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Report

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Executive summary

After more than 10 years of slow developments, the offshore wind market is now accelerating. Thanks to a sustained political drive from UK and Germany, the rest of Northern Europe is now following the path as offshore wind is being recognized as one of the key resources available to the EU to meet its renewable energy ambitions. Exposed to increasing technical issues, rising costs and the financial crisis, lessons learned are now being shared and integrated throughout Europe and appropriate regulatory and planning reforms are now being deployed to speed the deployment of offshore wind.

The present report outlines the trends, challenges and lesson learnt among them:

	Trends	Lessons learnt
Technology & project design	- Increased size of turbines and projects. - Local site conditions are getting more complex. - Greater distance to shore, greater water depths. - Numerous demonstration and pilot plants.	- Booming project pipeline obliges authorities to set up new offshore wind regulatory frameworks. - More complex EIA and spatial planning requirements including cumulative effects. - Local site conditions are getting more complex and requires upfront pre-selection of best projects. - Crossing of territorial waters with the grid export cable combined with turbine installation in EEZ requires streamlining on the planning side. - Demonstrators and pilots must be enabled in parallel to commercial projects.
Project delivery schedule	- 7-9 years for developments. Now being reduced to 5-6 years. - Project design & technology trends impacts planning.	- Governments incorporate lessons learned from earlier slow consenting process EIA / Multiple window consenting is the most time consuming element of the planning process. - Financing issues and supply chain bottlenecks could severely delay delivery towards National ambitions.
Cost trends	- Increasing investment costs since 2005. Typical capital expenditure (CAPEX) per MW has increased significantly in recent years, from MEUR 1.5-2/MW for projects installed until 2005 to around MEUR 3.0-3.5/MW for projects installed in 2009. - As a result levelised costs have increased but may have peaked. - Projects have been delayed due to rising costs. - Cost level should remain high on the medium term.	- Too optimistic cost estimations must be prevented. - Distance to shore and water depths are important cost drivers side turbine supply. - Financial support are necessary on the medium-term for offshore wind. - Introducing more competition will contribute to lowering costs. - Implement compulsory reporting from licensed projects to transfer experience and lesson learned related to CAPEX and OPEX.
Policy & targets	- Converging governmental rationale for deploying offshore wind. European prospect for 2020 are in the range of 40GW to be compared with 2,7GW installed today. - UK , Germany and the Netherlands at the lead with ambitious 2020 targets.	- Strong political will: Supportive government policy is a key success factor. - Political and regulatory long-term stability is essential.

Incentive schemes	- Increased cost require higher support schemes. - Leading countries have put in place higher levels of support and short term reward mechanisms for early movers.	- Need for long-term vision and support schemes. - Flexible but stable support mechanisms must be designed. - The schemes should be attractive on the short-term to accelerate market development and be periodically revised. - Grid connection cost burden to project owners must be reduced and grid ownership must be transferred. - Aside from the support to commercial projects, public grants required for national pilot projects. - Supporting financially the demonstration of technologies and strengthening the supply chain are critical to the sector.
Planning framework	- EIA / Multiple window consenting is the most time consuming element of the planning process. - Government are now incorporating lessons learned from earlier slow consenting process	- Appropriate legislative framework. - Proactive and flexible governmental support is key. - Inadequate government leadership is responsible for delays. - Usefulness of Strategic Environmental Assessments and spatial planning. - Plan for consecutive deployment rounds. - No penalty fine in tender award. - Flagship pilot projects are important to initiate learning curve. - Facilitate demonstration projects and securing pioneering risks. - Effective industry coordination.
Site approval & Consenting	- Relatively slow progress and low realization rates. - Incorporating lessons learned in the developing framework. - Tending towards strategic environmental assessments and pro-active spatial planning.	- Avoid processing consenting without an appropriate regulatory framework in place. - Setting up the appropriate regulatory framework is critical before initiating any consenting process. - Collect and integrated lesson learned. - Proactive government involvement through upfront work. - Strategic spatial planning and zonation. Preliminary screening of sites. - Simplification and centralization: Single window consenting procedures. - Coordination of stakeholder interests. - Introduce anti-speculation and binding clauses in the planning framework.
Grid connection & transmission	- Increased distance to shore creates larger challenges for grid connection and transmission and requires new technology and approached to projects. - Offshore grid is a success factor for the large scale deployment of offshore wind in Northern Europe and is being initiated through interconnectors, transnational projects (Kriegers Flak) and national cluster (Germany, UK round3).	- Transparency of the grid access process is key success factor. - Harmonization of European national regulations and need for joint efforts in the development of the offshore grid. - The cost burden and ownership of the grid is being passed over from the developers to the TSOs.

1. Introduction

1.1 Background

WSP is a global business providing management and consultancy services for the built and natural environment. The Group has over 9 000 staff operating from over 100 offices worldwide bringing together multidisciplinary planning, engineering, corporate services, sustainability, environmental and management skills and is active across the full range of sectors. Renewable energy, especially wind power, is a fast growing business area within the company.

Multiconsult is a Norwegian affiliated company to WSP with offshore wind competence and track record in market and policy advisory, multi-disciplinary engineering and project management. Together with WSP, the joint project team brings the offshore wind and renewable energy expertise and international perspective necessary to support NordVind.

NordVind is a working group as a part of the Nordic Council of Ministers. The aim of the group is to assess the planning process and other issues related to wind power in the Nordic countries. Nordvind contracted WSP and Multiconsult in June 2010 to perform a broad market outlook study on the offshore wind market in Scandinavia and the rest of Northern Europe. The main objectives are to describe the trends, challenges and experience from offshore wind and identify some key lesson learned for future developments in Scandinavia.

The WSP-Multiconsult project team is further described in appendix.

1.2 Objectives

- Scope of work
    - Offshore wind market outlook in Nordic countries and the rest of Northern Europe
    - Market status and development trends
    - Planning framework and procedures
    - Cost review and drivers
    - Support schemes
    - National and European transnational grid
    - Case studies / Lesson learned offshore wind farms and demonstrator projects

- Geographical coverage
    - Denmark, Finland, Norway, Sweden
    - Germany, Ireland, The Netherlands, UK

- Timeframe

The project was contracted on 9 of June 2010. This final report was completed early November 2010.

1.3 Methodology

The project team performed a bottom-up research of publicly available information in the three approaches presented below. This was combined with first-hand experience and knowledge of the project team and company exposure.

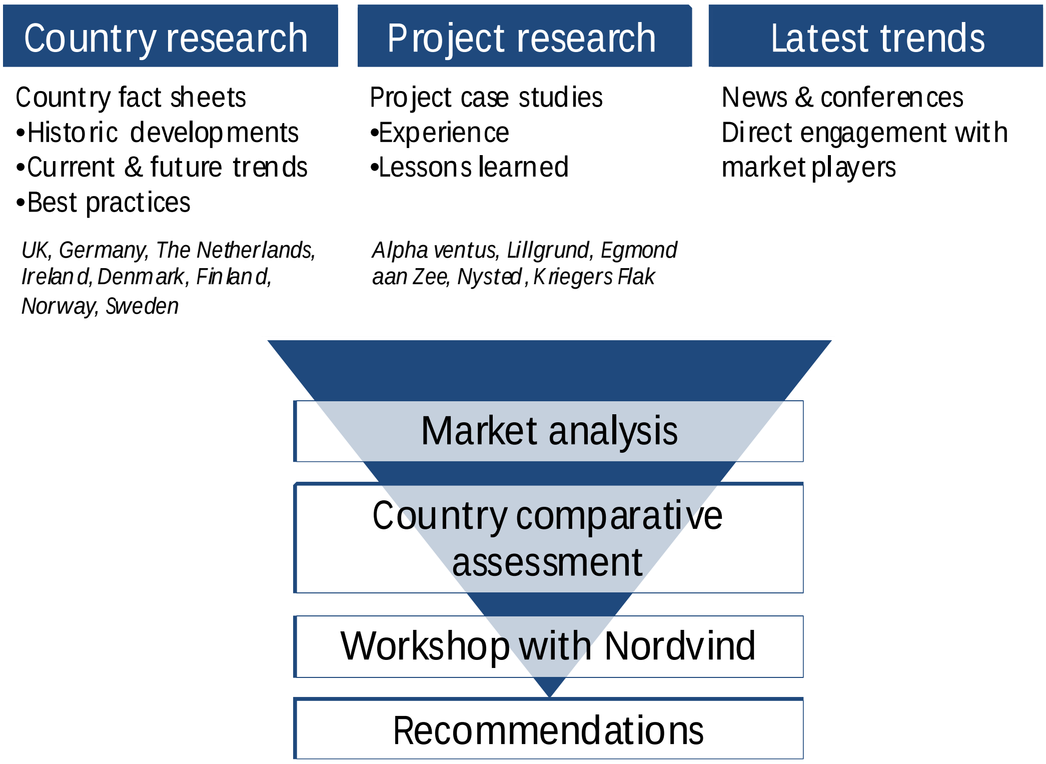

Figure 1-1 Methodology

An intermediary draft report was delivered in August the 20th 2010 and a workshop with a Nordvind committee was organised in Helsinki, Finland on the 2nd of September 2010.

A final report was completed early November 2010 based on comments and remarks communicated by Nordvind.

2 Market trends and challenges

2.1 European wind power market overview

The European Environment Agency (EEA) released in 2009 an updated estimation of the European onshore and offshore wind potential announcing an offshore economic potential for 2020 of 2200 TWh, equal to 60-70% of the projected electricity demand at that time. The EEA have estimated that the unconstrained technical potential of offshore wind in Europe is approximately 25,000 TWh.

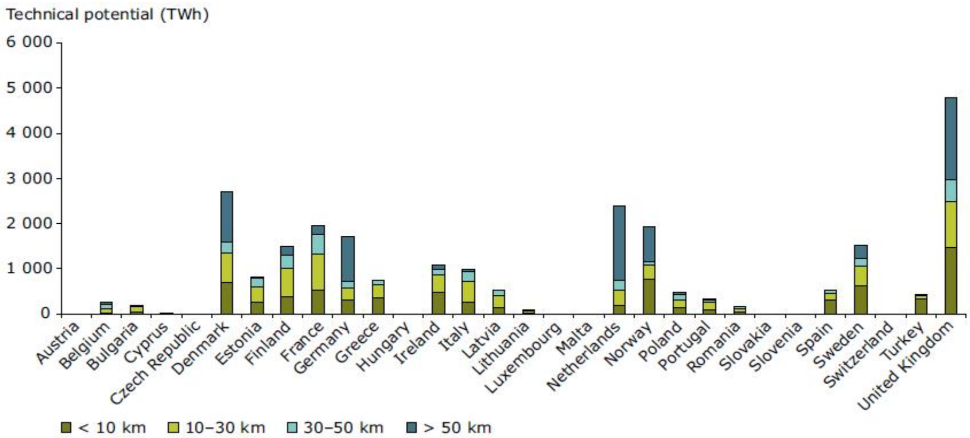

Figure 2-1 Technical potential for offshore wind energy across Europe (TWh)[1]

The contribution of wind power in the European electricity system has progressively increased in the past 15 years. In 2009, it is the largest contributor of new built electricity generating capacity with 10 GW out of a total of more than 25 GW additional capacity. Over the 1990-2009 period, wind power represents the second contributor with 65 GW, just behind natural gas power plants with 81 GW.

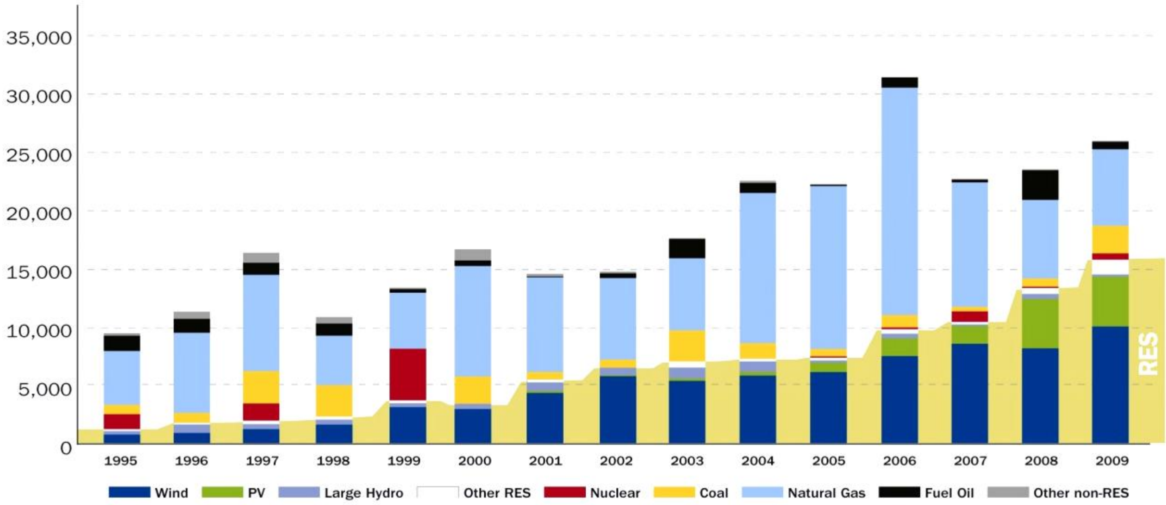

Figure 2-2 New installed power generation offshore wind capacity per year in MW[2]

[1] "Europe's onshore and offshore wind energy potential", EEA, 2009 http://www.energy.eu/publications/a07.pdf
[2] EWEA, EPIA, ESTELA, EI-OEA, and Platts Powervision

2.2 Offshore wind market updates

2.2.1 Installed capacity

While onshore wind is already considered as a mainstream of electricity, offshore wind is still in the earlier phases of its development. At time of writing, the total installed offshore wind capacity in UK, Germany, The Netherlands, Ireland, Norway, Finland, Denmark and Sweden is about 2,7GW. The main offshore markets in Europe are the United Kingdom (1341 MW) and Denmark (871 MW), followed by the Netherlands (247 MW), Sweden (163 MW), Germany (72 MW), Belgium (30 MW) and Ireland (25 MW). Finland has a single operating near shore project (24 MW) and Norway a fully grid connected experimental floating turbine (2.3 MW).

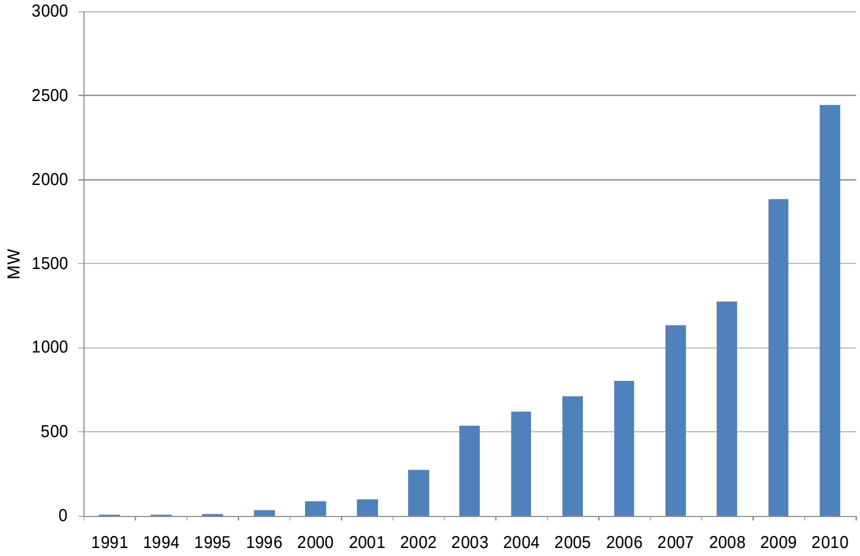

Figure 2-3 Cumulated installed capacity offshore wind over the 1991-2010 period

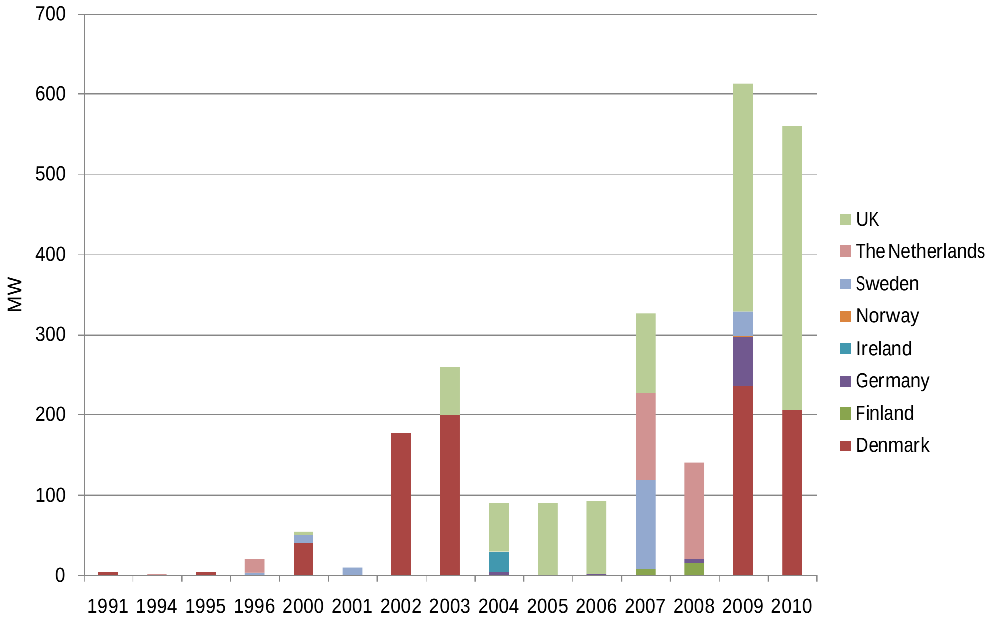

Figure 2-4 Annual installed capacity offshore wind over the 1991-2010 period (MW)

There are about 40 offshore wind projects installed in the countries covered in the study. More than half of them have capacities over 30 MW with an average size above 100MW, ranging from 30 to 209 MW. There are only 10 offshore wind farms with over 100 MW installed capacity.

Table 2-1 Operating offshore wind farms in Scandinavia – Q2 2010 [3]

Country	Projects	MW	Online year	Foundation type	Water depth (m)	Distance from coast (km)
Denmark	Avedøre Holme	7	2009	GBS	2	0,4
Denmark	Frederikshavn	10,8	2003	monopile	1-4	3,2
Denmark	Horns Rev I	160	2002	monopile	6-11	17,9
Denmark	Horns Rev II	209	2009	monopile	9-17	31,7
Denmark	Middelgrunden	40	2000	GBS	3-6	4,7
Denmark	Nysted (Rødsand I)	165,6	2003	GBS	6-9	10,8
Denmark	Rødsand II (Nysted II)	207	2010	GBS	6-12	8,8
Denmark	Rønland	17,2	2002	monopile	0-2	0,1
Denmark	Samsø	23	2003	monopile	10-13	4
Denmark	Sprogø	21	2009	GBS	6-16	10,6
Denmark	Tunø Knob	5	1995	GBS	4-7	5,5
Denmark	Vindeby	4,95	1991	GBS	2-4	1,8
Finland	Kemi Ajos I	9	2007	GBS	1-7	2,6
Finland	Kemi Ajos II	15	2008	GBS	1-7	2,6
Norway	Hywind	2,3	2009	Floating	220	7
Sweden	Bockstigen-Valor	2,8	1996	monopile	5-10	1,6
Sweden	Lillgrund	110	2007	GBS	6-8	11,3
Sweden	Utgrunden	10,5	2000	monopile	6-15	4,2
Sweden	Vindpark Vanern	30	2009	GBS	1-22	3,5
Sweden	Yttre Stengrund	10	2001	monopile	6-10	5

2.2.2 Latest updates

In 2010, more than 310 offshore wind turbines were fully grid connected totalling 920 MW: Rødsand II in Denmark, Alpha Ventus in Germany, Gunfleet Sands, Robin Rigg and Thanet in the UK.

Preliminary work was carried out on a further four offshore wind farms: Fredrikshavn wind farm in Denmark, Global Tech 1 and Nordergründe in Germany, Ormonde and the London Array in the UK.

[3] Multiconsult offshore wind farm database, June 2010

2.2.3 Project pipeline[4]

Table 2-2 Installed capacity, project pipeline[5]

		operating	Construction	consented	under consenting	Other projects identified
Denmark	MW	871	0	418	36	> 6 000
	# Projects	12	0	2	1	> 28
Finland	MW	24	0	365	966	> 4500
	# Projects	2	0	1	4	> 11
Germany	MW	72	743	8 013	23 425	> 29 000
	# Projects	4	3	27	49	> 28
Ireland	MW	25	0	1 100	1 794	> 400
	# Projects	1	0	1	4	> 1
Norway	MW	2	0	395	200	> 9 800
	# Projects	1	0	6	1	> 19
Sweden	MW	163	0	1 851	1 550	> 6500
	# Projects	5	0	4	3	> 17
The Netherlands	MW	247	0	3 250	719	> 900
	# Projects	4	0	12	5	> 3
UK	MW	1 341	1 155	2 620	2 219	> 41 000
	# Projects	13	4	7	5	> 26
Total	MW	**2 745**	**1 898**	**18 012**	**30 909**	**> 99 000**
	# Projects	**42**	**7**	**60**	**72**	**> 133**

More than 2,7 GW is already installed and another 1,9 GW is under construction in the countries reviewed in this report. The project pipeline is also very large. The latest years have seen a rapid increase of consent application submitted to local authorities and a consented pipeline of an additional 18 GW over 60 projects is progressing. At least 30 GW of capacity is under consenting. Even though there is a significant number pf consented projects many of these projects are unlikely to be every built.

A very extensive early phase project pipeline (before consent process) has been identified demonstrating the great interest for offshore wind shown by project developers. Many of these projects are unlikely to be every built.

UK round 3 projects together with other planned projects across the region represents a capacity of more than 100 GW. UK (1,3 GW) is now larger than Denmark (871 MW) which used to be the market leader in offshore wind. UK and Germany are expected to dominate the market in 2020 with a combined target above 40GW. Germany is however just getting started with only 72 MW installed.

Among the latest trends:

- UK allocated exclusive rights of development for UK round 3 (32GW) and extensions of round 2 (2GW).
- At the time of writing, Germany had at least 750 MW under construction and another 8 GW of consented projects.
- The Netherlands has awarded a cumulated capacity of 400MW to 2 developers following a competitive tender process (round 2).
- Denmark has awarded the Anholt project (400MW) through a competitive tender process.

[4] Multiconsult offshore wind farm database, June 2010

[5] Multiconsult offshore wind farm database, 2010

- Norway has recently consented several demonstrator pilot projects to be located in the deep water of the North Sea and identified 15 development zones[6] to be further assessed in 2011 through a Strategic Environmental Assessment (SEA) driven by NVE.
- Sweden has recently consented the 265MW Storgrundet offshore wind farm.
- Ireland after several years of very slow progress seems to be moving forward through the publication of the strategic environmental assessment of Irish waters (5th Nov 2020) and the launch of the renewable energy development plan.
- Other countries such as Finland have not seen major evolution in consenting of projects.

A large number of projects have been consented, but it is important to keep in mind that a significant part of them will actually not be build.

2.3 Future prospects for offshore wind

According to recent market forecast, offshore wind is expected to reach a total installed capacity of 30GW in 2020 reaching an annual installation rate of about 4GW per year in 2020. The EWEA has an ambitious offshore wind target of 40GW by 2020 to be later expanded up to 150GW by 2030.

Germany and UK are expected to dominate the European offshore wind market followed by a group of countries including Sweden, Netherlands, Denmark and Ireland.

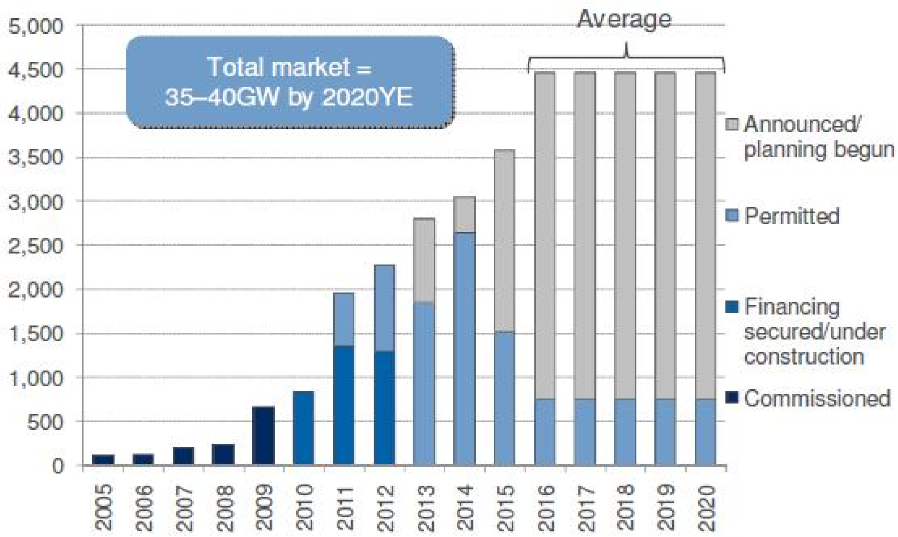

Figure 2-5 Annual installed capacity forecast for 2020 [7]

2.4 Electrical production and capacity factors

The power output of offshore wind projects is higher than onshore wind with capacity factors[8] ranging typically from 35 to 45 percent, equivalent to approximately 3000 to 4000 full load hours. The capacity factor of an offshore wind farm varies with local wind resource conditions which increase with the longer distance to shore.

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6 www.havvind.no

7 Source: Bloomberg New Energy Finance, 1 July 2010
http://www.wind-eole.com/fileadmin/user_upload/Downloads/Konferenzen/Finanzierung/Hodges.pdf

8 The capacity factor the ratio of the actual output of a power plant over a period of time and its output if it had operated at full nameplate capacity the entire time.

Loss of production due to wake effect (wind shadow effect between turbines within a single site or between neighbouring sites), electrical losses through longer transmission cables as well as down time due to maintenance must be taken into account to evaluate future expected capacity factor and production outputs from projects.

As shown in the table below, the analysis of the recently published 2010 NREAPs[9] shows that the expected national output levels and capacity factors vary across the Northern Europe region. This shows signs of either variable wind resource conditions or inconsistent understanding of the real potential from offshore wind and absence of standardized evaluation of the production potential. Further assessment of expected energy outputs from future projects is necessary.

Table 2-3 Expected national output levels according to 2010 NREAP analysis

Country	Expected capacity factor (%)	Nb of full load hours equivalent (hours)
Denmark	45,4 %	3 975
Ireland	35,0 %	3 066
Germany	42,2 %	3 700
Sweden	31,4 %	2 747
The Netherlands	42,0 %	3 676
UK	38,8 %	3 396

2.5 Technology and project design trends

Increased size of turbines and projects

Up to 5-6MW in commercial stage and up to 10MW in development/demonstration stage, turbines are now fully designed for offshore purposes. The immaturity of the new turbines deployed on projects does however introduce larger risks to the project.

Leading utilities are now focusing on projects of 300 - 400MW and above. The average size of consented/under consenting projects in the countries reviewed in this study is 375 MW, with projects ranging from 5 MW (test site) to above 4 GW per site (large scale projects initiated by pilot phases). Entire zones now being developed require an integrated approach to grid connection and transmission through the deployment of clusters and or offshore grid solutions (see chapter on Grid connection and transmission).

More complex site conditions

As the best sites with easy soil conditions (typically sand) have been already exploited, future projects now need to confront more difficult soil conditions. Same challenges apply with wave, current and tidal conditions. This introduces additional risks which need to be mitigated at early stage.

Greater distance to shore, greater water depths

Projects are located further offshore, where water depths generally exceed the 20 meters boundary. To date, most projects have been installed within this boundary. This implies new technical and industrial solutions to be elaborated such as new support structures (water depth), HVDC transmission technology (distance to grid) or HSE management.

[9] National Renewable Energy Action plans published in Q2 2010 for each member state

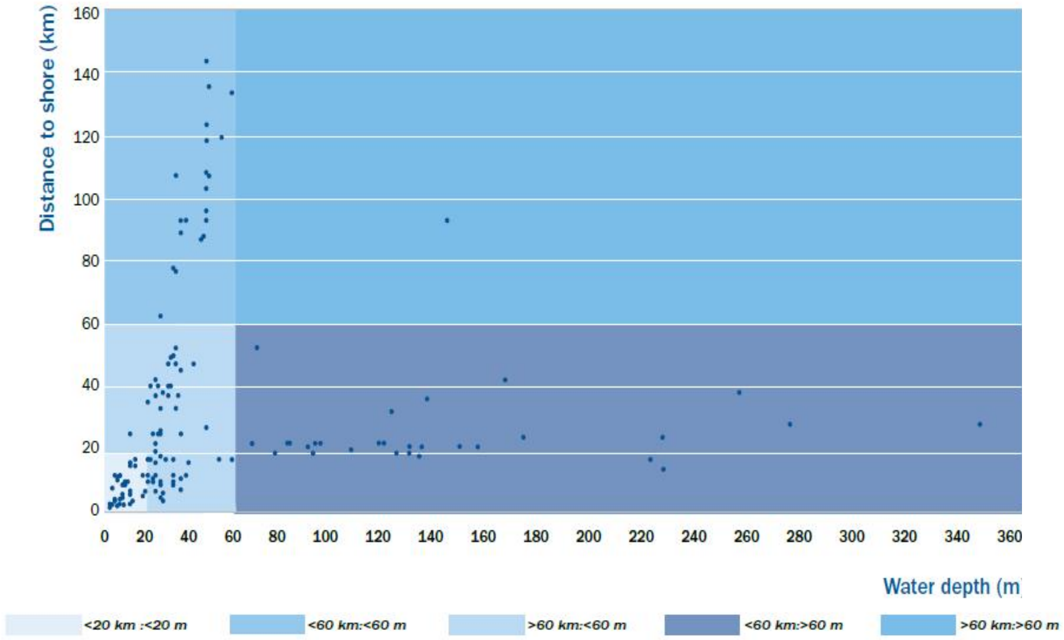

Figure 2-6 Water depth and distance to shore of project pipeline

Demonstration and pilot plants

Due to the new technical challenges being currently addressed, the commercial deployment of a wind farm may be preceded by a demonstration phase during which the technology will be tested. Many initiatives have been launched with direct implications on legal framework, consenting processes among others.

2.6 Project planning

2.6.1 Scope of work

The technical planning and realization of offshore wind farms can be divided in 7 phases along the complete lifecycle: Feasibility and consenting, planning and pre design, detailed engineering and procurement, Construction and commissioning, O&M, Repowering / Dismantling.

Feasibility & consenting	Planning & pre design	Detail engineering & procurement	Construction & commissioning	O&M	Repowering Dismantling
•Site screening – site attractiveness versus environmental and human constraint mapping •Pre-feasibility study – technical, economic assessment •Lease agreements •Consenting for met mast and wind farm construction, power generation, grid connections, grid extensions. •Stakeholder management, consultations •Health. Safety and Environment planning	•Surveys: bathymetry, oceano-meteorological, seabed, environmental •Basis of Design - definition of functional hypotheses and requirements •Front End Engineering and Design (FEED) including cost estimations •Planning of internal controlling system and master plan draft •Development of supply chain and partners strategies	•Detail engineering •Certification, Pre-testing of equipment •Training of personnel •Procurement: Tender process, Contract award and management •Master plan •Finalisation of financing and insurance arrangements	•Manufacturing •Testing •Delivery of equipment to base site •Installation & Logistics - Site preparation, onshore pre-assembly, Offshore operations •Environmental monitoring during construction •Commissioning	•Commercial and technical management •Maintenance •Environmental monitoring	•Typically 20-25 years after commissioning

Figure 2-7 Life cycle of an offshore wind farm project

2.6.2 Implication of technology and project design trends on project planning

The technology and project trends described above may have implication on legal, planning frameworks and consent procedures for future projects. As example, the list below illustrated a few of the Environmental impact assessment (EIA) implications:

Increased size of turbines and projects on EIA requirements and spatial planning

The height of hubs and blades is likely to increase in the future. Current commercial turbines with 5-6MW per unit may be replaced in the future with much larger turbines. As of today, the world's largest turbine with a nominal capacity of 10MW is currently under development in Norway. Its height is expected to reach 162,5m with implications on visual impact requirements.

The project's size should also see a major increase with implication on spatial planning including new requirements on environmental and human constraints. As seen in UK round 3 or Germany, the development of clusters will impact the consent procedures including the need for studies on the cumulative effects on the environment among others.

Local conditions are getting more complex and require upfront pre-selection of best projects.

Authorities are increasingly focused on deliverability and are therefore introducing upfront requirements to project developers in order to filter and prioritize the most cost effective projects.

Greater distance to shore and greater water depths implies crossing the territorial waters with the grid export cable and installing turbines in the Exclusive Economical Zone (EEZ)

These imply that projects will be located beyond the 12 nautical miles of territorial waters. The offshore grid transmission which crosses this zone will thus be subject to different consenting and EIA requirements depending on the country's framework.

Booming project pipeline obliges authorities to set up new offshore wind regulatory frameworks.

Considering the capital required developing and financing the investment, small developers have been replaced by larger utilities to take the lead in developing projects. In some markets this has been accelerated by the implementation of new requirements for consent approval and exclusive rights to develop (soil surveys in Germany; UK round 3 selection criteria on financial strength) which has contributed to position solid players with realistic projects and make the industry focus on deliverability up to commissioning.

Demonstration phase and pilots must be enabled in parallel to commercial projects.

Planning procedures must enable the deployment of such projects taking into account the additional risk and uncertainties. Expected learning curve and possible take-away's from a policy perspective must be taken into account.

2.6.3 Schedule

The flow chart given below presents an overview of a typical planning and construction phases for an offshore wind project, based on the last 10 years of experience from Northern Europe. This chart may not be applicable directly to all countries as planning processes are often country-specific. It is important to note that regulations and planning processes have been recently reviewed and as a result expected timeline will be significantly improved.

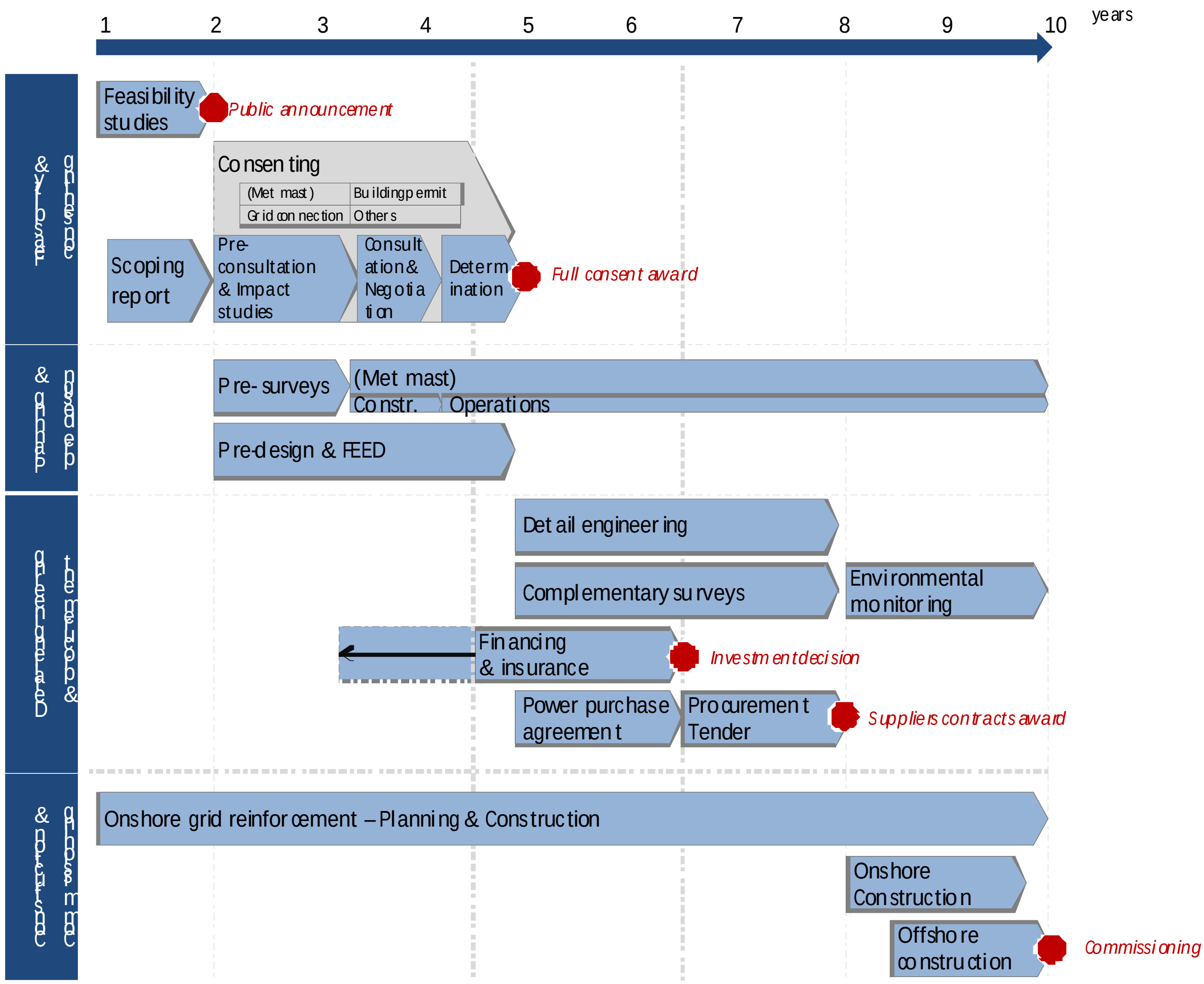

Figure 2-8 planning and construction phases for an offshore wind project

Historic trends shows 7-9 years from feasibility studies to commissioning. Overall duration does however vary among the different countries. As an example, in Denmark the development time is 4-6 years[10]. New project developments such as UK round 3 are expected to shorten the overall duration to 5-6 years.

[10] See case study of Nysted

2.6.4 Case studies

This chapter describes a few examples of projects across all countries covered in the study. The list or case studies and rationale for choosing them are indicated below.

Table 2-4 Selected case studies

Country / Round	Project	Rationale
UK round 1& 2	Gunfleet Sands I & II	The project has been recently commissioned in 2010 and is the result of two projects from round 1 and 2.
UK round 3	Morray Offshore Renewables ltd	A typical large UK round 3 project (1,6GW) at early stage of development, to be commissioned from 2016.
Germany	Alpha Ventus	Germany's first pilot offshore wind farm, recently commissioned in 2009.
Ireland	Arklow bank	Ireland first and only offshore wind farm.
The Netherlands	Egmond aan Zee	An important milestone pilot project for the Netherlands, fully commissioned in 2006.
Denmark	Nysted	One of the first large offshore wind farms in Europe, commissioned in 2003. A successful project on the planning and cost side.
Sweden	Lillgrund	An important milestone pilot project for Sweden, fully commissioned in 2007.
Sweden	Kriegers Flak (Sweden)	Key case study for Sweden and pilot for European offshore grid.
Norway	Havsul 1	The largest offshore wind project fully licensed to date, not yet constructed.
Finland	Kemi Ajos phase 1 & 2	The only offshore wind project fully commissioned to date in Finland.

Table 2-5 Gunfleet Sands - Phase 1 and 2 (UK rd 1&2)

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Feasibility starts															
Notification / Pre-consultation starts															
Tender award / Concession/ Lease															
EIA / Application sent								1	2						
Final consent approved									1				2		
Financial close															
Onshore construction starts															
Offshore construction starts															
Commissioning															

Table 2-6UK round 3

	2008 0	2009 1	2010 2	2011 3	2012 4	2013 5	2014 6	2015 7	2016 8	2017 9	2018 10	2019 11	2020 12	2021 13	2022 14
Feasibility starts															
Notification / Pre-consultation starts															
Tender award / Concession/ Lease															
EIA / Application sent															
Final consent approved															
Financial close															
Onshore construction starts															
Offshore construction starts															
Commissioning									several sites						

Table 2-7 Alpha Ventus (Germany)

	1998 0	1999 1	2000 2	2001 3	2002 4	2003 5	2004 6	2005 7	2006 8	2007 9	2008 10	2009 11	2010 12	2011 13	2012 14
Feasibility starts															
Notification / Pre-consultation starts															
Tender award / Concession/ Lease															
EIA / Application sent															
Final consent approved															
Financial close															
Onshore construction starts															
Offshore construction starts															
Commissioning															

Table 2-8 Egmond aan Zee (The Netherlands)

	1997 0	1998 1	1999 2	2000 3	2001 4	2002 5	2003 6	2004 7	2005 8	2006 9	2007 10	2008 11	2009 12	2010 13	2011 14
Feasibility starts															
Notification / Pre-consultation starts															
Tender award / Concession/ Lease															
EIA / Application sent															
Final consent approved															
Financial close															
Onshore construction starts															
Offshore construction starts															
Commissioning															

Table 2-9 Arklow Bank (Ireland)

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Feasibility starts	■														
Notification / Pre-consultation starts		■													
Tender award / Concession / Lease				■											
EIA / Application sent					■										
Final consent approved					■										
Financial close					■										
Onshore construction starts					■										
Offshore construction starts					■										
Commissioning						■									

Table 2-10 Nysted (Denmark)

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Feasibility starts	■														
Notification / Pre-consultation starts		■													
Tender award / Concession / Lease															
EIA / Application sent			■												
Final consent approved				■											
Financial close					■										
Onshore construction starts					■										
Offshore construction starts					■										
Commissioning						■									

Table 2-11 Havgul (Norway)

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Feasibility starts	■														
Tender award / Concession / Lease															
Notification / Pre-consultation starts			■												
EIA / Application sent					■										
Final consent approved								■							
Financial close															
Onshore construction starts															
Offshore construction starts															
Commissioning															

Table 2-12 Lillegrund (Sweden)

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Feasibility starts															
Tender award / Concession / Lease															
Notification / Pre-consultation starts															
EIA / Application sent															
Final consent approved															
Financial close															
Onshore construction starts															
Offshore construction starts															
Commissioning															

Table 2-13 Kriegers Flak (Sweden)

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Feasibility starts															
Tender award / Concession / Lease															
Notification / Pre-consultation starts															
EIA / Application sent															
Final consent approved															
Financial close															
Onshore construction starts															
Offshore construction starts															
Commissioning															

Table 2-14 Kemi Ajos 1 & 2 (Finland)

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Feasibility starts															
Tender award / Concession / Lease															
Notification / Pre-consultation starts															
EIA / Application sent															
Final consent approved															
Financial close															
Onshore construction starts															
Offshore construction starts															
Commissioning												1	2		

2.6.5 Lessons learnt

The proactive involvement of a government and leasing authority in early phase development is key to accelerating the overall planning duration.

As seen in UK round 3, Strategic Environmental Assessment enables a preliminary constraints assessment resulting in the identification of development zone. Upfront site characterization and even preliminary studies can be performed by the government as seen in Denmark which gives the authorities a better expectation of the potential for a site, a good understanding of the benefits and risks involved and a better basis for negotiation with the developers when terms are to be negotiated in the context of a lease contract.

Both lease and concession processes can be further integrated in order to streamline and fast track approval or rejection of project plans.

Lease/concession processes have often been independent from consenting, introduced either before the submission consent application (UK) or after during a reform period such as the one seen in Netherlands recently.

Governments incorporate lessons learned from earlier slow consenting process

Based on the short review of the above case studies, it appears that first national pilot projects such as Alpha Ventus (Germany), Egmond aan Zee (Netherlands), Lillgrund (Sweden) have often taken a very long time to be developed, often more than 10 years.

Thanks to the experience of several pilot projects such as Middelgrunden and Hornsrev 1, Denmark have been successful at driving an efficient planning process for Nysted initiated in 1998 and completed successfully in 2003.

Thanks to two rounds of development, UK is now heading for a third round for which the complete development process is expected to take about 5-6 years including a single year of consenting process from submission to approval through the set up of a single window consenting body.

Consenting time is clearly improving as new reform incorporates lessons learned from earlier projects

EIA / Multiple window consenting is the most time consuming element of the planning process

The review of the projects listed indicates that consenting phase has clearly expended the project development duration. Feasibility studies, engineering design or construction do not impact the overall development duration as much as consenting phase.

The duration of processing several permits and related independent consultation, have impacted the duration of project development. By setting up a single window process and merging different consultations in a single process the project delivery will be accelerated.

In practice, *a meteorological mast may need to be installed offshore to collect real site data at least two years ahead of financial close* to meet the requirement of commercial banks towards financial close. Considering that projects are being developed further offshore, in deeper waters, local wind and oceanographic conditions are often less known but essential to allow innovative solutions to be engineered as early as possible. Once preferred sites were identified in Germany, the government sponsored the installation of a several offshore measurement platform ahead to the developer's project development.

Financing of commercial size projects became a key issue in the context of rising costs of offshore wind and financial crisis. The authorities have thus emphasized the need to secure strong financial players on board project development at early stage.

Ex: UK round 3 – Financial strength

Financing and long-term commitment has been tackled from day one of the round 3 process.

- Financial strength was one of 5 selection criteria used for the UK round 3 process.
- A 50 years lease agreements have been signed with the winning bidders.

As a result, all round 3 winning consortia are all led by large energy utilities with strong balance sheets. Small developers which played a key role in developing UK round 1 and 2 projects will be less involved in future large developments.

In order to assess soil condition risk at early stage and ensure that project developers with approved consent have the financial capacity to fully develop the project and *ensure its deliverability, requirements on soil surveys* have been included in the information to be provided in the consent application.

Developer and Authorities must expect supply chain bottlenecks to cause delivery delays.
Some leading developers are strengthening their supply chain strategies and relationships to future contractors. Authorities should take this into account while defining deliverability requirements.

2.7 Cost of offshore wind

2.7.1 Introduction

The cost of offshore wind per MW installed is divided into 3 main elements, the development cost, the capital expenditure (CAPEX) and the operation expenditure (OPEX). The levelised cost of energy which corresponds to a cost per kWh is estimated based on the above cost elements, life time of the project, load factors and applied discount rate.

Development cost

The development cost varies a lot depending on the technical and planning requirements to be faced by the developer. The development cost per installed MW decreases substantially with the number of MW.

For UK round 3, we estimated full development cost to be in the range of 15-20 kEUR/MW [11]. For example, the Forewind consortium is expected to spend 350 x 4 = 1400 MNOK for the development of the 9GW Dogger Bank zone[12] until 2014-2015, roughly equivalent to 20 kEUR/MW[13].

Although it represents a minor part of the levelised cost, these upfront expenses are still sizeable (typically 3M€ for an offshore met mast) and exposed to the risk of seeing the project not reaching completion.

Capital expenditure (CAPEX)

The CAPEX can be divided into 5 main components, the wind turbine, foundation, electrical infrastructure, installation, and planning & development cost. The following graph illustrates the typical distribution of CAPEX for projects currently under construction. Turbine cost account for roughly half of investment cost. Costs related to electrical infrastructure are further assessed in chapter *Grid connection and transmission*.

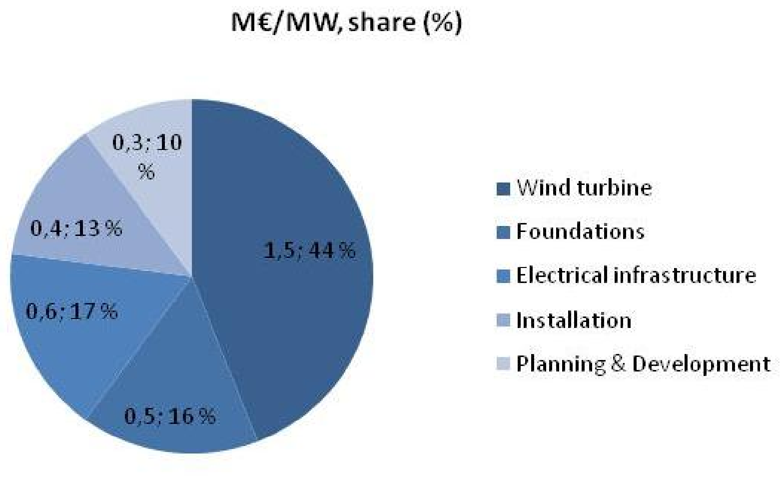

Figure 2-9 Typical CAPEX (M€ / MW installed)[14]

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12 http://www.bloomberg.com/apps/news?pid=newsarchive&sid=az9R2ViGV0Uo

13 1 EUR = 8 NOK

14 DW, 2010

Operation expenditure (OPEX)

The annual OPEX can be divided 5 components, equipment, grid maintenance, lease & insurance, personnel access, labour and installation/repair vessels.

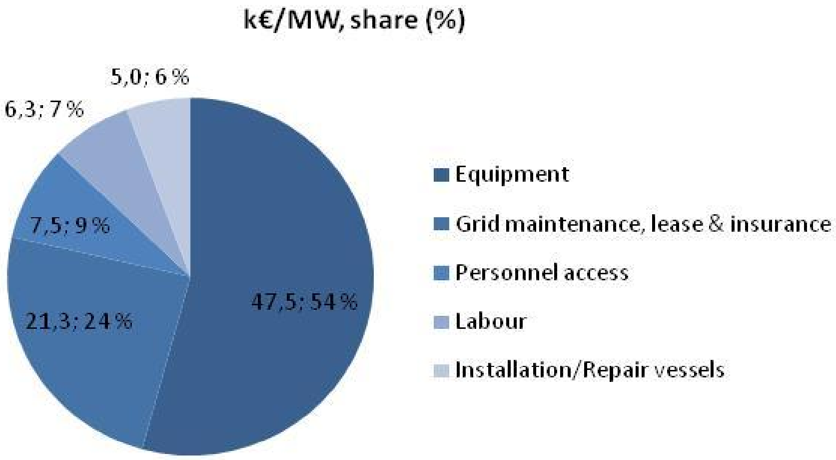

Figure 2-10 Typical annual OPEX (k€ / MW / year)[15]

Levelised cost [16]

The average lifetime electricity cost of energy (LEC) for offshore wind has been estimated for typical project with a project lifetime of 20 years, a capacity factor of 38% (corresponding to a *numbers of hours* of 3329) and an applied discount rate of 6% or 10%.

CAPEX = 3,4 M€ / MW[17]
OPEX = 87,5 k € / MW / year[18]
LEC @ 10% discount rate = 135 EUR / MWh
LEC @ 6% discount rate = 110 EUR / MWh

Further analysis of the levelised cost, in particular for the purpose of comparative benchmarking with other technologies, requires a discussion around assumptions used for the calculation (capacity factor, discount rate among others).

15 DW, 2010

16 *Generic formula for Levelised Cost of Energy (LEC):*

$$\mathrm{LEC} = \frac{\sum_{t=1}^{n} \frac{I_t + M_t + F_t}{(1+r)^t}}{\sum_{t=1}^{n} \frac{E_t}{(1+r)^t}}$$

LEC = Average lifetime levelised electricity generation cost
It = Investment expenditures in the year t
Mt = Operations and maintenance expenditures in the year t
Ft = Fuel expenditures in the year t
Et = Electricity generation in the year t
r = Discount rate
n = Life of the system

17 *Multiconsult estimate of current trends for 2009-2010*

18 Ernst & Young. Cost of and financial support for offshore wind. 2009

2.7.2 Trends & Challenges

Increasing investment costs since 2005.

Offshore wind, like other renewable energy technologies, is a capital intensive power generation source with high upfront costs and relatively low operational costs. The sector's immaturity, scale and time frame necessary for a successful offshore wind deployment make it vulnerable to supply chain bottlenecks and macro economic conditions.

Typical capital expenditure (CAPEX) per MW has increased significantly in recent years, from MEUR 1.5-2/MW for projects installed until 2005 to around MEUR 3.0-3.5/MW for projects installed in 2009.

This is due to several factors:

- increased water depth impacting the size and type of support structures as well as installation;
- increased distance to shore impacting the length of the export transmission cable;
- lack of competition and bottlenecks on the supply side, particularly for turbines and installation vessels;
- surging raw material costs, with steel and copper being important cost drivers (until 2008);
- currency fluctuations, especially in UK where over 80 % of projects' capital value is imported in a context in which the sterling has depreciated.

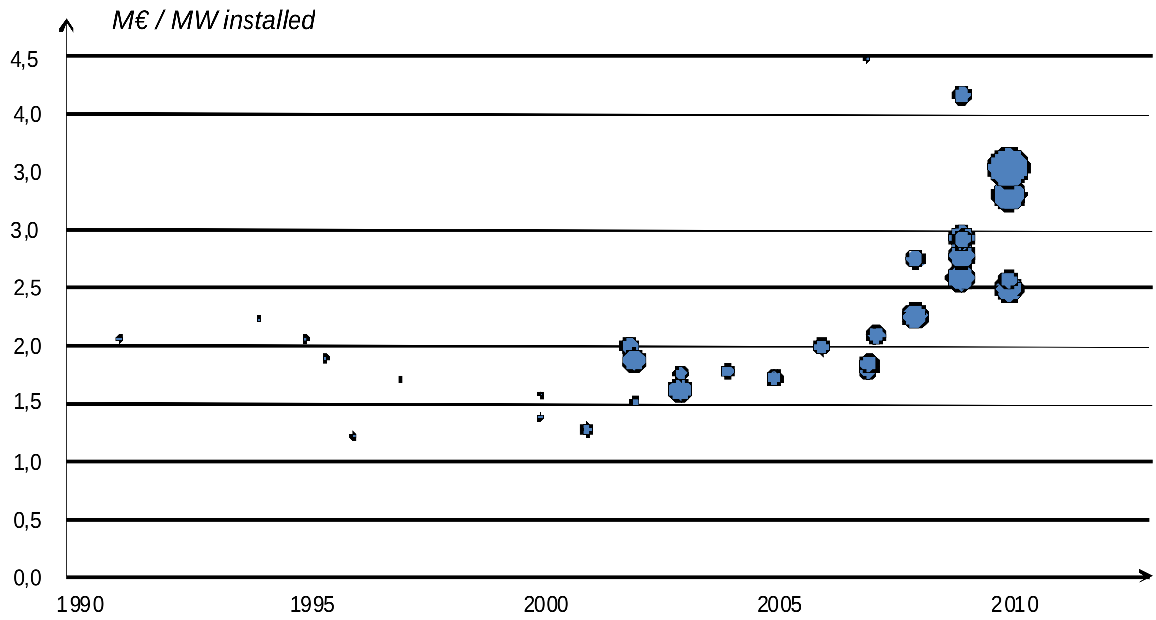

Figure 2-11 Historical and current capital expenditure trends (MEUR/MW installed) for offshore wind farms[19]

Operational expenditure (OPEX) is reported to have seen a similar increase. Project owners are reluctant to release data on operational costs. Some projects under the UK grant scheme for demonstrators have been well documented and illustrate cost levels. On a production basis, OPEX has been reported to be in the range of 9,6 - 14,4 EUR/MWh[20] produced. According to a 2009 analysis, OPEX on a per MW basis per year increased from kEUR 58 to 95 between 2004 and 2009.[21] The cost drivers are related to those stated above, including increased technical complexity (increased distance from shore), supply chain constraints, increased turbine costs, and

[19] Garrad Hassan; Multiconsult research. Historic values varies depending on the sources and currency rates applied.This figure should only be used as indication of general cost trends.

[20] 1 GBP = 1,2 EUR

[21] Ernst & Young. Cost of and financial support for offshore wind. 2009

currency fluctuations. Other factors include improved budgeting—reflecting track record and experience gained from operating early projects—as early projects may have underestimated stated O&M costs in 2004, as well as a trend towards more pro-active O&M strategies as UK lease periods is being extended from 20 years to 40 or 50 years[22]

Levelised costs have shot up but may have peaked.

Combining the CAPEX and OPEX estimates, Ernst & Young calculates that levelised cost for newly built UK offshore wind farms increased from 109 EUR/MWh in 2006 to 173 EUR/MWh in 2009. That represents an increase of 59 % in the period.[23]

Other types of power generation sources, including coal, onshore wind, gas and solar plants, also experienced significant cost increases in the period.

The latest projects such as Alpha Ventus have opened the door to the next generation of commercial projects in deep water conditions (30m). The leap in cost is due to a shift of site water depth from shallow water to deeper water (>25m) implying a new set of technology and installation methods to be implemented, leading to higher cost on the short term.

Projects have been delayed due to rising costs.

The Utgrunden II project is currently on hold in Sweden despite consent granted in 2005 by the authorities and an investment grant of 7,5 MEUR.

The Rødsand II project was initially awarded through a competitive call for tender with a binding tariffication, but put on hold in 2007 due to rising costs. The project was then re-submitted to a tender to readjust winning price conditions.

Similarly UK and Germany faced reluctance from investors to go ahead with some projects and had to increase the level of their support scheme to allow projects to be profitable and build investor's confidence.

Medium term cost trend.

Despite a significant cost increase in the last five years, signs of cost reduction may be observed as the financial crisis has relieved pressure on turbine prices, steel prices have fallen and investment in the supply chain, vessels in particular, is taking place. The global turbine industry, including onshore wind, is now reported to have a cumulative overcapacity of 100 %, and turbine prices are said to have dropped 10-15 % recently.[24]

Costs are however expected to remain in current levels for the 3 years to come. Cost reduction is on the top of the agenda of the offshore wind industry. In a 2020 perspective, the delivery of the UK 2020 ambition in offshore wind requires, according to market players, a decrease of 30% from current cost levels in order to finance the total amount of round 1, 2 and 3 projects.

These cost reductions cannot materialize in the absence of any policy intervention and substantial amounts of financial support is currently channelled into the industry in order to accelerate growth in the supply chain, increase competition and develop new cost effective solutions. As presented in a recent report[25] from the British

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22 Ernst & Young. Cost of and financial support for offshore wind. 2009

23 Ernst & Young. Cost of and financial support for offshore wind. 2009. All levelised cost calculations in the report used a post-tax real discount rate of 10% (12% pre-tax real).

24 *Michael Stenvei. Priskrig truer vindmøllemarkedet. Jyllands-Posten. 28.02.2010*

25 BWEA, UK Offshore Wind: Charting the Right Course - Scenarios for offshore capital costs for the next five years, 2009 http://www.bwea.com/pdf/publications/ChartingtheRightCourse.pdf

Wind Energy Association (BWEA), the likelihood of reducing cost substantially over the next 5 years is highly dependent on whether effective action is taken by Government and industry now.

It is foreseen that increased competition within the supply chain will drive cost down. However the volume of projects expected to come online during the 2015-2020 period is so large (UK round 3, German pipeline developments among others) that the demand is likely to remain higher than supply, contributing to keeping cost at relatively high levels. On the demand side, projects, and to some extent the national pipeline of projects, will compete to secure supply resources. Commercial players as well as national authorities are already putting in place strong supply chain strategies to reduce both bottlenecks and cost through long-term large commitments with leading supply chain players willing to grow. Some leading developers-operators have recently decided to invest directly in the supply chain such as heavy lift installation vessels (ex: DONG, RWE) or secure large long-term supply framework agreements with leading turbine manufacturers (ex: DONG). UK and Germany are addressing the issue by encouraging the creation of national markets with local projects supported by national supply industry, which at the same time contributes to regional economy.

Long term cost trends

The ongoing and continuous technology development in the industry is expected to lower both CAPEX and OPEX over time. The CAPEX will be lowered mainly from cheaper foundations and turbines, together with more experience making the planning and installation phase more streamlined. The increasing wind farm size is also expected to contribute. Previous experiences show that installation time is reduced significantly from the first to turbine the last turbine installed. As more projects are installed, the supply companies involved in the processes will be more experience and efficient. The OPEX will be reduced due to improved turbine technology reducing down time and need for maintenance. Extended lifetime[26] will also allow reduction of the overall levelised cost.

2.7.3 Lessons learnt

Too optimistic cost estimations

Estimating CAPEX on historical costs, based on cost effective projects (close to shore, favourable soil conditions, shallow waters), have misled developers into overestimated rate of returns, ultimately postponing the expenditure of key project development activities or financial close until more profitable support scheme were put in place.

CAPEX estimates on demonstration projects such as Alpha Ventus, where new technologies and installation methods are required, have been optimistic and have underestimated the risk and uncertainties of the projects.

Operational data including OPEX estimates and lessons learnt are yet to be benchmarked across different projects and markets. The information remains sensitive and confidential due to the immaturity of the market and issues with the reliability of new offshore wind turbines.

Cost estimates should track CAPEX, OPEX and levelised cost and should be specifically estimated using bottom-up calculations preferably backed by recent quotes from industry suppliers and contractors.

Distance to shore is an important cost driver.

Though cost data for the industry as a whole remain incomplete and immature, it can be concluded that distance to shore is one of the key cost drivers. Procurement of electrical infrastructure, notably export cables, and installation as well as operations and maintenance are particularly affected. One UK estimate—that should be

[26] Some large turbine manufacturers are now designing turbines with a 30 lifetime.

treated with some caution given the early stage of developments—note that capital investments to develop the Dogger Bank site as part of Round 3 might be 40 % higher than today's UK offshore wind farm developments [27].

Financial support will be required on the medium-term for offshore wind.

In a recent UK study[28], the levelised cost of electricity for projects initiating their construction in 2013 has been estimated for a range of technologies including offshore wind. Conventional sites and UK round 3 have been differentiated to take into account the increased costs due to distance to shore and water depth. Offshore wind appears to remain one of the most expensive alternatives on the short term and will require appropriate support schemes to enable market competitiveness.

A further analysis of levelised cost would be required to fully assess and compare the cost competitiveness of of different technologies. This study is however out of the current scope of the study and would require a discussion around assumptions used for the calculation such as capacity factor, discount rate, life time in particular.

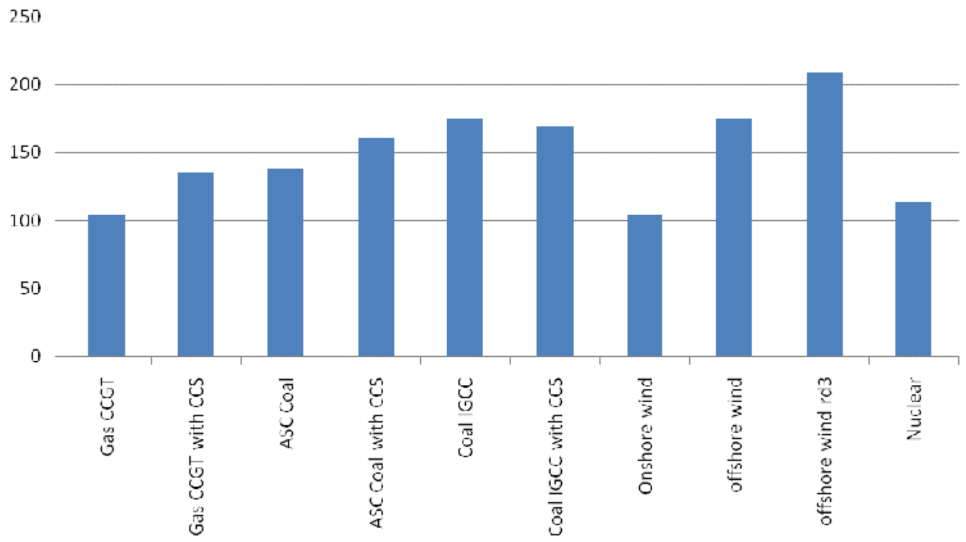


Figure 2-12 Levelised cost of electricity (EUR/MWh) 10% discount rate[29]

Introduce competition to lower costs.

Building in an element of competition to licensing helps ensure that the best sites are developed by the most capable companies at a competitive cost. This can be seen through the Rounds system in the UK, where potential Round 3 developers have been judged on financial strength and track record, and through the site-specific tendering in Denmark which is seen to support low-cost offshore wind deployment.

Governments play a role in reducing costs.

Cost reduction relies on the introduction of new solutions which needs to be demonstrated ahead of full scale commercial deployment. Governments play an essential role in order to incentivize the implementation of test and demonstration projects through appropriate and efficient planning framework and financial support scheme.

Implement compulsory reporting from licensed projects.

In particular demonstrator projects, in order to compile technical and economic data and allow access and distribution of lessons learnt. Sensitive data such as OPEX in particular must be emphasized.

[27] Carbon Trust. Offshore Wind Power: Big Challenge, Big Opportunity: Maximizing the Environmental, Economic and Security Benefits. 2008.

[28] Mott MacDonald, UK electricity generation cost update, June 2010; 1 GBP = 1,2 EUR ;10% discount rate

[29] Mott Mac Donald, June 2010

Design a planning framework which allows, on a given site, the planning of technology demonstration through a pilot plant phase to be later expanded in a large commercial scale project delivery. This allows the financing of technology development in connection to long-term commercial application and allows the financial support and risk sharing of the development phase.

3 Policy, planning framework and incentives

		Denmark	Finland	Norway	Sweden
Developments	Installed capacity (MW)	871,0	24,0	2,3	163,0
	Under construction (MW)	0,0	0,0	0,0	0,0
	Consented projects (MW)	418,0	365,0	395,0	1 586,0
Policy	National target	30% renewable energy by 2020	-	30 TWh/y of both renewable energy production and energy efficiency by 2016 – beyond that of the 2001 level.	Planning framework 30 TWh/y onshore & offshore wind (offshore expected to contribute for 10TWh), 182MW offshore wind according to Swedish 2010 NREAP
	Planning framework	tender and open door procedure	open door procedure	open door procedure	open door procedure
	Penalty / fine	yes, up to 400 MDKK	no	no	Buy-out charge for missing certificates (150 percent of the average yearly price)
Incentive	Certificate system	no	no	Joint Swedish-Norway certificate system under consideration	yes
	Feed in tariff	For tender lowest bid. For open door market premium 0,273 DKK/kWh	no	Predefined feed in over market price, capped	no
	Investment subsidy	RD&D and pilots	On a project basis	RD&D and pilots	RD&D and pilots
	Grid connection cost	TSO	Developer	Developer	Developer
	Tax deduction	no	yes	no	no
Consenting		Single window	Multiple window	Single window	Single window in EEZ
Expected changes		-	-	The new act on offshore energy "Havenergiloven" will introduce a new planning framework.	Support scheme to be revised

Table 3-1 Policy, planning framework and incentives: Denmark, Finland, Norway, and Sweden.

		Ireland	Germany	The Netherlands	UK
Developments	Installed capacity (MW)	25,0	72,0	247,0	1 041,0
	Under construction (MW)	0,0	743,0	0,0	1 455,0
	Consented projects (MW)	1 100,0	8 013,0	3 250,0	2 620,0
Policy	National target	1,6GW by 2020, 2,3GW according to Irish 2010 NREAP	10 GW by 2020, 10GW according to German 2010 NREAP	6GW by 2020, 5,2GW according to Deutsch 2010 NREAP	33GW by 2020, 13GW according to British 2010 NREAP
	Planning framework	tender	open door procedure	tender	tender
	Penalty / fine	no	no	20M€ penalty if project of a winning tender bid not realized	Buy-out price (set at £37.60 for each MWh shortfall – real April 2009), cancellation of lease agreement
Incentive	Certificate system	no	no	no	ROC, increased offshore wind adjustment on the short terms
	Feed in tariff	Predefined feed-in	Predefined feed in, plus bonus on the short term variable with distance to shore	Feed-in over market price based on lowest bid, capped, covering also the cost of the grid connection	no
	Investment subsidy	NA	RD&D and pilots	RD&D and pilots	RD&D and pilots
	Grid connection cost	Developer	TSO	Developer supported by Feed-in	OFTO
	Tax deduction	no	no	yes	yes
Consenting		Multiple window	Single window	Single window	Single window
Expected changes		Results of the SEA and restarts of developments	Prolongation of short term bonus will probably be considered if cost have not decreased		Shift to a feed in tariff model is considered, adjustment to phase support to account for long construction periods

Table 3-2 Policy, planning framework and incentives: Ireland, Germany, The Netherlands, UK

3.1 Year 2020 offshore wind targets

Most attractive countries for offshore wind development such as UK and Germany have defined specific offshore wind national objectives for 2020, some of which associated with intermediary milestones for 2015 and future ambitions for 2030 horizons. UK and Germany have set the highest offshore wind targets in Europe for 2020, respectively to 10GW and 33GW. Other countries such as Netherlands and Ireland have set their targets to more moderate levels, respectively 6GW and 2,3GW. These targets are ambitious in comparison to the maturity of offshore wind technology and the relatively low readiness of the industry to deliver.

Without any specific offshore wind targets for 2020, Scandinavian countries do not provide long-term visibility for market development. Sweden, Finland and Norway have broader targets for renewable energy and wind power based on both onshore and offshore. Denmark has an offshore wind ambition of 4 000MW for 2030[30] but the government has not set further objective by 2020 than the 400 MW additional capacity expected for a recent tender process.

30th June 2010 was the Deadline for EU member states (which excludes Norway) to present National Renewable Energy Action Plans to the European commission. It is the first time ever that the 27 member's states of the European Union join to establish "National Renewable Energy Action Plans" for 2020. Each member state identified its expected capacity in different renewable energy technologies including offshore wind.

Table 3-3 National 2020 target and expected capacity

Country	National 2020 target (MW)	NREAP expected capacity in 2020 (MW)	NREAP expected production in 2020 (GWh)
Denmark	NA	1 339	5 322
Finland	NA	NA	6 000
Ireland	1 600	2 308	7 076
Germany	10 000	10 000 [1]	(37 000)
Norway	(30 TWh/year of both renewable energy production and energy efficiency by 2016 – beyond that of the 2001 level)	NA [2]	NA [2]
Sweden	No real target. (a planning framework of 10 TWh/y offshore wind)	182	500
The Netherlands	6000	5 178	19 036
UK	33 000	12 990	44 120

Source: Multiconsult, European Commission 2010 [31]

[0] Denmark has not formulated any further 2020 targets than the added capacity resulting for the recent 400MW tender.

[1] Reuters, 2010

[2] Not applicable to Norway

Converging governmental rationale for deploying offshore wind

Key considerations for energy policy include security of energy supply; stable and affordable energy prices; carbon reduction and combating climate change; and finally in the case of offshore wind, leveraging at the national level the economic opportunity of a growing global market.

With the declining domestic energy reserves in some European countries, such as the UK and Germany, offshore wind is increasingly viewed as a core component of energy policy.

[30] Government's Energy Action Plan of 1996, Energi21

[31] http://ec.europa.eu/energy/renewables/transparency_platform/action_plan_en.htm

3.2 Planning frameworks

3.2.1 Trends and challenges

Various planning frameworks have been implemented throughout Europe. Each country has its specific framework in place due to different legislations, incentive models, national offshore wind ambitions in volume and timeframe as well as the degree of its governmental engagement.

The reviewed countries process their main offshore wind developments through either competitive tenders (Denmark, UK, the Netherlands) and or open door procedures (Sweden, Norway, Finland, Germany). Some national planning frameworks enables indeed both processes to co-exist so that the development of special projects (ex: Kriegers Flak in Denmark) can be addressed.

3.2.2 Good experience

Supportive government policy is a keys success factor.

Pro-active governmental agenda have been a key success factor to the deploying of offshore wind in Europe.

In Denmark for example, successive terms of social-democratic coalition in the 90s eventually led to the publication of Denmark's Action Plan for Offshore Wind in 1997. It scoped five demonstration projects to be funded by a Public Service Obligation and built by public utilities. After the EU electricity liberalization legislation, two of the five projects, Nysted and Horns Rev, were realized.

In the UK, in contrast, the initial offshore wind drive came from industry, reflecting the liberalized UK electricity industry. Round 1 in 2001 was initiated by developers seeking offshore sites but subsequent government backing has been a key driver for the development of the industry.

The success of some UK Round 1 projects such as North Hoyle and Scroby Sands, and notably the speed of consenting--respectively 6 and 12 months—reflects the benefits of well established and robust consenting regime in place in the UK for electricity projects at that time. This was adapted and applied to offshore wind, demonstrating the value and importance of a robust permitting framework for offshore wind.

Importance of flagship pilot projects

Horns Rev (Denmark), Lillgrund (Sweden), Egmond aan Zee (the Netherlands) and the UK Round 1 Projects, such as North Hoyle and Scroby sands, were effective in demonstrating the viability of offshore wind.

The incremental design of the UK Round 1 projects--small, minimum capacity requirements and close to shore--has delivered viable projects, generating considerable experience and lessons learnt for project developers, contractors, consultants and authorities. Importantly they have provided the confidence in terms of industry engagement but also government engagement. They have also generated the lessons to be learnt and technical understanding, thereby setting the framework of approach for future offshore wind.
The demonstration projects have also created a focus for wider public engagement and support for renewables; for example Middelgrunden, which is one of the most frequent photographically displayed wind farms in Europe.

3.2.3 Negative experience

Inadequate government leadership

The Netherlands has demonstrated how ineffective government policies, shifting financial support schemes and an unstable judicial framework constrain development and increases investment risk. Two Round 1 projects have progressed in Dutch waters: Egmond aan Zee and Princess Amalia, (however, Princess Amalia was developed outside governmental planning and obtained a permit during the project implementation). Such political and regulatory risk threatens industry engagement.

Equally, the Dutch Round 2 programme has been criticised by project developers for an alleged hands-off and slapdash nature,[32] lacking upfront government spatial planning. More than 70 projects were submitted to the Dutch government, forcing a moratorium by government on any new proposals in 2007, while it eventually whittled the list down to 12 realistic contenders. Other countries not covered in this review, such as Spain and France, have experienced long delays in the offshore wind deployment programs due to shifting government policies.

Projects on hold and abandoned.

Less discussed, but still significant from a policy and development framework perspective is cancelled offshore wind projects. In the UK, Round 1 projects Shell Flats and Southport, suffered from strategic planning and consenting hurdles.

As significant are those projects which have not been realized economically, post consent, for example the Cromer and Scarweather Sands Round 1 UK offshore projects, where technical foundation challenges made these projects sub-economic under the relevant subsidy mechanism. Utgrunden II in Sweden as well as Havsul I in Norway remains on hold due to non viable economic conditions despite having received full consent approval.

No penalty fine in tender award.

With the absence of penalty fine defined in the initial tender agreement of Rødsand II, the initial tender winner decided not pursue the project implementation due to changed, non favourable economics of the projects. A new tender had to be processed this time including penalty fine conditions for non completion/delay of up to 400 MDKK.

3.2.4 Lessons learned

Proactive and flexible governmental support is key

Strong and stable regulatory mechanism and development frameworks support the project progression. Robust judicial consenting/permitting regime, targeted for offshore wind infrastructure - to include:

- Simplified judicial framework;
- One-stop permitting procedure;
- Relevant EIA standards and guidelines;
- Durable support mechanisms;
- Establishment of R&D programmes for new technologies.

Pioneering projects such as Horns Rev, Alpha Ventus and Egmond aan Zee point to the importance and need for flexibility by the permitting authority, particularly in the early development stages of offshore wind where initial designs and layouts were established in the absence of empirical evidence relating to environmental impacts.

[32] Kees-Jan Rameau, a board member at Dutch energy utility Eneco

Additionally such flexibility will have to adapt as information becomes available and technology choices expand throughout the development process and maturity of the industry.

Plan for consecutive deployment rounds

National 'rounds' of tendered projects such as in the UK provide a progressive national deployment programme, configured initially with a demonstration round and subsequent rounds structured against national policy requirements. The tender can be designed in order to:

- Filter the large volume of projects through pre-selection/qualification by setting clear criteria. This will prevent the submission of too many consent applications which can saturate the limited resources of public bodies (ref. Germany, Netherlands, UK round 1);
- Evaluate the competency and capability of developers to deliver, technically and financially;
- Avoid developer speculation and insert certain conditions limiting reselling during development;
- Provide exclusivity over development zones to reduce risk profile of the projects and enabled developers to secure necessary capital to finance development phase;
- Commit developers to fully implement the projects through the introduction of penalty fines in case of delays or cancellation.

Introduce anti-speculation and binding clauses in the planning framework.

Introduce in lease option agreements and project consents clauses such as penalty fees or a loss of the concession to ensure a developer cannot hold a claim on a location indefinitely without installing a wind farm.

Facilitate demonstration projects and securing pioneering risks.

Support demonstration projects as an initial step in the deployment of offshore wind developments to:

- Create market dynamic and allow technologies to be tested;
- Incentivize the supply chain industry to trigger necessary investments for later phases;
- Design a first phase towards a larger expansion project, with such projects incorporating and demonstrating R&D and technology innovation.

3.3 Incentive schemes

3.3.1 Trends & challenges

Aside from European and or national green electricity feed requirements, governments have implemented various incentive mechanisms to support projects. The mechanisms vary from country to country in model, support levels, duration of validity of the schemes and applicability for a given project (typically from 10 to 20 years). The main mechanisms applied for offshore wind are:

Certificate-based systems - these electric feed requirements may be implemented through a certificate-based system**.** Rewards are provided to the renewable energy generators in the form of certificates which they can sell onwards to provide additional revenues. These are commonly referred to as TGCs (Tradable Green Certificates), ROCs (Renewable Obligation Certificates) or RPS (Renewable Portfolio Standard). The objective of this type of mechanism is to create competition between renewable generators to meet either defined targets, or receive a certain amount of certificates per MW generated. Such quotas may have a defined maximum cost through a price cap instrument. Variations to these generic conditions do exist and are country-specific. In UK and Sweden where such systems are in place, the revenues from the certificates are added to electricity market value. Although the systems are usually in place for a long time (2037 in UK) the eligibility of projects to this mechanism can be limited to the medium term: maximum 15 years in Sweden.

Feed-In tariffs - Across Europe, these are provided under a variety of names – FIT (Feed-in tariff), REFITs (Renewable Energy Feed-In Tariff Systems), FPOs (Fixed Price Offers) and standard offer contracts. The objective of this type of mechanism is to provide a long term payment to the renewable generators either in the form of a fixed or variable payment, or a combination of both over a set time period. Feed-in tariff are sometimes defined as a premium (Feed-in Premium) to be added to the power market price (Netherlands, Denmark, Norway) and can be capped to a maximum value (Netherlands, Norway).

Feed-in tariffs are either pre defined (Germany, Ireland, Norway, Finland) or the result of competitive tenders where bids for lowest tariffs are submitted by the developers and or negotiated with the government (Denmark, Netherlands).

Investment subsidies - this type of mechanism is aimed at the development and construction phases and can come in the form of grants or government subsidised loans. This mechanism has been used by all countries reviewed in the study to support demonstrator and pilot plants but none of them intend to use it as default support mechanisms for future large scale commercial projects. Investment subsidies have also been granted by the EU to several offshore wind projects in Northern Europe.

An important benefit of investment subsidies to pilot project support is that it permits the authorities to select projects that address development issues that are particularly relevant to domestic conditions (e.g., research on offshore operations in cold climates).

However, both tender feed-in tariff and Investment subsidies alternatives risk creating cycles of 'stop-and-go' with little investment activities taking place between the bidding rounds. These support schemes also tend to mainly favour large companies which are better equipped to deal with the risk of future cost escalations and may for instance present lower costs in a competitive bidding procedure just to win.

Grid connection cost transferred to transmission system operators (TSOs) – In some cases it is the developer's responsibility to finance these grid connection costs (Norway, Finland, Sweden, Ireland, The Netherlands), while other countries place the responsibility for these costs with the onshore TSOs (Denmark, Germany) or Offshore Transmission Operators (OFTO in UK).

Tax exemptions

- Through investment tax incentives – provided to encourage the development and construction phases of offshore wind farms. They provide for income tax deductions or credits on a proportion of the capital investment, thereby reducing the offshore wind developers' taxable income or offsetting taxes due. This support mechanism encourages capital expenditure on offshore wind farm development.
- Through production tax incentives - available once an offshore wind farm has started generating electricity into the grid. These provide income tax deductions or credits for each kWh of electricity actually produced by the offshore wind farm. Production tax incentives are aimed at encouraging more efficient long-term production.

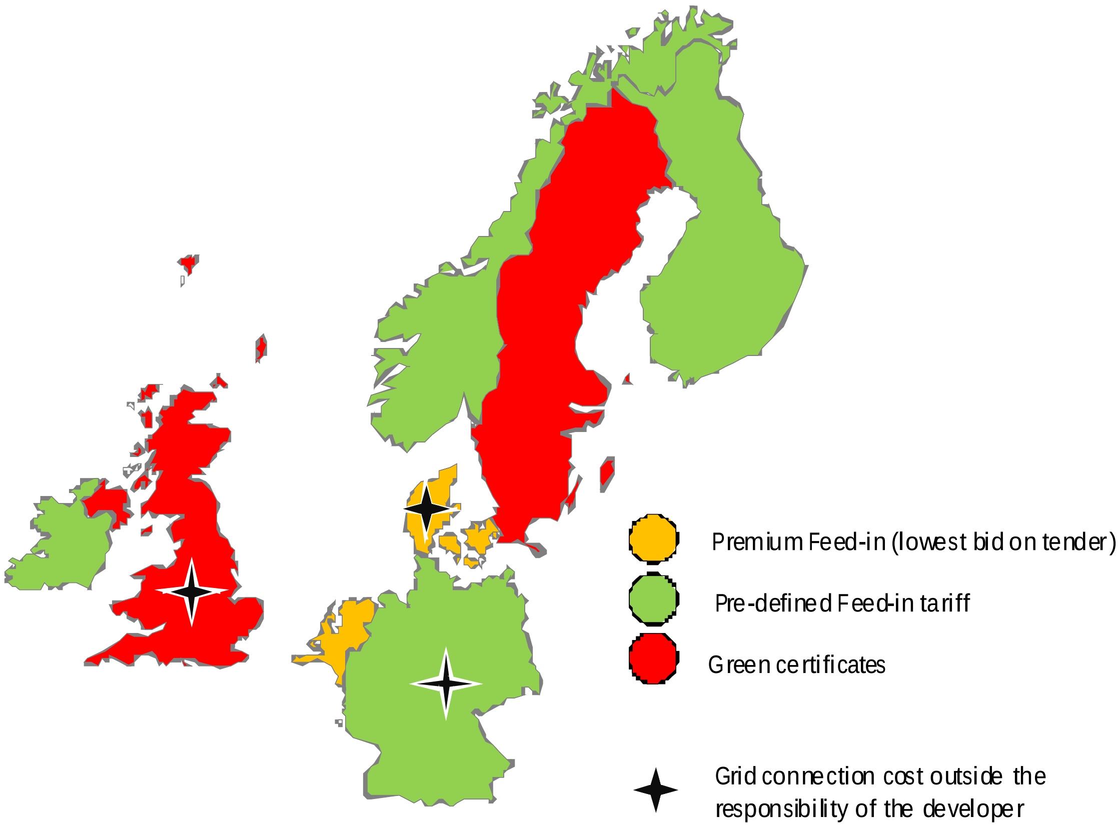


Figure 3-1 Feed-in & Certificates schemes for commercial projects[33]

Different support schemes in Germany, UK and Netherlands allow projects to be successfully implemented[34] . As of today the support levels implemented for commercial projects in Norway, Sweden and Finland does not allow economic viability of projects. Denmark is the only Scandinavian country which enables profitable projects to be implemented through tender process. In spite of Ireland revising support levels, the country faces other regulatory and grid challenges which have stopped all development since the 25MW Arklow Bank offshore wind farm was commissioned in 2004.

Regarding grid connection and transmission cost, Denmark is the only Scandinavian countries which has transferred grid expenditure responsibility to the TSOs. Germany and UK are not applying similar model.

Incentives have also been implemented at European levels and several projects have received support including cross border project Kriegers flak[35].

In addition, most countries have particular incentive schemes in place to support test and pilot projects.

3.3.2 Experience and lessons learned

Need for long-term vision and support schemes.

Pro-active governments have supported the growing industry by internalizing external costs or by providing direct subsidies. Securing investor's confidence in a given market is achieved by enabling long-term financial

[33] Based on National Renewable Energy Action Plans
[34] See comparative table in appendix.
[35] http://europa.eu/rapid/pressReleasesAction.do?reference=MEMO/09/543&format=HTML&aged=0&language=EN&guiLanguage=en

support frameworks. Implement long-term predictable regulatory environment and planning framework attached to specific offshore wind targets and attractive support scheme. The majority of offshore wind farms are now project financed, with the developers having to approach investment banks and private equity to raise the capital. Without long-term vision that lasts for the majority of a project's lifetime, the risk involved is seen to be high.

Design flexible but stable support mechanisms specific to offshore wind.

As seen since 2005, cost variations can manifest themselves quickly, causing project delivery to be postponed. Authorities must be able to quickly adapt to market conditions by enabling appropriate financial support schemes in line with the planning framework. For long-term offshore wind deployment and associated supply chain development it is important that market mechanisms and legislation are stable. Fluctuating levels of support harm investor confidence and can create stop-start industry progression cycles which damages supply chain investment and growth.

The schemes should be attractive on the short term to accelerate market development and be periodically revised.

While grant mechanism stopped for further projects in UK, the profitability of new projects was jeopardized from 2005 due to increasing investment costs. This led UK authorities to reassess the economics of offshore wind and eventually update its support regime in 2007 to a more favourable scheme for offshore wind in the form of 1,5 Renewable obligation Certificates/MWh and in 2009 to 2 ROCs for an interim period.

In Germany, the feed-in tariff was in 2009 increased from 80 to 140 EUR/MWh. According to German regulations, grid connection of offshore wind farms including offshore transmission is at the charge of the local transmission operator. Clustering solutions to optimize costs and delivery are planned to allow synergies between offshore wind farms.

Regular revisions and adjustments are thus necessary, firstly to avoid over-funding, and secondly so that one can react to retarding factors. They must, however, observe certain minimum intervals (ideally every four years), to prevent procrastination and uncertainty on the part of potential investors.

Reduce grid connection cost burden to project owners.

As implemented in Denmark, Germany and now UK Round 3, investigate the possibility of transferring the planning, construction, operation and ownership of grid connections and or offshore transmission to third parties outside the scope of developers and operators in charge of the offshore wind farms.

Public grants for national pilot projects.

Shortly after the start of UK Round 1, a capital grant scheme for offshore wind farms was announced. Consented projects received grants of up to MGBP 10 per project, approximately 10% of project costs. The grant scheme helped the industry collect lessons learnt through compulsory reporting during the first years of operations combined with special case study analysis.

Vattenfall received MSEK 213 in public grants from Energimyndigheten, the Swedish Energy Agency, to support the Lillgrund project. This accounted for 11.2% of CAPEX. As a condition, Vattenfall will document the experiences from the project through reports on economy, technology, environment, communication.

The Egmond aan Zee project in the Netherlands benefitted from three types of support schemes. A MEUR 27 CO2 grant was a key component of the package.

Supporting financially the demonstration of technologies and strengthening the supply chain.

Financial support is essential to trigger cost reduction efforts that will benefit projects on the long run. Depending on design, planning framework and support scheme will benefit national, regional and local economy and industry players. In July 2010, a Budget for developing next-generation offshore wind technology was announced by the Department of Energy and Climate Change. The first round of grants totalling £10 million was awarded to 7 UK companies with the aim to increase the UK supply chain for offshore wind as a £5 million grant for Siemens Windpower to develop a next-generation 6MW offshore turbine with an integrated foundation design in the UK.

3.4 Scandinavian country profiles

Denmark

Renewables national targets & commitment	Offshore wind national targets & commitment	National support scheme*	Development status (MW)
Denmark's long-term goal is total independence from fossil fuels. 30 % of energy consumption from renewable energy sources by 2020. Compared to 17% in 2005.	No long term national targets for offshore wind. Targets are set in the context of tenders: A tender round has just been finalised to award the 400MW Anholt offshore wind farm.	Fixed compensation bonus plus market price for tendered projects. Grid connection paid by the TSO. Tender price for first 50,000 load hours, market price (Nord Pool ~ 0,36 DKK/kWh) after reaching this limit. Tender price: - 0,518 DKK/kWh (Horns Rev II in the North Sea) - 0,629 DKK/kWh (Rodsand II off Lolland) - 1,051 DKK/kWh (Anholt offshore wind farm in the Kattegat off the North East coast of Jutland) For projects under the Open Door Principle compensation is 0,273 DKK/kWh. Delays or non completion can result in a penalty fine for up to 400 M DKK Grid connection is handled by energy.dk	Operating: 871 Construction: 0 Consented: 418 Key upcoming projects: -Kriegers flak (DK side)

Figure 3-2 Denmark profile

Finland

Renewables national targets & commitment	Offshore wind national targets & commitment	National support scheme*	Development status (MW)
The total use of energy in 2020 shall be 38% compared to 28,5% in 2005 New generation capacity of up to 3 GW required to 2020	No specific offshore wind target. The new national wind target is set to 6 TWh of wind power installed by 2020.	Not offshore wind specific. New feed in tariff for wind power from 2010: A guaranteed price of 83.5 €/MWh has been proposed for wind power. The difference between the guaranteed price and spot price of electricity will be collected from the consumers and paid to the producers as a premium. The recently completed 24MW Kemi Ajos project owned by PVO Innopower Oy received a funding of 9,6MEUR from the Finnish government.	Operating: 24 Construction: 0 Consented: 365

Figure 3-3 Finland profile

Norway

Renewables national targets & commitment	Offshore wind national targets & commitment	National support scheme*	Development status (MW)
In spite of the fact that Norway is not an EU member, the RE directive will be also adopted by this country by virtue of the 1994 European Economic Area Agreement. Estimated 70-74% of energy consumption from renewable energy sources by 2020. 30 TWh/y of both renewable energy production and energy efficiency by 2016 – beyond that of the 2001 level.	No specific offshore wind target. A new offshore energy act in 2010 introduces strategy and framework for further offshore wind development. No indication regarding the range of development has been provided.	Not offshore wind specific. Norway has a fixed feed in tariff over electricity market price in place for wind power over a 15 years period but this financial support is lowered if the electricity price is higher than approximately 50 EUR / MWh. Sweden and Norway agreed in September 2009 to establish a common market for green electricity certificates that will start from 1 January, 2012. Offshore wind may not be part of the certificate mechanism.	Operating: 2,3 Construction: 0 Consented: 395 Key upcoming project: -Havsul 1 -Karmøy demo -Kvitsøy -Rennesøy

Figure 3-4 Norway profile

Sweden

Renewables national targets & commitment	Offshore wind national targets & commitment	National support scheme*	Development status (MW)
Sweden's long-term goal is the total independence from fossil fuels. By 2050 the aim is to reduce the greenhouse gas emissions per capita by 40 %. The total use of energy in 2020 shall be 50% compared to 39,8% in 2005 and of the overall energy production shall 25 TWh be renewable. The Swedish Energy Agency proposes that the planning target for wind power for 2020 should be 30 TWh	No specific offshore wind target. Out of the 30TWh planning framework for 2020, it has been indicated that 10 TWh could come from offshore (in water areas)[36]. This would be equivalent to 2854MW assuming a 40% capacity factor.	Not offshore wind specific. Certificate price for 15 years or until the end of 2030, which ever comes earlier. Market price plus certificate price. The current average price is about 32 EUR/MWh. Sweden and Norway agreed in September 2009 to establish a common market for green electricity certificates that will start from 1 January, 2012. Offshore wind may not be part of the certificate mechanism. Alternative trans-national financing mechanisms are also been explored.[37]	Operating: 163 Construction: 0 Consented: 1 851 Key upcoming project: -Kriegers flak (SE side) -Stora Middelgrund - Utgrundee 2 (on hold) - Storgrundet

Figure 3-5 Sweden profile

3.4.1 Norway and Finland

To date, Norway and Finland have not implemented any specific offshore wind strategy and have distinguished onshore and offshore wind from an incentive mechanism point of view. Some investment subsidies have been granted to very few projects now in operation: Hywind in Norway (2,3MW) and Kemi Ajos in Finland (24MW).

3.4.2 Denmark and Sweden

Denmark and Sweden have implemented offshore wind strategies for several years and have started to gather some track record and experiences to be shared. The two illustrations next page summarizes the policy and development record through the 1991 to 2010 period for Denmark and Sweden.

Mentions of lessons learned are included throughout the report. Some of the important observation and take-away's regarding incentive schemes include:

Stop-and-go systems against sustainable growth. The system implemented by Denmark through competitive tender or investment subsidies triggered by Sweden for its initial pilot projects creates cycles of 'stop-and-go' with little investment activities taking place between the bidding rounds or grant allocation.

[36] http://www.energimyndigheten.se/en/About-us/Mission/Wind-power-in-Sweden/Targets-and-regulatory-instruments/Planning-targets/

[37] "*In 2009, deputy prime minister Maud Olofsson [Sweden] indicated that offshore wind could benefit from the provisions in the EU Renewables Directive, which allow countries to meet their targets outside their own borders through "joint projects". This would enable wind farms to be built in Sweden's waters at no cost to Swedish consumers." Windpower Monthly, October 2010*

Incentive level. Both Denmark and Swedish developments have been halted or delayed in the last 5 years due to increased cost of offshore wind. In that context, only Denmark has managed to readjust to appropriate incentive level through a competitive tender process where feed-in tariff was proposed in the context of a specific geographical area. The upfront site screening work performed by the authorities was therefore beneficial to the authorities in order to evaluate competing bids (including price) over a single area. Consented projects in Sweden are on hold waiting for a more beneficial financial position for the projects.

Offshore wind specific incentives. Denmark is the only country with an offshore wind specific incentive scheme and positive current installation rate. Norway, Finland and Sweden all have a common onshore / offshore wind scheme which doesn't take into account of the additional cost of offshore wind and no other project developments than demonstrator or pilot plants supported directly by investment subsidies. Because offshore wind is still immature and its costs remain higher than other alternatives an fluctuates overtime, technology neutral support schemes such as certificate system in Sweden does not enable offshore wind to be profitable without investment subsidies.

Figure 3-6 Evolution over the 1991-2010 of policy and installed capacity in Denmark

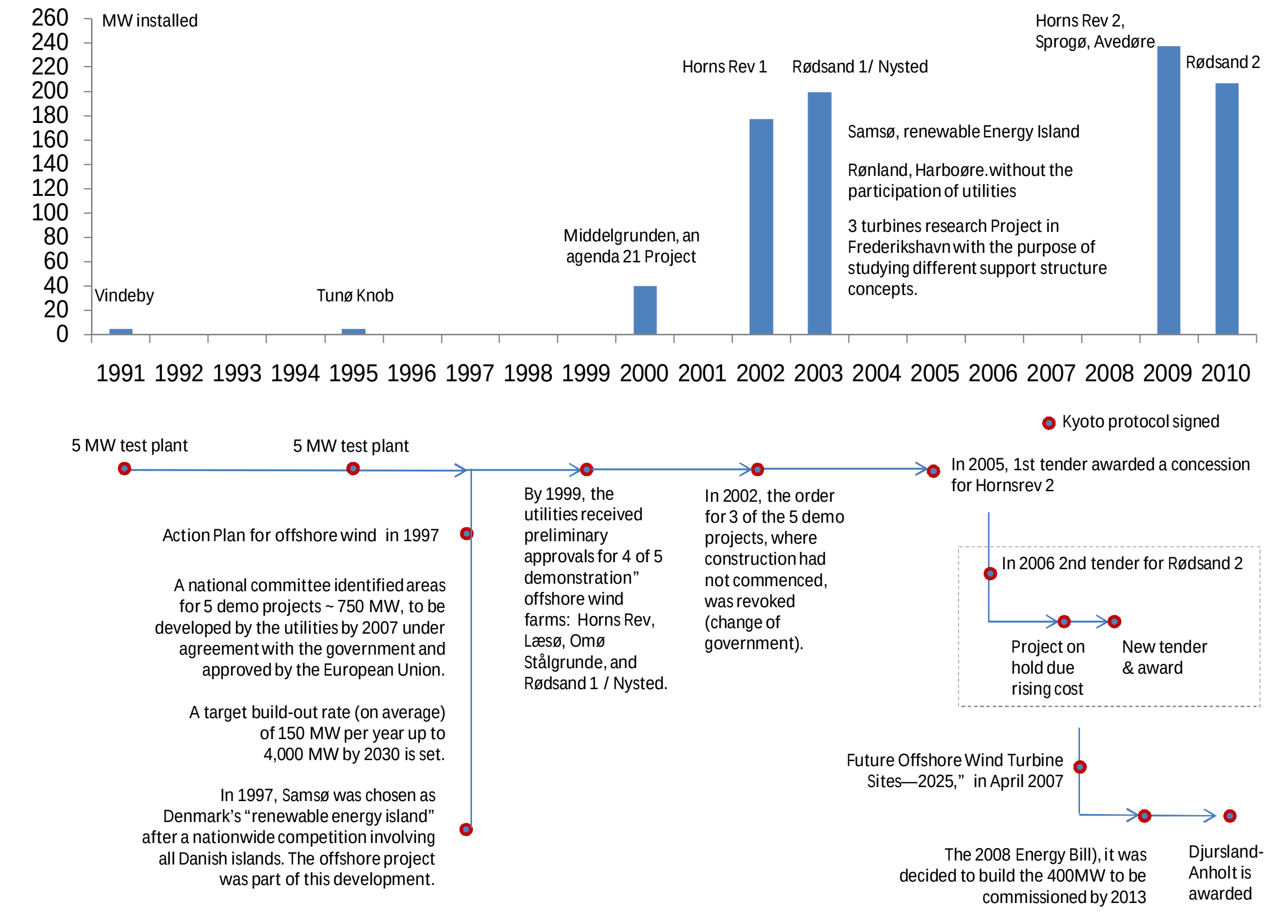
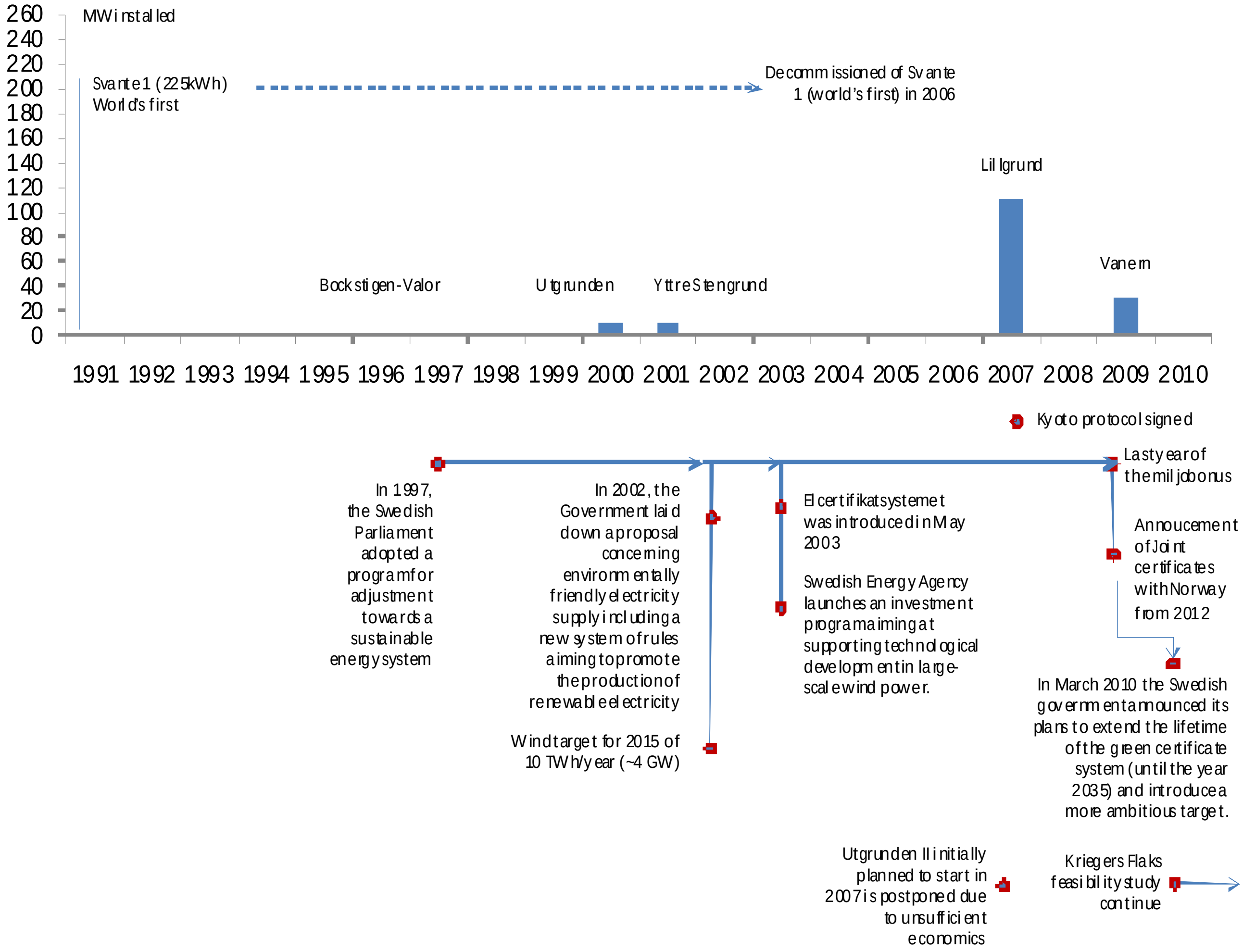


Figure 3-7 Evolution over the 1991-2010 of policy and installed capacity in Sweden



4 Concessions, spatial planning and consenting procedures

Note: This chapter does not cover the procedures related to grid connection permits.

4.1 Trends and challenges

The concessionary awards or 'leases' provide a company with the right to exploit defined natural resources within a specified area of the sea. They are usually administered by the national body retaining ownership of the seabed. In some national markets, this process is closely linked or conditional on the developer obtaining all statutory consents for the project, whereas in others the processes are less closely related.

Long-term planning for future use of the marine environment at a national level helps meeting policy objectives on energy, prevent conflicts of interests between various sites and stakeholders and support a better grid integration of related wind capacity.

In 2001, EU Strategic Environmental Assessment (SEA) legislation introduced the EU-SEA Directive 2001/42/EC[38] mandating SEA processes which will enforce this approach (for EU Member States, excluding Norway).

Denmark and UK have implemented such approach. The Dutch and German governments have sought to develop a more government-led spatial planning system and regulatory procedures overall (see next chapter).

A Strategic Environmental Assessment is now being undertaken in Ireland[39] to evaluate the likely significant environmental effects of implementing the plans to develop offshore renewable (offshore wind, wave and tidal) energy in all Irish waters. In Sweden, priority areas for offshore wind were identified and released by the National Energy Agency in 2009. Norway has initiated this work and preferred zones for the deployment of offshore wind were published in October 2010. Not included in this review, France and Spain have ongoing government-led spatial planning exercises.

Incorporating lessons learned in the consenting framework

Where government support for offshore wind is relatively strong and stable—notably the UK—authorities have worked to improve the development framework. More recently, Germany and the Netherlands have taken steps to improve their frameworks.

Whereas UK Round 1 was developer-led, with Round 2 launched in 2003, the UK government recognized the importance of spatial planning and the need to streamline the consenting framework, creating a 'one-stop-shop' approach as well as providing appropriate guidance to stakeholders and statutory consulters. Projects such as London Array and Gwynt y Môr (not included in this review) have benefited from these regulatory advancements.

Further, for Round 3 initiated in 2008, the Crown Estate, the seabed owner and manager, established a strategic spatial planning process, identifying nine Round 3 Zones in UK Waters, prior to running an extensive tender process to identify credibility and financial robustness.

[38] http://ec.europa.eu/environment/eia/sea-legalcontext.htm
[39] http://www.seai.ie/Renewables/Ocean_Energy/Offshore_Renewable_SEA/

Additionally, the UK Government has implemented a new Infrastructure Planning process (Planning Act 2008 and the establishment of the National Policy Statements and consenting by the Infrastructure Planning Commission)[40] for the permitting of offshore projects, providing improved, more efficient and a timelier consenting regime.

The perceived success of the UK judicial framework is reflected by the adoption by the Dutch government, in preparing its so-called Round 3 offshore wind development programme, utilizing the UK Round 3 framework as the example.

Towards the European harmonization

The development of cross border projects such as Kriegers flak and the initialization of a transnational offshore grid will require further collaboration and harmonization of planning frameworks. EU project such as “wind barriers”[41] and Seanergy 2020 will contribute to formulating and promoting concrete policy recommendations on how to best deal with and remove maritime spatial planning (MSP) policy obstacles to the deployment of offshore renewable power generation.

4.2 Positive experience

Usefulness of Strategic Environmental Assessments and spatial planning

Strategic Environmental Assessment is a critical pre-cursor to robust strategic planning, evidenced by its early adoption by Denmark and the UK. Both Horns Rev 2 and Gunfleet Sands 2 have been identified and progressed following assessments of carrying capacity and environmental impacts associated with an SEA process.

Denmark - Since the launch of the Action Plan for Offshore Wind in 1997, Denmark has implemented a preliminary site investigation and characterisation process ahead of a detailed planning by developers. This process was efficient both in terms of money and time.

UK Round 3 exemplifies the importance and benefits of strategic environmental assessments and pro-active spatial planning – ‘Zonation’. This framework approach, commencing in 2007 with a national Strategic Environmental Assessment, concluded with an extensive marine spatial planning constraint mapping process undertaken by The Crown Estate, with extensive consultation with stakeholders. Earlier, the failure of some UK Round 1 projects (such as Southport and Shell Flats) had demonstrated the importance and significance of a robust siting process, and as noted the UK framework have moved in that direction.

In Germany, the Federal Spatial Planning Act was expanded to German EEZ in 2004, paving the way for the development of a Spatial Plan (Raumordnungsplan) for offshore wind led by permitting agency BSH. The first draft released in 2008 identified five priority areas (Vorranggebiete) for offshore wind energy. Since then, the plan has been subject to several revisions based on industry feedback, which were concerned with the limitations that the initial draft of the plan imposed. In the meantime, BSH has continued to grant numerous project permits.

In the Netherlands the spatial planning for offshore wind for Round 3 is currently in reorganization. The so-called Round 2 in 2005 was a first come-first serve system under the Wet Beheer Rijkswaterstaatwerken (WBR), a law for spatial planning of waterworks at sea. This led to an unexpectedly large number of 70 project initiatives by 9 consortia in 2005, prompting the organizing Ministry of Transport and Waterworks to install a moratorium to stop further initiatives. Finally, at the end of 2009, 12 projects developed by 6 consortia were awarded the right to tender for subsidy in 2010. Two winning bids were awarded financial support in Q2 2010.

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[40] http://infrastructure.independent.gov.uk/

[41] http://www.windbarriers.eu

Neither government nor industry is satisfied with the planning and organization of the Dutch Round 2, and final decisions on how to organize Round 3 have not been made. Current plans are that the Ministry of Transport and Waterworks may reserve 4 large areas of ca. 1000 km2 total for offshore wind. Consortia may then be asked to tender for wind concessions in those areas, together with earmarked financial support. Selection should then be done based upon financial strength of the consortium, their plans and their track record, e.g. as in the UK system.

4.3 Negative experience

Slow progress and low realization rates

Most European projects covered by the study have suffered in one form or another from slow progress in the development process. This is as a consequence of, predominantly, delays in permitting and or environmental assessment, however government support (fiscal) mechanism have also been a contributing factor.

The majority of the UK projects were delayed through significant environmental assessment requirements by the statutory consultees, for example, the requirement for two years of ornithological monitoring.

The slow realization of projects such as Kentish Flats, Burbo Bank, Barrow and too some degree Lynn and Inner Dowsing resulted from consolidation of developers in the early years of offshore wind in the UK, that is, the sale of the projects to developers who had the balance sheet or access to finance to deliver the projects, compounded by the robustness of the support mechanisms required to deliver the investor confidence and thus build the projects.

The key to unlocking investor confidence has been government support policies and mechanisms, namely the Renewable Obligation[42] in the UK, the Dutch SDE ('Stimuleringsregeling duurzame energieproductie')[43] support tariff, and the German EEG ('Erneuerbare-Energien-Gesetz')[44]. These mechanisms have progressively unlocked the economic barriers for offshore wind, with such government policies forming as much a critical component of the policy framework for offshore wind, as are the permitting/consenting regulations.

Avoid processing consenting without an appropriate regulatory framework in place

As seen in the Netherlands, Germany or UK round 1 the level of interest from developers for offshore wind can be very high and the amount of consent applications to be submitted to the authorities can simply be too large to handle efficiently by the authorities. In Netherlands, more than 70 projects were submitted to the Dutch government, forcing a moratorium by government on any new proposals in 2007.

In addition, processing a change of regulations while projects are already in the consenting pipeline can be very difficult to achieve especially when prioritization to certain developers have been introduced earlier through for example "first in first out" mechanisms.

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42 *http://www.ofgem.gov.uk/Sustainability/Environment/RenewablObl/Pages/RenewablObl.aspx*

43 *http://www.ez.nl*

44 *http://www.erneuerbare-energien.de*

4.4 Lessons learned

Setting up the appropriate regulatory framework is critical before initiating any consenting process.

Collect and integrate lesson learned.

Offshore wind is a new technology for many policy makers and public bodies and the industry has not mature yet. Although many learning's are now available, many challenges lies ahead and lessons learned need to be quickly disseminated with the help of policy makers.

Proactive government involvement through upfront work

To reduce uncertainties and accelerate deployment, the governments should undertake some upfront work itself such as environmental and human constraint mapping, site screening and characterisation.

Strategic spatial planning and zonation

This should include Encompassing Strategic Environmental Assessments, government-backed constraint mapping, and environmental data collation and interpretation to pre-select areas suitable for offshore wind energy deployment. These should in turn be based upon findings of Environmental monitoring programs;

Single window consenting procedures

Single window procedures have proved to be more efficient that multiple window processes. As shown in the box below, UK is not putting place a new consent procedures and supporting organisation:

The reform of the consenting process in UK

For UK rounds 1 and 2, the overall process is coordinated by DECC. The previous consenting process applicable to Round 1 and 2 sites requires developers to obtain three consents, one from DECC (Section 36) and two from DEFRA (FEPA and CPA).

From April 2010 Round 3 wind farms above 100 MW are subject to a single new Infrastructure Planning Commission (IPC) consenting process. The IPC will have sole authority to grant the necessary consents.

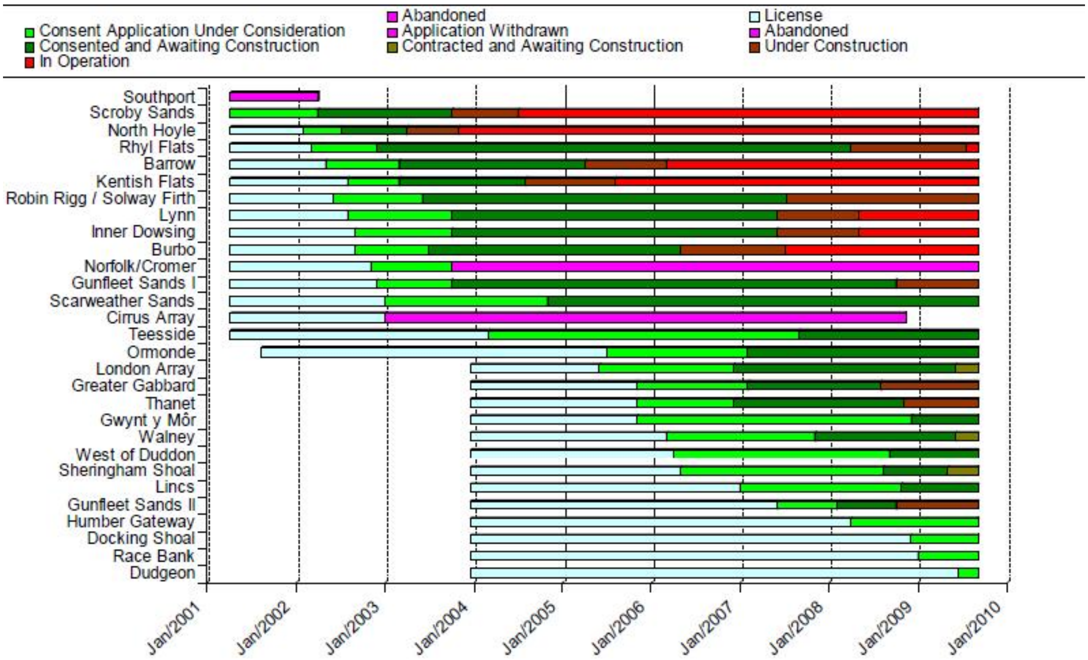
The IPC planning process can be broken down into five key stages:

- Pre-application consultation.
- Application.
- Acceptance of the application by the IPC.
- Examination of the application.
- Decision.

Currently, submissions often do not contain the full information that statutory consultees are looking for which introduces additional delay in the consultation process. The new IPC pre-consultation process is designed to resolve this by asking the consultees to define the information they require up-front, so that this can be included on submission.

Timeframe

The current average lead time for obtaining consent is two years.



Timeline of consenting process for UK round 1 and 2 projects as per Oct 2009 (source: Garrad Hassan, 2009)

The IPC has a target of granting consents of 12 months. To facilitate this, is expected that the IPC will have more authority to enforce deadlines on statutory consultees than DECC currently has.

Issues[1]

- Uncertainty on the consenting process. Awareness and policies continue to develop which lead to uncertainty within the process. In many cases, guidance notes to underpin activity are not yet established. In addition, various processes are yet to be defined; for example, DECC has not announced whether consents will be granted at zone level or individual wind farm.
- Limited statutory consultee resources. Feedback is that there are not enough resources within the statutory bodies to deal with the volume of activity today. Unless addressed, the delays introduced by the process will get worse.

4.5 Denmark

4.5.1 Governmental bodies

The central player for the regulation of offshore wind development in Denmark is the Danish Energy Authority (DEA). All other bodies involved in the consenting process in Denmark follow the procedure administered by the DEA and all communication between the various stakeholders in the process is also channel through this body.

During the consenting process for the Danish offshore wind projects, some contentious conflicts of interest between the various stakeholders have emerged, but they have all been solved in the process.

The Government bodies which have a statutory involvement in the consenting process are Danish Maritime Authority, The Royal Danish Administration of Navigation and Hydrography, Danish Environmental Protection Agency, Municipal and Regional County Councils, Danish Forest and Nature Agency, Cultural Heritage Authority, The Fisheries Inspection.

4.5.2 Spatial planning

The report *Future Offshore Wind Turbine Locations – 2025 published* in April 2007 charts a number of possible offshore areas where offshore turbines could be built to an overall capacity of some 4,600 MW. Offshore wind turbines with a capacity of 4,600 MW could generate approximately 18 TWh. The committee has examined in detail 23 specific possible locations each of 44 square km to an overall area of 1012 square km divided between 7 offshore areas.

Following an agreement in February 2008 between the Government and the Political Opposition regarding the energy policy for 2008-2012 (the 2008 Energy Bill), it was decided to build the two next 200 MW farms in accordance with the plan, with the alternative option of a single 400 MW offshore wind farm. Commissioning would occur by 2013. The grid operator stated very clearly that their preference is for a single project at Anholt. Their recommendations were followed and a tender has just been concluded with a single developer being awarded the exclusive development of the site. Expected commissioning of the Anholt wind farm will be in 2012.

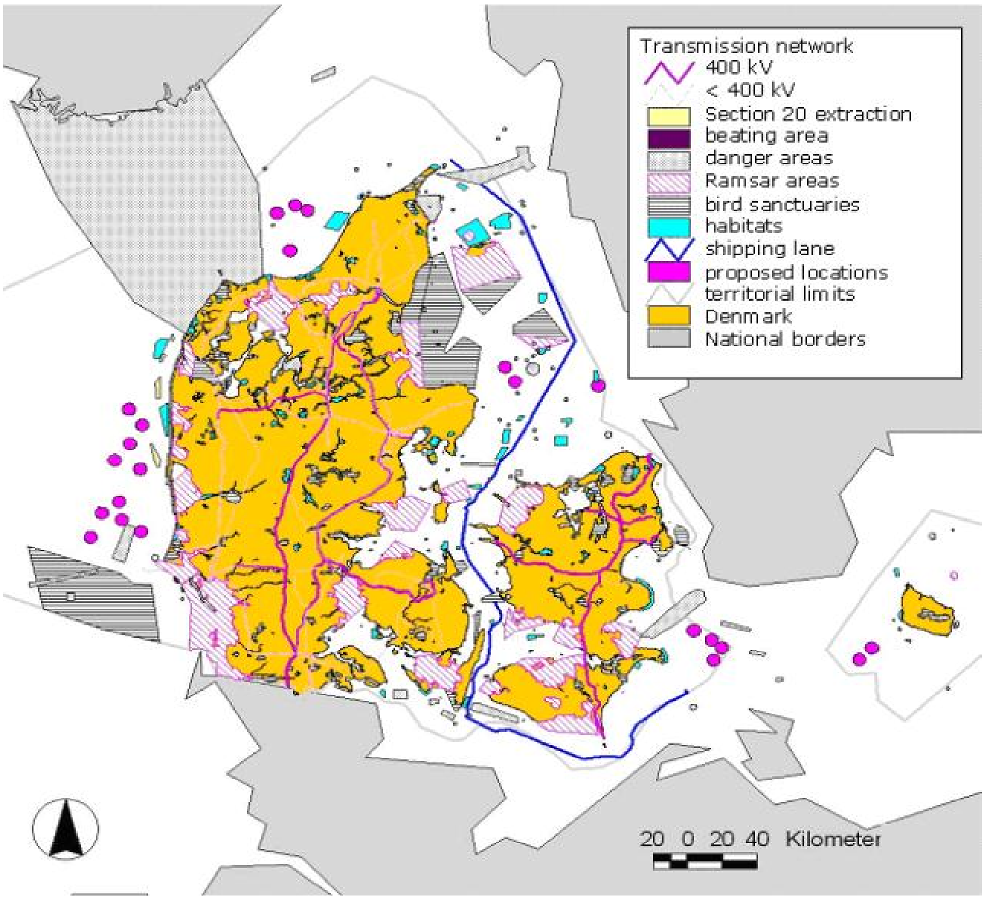


Figure 4-1 Proposed new sites for offshore wind farms

4.5.3 Consenting

License requirements

The establishment of offshore wind turbines can follow two different procedures: a government tender procedure run by the Danish Energy Agency; or an open-door procedure. For both procedures, the project developer must obtain all 3 licenses.

The conditions for offshore farms are laid down in the Promotion of Renewable Energy Act. It provides in its chapter 3 that the right to exploit energy from water and wind within the territorial waters and the exclusive economic zone (up to 200 nautical miles) around Denmark belongs to the Danish State.

In total 3 licences are required to establish an offshore wind project in Denmark. All licences are granted by the Danish Energy Agency, which serves as a "One-stop-shop" for the project developer in relationship to the many, often opposing, interests connected to the establishment of offshore wind power projects:

1. License to carry out preliminary investigations
2. Licence to establish the offshore wind turbines (only given if preliminary investigations show that the project is compatible with the relevant interests at sea)
3. Licence to exploit wind power for a given number of years (typically 25 years), and – in the case of wind farms of more than 25 MW – an approval for electricity production. (given if conditions in licence to establish project are kept)

Consenting process

All permissions are granted by the Danish Energy Authority, which consults all relevant parties in the consent process. The Danish consenting process for offshore wind can in this sense be called the “one-stop-shop” approach, as espoused in the Copenhagen Strategy[45]. The rules are formulated in the Act of Renewable Energy[46]. A one-stop-shop implies that the project developer has a single point of contact within the government for all consenting issues and that this government department is then responsible for communication with all other interested government bodies.

In general, an Environmental Impact Assessment (EIA) is required for any proposed offshore wind project.

The Danish Energy Authority will issue consent in three steps, before an offshore wind farm can be established:

1. A scoping (pre-investigation) permission must be obtained before environmental and technical survey work can start.
2. Permission for constructing the wind farm may be granted after the submission of an application, which delivers the pre-investigation reports.
3. Permission for energy production (typically for a period of 25 years) should be obtained before the wind farm is commissioned. The application must be followed by a documentary report, demonstrating that the stipulated conditions have been complied with. When a project is larger than 25 MW, the operator will need a concession for the production of electricity.

4.5.4 Concessions

The Danish Government has the sole right to utilisation of wind energy within Territorial Waters, in the Contiguous Zone and in the Exclusive Economic Zone. Consent can be awarded to projects on the basis of the Act of Energy Supply[47].

Two ways of applying for establishing a project exist:

1. Applying at the tender issued by the Danish Energy Authority
2. Apply via the “open door principle”

The main differences between the two procedures are that the cable connection to shore from the wind farm in situation 2) has to be carried by the operator and that the revenue is based on the onshore rules. In situation 1) the grid operator will cover the cost to the defined farm grid connection point and the revenue is subjected to negotiation (tender).

Government call for tenders

In the government tender procedure, the Danish Energy Agency announces a tender for an offshore wind turbine project of a specific size, e.g. 400 MW, within a specifically defined geographical area. A government tender is carried out to realize a political decision to establish a new offshore wind farm at the lowest possible cost. 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.

[45] Danish Energy Authority. “Copenhagen Strategy for Offshore Wind.” 2005. http://ens.netboghandel.dk/english/PUBL.asp?page=publ&objno=16267261.

[46] Danish Government. “Promotion of Renewable Energy Act.” Act no. 1392 of 27 December 2008

[47] Danish Government " Act on Electricity Supply ", Act no. 286 of 20 April 2005

The developers only have to deal with one authority in the negotiated tender; the DEA. This one-stop-shop procedure facilitates the developers in their permit acquisition.

Grid connection. In projects covered by a government tender, Energinet.dk owns both the transformer station and the underwater cable that carries the electricity to land from the offshore wind farm.

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. The winning price of the tendered project has generally been higher than the feed-in tariff that is paid for an open-door project, which corresponds to the feed-in tariff for new onshore wind turbines. The compensation price (in DKK per kWh) negotiated between the winner bidder and DEA is to be paid for 20TWh, corresponding to 50 000 load hours of a 400 MW. Support scheme focuses on the expected output in kWh rather than the installed capacity in MW and therefore transfers the uncertainties of wind resources to the developer.

Selection criteria. The technical and financial capacity of the bidding companies or consortia to implement the project is assessed. Only companies with capacity to complete the project can win a tender.

Fine. Based on the experiences of the Rodsand II offshore wind farm, where the winner of the first tender ultimately chose not to implement the project due to changed market conditions (increased cost of offshore wind), the Danish Energy Agency has tightened the conditions in the latest tenders so that the project developer has to pay a fine if the project is not implemented as planned or is delayed[48]. The fine can reach up to DKK 400 million in case the wind farm is not connected before the 31 December 2013.

To speed up the process and minimize the risk for the bidders The Danish Energy Agency has adjusted its previous tendering procedure. This time Danish grid operator Energinet.dk will begin preliminary investigations on the project site ahead of the tender. The preliminary investigations will include an Environmental Impact Assessment and preliminary geophysical/geotechnical surveys of the seabed. This work and the subsequent public hearing were completed and published before the deadline for bids to be submitted on 7 April 2010.

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 licence 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 the 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 September 2008.

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 the implementation of the project. On this basis, the Danish Energy Agency decides whether the area

[48] Tender specifications for Anholt offshore wind farm 30 April 2009, http://www.ens.dk/en-US/supply/Renewable-energy/WindPower/offshore-Wind-power/anholt_tender/Documents/udbudsbetingelser%20Anholt%2030%20april%2009%20ENDELIG%20_m%C3%A5l%20eng_.pdf

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 results of the preliminary investigations show that the suggested project can be approved, the project developer can obtain a licence to establish the project.

Several parks have been built using the possibility opened in the Electricity Reform Agreement of 1999; Middelgrunden for instance, is partly owned by a co-operative. When following this ‘open-door’ procedure, the DEA is allowed to invite others to bid on the project, therefore incorporating competition.

Demonstration projects

Offshore demonstration projects, however, are not subject to tender, but must still be approved by the ENS. The two demonstration parks have offered a wealth of data on the environmental impact of offshore wind farms, as the first large offshore farm Horns Rev is now almost 5 years in operation. An extensive environmental impact assessment of the first two large offshore wind farms has been performed, of which the results are available at the site of Danish Energy Authority.

4.5.5 Case study - Nysted

Nysted Offshore Wind Farm was installed during 2003 and commissioned in December 2003. It consists of 72 wind turbines each of 2.3 MW, corresponding to a total of 165.6 MW installed power.

	1998 0	1999 1	2000 2	2001 3	2002 4	2003 5	2004 6	2005 7	2006 8	2007 9	2008 10	2009 11	2010 12	2011 13	2012 14
Feasibility starts	■														
Notification / Pre-consultation starts		■													
Tender award / Concession / Lease															
EIA / Application sent			■												
Final consent approved				■											
Financial close					■										
Onshore construction starts					■										
Offshore construction starts					■										
Commissioning						■									

Table 4-1 Timeframe Nysted (Denmark)[49]

The project was implemented on schedule and on budget by ENERGI E2 as operator. Ownership is shared between ENERGI E2, DONG and Sydkraft.
In February 2008, the Danish Energy Authority solicited new tenders for the Rødsand II 200MW Offshore Wind Farm south of Lollandwhich shall be connected to the Danish electrical grid by 30 September 2011.

[49] Andersen, Boesen “Environmental issues concerning offshore windfarms”, 2004

Year	Event	Details, Nysted development
February 1998		In February 1998, the Danish Ministry of Environment and Energy instructed I/S Sjællandske Kraftværker, Københavns Belysningsvæsen and An/S Østkraft to construct offshore wind parks in East Denmark, capable of producing up to 450 MW. I/S Elsam and Eltra A.m.b.A. have likewise been instructed to construct similar offshore wind park (300 MW) in West Denmark (at Horns Rev and just south of the island of Læsø).
1999-2000	Site screening	On behalf of I/S Sjællandske Kraftværker, Københavns Belysningsvæsen and An/S Østkraft, SEAS Distribution A.m.b.A. (subsequently called SEAS) has applied for a principal approval for the construction of a demonstration wind park (up to 150 MW) at Rødsand. The National Agency of Environmental Protection approved in June 1999 under several conditions SEAS to conduct preliminary investigations and to plan the future wind park.
July 2000	EIA	
July 2001	Consent approval	
March 2002	Contract award	Beginning with the contract award
June 2002	Construction starts	
end of June 2002	Offshore construction begins	The offshore construction work for foundations commenced.
summer of 2003	Foundation work finished	All foundations were in place and ready for reception of the wind turbines. The first turbine was installed the 9th May 2003
12 July 2003	The first turbine started operation	
12 Sept 2003		The last turbine was installed and connected to the grid on
1 Dec 2003	Final commissioning	Operations start in Jan 2004

Table 4-2 Nysted milestones

4.6 Finland

4.6.1 Governmental bodies

The central player in the regulation of wind development is the ministry of the employment and the economy. Ministry of employment and the economy gives regional policies that make national goals to be reached e.g. wind power plants. Regional policy aims for balanced regional development throughout Finland. Together, the national regional policy and European Union regional policy form a whole which promotes the equitable and independent development of different parts of the country while also supporting less developed areas. Regions are developed with programme based regional policy.

4.6.2 Spatial planning

Wind power parks can only be built in areas that are compatible to regional policies. Regional policies reveal the areas suitable for planned use e.g. area has no special environmental value. Areas suitable for wind power are for example harbours, industrial and storage areas and sea areas that lay far away from the coast line. Also other kind of areas can be taken into consideration.

4.6.3 Consenting

Construction and other developments in Finland are controlled by the Land Use and Building Act. Construction and land use changes are controlled through official plans defined at various levels, including regional land use plans, local master plans and local detailed plans. Shorelines where no developments have yet been planned are generally protected from future construction developments, as stipulated in the Land Use and Building Act. Depending of the location of the planned wind power park environmental permit or permit due from the "Water Act" is needed for the wind park. The water act must be followed and the permit applied in offshore building projects.

At the moment the act on Environmental Impact Assessment does not list wind power parks as projects that needs to undergo an IEA procedure. That's why an enquiry is needed whether an EIA is required for the wind park project. The common practice is that if there are only few turbines and the area has no special environmental value EIA is not needed. In this case tough the environmental permit procedure contains more detailed studies concerning local points of interest.

Nature Protection Act's and Antiquities Act's goal is to protect nature and cultural in heritage and are important to be considered in wind power park projects. Other legislation that should be taken into consideration is e.g. the Aviation Act. The power lines that wind power parks needs are regulated by the Act on the Redemption of Immoveable Property and Special Rights.

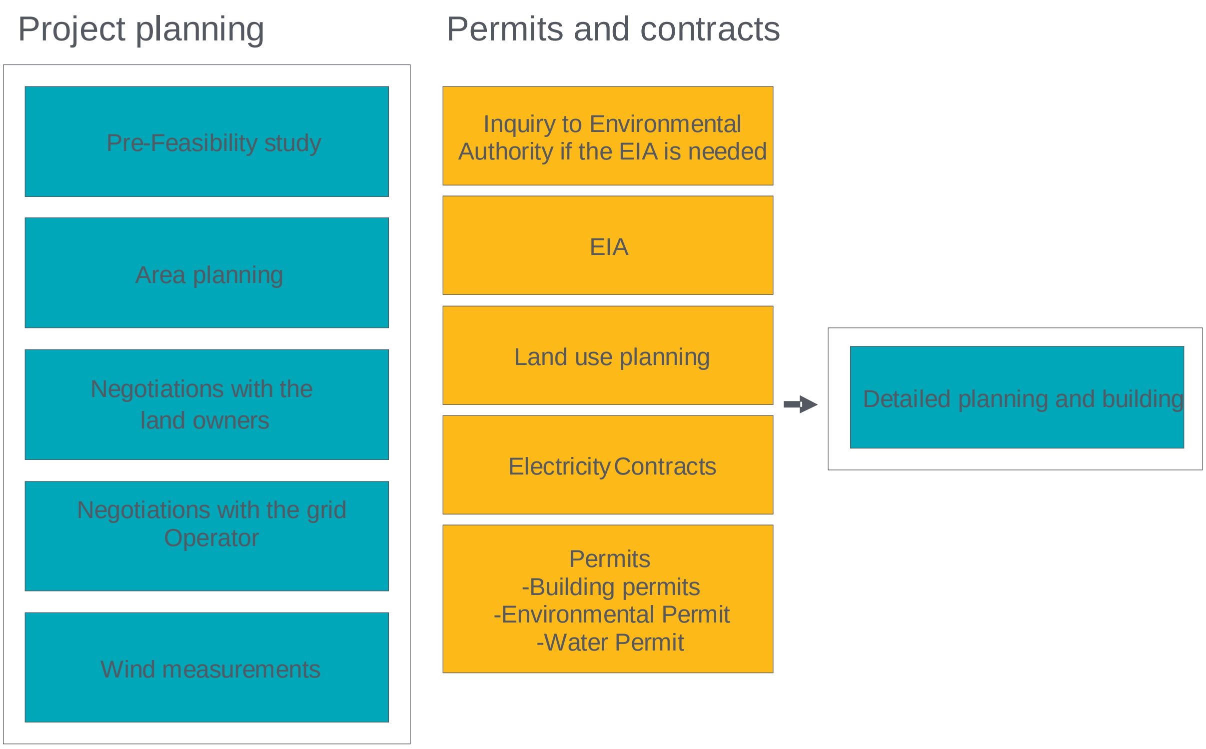


Figure 4-2 Finland consenting process

The project planning studies are normally done, at least partially, at same time as the EIA and land use planning. Land use planning and the EIA are also done at the same time but as separate projects. Building, Environmental or Water permits cannot be granted before EIA is accepted by the local environmental Authority.

4.6.4 Kemi Ajos

The Kemi Ajos project (25MW) is located in the Gulf of Bothnia. 8 turbines are installed in 1-7 m water depth on gravity based structure 2,6km from shore. It is Finland first offshore wind farm. It is owned by PVO-Innopower Oy.

PVO-Innopower plans to expand the existing offshore wind farm in front of Ajos harbour in Kemi from 30 MW to 230 MW. The EIA was completed in December 2009 and the authorities gave their statement in March 2010. The EIA process is expected to be completed during 2010.

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Feasibility starts															
Tender award / Concession/ Lease															
Notification / Pre-consultation starts															
EIA / Application sent															
Final consent approved															
Financial close															
Onshore construction starts															
Offshore construction starts															
Commissioning												1	2		

Table 4-3 Timeframe Kemi Ajos 1&2 (Finland)

Year	Event	Details
2006	Feasibility study / EIA	
Oct 2006	Onshore construction starts	Civil works started
2007	Construction phase 1	
2008	Construction phase 2	
2008-2009	Commissioning & inauguration	

Table 4-4 Kemi Ajos Milestones

4.7 Norway

4.7.1 Governmental bodies

The central player in the regulation of wind development (both onshore and offshore) in Norway is the Water Resources and Energy Directorate (NVE). Other bodies involved in the consenting process include Ministry of Petroleum and Energy; Ministry of the Environment and Ministry of Local Government and Regional Development; Ministry of Labour and Social Inclusion; Ministry of Fisheries and Coastal Affairs; and Ministry of Foreign Affairs.

4.7.2 Spatial planning

In October 2010, a governmental group, hired by NVE, released a report defining areas that might be used for offshore wind power generation[50]. These areas will further be subject to a strategic feasibility study that will be the basis for opening the areas for offshore wind power development.

15 areas has been identified, 11 for bottom fixed and 4 for floating wind turbines. If the maximum anticipated capacity is installed in these areas, it will be a total of 12 GW.

The size of the wind farm will differ from a minimum of 100 MW to a maximum of 2000MW. The size of the wind farm is determined by whether it is floating or not, and distance from shore.

Figure 4-3 Identified areas for offshore wind development in Norway

50 Havvind – Forslag til utredningsområder. NVE, 2010.

The mandate of the governmental group is to assess suitable offshore areas for potential offshore wind power development and provide knowledge of the realistic development potential.

Important issues are:

- Wind resources, water depths, infrastructure and energy marked
- Factors related to the environment, fisheries, maritime transport and other area interests

Strategic environmental assessment (SEA)

An SEA for some selected areas might be carried out in 2011

- The decision regarding a possible opening of areas for licensing will be based on the SEA
- The Regulator will invite tenders for possible licensing

The Ministry of Petroleum and Energy aims at submitting an updated strategy for offshore renewable energy production to the Norwegian Parliament in 2012.

The SEA is using a GIS Decision Support System (DSS) based on a UK model (MaRs) as a decision support system indicating the extent of conflicts of interest.

4.7.3 Consenting (ahead of the new Offshore Energy Act being fully implemented)

Applicable laws

There are four main European Union Directives[51], which affect the development of offshore wind projects. However Norway is exempted.

Under the present system, offshore wind power located within territorial waters is treated in exactly the same way as onshore wind power. Norway is currently introducing new specific set of rules to regulate the development and operation of offshore wind generation plants in EEZ through the recent Offshore Energy Act (Havenergiloven, 2010). Until the full regulation is provided, this chapter below describes the existing relevant legislation and process for offshore wind project consenting.

For the construction of a plant a construction and an operating permit are needed. In general these are given for a period of 25 years. The licensing of wind farms in Norway (both offshore and onshore) is awarded by the Water Resources and Energy Directorate (NVE). Only if an application is rejected or protested against the Ministry of Petroleum and Energy (MoPE) can be asked to analyze the case.

To date, onshore wind energy in Norway has been developed based mainly on two acts:

- The Energy Act 1990 – This law is only applicable to onshore and near-shore wind farms within the 12 nautical miles (territorial waters). According to this law, the licence application must be submitted to the licensing authority: NVE. This applies to all installations of above 25 kW. New transmission lines, built as a consequence of the wind farm, must apply for the same application.
- The Planning and Building Act 1985 - As part of the licence application, an EIA is also required. The EIA is circulated for consultation and made available for public inspection.

[51] *Environmental Impact Assessment* : European Union Directive 85/337/EEC;
Strategic Environmental Assessment Directive : EU Directive 2001/42/EU;
Habitats and Birds Directives: Under the EU Habitats Directive 92/43/EEC and under the EU Birds Directive 79/409/EEC

Four of the relevant legislations in the table below are directly related to environmental legislation and fall under the jurisdiction of the Ministry of the Environment, namely Planning and Building Act; Nature Conservation Act; Pollution Control Act; and Cultural Heritage Act.

Act	Area			Responsible ministry
	Inside the base line (outer coast contour)	Sea territory (out to 12 NM)	Norwegian economic zone (out to 200 NM)	
Energy Act 1990	X			OED
Planning and Building Act	X			MD
Nature Conservation Act	X	X		MD
Pollution Control Act	X	X	X	MD
Working Environment Act	X	X	X	AID
Act relating to the economic zone of Norway		X	X	FKD
Cultural Heritage Act	X	X		MD
Act relating to territorial waters and adjacent areas		X	X	UD
The Harbour Act	X	X	X	FKD
The Pilotage Act	X	X		FKD

Keys OED: Ministry of Petroleum and Energy
MD: Ministry of the Environment
AID: Ministry of Labour and Social Inclusion
FKD: Ministry of Fisheries and Coastal Affairs
UD: Ministry of Foreign Affairs

Figure 4-4 Norwegian legislation applicable to Offshore Wind development

Also worth noting, are a couple of documents (white papers/propositions) - passed by the Government and the Norwegian Parliament - on specific issues affecting the environment in the North Sea, these are:

- Protecting the Riches of the Sea - Document released on March 15th 2002[52], in which the Government intends to establish an integrated plan for management of the Barents Sea; to develop integrated plans for management of waters close to the coast and in the fjords, pursuant to the EU water framework directive; and to introduce a long-term policy, focused on ecosystem-based management of coastal and maritime areas, which is based (inter alia) on environmental quality goals for the ecosystems.

- Management plan for the North Sea - A document released on March 31st 2006[53], in which the Government announced the start-up of *preparations* for a management plan for the North Sea. The preparations shall be finished by 2010. It will be the starting point for a future ecosystem-based management plan for the North Sea. For the Norwegian Sea (North of the North Sea) such a management plan will be ready by 2009. There are many governmental bodies involved and a working group has been created.

52 Ministry of Environment, Report No. 12 to the Storting, http://www.regjeringen.no/en/dep/md/documentsand-publications/Government-propositions-and-reports-/Reports-to-the-Storting-white-papers-2/20012002/Report-No-12-2001-2002-to-the-Storting.html?id=452041

53 Ministry of Environment, Report No. 8 to the Storting http://www.regjeringen.no/en/dep/md/documents-andpublications/Government-propositions-and-reports-/Reports-to-the-Storting-white-papers-2/20052006/Report-No-8-to-the-Storting-20052006.html?id=456957

Consenting process - Current

The consenting process as of today usually lasts for between 2 to 3 years. It is performed through a single window process where NVE acts as a one stop shop.

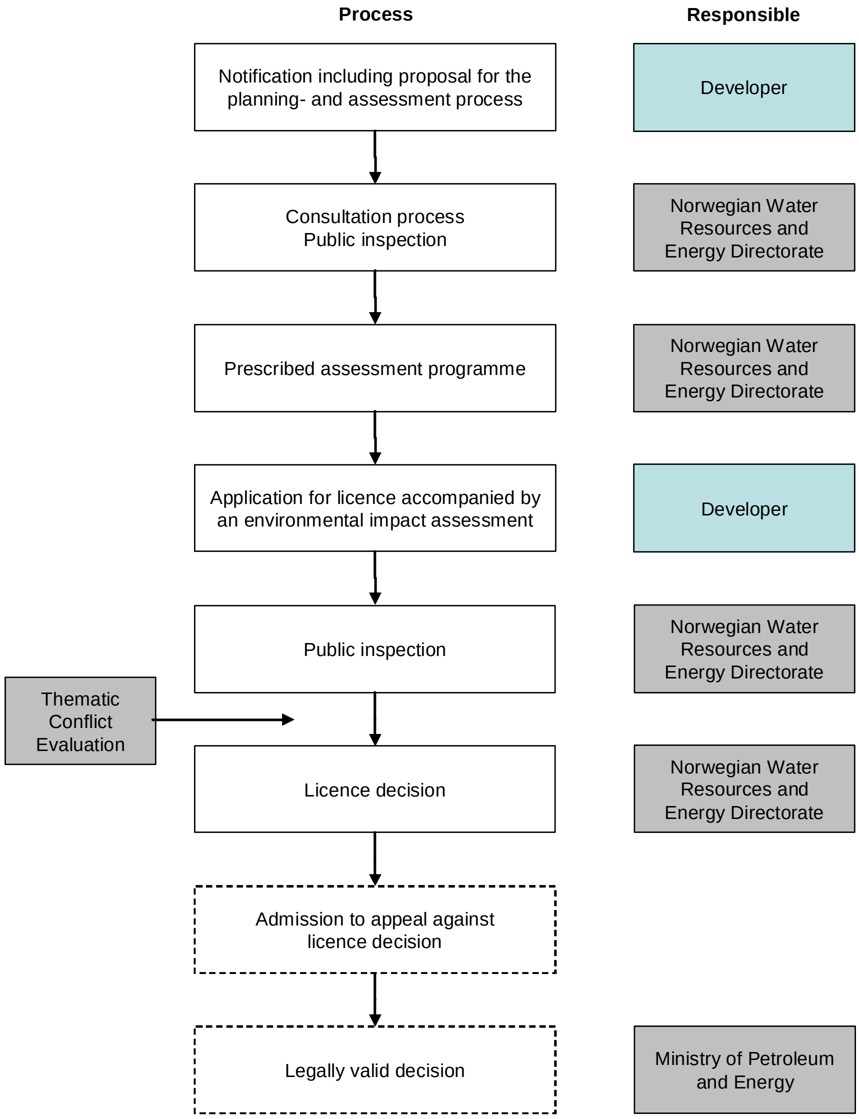


Figure 4-5 Planning process currently in place I Norway

Notification

- Early notification of planned project gives all affected parts information about the project and a chance to express their opinion
- The notification is worked out by the developer, and contains a description of project plans, including alternatives, a general description of the area and a proposed IA (impact assessment, including environmental impacts) program for the project
- The notification is an invitation to all concerned parties to make comments on proposed IA program

Consultation/Public inspection

- Organised by NVE

Evaluation/prescribed assessment program

- Projects larger than 10 MW need to carry out an evaluation program
- On the basis of the proposed program and input from concerned parties, NVE determine the requirements for the evaluation program.

Application and EIA

- After completion of the impact assessment program the developer can prepare a license application for the wind park
- The application should include a detailed description of the project and the results from the IA
- NVE checks that the application and IA reports are in accordance with the guidelines and then the application is sent on a public consultation

License Decision

- Based on the evaluation program, the application and opinions from authorities and public, NVE will make a final decision to grant license or not
- The resolution can be appealed to the Ministry of Petroleum and Energy

Handling of complaints

- Complaints on NVE's resolution are decided by the Ministry of Petroleum and Energy (MoPE) and are to be sent via NVE
- NVE will consider if the complaints contain new information on the basis of the resolution which may change the decision
- If NVE maintains their resolution, then the complaints will be sent on to the Ministry of Petroleum and Energy

The Offshore Energy Act "Havenergiloven" and the reform of the planning framework

A new offshore renewable energy act was approved in March 2010 [54] which will impact the chapter above. Is introduced among others:

- A legal framework based on Norway's long experience of administering hydropower and petroleum resources and electricity and gas infrastructures. "It regulates the planning, construction, operation and removal of facilities for producing renewable energy and for transforming and transmitting electricity at sea.
- Establishes that the right to exploit offshore renewable energy resources rests with the Norwegian state.
- Contains provisions on opening areas for the award of licenses for renewable energy production.
- Establishes the requirement for a licence to build, own and operate facilities for renewable energy production and for transforming and transmitting electricity at sea.

The Ministry of Petroleum and Energy (MoPE) will pre-qualify and open specific areas for development of offshore wind power. It is expected that the MoPE will open offshore wind farm tenders for these areas. Project owners must then apply for license within the pre-defined areas for offshore wind power.

Subsidies for electricity production, related for instance to technology development offshore, are granted from the public agency Enova which manages the Energy Fund.

The MoPE will be authorized to issue fines if the project owner does not fulfil the requirements set in the license, or other provisions following from the Act described above.

[54] OED, Summary in English: Proposition No. 107 (2008–2009) to the Storting Concerning an Act on Offshore Renewable Energy Production (the Offshore Energy Act), http://www.regjeringen.no/pages/2262063/PDFS/OTP200820090107000EN_PDFS.pdf

4.7.4 Norway – Havsul 1

Havsul I (350MW) is the first and only large offshore wind park approved in Norway. The consent for developing Havsul was initially given to the developer company Havgul but was in 2009 sold to Vestavind Offshore. The initial timeline says the project will be online by June 2013, but the developer is still awaiting support mechanisms to be put in place.

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Feasibility starts	■														
Tender award / Concession / Lease															
Notification / Pre-consultation starts			■												
EIA / Application sent					■										
Final consent approved								■							
Financial close															
Onshore construction starts															
Offshore construction starts															
Commissioning															

Table 4-5 Timeframe Havsul (Norway)

Year	Event	Details
2004-2005	Notification	The notification for Havsul I was sent to NVE on 17 December, 2004, and an additional attachment was sent on 18 February, 2005
22 July 2005	Evaluation	The final evaluation program for the Havsul projects was determined.
16 February 2006	Application and EIA	The applications for Havsul I was sent to NVE. The application and EIA for Havsul II comprises of two license applications, one for the wind park and one for connection to the electrical grid
June 2008	Decision	NVE granted Havsul I a license to develop the 350 MW wind park and a new 132kV power line to Nyhavna
June 2009	Vestavind offshore acquires the project	the project is sold to Vestavind Offshore AS, which is owned by 7 utility companies located on the west coast of Norway
September 2009	Final consent	Several parties appealed the NVE's license to Havsul I and the Ministry of Petroleum and Energy declined the appeals and granted Havsul I a final license to develop the 350 MW wind park and a new 132kV power line to Nyhavna
2010	FEED	FEED studies are expected to take place

Table 4-6 Havsul Milestones

4.8 Sweden

4.8.1 Governmental bodies

The Swedish County Administration Board is the supervisory authority for Swedish offshore wind farms, and is therefore a key player also within the environmental permit process. However, the Swedish Environmental Court is making the final decision of environmental permit. The local regulators, the Municipality's, approval is also obligatory for an environmental permit. Furthermore, several sectorial authorities, such as the Swedish Armed Forces, the Swedish Board of Fishery and the Swedish Environmental Protection Agency are important player within the environmental permit process. At the time, the Swedish government is working on the establishment of an Ocean Planning Authority (Havplanerings myndighet). When established, this will have a significant impact on how the planning process for offshore wind is conducted.

To obtain physical control over the water area the Swedish Legal, Financial and Administrative Services Agency, "Kammarkollegiet", has a key role and the Energy Market Inspectorate has an important role for the permit for the grid connection.

4.8.2 Spatial planning

The Swedish Energy Agency has defined areas that are prioritised for wind energy development from central government *(Områden av riksintresse för vindbruk, 2008).*[55]

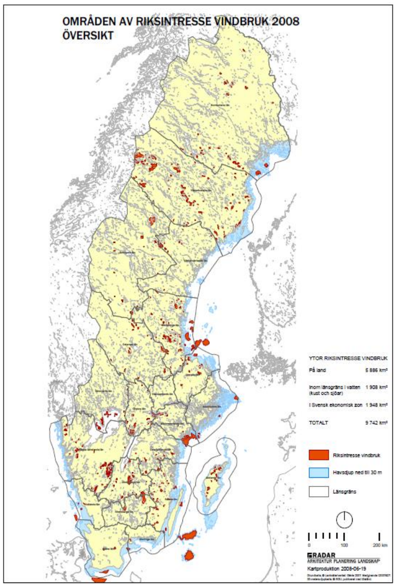


Figure 4-6 Prioritised areas for wind energy in Sweden

4.8.3 Required permits

The graphic below illustrate the necessary permits for an offshore wind power establishment depending on whether it is located within the Swedish territorial sea or the Swedish exclusive economical zone (EEZ).

[55] *http://www.energimyndigheten.se/sv/om-oss/Var-verksamhet/Framjande-av-vindkraft1/Bygga-vindkraftverk-/Riksintresse-vindbruk-/*

Permit according to the Swedish Environmental Code (1)

A wind power establishment within the Swedish territorial sea requires a permit according to the 9th Section of hazardous activities and the 11th section of water activity in the Swedish Environmental Code.

Physical control of the water area

To be able to obtain a permit for water activity according to the 11th Section in the Swedish Environmental Code the Operator must have physical control over the water area, i.e. the right to dispose of the water area where the activity is conducted.

If this is a private water area, the physical control can be obtained through acquisition of a property or through agreement with the owner of the property. If it is public waters,[56] the Swedish State is the owner, and physical control must be obtain through an application to the Swedish Legal, Financial and Administrative Services Agency, “Kammarkollegiet”.

The permit process

The permit process according to the 9th Section MB is normally examined by the County Administration Board and the permit process according to the 11th Section MB is examined by the Swedish Environmental Court. In practice these are merged into one examination which is only examined by the Environmental Court.

The below flow chart gives an overview of the examination process:

1. Consultation
2. Permit application and EIA is submitted to EC
3. EC decides the examination fee
4. EC request complementary information
5. Complementing information from the applicant
6. EC announces the application and send it to relevant authorities for consultation
7. Opinions regarding the application is communicated
8. EC holds the main hearing and inspection
9. EC decides the final permit and dates for possible appeal
10. Permits is announced

The Consultation process (1) includes the Applicant, the County Administration Board, the Local Authority (the Municipality), other concerned authorities (such as the Environmental Protection Agency, the Swedish Board of Fisheries, the Swedish Legal, Financial and Administrative Services Agency etc) and Private concerned parties.

A final permit according to 9th Section MB can only be deployed if the Local authority has approved the project. The approval is made by the Municipal council or other part of the Municipal appointed by the Municipal council.

Detailed planning document (2)

Offshore wind farms that follow the requirements of the Swedish Environmental Code would usually not need a detailed planning document. The exception is if there is competition for the selected area, e.g. for buildings or other structures. In this case, the local authority (Municipality) may require that a detailed plan is drawn up according to the Swedish Building Act. The Municipality is responsible for the planning procedure and for the

[56] The definition between Individual and public waters are set by The Act on boarder to public water area (SFS 1950:594)

planning document but often the developer bears the initial cost to develop the plan to speed up the process. The process demands an EIA including consultation process and exhibition of the plan.

Permit according to the Act of Continental Shelf (3)

Survey of the seabed and deployment of power cables within public water in the Swedish territorial Sea or within the Swedish exclusive economical zone requires a permit according to the Act of Continental Shelf (SFS 1966:314). The permit is applied for at the Swedish Government (at the Swedish Ministry of Enterprise, Energy and Communications). The application shall include an EIA and communication process.

Permit according to the Electricity Act and the Utility Easement Act (4)

A permit according to the Electricity Act is needed for installation and use of electric power current cables. Internal use within a wind farm is normally excluded. The permit process includes an EIA and consultation meetings, but can be coordinated with the Environmental permit process according to MB. The permit is applied by the operator and is applied for at the Energy Markets Inspectorate.

If it is necessary to locate electric power current cables on someone else's property to connect the wind turbines to the common grid, a right to do so could be applied for at the Land Surveying Service according to the Utility Easement Act. An application gives the operator the right to locate the cables on a property without the landowner's consent.

Hydrographic survey, dredging and infringement of protected areas (5)

Specific permits are required if a hydrographic survey, dredging or infringement of protected areas are planned.
A hydrographic survey requires permission from the Swedish armed forced according to the Act of protection of landscape details (SFS 1993:1742). Dredging requires either a notification or a permit according to the 11th Section in MB. If activities are planned inside or nearby protected areas such as Natura2000 areas, natural reserves, national farms, shore protection areas, water protection areas etc a special Dispensation or Permit can be required. This is applied by the operator and is applied for at the County Administration Board.

Permit according to the Cultural Heritage Act (6)

If any cultural heritage is affected by the activity, the developer needs a special permit according to the Cultural Heritage Act. The permit is applied for at the County Administration Board.

Permit according to the Act on the Swedish exclusive economical zone (7)

A permit from the Swedish government is required for construction and commercial use of water areas, such as wind power establishment, within the Swedish exclusive economical zone. The permit application requires an EIA including a consultation process according to MB, but with the Swedish government, or other part appointed by the government, as the permitting instance.

4.8.4 Case study 1 - Lillgrund

Lillgrund is to date the largest offshore wind farm in Swedish waters. The farm comprises 48 Siemens 2,3 MW turbines with a total installed capacity of 110 MW. Together they yearly yield 330 GWh supplying electricity to 60 000 homes. The project was started by Örestads Vindkraftsfarm AB, but commissioned, developed and built by Vattenfall Vindkraft AB. The project has status as a pilot project and is undertaking an extensive environmental monitoring program, of which the results are made public.

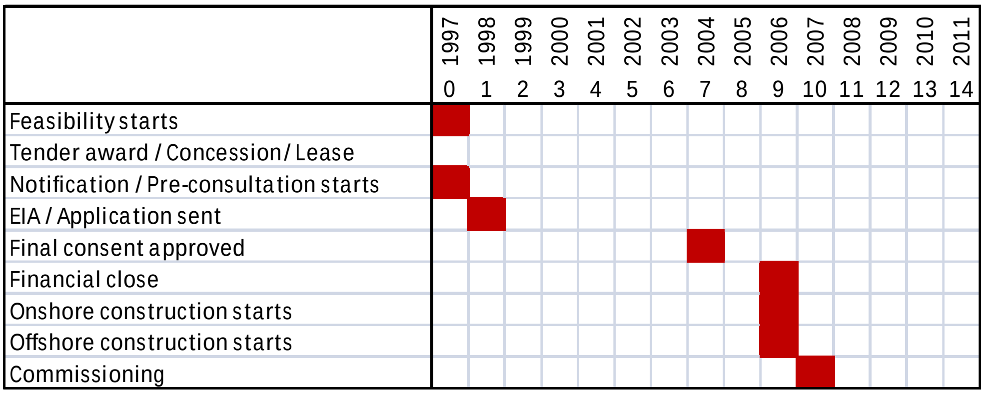


Table 4-7 Timeframe Lillgrund (Sweden)

Year	Event	Details
1997	Preliminary studies.	Preliminary studies was initiated 1997. Detailed studies were performed throughout the whole project.
1997	Physical control of the water area.	A permit from the Swedish Legal, Financial and Administrative Services Agency, “Kammarkollegiet” for physical control of the water area was achieved in 1997. The overall application period took a few months.
July 1998	Permit from the Swedish Government according to former NRL.	ÖVR submitted in July 1998 the permit application according to the former Naturresurslagen (NRL) to the government of Sweden.
March 2001	Project is approved.	Permit was authorized in March 2001. The overall application period took approximately three years.
2001	Detail planning document according to PBL.	In 2001 ÖVR submitted an application for a detail planning process to the Municipal of Malmoe.
Nov 2001	Permit according to MB.	In November 2001 ÖVR applied for a review of the conditions for the permit to the Environmental Court (Växjö district) according to Section 9 and 11 in the Swedish Environmental Act (SFS 1998:808) (MB). The permit process included a consultation process and EIA and took around 8 month from the first consultation meeting to submitted application.
October 2002	Alteration is approved.	ÖVR submitted a request for alteration of the given permit, requesting that no limits regarding the installed capacity should be stated. This alteration was authorized in October 2002.
2002-2003	Hearing, appeals, Final approval (environmental court and Supreme court).	The Environmental Court conducted a hearing 2002, one year after the application was submitted. The decision was given two month after the hearing. The case was appealed twice, first to the Environmental Court that after half a year rejected the complaints, and then to the Supreme Court, which after a few month decided not to review the permit. The decision becomes final in 2003.
2003-2004	Appeal and final clearance (municipality).	In 2003 the Municipal Council accepted the detail plan, but the decision is appealed in three instances by a nearby Municipality. The final decision is dated 2004.
2004	Vattenfall acquisition and design modification.	Vattenfall Vindkraft AB acquired Lillgrund from ÖVR in 2004. Vattenfall requested an increase of the total height (from 105 m to 115 m) of the turbines within the given permits. This was contrary to the Detail planning document, but was considered to be a minor alteration by the County administrative Court. However, this was appealed by a nearby Municipality to the Administrative Court of Appeal, but was rejected.

2006-2007	From start of construction to final commissioning

Table 4-8 Lillgrund Milestones

4.8.5 Case study 2 – Kriegers Flak (Sweden)

Kriegers flak is located in the Baltic Sea and is divided between Germany, Denmark and Sweden. Offshore wind farms are considered in all three countries. The overall offshore wind power potential is estimated to more than 1,5 GW, but so far the planning divides the area into three projects between the three countries (Kriegers flak I: Germany, Kriegers flak II: Sweden and Kriegers flak III: Denmark). This is mainly due to the differences within the planning and legislative areas, but the potential of exploiting the location in an international collaboration project is investigated.

The Swedish project, Kriegers flak II, was started by Sweden Offshore AB (joint venture between WPD Wind Project Development AG and Wind-project GmbH), but is now developed by Vattenfall Vindkraft AB. The project is located within the Swedish Exclusive Economical Zone and received permit from the Swedish Government for an installation of 640 MW in 2006.

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Feasibility starts	■														
Tender award / Concession/ Lease															
Notification / Pre-consultation starts	■														
EIA / Application sent			■												
Final consent approved					■										
Financial close															
Onshore construction starts															
Offshore construction starts															
Commissioning															

Table 4-9 Timeframe Kriegers Flak (Sweden)

Year	Event	Details
2002	Preliminary studies	Preliminary studies was initiated 2002. Detailed studies were performed throughout the whole project.
2002 -2004	Data collection and the consultation (Act of Swedish EEZ)	Data collection and the consultation process within the application was initiated in 2002 and finalized at the end of 2004.
2004	Physical control of the water area for cables (Act on Swedish EEZ)	A permit from the Swedish Legal, Financial and Administrative Services Agency, "Kammarkollegiet" for physical control of the water area for cables in public water, was achieved in 2004. The overall application period was not considered time consuming.
2005	Consultation for the Permit for the grid connection (Act of continental shelf)	The consultation process regarding the grid connection was initiated in 2005
2006	Consent application (Act of continental shelf)	The permit from the Swedish Government was received at 2006.
2006	Permit (Act of continental shelf)	Permit according to the Act of continental shelf was obtained in 2006. The overall application period was not considered time consuming.
2007	Submission of the Permit for the grid connection	An application according to the Swedish Electricity Act was submitted to the Swedish Energy Agency at 2007. The first feedbacks were given in 2009, but no final decision has been made yet.
May 2009	Joint Pre-feasibility of grid connection with DK and DE	Joint Pre-feasibility Study ByEnerginet.dk, Svenska Kraftnät, Vattenfall Europe Transmission
2010	Status in 2010	Germany has already decided to construct the first offshore wind farm at Kriegers Flak. German wind farm size decreasing from 400 to 300 MW Denmark has not yet made a political decision on offshore wind farms at Kriegers Flak. Swedish TSO withdrew/postponed participation, 01/2010. Svenska Kraftnät announced that, for the moment, Sweden will not participate in a common project because the construction of Swedish offshore wind farms at Kriegers Flak is not expected in a foreseeable future. EU envisaging financial funding with 150 Mio. Euro (economic recovery package). EU acknowledges that they will also support a Danish-German solution

Table 4-10 Kriegers Flak milestones

5 Offshore grid connection and transmission

5.1 Introduction

This chapter introduced the key physical components associated with the grid connection and transmission topic. Taking into account of technology and market trends, the implications on grid connection and transmission configurations and requirements in both national and European contexts are presented.

The chapter does not discuss in detail the technical design trends and issues related to the construction and operation phases.

5.2 Key components of grid connection and transmission

An offshore wind development involves the following key electrical components: the turbines, inter array cables, offshore substations, export cable(s), onshore substations, onshore grid.

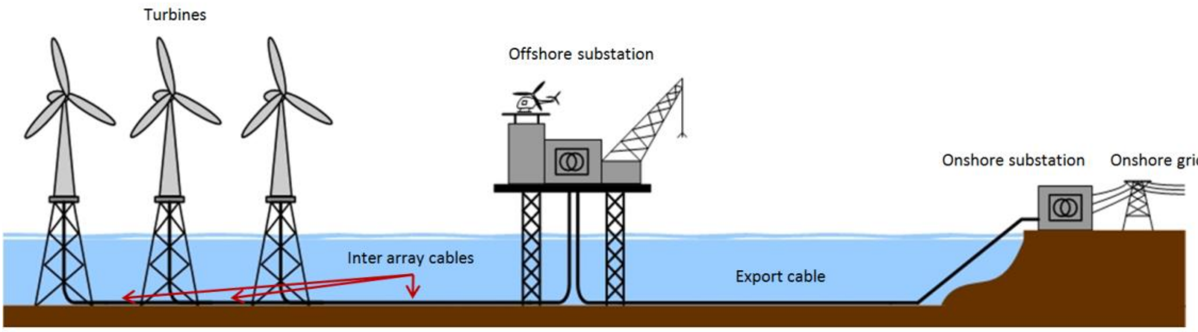


Figure 5-1Typical offshore wind farm configuration[57]

The grid connection and transmission is a critical part of an offshore wind farm and is playing an increasing role in the project's success or failure due to the increasing distance to shore and onshore grid connection and the necessary grid reinforcement to be implemented at both national and internal levels.

Wind turbines

Early offshore installations deployed small (less than 1 MW) wind turbines, which was the typical land based turbine size at the time. Commercial turbines of 5 – 6 MW are now available on the market for incoming projects while the "next generation" of turbines is now being developed reaching up to 10 MW per unit, such as the 10MW SWAY turbine scheduled to be demonstrated onshore in 2012 on the West coast of Norway.

Offshore wind turbines produce electricity at a low voltage level (typically 0,69 kV). They are equipped with step-up transformers generally located within the nacelle to increase the voltage to typically 33-34,5kV.

Inter array cables

Typically no more than two types of cable will be used to connect the wind turbines to each other in an array and to the substation for export. The type of cable used is dependent upon the size of the turbine.

[57] Multiconsult / Troll Wind Power

Offshore substation

In current and future offshore wind farms located beyond the 12 nautical miles limit, offshore substations are used to collect and transform the electricity to a higher voltage before being exported to shore via a high voltage offshore export cable. Offshore substations are equipped with another step-up transformer and protection equipments (circuit breakers, disconnectors) and converters (AC-DC) in case of a HVDC (High Voltage Direct Current) transmission cable.

Figure 5-2 Nysted offshore wind farm offshore substation[58]

Export cable

The step-up transformer will set the voltage to a transmission level (from 132 kV to 400 kV, according the connected power) in order to reduce the loss in the export cable. The size of these cables is dependent on the project's capacity and the amount of power that will be transmitted to the shore, trenching and scour protection technologies are employed to install transmission lines.

High voltage underwater transmission cabling is an important design and contracting consideration during the offshore wind development process. There are few manufacturers of the appropriate cable, and the fabrication and lead time is significant. The specialized installation vessels are relatively rare, costly and in high demand. These factors contribute to an installed cost for underwater transmission of around two to three times more than an equivalent voltage on land transmission.

Greater capacities and distances from shore (beyond 50 kilometres) are factors that make it technically difficult to connect high-voltage three-phase current (Reactive Power) to the mainland grid. Therefore, subsequent phases will probably need to provide for high-voltage direct current (HVDC) transmission to land. However, converting alternating current to direct current at the wind farm and reconverting direct current to alternating current on land is technically more complicated and expensive than using a three-phase current connection.

[58] Nysted Offshore Windfarm. http://www.dongenergy.com/SiteCollectionDocuments/NEW%20Corporate/Nysted/WEB_NYSTED_UK.pdf.

HVDC (High Voltage Direct Current)

Until today, most of the offshore wind farms were connected to the transmission grid through HVAC cables, due to the proximity of these farms to the shore. For far offshore wind farms (typically greater that 80-100 km), HVDC technology reduces the electrical loss and allows a larger transfer of active power for the same capacity size than HVAC cables. In addition, HVDC does not create magnetic fields which reduce the environmental impact, especially on fauna and cost savings can be realized on the substructures and foundations due to lighter and smaller components.

HVDC cables are still under technical development to improve their characteristics for such application. They are developed by different manufacturers using different technologies, so there is a need to make compatible those technologies to be used in the same grid and for the adaptation to different converters.

For the moment, one wind farm cluster is connected with HVDC cables: Borkum 2. This cable is both submarine (120 km) and underground (75 km) to reduce the environmental and visual impact.

Onshore substation

Onshore the transmission cable is connected to another substation, also equipped with protection equipments and convertors (DC-AC) when using HVDC cable.

Connecting several offshore wind farms to a single onshore grid connection point allows economies of scale. North Hoyle has benefited such economies of scale and CAPEX savings associated with the onshore Rhyl substation from North Hoyle’s sister project Rhyl Flats. Both utilize the same grid connection point sharing combined system upgrades.

5.3 Alternative configurations

In earlier projects, offshore wind farms were connected to the onshore grid via a radial connection, i.e. the whole farm is connected directly to a single point onshore though a single (or parallel) cable. This configuration is well adapted when the distance to the onshore grid connection point is short, and when it is only a single farm to be connected. Examples include:

- Middelgrunden: 3 km 30 kV connected directly into substation at power plant onshore, with conversion to 132 kV and 400 kV main grid.
- Egmond aan Zee: Three subsea cables converging before land fall, with an average 15 km connection to existing onshore substation near the beach. Substation was expanded to house the transformer, which converts 34 kV to 150 kV. The substation is connected by a 7-km underground HV cable to the grid.
- Scroby Sands: 19 km export cable including 5 km underground to an onshore substation in Wallasey. The substation steps up the distribution voltage (33 kV) to a transmission voltage (132 kV) and feeds it into the national electricity grid.
- Kentish Flats: The main 10 km, 33 kV export cables come ashore at Hampton Pier, Herne Bay and run 2.5 km inland to an existing substation, with conversion to 132 kV and connection to the National Grid distribution network.

Considering the increasing number of offshore wind farms planned alternative grid connection and transmission configuration have emerged leading up to the idea of a broad international offshore grid.

Such offshore grid concept is increasingly recognized as a success factor for the large and long term deployment of the offshore wind and marine renewable energy industry and is likely to take a key role in the even wider European grid development (see next chapter).

The choice of configuration is based a number of factors including:

- Capacity of individual turbines and the complete wind farm
- Distance to nearest connection point (onshore or offshore)
- Ability of the grid to integrate the additional power
- Connection possibilities with other nearby existing or planned projects
- Alternative cable routes subject to technical, environmental and human constraints

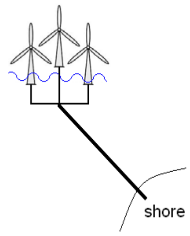
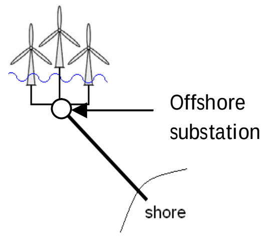
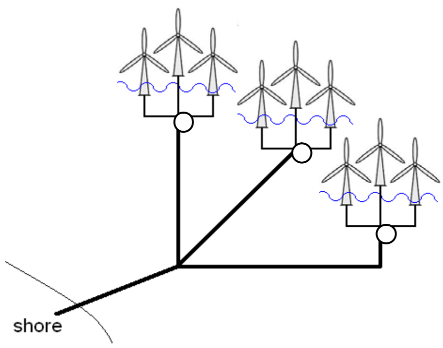
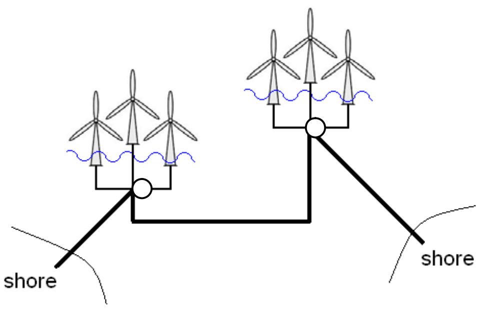
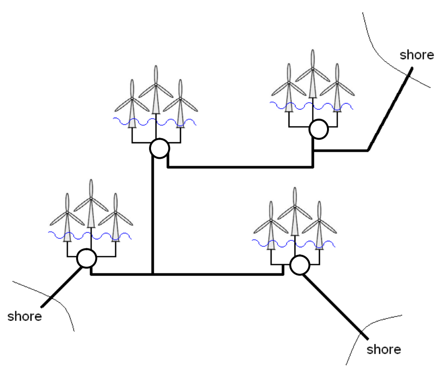
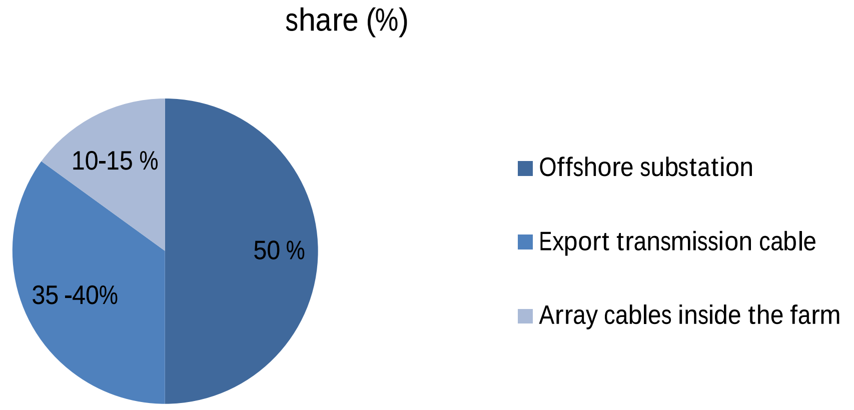
	Configuration	Layout principles	Typical characteristics	Examples
Past	Radial connection no offshore substation		Short distance to onshore grid One or several offshore cables	Many early projects: Middelgrunden (DK) Egmond aan Zee (NE) Scroby Sands(UK) Kentish Flats (UK)
Now	Radial connection with offshore substation		Long distance to onshore grid No other projects or offshore connection points available nearby	Horns Rev (DK) Nysted (DK) Horns Rev II (DK) Barrow (UK) Gunfleet Sands(UK) Robin Rigg (UK) Lillgrund (SE) Princess Amalia (NE) Alpha Ventus (DE)
Near Future	Cluster connection		Long distance to onshore grid Close distance with other projects	BorWin1 (DE) HelWin1(DE) SylWin1(DE) DolWin1(DE) BorWin2(DE) UK round 3 zones
	Hybrid connection		Long distance to onshore grid Close distance with other projects and offshore transmission cables possibilities	Kriegers Flaks project between Denmark and Germany, possibly Sweden
Future	Offshore grid		Long distance to onshore grid Close distance with other projects and offshore transmission cables possibilities Interconnector possibilities	Dogger Bank connection possibility through a UK – Norway interconnector Offshore North Sea supergrid

Table 5-1 Alternatives for grid layout

5.4 Cost of grid connection & transmission

The grid connection represents 15-20% of the overall CAPEX of an offshore wind farms, including the cost for the substation (50%), the export transmission cable (35-40%) and the array cables inside the farm (10-15%)[59]. For the substations, the costs are mainly issued by the electrical equipment (80-85 %).



The cost per MW of the offshore transmission varies particularly with the distance to shore and possible presence of an offshore substation. Data from UK Round 1 and 2 projects demonstrate that distance from shore is the main driver for cost of electrical infrastructure. On average, electrical infrastructure cost per MW will nearly double for project located 10 km from shore compared to projects sited 20 km from shore. Other factors are reported to have relatively minor impact as cost drivers[60].

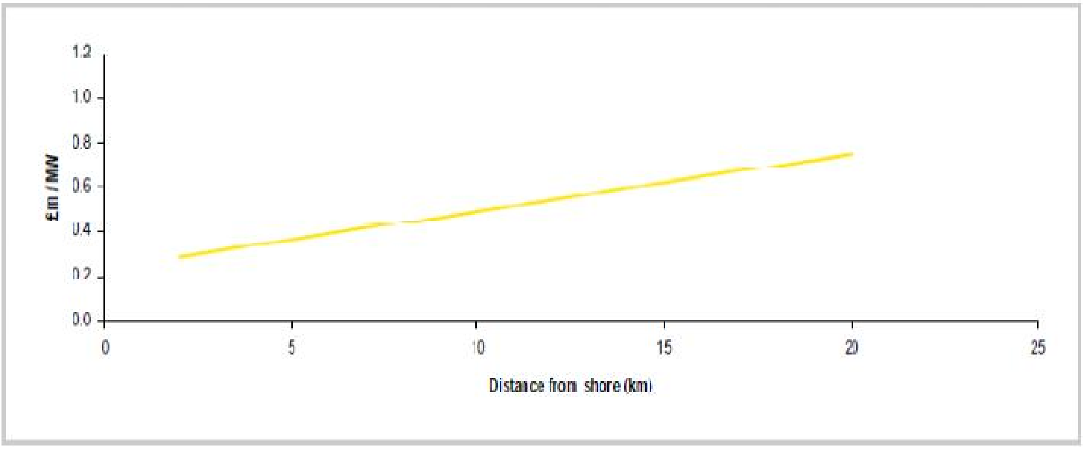


Figure 5-3 Cost of electrical infrastructure is closely related to distance from shore (UK projects)

In 2009, UK authorities tendered the transfer of the offshore transmission (export cable + offshore substation) from developers to the Offshore Transmission Operators (OFTO) for several of UK round 1 and 2 projects. The estimated value for the transmission ranges from 44 to 412 kEUR/MW with an average of about 154 kEUR/MW. As a function of different designs investigated for UK Round 3, the total installed generating capacity connected for round 3 is 25,295MW (with a connection capacity of 22,980MW) with a cost ranging from 344 to 572 kEUR/MW[61].

[59] Douglas Westwood, 2010

[60] Ernst & Young. Cost of and financial support for offshore wind, 2009

[61] assuming 1GBP = 1,2 EUR; The Crown Estate (TCE) , UK round 3 offshore wind farm connection study, 12.2008

5.5 Grid connection framework - Country comparison

	Denmark	Finland	Norway	Sweden	Germany	Ireland	Netherlands	UK
Grid connection supplied by	Grid operator (Danish transmission company Energinet.dk)	Grid operator	Not specified yet	Grid operator	Grid operator (only for OWPs whose construction stared till 2012)	Grid operator, by contract	Grid operator	Tender winner
Grid connection costs	Transmission grid operator in the case of a tender. Wind farm owner under the "open door principle"	Wind farm operator	Not specified yet	Wind farm operator	Grid operator.	Wind farm operator	Wind farm operator	Wind farm operator but Offshore Transmission Operator (OFTOs) have been introduced to own and operate offshore transmission
Connection responsibility	Principle of non discrimination	Principle of non-discrimination	Not specified yet	Plants shall be connected to the grid without certain plants being discriminated against.	Immediate and preferential connection of the plant generating electricity from renewable sources by the grid operators	Principle of non-discrimination	Principle of non-discrimination	Principle of non-discrimination
Infrastructure arrangements	No	No		No	Infrastrukturplanungs beschleunigungsgeset z	Yes, funding		
Grid expansion	Grid operators are obligated to expand the grids with special attention to renewable energy, costs are borne by consumers	Grid operator, if it is for the needs of more than one grid user and if the capacity of the systems to be connected does not exceed 2 MW. Wind farm operator, if it is to his own benefit only.	Not specified yet	Paid by wind farm operator	Financed by grid operator, has to be provided immediately as long the costs are reasonable. The latter is verified by the regulator.	Grid operator	No regulation	Grid usage fees, 27%of which are to be borne by the wind park operators and 73% of which are to be borne by the electricity consumers.
Priority connection	No, but priority for grid use	No	No	No	Yes	No	No	No
Grid extension facilitation	No	No	No	-	Energieleitungsausbau gese tz (law was passed to accelerate the extension of the present high-voltage grid)	Yes, funding	TenneT is planning the construction of an offshore grid and will most probably operate it	Competitive tender process for offshore – only the transmission system operators are responsible for grid extension

Table 5-2 Grid connection framework - Country comparison

5.6 Challenges and implications for future developments

Onshore grid reinforcement to accommodate next generation projects.

For any of the earlier project, major onshore grid reinforcements have indeed not been necessary. For example, to integrate the 165 MW Nysted into the power supply system, an analysis of the regional network was made, taking into account the existing 250 MW of onshore wind farms in Falster and Lolland. The existing 132 kV onshore network needed reinforcement: 2 km of 132 kV submarine cable at Guldborg Sund and 8 km of 132 kV submarine cable at Storstrømmen Sound. The reinforcement of the grid took four years and has been completed.[62]

While minimal upgrades have been needed for earlier projects, UK and German authorities are developing plans to upgrade onshore primary and secondary grids necessary for the capacity in subsequent rounds of offshore wind.

Onshore and offshore grid development should be designed together

The impact of where a project is connected to the onshore transmission system on connection timescales and overall cost has often been underestimated in the past, occasionally leading to unexpected revisions in assumptions on capital costs, additional consenting risk and the potential for sub-optimal overall design. This highlights the impact of the effect on the onshore transmission system as a result of a particular offshore design and the importance of the iterative nature by which the design process must take place in order to find the optimum combination between offshore and onshore assets.

As more effective solutions than simply connecting to the nearest point onshore can be found, the coordination of offshore and onshore design for the connection of offshore wind generation will thus essential following the high level principles presented below, applied for UK round 3 developments.

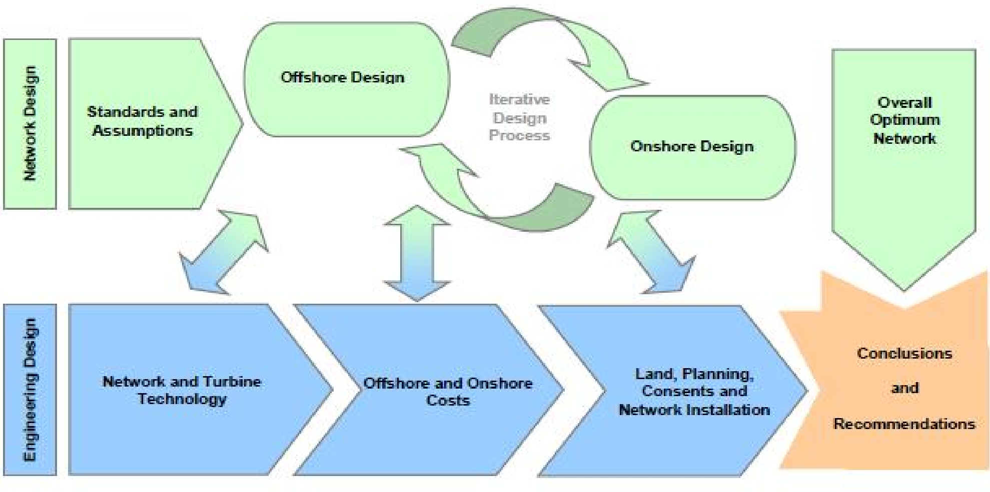


Figure 5-4 Coordination of offshore and onshore design for the connection of offshore wind generation. Source: TCE[63]

Need for cross-national grid developments.

National approaches to offshore grid extensions have prevailed given EU Member States individual renewable targets. In the absence of operational experience, legal aspects, market implications and relevant national

[62] Per Hjelmsted Pedersen. Nysted Offshore – success down to hard work, Wind Kraft Journal, page 8 – 17, 4/2004

[63] The Crown Estate (TCE) , UK round 3 offshore wind farm connection study, 12.2008

considerations, there remains a need to specify the case in favour of a possible North Sea or wider-European offshore grid in all its dimensions: technical, financial, economical and sometimes spatial.

Prioritized access to the grid.

According to Danish legislation, renewable energy has prioritized access to the grid. In practice, this means that wind power has access to grid capacity before all other electricity produced. However, special rules apply to Horns Rev and Nysted since, in the case of grid limitations, their production may be reduced with financial compensation. The system operator, Energinet.dk, has the task of coordinating the prioritized access with general system operation, during which production and consumption are constantly adapted to market conditions.

Grid connection cost covered by grid owner.

Regulations in Denmark and Germany require the grid operator to cover the cost of export cable supply and installation as well as onshore grid connection costs, reducing the investment cost. This has benefits to increase market attractiveness although this represents a additional challenges for the TSOs, especially in the context of cluster development.

The introduction of new technologies and solutions increases uncertainty and risk.

For example:

- Reliability issues of grid connection impacts directly bottom line

In 2007, the offshore transformer at Nysted broke down due to an earth fault. The Tironi-made transformer had to be shipped to ABB at Drammen for repairs, putting wind farm out of production for 4 ½ months.
In 2010, the Thanet offshore wind farm experienced problems with the cables inside the farm and the transmission cable concerning the burial of cables and the J-tubes, which make the interface in the substructure between the cable and the turbine or the substation. This induced delays in the commissioning and extra costs.

- Increased HSE risks

Connecting living quarters to offshore substation implies additional HSE risks. New designs for offshore substations in combination with living quarters are likely to emerge. As noted, Horns Rev 2 is the first project to employ and connect living quarters to the offshore substation. At Nysted, an early decision was necessary as to whether a helicopter deck and sleeping facilities were needed on the transformer station. As boat-based access can be achieved to the platform 80 % of the year, neither facility was provided on the transformer station.

5.7 European transnational offshore grid

5.7.1 Introduction

The development of the European grid.

Over the past hundred years, ever larger power systems developed taking advantage of scaling effects and mutual support of generation and transmission components in case of failure. The outcome nowadays is the high reliability standard the grid offers in Europe to end-users, coping with defaulting system components and, more generally, anticipating relevant risk and proposing mitigation measures.

Despite the ever changing context, drivers for grid development are primarily the same as they used to be for the last several decades, accommodating load and generation development. Changes in the legal and regulatory framework have induced major challenges for TSOs, such as:

- Respond to the EU energy policy, especially market integration and connection large amounts of RES generation often in remote locations, while maintaining a high level of Security of Supply;
- deal with an increased number of uncertainties and a globally complex legal and regulatory context, especially for permitting procedures, stemming from a multitude of different authorities;
- secure the financial means to achieve the expected network developments in due time.

Still, the main concern is the lack of social acceptance that severely delays or jeopardizes the realization of transmission projects.

Although TSOs play a key-role, both as operators and as privileged observers of the system, they are not the only party with a major role in this respect. Meeting EU energy policy targets by 2020 and 2050 and also fulfilling the Article 194[64] of recently ratified Lisbon treaty[65] will demand coordinated efforts from all concerned stakeholders in order to mitigate uncertainties, harmonise the legal and regulatory framework, and enhance social acceptance of transmission assets.

Uncertainty is also a challenge which transmission system planner must address, with the following concerns:

- the inherent uncertainty in predicting the future location of generation and consumption and the limited availability and quality of this information available to TSOs;
- the changes over time in the way electricity is generated (from embedded generation to large offshore wind power clusters, etc.), transported, and consumed (new high speed trains, heat pumps, electric vehicles, etc.);
- the medium and long term impact of separate policies (and also different policy implementation options) such as energy demand reduction and efficiency, renewable energy sources integration, CO_2 emissions reduction, decommissioning of polluting units, etc.

Transnational offshore grid.

The construction of a European offshore grid has become a major topic the last few years. Key drivers for an offshore grid include:

- Integration of renewables - National and European development goals for renewable energy, spatial smoothing of wind power, introduction of flexibility : e.g. reservoir of Norwegian hydropower,
- Security of supply & Transmission adequacy,
- Competition and market – Prices differences push for more commercial interconnectors, Offshore grid improves competition on EU energy market and supports trade.

The offshore wind farm developments in the North Sea and the Baltic Sea contribute to renewable energy goals and security of supply listed above as key drivers for a European offshore grid. Such offshore grid serves the deployment of offshore wind power in Europe:

- Offshore wind projects, including those sited far offshore, can get connected to the European grid,
- The generated electricity can be directly transmitted to the big centres of consumption, such as big cities (in the south east of UK, north of Netherland and Scandinavia) or oil and gas platforms (i.e. in the Ekofisk oil field).
- The European Grid will create a mesh network, where one offshore wind farm cluster will have several connection to the grids, so in case of a contingency on a cable or for maintenance purpose, the

[64] Setting the objectives of European Policy on energy; ensure the functioning of the energy market; ensure security of energy supply in the Union; promote energy efficiency and energy saving and the development of new and renewable forms of energy; and promote the interconnection of energy networks.

[65] Treaty of Lisbon amending the Treaty on European Union and the Treaty establishing the European Community, signed at Lisbon, 13 December 2007 and entered into force on 1 December 2009

production could continue and be exported, instead of being stopped, leading to important loss in exploitation revenues.

5.7.2 Current status and needs for further developments

As of today, there are 11 offshore interconnectors operating in Northern Europe. 9 of these (4,85 GW in total) involved at least one Scandinavian country.

Sweden is involved in 5 of them, Denmark in 3, Norway in 2 and Finland in 2.

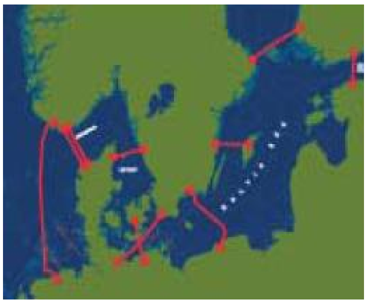


Figure 5-5 Existing offshore interconnectors

Two recent reports identify the existing and future need for further offshore interconnectors as well as describing existing and recommended project pipeline. While the ENTSOE aims at developing a master plan from a European grid perspective, the EWIS EU funded projects particularly aims at integrating wind power into the European grid from both onshore and offshore perspectives.

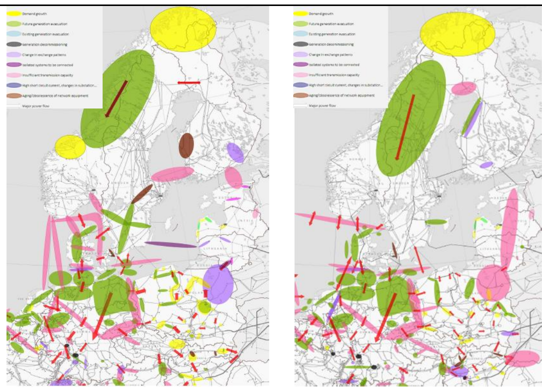
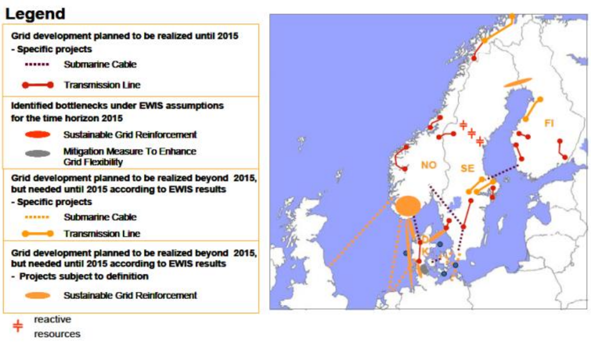
ENTSOE development master plan 2010[66]	The ENTSOE has recently published its identification of all investment needs of pan-European significance for the next 10-20 years	 mid and long term investment needs in the regional group Baltic sea
EWIS[67]	The EWIS EU funded project has identified bottlenecks and needs for further development in the 2015 horizon.	 Nordic grid development 2015

Table 5-3 Reports identifying existing and future need for offshore interconnectors

[66] ENTSOE , TEN-YEAR NETWORK DEVELOPMENT PLAN 2010-2020, June 2010

[67] http://www.wind-integration.eu/downloads/library/EWIS_Final_Report.pdf

5.7.3 Offshore grid project pipeline in Scandinavia

Several offshore point-to-point interconnections between countries are already in place and many other are planned. For that reason, many players in the industry believe that a future offshore grid will consist in a hybrid system: a combination of point-to-point connections and a meshed grid.

In its recent master plan ENTSOE has identified 9 planned offshore grid projects (see table below) involving either Sweden, Norway, Finland or Denmark. As designed and planned so far, none of these are directly related to the connection of offshore wind farms or clusters.

The EWEA in a recent report[68] describing its 20 year offshore network development master plan for the North and Baltic Seas recommends that some of these offshore grid projects should be planned in order to connect directly to offshore wind projects and or clusters. Some of the projects include Kriegers Flak linking Sweden to Denmark and Germany, NorGer Linking Norway and Germany, Nord Link linking Norway and Germany, Norway/UK linking.

[68] EWEA, Ocean of Opportunity / Offshore report, 2009

Substation 1	Substation 2	Project characteristics	Investment need alleviated	Expected benefits	Progress status	Online
Ishøj/Bjæverskov (DK)	Bentwisch (DE)	The Kriegers Flak project is the new subsea cable multiterminal connection between Denmark, Sweden and Germany used for both grid connection of offshore wind farms Kriegers Flak and interconnection. Technical features still have to be determined.	The project will alleviate mainly the need of 1) grid connection for new off-shore wind farms in the Baltic Sea and 2) additional cross-border transmission capacity of the grid.	RES integration and increase of NTC.	under consideration	2014
Tonstad (NO)	tbd (DE)	Nord.Link: A new HVDC connection between Southern Norway and Northern Germany. Estimated subsea cable length: 520 - 600km. Capacity: 700 - 1400MW.	Connecting isolated systems (currently no connection between Germany and Norway).	Increase of NTC (700 - 1400MW), diversity of supply and RES integration.	design & permitting	long term
Klaipeda (LT)	Nybro (SE)	(NordBalt) A new 300kV HVDC VSC partly subsea and partly underground cable between Lithuania and Sweden. (440km).	Connection between Lithuania and Sweden. 440km long.	Improved the market integration Nordic Baltic. Currently is no connection between LT and Sweden.	design & permitting	2015/2016
Västervik (SE)	Gotland (SE)	New AC or DC subsea cable interconnection 400kV (1000 MW).	Integration of new renewable power generation.	RES integration.	under consideration	2016/2020
Kvilldal (NO)	UK (substation to be determined)	A new 1400MW HVDC bipolar installation connecting Western Norway and the UK via 800km subsea cable; DC voltage is to be determined.	Currently there is no connection between UK and Norway.	1400MW increase of NTC; RES integration; diversity of supply: connection between a hydro and a thermal power system.	under consideration	2017/2020
Feda (NO)	to be determined (NL)	NorNed 2: a 2nd HVDC connection between Norway and The Netherlands via 570km 450kV DC subsea cable with 700 - 1400MW capacity.	Need to increase the current transfer capacity between both countries.	700-1400MW increase of NTC; RES integration; diversity of supply: connection between a hydro and a thermal power system.	under consideration	2015/2017
Kristiansand (DK)	Tjele (NO)	Skagerak 4: 4th HVDC connection between Southern Norway and Western Denmark, built in parallel with the existing 3 HVDC cables; new 700MW including 230km 500kV DC subsea cable.	Need to increase the current transfer capacity between both countries.	700 MW increase of NTC ; Diversity of supply: connection between a hydro and a thermal power system. Enabling increased RES integration.	design & permitting	2014
Endrup (DK)	Eemshaven (NL)	COBRA: New single circuit HVDC connection between Jutland and the Netherlands via 350km subsea cable; the DC voltage will be up to 450kVand the capacity 600-700MW.	Need to increase the current transfer capacity between both countries.	Increase of NTC ; improved security of supply; RES integration ; 600-700MW ; The purpose of the link is to allow for the exchange and integration of wind energy and increase the value of renewable energy into the Dutch and Danish power systems and to increase security of supply.	design & permitting	2016
Fraugde (DK)	Herslev(DK)	New single circuit HVDC-LCC installation including a 56km 450kV DC subsea cable with 600MW capacity.	Need for interconnection between Eastern and Western Denmark to exchange wind power & regulation power.	Improved security of supply; RES integration.	under construction	2010

Table 5-4 Project pipeline of offshore transmission projects involving Scandinavian countries according to ENTSOE [69]

[69] ENTSO-E, 2010

5.7.4 Case study on Kriegers Flak' offshore grid.

The building of Kriegers Flak is recognized as the possible first step offshore grid could be implemented. Located in the Baltic Sea, the 1,6 GW Kriegers Flak project could be the first step of the European Offshore Grid, involving 3 Transmission System Operators: Vattenfall (Germany), Energinet.dk (Denmark) and Svenska Kraftnätt (Sweden). Key critical features include:

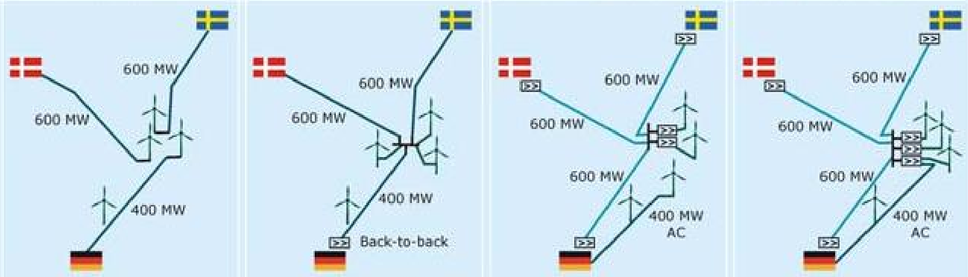
- two market systems,
- two synchronous zones,
- Interconnection between 3 transmission grids,
- Location outside the 12 Nautical mile limit,

Feasibility of the Kriegers Flaks' offshore grid.

In February 2010, the transmission system operators Energinet.dk (Denmark), 50Hertz Transmission (Germany) and Svenska Kraftnät (Sweden) published a feasibility study for grid solutions of a project at Kriegers Flak[70]. According to the main conclusion,

- combining the connection of future Danish, German and Swedish offshore wind farms at Kriegers Flak in the Baltic Sea with a common offshore power grid for cross- border trade in electricity will prove most attractive from a technical and economic perspective;
- the costs at present value of establishing separate grid connections (the reference project) are estimated at about EUR 1 billion for investments and operation, whereas the additional costs of a combined grid solution vary from some EUR 400 million to some 600 million depending on the solution chosen;
- The socio-economic value of a combined grid solution is expected to be considerably higher than the additional costs

[70] Energinet.dk Svenska Kraftnät Vattenfall Europe Transmission, An Analysis of Offshore Grid Connection at Kriegers Flak in the Baltic Sea Joint Pre-feasibility Study, May 2009



	(A) Separate, national grid connection of wind power plants	(B) Combined solution based on AC technology	(C) Multi-terminal, VSC-based HVDC solution (without Kriegers Flak 1)	(D) Hybrid solution combing (C) and AC-connection for Kriegers Flak 1
Concept				
Type of solution	Separate	Combined	Combined	Combined
Max. power exchange capacity: Nordel-UCTE	0	400 MW	600 MW	1000 MW
Additional cost of construction for a combined solution*	-	+ 130 M€	+ 245 M€	+ 300 M€
Costs for internal reinforcements, maintenance and losses	Not included			
Total Investment*	> 500 M€	> 630 M€	> 745 M€	> 800 M€
Socio-economic benefit from increased day-ahead trading**	-	38 M€/y	72 M€/y	95 M€/y

** Costs for platforms are not included*
*** This is a potential benefit - calculated under the assumption that German legislation does not limit day-ahead trading*

Figure 5-6 Diagram showing four technical concepts for grid connection of the Kriegers Flak offshore wind power plants. Separate connections (A), AC-based solution (B), multiterminal HVDC solution (C), and a hybrid solution combining multi-terminal HVDC with AC (D

Timeframe.

According to Peter Jørgensen, vice President of Energinet.dk, if a decision is made to establish a combined grid solution, it will take 2-3 years to obtain all approvals from the authorities, after which it will take about 4 years to construct the connections. So a project at Kriegers Flak will not be ready for commissioning until 2016 at the earliest.

Latest developments on reaching an international agreement:

- Germany has already decided to construct the first offshore wind farm at Kriegers Flak. German wind farm size decreasing from 400 to 300 MW
- Denmark has not yet made a political decision on offshore wind farms at Kriegers Flak.
- Swedish TSO withdrew/postponed participation, 01/2010. Svenska Kraftnät announced that, for the moment, Sweden will not participate in a common project because the construction of Swedish offshore wind farms at Kriegers Flak is not expected in a foreseeable future.
- EU envisaging financial funding with 150 Mio. Euro (economic recovery package). EU acknowledges that they will also support a Danish-German solution

5.7.5 Offshore grid clusters outside Scandinavia

Outside Scandinavia, several offshore grid planned projects are directly related to offshore wind clusters, especially in UK in connection to round 3 developments and the North Sea area of Germany (see table below).

Substation 1	Substation 2	Description	Capacity (MW)	Length (km)
Cluster BorWin1 (DE)	Diele (DE)	New line consisting of underground +subsea cable.	400	205
Cluster HelWin1 (DE)	Büttel (DE)	New line consisting of underground +subsea cable. This Project includes also a new substation Büttel and connection of this new substation with the existing OHL Brünsbüttel - Wilster.	860	145
Cluster SylWin1 (DE)	Büttel (DE)	New line consisting of underground +subsea cable.	690	210
Cluster DolWin1 (DE)	Dörpen/West (DE)	New line consisting of underground +subsea cable.	400	155
Cluster BorWin2 (DE)	Diele (DE)	New line consisting of underground +subsea cable.	400-800	205

Table 5-5 Current German offshore grid cluster developments

5.7.6 Future developments of the offshore transnational grid

Offshore grid studies.

A large number of studies (see complete list in appendix) are being carried out to propose blueprints of European Offshore Grids. All of them intend to interconnect UK, Scandinavia and Germany, together with offshore wind farm clusters in the North and Baltic Seas.

TEN-E programme.

In November 2008, the European Commission published a Green Paper "Towards a secure, sustainable and competitive European energy network"[71] to launch the revision of the TEN-E programme. ENTSO-E's TYNDP and the National Renewable Energy Action Plans should contribute to the ongoing work which will lead to the proposal for a new infrastructure instrument by the end of 2010.

The North Seas Countries Offshore Grid Initiative.

In 7 December 2009, the "Political declaration on the North Seas Countries Offshore Grid Initiative"[72] was signed by the Ministers of the North Seas Countries: Belgium, Denmark, France, Germany, Ireland, Luxembourg, the Netherlands, Sweden and the United Kingdom. Its objectives are:

- "To identify national ambitions for offshore renewable energy sources, shortcomings in present and future cross border grid infrastructure developments and national policies on relevant issues which have impacts on the sustainable development of an offshore North Seas grid (incl. maritime physical planning for offshore wind, site selection, grid configurations),
- To facilitate a coordinated electricity infrastructure development, both offshore and the necessary onshore connections, in view of the large amounts of wind power planned,
- To achieve a compatible political and regulatory basis for long term offshore infrastructure developments within the North Seas region,
- To foster a joint commitment of all relevant stakeholders to tackle all technical, market, regulatory and policy barriers, and,

[71] COM(2008)782 (http://ec.europa.eu/energy/strategies/consultations/2009_03_31_gp_energy_en.htm)

[72] http://www.ewea.org/fileadmin/ewea_documents/documents/policy/Offshore_Wind/Political_declaration_on_the_North_Seas_Countries_Offshore_Grid_Initiative.pdf

- To organize a workshop with relevant stakeholders, at the beginning of 2010 to prepare a strategic working plan aiming at coordinating the offshore wind and infrastructure developments in the North Seas and listing the potential actions, studies and issues to be tackled by the North Seas Countries' Offshore Grid Initiative. "

The ministries also convene a High Level meeting of the relevant stakeholders of the Region during the second half of 2010 in order to agree on a strategic working plan by means of a Memorandum of Understanding of the North Seas Offshore Grid Initiative.

5.7.7 Challenges and implications for future developments

The table below highlights some of the key challenges associated with the development of the European offshore grid. We explore in the next chapter some of the key issues.

Category	Challenges
Technical	Onshore bottlenecks Technology O&M
Market	Cost of technology Planning uncertainties Risk & Financing Variable generation versus long-term contract on cable
Regulatory	Different regulatory schemes Slow permitting procedures Unclear cost allocation & allowed profit margins
Policy	Unsynchronised legislation Conflicts of interest with other uses of marine environment Political interests not always in line

Table 5-6 Overview of key challenges[73]

Trade and territorial limitations and the need of international harmonization

There may be trade and territorial issues which prevent electricity generated by an offshore wind farm located in a given country to be connected or traded in other country via an offshore grid linking the two countries (See table below). The question of which country can count such generated renewable energy in its statistics for reaching its renewable targets still needs to be addressed. More generally, the lack of international consultation and coordinated planning is one of the main challenges for the development of offshore wind power.

Trade issues	• How can electricity be traded to other countries? • Is support still received if electricity is traded to another country?
Territorial issues	• Could an offshore wind park be planned and built on a country's territory but directly connected to another country? • Could an offshore wind park be planned and built elsewhere but directly connected to the country of origin and receive promotion?

Table 5-7 Trade- and territorial issues

Other more specific questions have been raised in the context of feasibility studies of the Kriegers Flak projects[74]. Consequently, the commercial opportunity for industry and financial players and socio economic benefits are jeopardized on the short-term as long as the framework for development, profitability and risk profile further clarified.

[73] Offshore grid, 2010

[74] Energinet.dk, Svenska Kraftnät, Vattenfall Europe Transmission: "An analysis of offshore grid connection at Kriegers Flak in the Baltic Sea", May 2009.

Time frame.

Most stakeholders think that an offshore grid might be realized within 10-15 years from now. Before 2015 an offshore grid is not seen to be built:

- The process to build new transmission lines is long, with detail studies (environmental impact assessments, consenting permits) and long time for material procurement and installation. According to Statnett, the total process of developing an offshore interconnector from pre-feasibility study, through licensing, investment decision until construction completion can take about 10 years[75].
- The creation of a European offshore grid as well as the integration of all expected offshore wind power capacity will imply massive investments in new onshore grid connection and grid upgrades,
- In the short term, the necessary acceleration could be challenged by supply chain constraints. The delivery of key items may take time. There are less than five providers on the market for both system transformer stations and high-voltage export cables. Lead times for these items can exceed two years.

It is necessary to include this in the national master plans, and decisions need to be taken quickly, to avoid delays offshore wind power development. Several bottlenecks are already foreseen on cable supply and installation, so incitation or incentives should be set to encourage industries to invest in new production facilities, infrastructures, new technologies etc.

Ownership and Financing.

Onshore TSOs do not necessarily have the responsibility of owning and financing the future offshore grid. The required investments are very large and include higher risks and longer return rates. The profitability of these investments is dependent on the development speed of future offshore wind farms. The need for guarantees needs to be addressed some suggest through the introduction of specific European instruments.

As of today, Statnett, the Norwegian TSO, acts as a commercial player when it comes to offshore grid developments and interconnectors. As such it competes with other players and does not have any national mandate to address the long term challenge of connecting offshore wind projects.

In order to address this issue, the UK authorities have introduced Offshore Transmission Operator (OFTO) framework (with ownership and financing responsibilities) to cover the needs of UK round 3 clusters and ongoing UK round 2 developments. Authorities are now facing an increasing opposition from offshore wind developers and industrials due to the uncertainties and risk of delays this approach has introduced.

[75] EWEA, Ocean of Opportunity / Offshore report, 2009

6 Project case studies

6.1 Introduction

A set of case studies have been performed to support this study. Both commercial and demonstrator projects were analysed based on public available information and first hand exposure to the projects.

A high level description of the projects is available below. Full case studies are available in appendix.

Key lessons learnt have been directly included in the report in different chapters.

Commercial projects

6 commercial size projects in operation or under development above 60MW have been reviewed covering Germany, the Netherlands, UK, Sweden and Denmark. Some of these projects were national pilots and have been very rich in lessons learned which have been mentioned in the report directly.

In addition, more projects such as Arklow bank in Ireland or Gunfleet Sands 1 & 2 in UK, Havsul 1 in Norway have been reviewed to feed inputs into the chapter on planning frameworks.

Demonstrator projects

5 technology demonstrator projects in operation or under development have been reviewed covering Germany, UK, Norway, and The Netherlands.

6.2 Commercial projects

	Alpha Ventus	Egmond aan Zee	Kriegers Flak	Gunfleet Sands 1 & 2	Lillgrund	Nysted (Rødsand 1)
Location	Germany, North Sea, German Bight	Netherlands, North Sea, off Egmond-aan-Zee	Sweden, Baltic sea, Trelleborg Kommun	UK, North Sea, off the coast of Essex	Sweden, Øresund	Denmark, Baltic Sea, off Lolland
Status as of June 2010	Operational	Operational	Consented on hold	Operational	Operational	Operational
Developer	Prokon Nord. Acquired by Deutsche Offshore-Testfeld und Infrastruktur (DOTI) in 2006.	Shell WindEnergy and Nuon	Sweden Offshore Wind AB (Vattenfall AB)	GE Wind Energy	EuroWind (50% owned by Fred. Olsen Renewables)	ENERGI E2 (now Dong Energy)
Current owner	DOTI (EWE, E.ON, Vattenfall)	Nuon	Vattenfall	Dong Energy	Vattenfall (since 2004)	DONG Energy and E.ON Sweden
Installed capacity	60 MW	108 MW	640 MW	108 + 65 = 173 MW	110 MW	165,6 MW
Nb of Units	12	36	128	30 + 18 = 48	48	72
Turbine type	6 REpower 5M (5MW) +6 Multibrid M5000 (5 MW)	Vestas V90 (3 MW)	NA	Siemens 3.6-107 (3,6MW)	Siemens 2.3-93 (2,3MW)	2.3MW Bonus (Siemens)
Foundation type	Quattropod jackets (6) and tripods (6)	Monopiles	NA	Monopiles	Gravity-based	Gravity-based
Availability (%)	NA	81% (2007), 76% (2008)	NA	NA	94% (2008), 98.7% (first five months 2009)	97% (2004)
Full load hours per year	3700-3800 (expected)	3066 (2007), 2890 (2008)	NA	NA	NA	NA
Water depth (m)	30 m	18 m	16-39	0.5 – 13 m	4-10 m	6-9.5 m
Distance to shore (km)	45 km	10-18 km	32,7 km	7 km	7 km	9 km
Distance to grid (km)	70 km	22 km	-	9 km	8.7 km	NA
Commissioning date	January 2010	December 2006	NA	2010	December 2007	December 2003
Years of development	1999-2008	1997-2006	> 8 years	2001 - 2008	1997-2006	1997-2002
Planning framework	"First come, first served" permitting framework	Pilot project. Government-led site identification, followed by tender.	EEZ application	Round 1& 2	Site chosen by developer--permitting procedure per onshore developments	Government-led EIA and tender process
CAPEX (total	MEUR 250	MEUR 217	NA	MGBP 297.5	MSEK 1900	MEUR 250
per MW)	MEUR 4.16/MW	MEUR 2.01/MW	NA	MGBP 1.72/MW	MSEK 17,3 /MW	MEUR 1.51/MW

Table 6-1 Commercial offshore wind projects

6.3 Demonstrator projects

Project name	Beatrice	Alpha Ventus	Hywind	FLOW	Carbon Trust offshore wind accelerator
Country	UK ,Scotland	Germany	Norway	the Netherlands	UK
Location	East coast, near the Beatrice field 22km offshore in the Moray Firth	North Sea, German Bight	12km of Karmøy, on Norway west coast.	Far offshore, North Sea	UK, to be defined
Status	Operational	Operational	Operational	Under development	Under development
Technological innovation introduced	Deep water jacket support structure, 5 MW offshore turbine	Deep water support structures, 2 different 5MW offshore turbine models	Floating support structure - SPAR, 1, 2.3MW offshore turbine model	complete large scale offshore wind farm technologies including, foundations, turbines among others	Three innovative support structures for deep water, far offshore and severe conditions.
Owner(s) & sponsor(s)	Talisman Energy (UK) Limited, Scottish and Southern Energy,	DOTI (EWE, E.ON, Vattenfall)	Owned by Statoil, sponsored by ENOVA	RWE, Eneco, TenneT, Ballast Nedam, Van Oord, IHC Merwede, 2-B Energy, XEMC Darwind, ECN and TU Delft	Carbon Trust and Airtricity Developments, DONG Energy, RWE Innogy (owner of Npower Renewables), Scottish Power Renewables and Statoil.
Installed capacity, Nb of Units	10MW, 2 units	60 MW, 12 turbines	2,3MW - 1 single unit	100-300 MW, 20-60 units	to be defined, 3 units
Turbines	2 REpower 5M (5MW)	6 REpower 5M (5MW) and 6 Multibrid M5000 (5 MW)	Siemens 2,3 MW	expected to include 2-B Energy and WEMC Darwind turbines	to be defined
Foundation type	Quattropod jackets	Quattropod jackets (6) and tripods (6)	Steel floater	to be defined	Final foundations to be determined out of 7 pre-selected concepts
Water depth (m)	45	30	220	30-35	40-60
Distance to shore (km)	22	45 km	12	75	far offshore, typically 180km
Commissioning date	2006	jan.10	sep.09	Q3 2013 earliest	2010-2012
Years of development	2004-2006	1999-2009	2001-2009	ongoing	2008-2012
Cost	MEUR 41 for the demonstrator	MEUR 250	MNOK 400	NA	MGBP 20
Financing	Developers supported with funding from the Scottish Executive, the UK Department of Trade and Industry, and the European Commission	Developers + government help of EUR 50 million for the RAVE R&D program connected to Alpha Ventus	Statoil is investing about NOK 340 million in the project, with Enova providing NOK 59 million	Governmental funding of €19.5 million is intended for the first phase of FLOW, which will begin to take shape in the next four years.	Each of the 7 offshore wind turbine foundation designs received 100 kGBP in support for concept development, engineering analysis, commercial feasibility and technical assistance. Funded by carbon trust and private companies

Table 6-2 Demonstrator offshore wind project

7 Appendixes

7.1 Key references

- Douglas Westwood, Offshore Wind Assessment For Norway Final Report, March 2010
- Energinet.dk Svenska Kraftnät Vattenfall Europe Transmission, An Analysis of Offshore Grid Connection at Kriegers Flak in the Baltic Sea Joint Pre-feasibility Study, May 2009
- Ernst & Young, Cost of and financial support for offshore wind, 2009
- EU COM(2008)782 http://ec.europa.eu/energy/strategies/consultations/2009_03_31_gp_energy_en.htm
- European Network of Transmission System Operators for Electricity (ENTSOE), TEN-YEAR NETWORK DEVELOPMENT PLAN 2010-2020, June 2010
- EWEA, Ocean of Opportunity / Offshore report, 2009
- EWEA, Political declaration on the North Seas Countries Offshore Grid Initiative http://www.ewea.org/fileadmin/ewea_documents/documents/policy/Offshore_Wind/Political_declaration_on_the_North_Seas_Countries_Offshore_Grid_Initiative.pdf
- EWIS, Final report http://www.wind-integration.eu/downloads/library/EWIS_Final_Report.pdf, 2010
- Offshore grid EU project, 2010
- The Crown Estate (TCE) , UK round 3 offshore wind farm connection study, December 2008
- WindSpeed EU project, 2020

7.2 About the project team

Wilfried Pimenta de Miranda – Main author

Head of offshore renewables in Multiconsult, Senior offshore wind advisor. More than eight years of experience in the development offshore wind projects in Europe, including planning, project engineering, technology development, business development and strategy. Through exposure to utilities, up-stream operators as well as offshore EPC contractors, Wilfried has experience of the broader oil and energy sector, renewable energies in particular. Wilfried has been involved in market and strategy advisory assignments on offshore wind and other renewable technologies over the whole European market. His client reference includes utilities such as Statkraft, Iberdrola, Acciona, Eon Sverige, Fortum and public bodies such as NVE, ENOVA in Norway and ADEME in France. Wilfried holds a MSc (sivilingeniør), NTNU, Trondheim, Norway and a MSc - Ingenieur generaliste from the Ecole Centrale de Lyon, France.

Christian Peterson - Contract manager

Responsible for WSP Nordic wind power group and has a long experience in wind energy issues. With a Master of Science in Chemical Engineering (Specialization in energy and environmental engineering) and Economics (M.Ec.) He has more than 15 years of experience in environmental and energy issues. He is currently working as project manager for a large number of wind projects for some of the markets major players.

7.3 Offshore wind farms operating in Scandinavia[76]

Country	Projects	MW	Online year	Foundation type	Water depth (m)	Distance from coast (km)
Denmark	Avedore Holme	7	2009	GBS	2	0,4
Denmark	Frederikshavn	10,8	2003	monopile	1-4	3,2
Denmark	Horns Rev I	160	2002	monopile	6-11	17,9
Denmark	Horns Rev II	209	2009	monopile	9-17	31,7
Denmark	Middelgrunden	40	2000	GBS	3-6	4,7
Denmark	Nysted (Rødsand)	165,6	2003	GBS	6-9	10,8
Denmark	Rødsand II (Nysted II)	207	2010	GBS	6-12	8,8
Denmark	Rønland	17,2	2002	monopile	0-2	0,1
Denmark	Samsø	23	2003	monopile	10-13	4
Denmark	Sprogo	21	2009	GBS	6-16	10,6
Denmark	Tunø Knob	5	1995	GBS	4-7	5,5
Denmark	Vindeby	4,95	1991	GBS	2-4	1,8
Finland	Kemi Ajos I	9	2007	GBS	1-7	2,6
Finland	Kemi Ajos II	15	2008	GBS	1-7	2,6
Norway	Hywind	2,3	2009	Floating	220	7
Sweden	Bockstigen-Valor	2,8	1996	monopile	5-10	1,6
Sweden	Lillgrund	110	2007	GBS	6-8	11,3
Sweden	Utgrunden	10,5	2000	monopile	6-15	4,2
Sweden	Vindpark Vanern	30	2009	GBS	1-22	3,5
Sweden	Yttre Stengrund	10	2001	monopile	6-10	5

Table 7-1 Offshore wind farms operating in Scandinavia

[76] Multiconsult project database, June 2010

7.4 Demonstrator projects – case studies

7.4.1 Beatrice, Scotland

Country	UK ,Scotland
Location	East coast, near the Beatrice field 22km offshore in the Moray Firth
Status	Operational
Objectives	• Better understand the environmental impact of deepwater wind farms • Prove the concept of a deepwater wind farm • Explore the cost-effectiveness of deepwater sites • Share knowledge and experience across Europe • Pioneer the development of deepwater wind farms • Improve and commercialise the technology
Technological innovation introduced	Deep water jacket support structure, 5 MW offshore turbine
Related R&D program	Incorporated into a pan-European initiative called DOWNVInD (Distant Offshore Wind farms with No Visual Impact iN Deepwater), comprising 15 different organisations from 6 European countries, which has been established as a catalyst for commercialising deepwater wind farm technology.
Owner(s) & sponsor(s)	Talisman Energy (UK) Limited, Scottish and Southern Energy,
Installed capacity, Nb of Units	10MW, 2 units
Turbines	2 REpower 5M (5MW)
Foundation type	Quattropod jackets
Water depth (m)	45
Distance to shore (km)	22
Commissioning date	2006
Years of development	2004-2006
Schedule	• 2004: The DOWNVInD duration was 60 months from the start date of 14th September 2004. • 2005: consultation exercise, environmental assessment • 2006: WTG A fully installed and commissioned , WTG B subsea jacket installed • 2007: installation of WTG B Tower and Nacelle
Cost	MEUR 41 for the demonstrator The DOWNVInD project budget was some MEUR 50
Financing	Developers supported with funding from the Scottish Executive, the UK Department of Trade and Industry, and the European Commission
Link(s)	http://www.beatricewind.co.uk

Source: OWEC Tower

7.4.2 Alpha Ventus, Germany

Country	Germany
Location	North Sea, German Bight
Status	Operational
Objectives	• Germany's first offshore wind farm. • Testing and comparative assessment of two alternative types of foundation structures for deep waters: Steel tripods and steel jackets. • Testing and comparative assessment of two models of 5MW offshore turbines: REpower and Multibrid (AREVA)
Technological innovation introduced	Deep water support structures, 2 different 5MW offshore turbine models
Related R&D program	The RAVE research initiative runs simultaneously with the construction and operation of the "Alpha Ventus" test site to attain broad based experience and knowledge for future offshore wind parks. RAVE is sponsored by the Federal Ministry for the Environment, Nature Conservation and Reactor Safety (BMU). It joins the scientific activities of the plant manufacturers and a multitude of research institutions.
Owner(s) & sponsor(s)	DOTI (EWE, E.ON, Vattenfall) with the support of the *Offshore Wind Energy Foundation*
Installed capacity, Nb of Units	60 MW, 12 turbines
Turbines	6 REpower 5M (5MW) and 6 Multibrid M5000 (5 MW)
Foundation type	Quattropod jackets (6) and tripods (6)
Water depth (m)	30
Distance to shore (km)	45 km
Commissioning date	jan.10
Years of development	1999-2009
Schedule	• 1998 -1999: Pre planning started and first formal application for a building permit in the EEZ • Nov 2001: building permit for the wind farm was granted by BSH. • April 2002: approval for the sea cable through the 12 - nmi-zone • Dec 2004: approval or the sea cable through EEZ • 2005: Formation of Offshore Wind Energy Foundation, rights of use sold to the Foundation by PROKON Nord GmbH for EUR 40m (USD 46.8m) • Jun 2006: Establishment of DOTI to construct wind farm • Dec 2006: Lease agreement signed between DOTI and Offshore Wind Energy Foundation • End of 2006: Federal government's "Infrastructure Planning Acceleration Act" • From 2007 onwards, the first contracts were allocated towards the construction phase. • 2009: Commissioning
Cost	MEUR 250
Financing	Developers + government help of EUR 50 million for the RAVE R&D program connected to Alpha Ventus. Offshore Wind Energy Foundation had bought the rights of use from PROKON Nord GmbH for EUR 40m (USD 46.8m)
Link(s)	www.alpha-ventus.de

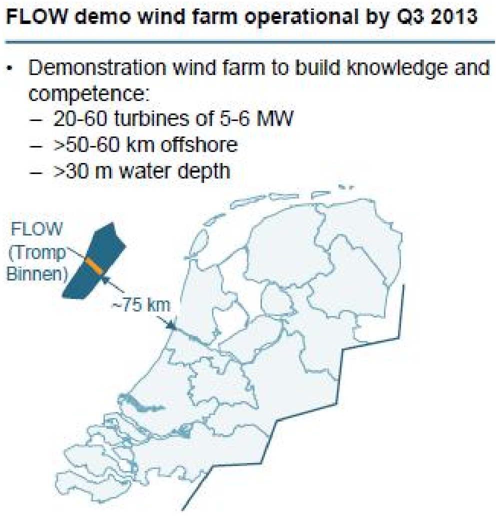
7.4.3 Hywind, Norway

Country	Norway
Location	12km of Karmøy, on Norway west coast.
Status	Operational
Objectives	• Demonstrate the world first floating offshore wind based on innovative foundation inspired from Oil & Gas sector. • Test on the basis of large scale turbine of 2,3MW offshore turbine by Siemens.
Technological innovation introduced	Floating support structure - SPAR, 1, 2.3MW offshore turbine model
Related R&D program	Statoil intern RD&D program
Owner(s) & sponsor(s)	Owned by Statoil, sponsored by ENOVA
Installed capacity, Nb of Units	2,3MW - 1 single unit
Turbines	Siemens 2,3 MW
Foundation type	Steel floater
Water depth (m)	220
Distance to shore (km)	12
Commissioning date	sep.09
Years of development	2001-2009
Schedule	• 1999: Statoil decides to try to capture wind energy offshore in a more effective way • 2001: The project is born involving researchers and people with relevant practical experience. Model testing was carried out at Norwegian R&D institute SINTEF MarinTech Ocean basin laboratory in Trondheim. • 2006: Governmental consent achieved for the proposed site • 2007: Technological collaboration with Siemens begins • May 2008: The executive committee in Statoil approves project • May-June 2008: Technip won the EPCI contract for the construction and installation. • April-May 2009: Delivery of unit to Dusavik. Offshore installation. • June-July 2009: Commissioning of unit in Dusavik. Nexans installed a 10km offshore cable. • August 2009: Towing of Hywind module to site • Sept-Oct 2009: Official start-up of Hywind
Cost	MNOK 400
Financing	Statoil is investing about NOK 340 million in the project, with Enova providing NOK 59 million
Link(s)	http://www.statoil.com/en/TechnologyInnovation/NewEnergy/RenewablePowerProduction/Offshore/Hywind/Downloads/Hywind%20Fact%20sheet.pdf

Source: Statoil

7.4.4 Flow, the Netherlands

Country	the Netherlands
Location	Far offshore, North Sea
Status	Under development
Objectives	• FLOW is instrumental to realizing the Netherlands' renewable energy goals, and will create sustainable, knowledge intensive employment. • Demonstrate large scale, far offshore, deep water offshore wind farm • Based on Deutsch technology and supply chain providers.
Technological innovation introduced	complete large scale offshore wind farm technologies including, foundations, turbines among others
Related R&D program	Far and Large Offshore Wind program (FLOW) consists of an ambitious R&D plan and a demonstration wind farm
Owner(s) & sponsor(s)	RWE, Eneco, TenneT, Ballast Nedam, Van Oord, IHC Merwede, 2-B Energy, XEMC Darwind, ECN and TU Delft
Installed capacity, Nb of Units	100-300 MW, 20-60 units of 5-6MW
Turbines	expected to include 2-B Energy and WEMC Darwind turbines
Foundation type	to be defined
Water depth (m)	30-35
Distance to shore (km)	75
Commissioning date	Q3 2013 earliest
Years of development	ongoing
Schedule	• September 2nd, 2009: Business Plan presented to the Minister of Economic Affairs during a meeting of the Dutch Innovation Platform. • Jan 2010: commencement of the R&D plan • Q2 2010: A measurement mast will be installed which will provide the necessary data to complete the design of the FLOW demo wind farm. • 2012-2013 : construction • Q3 2013: FLOW demo wind farm operational (earliest projection). • 2013-2014: Far-offshore measurement, demonstration and validation, results will be used to optimize models and concepts.
Cost	NA
Financing	Governmental funding of €19.5 million is intended for the first phase of FLOW, which will begin to take shape in the next four years.
Link(s)	http://www.flow-windpark.nl/downloads/FLOW_Summary.pdf



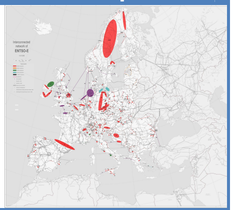
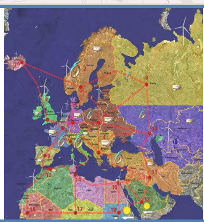
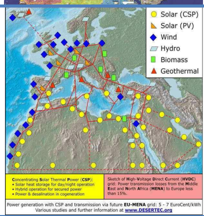
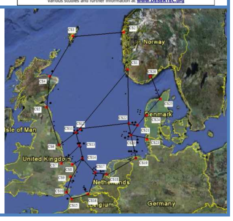
Source: FLOW

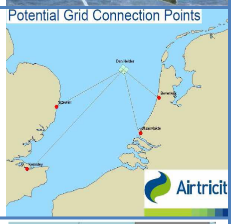
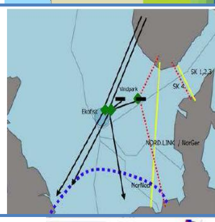
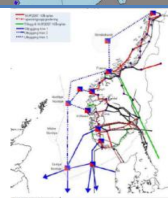
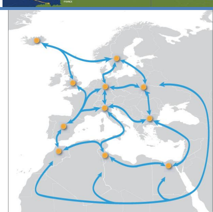
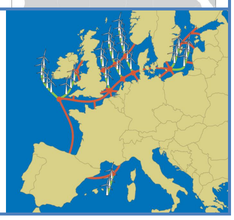
7.4.5 Carbon Trust Offshore Wind Accelerator (OWA) – Foundations, UK

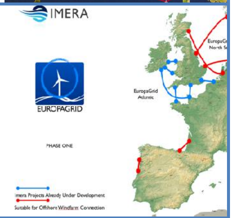
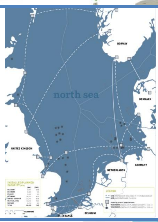
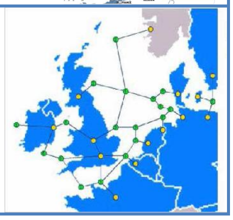
Project name	Carbon Trust offshore wind accelerator
Country	UK
Location	UK, to be defined
Status	Under development
Objectives	The objectives of the OWA's scope on foundations are: •Find new foundation designs for the challenging conditions that will be encountered in Round 3: water depths of 30-60m, complex soils, and harsher met ocean conditions • Demonstrate that by optimising designs to consider manufacturing, transportation, installation, maintenance and decommissioning, the total cost of foundations can be reduced by as much as 30%
Technological innovation introduced	Three innovative support structures for deep water, far offshore and severe conditions.
Related R&D program	The offshore wind accelerator (OWA) is focusing on developing innovative, lower-cost solutions in 3 other areas than foundations: • More efficient methods of accessing turbines to allow maintenance in heavier seas – this will increase availability, allowing more electricity to be generated • Improving the understanding of wake effects; this will not only allow wind array layouts to be optimised, but also allow increase the accuracy of yield forecasts – reducing financing costs • Researching ways to reduce electricity losses both within the array and in transmission to the onshore grid. Sponsors' intern RD&D program
Owner(s) & sponsor(s)	Carbon Trust and SSE renewables, DONG Energy, Scottish Power Renewables, Statoil, Statkraft, Mainstream Renewable Power, Eon.
Installed capacity, Nb of Units	to be defined, 3 units
Turbines	to be defined
Foundation type	Final foundations to be determined out of 7 pre-selected concepts.
Water depth (m)	40-60
Distance to shore (km)	far offshore, typically 180km
Commissioning date	2010-2012
Years of development	2008-2012

Schedule	More than 100 engineering companies from around the world s as far as 100 miles out to sea and in waters up to 60 m deep. The winning ideas will be demonstrated at full-scale by the OWA Partners.Tender was closed in June 2009. Winners were awarded end of 2009.The entries were selected based on manufacturing costs, transport and installation costs, potential for volume cost savings, structural design and durability, maintainability and turbine accessibility, and decommissioning and removal costs 1) FeasibilityThe current stage – focusing on identifying innovative concepts that have potential to reduce the cost of energy – will complete in Spring 2010. The successful shortlisted designs are receiving consultancy support to move their concept forward. 2) Large scale demonstrationThis starts in spring 2010. The Carbon Trust and its partners select one or more of the most promising foundation designs and take them to large-scale demonstration. This multi-year phase could include as much as £20 million of Offshore Wind Accelerator investment. 3) commercial scale for UK round 3
Cost	MGBP 20 (foundation scope only); the rest of the OWA is MGBP 30.
Financing	Each of the 7 offshore wind turbine foundation designs received kGBP 100 support for concept development, engineering analysis, commercial feasibility and technical assistance Funded by carbon trust and the 6 private companies
Link(s)	http://www.carbontrust.co.uk/emerging-technologies/current-focus-areas/offshore-wind/pages/owa-competition1.aspx

7.5 European offshore grid studies

Initiative	Name	Main idea	Map
European Network of Transmission System Operators for Electricity (ENTSOE)	TEN-YEAR NETWORK DEVELOPMENT PLAN 2010-2020	Master plan for the EU grid	
Dr. Gregor Czisch (Uni. Kassel)	Super grid	Connect wind power and bypass onshore bottleneck to connect major load centres, show that EU can work on 100% RE	
DLR, Trans-CSP	EUMENA backbone grid, DESERTEC	Interconnect renewable energies and reinforce grids, show how transmission of solar energy to Europe could work	
POWER Cluster	Offshore HVDC Grid	Optimal integration of offshore wind energy in the North Sea	

TradeWind	Meshed offshore networks	Interconnect wind power and power systems, bypass onshore bottlenecks	
Airtricity	Sea Electric Superhighway	Connect wind power and bypass onshore bottleneck to connect major load centres	
Airtricity	Super grid	(Inter)connect wind power and power systems, bypass onshore bottlenecks	
Airtricity	Den Helder	Potential project to connect wind farm to two countries (NL & UK) and to use connection infrastructure also for interconnection	
Statnett	Transnational Offshore grid	Interconnect power systems with wind power and oil & gas platforms	
Statnett	Statnett	Interconnect power systems with wind power and oil & gas platforms, bypass onshore bottlenecks	
EWEA	Master plan for offshore transmission cables in 2030		
European Climate Forum and the Potsdam Institute for Climate Impact Research	Super Smart Grid		
Airtricity	European Offshore Super grid®		

Friends of the Supergrid	*Supergrid*		
Mainstream Renewable Power	*Supernode*	First project, possible start of Supergrid	
Mainstream Renewable Power	*Supergrid*	Interconnect wind power and power systems, bypass onshore bottlenecks	
Imera	*EuropaGrid*	Interconnector projects which can form the first bones of an offshore grid in the North Sea, the Irish Sea and the English Channel	
Greenpeace/3E	Offshore Grid	Interconnect power systems with wind power, bypass onshore bottlenecks, utilize synergies, to push policy	
KEMA	Ocean grids	Offshore backbone for mainland transmission systems and connection of offshore wind farms and marine power	

7.5.1 Cross border trade and territorial limitation

Country	Support scheme	Trade issues	Territorial issues	
			Built elsewhere connected to the country	Built in the country and connected elsewhere
UK	Certificate system	Certificates for renewable energy are received and electricity is sold separately. Suppliers are obligated to source ROCs (or pay the buy-out price) for a certain share of the energy they supply (as described in chapter 0). The wind energy producer receives ROCs even if the electricity is sold outside the country, but the ROCs can only be traded within the UK. Vice versa RES producers outside the UK cannot receive ROCs even when selling the energy to the UK.	NA	NA
Sweden	Certificate system	Electricity trade and receiving of certificates are as well separated. Electricity can be sold elsewhere and certificates are still received.	It is possible to build a wind farm in one country and connect it to the Swedish grid. There might be some not yet identified details but it is still possible. This wind farm cannot be part of the electricity certificate system in Sweden since only wind farms on Swedish territory can.	A wind farm built in Sweden and connected to another country has never been realized even though this would be possible. Still, it would not fit in to the Swedish support system, because to receive Swedish electricity certificates is necessary that a wind farm is located on Swedish territory and connected to the Swedish grid.
Ireland	Feed in Tariff	Electricity can be traded abroad and the renewable electricity producer can receive support even if the electricity is sold abroad, or produced outside Ireland but in Europe or sold to Ireland	In Ireland there is the possibility that a wind park outside Ireland receives support within Ireland. Renewable electricity imported from another country can be subsidized. The specific questions asked above could not be answered more in detail.	
The Netherlands	Feed in Tariff/Tender	Electricity produced from renewable sources may be exported as common electricity. Electricity has to be fed into the Dutch system to receive the negotiated feed-in tariff. The green certificates can be sold abroad as well.	When a wind park is built abroad and request grid connection in NL, the Dutch TSO (TenneT) does not have an obligation to connect this “foreign” wind farm to the Dutch grid. The wind park would not receive the Dutch support since it is not located in the Netherlands or the Dutch EEZ.	For Dutch support, two criteria exist in order to qualify for the feed-in support: a) The wind park must be located in the Netherlands, or the Dutch EEZ and b) The electricity must be fed into the Dutch grid. It is possible to build a wind park in the Netherlands and connect the wind park to e.g. Belgium or the UK, but the Dutch feed-in support will not be granted. In any case, a

				developer can ask for the necessary permits to build a wind park in the Dutch North Sea. Such a permit cannot be refused, simply because to park would be connected to a different country.
Germany	Feed in Tariff	Wind energy plants have to be connected to the grid for common supply. Feed-in tariff is only received if the electricity is sold to a German TSO. If the electricity is traded directly to another country, no feed-in tariff is granted. The TSO can trade electricity on the national market and thus sell it then abroad.	Wind power plants built in another country may be directly connected to the German system. Still the support scheme (EEG – Renewable Energy Act) does not clarify whether a support can be granted.	Wind power plants built in Germany can be directly connected elsewhere. The legislation clearly states that no support is granted since the wind park is not directly connected to the German electricity system.
Finland	None	Wind energy may be sold freely without risking losing support as there is none.	NA	NA
Denmark	Tender	Support for offshore wind energy is negotiated in advance in the context of tender process. The support can only be received if the electricity is fed into the Danish grid.	The Danish act on promotion of renewable energy (Lov om fremme af vedvarende energi) applies to the Danish territory on land and at sea. If a wind park is build outside Danish territory under the existing legislation, it would not receive support. Under current legislation it is also a requirement that the electricity is delivered to the Danish electricity grid. However, special provisions are given by law for each new offshore wind park, as the support for each park is settled by a tendering procedure. The issue of who pays the support would have to be settled.	
Norway	None	Wind energy may be sold freely without risking losing support as there is none.	Needless to say that a “foreign” wind farm that seeks direct connection to Norway would not receive a support in Norway as there is no support for offshore wind energy at all.	A foreign wind park placed in the Norwegian sector with direct connection to the foreign country and no connection to Norway would most probably be seen as a foreign wind park with foreign subsides and counting fully on foreign RES obligations. Norway would possibly receive a fee for leasing the area. Thus in general, a wind park could be planned and built on Norwegian territory but directly connected to another country.

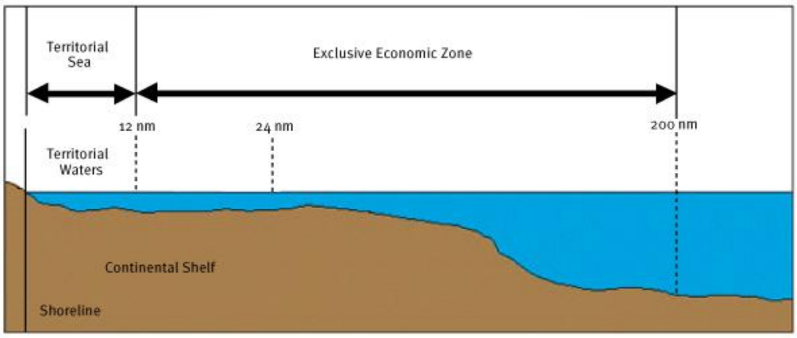
Source: Offshore grid, 2010

7.6 Definitions of water areas

The marine areas are divided into six different categories stemming from the United Nations Conference on the Law of the Sea, UNCLOS, which came into force in 1994. The permit process, required permits etc for off shore wind power establishment is depending on the classification of the establishment area.

Internal water area	Territorial sea	Contiguous zone	Exclusive economic zone (EEZ)	Continental shelf	The high sea
All water area between land and the national baseline (shoreline)	Water area within 12 Nautical miles from the national baseline	Water area within maximum 24 Nautical miles from the territorial sea.	Water areas within 200 Nautical miles from the national baseline.	The continental shelf is defined as an extension of the underwater territory of a State to the perimeter of the shelf or 200 Nautical miles from national baseline.	Outside the EEZ.
The internal water area and the territorial sea are defined as the national territorial Sea. Each country has full sovereignty over this area.		In the Contiguous zone, a state may exercise a limited set of its laws, such as smuggling and illegal immigration. E.g. Sweden has not defined a contiguous zone.	A State has exclusive right of exploitation of all natural resources within this water area.	A State has the exclusive right to harvest minerals and non-living materials in its continental shelf.	The high sea can freely be used by all States.

Definition of water areas



Definition of water areas

7.7 Country fact sheets – Denmark, Finland, Norway, Sweden

	Denmark	Finland	Norway	Sweden
Rationale for developing offshore wind	• Extend wind power supply to offshore areas as onshore gets saturated. • Population supportive of wind power. • Maintain Danish wind industry competitiveness in the Northern European market by going offshore	- Large coastal area	• Very large technical potential based on very high good wind resources but deep waters • Long term opportunity to balance intermittent offshore wind with hydropower but difficult to find economic viability in current regulatory context and limited export grid to the rest of Europe. • Important NIMBY trend regarding onshore despite good wind resources which favours offshore developments • Need to electrify offshore oil & gas infrastructure creates opportunity for offshore wind developments	• Large onshore areas still considered available for wind power installations. • The subsidies system promotes development of the most cost-effective areas. When no special grants are dedicated to offshore wind power, onshore wind power is believed to be developed at a larger extent than offshore. • Population supportive of wind power.
Site conditions	Key siting areas: • Baltic Sea favoured with the northwest coast also featuring high wind speeds Sea bed features: • Favourable sandy soil conditions in relatively shallow waters • Existing farms have mostly been <20 km from shore • Some areas of the Baltic Sea featuring over 40 m seabed depths; 20 m is more common	Key siting areas: • Gulf of Bothnia; designated offshore wind areas (3 GW to 5 GW potential) • Severe weather conditions due to icing – winter ice cover can be up to 1.3 meters high	Key siting areas: • Centre west coastline Seabed features: • Very large wind resources located in relatively deeper waters than development to date, typically above 40m. • Seabed slopes quickly away from shore • Planned projects are within 5 km of shore	Key siting areas: • Baltic Sea, especially in Swedish Exclusive Economic Zone (SEEZ, >12 nautical miles) Siting issues: • Currently, most projects planned in south of country, where population is concentrated and transmission network is most extensive. Nonetheless, there is more space and less resistance to offshore wind in the north • Distance from shore: 30 meters • Seabed depth: >25 meters • Possible icing issues in the North of the Baltic sea
RE status in 2005 / Mandatory 2020 targets set out in the directive [77]	17% / 30%	28,5% / 38%	NA / 70-74% estimate	39,8% / 49%

[77] share of energy from renewable source in final consumption of energy

Governmental objectives / Targets	• 30 % of energy consumption from renewable energy sources by 2020 (Compared to 17% in 2005) equivalent to 200MW offshore wind installation per year. • National Renewable Energy Action Plan for 2020: 1339 MW • Denmark's long-term goal is total independence from fossil fuels by 2050 • A tender round has just been finalised to award the 400MW Anholt Offshore Wind Farm. • The plans for establishing further offshore wind farms beyond 2012/13 could not be agreed on by the government and political opposition within the scope of the 2008 Energy Bill—hence a certain degree of uncertainty remains for the medium term	• Earlier target of 500 MW total (onshore and offshore) through 2010; 100 MW installed already • The new target proposed by Finland's climate and energy strategy in 2008 was 2,000 MW of wind power installed by 2020. . • National Renewable Energy Action Plan for 2020 : NA	• 30 TWh/y of both renewable energy production and energy efficiency by 2016 – beyond that of the 2001 level. • No offshore wind specific targets • Ongoing development through demonstrator projects only • A new strategy has been announced as part of the introduction a new regulatory scheme for the development of offshore wind in Norway under the" Offshore Energy Act", 2010	• Sweden's long-term goal is the total independence from fossil fuels. • By 2050 the aim is to reduce the greenhouse gas emissions per capita by 40 %. • The total use of energy in 2020 shall be 50% compared to 39,8% in 2005 and of the overall energy production shall 25 TWh be renewable. • 30TWh by 2020 for onshore and offshore wind • The Swedish Energy Agency has presented a planning frame on 10 TWh offshore wind power until 2020. • National Renewable Energy Action Plan for 2020 : 182 MW
Offshore wind potential	• Unconstrained technical potential according to the EEA: 2700 TWh/a. • Wind potential (EER): Offshore resource estimated at 550 TWh/a • In April 2007, the Danish Energy Authority published the report: Future Offshore Wind Turbine Locations – 2025, where the offshore committee charted a number of possible areas where offshore turbines could be built with an overall capacity of some 4,600 MW, which can generate approximately 18 TWh, or just over 8% of energy consumption in Denmark. This corresponds to approximately 50% of the Danish electricity consumption. The committee examined in detail 23 specific possible locations, each of 44 km2, for an overall area of 1,012 km2 divided into seven offshore areas.	• Unconstrained technical potential according to the EEA: 1500 TWh/a. • Wind potential (EER): >13 GW; 40 TWh/a capacity estimated in Gulf of Bothnia, wind speed at hub height is 8m/s. New wind atlas required	• Unconstrained technical potential according to the EEA: 2000 TWh/a • Wind potential (EER): 76 TWh/a •A Norwegian study (NVE, 2008) estimates Norwegian offshore wind power capacity to be around 55 300 MW (at maximum depths of 50 m and minimum distances to the coast of 1 km).	• Unconstrained technical potential according to the EEA: 1500 TWh/a
Site conditions	Key siting areas: • Baltic Sea favoured with the northwest coast also featuring high wind speeds Sea bed features: • Favourable sandy soil conditions in relatively shallow waters • Existing farms have mostly been <20 km from shore • Some areas of the Baltic Sea featuring over 40 m seabed depths; 20 m is more common	Key siting areas: • Gulf of Bothnia; designated offshore wind areas (3 GW to 5 GW potential) • Severe weather conditions due to icing – winter ice cover can be up to 1.3 meters high	Key siting areas: • Centre west coastline Seabed features: • Very large wind resources located in relatively deeper waters than development to date, typically above 40m. • Seabed slopes quickly away from shore • Planned projects are within 5 km of shore	Key siting areas: • Baltic Sea, especially in Swedish Exclusive Economic Zone (SEEZ, >12 nm) Siting issues: • Currently, most projects planned in south of country, where population is concentrated and transmission network is most extensive. Nonetheless, there is more space and less resistance to offshore wind in the north • Distance from shore: 30 meters • Seabed depth: >25 meters • Possible icing issues in the North of the Baltic sea

		Denmark	Finland	Norway	Sweden
Development trends	Installed capacity (MW)	871,0	24,0	2,3	163,0
	upcoming projects	• 600 MW Kriegers Flak • 400 megawatts (MW) Anholt Offshore Wind Farm was awarded to DONG for 105.1 øre/kWh	Many projects > 6GW at early stage. Pori offshore demonstration is the closest to the building phase (100 MW). Environmental Impact Analyses have been started for Suurhiekka (400 MW), Oulu-Haukipudas (500 MW), Maakrunni (350-450 MW), Pitkämatala (800-900 MW), Oulunsalo-Hailuoto (150-210 MW), and Raahe (300-500 MW) on the Northern part of the West coast, as well as Kristiinankaupunki (240-400 MW), Siipyy (about 250 MW), and Inkoo (180-300 MW) on the Southern part of the West coast.	Consented: 395MW Key upcoming project: -Havsul 1 : 350MW -Karmøy demo: 10MW -Kvitsøy: 10MW -Rennesøy: 10MW More than 1 GW of planned development	Around 1586 MW permitted Around 1850 MW under consent more than 8,6GW in planning phase

		Denmark	Finland	Norway	Sweden
Development framework	Planning model	• Tender process. Applicants submit a quote for the price per kWh they can operate the plant with. Or • Submission of project "under the open Door Principle" (grid connection must be paid by the developer and tariff is the same as onshore)		• Not effective as of today (former planning framework has been put on hold) • The Ministry of Petroleum and Energy (MoPE) will pre-qualify and open specific areas for development of offshore wind power. It is expected that the MoPE will open offshore wind farm tenders for these areas.	• Multiple window application • The benefits for public and private interests must be proven higher than the costs and disadvantages. • Offshore plants must be approved with socioeconomically measures in consideration (which is not the case onshore)
	Pre-selection of areas / SEA	• Appropriate locations for offshore wind parks are identified and pre-planned and then tendered by the Danish		Ongoing, the Ministry of Petroleum and Energy (MoPE) will pre-qualify specific areas for development of offshore wind power. Results expected in 2010-2011.	The identification of potential locations are made by the Developer
	Consenting procedure	• Single-window Application Process		• Single-window Application Process • Indicated by new legislation introduced in 2010 by Offshore energy law announcing a tender process by block, inspired from existing Oil & Gas processes. • Project owners must apply for license within the pre-defined areas for offshore wind power.	• Multiple-window application process in territorial waters • The permit process are varies with location (in Swedish territorial waters or in Swedish economical zone). Permit from several different legislations are required; the main framework is the Environmental Code or the Act on Swedish economic zone. • Consultation with a numerous stakeholders is required. To gain physical control over common waters (Governmental owned waters) the benefits for public and private interests must be proven higher than the costs and disadvantages. This is not necessary for onshore wind power installations

		Denmark	Finland	Norway	Sweden
Support schemes	Compensation model	• Tendering system with integrated compensation. • Compensation under the "open door principle" is the same as onshore wind.	• No compensation but investment subsidies on project basis. • A feed-in premium has been proposed to begin in 2010 to promote wind power.	Not specified, from 2012 connection to the Swedish obligation system	• Combined system: quota obligations linked to tradable certificates. • Investment subsidies on project basis for demonstration/pilot projects
	Compensation tariff	• Fixed, lowest bid compensation bonus plus market price for tendered projects. Grid connection paid by the TSO. • Tender price for first 50,000 load hours, market price (Nord Pool ~ 0,36 DKK/kWh) after reaching this limit. Tender price: • 0,518 DKK/kWh (Hornsrev II in the North Sea) • 0,629 DKK/kWh (Rodsand II off Lolland) • 1,051 DKK/kWh (Anholt Offshore Wind Farm in the Kattegat off the North East coast of Jutland)	• The recently completed Kemi Ajos project owned by PVO Innopower Oy received a funding of 9,6MEUR from the Finnish government • New feed in tariff from 2010: A guaranteed price of 83.5 €/MWh has been proposed for wind power. The difference between the guaranteed price and spot price of electricity will be collected from the consumers and paid to the producers as a premium.	• Norway has a fixed feed in tariff over electricity market price in place for wind power over a 15 years period but this financial support is lowered if the electricity price is higher than approximately 50 EUR / MWh. This mechanism is barely enough to make onshore wind power viable and is therefore not considered as an option for offshore wind developments. • Sweden and Norway agreed in September 2009 to establish a common market for green electricity certificates that will start from 1 January, 2012. Offshore wind may not be part of the certificate mechanism. • A new support scheme needs to be introduced.	• Market price plus certificate price • The current average price is about 32 EUR /MWh • Sweden and Norway agreed in September 2009 to establish a common market for green electricity certificates that will start from 1 January, 2012. Offshore wind may not be part of the certificate mechanism.
	Compensation duration	For tender 50 000 full load hours. For open door 22 000 full load hours Usually 10 years, maximum 20 years	-	Not specified	Certificate price for 15 years or until the end of 2030, which ever comes earlier.
	Benefits or tax deduction	None	Tax reductions (6.9 €/MWh)	None, government proposes 'area fees'	• Energy tax deduction: The suppliers of wind energy are eligible for an energy tax credit of 12 SEK öre/kWh if the wind power stations are located offshore or in lake Väner. Entitlement to tax reduction ends if the total electricity generated by the plant amounts to 20,000 kWh per kW installed.
	Subsidies	2,3 øre/kWh in the entire lifetime of the turbine to compensate for the cost of balancing etc. Tender price for first 50,000 load hours, then after reaching this limit, market price (Nord Pool ~ 0,36 DKK/kWh). For open door principle price is a feed-in premium of 0,25 DKK/kWh for 22,000 full load hour	Up to 40 % of the investment	• Investment subsidies, subsidies for R&D. • Subsidies for electricity production are granted from the public agency Enova which manages the Energy Fund. • Currently, relevant grants are related to technology development offshore. • Although no geo limits are explicitly stipulated, the projects must be relevant for the Norwegian energy market.	• Investment subsidy for RD&D. ex: Lillgrund (23 MEUR), Utgrunden II (7.5 MEUR).
	Order of acceptance	Tender	First come first served	Tender	First come first served
	Priority feed-in	No, non-discrimination	No, non-discrimination	No	No, non-discrimination
	Geographical limitation	Electricity generated within Danish systems	Finnish territory	No geographic limits explicitly stipulated, projects must be relevant for Norwegian energy market	Electricity generated within the Kingdom of Sweden
	Penalties / Fines	Up to 400 MDKK	-	Fines, if requirements set in license or other provisions are not fulfilled	Buy-out charge for missing certificates (150 percent of the average yearly price)

		Denmark	Finland	Norway	Sweden
Grid connection regulations	Grid connection supplied by	Grid operator (Danish transmission company Energinet.dk)	Grid operator	Not specified yet	Grid operator
	Grid connection costs	Transmission grid operator in the case of a tender. Wind farm owner under the "open door principle"	Wind farm operator	Not specified yet	Wind farm operator
	Connection responsibility	Principle of non discrimination	Principle of non-discrimination	Not specified yet	Plants shall be connected to the grid without certain plants being discriminated against.
	Infrastructure arrangements	No	No		No
	Grid expansion	Grid operators are obligated to expand the grids with special attention to renewable energy, costs are borne by consumers	Grid operator, if it is for the needs of more than one grid user and if the capacity of the systems to be connected does not exceed 2 MW. Wind farm operator, if it is to his own benefit only.	Not specified yet	Paid by wind farm operator
	Priority connection	No, but priority for grid use	No	No	No
	Grid extension facilitation	No	No	No	-

7.8 Country fact sheets – Germany, UK, The Netherlands, Ireland

7.8.1 Germany

	Accelerators	Inhibitors	Experience
Policy	• Strong political will and engagement • Public support for wind power • National economy • Saturated onshore potential	• Lack of suitable deep water technology and industrial experience	No significant developments to date due to difficult project economics Lack of experience and local industry capability/capacity in early stage The entry of large solid developers/operators and improved incentive regime is now boosting market attractiveness
Site approval	• Spatial planning tools in place and shared with stakeholders • Experienced permitting authorities; defined process • Many projects have now been consented	• Bureaucratic process that can take many years to complete.	Huge project pipeline has been submitted to the authorities ahead of an appropriate regulatory regime was put in place.
Grid connection & transmission	• National grid access obligation, quick grid connection • Infrastructure law obliges TSOs to bear costs of connecting offshore wind farms to onshore grid • Cluster built out frees export capacity for multiple projects at the same time	• Joint development / synchronisation necessary between clusters and offshore wind projects	Now that the regulatory regime has brought confidence to investors and that grid connection is being addressed and implemented through cluster solutions, the market is taking off.

Key issues	Lesson learned
High level of environmental and human constraints Spatial planning	• Future large sites are all developed in the EEZ • Appropriate spatial planning tools have been put in place and prioritized site selection had initially been identified.
Challenging water depths	• Deep water conditions have been challenging to address and a pilot project helped the industry and public bodies get aligned.
Offshore project sites were allocated in an unstructured manner, not always to the most capable developers and realistic projects.	• Possible rewards for developers reaching successful consent has attracted many applicants before an appropriate regulatory regime was in place, benefiting from an unstructured permitting process. The original regulatory regime was not suitable for potentially high-cost and high-value projects and the majority of permits were lodged before the regulatory regime could be adapted. • Many projects supported by pure developers with limited resources and or with non economic rationale will need to be reprioritized in front of more serious projects with strong owners
Insufficient in incentive scheme due to the increase of costs.	• Incentive scheme had to be revised to take into account of increased cost of offshore wind. An early mover bonus is in place on the short term. • Burden of grid connection cost is transferred to the TSO
Grid connection & transmission of many developments	• Offshore cluster are being planned in order to optimize cost and delivery.
Absence of local industry to support the projects	• Germany has put in place on e of the best regulatory regime and support schemes to bring visibility and long term confidence to investors. As a result, the coastal regional has attracted many new industrial developments to deliver the incoming market.

7.8.2 UK

	Accelerators	Inhibitors	Experience
Policy	• International commitment • Strong political will and engagement • Limitation regarding onshore potential • National economy	• Grid regulations and costs • Undifferentiated incentives scheme	Reform of regulation and incentives for offshore wind has been implemented and has stimulated growth. The alignment of grid regulation to government policy has not been clarified which is a major barrier for future development.
Site approval	• TCE[78]'s licensing process has resulted in 33 GW of project application between 2000 and 2009 in the context of UK round 1 and 2 • UK round 3 has extension of existing projects have been kicked off • As of 1st March 2010, the IPC took over responsibility for the consenting process	• Several projects have faced public opposition or have been refused for environmental reasons	As the results of early stage interest for offshore wind developments, phasing the developments in several rounds has been very positive in terms of consenting efficiency in line with changing policies and targets.
Grid connection & transmission	• An onshore reinforcement plan has been proposed, allowing an additional 34 GW of onshore and offshore generation, with an initial phase to be delivered in 2015	• Introduction of the Offshore Transmission Operator (OFTO) framework applicable to late UK round 2 and UK round 3 projects is threatening to delay the deployment of projects.	Grid has not been a major issue until now but is expected to be a major barrier if uncertainties regarding grid connection and transmission remains. The regulation of electrical grid infrastructure and energy transfer in the United Kingdom is controlled by the independent body, Ofgem. Disputes between offshore wind project developers and network operators are arbitrated by this body whose primary objective is to protect the rights of consumers and not to help the government achieve strategic energy targets. It is argued that this incongruity is not for the long-term good of anyone and has helped to stall offshore wind deployment in the United Kingdom. Alignment of grid regulation and government energy objectives would help to accelerate the deployment of offshore wind.

Key issues	Lesson learned
Multi windows application process	News streamline consenting: • The creation of IPC, a single government body for dealing with consents for all offshore renewable energy projects in the UK has contributed to both the relatively high success rates and short evaluation periods achieved to date. • Further streamlining of the consenting process, including the consideration of strategic national issues, through the forthcoming Marine Bill, is likely to simplify the process further. • Where existing legislation is inappropriate to facilitate renewables deployment in line with government policy, industry should lobby to amend such legislation and, where possible, simplify consenting procedures.
Grid regulation	• Align grid regulation with strategic energy policy.

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The new OFTO regime raised opposition and threatens to delay delivery	• Consultation and upfront dialogue with developers is key to define and deploy new frameworks. The OFTO regime was introduced before the UK round 3 winners was selected.
Fluctuating cost of offshore wind	• Deal with differences in cost and deployment potential when incentivizing renewables. The Renewables Obligation incentive system in the UK does not adapt quickly or severely enough. Reforming the RO, as been necessary to take into account of short term rising costs.

7.8.3 The Netherlands

	Accelerators	Inhibitors	Experience
Policy	• International commitmen t • Recent political engagement	• Unstable support mechanism • Unsuitable and unstable regulation • High cost of grid upgrades	• Successive changes to both support mechanism and regulatory framework have slowed down market take off. Despite this, a very large volume of applications has been made but the system for dealing with these has been unsuitable until a tender process was launched. • To reach the 6GW target, the Netherlands is putting in place a stable concession system and a long term subsidy support mechanism. • Most of the subsidy is based on production; hence only successful projects are rewarded fully.
Site approval	• Far offshore FLOW demonstrat or project	• Absence of efficient framework	• Too many applications were submitted to the authorities prior to a regulatory regime was deployed. • Recent tender round process
Grid connection & transmission	• Grid connection cost are taken into account in the feed in tariff awarded to the developers	• Grid connection cost paid by the developers • Need for grid reinforcement	

Key issues	Lesson learned
Regulatory uncertainty slows down development	• The number of changes in the past years of the subsidy schemes and permitting policies means that offshore wind power has not been as successful as it could have been. Any government support scheme needs to follow the principles of being clear, free from unnecessary change, and sufficiently long term to attract investors.
Appropriate support scheme	• A mixture of tax reduction and guaranteed premium should encourage both indigenous demand and supply. The majority of the subsidy should reward the successful projects with a low levelised cost per MWh.
Spatial planning	• Uncertainty for the developers, generates duplicate work for the permitting authorities, and delays the approval processes. Having a more defined spatial planning process up front to ensure that permit applications do not overlap.
Grid connection & Transmission	• The inclusion of timely and appropriate grid studies and transparency in the timing and allocation of financial and permitting responsibilities is also important, as are the development and publication of grid codes and standards applicable to offshore wind

7.8.4 Ireland

	Accelerators	Inhibitors	Experience
Policy	• Good wind resources • A strategic Environmental Assessment (SEA) is now taking place	• Lack of political will • Uncertain and ineffective planning process • Weak grid conditions	Hardly any developments despite good wind resource potential. The feed-in support scheme was increased. Lack of political engagement and slow progress in upgrading grid and interconnection to UK.
Site approval	• Spatial planning and SEA under preparation	• Unclear process	Very projects have been processed. Arklow bank is the only operational projects The current SEA process may trigger further developments.
Grid connection & transmission	• Limited alternative to wind power. • Interconnector with UK may solve some grid challenges.	• Small grid which delivers electricity for 5-6 million people. • Grid has been a major barrier in Ireland	With no solid grid integration planning in place, no project is able to progress.

Key issues	Lesson learned
Grid integration	Grid connection and transmission planning is key to offshore wind success and must be planned long ahead to the lead time involved.

7.9 Contact information

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