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Experience from Denmark

In an effort to leverage experience from other locations, I have attached a benchmarking study from Denmark that may provide some practical suggestions for improving the approach for the lease auction and methods to better engage local stakeholders. Offered in the spirit of improving outcomes for all.

Additional submitted attachment is included below.

Danish Experiences from

Offshore Wind Development

DANISH ENERGY AGENCY

TABLE OF CONTENTS

This publication was prepared by the Danish Energy Agency, part of the Ministry of Climate, Energy and Building in Denmark.

The aim of the publication is to convey experiences from the 25-year long development of the Danish offshore wind industry, in particular the regulatory side.

Comments to the report are welcome, and can be adressed to the authors Ms Mette Cramer Buch (mcb@ens.dk) and Mr Erik Kjaer (ekj@ens.dk), both from the Danish Energy Agency.

Updated May 2015

1. INTRODUCTION

In spite of Denmark's limited size, the country has had tremendous success with the development of its offshore wind industry. Its natural resources such as a long coastline, excellent wind resources and shallow waters have provided a solid starting point for a new industry born 25 years ago.

On the back of broad and long term political commitment, an evolving sophistication in the regulatory framework has provided the backbone for a Danish offshore wind success story.

History shows, that it takes unwavering political support to create an offshore industry. However, globally this is an industry still in its infancy with around 8 GW of installed capacity presently.

One of the prominent challenges still facing the industry is to lower the Levelized Cost of Energy (LCoE) from offshore wind.
This is a process largely driven by volume, R&D and to a less degree time. Therefore, there is a collective burden on governments of this world with offshore wind ambitions, to contribute to creating volume on the journey towards lower LCoE. If governments sit back and wait for lower LCoE, it may never happen.

Denmark is carrying its fair share of this burden with ambitions for a doubling of its off-shore capacity by 2020.
As offshore wind is inherently still a risky business, planning procedures and allocation of risks are both important issues when designing a regulatory framework.

This report describes the Danish journey for offshore wind up to now with an emphasis on what governments can do when aspiring to creating a new industry.

It is our ambition that you will find inspiration in the Danish thinking.

1.2 KEY LEARNINGS

- Prices of offshore wind may be driven down by preparing and providing the preliminary surveys to the investor. This will allow the investor to know the site intimately before planning the actual project. This will allow the investor to give a cost price rather than an estimate for the price of the production.

- Prices of offshore wind may be driven down if the investor has certainty that the grid connection can offtake the production as soon as the park starts producing.

- Consider establishing a one-shop-stop for investors, planners and contractors, i.e. providing one primary government entry point.

- Consider to have all preliminary investigations including EIAs carried out before the investor will set the price, so that the designated areas are ready with limited risks for investors and developers. The advantage is that the time when the price is calculated is very close to the time of contracting with the sub suppliers. The risk of price volatility in the market is thus significantly reduced.

Photo credit: DONG Energy A/S

2. HISTORY AND BACKGROUND OF WIND ENERGY IN DENMARK

The first batch-produced Danish wind turbines from the late-1970s had an output of 22 kW, and the wind turbines were gradually scaled up to 55, 75 and 95 kW through the course of the 1980s. Alongside this commercial production, a government-funded development programme was undertaken by the electricity companies to test considerably larger pilot wind turbines.

Since the 1980s, the wind turbine industry's commercial products have become increasingly larger-scale. Today's largest turbine, currently undergoing prototype testing is an 8 MW unit with a rotor diameter of 164 m.

The number of wind turbines in Denmark peaked in the year 2000 at more than 6,200 installed turbines, of which more than half were older wind turbines with an electrical output of less than 500 kW. Almost all installed capacity was on land at this time.

Since then, the number of wind turbines has decreased by around 1,000, while the total installed output has doubled from just less than 2,400 MW in 2000 to over 4,800 MW by April 2014. The wind power share of the domestic electricity supply has been growing steadily since 1980. In 1990, the share was 1.9%, and since then it has increased sharply.
In 1999 the figure topped 10%, and in 2008 it reached 19.1% of the electricity supply. The wind penetration* in 2014 amounted to 39% of Danish power supply.

Future projections show that with the planned wind farms amounting to 1400 MW installed capacity, the wind penetration will be over 50% by 2020. In 2014, the wind turbine industry's Danish production sites had a gross turnover of DKK 84 billion, and overall exports reached DKK 54 billion.

* Wind penetration is defined as total yearly generation from wind as a percentage of total domestic consumption.

PUBLIC INVOLVEMENT

The development of wind power in Denmark has been characterised by strong public involvement. It was small machinery manufacturers that created the established wind turbine industry, and only after the consolidation of the industry through the 1990s did it become dominated by large, partly internationally owned and listed companies.

Similarly, on the customer side numerous jointly owned wind turbines were established in the period 1984- 94. The majority of wind turbines erected since 1995 are owned by individuals, energy companies and other commercial wind power companies.

The progression towards fewer jointly owned and relatively large wind turbines has made it difficult to maintain local support for new wind power projects. But to ensure continued development of wind power, it is essential to have backing in the local community.

The Energy Policy Agreement of 21 February 2008 therefore stipulated that a range of new initiatives should be undertaken to promote local acceptance, including options to purchase wind turbines shares of new wind power projects.

3. OFFSHORE WIND IN DENMARK

In 1991 Denmark became the first country in the world to take wind turbines out to sea with 11 x 450 kW turbines in the Vindeby offshore wind farm. This was followed by a number of smaller demonstration projects, leading to the first two large offshore wind farms Horns Rev I and Nysted with outputs of 160 and 165 MW respectively.

Some offshore wind farms have been built because power companies were given political orders to do so or via tenders, while others are wholly or partly owned by local wind turbine owners' associations such as Middelgrunden and Samsø.

With almost 1,300 MW offshore wind turbines connected to the electricity grid in 2013, Denmark is still one of the largest developers of offshore wind farms. Only the United Kingdom has a larger capacity.

It is considerably more expensive to build and operate offshore wind turbines than on-shore wind turbines. On the other hand, the wind production conditions are better at sea with higher wind speeds and more stable wind conditions. In Denmark, the wind farms are commissioned in a competitive tender process, and the cost of production of electricity is reflected in a feed-in tariff given per kWh produced.

Name of ofshore wind farm	Year of Commissioning	Number of Turbines	Total Capacity
Vindeby	1991	11	5 MW
Tunø Knob	1995	10	5 MW
Middelgrunden	2001	20	40 MW
Horns Rev 1	2002	80	160 MW
Samsø	2003	10	23 MW
Rønland	2003	8	17 MW
Frederikshavn	2003	3	8 MW
Nysted	2003	72	165 MW
Horns Rev 2	2009	91	209 MW
Avedøre Holme	2009/2010	3	11 MW
Sprogø	2009	7	21 MW
Rødsand 2	2010	90	207 MW
Anholt	2012	111	400 MW
Horns Rev 3	2017	N.A.	400 MW
Nearshore (max 6 projects)	2019	N.A.	350 MW
Kriegers Flak	2021	N.A.	600 MW

Operating offshore wind farms in Denmark by end 2014. Upcoming wind farms shown in red.

The offshore wind farms Rødsand II, Horns Rev II and Anholt were established on the basis of tenders. These projects are the result of the Energy Policy Agreement of 29 March 2004 and the Energy Policy Agreement of 21 February 2008 respectively.

DONG Energy, which is the concessionaire for Horns Rev II, receives DKK 0.52 per kWh for 10 TWh, corresponding to around 50,000 full-load hours, after which the electricity produced has to be sold under market conditions. E.ON AB from Sweden, who won the tender for Rødsand II, receives DKK 0.63 per kWh for 10 TWh, corresponding to around 50,000 full-load hours. The Anholt project was awarded 1,05 DKK/kWh for the first 20 TWh, corresponding to 50.000 full-load hours.

Early in 2015, it was announced that Vattenfall had won the concession for the 400 MW Horns Rev 3 at a price of 0.77 DKK/kWh for the first 20 TWh of energy generated. This marks a significant price reduction compared to Anholt and is considered a trendsetting price level at a challenging North Sea site.

Operating offshore wind farms in Denmark by end 2013.

4. PERFORMANCE AND TARIFFS FOR DANISH OFFSHORE WIND FARMS

Name	Total Capacity	Feed-in Tarif/@full load hours *) Feed-in premium/@full load hours*)	Prod. 2012 (kWh)	Full load hours 2012	Prod 2013 (kWh)	Full load hours 2013
Vindeby	5 MW	N.A.	8,796,253	1,759	8,227,484	1,645
Tunø Knob	5 MW	N.A.	14,325,790	2,865	13,334,401	2,667
Middelgrunden	40 MW	0,43 DKK/kWh@10 years	90,741,980	2,269	77,714,701	1,943
Horns Rev 1 #)	160 MW	0,35 DKK/kWh@42,000 hours	675,995,150	4,225	615,396,325	3,846
Samsø	23 MW	0,36 DKK/kWh@10 years	85,274,406	3,708	77,621,801	3,375
Rønland	17 MW	0,36 DKK/kWh@10 years	73,209,394	4,306	62,778,739	3,693
Frederikshavn	8 MW	0,36 DKK/kWh@10 years	20,556,019	2,70	21,849,069	2,731
Nysted #)	165 MW	0,35 DKK/kWh@42,000 hours	575,157,364	3,486	532,868,598	3,230
Horns Rev 2 #)	209 MW	0,52 DKK/kWh@50,000 hours	956,027,802	4,574	900,055,183	4,306
Avedøre Holme	11 MW	0,27 DKK/kWh@22,000 hours	38,050,937	3,759	35,109,531	3,192
Sprogø	21 MW	0,27 DKK/kWh@22,000 hours	67,059,773	3,193	62,226,853	2,963
Rødsand 2 #)	207 MW	0,63 DKK/kWh@53,000 hours	834,745,838	4,033	738,511,986	3,568
Anholt #)	400 MW	1,05 DKK/kWh@50,000 hours	31,812,240	80	1,205,398,737	3,013
Horns Rev 3 #)	400 MW	0,77 DKK/kWh@50,000 hours	N.A.	N.A.	N.A.	N.A.
Nearshore (Max 6 projects)	350 MW	Auction Capped at 0,70DKK/kWh@50,000 hours	N.A.	N.A.	N.A.	N.A.
Kriergers Flak #)	600 MW	N.A.	N.A.	N.A.	N.A.	N.A.

Notes to table:
**) The feed-in tariffs in black font are fixed payments granted the owner for the equivalent number of full load hours. E.g. 50,000 equivalent full load hours equates to 10-12 years of operation, depending on wind resource and operational performance etc. After this period, the wind farm is paid market price only.*

The tariffs in red font are feed-in premiums, paid on top of market prices for a number of equivalent full load hours. After this period, the wind farm is paid market price only. The market price level is currently around 0.30 – 0.40 DKK/kWh in average, with substantial variations.
The Danish authorities do not require developers to report investment costs. Capital expenditure numbers are therefore not available to Danish authorities.

#) Projects marked have had grid connections costs paid by all electricity consumers, i.e. grid costs are not to be paid through feed-in tariff. These grid connections are designed, constructed, owned and operated by the national TSO as an integral part of the Danish back-bone electricity grid.

*Capacity factors can easily be calculated from full load hours, by use of this formula: (No. of full load hours in a year)/8760 * 100%. E.g. 4,125 full load hours corresponds to a capacity factor of 47.09%.*

5. OPERATORS AND TURBINE TYPES IN DANISH OFFSHORE WIND

Name	Operator *)	Capacity	No of turbines	Brand/type	Foundation type
Vindeby	DONG Energy	4.95 MW	11	Bonus 450 kW/37	Gravity based
Tunø Knob	DONG Energy	5 MW	10	Vestas V39-500 kW	Gravity based
Middelgrunden	DONG Energy	40 MW	20	Bonus 2,0 MW/76	Gravity based
Horns Rev 1	Vattenfall	160 MW	80	Vestas V80-2.0 MW	Monopiles
Samsø	Samsø Havvind	23 MW	10	Bonus 2.3 MW/82	Monopiles
Rønland	Vindenergi/ Harboøre Møllelaug + Thyborøn-Harboøre Vindmøllelaug	17.2 MW	8	Vestas V80-2.0 MW / Bonus 2.3 MW/82	Gravity based / Gravity based
Frederikshavn	DONG Energy	7.6 MW	3	Nordex N90/2300 / Vestas V90-3.0 MW / Bonus 2.3 MW/82	Monopiles / Suction bucket / Monopiles
Nysted 1	DONG Energy	165.6 MW	72	Bonus 2.3 MW/82	Gravity based
Horns Rev 2	DONG Energy	209.3 MW	91	Siemens SWT-2.3-93	Monopiles
Avedøre Holme	DONG Energy	10.8 MW	3	Siemens SWT-3.6-120	Gravity based
Sprogø	Sund & Bælt	21 MW	7	Vestas V90-3.0 MW	Gravity based
Rødsand 2	E,ON	207 MW	90	Siemens SWT-2.3-93	Gravity based
Anholt	DONG Energy	399.6 MW	111	Siemens SWT -3.5-120	Monopiles
Horns Rev 3	Vattenfall	400 MV	N.A.	N.A.	N.A.
Nearshore (Max. 6 projects)	N.A.	350 MW	N.A.	N.A.	N.A.
Kriegers Flak	N.A.	600 MW	N.A.	N.A.	N.A.

The table shows the operating offshore wind farms (as of end 2014), including operator, turbine type and foundation type.

Notes to table:
**) Operator not to be confused with owner. The operator will normally make up a part of the investor group.*

As a result of Denmark's first-mover status within wind power, on- and offshore, Denmark is home to an advanced supply chain within wind energy. The industry employs around 28,000 people. The world's largest turbine supplier, Vestas Wind Systems A/S, is listed on the Nasdaq OMX Copenhagen Stock Exchange and has its corporate headquarters in Denmark. Siemens Wind Power (formerly Bonus Wind) has the majority of its manufacturing footprint in Denmark.

6. DANISH PLANNING FOR OFFSHORE WIND FARMS

The main driver for Denmark to move offshore is the scarcity of land for onshore sites, and the abundance of shallow waters with ample wind resources. Since 1991 offshore wind has purposely been placed in large wind farms evenly distributed between East and West with due consideration to the power output and build-up of experience.

In 1985 the 2 large vertically integrated power utilities (i.e. having ownership of production and transmission/distribution) were given an obligation to engage in large scale offshore wind power in order to gain experience.

The objective was also to research the impacts of large scale offshore wind on the environment. An environmental monitoring programme was undertaken on the two farms, which investigated the different offshore conditions i.e. different salinity, currents and tides, and different locations providing for different species, habitats and impact on migratory patterns etc.

The purpose was to ensure that offshore wind power does not have damaging effects on the natural ecosystems and to provide a solid basis for decisions about further development of offshore wind power. The measurement and monitoring programme has been considered important for both the extension of the offshore wind farms at the specific sites, and for the establishment of additional large scale offshore wind farms. All information has been published in English and placed in the public domain.
The power utilities' obligation to build offshore wind farms was realised by 2 pilot projects in Eastern and Western Denmark respectively. The geographically different locations in the North Sea and Baltic Sea also gave opportunity to obtain experience in the Western and Eastern transmission grids both in relation to handling grid connection from offshore transformer platforms and in relation to system operation, i.e. managing the variable power.

Large offshore wind farms are usually located far from major centres of consumption and are connected to the transmission grid in sparsely populated areas. The transmission grid must therefore also be able to transport the power from the offshore wind farms over long distances. Spatial planning has subsequently been used to identify potential locations for offshore wind farms – taking into account grid connection routes and other areas of interests.

In "A visionary Danish energy policy 2025" from 2007 the Danish Government formulated an objective of more wind power through strategic planning of wind turbine development. Strategic planning includes a good spatial planning framework for Danish wind capacity and the promotion of onshore and offshore demonstration and pilot sites as well as the drafting of an infrastructure plan for offshore wind turbines.

MARINE SPATIAL PLANNING FOR OFFSHORE WIND FARMS

While offshore wind is an attractive energy alternative, development of offshore wind farms should be based on thorough and well considered planning. This should involve a planning approach, which respects the vulnerability of the marine environment, and takes all sea uses into account.

Wind farms cannot be seen in isolation from the natural and anthropogenic landscape in which they are constructed. Therefore planning systems are necessary to reveal the multitude of pressures on the sea space. It is important in planning to observe the multitude of interests at sea and to attempt to mitigate the effects. This is the only way to secure appropriate sites for offshore wind farms while respecting the environment and other users the same time.

In 1995, a spatial planning committee for offshore wind was established and it still exists. The committee is led by the Danish Energy Agency and consists of government authorities responsible for the natural environment, safety at sea and navigation, offshore resources extraction, visual interests and grid transmission conditions.

Furthermore, the committee comprises expertise within the technical fields of wind power as well as turbine, foundation and grid technologies. Emphasis is also put on ensuring a planned and coordinated development of offshore wind farms and the associated transmission grid.

The committee examines the engineering, economic and planning options for landing power and the consequences for the underlying grid. The committee assesses on a regular basis the siting of offshore wind farms with respect of other interests at sea and appropriate sea uses. The committee is tasked with finding appropriate sites for offshore wind farms, i.e. sites where the impact on nature and other sea uses is expected to be low, whilst suitable for harvesting offshore wind. When these sites are found, they are reserved for the establishment of offshore wind farms.

In actual terms the committee works with GIS mapping. Each governmental authority has their own reserved areas charted in a GIS map, such as sailing routes and environmental protection sites, cables, etc. When the maps are collated on top of each other, a picture of the areas with no reservations become apparent. These are then evaluated in relation to distance to shore, wind speeds, water depth, etc.

The sites which are identified as useful and available for offshore wind farms according to wind speed, grid transmission, naval and air navigation, nature, landscape, raw material extraction, are assessed according to the anticipated cost of establishing and operating the offshore wind farms. The committee attaches importance to a planned and coordinated expansion of wind power and the transmission network with a view to obtain the greatest possible economic benefits from the greatest wind speeds and the lowest construction costs.

Subsequently, the suggested sites are discussed with the remaining marine authorities and the affected municipalities onshore. When all public authorities agree to appropriate placements of offshore wind farms, these are sent into public hearing. A hearing of relevant neighbouring countries is also carried out when appropriate. This may lead to further adjustments of the plans.
This process was carried out in 1997, 2007, 2011 and 2012. The committee is dormant between planning exercises, but is revived when new planning needs arise.

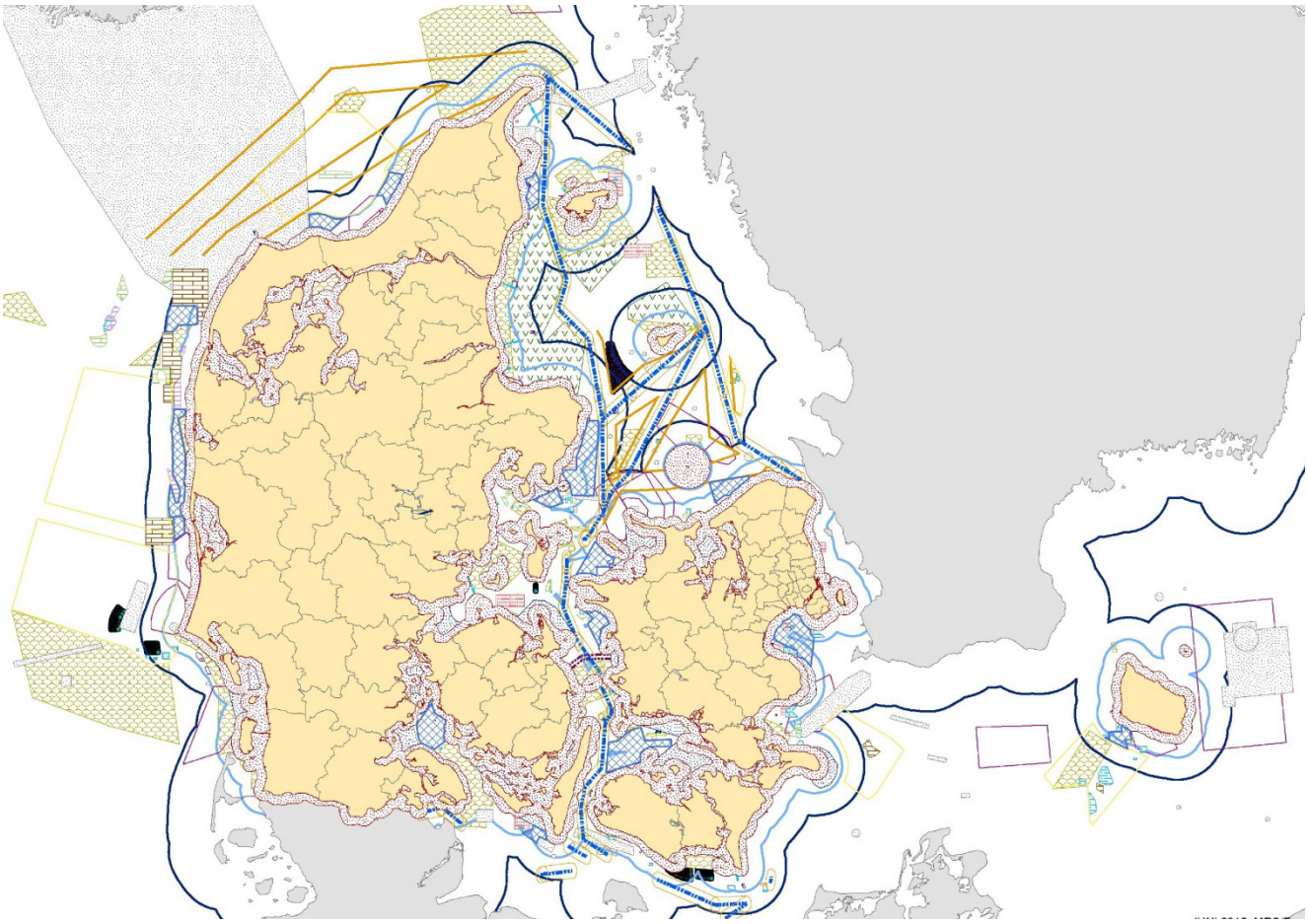

Figure 1: Example of a spatial planning map detailing relevant sea uses and distances to shore

THE ORIGINAL PLANNING EXERCISE - THE ACTION PLAN IN 1997

An action plan for offshore wind farms from 1997 recommended to concentrate large offshore development within a few areas and to carry out a large-scale demonstration programme to show the environmental and grid related effects of large scale wind.

In the action plan five areas were identified as suitable for future offshore wind farms. The selection was based on experiences from the first two small pilot projects (Vindeby and Tunø) and the recommendations from the work of the governmental committee, which included wind speed measurements, mapping of water depths, visual impact on the coastal landscapes and an assessment of other interests in Danish waters.

The objective of the program was to investigate economic, technical and environmental issues and speed up offshore development to open up the selected areas for future wind farms.

Three of the identified areas were subsequently ruled out as being less attractive due to other area interests such as sailing routes and potentially environmental unacceptable impact on certain species etc. For the remaining two areas – Horns Rev and Rødsand (Nysted) a comprehensive environmental measurement and monitoring programme was initiated to investigate the effects on the environment before, during and after the completion of the wind farms.

MARINE SPATIAL PLAN OF 2007 AND 2011

The report "Future Offshore Wind Turbine Locations – 2025" was first published in April 2007. The committee examined in detail 23 specific possible locations, each of 44 square kilometers.

This report was subsequently updated in April 2011. The update was necessary due to the ever changing framework conditions for developing offshore wind farms caused by the emergence of new interests such as bridges, pipelines, harbours, fishing quotas. In other words the update recognised that mapping is a dynamic process.

The reports chart a number of possible offshore areas where offshore turbines could be built to deliver an overall capacity of app. 4,200 MW. The sites correspond to app. 50% of Danish electricity consumption. Several of the sites identified are currently being developed for large-scale wind farms, e.g. Horns Rev 3 (400 MW) and Kriegers Flak (600 MW).

PLANNING IN 2012 FOR NEARSHORE WIND SITES

As nearshore wind farms are expected to be cheaper than offshore wind farms, a planning exercise was launched in order to find the most suitable sites for nearshore wind farms. In addition to the large offshore areas, 15 suitable nearshore sites have been identified in a mapping exercise carried out in 2011. The 15 sites were submitted to a strategic environmental assessment in order to prevent any future conflicts with environmental and natural interests.

In 2012 the spatial planning committee for offshore wind published the results of a planning exercise aiming at identifying the most suitable sites for nearshore offshore wind farms. 15 areas were selected, each with a possible capacity of up to 200 MW.

Knowledge from the environmental monitoring programme for large-scale offshore wind farms, and the knowledge collected in environmental impact assessments have continually been fed into the spatial planning process.

WIND RESOURCE MAPPING

Wind is the most important factor for the income from a wind farm, so it has always been given special attention in Danish wind power planning.

Since the 1980s wind resource mapping has been developed and included in wind power planning both at national and municipal level. A refined wind atlas for Denmark identifying national wind resources was published in 1999. The wind atlas is used in the planning process when
assessing the wind resource potential in a given area and to assess identification of potential wind development zones in line with the strategic environmental framework or assessments studies.

Also it provides wind speeds prediction with known and traceable accuracy for developers and allows them to calculate the potential yield of the wind energy resources. In addition it gives the TSO ability to handle variable wind resources and it gives input to long-term grid planning.

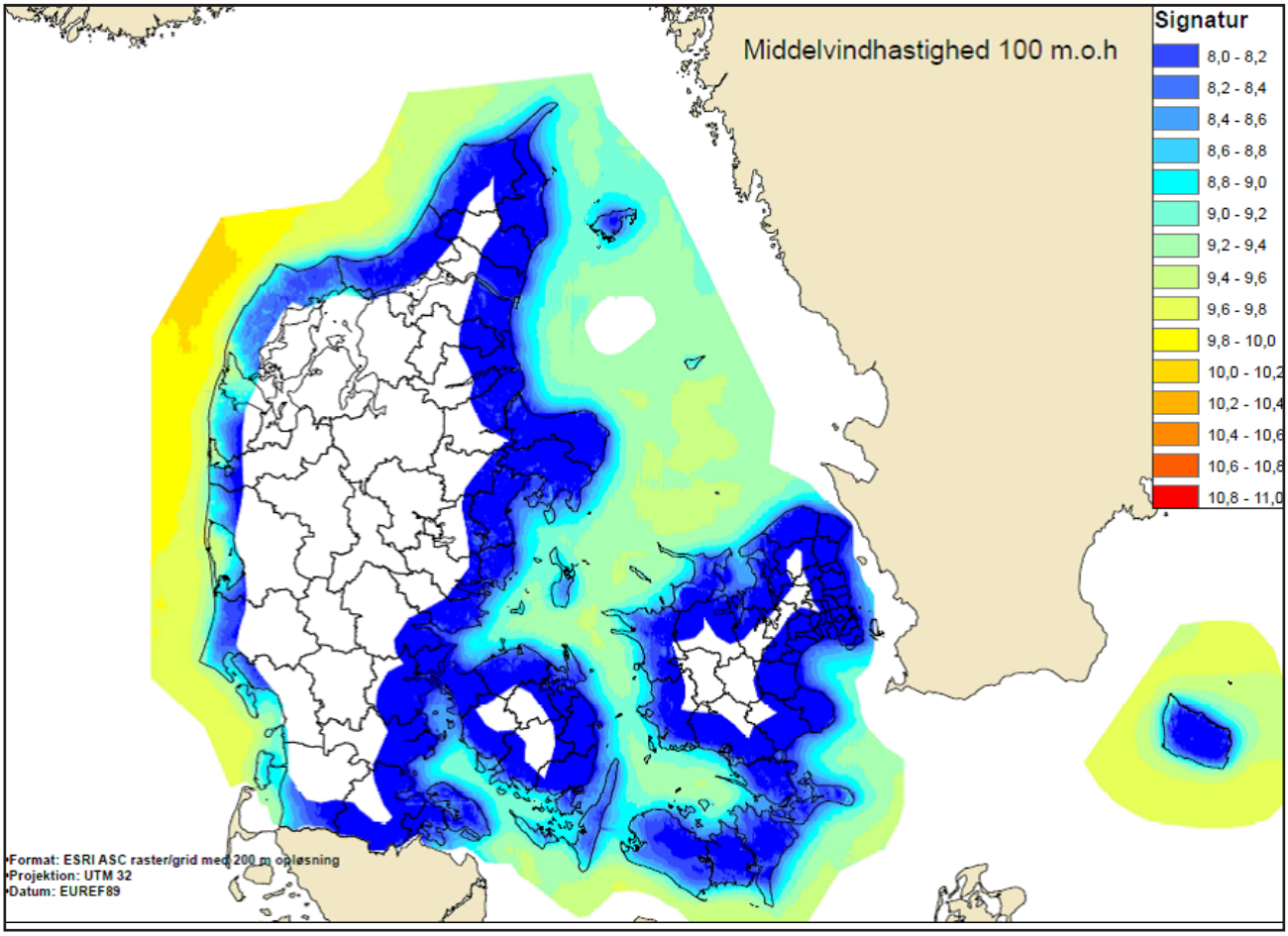

Figure 2: Wind Speeds in Denmark, 100 meter above sea level

6.1 KEY LEARNINGS

- Carry out a thorough screening and planning before designating areas for offshore wind turbines.
- Take wind conditions, sea depths, grid connection options, seabed conditions, marine life etc. into consideration when screening for suitable sites for offshore wind farms.
- Consult all relevant authorities with interests at sea, in order to avoid future conflicting interests. Often compromises can be found.
- Consider also as a minimum competing interests such as shipping routes, environmentally sensitive sites, fishing areas, resources and extraction up front in the planning.
- Involve all affected parties with interests at sea at government level already at the beginning of the planning procedure. This will create ownership of the process and commitment to the sites chosen.
- Consult with evidence from effect studies on environmental impacts already assessed and accessible in the public domain before requiring expensive and time consuming analysis as part of the EIA requirements.
- Consider to set up a general framework for environmental impact assessments (EIAs).

7. CONSENTING PROCEDURE

BACKGROUND

The Danish Energy Agency (DEA) has been given the mandate to plan for and issue licenses and production approvals to offshore wind turbines and is thus the responsible authority for planning and commissioning. DEA also approves new grid connections.
4 licences are required to establish an offshore wind project in Denmark. Other licences are required for the grid connection. All licences are granted by the Danish Energy Agency, which serves as a "One-stop shop" for the project developer in relation to the many – often opposing – interests connected to the establishment of offshore wind power projects. The 4 licences are:

1. License to carry out preliminary investigations.

2. License to establish offshore wind turbines. Before this license can be granted, an Environmental Impact Assessment (EIA) must be carried out.

3. License to exploit wind power for 25 years. This license may be prolonged.

4. Approval for electricity production in compliance with the electricity legislation.

The 4 licenses are given successively for a specific project. The license for grid connection can be included in the license to establish the offshore wind turbines when the project is small. For larger project an approval for the grid connection is given separately. Licenses from other authorities may also be necessary; however these are usually not blocking the project if a license to establish the offshore wind farm can be given.
In the Danish case, new offshore wind farm projects can be established according to two different procedures: a *government tender* or an *open door procedure*. The procedures have been gradually developed as experience has been gained since the first off-shore wind power projects.

APPEAL

For all types of offshore and nearshore projects, individuals, that are significantly and individually affected, as well as relevant environmental organisations may appeal the project to the Energy Board of Appeal within four weeks of the publication of the decision to establish a project. Likewise the onshore infrastructure may be appealed to the Environmental Board of Appeal.
Due to the thorough strategic planning in identifying suitable locations offshore ahead of the EIA for concrete projects – evidence show that projects are rarely appealed.

ONE STOP SHOP

In order to ensure rapid and unbureaucratic application processing, enterprises or consortia awarded concession contracts will be using the Danish Energy Agency as single point of access to assistance on issues related to all permitting. The Danish Energy Agency will grant the required permits, and will coordinate these with other relevant authorities. This means that the permits granted by the Danish Energy Agency also contain terms and conditions from other authorities, such as the Danish Nature Agency, the Danish Maritime Authority, the Danish Coastal Authority, the Danish Agency for Culture, the Ministry of Defence, etc. This, however, can be supplemented by licences from other authorities.

GOVERNMENT CALL FOR TENDERS

A government tender is carried out to realise a political decision to establish a new offshore wind farm at the lowest possible cost. In the typical government tender procedure, the Danish Energy Agency announces a tender for an offshore wind turbine project of a specific size, e.g. 600 MW, within a specifically defined geographical area.

Depending on the nature of the project, the Danish Energy Agency invites applicants to submit a quotation for the price at which the bidders are willing to produce electricity in the form of a fixed feed-in tariff for a certain amount of produced electricity, calculated as number of full-load hours. The winning price will differ from project to project because the result of a tender depends on the project location, the wind conditions at the site, the competitive situation in the market at the time, etc.

In projects covered by a government tender, Energinet.dk typically constructs, owns and maintains both the transformer station and the underwater cable that carries the electricity to land from the offshore wind farm. Energinet.dk is responsible for the electricity infrastructure in Denmark and act as an independent system operator (TSO)

OPEN-DOOR PROCEDURE

In the open-door procedure, the project developer takes the initiative to establish an offshore wind farm of a chosen size in a specific area. This is done by submitting an unsolicited application for a license to carry out preliminary investigations in the given area. The application must as a minimum include a description of the project, the anticipated scope of the preliminary investigations, the size and number of turbines, and the limits of the project's geographical siting. In an open-door project, the developer pays for the transmission of the produced electricity to land.

An open-door project cannot expect to obtain approval in areas that are designated for offshore wind farms in the report Future Offshore Wind Power Sites – 2025 from April 2007 and the follow-up to this from 2011.

Before the Danish Energy Agency actually begins processing an application, as part of the one-stop shop concept, it initiates a hearing of other government bodies to clarify whether there are other major public interests that could block implementation of the project. On this basis, the Danish Energy Agency decides whether the area in the application can be developed, and in the event of a positive decision it issues an approval for the applicant to carry out preliminary investigations, including an EIA.

If the result of the preliminary investigations shows that the suggested project can be approved, the project developer can obtain a license to establish the project.

8. OFFSHORE TENDERING

A political decision has been taken by a broad majority in the Danish Parliament to significantly expand offshore wind capacity up to 2020. A doubling of offshore capacity and a significant expansion of onshore capacity, will secure that 50% of total electricity consumption by 2020 comes from wind power - making Denmark a world leader within this area.

The existing capacity will be expanded by 1400 MW through tenders for offshore wind turbines. The procedure will be characterised by openness and transparency and that all potential applicants are treated equal.
The areas that are offered for tender are the sites identified in the spatial planning pro-cess. The fact that other government authorities have been involved in the process of identifying the sites for new offshore wind farms and have approved the final report, creates commitment to securing the sites. This, in turn, creates great investor security and up front knowledge about the sites.

The Danish independent system operator (TSO) is responsible for the Environmental Impact Assessment; geophysical surveys as well some geotechnical surveys to be carried out in the planning phase ahead of the call for tenders. These in-depth studies of the physical features of the site deepen the knowledge of the sites, and give future investors an insight into the technology choices they can take in the bidding procedure. This early action is implemented in order to reduce the length of the approval process and to give applicants better possibilities to offer a price that is real-cost based. At the same time it provides potential bidders with a high investment security and thus supports a reduced risk premium.

The purpose of the geological preliminary surveys is to generate knowledge about geological conditions, undetonated explosives (from World War II) and other man-made obstructions, biological aspects (for example bubbling reefs, stone reefs and sub-merged/ benthic vegetation), as well as objects of marine archaeological interest (such as wrecks and ancient monuments) on the seabed.

The preliminary surveys will contribute to a detailed survey of seabed conditions. They will be included in the EIA reports and will ensure accurate and optimal planning and construction of the technical electricity transmission installations to be established on the seabed in connection with the establishment of the offshore wind farms. The preliminary surveys will also provide knowledge about requirements for the design of the wind farms, including the choice of foundations.

The results of the preliminary investigations will be published in good time before completion of the tendering procedure. The costs of the preliminary investigations will subsequently be refunded by the owner of the concession. Also the costs will be published well before tenders for the wind farm are to be made.

Simultaneously with the preliminary surveys the TSO also undertakes planning, procure-ment, and financing of the substation and sea cable to shore. This important part of the project must be ready by the time the offshore wind farm is up and running. If this should not be the case, the wind farm is entitled to compensation by the TSO.

Two sites - Horns Rev 3 and Krieger's Flak – have been identified as best suited for the next tenders. These areas have average wind speeds of around 10 metres per second. The good wind conditions at the chosen sites will allow offshore wind farms to produce for around 4,000 full-load hours a year. With sea depths of 10-35 metres, good wind speeds and a distance to the coast of 22-45 kilometres in the mapped suitable sites, a balance has been struck between economic considerations and the visual impact

observed from the shoreline.

The tender documents will provide drafts of the four necessary permits: a preliminary investigation permit, an establishment permit, an electricity production permit and an electricity production authorisation.

The enterprises or consortia awarded concession contracts can expect to obtain a preliminary investigations permit and an establishment permit soon after completion of the tendering procedure. The preliminary investigations permit will allow enterprises or consortia awarded concession contracts to conduct further geotechnical and geophysical surveys to supplement the surveys already carried out.

Similarly, enterprises or consortia with an establishment permit will be able to commence detailed planning activities and prepare the final project in detail. The final project has to be approved before actual construction work can commence.

Furthermore, enterprises or consortia also need to obtain a permit to exploit the wind resources in a given area to produce electricity (electricity production permit). The permit is not usually issued until after construction work has commenced and no later than after grid connection of the first turbine. Compliance with the terms of the construction permit must be documented.

Before the installation is connected to the grid, authorization to produce electricity must be granted. A certain level of technical and financial capacity is required in order to obtain this permit.
All of the permits mentioned above will be included in the tender specifications as draft permits. They will be issued by the Danish Energy Agency which, by that time, will have consulted all other relevant authorities in advance, or when the need arises during the construction phase.

OTHER CONDITIONS AND REQUIREMENTS

Tender specifications also states that the successful tenderer will be subject to normal company taxation, i.e. no special tax rules apply. In terms of insurance requirements, a liability insurance covering the concession-holder as well as his sub-suppliers must be documented.

A parent company guarantee covering i.a. decommissioning costs must be in place before final award of the concession.

How the successful tenderer chooses to finance the offshore wind farm, is entirely up to him. Bearing in mind, that the pre-qualification step has established his financial capability to finance the wind farm construction and operation, the Danish authorities will not put further requirements on him related to financing.

This means that authorities are not informed about the tenderer's detailed business case assumptions, such as Capex, Opex, Risk premiums, IRR etc. When contracts for components like foundations, cables and turbines are placed by the concession holder or the operator responsible, terms and conditions in these contracts will remain commercial secrets, not to be reported to authorities.

TYPICAL COMPANY STRUCTURE OF CONCESSION HOLDER

It is common, that the successful bidder will register a Special Purpose Vehicle (SPV), a company which single mission is to build, own and operate the offshore wind farm in question.

Such structure will ease any limited recourse finance (project finance) the owners may wish to obtain. In case the bidder is a joint venture (JV) between two or more companies, it is common to see JV contracts inspired by the oil and gas industry. This entails naming an operator, who will be the party taking on e.g. the construction task on behalf of the JV.

THE TENDERING PROCEDURE IN BRIEF

1. Technical dialogue with interested tenderers and investors.
The Danish Energy Agency is inviting potential tenderers and investors to a bilateral technical dialogue. This will enable adjustment of preliminary surveys and tender specifications to market requirements. The dialogue will take into account the principles on equal treatment, transparency and proportionality.

2. Publication of the contract notice and the full tender specifications.
The contract notice notifies the market that the Danish Energy Agency wants to enter into a concession contract. The Danish Energy Agency will draw up technical and financial criteria for pre-qualification of potential tenderers suitable for meeting the concession contract. The full tender specifications will list the terms of the tendering procedure, framework conditions for establishing the offshore wind farms, draft permits for preliminary surveys, establishment and operation of the offshore wind farms, as well as a draft concession contract.

3. Negotiation with prequalified tenderers.
Potential tenderers express their interest in participating in the tendering procedure by submitting an application for prequalification. Applicants for prequalification must submit documentation that they meet the suitability conditions. On the basis of the first proposed tenders by the prequalified tenderers, the Danish Energy Agency will negotiate the final design of specification requirements, contract proposal, etc. with the pre-qualified tenderers. The reason for the negotiations is that the Danish Energy Agency must be able to clarify, specify and adjust the tender documents, if necessary. Negotiations will be carried out without the risk of distorting competition. Prior to the negotiations, the Danish Energy Agency will provide information about which items are open for negotiation. The items open for negotiation will primarily concern whether and how the tender documents can be improved with a view to lowering prices.

4. Final call for tender.
On the basis of the negotiations, the tender documents will be adjusted within the framework of the published tender documents. Submission of final tenders based on the final tender documents.

5. Selection of winner and drafting of contract.
The final winner will be selected on the basis of the award criteria in the tender documents. Danish Energy Agency can enter into the concession contract with the winner and award permits for preliminary surveys and establishment.

NEW TENDER MODEL UNDERWAY FOR NEARSHORE WIND FARMS

It is expected that nearshore wind farms will be cheaper to build due to the shallower waters and the shorter cabling to shore. The nearshore sites in question are a minimum of 4 km from shore.

Therefore, a political decision has been taken by a broad majority in the Danish Parliament that 6 nearshore sites that can hold up to 200 MW each will compete to host a total of 350 MW. The areas will be in competition with each other – thus it is not expected that more than 3 sites are to be developed in this round.

The near shore wind farms will be visible from shore. Therefore local support for the projects is very important. Thus the 6 areas have been selected partly because there is already significant municipal support for the wind farm project in these areas. In order to maintain local support, it has been decided that concession owners will be required to offer at least 20% of each project to local residents and enterprises – like in the case for onshore projects. Note that there is only an obligation to offer this share, not to achieve it. In order to give an additional incentive for gaining public support a higher feed-in tariff will be available to projects that achieve at least 30% community ownership on the date of grid connection.

The developer must pay for grid connection to the nearest coast. From that point, costs will be carried by electricity consumers as part of the Public Service Obligation (PSO) fee. The reason for this is that it is unknown until after the tender, how large the wind farm will be or in which areas they will be constructed. In this case it is better to let the grid connection be a part of the project and let the planning and the cost of grid connection and transformer substations be covered by the concessionaire.

The TSO will carry out EIAs for all 6 sites. The Danish TSO Energinet.dk will conduct preliminary surveys in the six areas in the tender for 350 MW nearshore wind turbines. Preliminary surveys comprise geophysical, geotechnical surveys, EIA reports and MetOcean surveys (wind, current, tidal waters and wave conditions).

The preliminary surveys have been planned so that the results will be published in good time before completion of the tendering procedure. This means that the enterprises submitting tenders to construct, own and operate the nearshore wind turbines will know the conditions and risks of building in the area.

The concessionaire that wins the tender will have to refund the costs of the preliminary survey. This applies to the geological surveys as well as the MetOcean and EIA reports. The size of these costs will be published well before the submission of tenders.

Photo credit: DONG Energy A/S

9. OPEN DOOR

In the open-door procedure, the project developer takes the initiative to establish an offshore wind farm in a particular area. This is done by submitting an unsolicited application for a license to carry out preliminary investigations in the given area, outside areas that already are designated wind power areas found in the spatial planning process. The application must as a minimum include a description of the project, the anticipated scope of the preliminary investigations, the size and number of turbines, and the limits of the project's geographical siting.

Before the Danish Energy Agency actually begins processing an application, a hearing of other government bodies is initiated to clarify whether there are other major public interests that could block the implementation of the project. On this basis, the Danish Energy Agency decides whether the area in the application can be developed, and in the event of a positive decision it issues an approval for the applicant to carry out preliminary investigations, including an environmental impact assessment (EIA). The preliminary investigations include as a minimum an EIA as well as geophysical and geotechnical surveys of the seabed to clarify what type of foundation should be used. The EIA must assess the offshore wind farm's impacts on the environment.

On the basis of responses from the initial consultation of authorities and other stakeholders, the Danish Energy Agency determines what the EIA should include offshore. As an EIA needs to examine the total coherent project i.e. also the onshore infrastructure necessary, hence the Danish Nature Agency and municipalities are the EIA authority regarding what to include for these parts. The EIA must demonstrate, describe and assess the environmental consequences of implementing the project in respect of: people, fauna and flora, seabed, water, air, climate and landscape, tangible property and Danish cultural heritage. Furthermore, the EIA must describe proposals for alternative siting and proposals for how demonstrated environmental nuisances can be prevented or reduced.

The project developer's application to establish the offshore wind farm must therefore include a full description of the project's expected scope, size, geographical location, coordinates for turbines, grid connection plans and cable trace, etc., as well as the results of the preliminary investigations.
Once the Danish Energy Agency has received the EIA together with a final application to establish the offshore wind farm, it sends both for public consultation with a deadline for reply of at least eight weeks.

The consultation is announced on the Danish Energy Agency's website and in national and local newspapers. This gives other authorities, interested organisations and citizens the opportunity to voice objections and other comments, which the Danish Energy Agency includes in its processing of the application and the EIA. If the Danish Energy Agency does not receive any objections with weighty arguments for cancelling the project such as detrimental impact on a protected species, it grants a license to establish the offshore wind farm. In this regard, the Danish Energy Agency will generally require the project developer to document, prior to starting the construction work, a detailed project description.

Finally, the project developer must apply for a license to exploit wind power from the offshore wind farm and, in the case of wind farms of more than 25 MW, for an authorisation to produce electricity. This must be done after the installation work has begun and at the latest two months before the first wind turbine is ready to begin operating. The offshore wind farm must not supply electricity to the grid until the license

has been granted. In this way it is assured that all obligations given in the consented document is fulfilled.

In open door concessions in locations outside designated offshore wind areas – the project developer receives the same price premium as for new onshore wind turbines. In offshore open door concessions and near shore concessions the developer finances the grid connection up to the nearest shore.

TURBINES FOR TEST AND DEMONSTRATION

50 MW for test turbines is also planned. The test projects are not tied to the designated areas, and can be located anywhere conditions allow for it. Furthermore, the test element is not tied to the actual turbine – the test element could be testing of new foundation types, new installation methods, new cables, etc. Test projects can include up to eight turbines. The projects must have a clear technological development object aiming at reducing the future costs of offshore wind turbines.

Test turbines are typically allocated according to the open door regime.

10. THE DANISH GRID AND ELECTRICITY MARKET

Denmark has a well-functioning and efficient power market. As much as 39% wind power (out of total consumption 2014) has already been integrated into the market without any disruptions to operations. Thorough planning, along with initiatives already adopted to improve the market, will ensure that approximately 50% wind will have been integrated into the system by 2020 while maintaining the high security of supply.
The Danish Energy Agency makes projections of how energy consumption, energy production, electricity market prices etc. will develop, assuming that no new energy policy initiatives are decided. This development is often referred to as the business-as-usual scenario. Actual developments will be influenced by new energy policy initiatives.

ELECTRICITY GRID, ELECTRICITY PRICES AND SETTLEMENT, WHAT MAKES IT WORK?

Denmark is among the founding members of the Nordic cooperation within electricity. The cooperation started in the monopoly days before the year 2000 and in those days exchange of electricity took place whenever two countries saw a mutual financial interest. If the marginal price in one country was x (the higher of the two) and y (the lower of the two) in the other, then electricity was exchanged at the price y+(x-y)/2, splitting the price difference evenly.

Since 2000, all EU-member countries liberalised their electricity markets, and this process gave birth to the Nordic electricity market Nordpool. Today it is a highly sophisticated marketplace trading several products. The spot market (day-ahead market) is considered the world's most liquid electricity market and owned jointly by the Nordic TSOs. Sellers and buyers will trade themselves into overall balance through an intra-day market with a regulated balancing market as support.

It is beyond the purpose of this report to go into detail with the market itself.
It is however important to note that due to the cross-border trading both before and after liberalisation, Denmark has strong interconnectors to the neighbouring countries. Theoretically, the interconnector capacity is so high, that Denmark would be able to import close to all of its electricity consumption, with the exception of some of the highest peaks. Construction of even more cross-border interconnector capacity continues, as this is an important prerequisite for integration of a growing share of fluctuating renewables, on- and offshore wind in particular.

THE TSO IN DENMARK

According to EU requirements, Denmark has an independent TSO, which is not allowed to own or operate generation capacity. One of the TSO's important roles is to secure a transparent and non-discriminatory day-ahead market as a so-called playmaker. The TSO owns and operates the high voltage network (132 kV up to 400 kV) as well as interconnectors to neighbours. The TSO is now fully state owned, has its own planning with strategic outlook as well as strong project management skills in terms of new infrastructure.

The structure of the electricity sector is so that all generation is fully commercialised, whereas distribution is regulated business.
Priority access to the grid serves as assurance for renewable power generators that they will always be able to sell and transmit their power in accordance with current connection rules. In case of curtailment, which happens extremely seldom, the TSO carries an obligation to fully compensate curtailed generation for loss of revenue.

GRID CONNECTIONS FOR OFFSHORE WIND FARMS

In Denmark (as well as in Germany), the grid connections for large offshore wind farms is planned, procured, installed, operated and paid for by the TSO. This was described in more detail in the section “Offshore Tendering”. This choice of model has the advantage that it preserves the electrical integrity of the high voltage grid as the responsibility remains with the TSO. It also means that the responsibility for the EIAs for the grid connection and the wind farm rests with one single party, namely the TSO and thus may be combined.

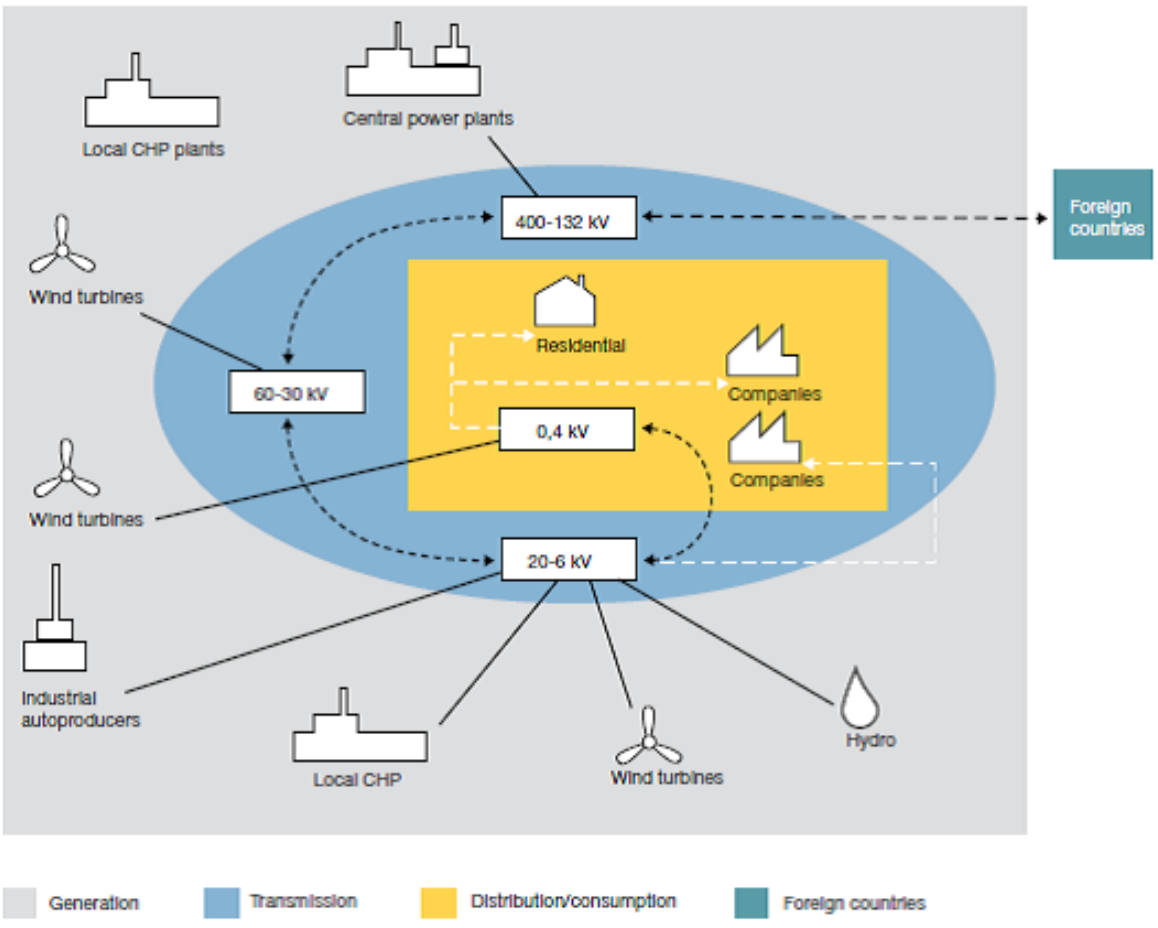

Figure 3: Structure of the grid in Denmark.

11. ECONOMICS OF OFFSHORE WIND IN DENMARK

MACRO-ECONOMIC DRIVERS FOR OFFSHORE WIND IN DENMARK

Since the start of deployment of wind energy in Denmark, onshore wind has undergone a tremendous technical development. It is now the cheapest renewable technology, with a potential for being able to generate without subsidies on good wind locations within half a decade.

It is this impressive development, offshore wind will hopefully replicate.

The political rationale for offshore wind in Denmark includes the following:

- Overall good wind resources, on- and offshore
- first-mover advantages in deployment of wind energy
- considerable job creation and exports of components for wind energy
- Denmark has limited onshore land resources and is relatively densely populated
- Denmark has a very long coastline (> 7,300 km) and plentiful shallow waters

Earlier in this report, we have shown the feed-in tariffs achieved for Danish offshore wind farms (chapter 4). It is clear that these tariffs are well above average wholesale market prices for electricity. This differential is captured in the so-called PSO-cost (Public Service Operation), levied on all sold electricity. The graph below shows the development of the PSO costs since 2001. PSO cost data for offshore wind alone is not available.

Comparing Danish residential consumers prices with other EU countries, gives the below picture:
All commercial consumers in Denmark are exempted from an energy tax element. Certain heavy industry will further enjoy

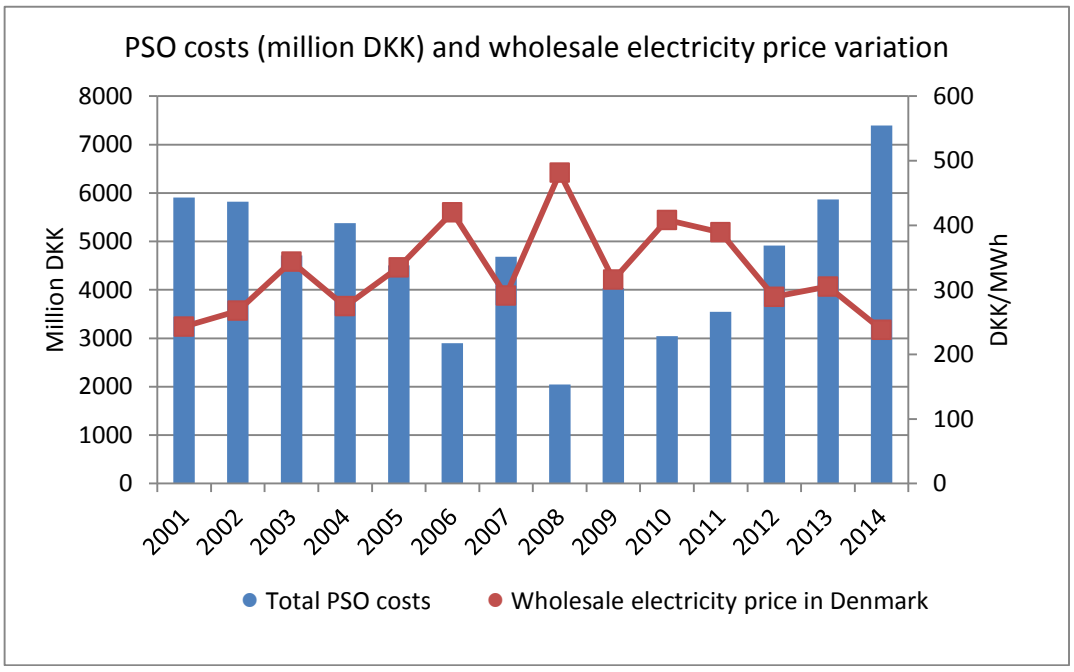

Figure 4: The development in Danish PSO costs since 2001. PSO costs cover all renewable generation subsidies. Source: The Danish Energy Agency.

exemption from other elements of the energy taxes. Therefore the above residential price is not to be confused with commercial rates.
Part of the explanation why Denmark has the highest prices is high taxation and high PSO costs. This is shown in the below normalized graph

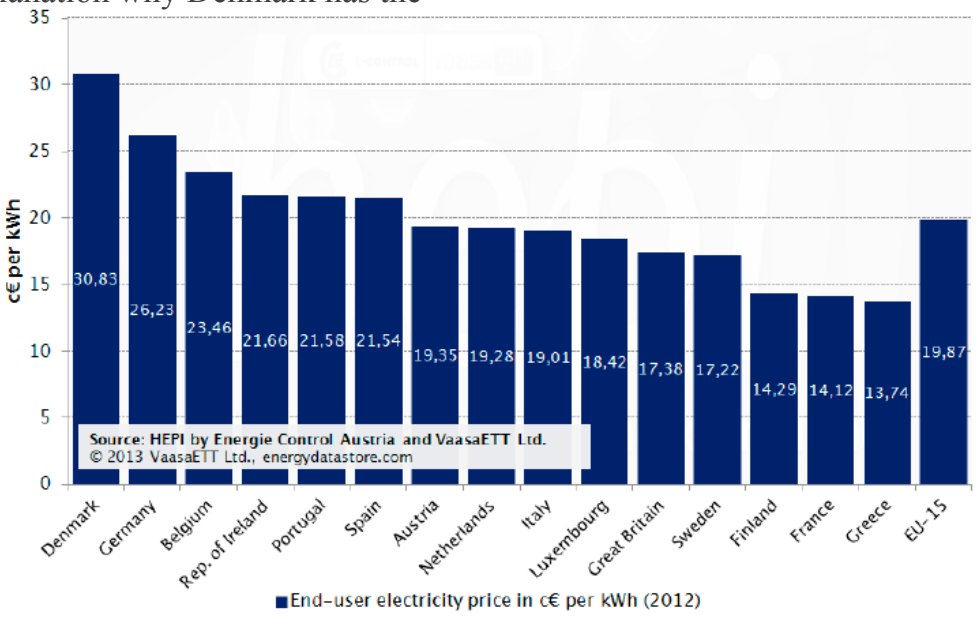

Figure 5: Average residential electricity prices including taxes (2012). Source: HEPI by Energie Control Austria and VaasaETT Ltd. 2013

As can be seen, the energy price itself is the lowest of all countries shown. Denmark has chosen to recover subsidies for renewables through electricity prices, but this is not the case for all countries, making comparisons somewhat difficult. Denmark's way of recovering these costs is arguably the most fair, as the burden is apportioned according to electricity consumption.

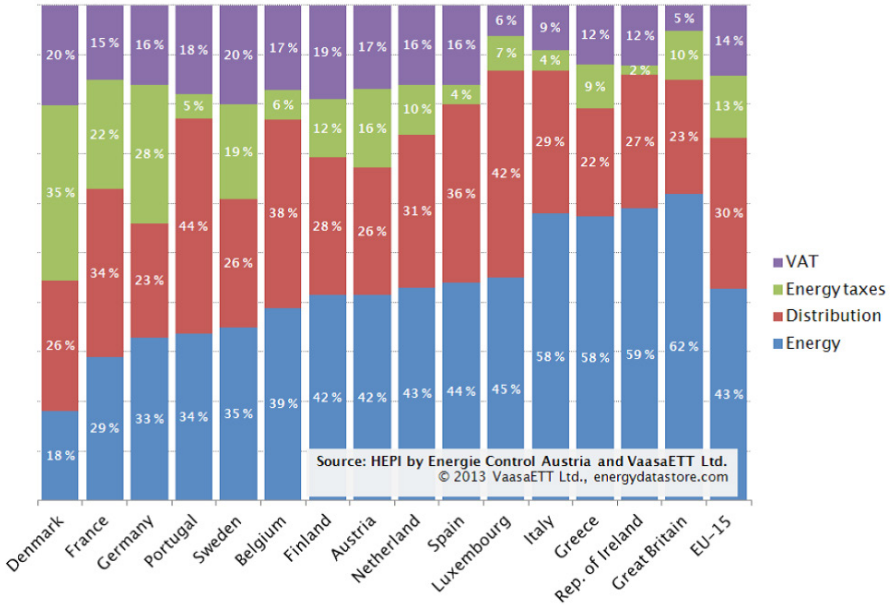

Figure 6: Residential electricity price breakdown (average 2012)

12. INVESTMENT CLIMATE

These days, investors with an appetite for renewable assets like offshore wind have become global. This means that their investment strategies will be based on i.a. the following:

- Where the most profitable investment opportunities with least risk are?
- Where the most secure and stable regulatory framework is?
- How they can design a portfolio of projects with balanced risks (not all eggs in the same basket)?
- Wind climate, seabed conditions, distance to shore, synergies with other assets etc.

The result being that regulatory frameworks for offshore wind to some degree compete against each other. This is why the Danish Energy Agency had made a tremendous effort to market the opportunities in Denmark to an international audience. Attracting the most competent developers with matching strategies is the best recipe for successful projects, completed on time and operated with the best possible performance.

As the offshore wind industry mature, Europe is seeing new types of investors enter, namely institutional investors like pension funds etc. Pension funds are normally rather risk averse, but they often invest in long-term assets with a stable income and stable and low risk profile.

Through innovative partnerships with experienced industrial investors like utilities, institutional investors come to grips with the inherent risks. The first Joint Ventures (JVs) of this type saw institutional investors enter only after successful commissioning, but now there is a growing confidence on the side of institutional investors in taking on part of the construction risks.

One attraction of the Danish offshore wind projects to pension funds is that the income is long term, defined and stable and seen as close to risk free, due to the long term commitment of changing governments to stable framework conditions.

Below are arguments used by the Danish Government to attract investor interest in the Danish offshore wind opportunities.

WHY ESTABLISH OFFSHORE WIND FARMS IN DENMARK?

Denmark is among the most experienced countries in the world when it comes to establishing offshore wind farms, and the Danish tendering procedure is based on the following elements, which together minimise risks and thereby make Danish offshore wind farm projects attractive:

- Having established the bidders' technical and financial capabilities, price is the primary bidding criteria. Final bidding criteria will be concluded after a dialogue with the pre-qualified bidders.
- A fixed settlement price (contract for difference) for 50,000 full hours is ensured through Danish legislation. This provides a regular and predictable income.
- The planning and EIA process up to announcement of the call for tenders ensures agreement among Danish authorities on the use of the area for offshore wind turbines.
- Before the submission of tenders, there will be a complete and fully approved Environmental Impact Assessment (EIA) of the designated offshore areas and the possible grid solutions. The EIA report will be drawn up on the basis of the principle of the greatest conceivable environmental impact (worst case) and it will ensure that subsequent EIAs will not be necessary for the specific project.
- Before the submission of tenders, the results of the preliminary investigations of wind, waves and current conditions (MetOcean data) will be published so that tenderers will have opportunity to submit a qualified bid for the offshore wind farm.
- Before the submission of tenders, the results of the preliminary survey of the geological conditions will be published.
- The Danish Energy Agency functions as a one-stop-shop to obtain permits. This means that the Danish Energy Agency facilitates the necessary permits in cooperation with all relevant authorities. Permits in draft form are provided as part of the tender material.
- The negotiated tender and the initial technical dialogue will provide tenderers good opportunity to contribute to designing the tender specifications and frame-work conditions.
- Secured access to the grid serves as assurance for renewable power generators that they will always be able to sell and transmit their power in accordance with current connection rules.
- An efficient and transparent electricity market in which market data is made easily available by the TSO, Energinet.dk.
- Full flexibility to design the wind farm and choose foundations, turbines and other components. No requirements for local content of the project.

13. APPENDICES & LINKS

Energy Policy in Denmark, see http://www.ens.dk/en/info/publications/energy-policy-denmark

IEA report on cost of energy, see http://www.ieawind.org/publications/26.html
and more specifically, for definitions, see e.g. http://www.nrel.gov/docs/fy11osti/48155.pdf

New Offshore Wind Tenders in Denmark, see
http://www.ens.dk/sites/ens.dk/files/supply/renewable-energy/wind-power/offshore-wind-power/new-offshore-wind-tenders/ewea_offshore_2013_all.pdf
and more generally http://www.ens.dk/en/supply/renewable-energy/wind-power/offshore-wind-power/large-scale-offshore-wind-tenders

Project example: Geophysical Survey of upcoming wind farm Kriegers Flak: see http://www.energinet.dk/SiteCollectionDocuments/Engelske%20dokumenter/Anlæg%20og%20projekter/KF_OWF_Geophysical_Survey_Results_v4.pdf

Energy Policy Toolkit: Physical Planning of Wind Power, see http://www.ens.dk/en/policy/Global-cooperation/information-materials/general-information-policies-tools/toolkits
Environmental impact of offshore wind farms in Denmark, see http://www.ens.dk/node/3206/environmental-impacts

The Danish Energy Agency's Centre for Global Cooperation supports emerging economies to combine sustainable future energy supplies with economic growth. The initiative is based on four decades of Danish experience with renewable energy and energy efficiency, transforming the energy sectors to deploy increasingly more low-carbon technologies.

Learn more on our website:
www.ens.dk/global-cooperation

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