International Renewable Energy Agency

# Offshore wind investment, policies and job creation

## Review of key findings for G7 ministerial meetings

**Halifax, Canada**

**September 2018**

## About IRENA

The International Renewable Energy Agency (IRENA) is an intergovernmental organisation that supports countries in their transition to a sustainable energy future, and serves as the principal platform for international co-operation, a centre of excellence, and a repository of policy, technology, resource and financial knowledge on renewable energy. IRENA promotes the widespread adoption and sustainable use of all forms of renewable energy, including bioenergy, geothermal, hydropower, ocean, solar and wind energy, in the pursuit of sustainable development, energy access, energy security and low-carbon economic growth and prosperity. **www.irena.org**

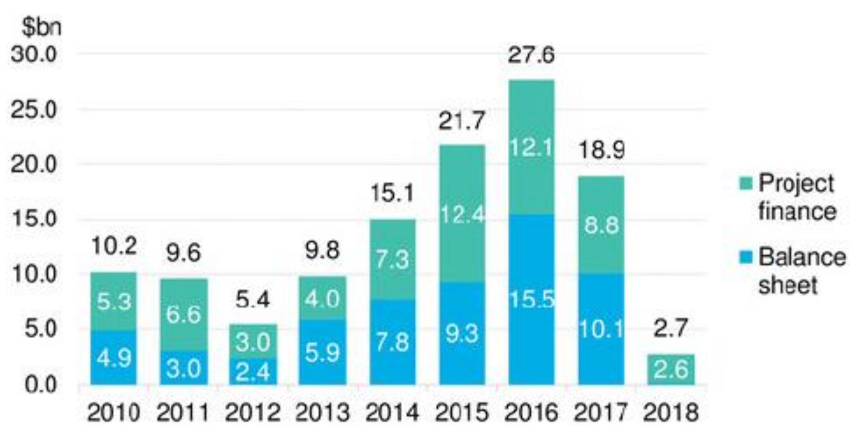
# Offshore wind investment and jobs

Power generation from offshore wind energy has emerged as a promising way for countries to expand their renewable energy portfolios and advance the necessary transformation for a sustainable energy future. This note reviews investment trends, recent auction results and G7 deployment in the sector, along with highlighting local benefits from offshore wind development.

## Offshore wind investment trends

Global offshore wind investment had risen to record levels of USD 27.6 billion in 2016, but fell to USD 18.9 billion in 2017 and a projected USD 15.1 billion in 2018 (BNEF, 2018a), reflecting the ebb and flow of project and policy cycles as well as falling costs (see Figure 1).

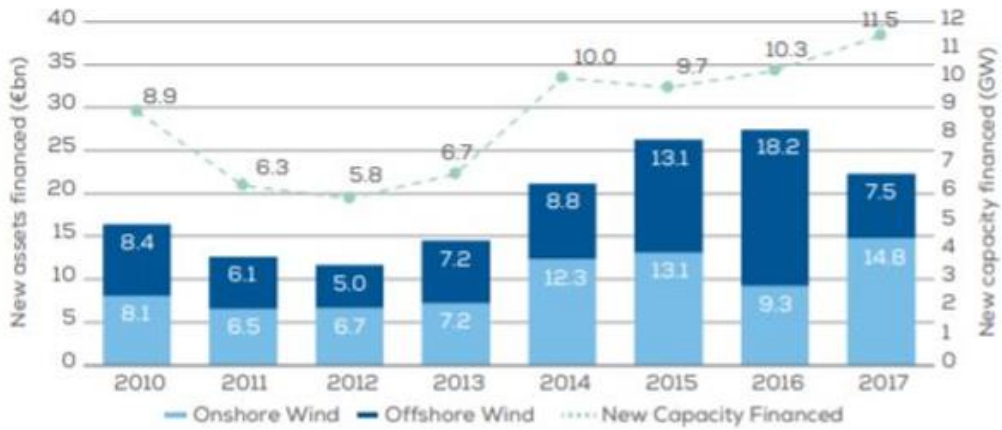
*Figure 1. Global investments in offshore wind energy, 2010-2018*




*Source: BNEF, 2018a.*

Given Europe's commanding lead in offshore wind development, the continent has accounted for the preponderance of investments to date. According to WindEurope (2018), the EUR 7.5 billion (around USD 8.7 billion) spent in 2017 was down from a record EUR 18.2 billion in the previous year (see Figure 2). China is picking up its pace; 13 projects with a capacity of 3.7 gigawatts (GW) may require USD 10.8 billion (Louw, 2018). Globally, investments in offshore wind are set to grow substantially over the next several years.

*Figure 2. European investments in offshore wind energy, 2010-2017*




*Source: WindEurope, 2018.*

## Recent auctions in G7 member countries

**Major Trends in Auctions.** G7 member countries have increasingly adopted auctions as an instrument of choice to support the development of the offshore wind sector. The following presents an overview of the latest offshore wind auctions in these countries:

- **Canada** is the latest to join the offshore wind movement, and companies in and outside Canada have joined forces to investigate the potential for offshore wind energy in the country. Ørsted and NaiKun Wind Energy Group have signed a letter of intent that gives Ørsted exclusive rights to negotiate a joint development agreement for a project in British Columbia. In October 2016, a partnership was developed with one of the world's leading offshore wind investors, Copenhagen Infrastructure Partners, to develop, own and operate offshore wind farms in Atlantic Canada (Foxwell, 2018).

- In 2012-2014, **France** had awarded six offshore wind projects with contracts to sell electricity at tariffs guaranteed by the government of around EUR 200 per megawatt (MW) (about USD 240/MW), for 20 years. In 2012, two consortia, one led by French state-owned utility EDF and one led by Spanish utility Iberdrola, were awarded a combined capacity of 2 000 MW, representing investment of around EUR 7 billion (nearly USD 8.5 billion). In 2014, a consortium led by Engie was awarded a contract for 1 000 MW, worth EUR 4 billion. These auctions were awarded at relatively high prices, with hopes that state-owned firms Areva and Alstom would deliver French-design wind turbines for the projects and a French offshore wind industry would develop to compete with Denmark's Vestas and Germany's Siemens. Since then, wind turbine activities of Areva and Alstom have been sold to foreign companies - Siemens Gamesa and GE respectively – and the plan to develop a domestic offshore wind industry in France has been dropped.

- In 2018, the French government approved the long-delayed projects but sharply cut their subsidies. Public opposition to wind farms had delayed the projects, but since prices for international offshore wind power have more than halved, auctions will now resume and tariffs are to be cut to about EUR 150/MW (around USD 180/MW) (Reuters, 2018).

- **Germany** held its first round of offshore wind auctions in 2017. Out of the four winning projects, three (1 380 MW out of the total 1 490 MW) offered a strike price of EUR 0/MWh, meaning that they did not request any support on top of wholesale electricity prices. One 110 MW project was awarded at a strike price of EUR 60/MWh (USD 55/MWh). These prices were comparable to onshore wind and solar photovoltaics (PV) (NERA, 2017).

- The prices increased in the second round in 2018 with an average of EUR 46.60/MWh (USD 55/MWh). Winning projects are guaranteed grid connection, financed by electricity consumers, and have a 25-year permit to operate. Fewer bids were submitted because the auction was only open to already permitted or far-advanced projects that were unsuccessful in the 2017. Moreover, the 2018 auction rules prioritised bids for at least 500 MW of Baltic Sea projects (Eckert, 2018).

- **Italy** concluded a renewable energy auction at the end of 2016 and awarded a 30 MW offshore wind farm to be developed in the southeast (out of a total of 870 MW) at a price of EUR 161.7/MWh (USD 152/MWh). It was the only eligible bid. It comprises ten 3 MW turbines and must be commissioned in 2018 (Ministero dello Sviluppo Economico, 2016).

- In March 2018, a new bill in **Japan** that set rules to promote offshore wind was approved by the Japanese Cabinet and submitted to the Japanese Diet. The new design aims to reduce offshore wind prices, which are currently at around JPY 36 per kilowatt-hour (kWh) (USD 320/MWh) and are three to six times higher than those in Europe. The bill clarifies required permitting procedures. The industry and transport ministries will designate areas to be promoted for wind power operations, taking into consideration opinions from local residents. In the next steps, select candidate operators will be invited to submit bids (Japan Times, 2018).

- In 2017, offshore wind generated 6% of power in the **United Kingdom (UK)**. The UK has over 7 GW of operational offshore wind capacity – the largest amount of any country – and a further 7 GW is either under construction or has contracts secured, mostly as a result of the Contract for Difference (CfD) auction. The Minister for Clean Growth and Climate Change announced in early 2018 that further CfD auctions will take place every two years, supported by a budget of GBP 557 million (USD 740 million). The government's announcement of support for an additional 2 GW of offshore wind per year in the 2020s could deliver up to 16 GW of new capacity, which would generate approximately 20% of the UK's power. The next offshore wind auction will take place in May 2019, with remote island wind and a range of other projects competing for CfD (Clark, 2018).

- In 2018, in the **United States**, the north-eastern states of Massachusetts and Rhode Island selected developers to install 1 200 MW of offshore wind in the Atlantic Ocean (Efstathiou, 2018).

    - Avangrid Inc. and Copenhagen Infrastructure Partners jointly won a bid in Massachusetts to build an 800 MW wind farm and a transmission line to bring the power to shore. Phase 1 was awarded at USD 74/MWh in the first year, escalating 2.5% each year over a 20-year period. The price represents both energy and renewable energy credits (RECs). In Phase 2, the long-term contract price for energy and RECs begins at USD 65/MWh, with a 2.5% annual increase. The 20-year average cost of the two long-term contracts is USD 84.23/MWh. Construction is expected to begin in 2019, with the project in operation by 2021. Massachusetts wants to install 1 600 MW of offshore wind, enough to power about 1 million homes, by 2027 to help reduce carbon emissions. It is among several states – including Maryland, New Jersey and New York – targeting a combined addition of almost 8 GW by 2030.

- In Rhode Island, Deepwater LLC was selected for a 400 MW power plant. Deepwater could begin construction in around 2020, with the project in operation by 2023. Deepwater built the first US offshore farm in 2016 – the 30 MW, USD 300 million Block Island wind farm off the Rhode Island coast. Deepwater also participated in the Massachusetts auction and did not win.

## Impact of Design Elements on Auction Price

In 2017 IRENA published a report analysing the impact of the design of offshore wind auctions on the prices globally, including in G7 member countries (IRENA, 2017). A key factor contributing to the rapid decline in prices is that some developers have successfully won more than one bid in the same area, benefiting from economies of scale, past experience and market power. Given the volume of their purchases, these developers can push suppliers for lower prices. As of September 2016, Vattenfall, for example, had installed 1 325 MW of offshore wind capacity (out of a total of 2 265 MW wind installed) in Denmark, Germany, the Netherlands, Sweden and the UK. DONG secured three projects in Germany totalling 590 MW, following its 700 MW win in the Netherlands. As with other technologies, the main factors impacting auction prices include country-specific conditions, investors' confidence and access to finance, renewable energy support policies and auction design.

Several auction design elements are particularly relevant to price. These include specifying the project site to reduce investor risks and costs, setting up qualification requirements so as to minimise bidders' transaction costs, setting winner selection criteria that favour lowest prices and designing contracts, and defining liabilities so as to encourage bidders. As some of the G7 members have been pioneers in offshore wind auctions, many lessons can be shared that demonstrate the impact of some choices regarding the auction design on the price:

**Site-specific auctions have helped reduce investor risks in G7 member countries.** Such auctions reduce project developers' risks and facilitate the procurement of necessary permits and documentation by centralising this task to the government.

- Site-specific auctions have been the norm for offshore wind auctions in **Germany**, **Japan** and **the United States**. Pre-selecting a site typically implies that the installed capacity and grid interconnections are determined beforehand, allowing policy makers and project developers to concentrate their efforts on the challenges and features of the chosen site, and to tailor the auction design and awarded contract to these conditions.

- In the **UK**, offshore wind projects are not site-specific, which explains in part why prices have been higher there than in other countries. The UK auction design does not follow the traditional site- and technology-specific norm for offshore wind, since the auction is technology-neutral. The UK auction passes on costs to the project developers for activities such as grid connection, transmission, resource assessments and environmental impact assessments, unlike in other countries where these costs are paid by the government or by the transmission system operator. In addition, UK projects are located in deeper waters than projects elsewhere, which can also impact installation costs. While the UK auction design serves the purpose of letting markets decide the most cost-competitive technology, its results indicate that mitigating the risks and responsibilities assigned to bidders (or not) can have a substantial impact on the auction price.

**Qualification requirements tend to be less stringent in site-specific auctions**. Since sites are pre-determined, bidders need only to prove their technical and financial capability to deliver the project.

- In the **UK**, where bidders propose their own sites, qualification requirements tend to be more stringent and bidders must present additional documentation, which increases the prices.

One considerable source of risk with regard to site selection is the impact that an offshore project could have on the marine life, fisheries and other economic activities in the area. Environmental licensing for offshore wind tends to be a complex and costly endeavour, and conflicts with the fishing industry can lead to administrative difficulties.

- The **United States** competitively awards rights for exploration in a given area, rather than awarding a power purchase agreement directly. This assigns substantially more risk to the developer, who has little assurance that the investment will be recovered or even that the project will be built. In the case of New York, the Bureau of Ocean Energy Management had to remove about 1 780 acres (720 hectares) from the lease area after an environmental assessment identified the sea floor as a sensitive habitat to be avoided for the placement of structures. Moreover, in response to environmental concerns regarding commercial fishing interests, bidders were required to develop a publicly available fisheries communications plan and to work with a fisheries liaison to facilitate communication with the fishing industry.

**A simplified auction design that aims to award projects based only on the price offered can help increase the competitiveness of offshore wind technology.** How winners are selected can impact the resulting price.

- The **UK** and **the United States** have adopted a minimum-price criterion to select the winner.

- In **Japan**, however, a weighted score considering multiple aspects was used, highlighting other important policy objectives besides attaining the minimum price possible. One of the main qualification requirements is past experience in developing or operating offshore projects of at least 10 MW. The winner selection process involves a score-based system, with different weights assigned to various criteria that include bidder credentials, project documentation and feasibility, proposed financing structure, and socio-economic contributions to the port area and local companies.

**The price outcome is heavily impacted by the sellers' liabilities**. These include the date of project delivery; the structure of the contract, including the remuneration profile of the developer; and the penalties and liabilities involved.

- A key factor that contributed to the low bids in **Germany's** offshore auction is the date of project delivery, which is not until 2024–2025 for most of the projects. Projects commissioned in later years are expected to incur lower technology costs, as turbine and construction costs decline and as technology advances (*e.g.*, bigger and more corrosion-resistant turbines).

- In the **UK**, projects are expected to come online between 2017 and 2019, leaving little time for costs to fall.

With regard to contract terms:

- In the **UK**, contracts are for 15 years, compared to 20 years in most countries. The price awarded is also not inflation-indexed.

- **Germany** has adopted rather lenient compliance rules to encourage the participation of bidders. This has contributed to investor willingness to sell at zero support.

## Offshore wind power deployment trends and jobs in G7 member countries

The European wind industry is the global technology leader in the offshore segment. According to the Global Wind Energy Council (GWEC, 2018), Europe's 15.8 GW of installed capacity at the end of 2017 accounted for 84% of the global total of 18.8 GW, with the rest of the world accounting for just 16%.

Among European Union member states, G7 members the UK and Germany are the clear global leaders, accounting for 36% and 28.5% of total offshore wind capacity installed worldwide.

- The **UK** is the leader in offshore wind installations, which account for more than a third of the country's total installed wind energy capacity (WindEurope, 2018). Estimates by the UK Renewable Energy Association (REA, 2016) for 2014/15 indicate that offshore wind power employment was slightly larger than onshore wind employment: 20 570 jobs compared to 19 210 jobs[1].

- Econometric analysis indicates that **Germany's** offshore wind power sector employed 27 100 people in 2016, up from under 10 000 in 2010 and just 420 in 2007 (BMWi, 2018). The offshore segment accounted for 17% of total German wind employment in 2016, even though it represents no more than about 10% of the country's current total wind capacity (WindEurope, 2018).

The UK and German data suggest that offshore wind development is more **labour-intensive** than onshore wind development – not a surprising finding given the remoteness of offshore sites (which translates into a need for greater material inputs for grid connection) and the greater challenges inherent in building and operating offshore farms in often difficult environments.

The bulk of the remaining 16% (GWEC, 2018) of existing global offshore wind power capacity is located in China (15%, or 2.8 GW) (Siemens Gamesa, 2018), followed by Vietnam, G7 member Japan, the Republic of Korea, and G7 member the United States. The other G7 members (Canada, France, Italy) are not yet on the map. Japan and the United States together have a 0.5% share of offshore wind capacity; therefore, employment in both countries is likely miniscule for the time being. However, as these markets expand, manufacturers may decide to set up local production plants for turbines and blades.

- **Japan's** pace of installation has been slow – with just 24 MW installed by the end of 2017 – although a law promoting offshore wind power may change that. Also, the impact of the planned move from feed-in tariffs to auctions in 2019 or 2020 remains to be seen. Japan has a capacity target of 10 GW of offshore wind power by 2030 (GWEC, 2018).

- The first **US** offshore wind farm came online only in 2016, with a total installed capacity of 30 MW. Projects with a potential capacity of 25 GW are in the planning or approval phase (Maritime, 2018).

Bloomberg New Energy Finance's (BNEF's) *Offshore Wind Market Outlook* (BNEF, 2018a) reports that the UK is likely to retain its leadership — with 6.8 GW currently installed and another 5 GW in projects that have reached financial close (and are likely to commission by 2023), for a combined 11.8 GW. China, currently at 8.1 GW, may overtake Germany (7.6 GW) by 2023. All other markets will remain substantially smaller.

[1] In its most recent report covering 2015/16, REA does not provide a breakdown of employment between the onshore and offshore segments.

## Local benefits of offshore wind development

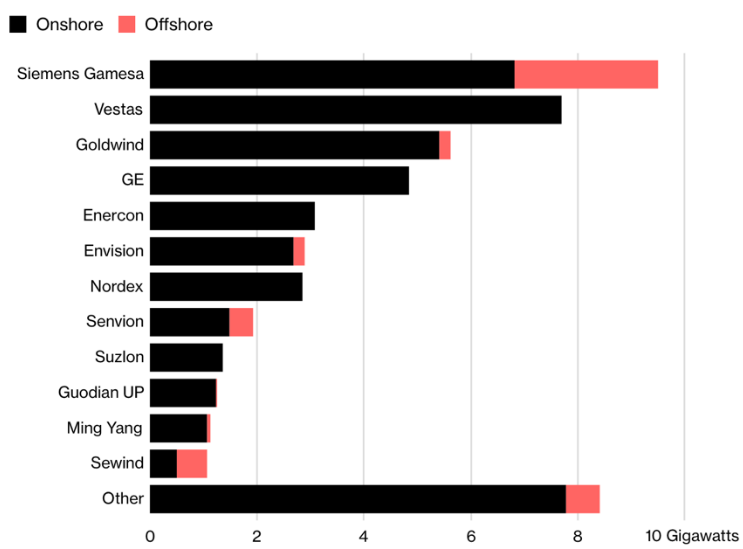
IRENA's work on *Renewable Energy Benefits: Leveraging Local Capacity for Offshore Wind* shows that for the development of a 500 MW offshore wind farm, much of the labour requirements across the value chain (totalling 2.1 million person-days) are found in the manufacturing and procurement segments (59% of the total). Existing manufacturing facilities for onshore wind can serve the needs of the offshore sector, as many components are comparable. But some components (such as the gearbox) require new production lines.

Countries that do not have sufficient capacity to manufacture equipment locally can derive jobs and other benefits in segments of the value chain that are easier to localise. For example, operations and maintenance accounts for 24% of total labour requirements, and installation and grid connection represent another 11% of the total (IRENA, 2018).

The manufacturing of offshore wind turbines is dominated by a handful of European companies. German-Spanish firm Siemens Gamesa is the leading company, with the largest installed base (11 GW), the largest order book (1.7 GW), a market share of more than 70%, and 6 000 employees (Siemens Gamesa, 2018).

According to BNEF[2], in 2017 Siemens Gamesa sold 2.7 GW worth of turbines for offshore wind projects. It was followed by China's Sewind (0.56 GW), Germany-based Senvion (0.44 GW) and a few smaller Chinese producers (Goldwind, Envision, Min Yang, Guodian UP) producing for the domestic market (see Figure 3) (BNEF, 2018b). Other manufacturers include GE (United States) and Doosan (Republic of Korea). BNEF's *Offshore Wind Market Outlook* expects that MHI Vestas will gain market share, but that GE and Senvion will continue to lag.

*Figure 3. Top wind manufacturers in 2017*




Source: BNEF, 2018b

[2] BNEF's ranking does not include MHI Vestas, the joint venture between Mitsubishi Heavy Industries and Vestas.

To localise the socio-economic benefits of wind development, decision makers may consider measures to facilitate domestic manufacturing of the main components of an offshore wind farm, such as the foundation and the substation, as well as parts of the turbine, blades, tower, and monitoring and control system.

Decisions will principally depend on:

1) the level of expected local or regional demand for wind energy;

2) the existence of government policies to require or incentivise local value creation;

3) the availability of raw materials and the presence of related domestic industries; and

4) the ability to overcome high costs and logistical challenges related to transporting bulky equipment.

Countries can **leverage existing oil and gas assets in support of offshore wind**, given the significant synergies that exist in hardware and skills. The basic design of the foundations and substations for offshore wind turbines is essentially the same as for oil and gas platforms. Specific policy measures, such as upgrading and supplier development programmes, support for joint ventures, and industrial promotion schemes, may be needed to strengthen the industrial capacity of domestic firms.

Successful job migration from the oil and gas sector to wind power also may require dedicated retraining policies.

- With regard to the construction and installation of platforms, one example of the interest among oil and gas companies in offshore wind is the Borssele III and IV tender in the Netherlands, which was won by a consortium that included oil and gas producer Shell and natural gas supplier Eneco (OffshoreWIND, 2016).

- Some service providers for oil and gas platforms are increasingly orienting themselves to offshore wind farms (heavy-lift vessels, crewboats, pipe-laying vessels, survey vessels). This is happening in the North Sea but is also of interest in the United States, in Southeast Asia and on the Indian subcontinent (Maritime, 2018). For example, Saipem, an Italian oil and gas industry contractor (drilling services; engineering, procurement and construction (EPC); installation) has branched out into offshore wind installation and EPC services, as well as the fabrication of jacket components for foundations.

- Shipyards also benefit. Offshore wind farms require large, specialised vessels, and existing oil and gas ships may require extensive conversions for the new tasks. The market for new wind farm vessels in the New England region of the United States is booming.

## Key findings

- Compared with the onshore market, the offshore wind segment is still small, but this is changing rapidly, with more countries investing resources and installing generating capacities.
- G7 member countries are increasingly adopting auctions as the policy instrument of choice for the deployment of offshore wind. The design of auctions heavily influences the risks associated with the development of offshore wind projects, including obtaining permits and connecting the wind farm to the grid, and the resulting price.
- Leadership in offshore wind currently rests with two countries: G7 members the UK and Germany, which together employ close to 50 000 people in the sector. Other G7 members still play a limited role for now.
- More than half of the required labour inputs for a typical offshore wind farm are in the manufacturing and procurement segments of the value chain.
- The opportunity to develop domestic value chains for offshore wind development depends on expected demand, adequate policy support, the existence of related industrial capacities, and the ability to address cost and logistical challenges. To build viable local industries for turbine manufacturing, engineering, construction, and related services, the development of supplier development programmes is essential.
- Countries that lack the required capabilities may find it easier to localise parts of the value chain other than manufacturing, for example the installation and operations and maintenance segments.
- Significant synergies exist between the offshore oil and gas industry and the offshore wind sector. Conventional energy assets and expertise can be thus leveraged but may require navigating a learning curve that includes adaptation or upgrading of equipment and retraining efforts.

## References

BMWi (2018), *Economic indicators of the energy system*, Bundesministerium für Wirtschaft und Energie. www.bmwi.de/Redaktion/DE/Publikationen/Studien/oekonomische-indikatoren-und-energiewirtschaftliche-gesamtrechnung.pdf.

BNEF (2018a), "1H 2018 Offshore Wind Market Outlook", Bloomberg New Energy Finance, 6 July.

BNEF (2018b), "These four power giants rule the world's growing wind market", Bloomberg New Energy Finance, www.bloomberg.com/news/articles/2018-02-26/these-four-power-giants-rule-the-world-s-growing-wind-market.

Clark, L. (2018), "UK offshore wind capacity set to double following government announcement", www.renewableuk.com/news/410144/UK-Offshore-wind-capacity-set-to-double-following-Government-announcement-.htm.

Eckert, V. (2018), "Germany approves offshore wind parks able to generate 1,610 MW", www.reuters.com/article/us-germany-power-offshorewind/germany-approves-offshore-wind-parks-able-to-generate-1610-mw-idUSKBN1HY25I.

Efstathiou, J. (2018), "Offshore wind, long delayed in U.S., gets a lift in New England", www.bloomberg.com/news/articles/2018-05-23/avangrid-project-wins-auction-for-first-big-u-s-offshore-wind.

Foxwell, D. (2018), "Canada comes to the offshore wind party", www.owjonline.com/news/view,canada-comes-to-the-offshore-wind-party_50505.htm.

GWEC (2018), "Offshore Wind" chapter in *Global Wind 2017 Report*, Global Wind Energy Council, Brussels, www.gwec.net/wp-content/uploads/2018/04/offshore.pdf.

IRENA (2018), *Renewable Energy Benefits: Leveraging local capacity for offshore wind*, International Renewable Energy Agency, Abu Dhabi, www.irena.org/publications/2018/May/Leveraging-Local-Capacity-for-Offshore-Wind.

IRENA (2017), Renewable Energy Auctions: Analysing 2016, International Renewable Energy Agency, Abu Dhabi.

Japan Times (2018), "Japan to set rules for offshore wind power generation", www.japantimes.co.jp/news/2018/01/09/national/japan-set-rules-offshore-wind-power-generation/#.W54XSc4za8w.

Louw, A. (2018), Clean Energy Investment Trends, 2017," BNEF, 16 January, www.data.bloomberglp.com/bnef/sites/14/2018/01/BNEF-Clean-Energy-Investment-Investment-Trends-2017.pdf.

Maritime (2018), "Can offshore wind save the workboat industry?" The Maritime Executive, www.maritime-executive.com/magazine/can-offshore-wind-save-the-workboat-industry.

Ministero dello Sviluppo Economico (2016), "Incentivising electricity production from renewable sources other than PV", Rome.

NERA (2017), *Method or madness: Insights from Germany's record-breaking offshore wind auction and its implications for future auctions*, www.nera.com/content/dam/nera/publications/2017/PUB_Offshore_EMI_A4_0417.pdf.

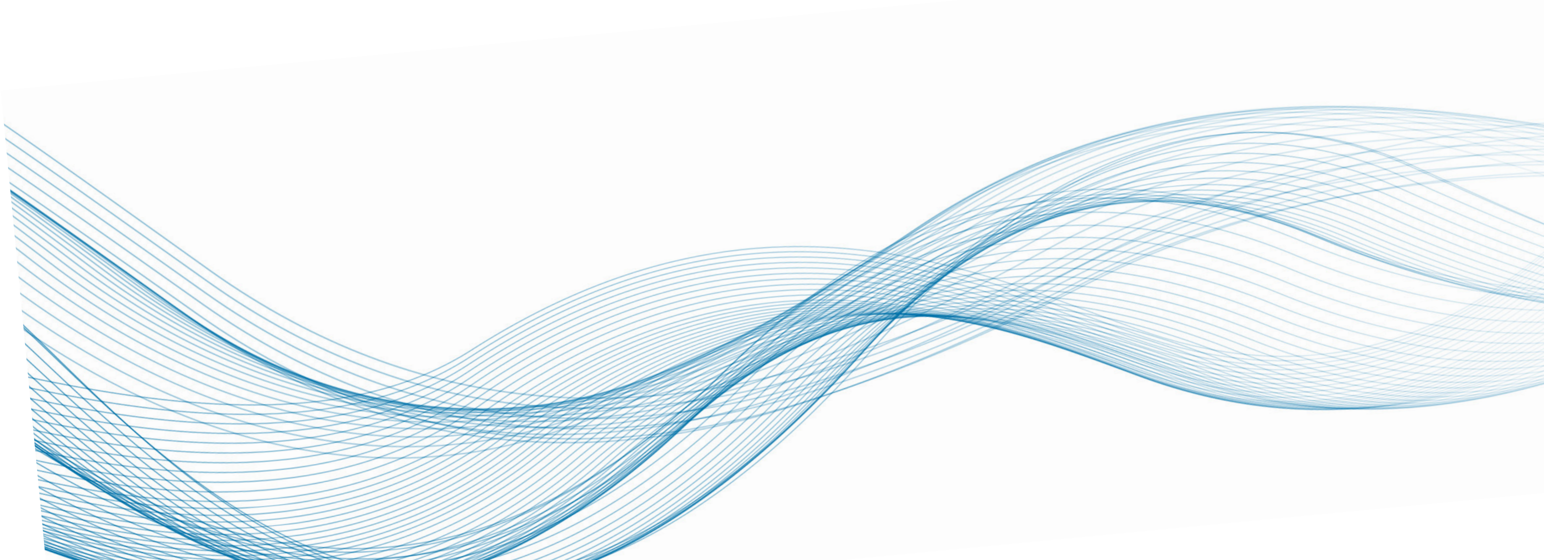
OffshoreWIND (2016), "Oil & gas giant to build Dutch Borssele III & IV offshore wind farms", www.offshorewind.biz/2016/12/12/oil-gas-giant-to-build-dutch-borssele-iii-iv-offshore-wind-farms/.

REA (2016), *Renewable Energy View 2016*, UK Renewable Energy Association, www.r-e-a.net/upload/rea_review_2016_low_res.pdf.

Reuters (2018), "France cuts tariffs on controversial offshore wind projects", www.reuters.com/article/us-france-windpower-offshore/france-cuts-tariffs-on-controversial-offshore-wind-projects-idUSKBN1JG1N8.

Siemens Gamesa (2018), *Offshore Wind*, www.siemensgamesa.com/en-int/products-and-services/offshore.

WindEurope (2018), *Wind in Power 2017*, Brussels, www.windeurope.org/wp-content/uploads/files/about-wind/statistics/WindEurope-Annual-Statistics-2017.pdf.



IRENA

International Renewable Energy Agency

www.irena.org