offshore (North Sea and Baltic Sea), which forms the main basis for offshore grid planning in the EEZ. Source: German Offshore Wind Energy Foundation 2014

23 http://www.offshore-windenergie.net/en/politics/legislation-and-responsibilities

24 Only available to projects starting before 2018

25 MUMM: Management Unit of the North Sea Mathematical Models

26 Rechargenews 'China sees less offshore wind', October 23, 2014

27 The winning bids for these projects ranged between CNY 0.62 and CNY 0.74 per kWh

28 Presentation titled 'China Offshore Wind Development Status and Outlook' by Qin Haiyan, Secretary General, Chinese Wind Energy Association on 22 September 2011 at China Wind Power 2011 (Beijing)

29 To finance renewable energy projects, the government put a surcharge per kWh on the electricity price. The surcharge started as CYN 0.002/kWh and was raised to CYN 0.004/kWh in 2008. This income is pooled with other national funding sources into a national Renewable Energy Fund to finance both special renewable energy projects and the feed-in tariff for wind power (GWEC, 2012)

30 These demonstration projects were initially of a smaller size, consisting of several turbines with a maximum capacity of 20-30 MW. However the Rudong project (150 MW) was approved and labeled as a 'demonstration project' in 2011. Demonstration projects received a favorable tariff, compared to the lower tariff resulting from the bidding process. This mechanism played a positive role in testing the offshore technology and offshore wind farm management in the country (GWEC, 2011)

SUMMARY OF OFFSHORE WIND POLICY DRIVERS IN EUROPE AND CHINA

	United Kingdom	Germany	Denmark
Installed capacity	3743 MW	520 MW	1270 MW
Target	8-13 GW by 2020	6.5 GW by 2020	2.8 GW by 2020
Key policy drivers	Energy security: ●●● Decarbonisation: ●●● Industrial benefits: ●●	Energy Security ●●● Decarbonisation ●● Industrial benefit ●●●	Energy Security ●● Decarbonisation ●●● Industrial benefit ●●●
Land /seabed tenure & development rights	The Crown Estate owns seabed and leases sites. Consent provided through 'one stop shop' in England and Wales Separate onshore and offshore consents required in Scotland	Developer led approach to identification of sites, within overall Marine Plan. Marine regulator BSH has leading role, supplying most permits	All permissions are granted by the DEA. The Danish consenting process for offshore wind can be considered a one-stop-shop approach
Grid connection	Developers fund and construct transmission infrastructure but then required to sell to third party	TSO is required to fund all offshore wind grid connection works to an offshore connection point	Connection developed and financed by grid operator Energinet
Financial support mechanism	Green support certificate to date moving to a form of feed-in tariff called Contract for Difference	15 year feed-in tariff with potential for accelerated 12 year feed-in tariff at higher rate	Feed-in tariff set through competitive auction of individual sites

Belgium	Netherlands	China
495 MW	247 MW	429 MW
1.8 GW by 2020	4.45 GW by 2023	10 GW by 2020
Energy Security ●● Decarbonisation ●●● Industrial benefit ●●	Energy Security ● Decarbonisation ●●● Industrial benefit ●●●	Energy Security: ●●● Decarbonisation: ●● Industrial benefit: ●●
Seabed split into seven lease areas. Four permits issued by different authorities	Lease areas and one stop consenting shop provided by Ministry of Infrastructure and Environment	Sites identified by NEA. Developers then follow 'Interim Measures for the Administration of Development and Construction of Offshore Wind Power'
Grid connection borne by developer, except for € 25million contribution from TSO	Historically funded by developers but currently under debate	Connection developed and financed by grid operator
Green certificate	Sliding premium feed-in tariff, auctioned through competitive tenders	Feed-in tariff for offshore projects based on distance from shore. Demonstration projects get a more generous FIT comparatively

8

CONCLUSIONS FOR INDIA

The previous chapters of this report have discussed the policy and regulatory pathways followed by six key markets, drawing out key lessons. This section takes these learnings and considers how they may be applied to India as it begins to develop its own offshore wind industry.

The design of India's offshore wind policy is critical to creating the necessary conditions for long-term growth and to lower investment risk in the offshore wind sector. Policy choices will be made not just for the financial mechanism, but also regulatory and permitting issues and grid integration. Ensuring that all of these issues are coordinated is vital to the long-term success of the sector.

Careful examination of what has worked and not worked in Europe can help the coastal states of Gujarat and Tamil Nadu, plus central Government, to avoid repeating costly mistakes and maximise the impact of public investment. The lessons can help strengthen policy design to give clarity and consistency to an emerging industry that could in time create jobs and contribute to the nation's energy independence.

The FOWIND consortium recognises that some aspects of offshore wind policy development are already in discussion within MNRE. The following recommendations are suggested as inputs into this process, focusing on areas that are still open.

i. Set a clear offshore wind target and roadmap to convey the vision to industry

Experience shows that a clear, time-bound, quantitative target for offshore wind development, and a roadmap of how to achieve it, is an effective tool to focus minds on the offshore wind opportunity.

Europe provides evidence of the importance of targets and roadmaps. The EU 2020 National Renewable Energy Action Plans played a crucial role in catalysing industry activity, raising public awareness and attracting investors. In fact, nearly all offshore wind markets today have either national or state-level targets and specific plans for renewable energy. The signals are strongest where these targets are offshore wind-specific, rather than pertaining to renewables in general.

It may be premature for India to set long term targets given the current uncertainty associated with both the resource and local offshore wind levelised costs. However, as understanding increases, then a clear long-term target and roadmap is likely to provide a significant stimulus to offshore wind deployment.

ii. Clearly articulate and affirm energy policy objectives to maintain industry confidence

Whilst targets are hugely beneficial, in real life roadmaps do not always go to plan; unforeseen issues, such as changes to the financing climate, mean that the future may turn out differently from expectations. For instance, the history of European offshore wind shows that deployment has tended to fall short of targets.

For this reason, it is best practice for targets to be backed up by a clear articulation of wider policy objectives. Common energy policy objectives are decarbonisation, energy security, affordability and job creation.

A clear understanding of these wider policy objectives helps to provide industry with confidence that the drivers for offshore wind will persist even if the exact milestones do not always go to plan. Clear policy objectives also provide focus for industry activity; for instance, the UK Government's repeated articulation of the importance of affordability has sparked concerted industry effort on cost reduction.

A simple and strong message from industry and investors is always the need for dependable, long term policy signals to be present. Results have been delivered where this has been the case: for example Germany and Denmark have had stable policies to promote offshore wind for many years, and both have successfully created a robust local offshore wind sector.

India already articulates its policy objectives to some extent. For instance, India has had a climate change action plan since 2008, and the need to address power shortages is regularly communicated. However, the integration of mitigation and adaptation efforts is yet to be initiated at the broader economic and resource planning levels. There is scope for even better integration of climate, decarbonisation and economic growth signals.

iii. Ensure managed progression from demonstration to commercial projects

Offshore wind projects pose a significant technical, commercial and regulatory challenge that should best be approached step-wise, beginning with demonstration projects.

Most of the markets studied in this report have undertaken demonstration projects, usually more than one, to assess local appetite and environmental conditions, identify regulatory issues, create learning opportunities for domestic developers and suppliers, gauge the gaps in auxiliary infrastructure (ports, vessels, grid connections etc.) and to test new technology. Such demonstration projects in India could provide invaluable first-hand experience and tease out any India specific issues. They can help transfer knowledge through collaboration between local Indian stakeholders and more experienced partners.

The challenges of bringing forward a demonstration site can help both developers and regulators understand whether offshore wind is a sector worth pursuing and in turn help shape any future commercial scale projects. It it therefore encouraging that MNRE and a consortium of industry partners have committed to the first 100 MW demo site in India. See box on page 68 for further discussion of next steps for this demo site.

Yet, it is not just about demonstration sites. A demonstration site will almost certainly be expensive, given that it will be doing something new. For the industry to make the necessary investment in infrastructure, a clear plan for progression to the next

Floating installation, Japan
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level of project is required. For instance this could be a large number of smaller projects, driving competition amongst developers and mitigating the risk if any one project was to fail, or it could be the identification of larger zones that could provide a clear pipeline for one developer and in turn drive industrialisation. These are important choices that will shape how the sector develops.

KEY CONSIDERATIONS FOR DEMONSTRATION SITES

Undertake robust wind resource assessment campaign
Understanding the wind resource is crucial in determining how viable offshore wind is in India, with wind speeds a significant driver of levelised cost. At present there are relatively few offshore wind speed measurements with current resource assessments based on a high-level mesoscale modelling. With the announcement of a demo site, there is a good opportunity for a robust wind measurement campaign that could help support not just the demo site itself but the industry as a whole.

Plan for a streamlined approval process, proper grid access and ancillary infrastructure development
Regulatory barriers to demonstration sites can take a significant amount of time to resolve. Key actors should therefore start to be engaged now. For instance, it will be vital to ensure early buy-in by the grid operators and utilities to allow power evacuation. Indian policy makers should also look at providing a single window clearance mechanism for the sector given that scores of ministries and departments would need to give the necessary approvals. This would help avoid delays.

iv. Provide strong initial public investment and utilise Public-Private partnerships where possible

Public investment is critical for this emerging sector. This is needed not just to reduce project risk and to provide soft loans but also to ensure that the preliminary assessments and necessary supporting infrastructure is developed. For example The Crown Estate in the UK have undertaken work to de-risk the environmental and consenting process through targeted research, with industry and non-profit organiations, on issues such as birds, collision risk for vessels and helped managed the interaction between the offshore wind and telecoms sectors. In Germany, the Bremen region invested heavily in the Port of Bremerhaven, which is now the offshore wind hub for the German sector.

In terms of financing, the high cost of offshore wind has meant that a mix of public and private finance has been required. For instance, KfW, the UK's Green Investment Bank and the European Investment Bank have all invested heavily in offshore wind, aiding developers' constrained balance sheets and bringing in new investors.

The financing, technical and regulatory challenges of offshore wind are such that private and public sector partnerships are vital to the overall success of the sector. In India, the demonstration site announced by MNRE is an encouraging first step. Going forward, the Indian Renewable Energy Development Agency (IREDA) within MNRE will be critical to establishing such partnerships.

v. Ensure sufficient volume, delivered in a smooth pipeline, and design risk-informed support mechanisms to drive cost reduction

The expected higher costs of offshore wind development are one of the key concerns of decision makers in India. The levelised costs of offshore wind are still high in Europe in comparison to other renewable technologies such as onshore wind and even solar.

There are various policy initiatives, particularly in the UK and Germany, which are focused on driving down cost. India will benefit indirectly from these initiatives, but equally Indian policymakers can also directly have an impact on local costs themselves.

A key message coming from leading markets is that confidence in sufficient market volume helps industry to maximise local 'learning by doing' and benefit from economies of scale – thus pushing down costs. In particular, it is important to ensure a smooth pipeline, as rapid increases or decreases in deployment are challenging for the supply chain to manage. A further aid to cost reduction can be designing 'risk informed' financial support mechanisms, which are structured such as to minimise upfront developer risk, to minimise cost of financing.

It is also important for policymakers to keep their eye on the bigger, longer term picture. Initially at the demonstration phase, offshore wind costs can be expected to be high. However, as more and more parts of the puzzle of offshore wind farm design, development and operations become more familiar to local actors, cost efficiencies will be found.

Long term the focus should be on cost reduction in those areas that India can influence. Localization and learning from other markets could result in lowering the costs for the technology for India. However this will require long term political, policy and regulatory investment and guidance to be available to the sector.

vi. Carefully consider the costs and benefits of promoting a local supply chain

A crucial motivation for the countries discussed in *Chapter 7* is often the overt desire to create local economic value, in terms of jobs, additional income and manufacturing. Those benefits vary significantly from market to market, and include localised installation and maintenance capacity, component supply or large-scale wind turbine manufacturing and local skills development.

Policymakers can influence local content through both proactive supply chain support programmes, and through attaching conditions to financial support mechanisms. However, the excessive promotion of local content may bring the risk of reduced market competition (and thus higher prices) and prevent opportunities for knowledge transfer if international players are deterred from market entry.

A diversity of approaches has been taken by leading offshore wind markets to date, steered by a mix of policy and culture. The UK has been notable for its relatively open door policy, whereas offshore wind development in China has been delivered largely domestically. Meanwhile, some Japanese players have taken the strategy of partnering with European companies, as well as making direct investments in the European market, to aid knowledge transfer.

The decision on the extent to which local content is emphasised ultimately lies with Indian decision makers, and depends partly on the business culture. It could be beneficial for India to promote investment in this sector with a view towards creating a robust supply chain as part of the country's industrial development strategy. However the decision to develop a supply chain must be based on whether the potential market is big enough to warrant a local supply chain that is commercially viable and able to win export opportunities in the wider global market.

Analysis of country case studies does not provide one 'right' answer. The key point is to be aware of the benefits and trade-offs.

Daman, India © Suzlon

RECOMMENDATIONS FOR INDIA'S OFFSHORE WIND POLICY DEVELOPMENT

Key policy recommendations to catalyse offshore wind development in India:

- **Set a clear offshore wind target** and roadmap to convey the vision to industry
- Clearly articulate and affirm energy **policy objectives** to maintain industry confidence
- Ensure managed progression from **demonstration to commercial projects**
- **Provide strong initial public investment** and utilise Public-Private partnerships where possible
- Ensure sufficient volume, delivered in a smooth pipeline, and design risk-informed **support mechanisms** to drive cost reduction
- Carefully consider the costs and benefits of promoting a **local supply chain**

PROJECT PARTNERS

Global Wind Energy Council (Brussels, Belgium) is the international trade association for the wind power industry. The members of GWEC represent over 1,500 companies, organisations and institutions in more than 70 countries. *www.gwec.net*

Center for Study of Science, Technology and Policy (Bangalore, India) is one of the largest think tanks in South Asia; its vision is to enrich the nation with technology-enabled policy options for equitable growth. *www.cstep.in*

DNV GL is the world's largest provider of independent renewable energy advice. The recognized authority in onshore wind energy, DNV GL is also at the forefront of the offshore wind, wave, tidal and solar sectors. *www.dnvgl.com*

Gujarat Power Corporation Limited (Gandhinagar, India) has been playing the role of developer and catalyzer in the energy sector in the state of Gujarat. GPCL is increasing its involvement in power projects in the renewable sector, as the State of Gujarat is concerned about the issues of pollution and global warming. *www.gpclindia.com*

World Institute of Sustainable Energy (Pune, India) is a not-for-profit institute committed to the cause of promoting sustainable energy and sustainable development, with specific emphasis on issues related to renewable energy, energy security, and climate change. *www.wisein.org*

STRATEGIC PARTNER

IL&FS Energy Development Co.Ltd (IDECL) is a group company of Infrastructure Leasing & Financial Services (IL&FS). It is engaged in the business of generation, transmission & distribution of power & is currently developing various projects with an aggregating capacity of more than 14 GW. *www.ilfsindia.com*

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