Study on Blue Growth and Maritime Policy within the EU North Sea Region and the English Channel

FWC MARE/2012/06 – SC E1/2012/01

Annex III A - Sector Analysis – Offshore Wind

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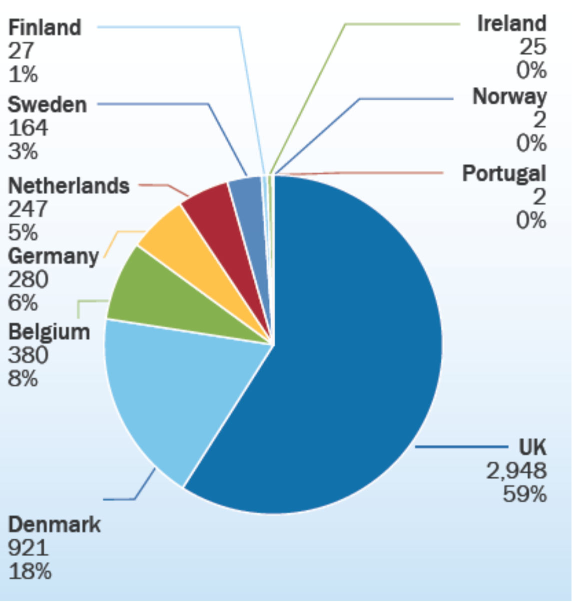
1. State of Play

1.1 Description of the current situation

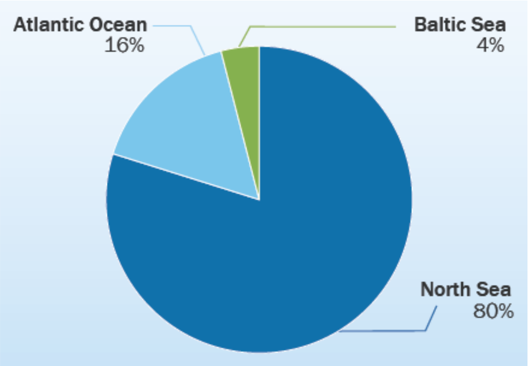
The statement *"The North Sea has […] become home to the greatest concentration of offshore wind arrays (wind farms) in the world, mostly developed in recent years following the Renewables Directive (009/28/EC)."*[1] demonstrates the growing importance of offshore wind for the North Sea region.

Offshore wind technology is thereby following it's "older brother" onshore wind with strong growth rates in recent years. About 5 000 MW of capacity have been installed so far in the EU whereas North Sea countries play thereby a very strong role in the development of this technology. The UK alone as leading country concerning offshore wind has installed 2 900 MW so far and therefore obtains almost 60% of EUs offshore wind capacity.[2]

Figure 1 Installed capacity and new installations of offshore wind in the North Sea (in MW)



Source: EWEA (2013): The European offshore wind industry - key trends and statistics 2012, p.12



Source: EWEA (2013): The European offshore wind industry - key trends and statistics 2012, p.6

Moreover, the North Sea region also proves to remain the driving region for future growth of the sector in the EU. In 2012 1166 MW capacity were connected to the grid in the EU, of which 80% in the North Sea.[3] In 2013 the installation capacity increased even more: in the first half of 2013, a total of 277 wind turbines were fully grid connected, totalling 1 045 MW in seven wind farms: Thornton Bank (BE), Gunfleet Sands 3 (UK), Lincs (UK), London Array (UK), Teesside (UK), Anholt

[1] ESPON (2013): ESaTDOR European Seas and Territorial Development, Opportunities and Risks ANNEX 7 to the Scientific Report: North Sea Regional Profile, p. 44
[2] EWEA (2013): The European offshore wind industry - key trends and statistics 2012, p.6
[3] EWEA (2013): The European offshore wind industry - key trends and statistics 2012, p.6

(DK), BARD offshore 1 (DE). Further 130 turbines, totalling 484 MW, are installed but awaiting grid connection.[4] The following table shows a list of North Sea offshore wind farms put into service.

Table 1 List of selected big offshore windfarms in the North Sea

Windfarm	Capacity (MW)	Turbines	Year put into service	Construction cost	km to shore	Country	Owner
Greater Gabbard[5]	504	140 × Siemens SWT-3.6-107	2012	£650-1500m	23	UK	SSE Renewables
Sheringham Shoal[6]	317	88 × Siemens SWT-3.6-107	2012	£1.1b	17	UK	Statoil 50%, Statkraft 50%
Thanet[7]	300	100 × Vestas V90-3.0MW	2010	£780-900m	11	UK	Vattenfall
Horns Rev II[8]	209	91 × Siemens SWP-2.3-93	2009	€470m	32	DK	DONG
Lynn and Inner Dowsing[9]	194	54 × Siemens SWP-3.6-107	2009	£300m	5	UK	Centrica 50%, TCW 50%
Gunfleet Sands 1 & 2[10]	172	48 × Siemens SWP-3.6-107	2010	£300m	7	UK	DONG
Horns Rev I[11]	160	80 × Vestas V80-2MW	2002	€272m	18	DK	Vattenfall 60%, DONG 40%
Princess Amalia[12]	120	60 × Vestas V80-2MW	2008	€350m	26	NL	Eneco Energie
OWEZ[13]	108	36 × Vestas V90-3MW	2008	€200m	13	NL	Nuon, Shell
Kentish Flats[14]	90	30 × Vestas	2005	£121.5m	10	UK	Vattenfall

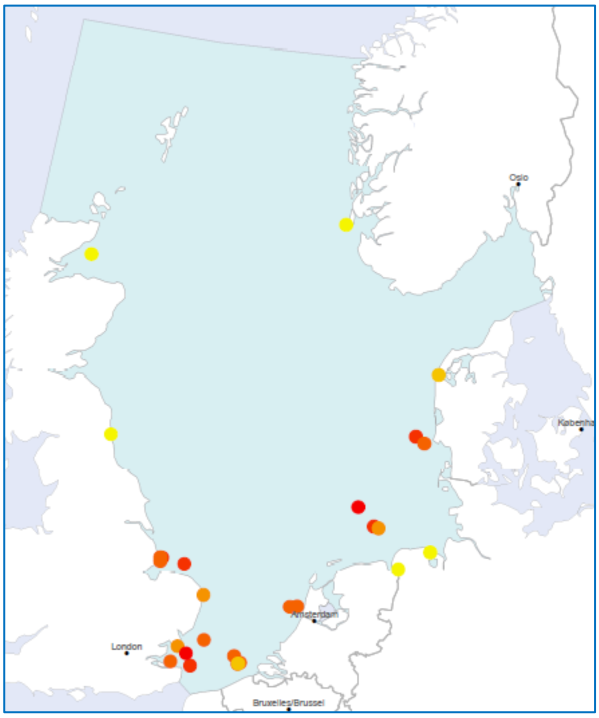
[4] EWEA (2013): The European offshore wind industry - key trends and statistics 1st half 2013, p.2
[5] http://www.sse.com/GreaterGabbard/ProjectInformation/
[6] http://www.scira.co.uk/
[7] http://www.vattenfall.co.uk/en/thanet-offshore-wind-farm.htm
[8] http://www.dongenergy.com/hornsrev2/en/about_horns_rev_2/about_the_project/pages/turbines.aspx
[9] http://www.centrica.com/index.asp?pageid=917
[10] http://www.dongenergy.com/en/business%20activities/generation/electricity%20generation/wind/pages/gunfleetsands.aspx
[11] http://www.dongenergy.com/hornsrev/DA/Pages/index_DA.aspx/index.en.html , http://powerplants.vattenfall.com/node/294
[12] http://www.q7wind.nl/en/index.asp
[13] http://www.noordzeewind.nl/home_14.html
[14] http://www.kentishflats.co.uk/

Windfarm	Capacity (MW)	Turbines	Year put into service	Construction cost	km to shore	Country	Owner
		V90-3.0MW					
Alpha Ventus[15]	60	6 × Multibrid M5000, 6 × REpower 5M	2010	€250m	56	DE	EWE 47.5%
Scroby Sands[16]	60	30 × Vestas V80-2MW	2004	£75.5m	2.5	UK	E.ON
Thorntonbank[17]	30	6 × REpower 5M (will be 56)	2009	€150m	27	BE	C-Power
Beatrice[18]	10	2 × REpower 5M	2007	£35m	23	UK	SSE and Talisman Energy
Blyth Offshore[19]	4	2 × Vestas V66-2MW	2000	£4m	1.6	UK	E.ON
Hywind[20]	2.3	1 × Siemens SWP-2.3-82	2009	NOK 400m	10	NO	Statoil

The listed wind farms are also shown in the figure below which shows the so far preferred geographical location of such wind parks.

[15] http://www.eon-uk.com/481.aspx
[16] http://www.alpha-ventus.de/
[17] http://www.c-power.be/applet_mernu_en/index01_en.htm
[18] http://www.beatricewind.co.uk/home/default.asp
[19] http://www.narec.co.uk/demonstration/blyth-offshore-wind-demonstration-site
[20] http://www.statoil.com/en/technologyinnovation/newenergy/renewablepowerproduction/offshore/hywind/pages/hywindputtingwindpowertothetest.aspx

Figure 2 **Installed offshore wind farms in the North Sea**



**the darker the colour, the higher the MW capacity*

Source: ESPON (2013): ESaTDOR European Seas and Territorial Development, Opportunities and Risks ANNEX 7 to the Scientific Report: North Sea Regional Profile, p. 45

The strong growth rates in installation in recent years led to about 30 000 [21] jobs in 2012 directly linked to offshore wind. As offshore wind is still in a development stage, most jobs (> 90%) are linked to manufacturing and installation. Over time there will be a shift towards more jobs also in maintenance of installed wind farms. Furthermore the offshore wind sector in the North Sea generated an estimated € 2 bn[22] of GVA. Given the data for the first half of 2013 a doubling of employment and GVA can be expected in comparison to 2012. These estimates are supported by observations from the UK where direct employment doubled between 2010 and 2013 from 3 151 to 6 830.[23]

1.2 Description of the value chain

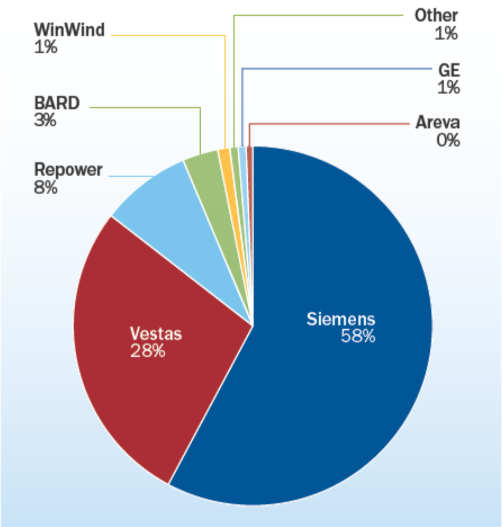
As visible in the estimations above, offshore wind creates employment in various areas. These range from research and development to maintenance of installed capacity.

In times of globalisation, different countries are stronger in different parts of the value chain. While operation and also parts of the development (demonstrators) need to be located in the sea, component production can take place also in countries without access to the sea. As seen above, the strongest country with a North Sea coastline concerning operation of offshore windfarms is the UK. On the other hand market leader on EU wind turbine manufacturers is the (Danish origin) German Siemens Wind Power. Siemens is serving 58 % of Europe's wind farms, followed by the

[21] Based on multipliers from Rutovitz, J. and A. Atherton (2009): "Energy sector jobs to 2030: a global analysis." Final report. Institute for Sustainable Futures. Study conducted on behalf of Greenpeace. P.10 which 0.77 jobs/MW in maintenance, 4.8 jobs in construction/installation per MW and 24 jobs/MW in manufacturing.
[22] Estimation based on the ratio GVA/employee in Ecorys (2012): Blue Growth Scenarios and drivers for Sustainable Growth from the Oceans, Seas and Coasts, p.35
[23] http://www.offshorewind.biz/2013/09/19/uk-number-of-offshore-wind-jobs-doubles-in-the-last-3-years/

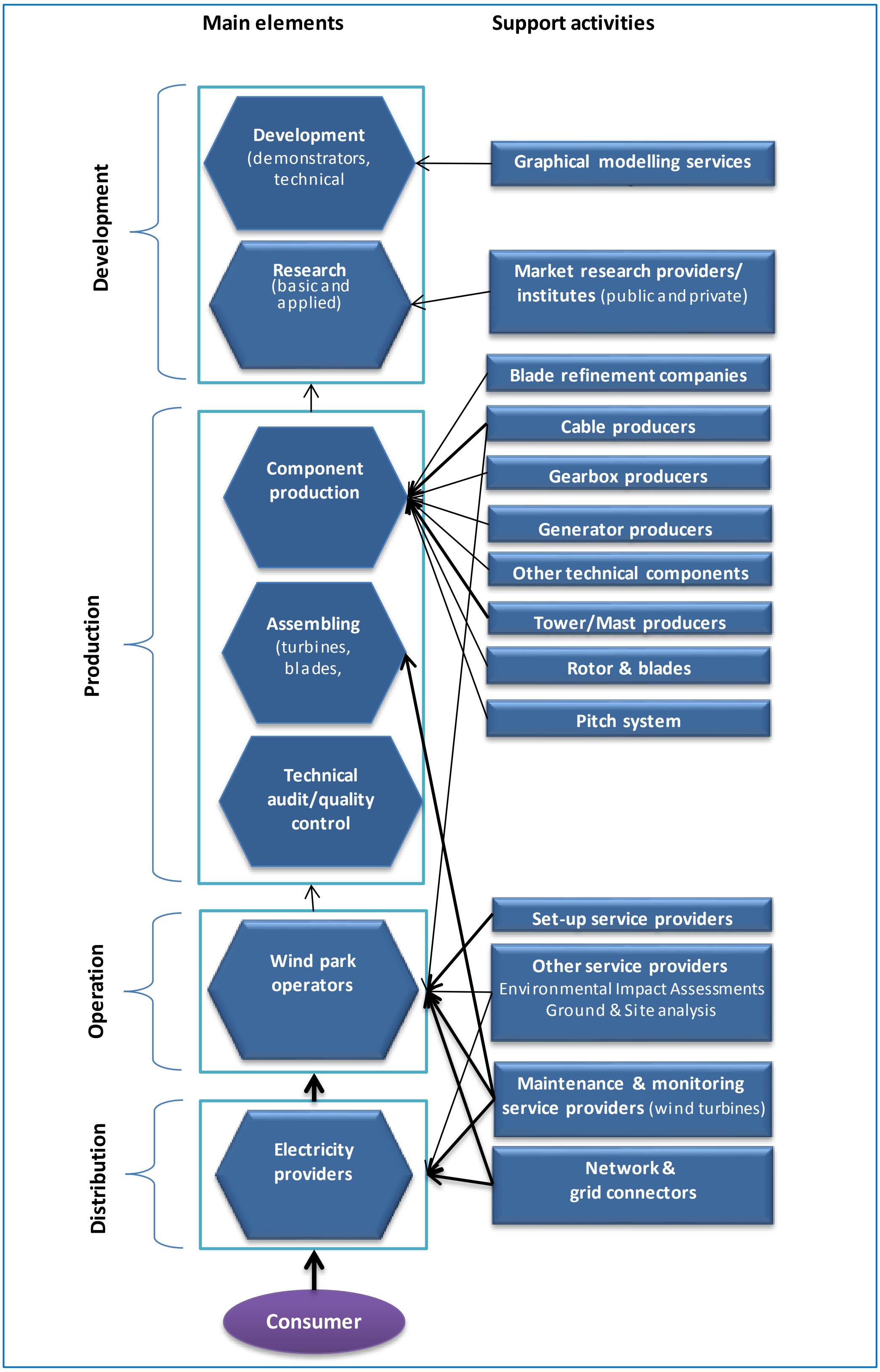
Danish Vestas (28%). Together the two companies have an 86% market share which can be raised to 94 % when including the third strongest provider (Repower). This strong concentration shows that there are so far only few companies which have strongly invested in the field at a development stage, but more are expected to come when technologies achieved a more mature stage.

Figure 3 **Market share of turbine producers**



Source: EWEA (2013): The European offshore wind industry - key trends and statistics 2012, p.14

Figure 1 Indicative value chain for the offshore wind industry



Source: Ecorys

1.3 Strengths and weaknesses

The sector characterized by several strengths and weaknesses which are in some cases of general validity for offshore wind and in some specific for the North Sea. The following table provides an overview of the main strengths and weaknesses discovered:

Table 2 Main strength and weaknesses of offshore wind in the North Sea

Strengths	Weaknesses
• Already substantial capacity installed in the North Sea • Shallow waters and strong winds • Proximity to major urban centres and electricity users • Large parts of the value chain situated close to North Sea • Ports offer good infrastructure • Substantial research basis, supporting site selection and innovation • Employment offered, not only in installation but also in maintenance	• Costs of offshore wind production still high (150 Euro per MW installed) • Rough environment of the seas leads to technical challenges and high maintenance costs • Fluctuation in supply – depending on wind speed • Limited grid connectivity – and high costs related to these • Strong dependence on public financial support • Fragile equity position of certain providers

Source: Ecorys

Strengths

Substantial capacity, in particular in the North Sea has been installed so far. For the North Sea this means a worldwide leading position in this sector. This can serve as a first mover advantage where experiences are collected, the political environment is already familiar and skilled people are already located close by.

The *shallow waters* (< 30 meters) *and strong winds* are important factors. Even though parts of the North Sea are deeper, the depth is still a considerable advantage as compared to other sea-basins. High wind speeds are equally crucial.

As long as long-distance transportation of electricity is problematic, the relative *proximity to urban centres and electricity users* is important as well. This advantage is especially strong in the UK, and less so in the German or Netherlands parts where distances to population centres are substantially larger.

Leading industries (Siemens, Vestas) are *located* in North Sea countries. Their geographical proximity lowers costs of transport and facilitates the cooperation between operators and producers. *Ports* are relatively well equipped as well, which is important as the ever larger wind turbines pose specific challenges in the installation phase. Ports are also important for servicing the wind parks.

Research for offshore wind can build on experiences from onshore wind as well as offshore experiences from other sectors (e.g. offshore oil and gas). In addition there is a solid basis of research already conducted for offshore wind which new projects can build on. The North Sea has a large concentration of research centres as well as industrial players

The North Sea is already a place of many offshore activities, and therefore offers a unique skills base. In addition to the skilled engineers which are needed in production and installation, the area can draw on *experienced workers for maintenance* in the area.

Weaknesses

Costs for offshore wind are still far too high to be competitive. Installation costs are on average € 150-200 per MW installed. But this current weakness may be tackled by an expected steep learning curve in installations and logistics. There are expectations that this might lower the costs by 33 to 50 % in the upcoming years. Also maintenance costs for the newest generation of turbines are expected to decrease as they are less sensitive to the high sea. Furthermore, installation costs could further reduce once new exploitation statistics become available: some wind parks turn out to generate up to 50% more electricity than originally planned.

Technology and staff are facing *a rough environment offshore*. Salty water and strong winds are creating a demanding environment for the technology. The installation in deep sea waters is highly complex and costly.

As for other renewable sources, the supply of offshore wind energy depends on *fluctuations of wind*. Even though winds are more constant offshore, they are underlying fluctuations. This creates a problem when matching demand and supply, especially so when strong winds coincide with low demand – in which case lots of excess electricity is sold on international markets for very low prices.

Grid connections are mainly radial – based on national grids. This point-to-point network is considered suboptimal as it fails to connect various wind parks jointly and as it contributes to fragmentation of markets.

A final weakness concerns the strong dependence on *public financial support*, which is open for review. Within the context of the public budget crisis, governments are increasingly reviewing their public support schemes and the tendency is to cap such public support. [24] Even more important, the EU policy framework is currently only in place until 2020 and the uncertainty about the period afterwards already discourages new plans and initiatives right now. Adding to this, the equity position of certain wind energy providers can be weak, as there is a time gap between investment costs and returns from exploitation. [25]

[24] For example the Belgian federal government reviewed its wind energy support policy in early November 2013. Consumers and industry contribute through a surcharge on electricity prices, amounting to € 250 mln. per year. The overall contribution of industry will now be capped to € 250,000 per company. The remaining deficit will for the moment be supplemented by the federal government.

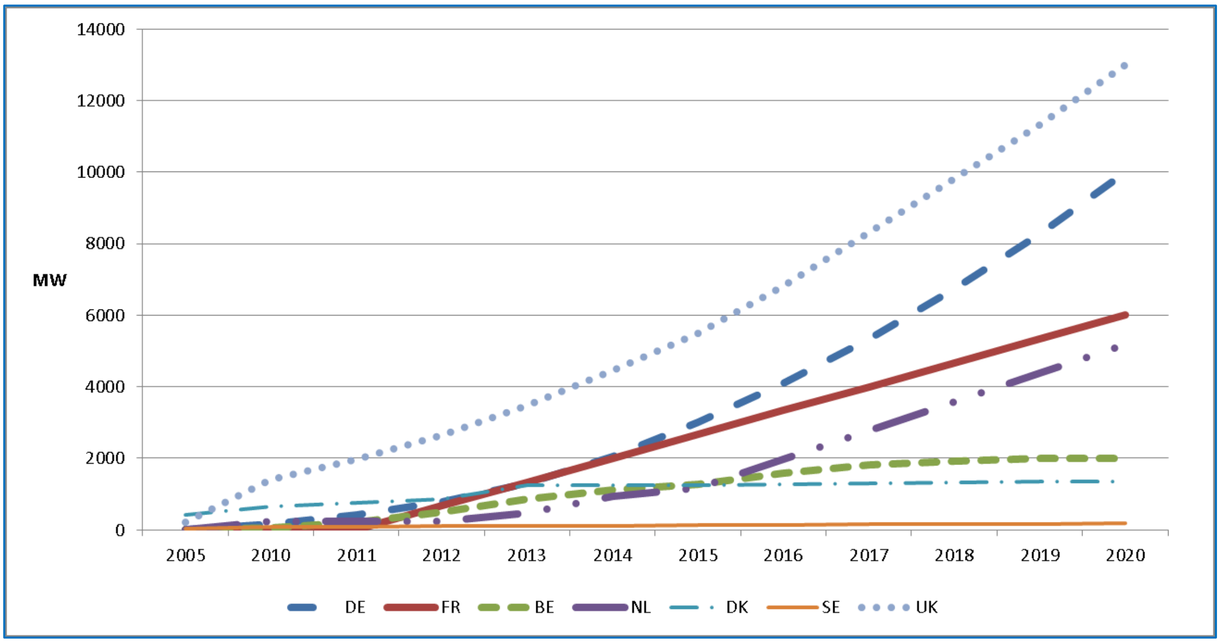
[25] For example, the Belgian Electrawinds company suffers currently from such equity shortages, preventing further investments (Trends weekly journal, 31/10/2013).

2. Analyse the sector's potential to achieve Blue Growth during 2014-2020

2.1 Key trends

As a growing technology, offshore wind can contribute substantially to achieve Blue Growth in the upcoming years. An indication of this ambition are the National Renewable Action Plans (NREAPs) of all countries along the North Sea. Apart from Norway (which does not declare any offshore wind targets until 2020[26]), all countries show an ambition to invest in offshore energy's development. The following figure shows the planned development until 2020.

Figure 2 Offshore wind ambitions in North Sea countries (except Norway) until 2020 according to NREAPs



Source: Ecorys based on NREAPs

As visible in the figure above, especially the UK and Germany plan to expand offshore wind energy capacity, making it a major component of their national energy mixes[27]. The most ambitious country, the UK, plans investments on both coasts (Atlantic and North Sea). There are currently two offshore wind farms under construction on the west coast and two on the east coast (North Sea: one in Buckhaven and one in the east of Hull). All further (7) currently approved projects will be implemented in the North Sea (4 of them in the Bay between Hull and Norwich).[28] In Germany all major future developments are expected to happen in the North Sea[29]. The third most ambitious country according to the figure, France, has to be treated with care in this analysis as virtually none of the projects are expected to happen along the North Sea coast. Sweden's targets are low and

[26] Ministry of Petroleum and Energy (2012): National Renewable Energy Action Plan under Directive 2009/28/EC Norway, p.132-134
[27] ESPON (2013): ESaTDOR European Seas and Territorial Development, Opportunities and Risks ANNEX 7 to the Scientific Report: North Sea Regional Profile, p. 44
[28] Renewable UK: http://www.renewableuk.com/en/renewable-energy/wind-energy/uk-wind-energy-database/index.cfm/map/1/status/Consented/project_type/offshore/
[29] Expert judgement

anyhow focussed on the Baltic Sea. On a country level we can already compare to what extent Member States comply with their own targets.

Table 3 **Member States NREAP Cumulative Offshore Wind Installation Targets for 2012, and Real Installations (MW)**

Country	NREAP target	Real Installations	Difference
Belgium	503	380	-24.5%
Denmark	856	921	+7.6%
France	667	0	-100.0%
Germany	792	280	-64.6%
Netherlands	228	248	+8.8%
Sweden	97	164	-69.1%
United Kingdom	2,650	2,948	+11.2%
Total	**5,793**	**4,941**	**-14.7%**

Source: Ecorys based on EWEA (2013): The European offshore wind industry - key trends and statistics 2012, p.13

As visible in the table above, the performance of countries since publication of the NREAPs differs substantially. Overall, the countries are below their target (-14.7%). However, the example of the UK where already large installations have been made shows that further growth is easier achievable when preparations (e.g. legislation, grid,…) are further developed than when starting from zero. More surprising is the lower performance so far of Germany, given the decision of Germany to exit nuclear energy. Under such conditions a stronger engagement in the up-coming years in Germany can be expected. Furthermore, North Sea countries offshore wind manufacturers are expected to have export potential of their tested technologies to other regions worldwide.

2.2 Key drivers and barriers for growth

Table 4 **Overview of key drivers and barriers to growth**

	Drivers for Growth		Barriers for Growth	
	Driver	**Best practice example**	**Barrier**	**Best practice**
Maritime research	Research on wind strength in the North Sea help to improve the choice of location of wind farms	NORSEWIND		
Development and innovation	Innovation in new concepts and technologies	Manmade Island	Strong innovation is needed to address technical hurdles.	
Access to finance	Large players in the sector provide financial guarantees		Projects are very costly and profitability is still limited	

Smart infrastructure	Putting in place a supergrid for Europe's renewable energy sources would drastically reduce cost and therefore increase profitability		Still very national set-up of grid development	Belgium as well as Germany create hubs for their wind parks
Maritime clusters		NORTH SEA MARINE CLUSTER (NSMC)		
Education, needs in training and skills	Skills acquired from onshore wind can help to build the basis for the wind farms as well as experiences with offshore oil and gas		Shortage of engineers willing to work on the rough seas	
Maritime spatial planning	Substantial opportunities for synergies	MERMAID	Offshore wind parks pose problems for shipping	Netherlands decision to adjust shipping lanes
Integrated local development	N.a.		N.a.s	
Public engagement	Resistance of on-land wind turbines can be addressed;		Offshore wind close to the shore receives resistance	
Market prices	Higher electricity prices will provide a boost to investor's appetite		Lower prices will provide a brake to investors'appetite	
Competition from other energy sources	Wind likely to become more competitive in the North Sea than other renewable energy sources (e.g. ocean renewable energy)		Large-scale Shale gas exploitation reduces investor interest	
Combining other energy sources	Multi-purpose platforms; synergies with ocean renewable energy	MERMAID; Belgian Energy island		

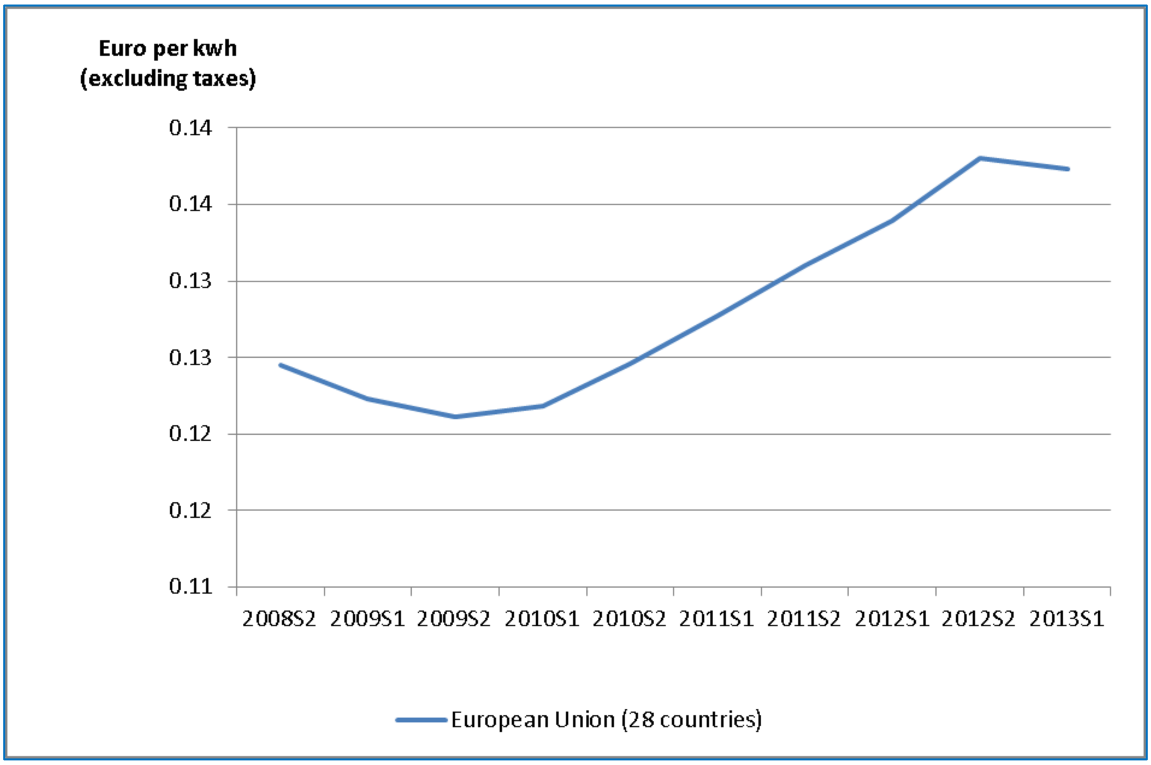
Maritime Research

NORSEWIND providing an offshore wind atlas - Norsewind is a project to reduce the uncertainty and unpredictability of wind power in the North Sea. It's output is a dependable offshore wind atlas of the North Sea, the Irish Sea and the Baltic Sea. The budget of the four years project coordinated by Oldbaum Services and carried out by a consortium of 21 partners throughout Europe was 7.9 mln € (whereas about half of the amount was funded under the EC FP7 programme). [30]

Market prices for electricity

A driver for new investments in offshore wind are electricity prices. The higher these prices the more willingness to invest in renewables (and also offshore wind). The following figure shows the development of electricity prices in the last five years.

Figure 3 **Development of electricity prices in the EU 2008-2013**

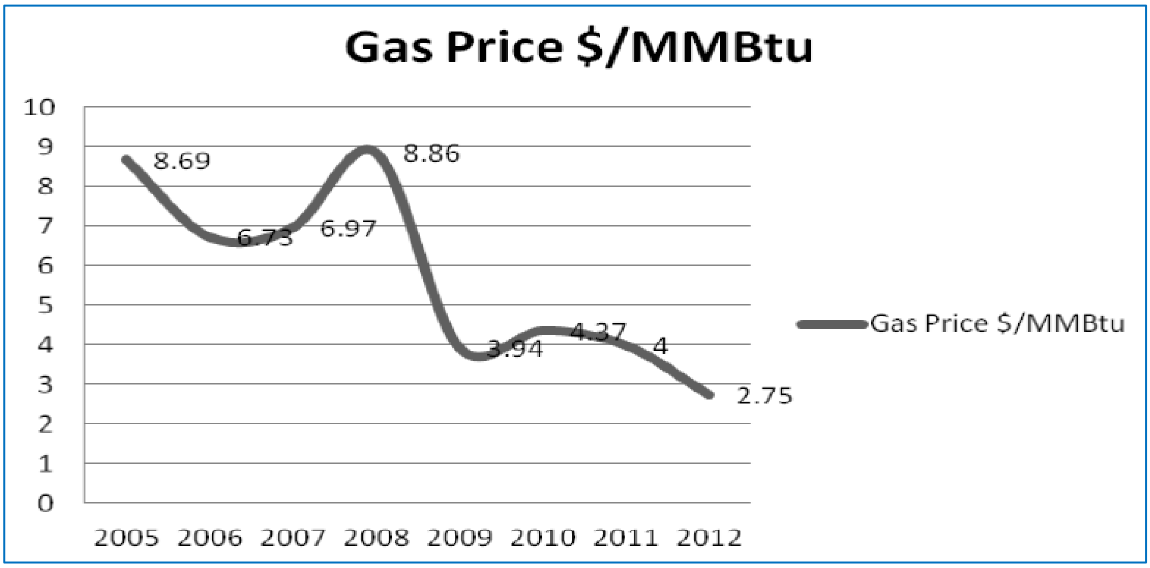


Source: Eurostat (2013)

As we can see in the figure above, after decreasing electricity prices (due to the Crisis) in 2009 the prices started to increase again. Furthermore, in the UK and Germany (two North Sea countries) prices went up particularly strong. Such a development is a positive incentive for investments in offshore wind. Given the increasing demand for fossil fuels, the prices are in general expected to further increase in the next years. However, there is one factor of uncertainty which may reduce electricity prices in the foreseeable future: the use of unconventional gas (shale gas) predominantly in the US. Massive investments in the US into shale gas extraction have led to a strong decrease in costs for gas. According to the IEA, this has a knock-on effect on the price of other non-renewable energy sources such as goal. As global energy markets are increasingly connected, this can lead to a downward pressure on European energy prices as well – and make the cost gap with renewable energy (such as offshore wind) larger.

[30] http://www.norsewind.eu/

Figure 4 **Development of the US gas price 2005 - 2012**



Source: EIA used in
http://www.erec.org/fileadmin/erec_docs/Documents/EREC_Factsheet_on_Affects_of_Shale_Gas_on_RES.pdf

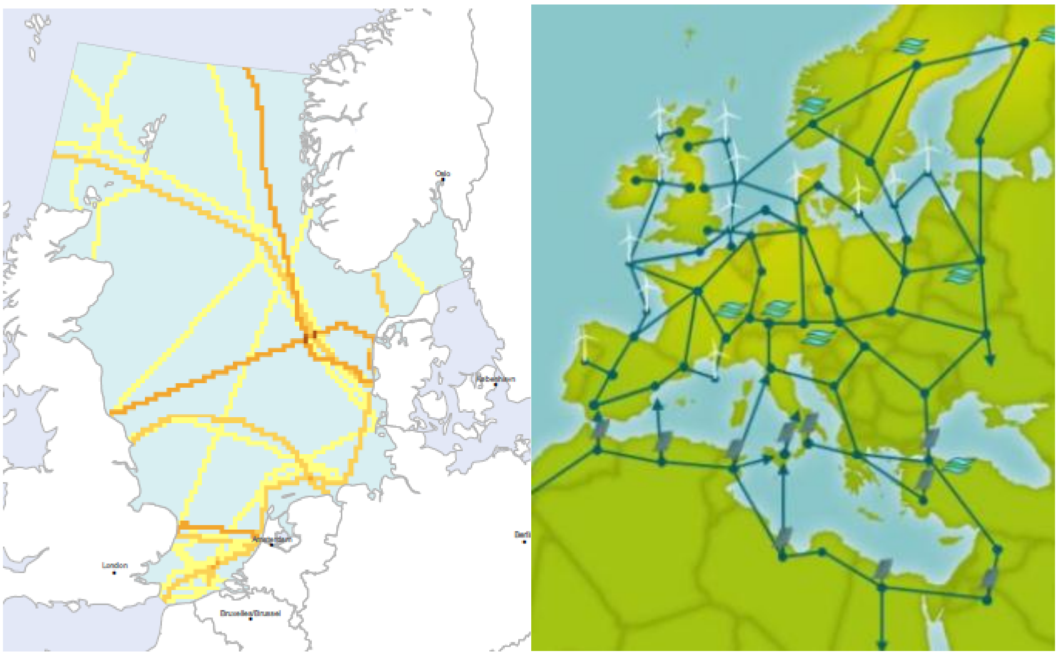
Smart infrastructure

Associated with the development of offshore wind in the region is the development of offshore grid systems to bring supply onshore as well as plans to develop a transnational North Sea grid to facilitate power sharing across northern Europe.[31] Up to the current state, grid connections are focussed on point-to-point connections. This is the result of a mostly national viewpoint of most stakeholders. As a result there are mainly national regulations, national subsidies and national interests respected. Thus short term actions of direct point-to-point connections are supported. For example, wind farm developers can now ask for the connections only in a very advanced stage of development – sometimes when windturbines are ordered. This makes it more difficult to connect multiple windfarms and further explains the radial connection patterns.

However, as renewable energy power plants are less predictable than e.g. gas, on a smaller market without a European grid, there is always the need for a back-up solution. This increases costs and is therefore a barrier for growth of all, but especially offshore technologies. One way to reduce costs may be connecting offshore wind farms in hubs. Some claim that these cost reductions can be substantial. A recent study for example showed that in the EU “connection costs for offshore wind farms up to 2030 can be reduced by €14 bn by sharing connections via hubs compared to a business-as-usual individual wind farm connection”[32]. The cost reduction would be especially high for Germany (€9.4 bn, 34%), the United Kingdom (€1.9 bn, 8.7%) and the Netherlands (€1.8 bn, 22%) where wind farms are often far from shore and concentrated in a few specific areas. Nevertheless, this reduction of prices underlines the expected realisation of a common renewables market as well as a supergrid network[33] in the upcoming years. According to industry representatives, such a development is expected to happen around the year 2020 (might be earlier or later depending on the political will). The claim is that the existence of such a grid can serve as a boost for further offshore wind installations in the North Sea. However other sources (such as those used by DG ENER) point to substantial lower benefits of really matched offshore grids – except for wind parks built in mid-sea.

[31] ESPON (2013): ESaTDOR European Seas and Territorial Development, Opportunities and Risks ANNEX 7 to the Scientific Report: North Sea Regional Profile, p. 44
[32] Offshore Grid (2011): OffshoreGrid: Offshore Electricity Infrastructure in Europe
[33] A network making transfer of renewable energy from Northern Europe to Southern Europe an vice versa possible.

Box 2 **From grid to supergrid**



Sources: ESPON (2013): ESaTDOR European Seas and Territorial Development, Opportunities and Risks ANNEX 7 to the Scientific Report: North Sea Regional Profile, p. 48, http://www.friendsofthesupergrid.eu/

Currently grid connections in the North Sea are built on a project by project basis and therefore similar to onshore grid connections (point-to-point). Nevertheless, there are visible steps undertaken by several actors towards a hub-based supergrid. Belgium as well as Germany are in the process of connecting their own offshore wind parks in hubs to reduce cost. At a later stage such hubs could be connected between each other, as soon as a common renewables market and a common regulation exist. Such a connection between wind parks of different countries would not only further reduce costs, but also help to reduce the unpredictability of renewables. A grid/market covering various states attracts much more investments as oversupply in one country can counterbalance over demand in another.

Source: Expert interview

Connections on a smaller scale, which can serve as the basis for a supergrid are already taking place and listed as “Project of Common Interest/Cluster of PCIs” by the European Commission categorised under “Electricity Northern Seas Offshore Grid (NSOG)”. Examples are:

- interconnection between Endrup (DK) and Niebüll (DE)
- PCI Denmark - Netherlands interconnection between Endrup (DK) and Eemshaven (NL)
- PCI Belgium – two grid-ready offshore hubs connected to the onshore substation Zeebrugge (BE) with anticipatory investments enabling future interconnections with France and/or UK
- PCI Germany - Norway interconnection between Wilster (DE) and Tonstad (NO) [currently known as the NORD.LINK project]
- Cluster Belgium – United Kingdom between Zeebrugge and Canterbury [currently known as the NEMO project][34]

[34] DG ENER (2013): Project of Common Interest/Cluster of PCIs, http://ec.europa.eu/energy/infrastructure/pci/doc/2013_pci_projects_country.pdf

Combining energy sources

Another way of boosting offshore wind by reducing its cost is the use of synergies and a combination of different sources. Ocean energy (covering four technologies: wave, tidal, OTEC, osmotic with wave and tidal being the more mature ones) is another source of energy generation offshore which is expected to substantially grow in the upcoming decades. Even though, ocean energy has not really overcome the development stage it can, in combination with other offshore technologies, help to boost each other. There are projects (e.g. MERMAID) to combine offshore wind farms with other functions (aquaculture, new ocean energy technologies, …)

Box 3 **The ideal multipurpose design - MERMAID**

The FP7 project “MERMAID” is one out of three EU funded projects (the others are: TROPOS and H2OCEAN) towards more innovative multi-purpose off-shore platforms. The specificity of this project is that it is not innovative in a technological sense, but in the sense that it searches for the optimal combination of existing technologies depending on the location of the platform. The idea is to use the space between offshore wind farms for other functions (e.g. aquaculture). The advantage of this approach is that it avoids to create even more technological difficulties (as the proper installation of a offshore windfarm is already difficult enough) which raises the chance of earlier implementation of the concept.

First findings of the 7,4 million euro project (5.5 million euro EU contribution) show that especially construction sector is very open to these platforms and does not see many problems in adding further functions to the structures (as long as this is taking place ex-ante).

The aim of the project is to design the ideal combination for four different typical Seas so that every country in the EU (with access to the sea) can profit from the modeling of the technology. Included in the project are 30 partners and various stakeholders at three stages of the planning. At the very moment the ideal multipurpose platform for the North Sea combines offshore wind, sea weed and mussel farming. The implementation of such multipurpose platforms is already in process in the Baltic Sea. Nevertheless, until 2020 the majority of new wind parks will be built as single purpose platforms as the planning and permission process take several years for offshore projects. From 2020 on we expect more and more multi-purpose platforms to be built and in the long-run that these will be the majority.

Two drivers for such a development can be a different subsidies regime (incentivizing to create multiple purpose platforms) and/or the need to decrease the costs for offshore wind power.

Sources:

http://www.mermaidproject.eu/ as well as one interview

Such marine energy farms would profit from a common grid, lower construction and maintenance costs. Nevertheless, the costs of planning as well as the installation time are higher than for simple offshore wind farms.

But offshore wind technology cannot only be combined with upcoming new renewable technologies, but also profit from offshore oil and gas:

- Power Industry OEM’s (Original Equipment Manufacturers) understand design for manufacture for the conditions offshore

- Oil and gas contractors have experience in delivering mega offshore projects on time and budget[35]

As large offshore investments are very costly all synergies possible need to be used to support a strong growth of the offshore wind sector. Especially in the North Sea experiences with offshore oil and gas (especially driven by the Norwegian Statoil) can serve as a source for skills and knowledge to further improve the process of production and installation of offshore wind farms.

Box 4 **Offshore oil industry investing in offshore wind – The Hywind project**

The Hywind project, the world's first full-scale floating windturbine, conducted by Statoil starting in 2009 shows the potential involvement of offshore trained oil and gas companies in the development of new offshore wind technologies.

Source: http://www.windpoweroffshore.com/article/1216471/statoil-pulls-hywind-maine-project

The ten kilometres off the south-west coast of Norway installed pilot project had as a primary intention to be a demo and not to derive revenues from the power. Hywind has generated 15 MWh of production since start-up in 2010.

Even though the company decided in 2013 to freeze the further development of the project, it remains a symbol of potential involvement of oil companies into offshore wind in the North Sea.

Sources:

http://www.statoil.com/en/technologyinnovation/newenergy/renewablepowerproduction/offshore/hywind/pages/hywindputtingwindpowertothetest.aspx

http://www.windpoweroffshore.com/article/1216471/statoil-pulls-hywind-maine-project

One criticism towards renewables as wind or solar energy is their unpredictability and inflexibility. When more electricity is needed it is rather easy to turn on a gas or coal power plant, but not possible to "turn on" a wind farm. Therefore a challenge for the future is to better store energy generated in offshore wind farms and to make it accessible when demand rises.

One example of an idea how to best store such energy is the Belgian plan for an **artificial energy atoll** – a manmade energy island. The idea is to build an artificial island 2.4 kilometres wide close to the coast. There they make use of the oldest and most cost-effective bulk energy storage there

[35] Petrofac: Synergies between Offshore Oil and Gas and Offshore Renewables, http://www.windplatform.eu/fileadmin/ewetp_docs/Events/2nd_Energy_Event/Andrew_Donaldson.pdf

is: pumped hydro. During off-peak times, power from the turbines would pump water up 15 meters to a reservoir. To generate electricity during peak times, the water is released to turn a generator. This would allow to be able to better address energy needs also in times when the wind farm does not generate a lot itself. Moreover, the plan is not to finance the project with public money but to attract private investors.[36] Informal sources from within DG ENER confirm that these plans are worth considering and deserve to be scrutinised.

http://www.technologyreview.com/view/510806/a-manmade-island-to-store-

Maritime Clusters

Clusters like **"The North Sea Marine Cluster (NSMC)"** can help to develop regional strategies. This cluster was identified by the Lisbon Agenda and part of the UK Government policy. Its central aim is to develop a collaborative strategy for the region. Members included are Gardline, the Nortfolk County Council and the University of East Anglia. By combining research institutions as well as local administration it helps to raise knowledge about challenges and business opportunities in the North Sea.[37]

[36] http://www.technologyreview.com/view/510806/a-manmade-island-to-store-wind-energy/

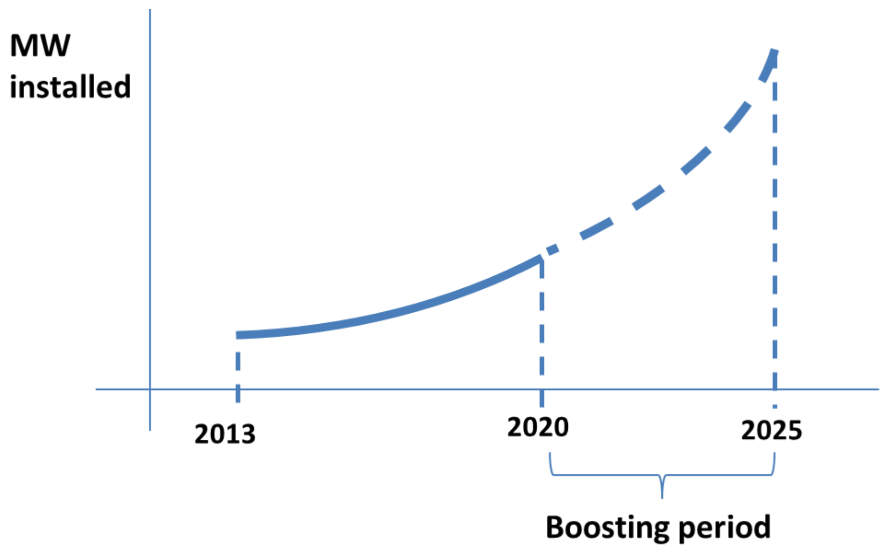
[37] http://www.nsmc.eu.com/page/about-the-cluster

3. Overview of growth scenarios for the sector at Sea-basin level

3.1 Potential development: Description of economic and infrastructural scenario

Building on the present knowledge about the sector we can create a microfuture for the sector until the year 2025. The research underlined by interviewees has shown that the sector has huge potential in the North Sea and is expecting strong growth rates until 2020. Given the long preperation time (planning, getting permissions etc.) before actual installation the period until 2020 is already rather certain. But the innovation and development in the sector is not stopping. Many ideas are currently in a testing phase and the regulatory framework under discussion. These factors may lead to an even stronger development after 2020 which can be called a “boosting period” from 2020 to 2025. The following figure illustrates such a positive future development:

Figure 5 A scenario for EUs offshore wind 2025



Source: Ecorys

It is expected however that the factual realisation of installed capacity will fall somewhat behind the current plans. The actual performance in the period 2020-2025 will depend on the development of a number of critical factors which are being shaped up right now. Such key factors can be either drivers or barriers for growth. The key factors for offshore wind in the upcoming years are:

- Electricity price – the development of non-renewable energy sources
- Technological development and construction costs
- Access to finance – both loans and equity
- Regulatory framework – which is currently not known for the period beyond 2020
- Public support
- Grid development and Supergrid
- Multipurpose platforms

3.2 Key factors and uncertainties towards a boosting period

Despite the optimism that offshore wind will move into a boosting period in the upcoming decade there are several uncertainties which can hamper an optimum development of the sector. In the following we explain the key factors which need to follow a positive development to get to a boosting period 2020-2025.

Electricity price

One driver for renewables is the development of the electricity price. Increasing prices of fossil fuels reduce the gap of competitiveness for all renewables and make therefore an investment in new technologies more attractive. However the development of such prices remains uncertain as new energy sources – notably unconventional or shale gas have a downward pressure on all non-renewable energy sources including coal. This development could be further influenced by decisions within the EU, notably in the UK where openness to shale gas tends to be high. A European decision for shale gas exploitation will not only draw public attention away from renewables, but also reduce the private interest in investments in offshore wind.

Technological development

Installation costs are still high (€150-200 per MWh) and preventing competitiveness. There is a steep learning curve in installation and logistics which leads to the expectation that these costs could go down to €100 per MWh provided the large-scale projects are being realised. Furthermore the newest generation of turbines (e.g. direct drive turbines) are less sensitive to the rough seas which should lower maintenance costs. Moreover there is growing experience in dealing with manned platforms and using offshore/specific vessels.

Access to finance

The current appetite of private banks to invest in long-term investment projects such as offshore wind is limited. Public financial instiutions such as the Kreditanstalt für Wiederaufbau (KfW) and the European Investment Bank (EIB) are important actors in this field, as they have a longer term focus. However a minimum of equity capital will remain important as well, and the willingness of major electricity companies to fully join this type of investment remains crucial. The general situation could improve in 2-3 years when exploitation data become available, which are likely to point towards higher yields – up to 50% above expected yields which would be a bonus and help to get access to finance.

Regulatory framework

The regulatory framework needs to adapt to the needs of the sector to further boost its development. Currently the energy markets are a domain of national interests which hamper a European connectivity and a common development. There is a need for a single market for renewable energy sources. The current legislative framework runs out in 2020 and the EU's energy policy beyond 2020 is currently being developed. However, this creates already regulatory uncertainty in the market right now – as it prevents investors from making precise assessments of investment plans.

Public support

Due to the budgetary situation of many Member States the public support is limited. Especially the appetite to support onshore wind and PV is very limited now. Public actors still regard offshore wind relatively favourably, however the major investments related to further expansion of offshore wind can still be considered daunting from the perspective of the public purse. In any case, the need is felt for more market-conform instruments than the current feed-in tariffs.

Multipurpose platforms

The modelling and testing of multipurpose plattforms (e.g. MERMAID) is under way and more and more installations of such type are expected to happen from 2020 on. These multifunctional projects may help to reduce costs of offshore wind and therefore help to further boost investments in the sector. In the North Sea such platforms are ideally a combination of offshore wind, acquaculture and sea weed farms. The positive side effect of such an integrated approach is that their negative environmental impact is expected to be quasi zero. However, given the state of development and size of activities, such cost advantages are most likely to be limited from the offshore wind perspective.

Grid developments and Supergrid

Wind parks in Belgium and Germany are currently connected to hubs. The next step will be to connect these hubs with each other. Given the existence of a single renewable energy market in the EU (which is not yet in place), a so-called supergrid (combining the North Sea countries with the Southern European countries) will not only reduce costs of connection, but also overcome the problem of unpredictability and unstable electricity generation. In a simplified way, this means that in winter, when Northern Europe needs a lot of energy to heat houses, there is additional supply coming from renewables in the South, while in summer, when Southern Europe needs a lot of energy to cool their houses, electricity comes from offshore wind farms in the North Sea. In the ideal case, a common supergrid may provide the possibility to use renewables from all over Europe wherever needed on the continent. Furthermore it reduces the necessity for back-up solutions and therefore further reduces costs of offshore wind. This will help to boost further the development. According to the “Friends of the Supergrid” the Supergrid will come, but it is not yet clear when it will come. The difficulty about a well-functioning Supergrid lies in the coordination and especially in the fact that first a common market for renewable energies needs to be created. Without such a market and the clear commitment to invest in such a grid, the grid connections will remain point-to-point or maximum onshore to national offshore hub.

3.3 Synergies and tensions: potential environmental consequences and spill-over impacts to other sectors

Table 5 **Key impacts of the expected trends on the sector**

Type	Key questions	Extent of impact
	Economic	
Competitiveness, trade and investment flows	What is the sector`s impact on the global competitive position of the EU? Is the sector characterised by high cross-border investment flows (including relocation of economic activity- outsourcing)?	The sector is of high strategic importance to keep Europe’s leading position in renewables and especially wind. A successful development in the North Sea can become a prototype to sell towards other parts of the world

Type	Key questions	Extent of impact
Operating costs and conduct of business/Small and Medium Enterprises	Are there special procedural elements that burden enterprises in this sector? E.g. exploration costs Does it impact on the investment cycle?	High entry costs and an inhomogeneous regulatory framework hamper development for SMEs in the sector
Administrative burdens	Are there specific information obligations placed on businesses in the sector? What is the impact of these burdens on SMEs in particular?	There is no common market for RES and no common grid. This creates a very “national” based approach which creates administrative burden.
Innovation and research	What the stage of innovation intensity characterises the sector? Low-innovation, medium innovation or high innovation Is there a hidden innovation potential in the sector? What is the impact of the stage of innovation on sector performance?	The sector is characterised by high innovation, but also still remaining high innovation potential. The clear will to invest in the sector and the strong barriers oblige strong innovation capacity.
	Social	
Employment and labour markets	Does the sector development trend indicate a growth in employment? Does it affect particular age groups? Does it affect the demand for labour?	In the upcoming decade large installations are expected which leads to a strong increase in employment. This effects specially qualified staff on the field as well as manufacturing staff. In the long run specialists for maintenance will be of higher demand.
Social inclusion	Does the sector development trend indicate changes in access to the labour market? Does it affect specific groups of individuals (gender, age or ethnic group) more than others?	In installation it affects mainly male and young people as these are to be done in rough environment.
Access to educational systems	Does the sector development trend indicate a change in quality or access to educational services? Does it impact the access (including cross-border) of individuals to public/private education or vocational and continuing	There is a need for further specialised staff for all kind of offshore installations also for multi-purpose platforms. New training methods/institutions will

Type	Key questions	Extent of impact
	training?	be needed to cope with the growing demand.
	Environmental	
Impact on climate	Do the operations in the sector affect the emission of greenhouse gases and other ozone depleting substances? Do RDI innovations within the sector result in a decrease of emissions?	Offshore wind has a positive impact on the reduction of GHGs. The more efficient these plants are getting, the more emissions they can prevent.
Transport and usage of energy	Do the operations in the sector affect the energy intensity of the economy? Do the operations in the sector affect the fuel mix (between coal, gas, nuclear, renewables etc.) used in energy production? Does it impact demand for transport (passenger or freight), or influence its modal split?	Investments in offshore wind reduce the dependency on fossil fuels and help to raise the share of renewables in the energy mix.
Impacts on biodiversity	Does the operation of the sector impact on biodiversity? Does it affect protected or endangered species or their habitats or ecologically sensitive areas?	No significant negative impacts expected.
Impacts on water quality and resources	Does the operation of the sector impact on the quality of waters in coastal and marine areas (e.g. through discharges of sewage, nutrients, oil, heavy metals, and other pollutants)?	Significant impacts on water quality resulting from the disturbance of seabed sediments or releases of materials from vessels operating in the project area are not anticipated. This is due to the small scale and transient nature of any potential effects on water quality and the dispersive effects of the surrounding waters, as demonstrated by detailed modelling exercises.[38] However, the noise throughout the construction phase may have a limited impact on

[38] RWE (2005): http://www.rwe.com/web/cms/mediablob/en/1269360/data/1202906/1/rwe-innogy/sites/wind-offshore/under-construction/gwynt-y-mr/English.pdf

Type	Key questions	Extent of impact
		animals in the area.
Likelihood and scale of environmental risks	Does the operation of the sector carry environmental risks?	Risks are expected to be low

4. Joint actions leading to growth and jobs

The European Union can act in various forms to support a positive development of key factors. Especially it can support the improvement of the regulatory framework. Also, further integration of the renewable energy market needs to be agreed on. These actions need to look beyond 2020. The development until 2020 is already put in place and not much different is expected until then. A regulatory framework reducing barriers, combining public support and a coherent framework are necessary.

5. Conclusion

The current review confirms the crucial importance of offshore wind as a Blue Growth sector in the North Sea. Offshore wind is a sector with large potential worldwide, for the European Union and especially for the North Sea region. The region is in the position to remain world leader of this technology which can contribute substantially to economic growth, but also energy independency of the region. Nevertheless, despite the optimism and the upbeat outlook until 2020, there are multiple challenges to overcome to continue this growth rate in the period post-2020. The prospect exists for offshore wind to become a crucial and competitive electricity source in the medium to long-term. Cost competitiveness can be driven by both technology, scale as well as innovative concepts which can address the storage challenges (Supergrid, multi-purpose islands, energy atoll, etc.) as well as the development of competing electricity sources. However such a step change will require a long-term favourable regulatory framework. Without such a framework, Europe could lose its competitive edge vis-à-vis other world regions.

6. Annex

List of people consulted (telephone interviews)

- Ana Aguado (Friends of the Supergrid)
- Jan-Joost Schouten (Deltares; working on the MERMAID project)
- Matthieu Craye (DG ENER)

References

EWEA (2013): The European offshore wind industry - key trends and statistics 2012

EWEA (2013): The European offshore wind industry - key trends and statistics 1st half 2013

ESPON (2013): ESaTDOR European Seas and Territorial Development, Opportunities and Risks ANNEX 7 to the Scientific Report: North Sea Regional Profile

Offshore Grid (2011): OffshoreGrid: Offshore Electricity Infrastructure in Europe

Rutovitz, J. and A. Atherton (2009): "Energy sector jobs to 2030: a global analysis." Final report. Institute for Sustainable Futures. Study conducted on behalf of Greenpeace.

http://www.sse.com/GreaterGabbard/ProjectInformation/

http://www.scira.co.uk/

http://www.vattenfall.co.uk/en/thanet-offshore-wind-farm.htm

http://www.dongenergy.com/hornsrev2/en/about_horns_rev_2/about_the_project/pages/turbines.aspx

http://www.centrica.com/index.asp?pageid=917

http://www.dongenergy.com/en/business%20activities/generation/electricity%20generation/wind/pages/gunfleetsands.aspx

http://www.dongenergy.com/hornsrev/DA/Pages/index_DA.aspx/index.en.html , http://powerplants.vattenfall.com/node/294

http://www.q7wind.nl/en/index.asp

http://www.noordzeewind.nl/home_14.html
http://www.kentishflats.co.uk/

http://www.eon-uk.com/481.aspx

http://www.alpha-ventus.de/

http://www.c-power.be/applet_mernu_en/index01_en.htm

http://www.beatricewind.co.uk/home/default.asp

http://www.narec.co.uk/demonstration/blyth-offshore-wind-demonstration-site
http://www.statoil.com/en/technologyinnovation/newenergy/renewablepowerproduction/offshore/hywind/pages/hywindputtingwindpowertothetest.aspx

http://www.offshorewind.biz/2013/09/19/uk-number-of-offshore-wind-jobs-doubles-in-the-last-3-years/

Ministry of Petroleum and Energy (2012): National Renewable Energy Action Plan under Directive 2009/28/EC Norway

Renewable UK: http://www.renewableuk.com/en/renewable-energy/wind-energy/uk-wind-energy-database/index.cfm/map/1/status/Consented/project_type/offshore/

http://www.norsewind.eu/

http://www.erec.org/fileadmin/erec_docs/Documents/EREC_Factsheet_on_Affects_of_Shale_Gas_on_RES.pdf

DG ENER (2013): Project of Common Interest/Cluster of PCIs, http://ec.europa.eu/energy/infrastructure/pci/doc/2013_pci_projects_country.pdf

http://www.mermaidproject.eu/

http://www.windpoweroffshore.com/article/1216471/statoil-pulls-hywind-maine-project

http://www.statoil.com/en/technologyinnovation/newenergy/renewablepowerproduction/offshore/hywind/pages/hywindputtingwindpowertothetest.aspx

http://www.windpoweroffshore.com/article/1216471/statoil-pulls-hywind-maine-project

Petrofac: Synergies between Offshore Oil and Gas and Offshore Renewables, http://www.windplatform.eu/fileadmin/ewetp_docs/Events/2nd_Energy_Event/Andrew_Donaldson.pdf

http://www.technologyreview.com/view/510806/a-manmade-island-to-store-wind-energy/
http://www.nsmc.eu.com/page/about-the-cluster

RWE (2005): http://www.rwe.com/web/cms/mediablob/en/1269360/data/1202906/1/rwe-innogy/sites/wind-offshore/under-construction/gwynt-y-mr/English.pdf