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WP 5 – Energy Infrastructure in MSP

## Status quo report on offshore energy planning provisions in the North Sea Region



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# 1. Executive Summary

The North Sea is one of the busiest seas for maritime industries in the world. Its shared resources represent a crucial asset, but also a shared territorial challenge to North Sea Region (NSR) countries, including Belgium, Denmark, Germany, Netherlands, Norway, Sweden, and the United Kingdom. Various maritime sectors, such as offshore energy, play a major part in generating economic value and employment and are set to expand in line with smart 'Blue Growth' objectives. Given the transnational nature of offshore energy activities and the transnational character of marine ecosystems, facilitating greater transnational coherence and cooperation in Maritime Spatial Planning represents a key shared challenge. The European-funded NorthSEE project addresses this challenge directly.

The NorthSEE project promotes a better exchange of information among MSP authorities, related experts and institutions in the North Sea Region (NSR). NorthSEE aims at achieving greater coherence in MSP across the NSR for three topics of transnational nature (organised as individual Work Packages; WP): Environmental aspects (WP3), Shipping routes (WP4), and Energy infrastructure (WP5). This report is specifically focused on WP5 Energy Infrastructure and the *status quo* of offshore energy planning provisions in the NSR.

Chapter 1 highlights the importance of the Energy Union and the 2020, 2030 and 2050 Energy Strategy targets as a coherent long term strategy to make energy more secure, affordable and sustainable across the EU. Drivers and Barriers to offshore wind are examined. It can be concluded that policy interventions are necessary to ensure the continuous growth of the offshore wind energy industry and to overcome any existing barriers. The long tradition of regional energy cooperation with links to energy in the North Sea is displayed in the form of North Sea-wide institutions, non-sectoral organisations, stakeholder forums, trade bodies and European projects.

In Chapter 2, energy profiles show that there is an on-going dominance of fossil fuels. Norway is largest producer of oil and gas and Germany is the largest producer of wind energy (combined onshore and offshore). Germany is also the largest consumer of energy. Growth of offshore wind in the North Sea is beginning to meet EU's power demand. UK is in the lead with the largest amount of installed offshore wind capacity in Europe. It also highlights the differences in MSP status in NSR countries where most NSR countries already have MSP in place except Denmark and Sweden.

Chapter 3 demonstrates the wide differences in policies, objectives, targets and timelines between Member States. Most energy targets and commitments only run up to 2020 and there is a general lack of medium term (2030) targets. The remaining targets are aspirational targets running up to 2050. Most offshore wind farms in operation, planning and under construction are within UK and German

waters. Scotland is leading on wave and tidal energy developments. Future outlooks are discussed and the 2020 outlook for wind energy is promising in terms of achieving energy policy commitments and targets. However, the future outlook for 2020 and 2030 for offshore wind shows a mismatch in the level of aspirations between government and industry. Future energy industry trends are predicted and these include; larger, more powerful offshore wind turbines further offshore in deeper waters, floating wind turbines, multi-rotor turbines, increased ocean energy developments, multi-use developments and decommissioning. Topics such as oil spills and the implications of Brexit are also discussed. These trends will have implications for MSP and considerations of the space requirements will be needed for meeting offshore industry growth forecasts for 2020 and 2030 in the North Sea.

The main findings of the report include the vast differences in national MSP approaches between countries within the NSR. It was also found that national approaches to MSP and sectoral planning is affected by country history, priorities, and geography. The importance of using and maintaining existing data infrastructure and encouraging industry to submit their data to portals was highlighted. It was also identified that there is no over-arching body for MSP coordination in the North Sea. Incoherent and inconsistent terminology was found to be a barrier and hindrance to transnational cooperation in the North Sea. Strong offshore energy industry growth was identified by 2020, however there are some risks post-2020. It is recommended that spatial implications of future trends are explored further. In terms of achieving energy targets, partner countries are on track to achieving GHG 2020 targets and interim renewable energy targets have been met. The findings then conclude with lessons learned from countries with MSP in place and advice to others without MSP.

The report makes a series of recommendations aimed at marine planners and other bodies to help facilitate greater transnational coherence and cooperation in maritime planning.

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# List of acronyms and abbreviations

CCS	Carbon Capture and Storage
CPMR	Conference of Peripheral Maritime Regions
EEZ	Exclusive Economic Zone
EMEC	European Marine Energy Centre
ETS	Emissions Trading System
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
GHG	Green House Gases
HRA	Habitats Regulations Appraisal
HVDC	High Voltage Direct Current
ICES	International Council for the Exploration of the Sea
MSP	Marine/Maritime Spatial Planning
Mtoe	Million tons of oil equivalent
MW	Megawatt
MWh	Megawatt hour
NSCOGI	North Sea Countries' Offshore Grid Initiative
NSR	North Sea Region
OSPAR	1992 OSPAR Convention (Oslo and Paris Conventions) for the protection of the marine environment in the North-East Atlantic
SEA	Strategic Environmental Assessment
TEC	Tidal Energy Converter
TW	Territorial Waters
TFC	Total Final Consumption
TPES	Total Primary Energy Supply
WEC	Wave Energy Converter
WP	Work Package

# 1. Introduction

## 1.1. Background

The North Sea is one of the busiest seas for maritime industries in the world and its shared resources represent a crucial asset but also a shared territorial challenge to North Sea Region (NSR) countries, including Belgium, Denmark, Germany, Netherlands, Norway, Sweden, and Scotland (on behalf of the United Kingdom) as shown in **Figure 1**. Various sectors, such as offshore energy, play a major part in generating economic value and employment and are set to expand in line with smart 'Blue Growth' objectives. Appropriate management is essential to ensure that maritime sectors develop sustainably, in line with the ability of the marine environment to accommodate the associated pressures.

Maritime Spatial Planning (MSP) has been identified as a main tool for implementing the EU Integrated Maritime Policy [1] and is the central approach to give effect to the EU's Blue Growth Strategy [2], while at the same time contributing to the achievement of Good Environmental Status in line with the Marine Strategy Framework Directive (MSFD) [3]. The EU MSP Directive [4] requires all Member States to establish marine spatial plans by 2021. Although MSP is a national competency, the Directive calls for national plans to be coherent across sea basins. Given the transnational nature of offshore energy activities and the transnational character of marine ecosystems, facilitating greater transnational coherence and cooperation in MSP for the benefit of the North Sea represents a key shared challenge. The European co-funded NorthSEE project addresses this challenge directly.

The NorthSEE project promotes a better exchange of information among MSP authorities, related experts and institutions in the North Sea Region (NSR). NorthSEE aims at achieving greater coherence in MSP across the NSR for three topics of transnational nature (organised as individual Work Packages; WP): Environmental aspects (WP3), Shipping routes (WP4), and Energy infrastructure (WP5). More information about the project can be found online at [www.northsearegion.eu/northsee](http://www.northsearegion.eu/northsee).

'WP5 Energy' deals with the national and transnational offshore energy planning provisions for the production and transportation of energy in the North Sea. The WP focuses on the sustainable development of offshore renewable energies and related offshore grid infrastructure in the NSR.



**Figure 1:** Map showing NSR countries and the blue shaded area of eligibility under the North Sea Region Programme. Flags represent the country origin of project partners.

## 1.2. Report Layout

In this report, we present an overview of the state-of-the-art of offshore energy planning provisions for the production and transportation of energy in the North Sea, including:

- the existing international MSP institutional framework in the NSR, including past and current experience of transnational energy cooperation between North Sea countries;
- an overview of short- (2020), mid- (2030), and long- (2050) term national and transnational energy planning provisions, including energy objectives, policies, and planning areas; and
- future trends in the offshore energy policy landscape and industry developments across the NSR;

The report is structured in 4 main chapters: Introduction, Status Quo, Future Trends and Conclusions. Chapter 1 (Introduction) gives an overview of current energy policies on an EU level, drivers and barriers to offshore wind and recent experience of transnational energy cooperation between North Sea countries. Chapter 2 (Status Quo) presents the national energy profiles in the North Sea, the current state of play of energy planning provisions in NSR countries, and an overview inventory of all current offshore energy developments within the NSR. The

chapter concludes with describing the role of MSP for offshore energy developments. Chapter 3 (future trends) includes an overview of short- (2020), mid- (2030), and long- (2050) term national and transnational energy policies. The chapter also describes the offshore renewable energy industry outlook and the future energy industry trends expected to be seen within the NSR up to 2020, 2030 and beyond. Chapter 4 (Conclusions) details the main findings and key lessons learned so far. Next steps for the NorthSEE energy work package is briefly presented, including analysing the planning and technical design criteria used for offshore energy planning and licensing, respectively. All background information is contained within annexes.

### 1.3. Aims of the report

The *status quo* of offshore energy planning provisions in the NSR is presented in this report. The report aims to:

- ✓ present the existing international MSP institutional framework in the NSR and its role for offshore energy developments;
- ✓ describe and compare the national and transnational offshore energy planning provisions of national and regional authorities, including energy objectives, policies, and designated planning areas;
- ✓ identify future trends in the offshore energy policy landscape and industry developments across the NSR, and
- ✓ consider the spatial implications of future policy and industry trends for Maritime Spatial Planning in the NSR.

The target audience of the report includes marine planners at National MSP authorities in the NSR, European Institutions (e.g. European Commission's Department for Maritime Affairs and Fisheries, The Conference of Peripheral Maritime Regions (CPMR) North Sea Commission etc.), local authorities, energy developers, and Non-Governmental Organisations, together with their advisers, institutes of higher education and other scientific bodies involved in the field of maritime spatial planning.

The status quo report also serves as an internal project report for the NorthSEE consortium. The report documents progress towards Task 5.1 "Status quo of energy infrastructure provisions in national MSPs" and Task 5.2 "Analysis of national and transnational energy policies by country in the NSR" as listed in the project agreement. Outputs of this report will contribute to future WP5 Tasks for the identification of the critical elements impacting the coordinated sustainable development of offshore renewable energies; and will provide marine planners with suggestions and recommendations to help facilitate transnational cooperation in NSR.

## 1.4. EU Energy Policies Overview

A number of EU Energy Policies underpin Europe's goals to achieve security of energy supplies, ensure energy prices are affordable, protect the environment, combat climate change and improve energy grids. In order to achieve these long-term challenges, Europe has formed an 'Energy Union' and Energy Strategies for 2020, 2030 and 2050.

Europe currently has to import over half of its energy, and therefore the price of energy in Europe is highly dependent on world markets. It is therefore important for Europe to become less dependent on energy imports and increase its energy mix, which fortunately is already very diverse. However, EU Member States need to work together to make the most of their diversity.

The Energy Union [5] aims to make energy more secure, affordable and sustainable across the EU. It will facilitate the free flow of energy across borders and a secure supply in every EU country. This energy union of EU countries will lead to a sustainable, low carbon and environmentally friendly economy, putting Europe at the forefront of renewable energy production, clean energy technologies, and the fight against global warming.

The Energy Union is made up of 5 mutually supportive and interlinked dimensions as shown below in **Figure 2**.



**Figure 2:** Five closely related and mutually reinforcing dimensions of the Energy Union (Source: [www.ief.org](http://www.ief.org)).

The European Union's energy policies are driven by three main objectives as highlighted in

**Figure 3:**





**Figure 3:** The three main objectives that drive the European Union's energy policies (Source [www.ief.org](http://www.ief.org)).

To pursue these objectives within a coherent long-term strategy, the EU has formulated targets for 2020, 2030, and 2050.

The 2020 Energy Strategy [6] defines the EU's energy priorities between 2010 and 2020. It aims to:

- reduce greenhouse gases (GHG) by at least 20%,
- increase the share of renewable energy in the EU's energy mix to at least 20% of consumption, and
- improve energy efficiency by at least 20%.

EU countries have agreed to the following objectives to be met by 2030. The following goals provide the EU with a stable policy framework on GHG emissions, renewables and energy efficiency giving investors more certainty and confirming the EU's lead in these fields on a global scale. On 30 November 2016, the Commission released draft legislative proposals designed to help achieve these targets. The measures include draft proposals on electricity market design, renewables and energy efficiency:

- a binding EU target of at least a 40% reduction in GHG emissions by 2030, compared to 1990 levels,
- a binding target of at least 27% share of renewable energy consumption in the EU,
- an energy efficiency increase of at least 27%, to be reviewed by 2020 potentially raising the target to 30%, by 2030, and
- the completion of the internal energy market by reaching an electricity interconnection target of 15% between EU countries by 2030, and pushing forward important infrastructure projects.

The EU aims to achieve an 80% to 95% reduction in GHGs compared to 1990 levels by 2050. Its Energy Roadmap 2050 [7] analyses a series of scenarios on how to meet this target. The Roadmap sets out four main routes to a more sustainable, competitive and secure energy system in 2050: energy efficiency, renewable energy, nuclear energy and carbon capture and storage. It combined these routes in different ways to create and analyse seven possible scenarios for 2050. Conclusions of the roadmap analysis include:

- Decarbonising the energy system is technically and economically feasible. In the long-run, all scenarios that achieve the emissions reduction target are cheaper than the continuation of current policies.
- Increasing the share of renewable energy and using energy more efficiently are crucial, irrespective of the particular energy mix chosen.
- Early infrastructure investments cost less, and much of the infrastructure in the EU built 30 to 40 years ago needs to be replaced anyway. Immediately replacing it with low-carbon alternatives can avoid costlier changes in the future. According to the International Energy Agency, investments in the power sector made after 2020 would cost 4.3 times as much as those made before 2020.
- European approach is expected to result in lower costs and more secure energy supplies when compared to individual national schemes. With a common energy market, energy can be produced where it is cheapest and delivered to where it is needed.

The EU has already made important progress towards meeting its targets:

- The first 'state of the Energy Union' report published in November 2015 showed that much progress has been made since the adoption of the Energy Union in February 2015, and 2016 would be a key year of delivery.
- Between 1990 and 2012, the EU cut greenhouse gas emissions by 18% and is well on track to meet the 2020 target.
- The projected share of renewable energy in the gross final energy consumption is 15.3% in 2014, up from 8.5% in 2005.
- The latest renewable energy progress report from 2015 states that 25 EU countries were expected to meet their 2013/2014 interim renewable energy targets.
- Energy efficiency is predicted to improve by 18% to 19% by 2020 – barely missing the 20% target. However, if countries implement all the necessary EU legislation, the target should be reached.

The EU believe that the continued progress of and commitment to the Energy Union and energy strategies can only be achieved through European integration of

internal energy markets. European countries must agree on their energy policies and work together in order to make energy more secure, affordable and sustainable. The national energy policies of individual North Sea countries are detailed in section 3.1 and Annex 3.

## **1.5. Offshore wind - Drivers and barriers**

The EU Member States have a strong commitment to achieving the energy policies, strategies and targets stated in Section 1.4, such as GHG emission reduction, low carbon economy and energy security. The large-scale deployment of renewable energy capacity is fundamental to Europe moving forward. Offshore wind energy, in particular, represents a crucial component of the future European energy system as it is currently one of the most stable sources of renewable energy and is continuing to grow and to mature (see also Section 2.2). New investments in offshore wind in Europe continued to grow with most of this activity in the North Sea Region.

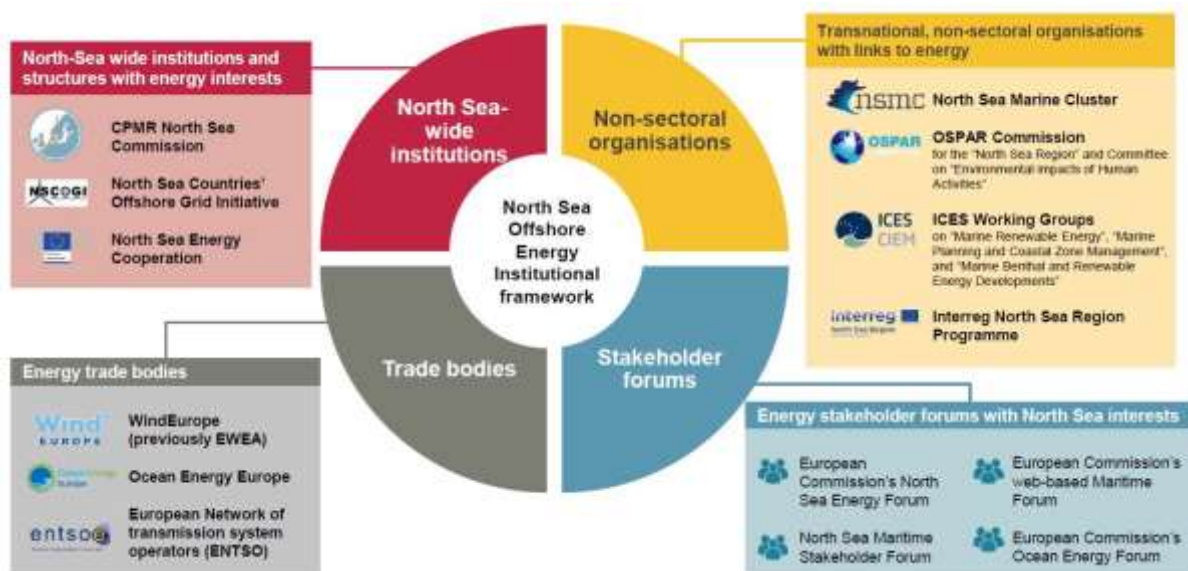
Policy interventions are necessary to ensure the continuous growth of the offshore wind energy industry and to overcome any existing barriers. Barriers can include legislation, lack of investment, lack of social acceptance, lack of grid connection/capacity, regulation of liability and of insurance, cost-effectiveness of technology (operational costs & maintenance and repair costs), availability of technology, current situation on the job market (availability of skilled/qualified personnel), and administrative procedures (planning and licensing by national competent authorities).

All aforementioned drivers and barriers may influence the development of offshore wind in the North Sea Region over the coming years. However, those relevant to the NorthSEE project include planning and licensing of offshore wind farms. These processes can be seen as drivers in some NSR countries, as they help to identify preferred development areas for offshore wind, where conflict with other marine users is reduced. However, poor planning and no spatial designation is a barrier to the development of offshore wind as it can hinder the speed of allocation of areas for wind farms, and introduce further delays in the licensing process. It also increases the chance of conflict with other marine users.

Due to the maturity of the sector, high prospects of meeting EU and national targets, and due to the sphere of influence by the NorthSEE consortium partners, out of all renewable energy technologies currently available, the biggest part of this report is focused on offshore wind developments.

## 1.6. Transnational energy cooperation between North Sea countries

There is a long tradition of regional energy cooperation in the North Sea. The institutional framework of North Sea energy cooperation over the recent years included regional sea basin mechanisms and organisations, multi- and bi-lateral energy declarations and agreements, energy trade bodies and stakeholder forums with sea basin interests, as well as European projects looking to promote the sustainable development of offshore energy in the NSR. A simplified overview of the North Sea Offshore Energy Institutional framework is given in **Figure 4**. Detailed descriptions of individual organisations and their links to offshore energy in the North Sea can be found in **Annex 1**.



**Figure 4:** North Sea energy institutional framework.

### North Sea Offshore Energy Institutional framework

Currently, North Sea-wide government or industry-led structures with links to offshore energy include regional cooperation platforms, regional sea basin forums, energy trade bodies, other transnational non-sectoral organisations, the and regional sea conventions. Some notable examples include the North Sea Commission, the North Sea Countries' Offshore Grid Initiative (NSCOGI) and the Political Declaration on energy cooperation between North Seas Countries (hereafter "the North Seas Energy Cooperation"). Important energy trade bodies include WindEurope, Ocean Energy Europe, and ENTSO-E.

The CPMR North Sea Commission is a cooperation platform for regions around the North Sea. The Commission's work aims to exploit opportunities and address common transnational challenges in the NSR. Implementation work is

delivered by thematic working groups, such as the “Energy and Climate Change” and the “Marine Resources and Transport” groups.

NSCOGI was established in 2009 as a regional cooperation of 10 countries around the North Sea. It aims to achieve the renewable targets up to 2020 and seeks to evaluate and facilitate coordinated development of a possible offshore grid in the North Sea, that maximises the efficient and economic use of renewable sources and infrastructure investments. NSCOGI includes a working group on permissions and planning which develops guiding principles such as the development of integrated offshore cross-border infrastructure.

The North Seas Energy Cooperation was formed in 2016 where North Sea countries (Belgium, Denmark, France, Germany, Ireland, Luxembourg, the Netherlands, Norway and Sweden, and later also the UK) agreed to further strengthen their energy cooperation to improve conditions for the development of offshore wind energy in order to ensure a sustainable, secure and affordable energy supply in the area. One of the specific energy cooperation work areas is Maritime Spatial Planning and the outputs of this group will be brought to a political level.

WindEurope is Europe’s wind energy trade association promoting the use of wind power in Europe. WindEurope actively coordinates international policy, communications, research and analysis. They publish European offshore wind statistics half-yearly and these provide data on, for example, installed and grid-connected wind power capacity, future outlooks for the EU market, financing and investment trends and energy industry trends.

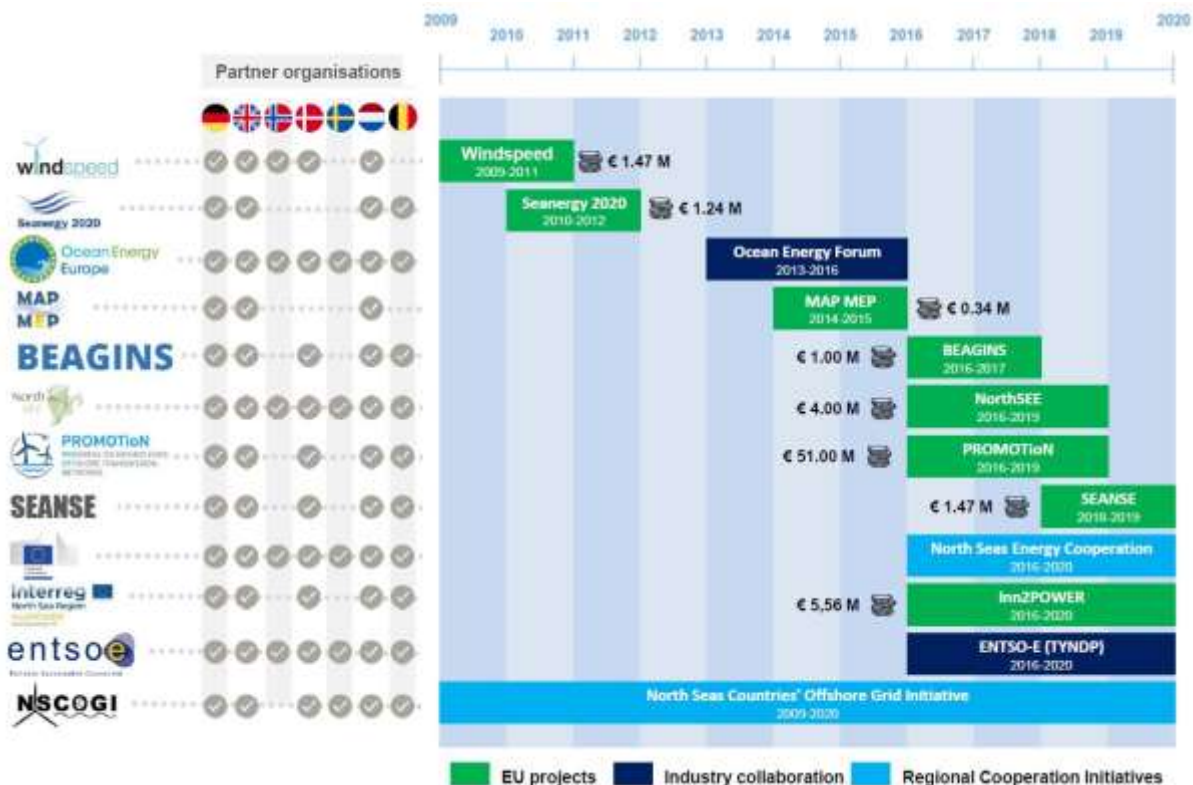
Ocean Energy Europe (OEE) is the European ocean energy association of professionals that represent the interests of Europe's ocean energy sector. The aim of OEE is to create a strong environment for the development of ocean energy, improve access to funding and enhance business opportunities for its members. To achieve this, OEE engages with European Institutions such as the Commission, Parliament and Councils and national ministries on policy issues affecting the ocean energy sector. OEE has been largely successful in the past four years by significantly increasing the profile of ocean energy, which in turn has encouraged the EU to be a major driver of the industry

The European Network of transmission system operators for electricity (ENTSO-E) has created a Ten-Year Network Development Plan 2016 (TYNDP 2016). The 2016 edition of the TYNDP builds on the 2014 edition and offers a view on what grid is needed where to achieve Europe's climate objectives by 2030. As part of the TYNDP 2016, Regional Investment Plans were developed from September 2014 to June 2015 for six regional groups for grid planning in Europe, including the North Sea region. These reports include the main infrastructure challenges and needs of every region in Europe by 2030.



## European projects

EU-funded projects offer a great opportunity for North Sea countries to cooperate on matters of transnational importance, including offshore energy. Since 2010, a total budget of over 15 million euro has been invested on energy cooperation projects of direct relevance by the European Commission, via the European Regional Development Fund, EASME's Intelligent Energy Europe programme, and the Directorate-General for Energy (see **Figure 5**).



**Figure 5:** Timeline of transnational energy cooperation between North Sea countries

In the early 2010s, European projects emphasised on making the case for the North Sea's potential in offshore energy, notably offshore wind.

The WindSpeed project was one of the first technical projects, back in 2010, to establish a spatial inventory of wind potential in the central and Southern North Sea. The project delivered a roadmap which identified barriers and potential surplus conditions in the North-European electricity grid, defined a realistic target for the spatial deployment of offshore wind in the North Sea and developed a development pathway up to 2030.

Following this technical project, SEANERGY 2020 project was undertaken with a focus on policy. In 2012, the project developed policy recommendations to remove MSP obstacles that could hinder the development of offshore renewable plans in the EU, explored the development of existing and potentially new international MSP instruments, and identified inconsistencies between international MSP processes.

Next, the MAP MEP project delivered an interactive energy map for the North Sea in 2015, which provided a direct overview of up-to-date energy information in the region. The interactive map offers insight of the energy potential of the NSR for wind, wave and tidal renewable energy and fossil fuels.

By the mid-2010s, the development of an offshore energy system in the North Sea had been recognised as a significant opportunity towards meeting the EU's energy, environmental, growth and employment objectives. To ensure that environmental concerns and impacts are appropriately considered in the development of such an offshore energy system, the European Commission ordered the BEAGINS study in 2016, which compiled an Environmental Baseline of impacts including maps, constraints, risks, impacts, ways of mitigation and alternatives [8].

Additional support to the offshore wind industry in the North Sea Region was provided by the Inn2Power project in late 2016. The aim of the project is to expand the capacity for innovation and to improve access to the offshore wind industry for small and medium enterprises (SMEs) by connecting offshore wind businesses in the North Sea Region.

## Chapter 1 Summary

- The Energy Union and the 2020, 2030 and 2050 Energy Strategy targets are required as a coherent long term strategy to make energy more secure, affordable and sustainable across the EU.
- Continued progress of and commitment to the Energy Union and energy strategies can only be achieved through European integration of internal energy markets. European countries must agree on their energy policies and work together.
- There are many different drivers and barriers to offshore wind, but to ensure the continuous growth of the offshore wind energy industry and to overcome any existing barriers, policy interventions are necessary.
- There is a long tradition of regional energy cooperation with links to energy in the North Sea. These include North Sea-wide institutions, non-sectoral organisations, stakeholder forums, trade bodies and European projects. However, there is no over-arching body for MSP coordination.

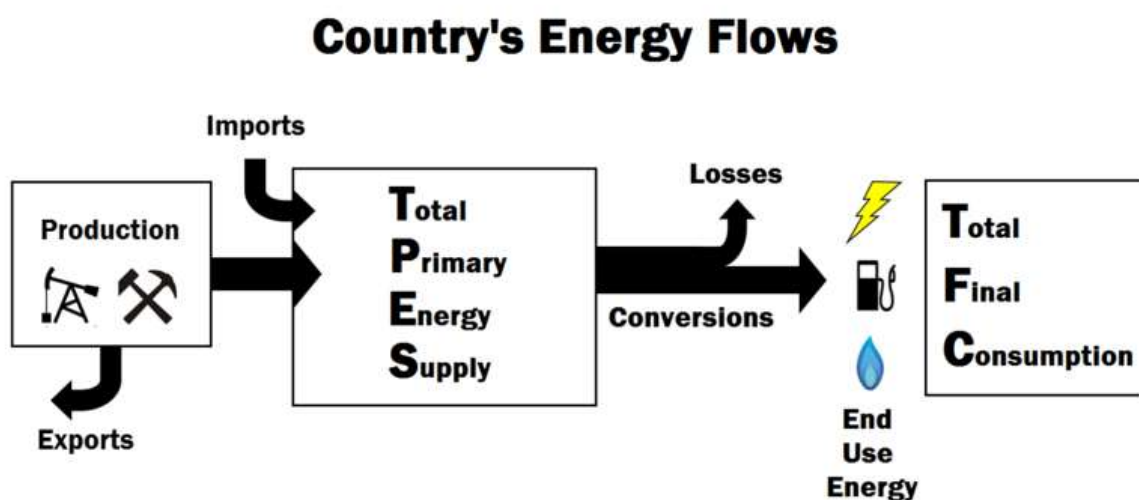


## 2. Status Quo

### 2.1. Energy profiles in the North Sea

This section provides an overview of the overall energy profiles in each country, in terms of the current energy mix, energy produced and consumed, and energy imported and exported in order to meet supply and demand needs. Terminology, including Total Primary Energy Supply (TPES) and Total Final Consumption (TFC) as defined by Organisation for Economic Cooperation and Development (OECD), is used to profile countries (**Figure 6**). More information about the energy profiles of individual North Sea countries can be found in **Annex 3**.

TPES is defined as energy production plus energy imports, minus energy exports, minus international bunkers, then plus or minus stock changes. Total Final Consumption (TFC) is the total value of all expenditures on individual and collective consumption goods and services incurred by resident households and general government units. It may also be defined in terms of actual final consumption as the value of all the individual goods and services acquired by resident households plus the value of the collective services provided by general government to the community or large sections of the community. Both TPES and TFC metrics are expressed in million tonne of oil equivalent (Mtoe).

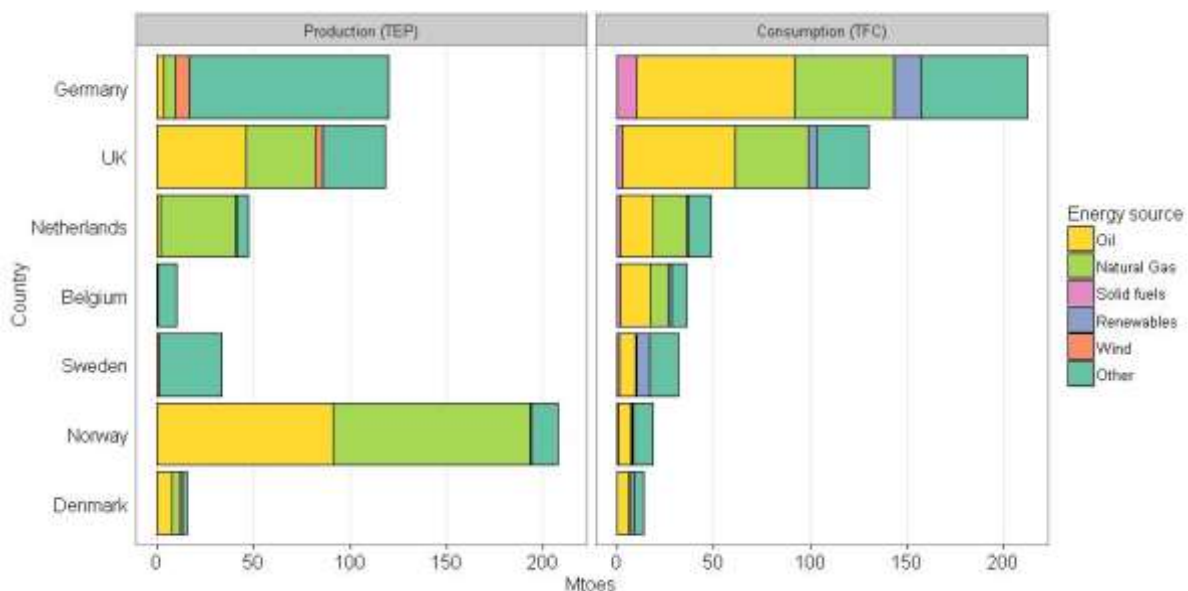


**Figure 6:** Country Energy Flows, including TPES and TFC (Source: energyeducation.ca).

The TPES varies widely for the different North Sea countries (see **Figure 7**). Germany has, with 311.8 Mtoe in 2015, by far the highest of all, followed by the UK (180 Mtoe in 2015). The TPES of the remaining countries of this same year ranges between 71 Mtoe in the Netherlands and 16 Mtoe in Denmark (Figure 7). Germany had the 6th highest TPES worldwide in 2014.

Furthermore, the TFC of Germany is the highest of all the North Sea countries listed here (212 Mtoe by 2015), again followed by the UK with 130 Mtoe. Denmark has the lowest final consumption, with a consumption of 13.94 Mtoe in 2015.

The energy production of the various countries shows the on-going dominance of fossil fuels. Norway stands out with the highest production of oil and natural gas and the highest production of energy in general. In 2015, they produced 91.4 Mtoe oil and 102.1 Mtoe natural gas, representing 93 % of their total energy production. In second position the Netherlands has an 86.2 % share of oil and natural gas in their total energy production. This high share of fossil fuels for the Netherlands is due to its high gas production. In 2015, the Netherlands produced 39 Mtoe, natural gas, and only 2 Mtoe oil. For the other oil and natural gas producing countries, the share of these fuels seems to be more in balance. Sweden has not produced any oil or gas in 2015, and the same accounts for Belgium in terms of natural gas<sup>1</sup>.



**Figure 7:** National energy profiles of North Sea countries in 2015. Countries ranked based on energy consumption (TFC).

In absolute terms, Germany is the leading country producing wind energy (including both on- and offshore wind) of the North Sea countries. Producing 6.81 Mtoe in 2015, they are by far the largest producer. The UK, Sweden and Denmark follow, producing respectively 3.47 Mtoe, 1.4 Mtoe and 1.22 Mtoe. The other countries all produce less than 1 Mtoe. In relative terms, however, the picture is slightly different. Denmark leads with wind energy representing 7.7 % of its total production. Germany follows with 5.69 % wind energy and Belgium and Sweden both produce over 4 % of their energy using wind. Norway had the lowest share of wind energy in their total production in 2015. The resource only represented 0.11 %.

<sup>1</sup> The 2015 oil production for Belgium is unknown. However, in 2007 and 2014 Belgium did not produce any energy using oil.

On a global scale, this resource is steadily growing in importance, although its share is still relatively small. Wind, solar, thermal, solar PV and geothermal together accounted for little more than 1 % of the global energy production in 2014 according to the OECD.

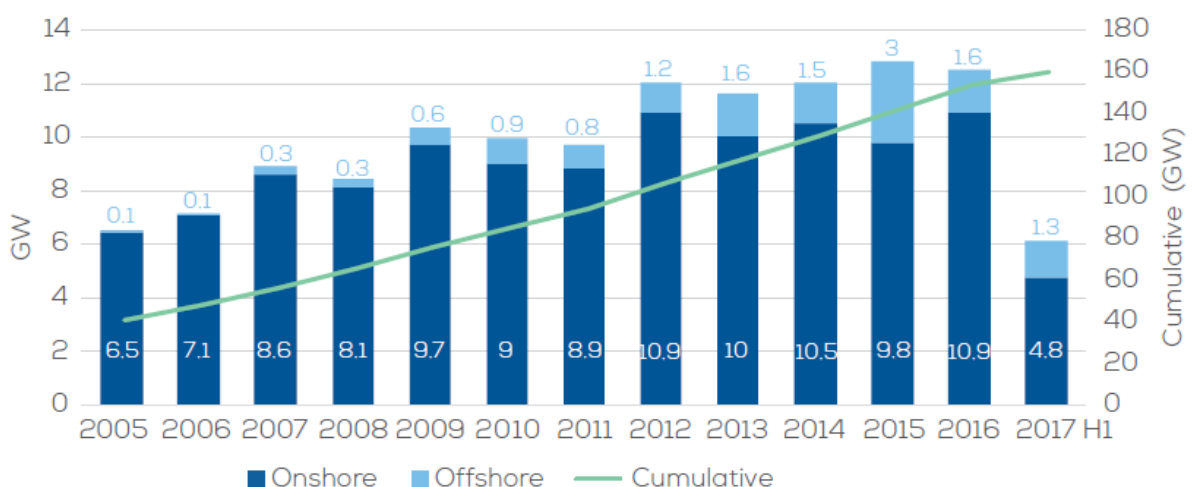
All countries, apart from Norway, have a higher import than export rate. This difference can be explained by the high oil and natural gas production of Norway. The country exported 185.2 Mtoe in 2015, and only imported 8.1 Mtoe. Germany has the highest import, both absolutely and in relation to its export. Germany imported 255.8 Mtoe in 2015, which is over 4 times what they export (59.8 Mtoe). For the other countries, these numbers are closer together.

## 2.2. Offshore renewable energy developments in the North Sea

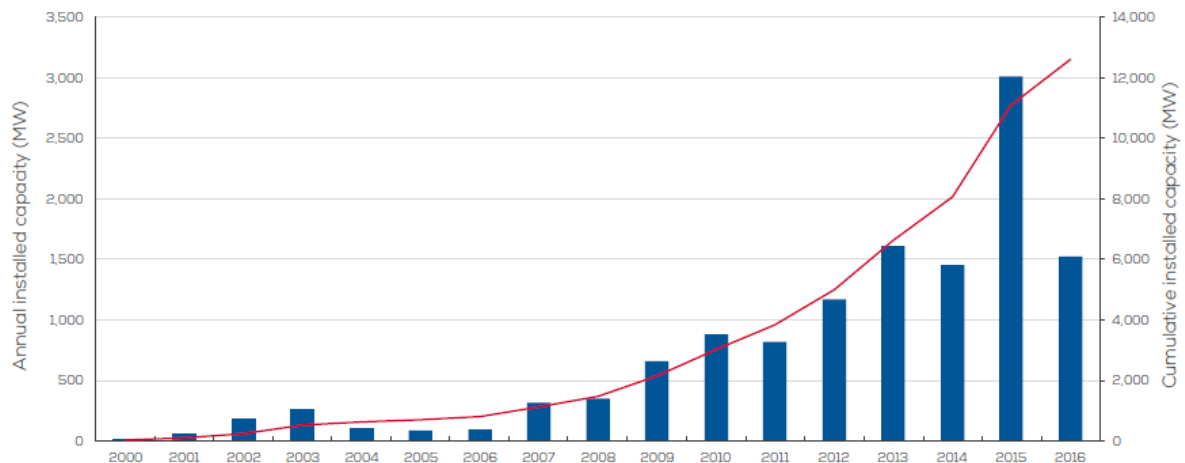
### Offshore wind

Wind energy (both onshore and offshore markets) already meets 10.4% of the EU's power demand and is the most competitive source of new power generation. It is also thought that technology costs will decline further provided there continues to be a robust home market in the EU (**Figure 8**).

European offshore wind has seen a strong and steady growth since the early 2000s. By the end of 2016, 81 offshore wind farms with a total of 3,589 offshore turbines have been installed and are grid-connected in 10 European countries, making a cumulative total of 12,631 MW (**Figure 9**).



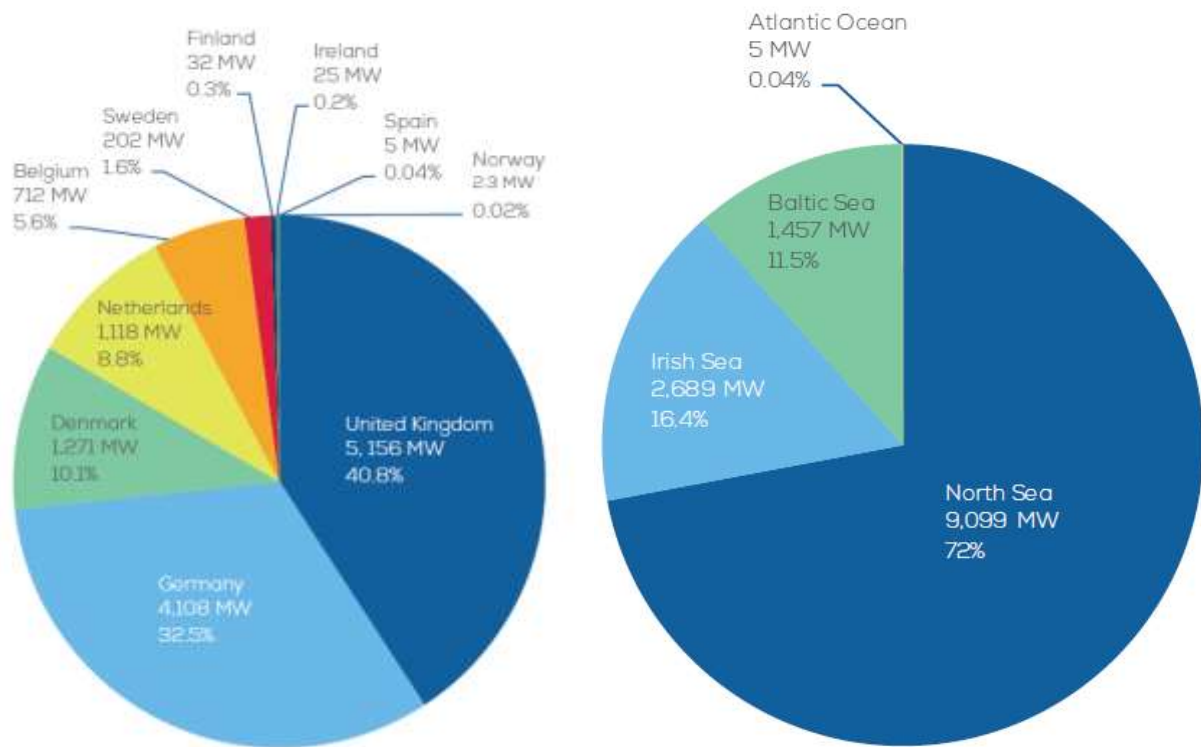
**Figure 8:** Annual wind installations (both onshore and offshore markets) for the period 2005-2016 in Europe (see left axis). Cumulative wind installations are also shown (light blue line) (Source: [9])



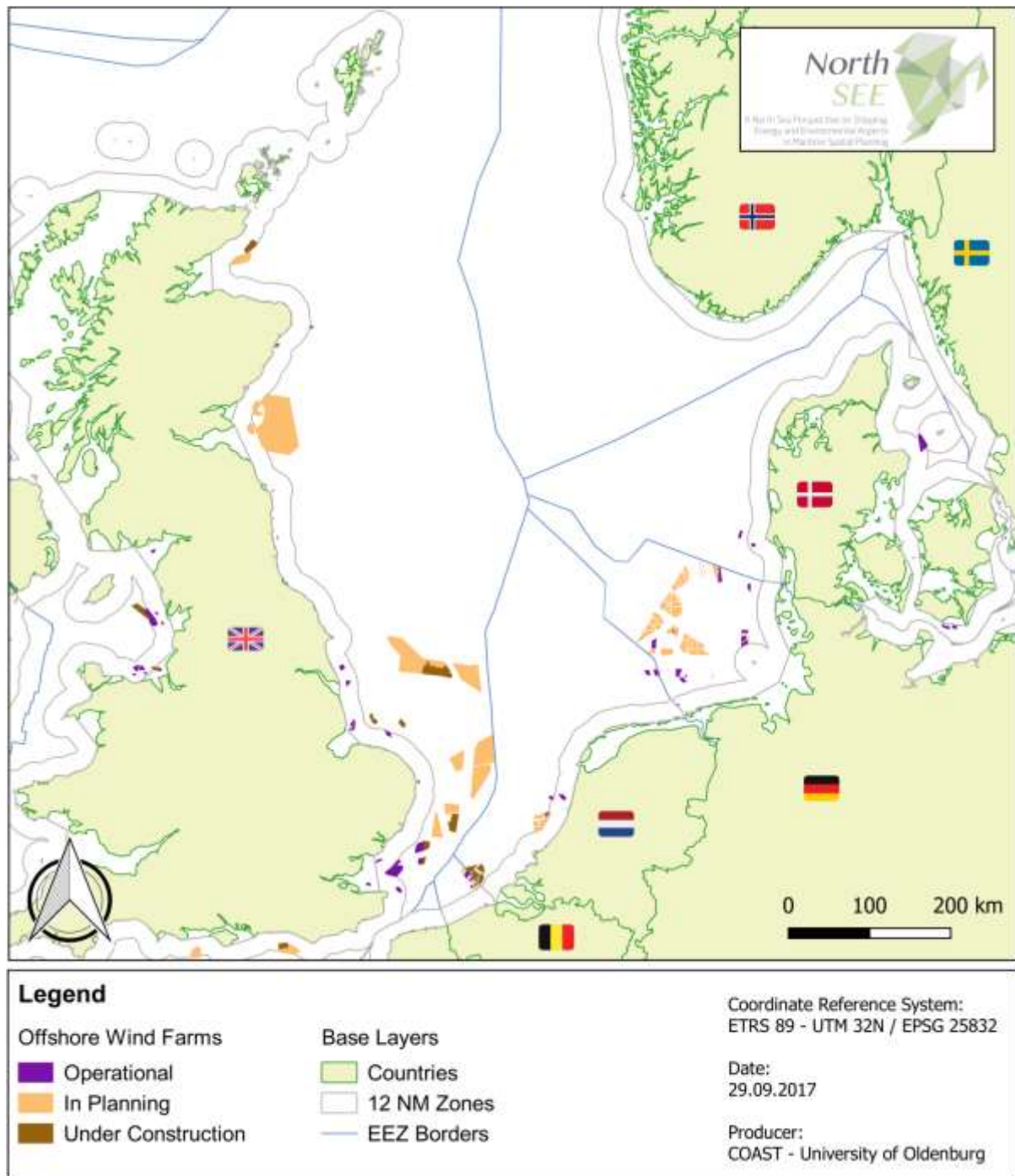
**Figure 9:** Cumulative (red line) and annual (blue bars) offshore wind installations 2000-2016 in Europe (Source: [9])

All top 5 European countries with the largest amount of installed offshore wind capacity are bordering the North Sea (**Figure 10**). The UK leads with the largest amount of installed offshore wind capacity in Europe, representing 40.8% of all installations. The vast majority of UK installed developments are found in English waters, but significant developments are expected in Scotland. Germany follows with 32.5%. Denmark remains the third largest market with 10.1% and the Netherlands (8.8%) and Belgium (5.6%) follow in the fourth and fifth places, respectively. Countries follow similar ranking in terms of cumulative installed wind turbines. Combined, the top five countries of the North Sea represent 97% of all grid-connected turbines in Europe. A detailed inventory of offshore renewable energy developments in the North Sea can be found in **Annex 4** of this report.

A map of all offshore wind farms in operation, under construction and consented within the North Sea Region can be found in **Figure 11**.



**Figure 10:** Cumulative installed capacity of offshore wind by country (MW) and percentage share of European total (left). Same metrics broken down by sea basin (Source: [9]).

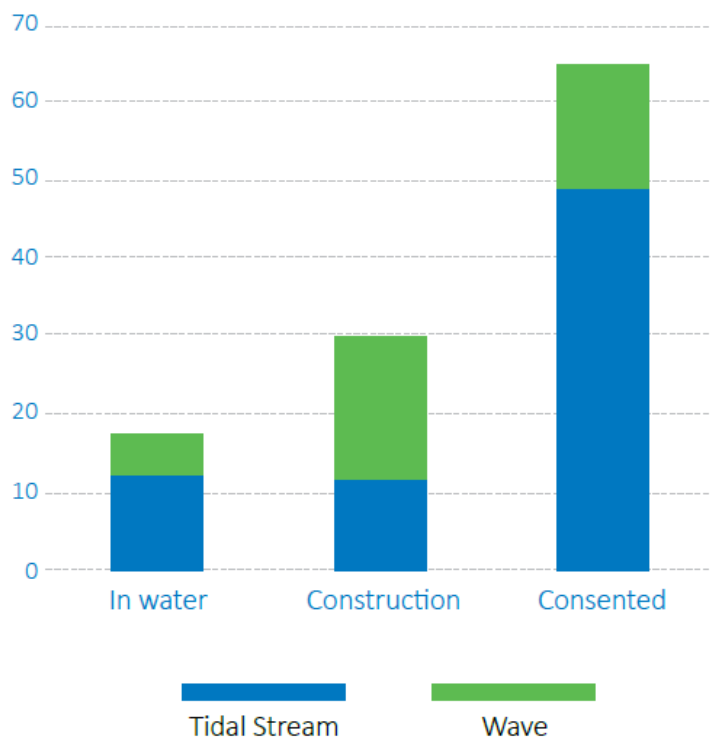


**Figure 11:** Map of offshore wind farms (in operation, under construction and consented in the North Sea Region).



## Ocean energy

The world's oceans and seas are an enormous untapped energy reserve. Ocean tides and waves have enough energy to potentially power the whole planet. The ocean energy industry is actively developing and deploying devices to tap this inexhaustible energy source (**Figure 12**).



**Figure 12:** European wave and tidal energy projects in water, under construction, and consented at the end of 2016 (Source: OEE, 2017).

By end of 2016, 21 tidal turbines of over 100 kW were deployed in European waters totalling 13 MW. Construction is on-going on a further 20 turbines adding up to 12 MW. A number of future projects have obtained permits. The rollout of these will depend on reliability and survivability of current projects and technologies in harsh conditions, energy generation and ability to increase bankability of projects. It will also depend on policy frameworks conducive to the development of ocean energy and access to project financing. 2016 saw a significant amount of ocean energy activity. Alongside the deployment of several single wave and tidal energy devices, the first tidal energy farms were installed and connected to the electricity grid. 2 out of the 3 tidal energy farms were installed in the North Sea (Shetland and Pentland Firth in Scotland), including the world's first commercial tidal energy farm, the MeyGen Tidal Stream Project has been built in the Pentland Firth, Scotland. These come in addition to a multi-turbine project built into an existing sea-wall in the Netherlands (**Figure 13**).

By the end of 2016, 13 wave energy devices of 100 kW or bigger have been deployed at sea, totalling almost 5 MW. Ten of these were deployed over the last 3



years alone, prompted by recent renewable energy and climate policies in Europe and globally.



**Figure 13:** Spotlight wave and tidal energy projects in the North Sea region (adapted from OEE, 2017).

## 2.3. The role of MSP for Offshore Energy Developments

As part of this section, information on the existing national MSP practices and their impact on offshore renewable deployment have been collected. Information included the status of national marine planning as well as sectoral planning for offshore energy. The relevant public authorities responsible for carrying out planning activities by country have also been listed. Each national profile reflect the country's legislative framework and history of MSP, planning responsibilities, planning provisions undertaken so far and includes links to the national process of marine licensing. MSP status of NSR countries and the blue shaded area of eligibility under the North Sea Region Programme is displayed in **Figure 14**. More summary information can be found in **Table 1**. A detailed overview of the policy and legal framework of national MSP practices for each North Sea country can be found in **Annex 2**.



**Figure 14:** MSP status in North Sea countries.

The nations bordering the North Sea are developing MSP to fulfil their requirements under the EU Directive for MSP [4], to deliver maritime spatial planning by March 2021. NSR countries are in different stages in MSP development. Overall, MSP practices in NSR countries are well rooted in national legislation, with country-

specific institutional frameworks in place. Current structures reflect traditional planning procedures as well as national needs and priorities. Most NSR countries have had at least one version of a statutory national marine plan adopted. Countries including Belgium, Netherlands, and Germany are already in the process of revising their national MSP. Others, such as Denmark and Sweden are in the process of establishing a marine plan for the first time.

Considering transnational aspects of MSP, it is acknowledged that national approaches do not necessarily need to be harmonised. However, processes need to be compatible to efficiently manage human activities and management issues of transnational nature, including offshore energy. All national MSP frameworks have had explicit reference to transnational cooperation. However, the issue of transnational cooperation is generally handled only a peripheral way and proactive engagement is limited. Some transnational consultation is dealt by acknowledging its importance, or undertaking ad-hoc consultation quite late in the MSP process. In addition, only some countries have not signed up to concrete transnational cooperation on joint projects.

There are important interdependencies between national and transnational levels of MSP with room for improvement, primarily around offshore energy. Energy issues, including spatial designations for offshore wind, licencing procedures for developments of transnational character, environmental management and marine conservation, as well as general offshore energy linear infrastructure provision (e.g. offshore grid, interconnector cables etc.), transcend national borders, and must be discussed cooperatively. Transnational approaches to MSP can benefit offshore renewables through additional efficiencies from cross-border coordination, reduced planning uncertainty for developers, and expanded opportunities for deployment and/or cost savings from shared infrastructure.

Regional sea basin forums, as well as cooperation project such as NorthSEE, offer the opportunity to improve coordination of a number of aspects related to MSP including: planning timeframes, better communication, onshore and offshore grid infrastructure, data formats and availability, research methodologies and efforts, and some management measures including elements of permitting.

At this stage, it should be noted that the English authorities are not participating in the NorthSEE transnational projects. As a result there is a knowledge and data gap for UK waters, including energy targets and planning provisions. The Scottish Government currently represents the Scottish part of the United Kingdom, and has reviewed publicly available information for the English part, due to the English MSP authority not participating in the project.

**Table 1:** Summary information about MSP status of NSR countries

Country	National MSP Authority	Sectoral Planning Authority	Marine Licensing Authority	MSP in place	Current status	Spatial areas designated for offshore energy	Web portals	Spatial Data infrastructure
<b>BE</b>	Belgian Minister of the North Sea	Federal public service for Economy (FPS)	Management Unit of the North Sea Mathematical Model (MUMM)	YES	Second revision in preparation	YES – multi-use areas	<a href="#">The Marine Atlas</a> : multi-sectoral marine data available for viewing through interactive maps and also available to download	<a href="#">IDOD database</a> : provides oceanographic data (on request) held by the Royal Belgian Institute of Natural Sciences
<b>DK</b>	Danish Maritime Authority	National authorities	Danish Energy Agency	NO	No comprehensive marine spatial plan for its sea areas, but is beginning to develop one. A range of sectoral plans exist and these will be used on the new maritime spatial plan	YES	<a href="#">GEUS</a> : geological data repository (usually available for viewing through interactive maps, download fees)	Marine spatial data infrastructure (Danish Geodata Agency): <a href="http://msdi.dk/">http://msdi.dk/</a>
<b>DE</b>	Federal Ministry for Transport and Digital Infrastructure (BMVI)	German Federal Maritime and Hydrographic Agency (BSH)	German Federal Maritime and Hydrographic Agency (BSH)	YES	Second revision in preparation	YES – offshore wind only	<a href="#">CONTIS</a> : multi-sectoral data available for viewing through digital maps (BSH)  <a href="#">GeoSea Portal</a> : multi-sectoral	<a href="#">MDI-DE</a> : multi-sectoral spatial data infrastructure providing free access to data

							available for viewing through interactive maps
<b>NL</b>	Interdepartmental Directors' Consultative Body North Sea – Ministry of Infrastructure and the Environment		Netherlands Enterprise Agency (RVO.nl)	YES	Third revision in preparation	YES – offshore wind only, multi-use encouraged	<a href="#">North Sea Atlas</a> : interactive maps (view only)  <a href="#">Marine Information and Data Centre</a> : interactive maps and data available to download for free
<b>NO</b>	Norwegian Environment Agency		Norwegian Water Resources and Energy Directorate (NVE)	YES	Integrated management plans in place, equivalent to MSP	YES – not yet opened	Interactive maps displaying multi-sectoral GIS data (view only): <a href="http://www.environment.no/maps/">http://www.environment.no/maps/</a>  Interactive maps displaying environmental data (view only): <a href="http://www.xn--havmilj-w1a.no/">http://www.xn--havmilj-w1a.no/</a>
<b>SE</b>	Swedish Agency for Marine and Water Management (SwAM)	Swedish Energy Agency	TW – Swedish Land and Environmental Court. EEZ – National Government	NO	No national marine spatial plans currently cover the territorial sea and the EEZ in Sweden, but legislation for national marine spatial planning has been in place since	NO	N/A  <a href="#">The Swedish GeoData Portal</a> : provides multi-sectoral data available for viewing (interactive maps), some are free to download

					September 2014.			
<b>SCOT</b>	Marine Scotland	Marine Scotland	Marine Scotland Licensing Operations Team (MS-LOT)	YES	Reviewing MSP for the first time.	YES	<p><a href="#">NMPi (National Marine Plan Interactive)</a>: interactive maps displaying multi-sectoral marine data, some are available to download</p> <p><a href="#">Marine Scotland Information</a> is a web portal that provides access to descriptions and information about the Scottish marine environment while providing links to datasets and map resources that are made available by Marine Scotland and Partners.</p>	<a href="#">MEDIN</a> : marine data available to download or on request, provided by public sector organisations

## Chapter 2 Summary

- The energy profiles show that there is an on-going dominance of fossil fuels. Norway is largest producer of oil and gas and Germany is the largest producer of wind energy. Germany is also the largest consumer of energy.
- Growth of offshore wind in the North Sea is beginning to meet EU's power demand (10.4%). UK is in the lead, with the largest amount of installed offshore wind capacity in Europe (40.8%).
- The ocean energy industry is actively developing and by the end of 2016, 21 tidal turbines were deployed in European waters totalling 13 MW.
- The EU MSP Directive commits countries to have marine plans in place by 2021, and calls for transnational coherence. However, differences exist, where some countries such as Denmark and Sweden have yet to adopt their first national plan, whilst others are going through plan iterations. This progress mismatch and transnational incoherence are threats to the sustainable management of the North Sea.
- Additional transnational challenges include different MSP approaches adopted between countries and differences in terminology used. National approaches do not necessarily need to be harmonised, but need to be compatible.
- With the exception of Norway and Sweden, most NSR countries have planned and designated spatial areas for offshore renewable energy and set goals to meet renewable energy targets. No zones have been opened in Norway yet, but areas have been identified and no specific target goals or spatially designated areas have been set in Sweden. The method of spatially designating areas for offshore renewable energy is considered as best practice.
- Proactive engagement in transnational consultation is limited and needs to be given higher priority and undertaken earlier in the process.



## 3. Future Trends

This chapter gives an overview of the energy policies seascape across the North Sea Region in the short- (up to 2020), medium- (2030) and long-term (2050). Emphasis is given on offshore renewable energy policies (particularly offshore wind). Furthermore, future trends of the offshore renewable energy industry are presented, including an industry outlooks for 2020 and 2030.

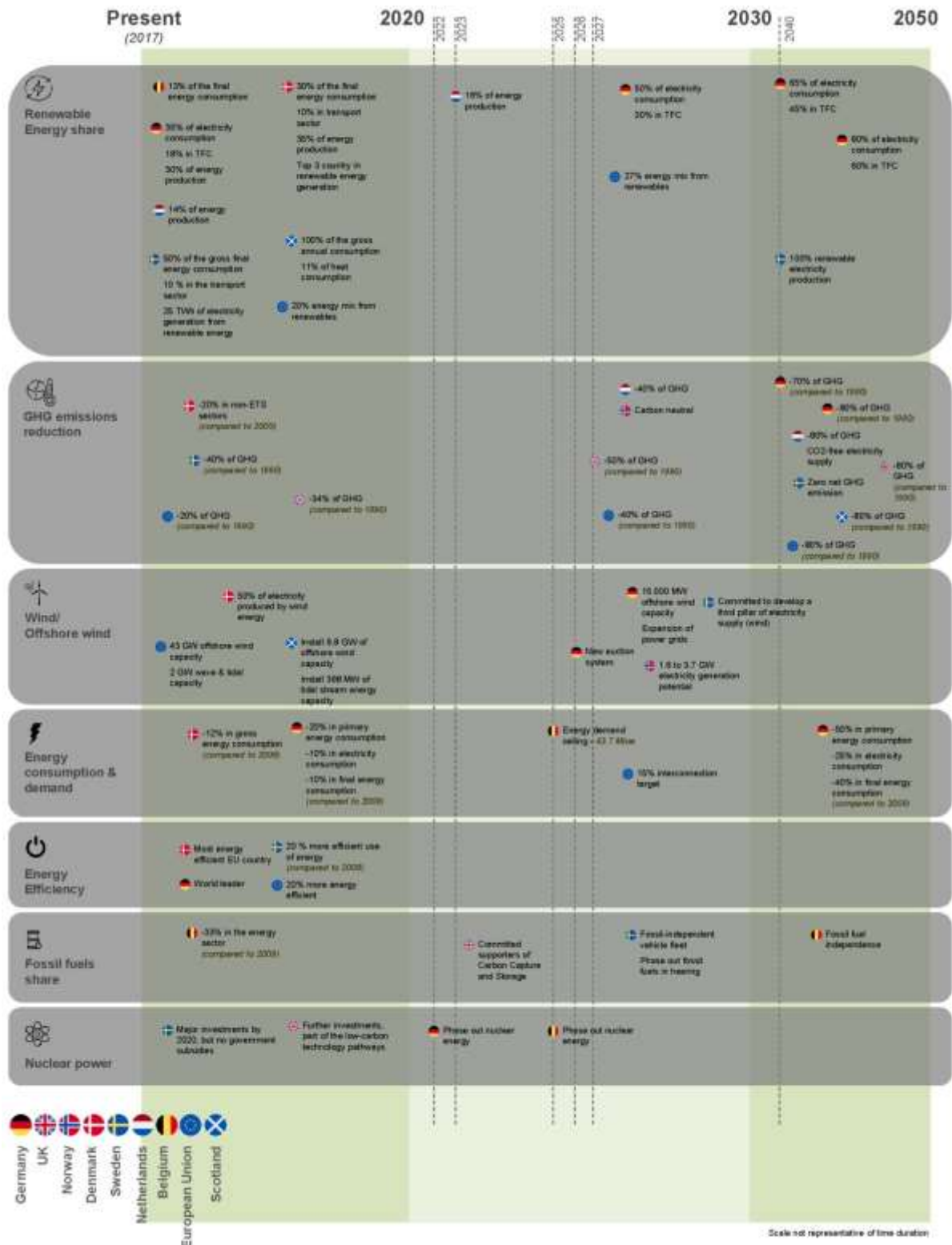
### 3.1. Energy policies in the North Sea

This section presents a summary of the energy policies, strategies and targets for each country in the NSR. It also highlights the individual energy policies and policy outlook in each country relating to offshore renewable energy developments. More information about the energy policies of individual North Sea countries can be found in [Annex 3](#).

North Sea countries are characterised by a range of environmentally friendly energy policies ([Figure 15](#)), including:

- decarbonisation of national energy systems, by increasing the renewable energy share and reducing green-house gas (GHG) emissions;
- increased energy efficiency and reduction of primary energy consumption;
- offshore wind and ocean energy (primarily tidal stream) commitments of installed capacity;
- reduction commitments of fossil-fuel reliance for some NSR countries
- continuous support of Carbon Capture and Storage; and
- support to other low-carbon technologies (i.e. nuclear power) in some NSR countries and full-phase out of nuclear power in some others.

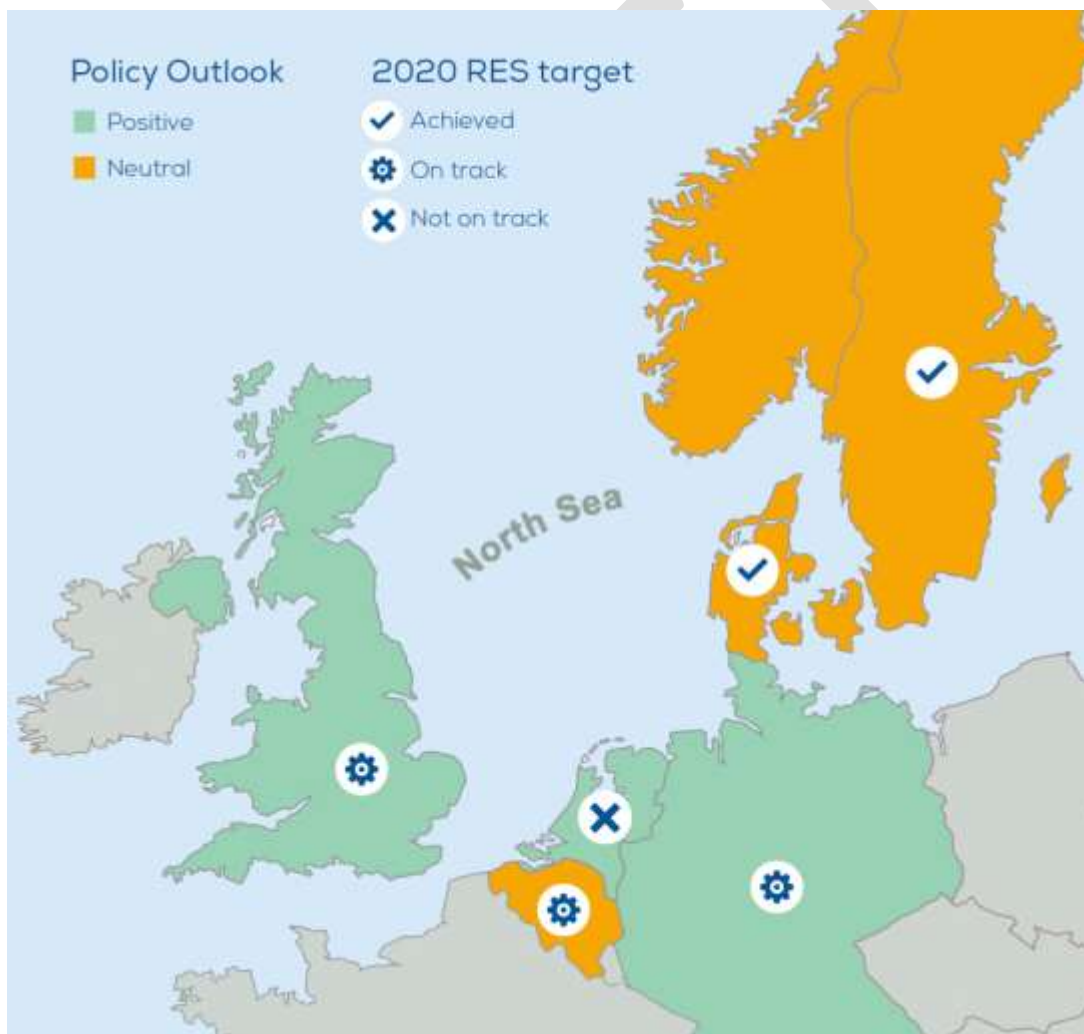
Denmark is a frontrunner in well-designed and aspirational policies for renewable energy, energy efficiency and tackling climate change. Renewable energy has been the heart of Denmark's energy strategy. Denmark strongly relies on wind and biomass as sources for renewable energy. Simultaneously, Germany aims to develop cost-effective market-based approaches, while the Netherlands is moving towards an open, liberalized and advanced market economy and is strong in terms of market integration, ease of entrepreneurship, investment and innovation in their energy sector. Norway can be summarized as a frontrunner in cross-border integration and electricity market liberalization.



**Figure 15:** National and EU energy policies seascape across the North Sea Region in the short- (up to 2020), medium- (2030) and long-term (2050).

Furthermore, Norway opts for a long-term management and value creation with an environmentally friendly framework for its petroleum sector. Sweden meanwhile is regarded to be the leader in smart grid technologies and it is well integrated into the Nordic electricity market. The UK has traditionally heavily relied on fossil fuels, which is slowly changing into strategies towards less carbon emissions. Climate change has become a priority in the energy policies. UK is the only North Sea country with a firm commitment towards Carbon Capture & Storage technologies, and Scotland is the world-leading country of ocean energy support and commitment.

All North Sea countries (with the exception of Norway) are progressing towards achieving their European objectives for 2020 under the Renewable Energy Directive (**Figure 16**). Countries with a positive policy outlook are highlighted in light green. Amber colour is used for counties with a neutral policy outlook.



**Figure 16:** Progress towards 2020 RES targets in the North Sea region (adapted from [10]).

Denmark and Sweden have already achieved their targets. These countries have set national energy plans with concrete renewable energy goals. As an example, Denmark is aiming to go for 100% renewable electricity by 2035, which

forces a renewable trajectory to 2020 that goes far beyond the European target. Sweden, which plans to reach 100% of renewable electricity by 2040, will also need to overshoot its 2020 European target. Belgium, Germany, and UK are on track towards achieving their 2020 targets. Netherlands is unlikely to fulfil their commitments, unless the country accelerates the pace of installation. Norway has made no binding commitments for 2020.

As part of the European objectives for 2020, the binding targets for renewable energy will have a significant influence on wind energy installations for the next few years. NSR countries have adopted different approaches for the support of offshore wind, including differences in support schemes, and spatial designations with varying exclusivity levels for offshore wind installations. A detailed overview can be found as part of **Annex 2**. A summary of the current status (2017) of wind energy policies for all NSR countries is provided in **Table 2**. As previously, countries with a positive policy outlook are highlighted in light green. Amber colour is used for counties with a neutral policy outlook. In addition, Figure 17 shows all spatial designations for offshore wind in the North Sea.

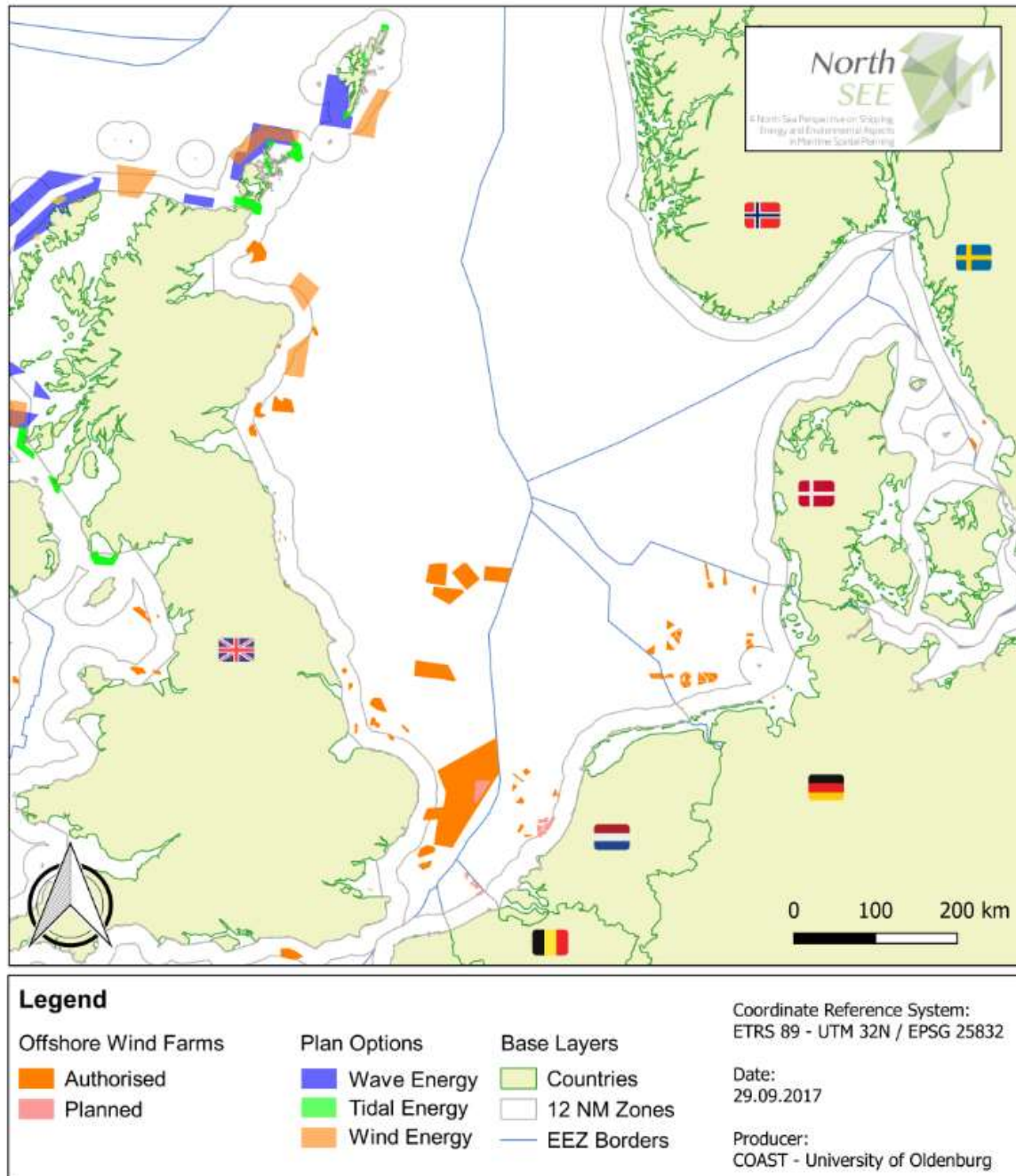
**Table 2:** Summary of wind energy policy landscape per NSR country up to 2020 (Source WindEurope 2017a).

Country	Short-term wind energy policy landscape (up to 2020)
Belgium	Large development offshore but some risks of retroactive changes on the already awarded support schemes.
Denmark	The scheme for onshore wind expires in February 2018. One year stand still is unavoidable until new scheme introduced.
Germany	Full switch to tenders system both for onshore and offshore with good visibility and long term certainty.
Norway	No binding commitments for 2020.
Netherlands	Projects still supported by the SDE+ (budget auction) until 2020. Target of 6 GW of onshore wind by 2020 unlikely to be met. Offshore target of 4.5 GW by 2023.
Sweden	Target of addition 18 TWh RES electricity by 2030 but exponential trajectory with strong growth only at the end of the period.
UK	End of the Renewable Obligation Certificate system. Offshore wind still supported through auctions.

Furthermore, the use of competitive bidding processes (e.g. state-aid/support schemes, tenders mechanisms) as from January 2017 is another variable significantly affecting the deployment of offshore wind. Competitive bidding processes are a condition established by the European Commission in order for Member States to comply with state-aid regulation. Competitive actions vary greatly between countries and are dependent on many conditions going beyond the scope of this report. Prior to 2017, North Sea countries (Denmark, UK, the Netherlands, and Germany) had already implemented competitive auctions to select wind energy projects. Between 2017 and 2020, more than 8.4 GW are already set in the plans of 3 countries (the Netherlands, Germany, and UK) for auctions including offshore wind



energy (**Figure 18**). Most of this capacity will be auctioned in 2017. More countries are expected to make additional announcements.



**Figure 17:** Offshore wind farms, tidal and wave lease sites authorised and planned in the North Sea Region.



**Figure 18:** Announced offshore wind state-aid tenders until 2020 in the North Sea region (adapted from [10]).

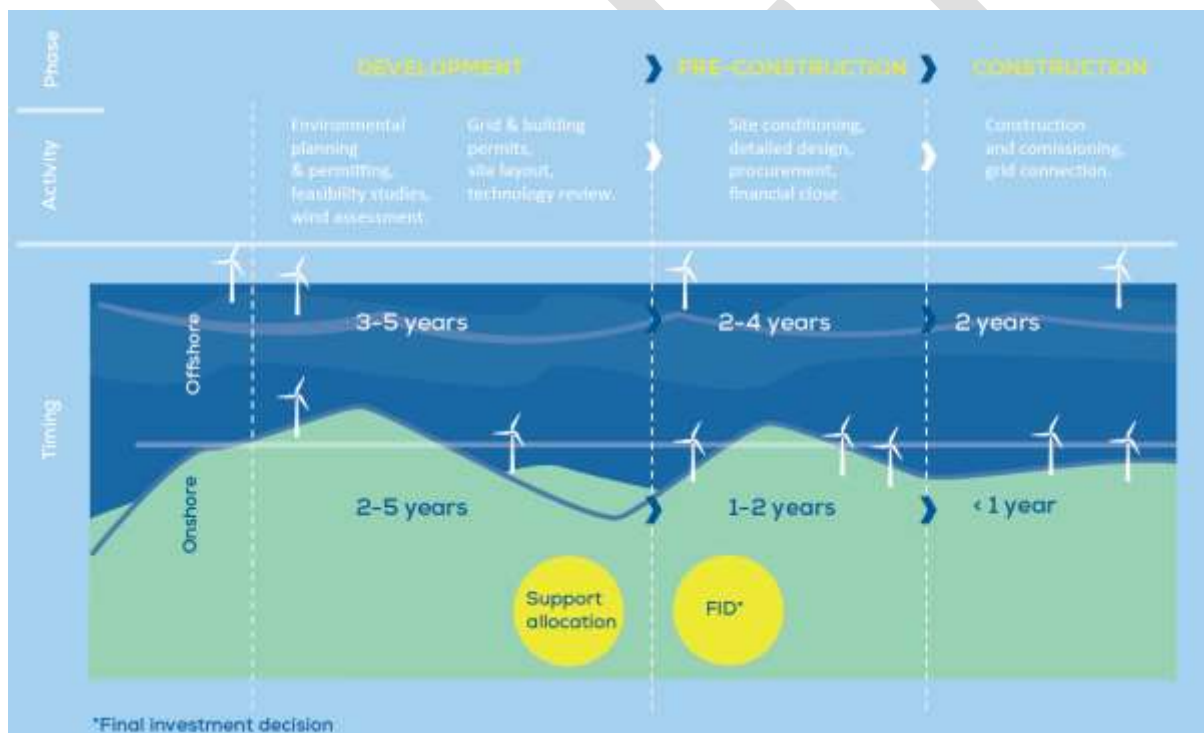
The time horizon of environmental-friendly policies is front-loaded, with most targets and commitments running up to 2020 (see **Figure 15**). Most of the remaining aspirational targets are running up to 2050. There is a notable lack of energy targets for the period 2020-30, demonstrating the lack of a concrete roadmap to achieving 2050 targets.

National commitments vary both in terms of aspirational levels, policy direction and in the way they have been expressed. This introduces challenges in a cohesive North Sea wide policy direction and comparison between NSR countries. Most countries have expressed a level of commitment to targets in renewable energy shares and GHG emissions reduction. Fewer countries have explicit commitments to targets for installed offshore wind capacity or energy efficiency. Considerable divergence exists between NSR countries in policy direction on fossil fuel dependency and the further deployment of nuclear power. Differences in the way targets have been expressed include variable units (percentage shares versus absolute units), expressing energy shares as a function of the energy consumption, production, or other sector/market subcomponents, and a range of base years used to express GHG emissions reductions.



### 3.2. Offshore renewable energy industry outlook

Wind energy projects are characterised by a significant time lapse between the developer being granted a support mechanism (e.g. tender results announcement) and the time that the wind farm starts to operate (grid connection; **Figure 19**). In the case of offshore wind projects, this time is typically approximately five years. However, the overall project timeline is much longer: this includes site investigation, resource assessment, environmental impact assessments and other technical studies and consultations with local communities and other administrative procedures. It is therefore crucial for developers to have good visibility on upcoming tenders and the regulatory framework. Once a support mechanism is granted or the capacity is awarded to the developer, the time allowed to realise projects is largely dependent on the regulatory framework. As a result, time lapses of offshore wind energy projects are considerable and should be taken into consideration in sectoral planning.

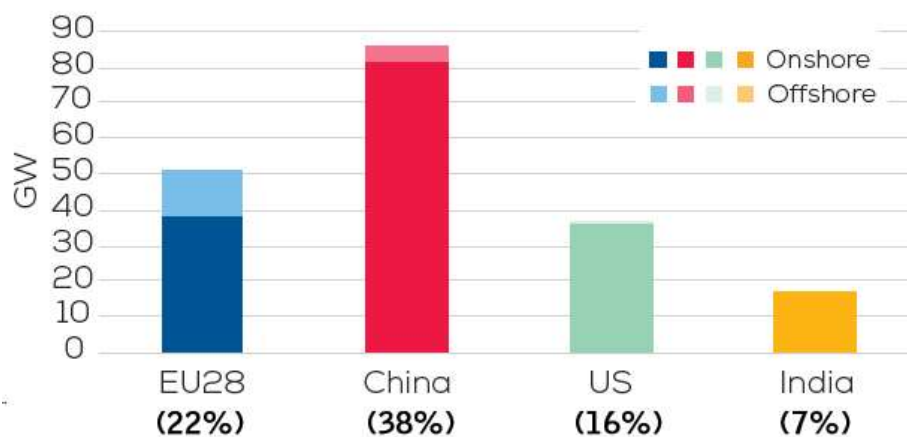


**Figure 19:** Wind energy (on-shore & off-shore) projects' development timeline (Source: [10]).

### Outlook 2020

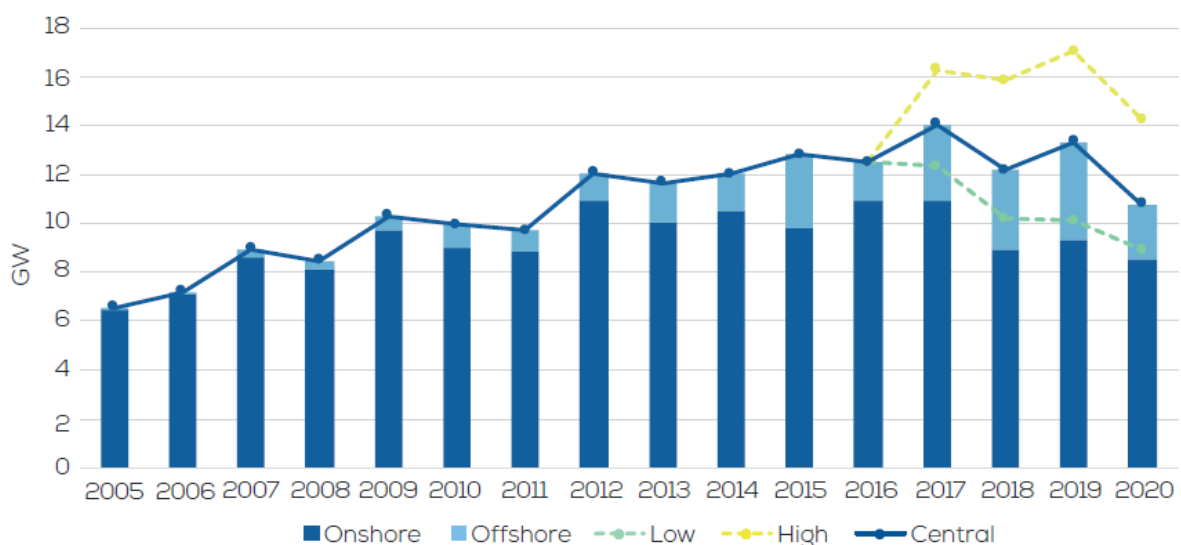
Wind energy has contributed and will make further significant contributions towards achieving energy policy commitments in the global power sector, allowing countries to reach their targets and continue their energy system transformation.

Year 2020 will mark an important milestone for the European Union, including the North Sea region countries, as Member States will be tested on their climate change and energy commitments. Although Europe will represent only a quarter of global installations of the total wind market, Europe (primarily North Sea countries) will be at the helm of the offshore wind market worldwide until 2020, followed by China (**Figure 20**). Considering all new expected additions between 2017-2020, wind power will account for more than half of new renewable energy installations during that period in the EU (Wind 52%, Solar PV 37%, Bioenergy 7%, Hydro 4%).



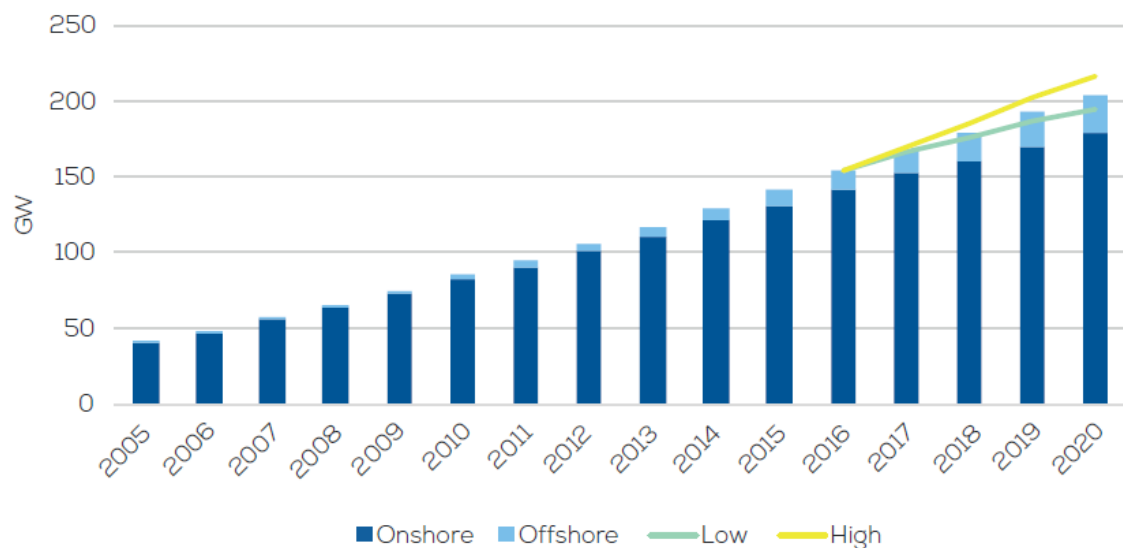
**Figure 20:** Global wind installations in 2017-20 (adapted from [10]).

The biggest part of wind energy contribution in Europe comes from on-shore projects. However, offshore wind has been growing significantly over the last 10 years and its share to annual installed capacity is expected to grow further (**Figure 21**).

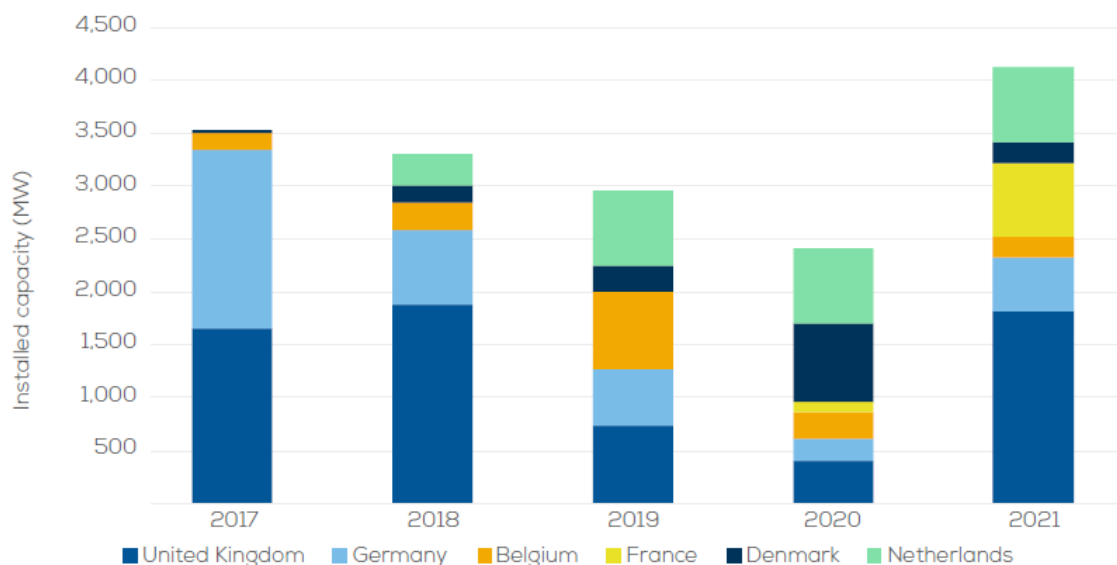


**Figure 21:** European wind energy (on-shore & off-shore) market outlook up to 2020 (Source: [10]).

WindEurope's Central Scenario provides a best estimate of the installed capacity in Europe in the next 3 years (up to 2020; **Figure 22**). With an average 3.1 GW/year, offshore wind will represent about one quarter of the total market by 2020. The offshore market (**Figure 23**) will concentrate mainly in the UK with 5.2 GW or 42% of the new grid-connected capacity. Another four countries will see offshore installations: Germany (3.5 GW), Belgium (1.5 GW), the Netherlands (1.4 GW) and Denmark (1.0 GW). By 2020, total European offshore wind capacity will be 24.6 GW.

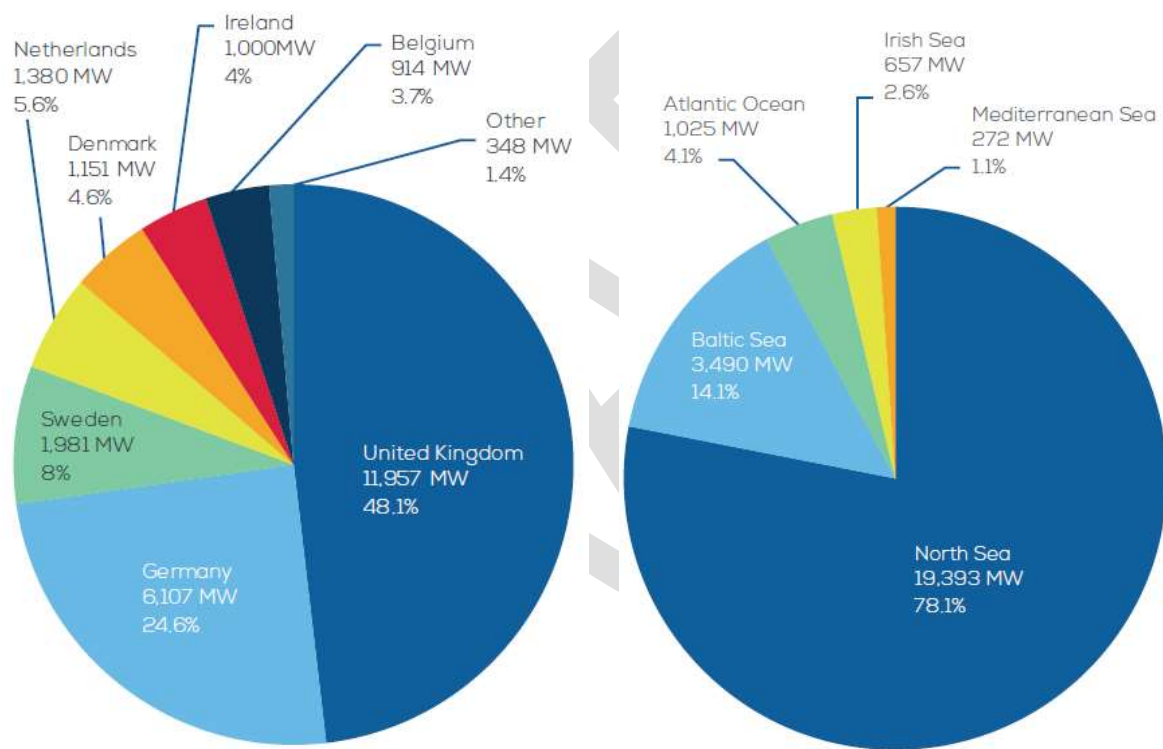


**Figure 22:** Expected cumulative European installed capacity until 2020 under WindEurope's Central Scenario (adapted from [10]).



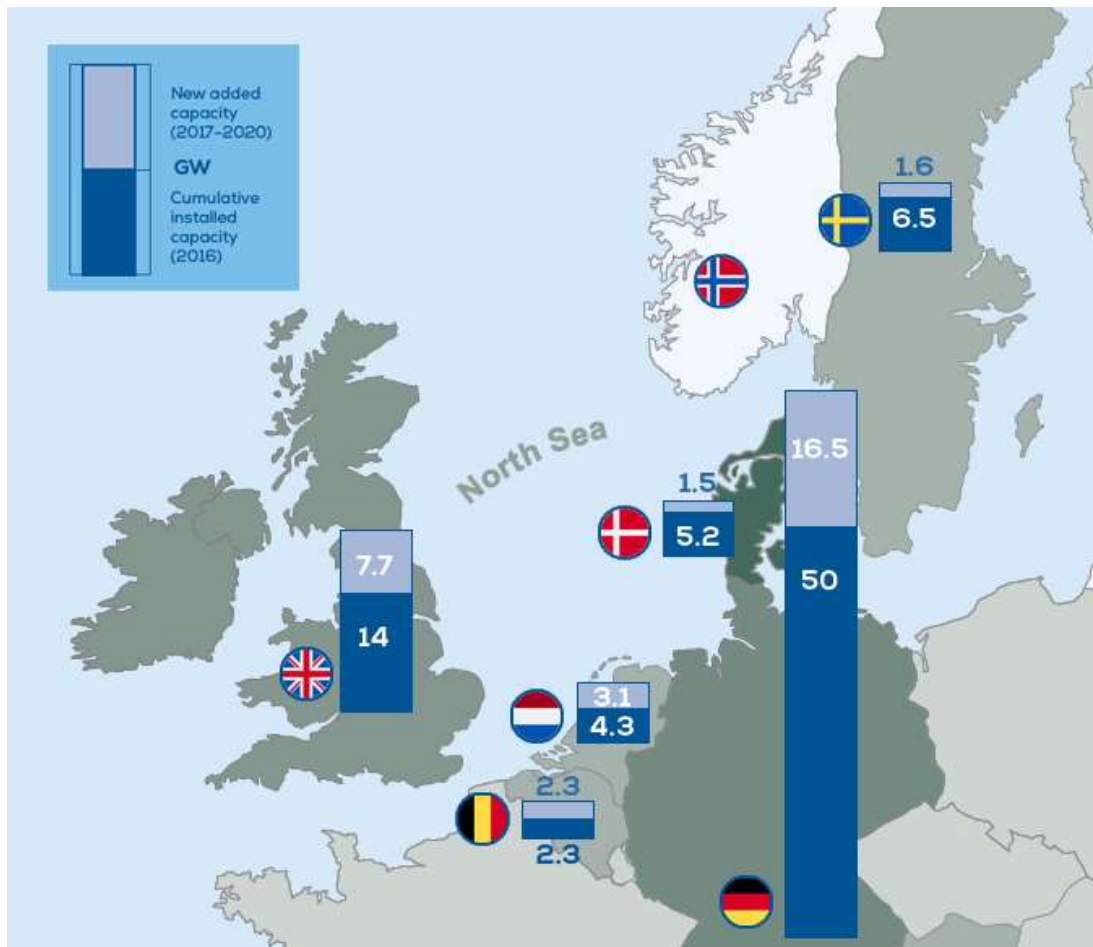
**Figure 23:** Five-year outlook of offshore wind farm project by NSR countries (Source: [10]).

The largest capacity of net annual installation in 2016 was in the North Sea basin (72%). An additional 11 projects (all in the North Sea) are currently on-going (reached Financial Investment Decision or under construction). WindEurope has further identified 24.2 GW of projects which have been obtained consent to construct (see **Figure 24**) and a further 7 GW of projects that are applying for permits. The UK has the highest share of offshore wind capacity (48.1%) that has received government consent to construct, followed by Germany (24.6%), Sweden (8%), and Denmark (4.6%). Besides Sweden, projects in North Sea countries are expected to be constructed within the immediate outlook. A total of 65.6 GW of projects are currently in the planning phase. As a result, the offshore market will grow at a higher rate over the coming years and North Sea countries are expected to see significant capacity additions.



**Figure 24:** European share of consented offshore wind capacity (MW) by country (left) and by sea basin (right; Source: [10]).

Many projects started construction in 2016 and grid-connected activity is set to increase noticeably in 2017 and 2018. However, the number of project starts will fall towards 2019 as European member states complete their National Renewable Energy Action Plans (NREAPs) under the current Renewable Energy Directive which covers the period up to 2020. Similar to 2016, capacity additions will stall in 2020, though a good level of construction activity will still be on-going (see **Figure 23**). **Figure 25** shows the expected cumulative installed capacity of wind (both on-shore & off-shore) for each NSR country up to 2020.



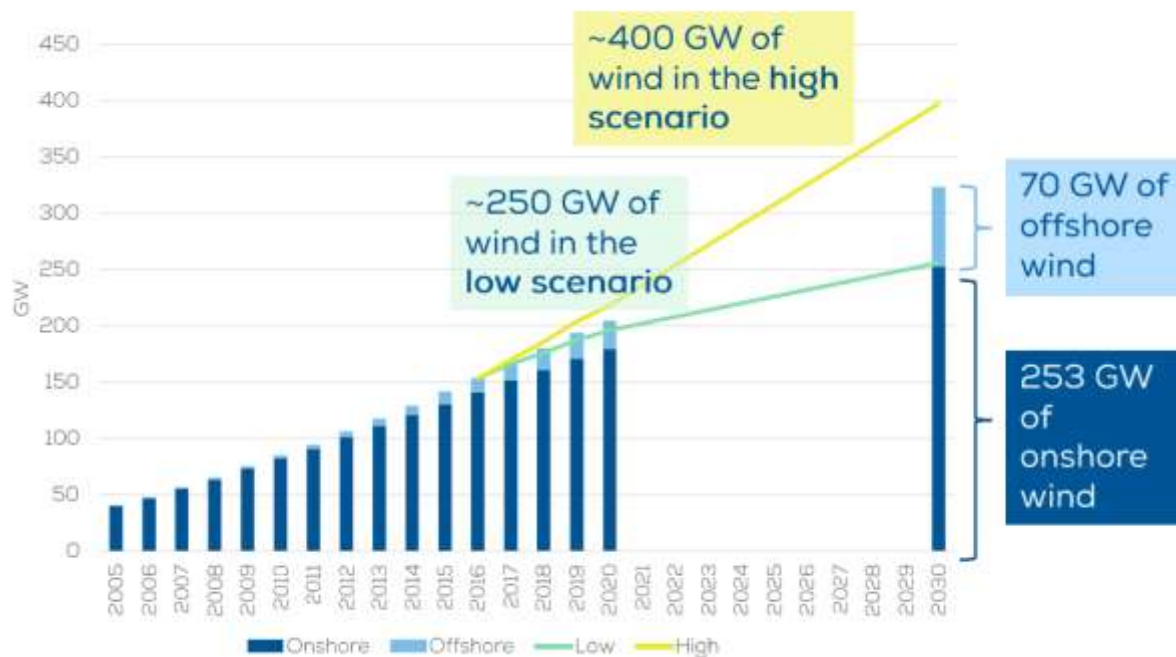
**Figure 25:** Wind energy (on-shore & off-shore) cumulative installed capacity by NSR country and WindEurope's central scenario of added capacity between 2017-2020 (adapted from [10] ).

### Outlook 2030 and beyond

The offshore energy industry in the North Sea is constantly evolving with new advancements in technology allowing larger wind farms to be built further offshore that use bigger and more powerful turbines than current models. There is also the introduction of other new energy technologies such as floating wind, hybrid platforms, tidal energy lagoons and energy storage (see **Section 3.3** for a more information of offshore energy industry trends). These advancements are pushing to reach set energy targets in order to tackle the issues of energy demand and security, reducing CO<sub>2</sub> emissions and climate change.

According to WindEurope's Central Scenario, there would be 323 GW of cumulative capacity by 2030: 70 GW offshore and 253 GW onshore.





**Figure 26:** Forecasted cumulative installed capacity until 2030 under WindEurope's low and high scenario (adapted from [11]).

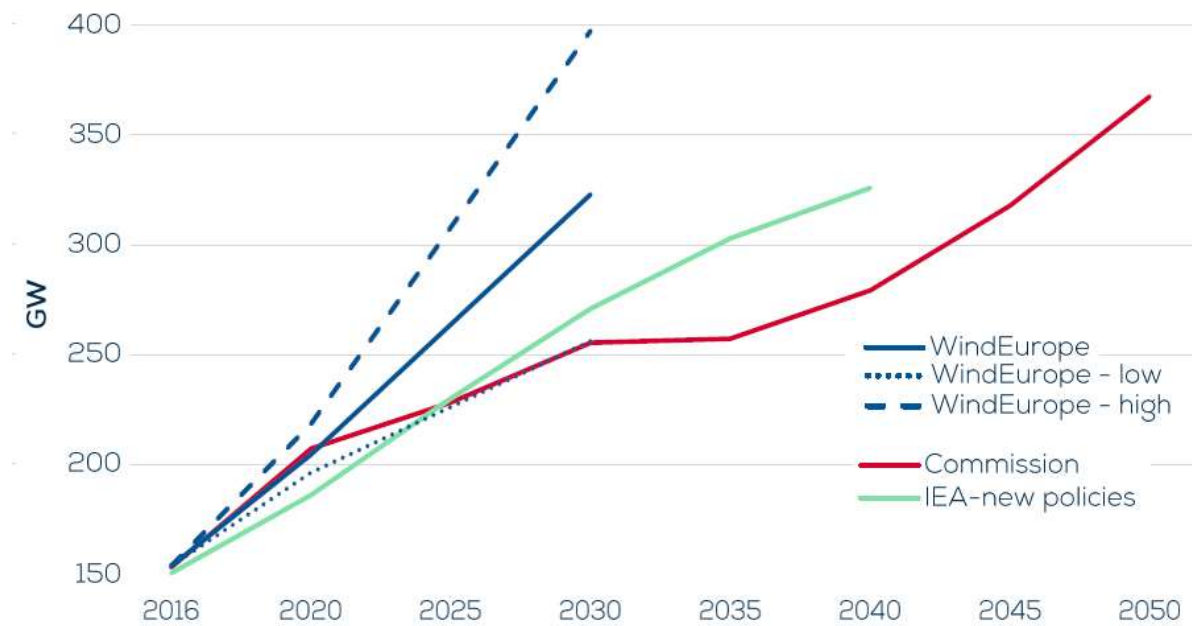
WindEurope's Central Scenario indicates significantly more capacity than both the European Commission (+78 GW) and the International Energy Agency (IEA) New Policies (+31 GW) scenarios (**Figure 27**).

The various IEA scenarios accounts national policy and targets of all EU member states, country climate pledges as part of the Paris Agreement, as well as an aspiration of limiting average global temperature increase in 2100 to 2°C above pre-industrial levels. Even under the most optimistic scenario, IEA prediction results in 292 GW of cumulative wind energy capacity installed by 2030 in the European Union, but still 31 GW less than WindEurope's Central Scenario.

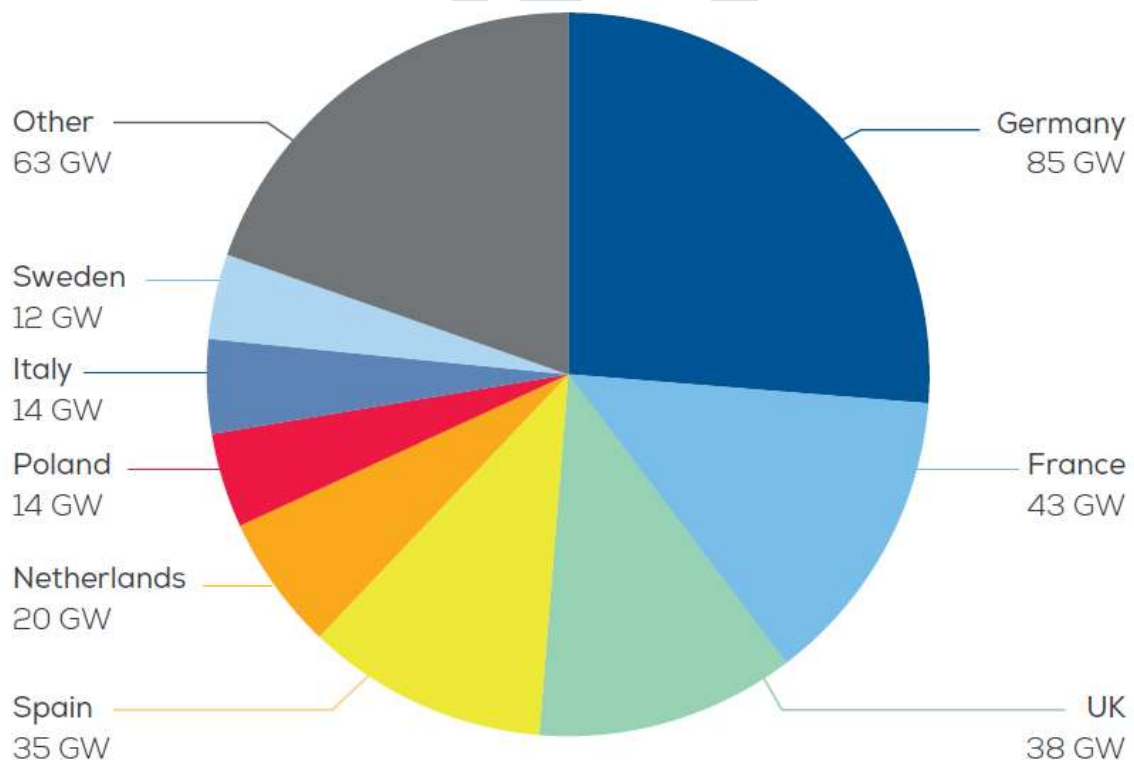
The European Commission Reference 2016 scenario results in 255.4 GW of cumulative wind energy capacity installed by 2030. It assumes that the EU's legally binding greenhouse gas emissions and renewables targets to 2020 are met. It also assumes a constant decrease in CO<sub>2</sub> emissions as well as strong reduction in final energy demand due to successful energy efficiency policies. This is equivalent to WindEurope's Low Scenario and can be considered a conservative forecast estimate.

Wind energy growth forecasts for both on-shore and off-shore markets in 2030 broken down by leading countries are provided in **Figure 28**. Germany, UK, Netherlands, and Sweden are the North Sea countries who are expecting to maintain a leading role in wind energy market by 2030.





**Figure 27:** Wind energy (on-shore & off-shore) growth forecasts. WindEurope scenarios in comparison to Commissions and IEA's forecasts (Source: [12]).



**Figure 28:** Wind energy (on-shore & off-shore) 2030 growth forecasts for EU countries by WindEurope according to Central Scenario (Source: [12]) .

Besides offshore wind, ocean energy (wave and tidal energy) is expected to play an important role post 2020. According to Ocean Energy Europe (OEE) [13], industry scenarios indicate that 337GW of wave and tidal energy capacity could be deployed around the world by 2050. A third of that capacity (100GW) is found in Europe alone. 100GW of wave and tidal capacity can produce around 350 TWh of electricity a year. Consequently, the roll-out of wave and tidal energy over the next 35 years could cover up to 10% of the European Union's energy demand.

The European Union has significantly increased its support for ocean energy over the past years through grant schemes for both early stage development and deployment. Moreover, ocean energy can tap into risk capital financing through the European Investment Bank. Most North Sea countries (Belgium, Denmark, Germany, the Netherlands, Norway, and the United Kingdom) have set-up funds to promote ocean energy research and innovation. Alongside these, a number of national support schemes facilitate deployment of pilot ocean energy projects.

### 3.3. Future Energy Industry Trends

In the last 10 years, there have been significant achievements in the offshore wind industry:

- The rated capacity of offshore wind turbine has grown 62% over the past decade, with 8 MW turbines now generating energy at sea, and larger turbines in development.
- The average size of installed wind farms increased 8-fold, with an average wind farm size of 379.5 MW
- The largest wind farm project ever (1.2 GW Hornsea One project) reached financial investment decision in 2016.
- Projects are being constructed in deeper waters, with bottom-fixed projects at an average water depth of 29.2 m and an average distance to shore of 43.5 km.

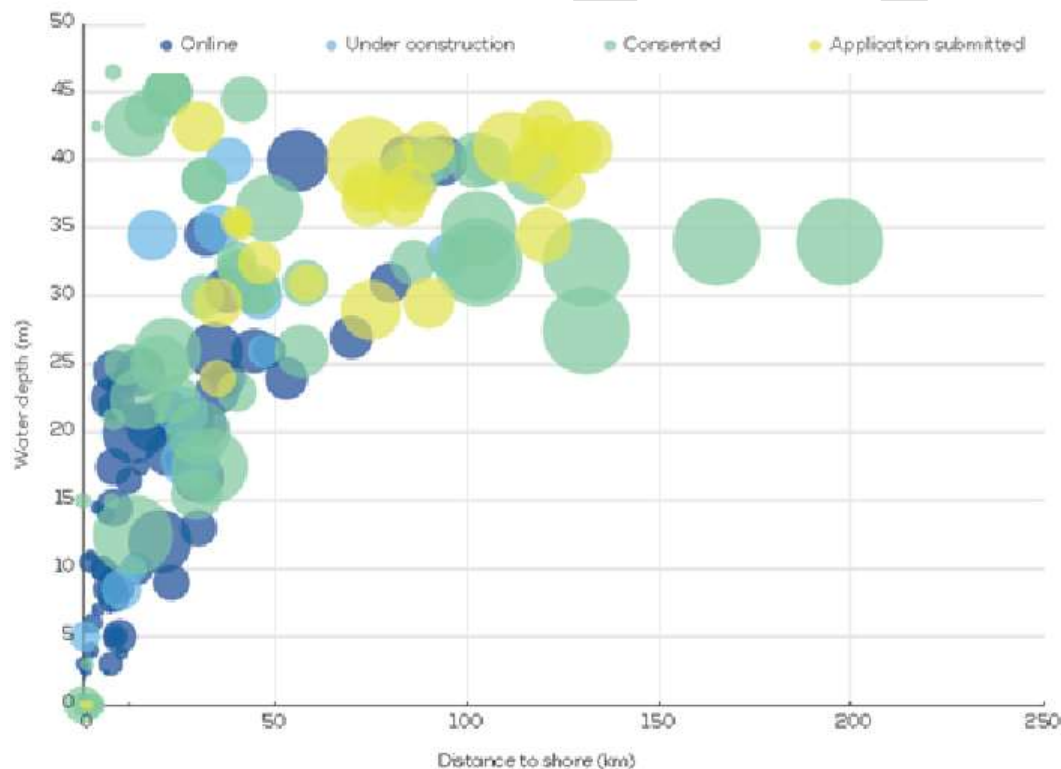
The average size of offshore wind farm projects is expected to grow further with average size of currently consented projects being ca. at 700 MW, and projection of planned projects by WindEurope exceeding 1,000 MW in average size. This will result in a range of industry trends detailed below.

Overall, these future energy trends will have spatial implications for MSP and it will be critical for MSP to keep up with these advancements in energy technology in order to mitigate against any spatial implications that may arise.

## 1. Increased depth of offshore wind farms/further offshore and increased turbine capacity

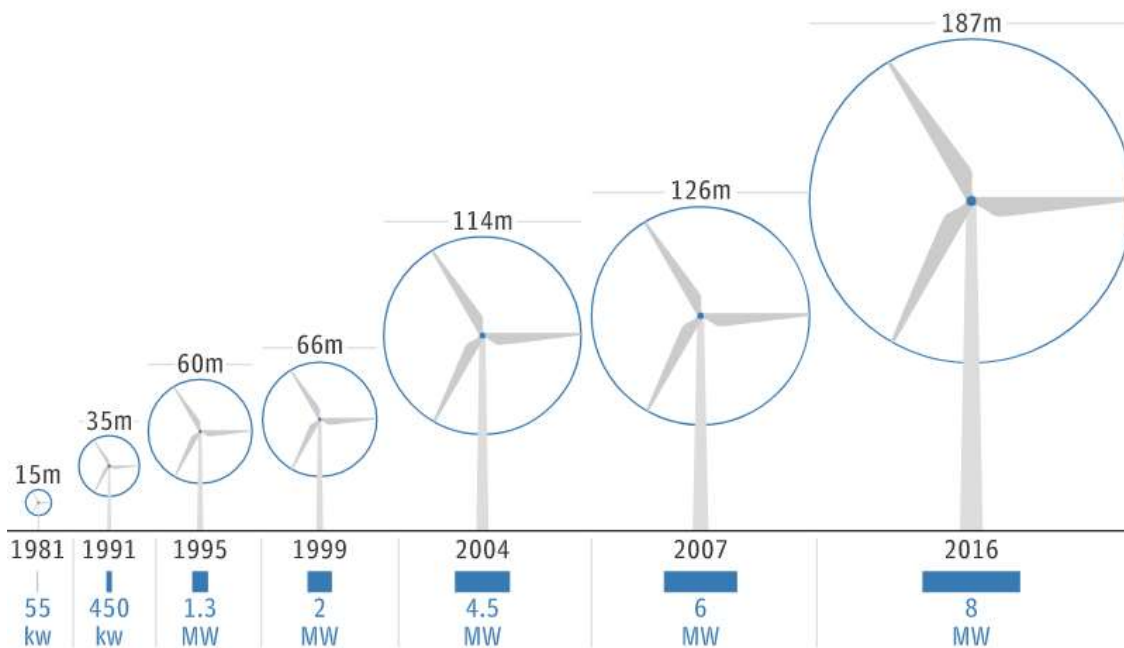
In order to meet the increasing energy demands and EU electricity targets, offshore wind farms are being moved further offshore in order to tap into the large wind potential and deep North Sea waters. Current commercial substructures are economically limited to maximum water depths of 40 m to 50 m [14]. The 'deep offshore' environment starts at water depths greater than 50 m and 66% of the North Sea has a water depth between 50 m and 220 m.

In 2015 the average water depth of offshore wind farms was 27.2 m and the average distance to shore was 43.3 km. In 2016, the average water depth rose to 29.2 m and the average distance to shore has also rose to 44 km (**Figure 29**). It is clear that the average water depth and distance to shore are expected to continue to increase in the future.



**Figure 29:** Average water depth, distance to shore of bottom-fixed, offshore wind farms by development status. The size of the bubble indicates the overall capacity of the site (Source: [9]).

Along with the trend towards deeper waters, the offshore wind industry is also developing larger, more powerful turbines. The average size of the turbines grid connected during 2012 was 4 MW. This has now risen to 4.8 MW in 2016 (**Figure 30**). 8 MW turbines were installed in 2016 and generating power for the first time, reflecting the rapid pace of technological development.



**Figure 30:** Progression of wind turbine sizes and their rated energy output (MW) up to 2016 (Source: Telegraph<sup>2</sup>).

### Conclusion and effect on MSP

- Trends of offshore wind farms becoming bigger, more powerful and moving further offshore in deeper waters are set to increase
- Floating wind will become more popular in deeper waters, further offshore.
- Maritime spatial planning can help the development of offshore wind farms in deeper waters by defining spatial zones. This will provide stability and clarity for investors and help to reduce project costs.
- Provided there is appropriate siting and careful spatial planning of wind farms in deep water locations, it will reduce spatial conflict within congested inshore waters and avoid higher densities of marine users.

## 2. Increased development area (no. of turbines)

Due to spatial restrictions in the North Sea, many offshore wind farms are limited by the size of their development area and the number of turbines. However, larger offshore wind farms with 100 plus wind turbines have been constructed. For example, the London Array in the Southern North Sea is currently the largest

<sup>2</sup> <http://www.telegraph.co.uk/business/2017/05/16/worlds-largest-wind-turbines-may-double-size-2024/>

offshore wind farm in the North Sea with 175 turbines. The final turbine was put in place in December 2012. The Gemini wind park 85 km off the North coast of the Netherlands which was fully commissioned in April 2017, is not far behind with 150 turbines. Whether or not increasing numbers of turbines within offshore wind farms will become a future trend in the North Sea is not yet clear and is largely dependent on spatial limitations, competition with other marine users and relative profitability of smaller versus larger turbines.

### Conclusion and effect on MSP

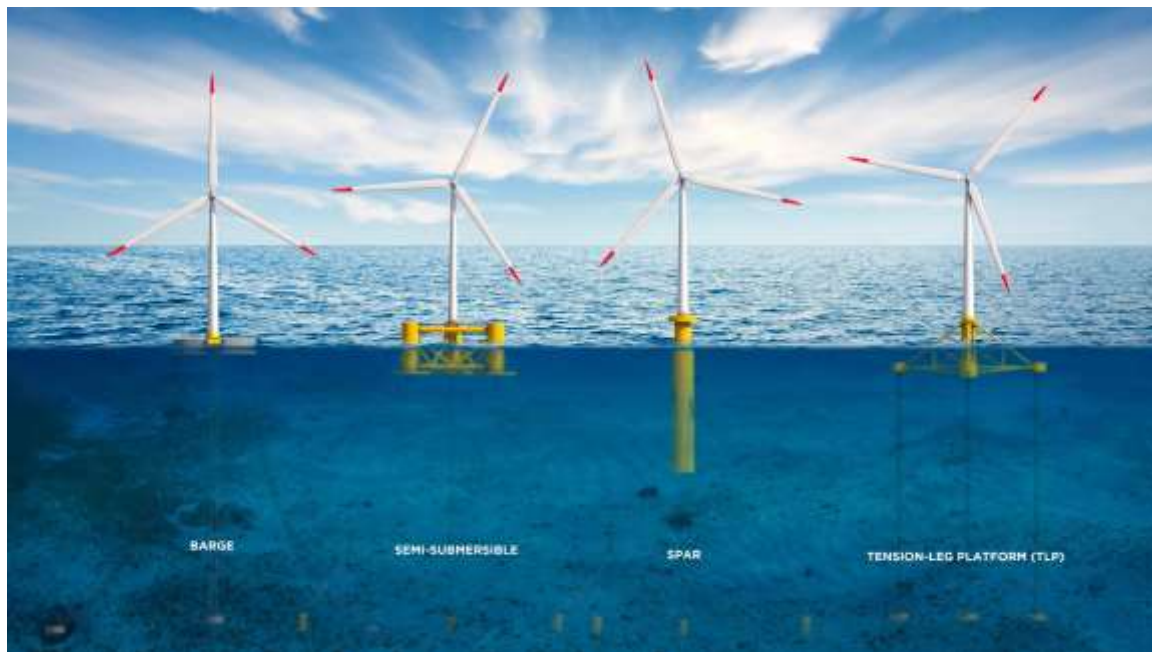
- Trend for increased development area (no. of turbines) is not yet clear
- Fewer, more powerful turbines may be favoured over the more, less powerful turbines due to spatial restrictions.
- For MSP this means that offshore wind farms will require and occupy more sea space and increase competition with other sea users.

### 3. Floating wind

A floating wind turbine is an offshore wind turbine mounted on a floating structure that allows the turbine to generate electricity in water depths where bottom-mounted structures are not feasible. This offers the advantage of unlocking deeper water sites and a virtually inexhaustible resource potential. In European waters, 80% of all the offshore wind resource is located in waters 60 m and deeper [15].

Most offshore wind farms are still traditionally bottom-fixed. However, floating wind technology has developed significantly in recent years and is now ready to be integrated into the energy market (**Figure 31**). Semisubmersible and spar buoy floating substructures are now deemed appropriate for launch and operations, while the barge and the tension leg platform (TLP) floating substructure concepts are still under development and are expected to become operational in the coming years. The floating offshore wind sector will benefit from the latest technologies available in the offshore wind supply chain, enabling costs to fall significantly in the years to come. Nine projects, with a total of 338 MW of capacity are planned to be commissioned by 2021 in France, the UK, Ireland and Portugal.



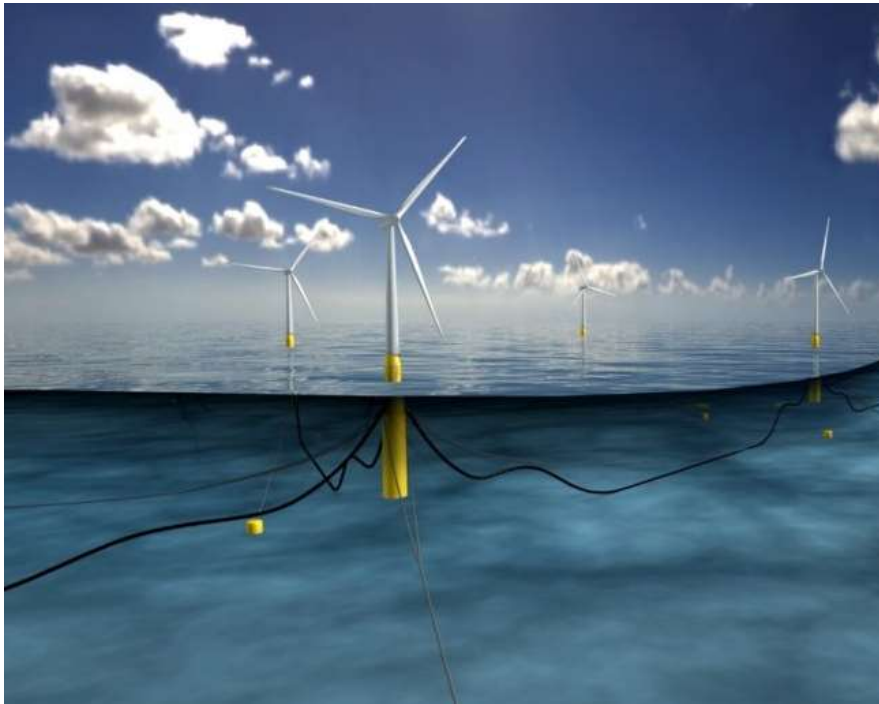


**Figure 31:** The four main technologies for floating offshore wind (Source: Green Giraffe<sup>3</sup>).

Floating wind in the North Sea consists of the world's first floating wind farm, Hywind pilot park, 25 km off the coast of Peterhead, Aberdeenshire in Scotland (**Figure 32**). Hywind consists of a 30 MW wind farm made up of 5 wind turbines on floating structures at Buchan Deep. The pilot park will cover around 4 square kilometres, at a water depth of 95-120 metres.

<sup>3</sup> <https://green-giraffe.eu/blog/floating-offshore-wind-coming-age>





**Figure 32:** The world's first floating wind farm, Hywind pilot park, 25 km off the coast of Peterhead, Aberdeenshire in Scotland (Source: StatOil<sup>4</sup>).

Another large scale project in the North Sea is the Kincardine Floating Offshore Windfarm, approximately 15 km south east of Aberdeen, Scotland. The wind farm consists of 8 floating wind turbines with a maximum generating capacity of 50 MW. The wind farm will cover around 110 square kilometres, at a water depth of around 60-80 metres.

<sup>4</sup> <https://www.statoil.com/en/news/hywindscotland.html>

### Conclusion and effect on MSP

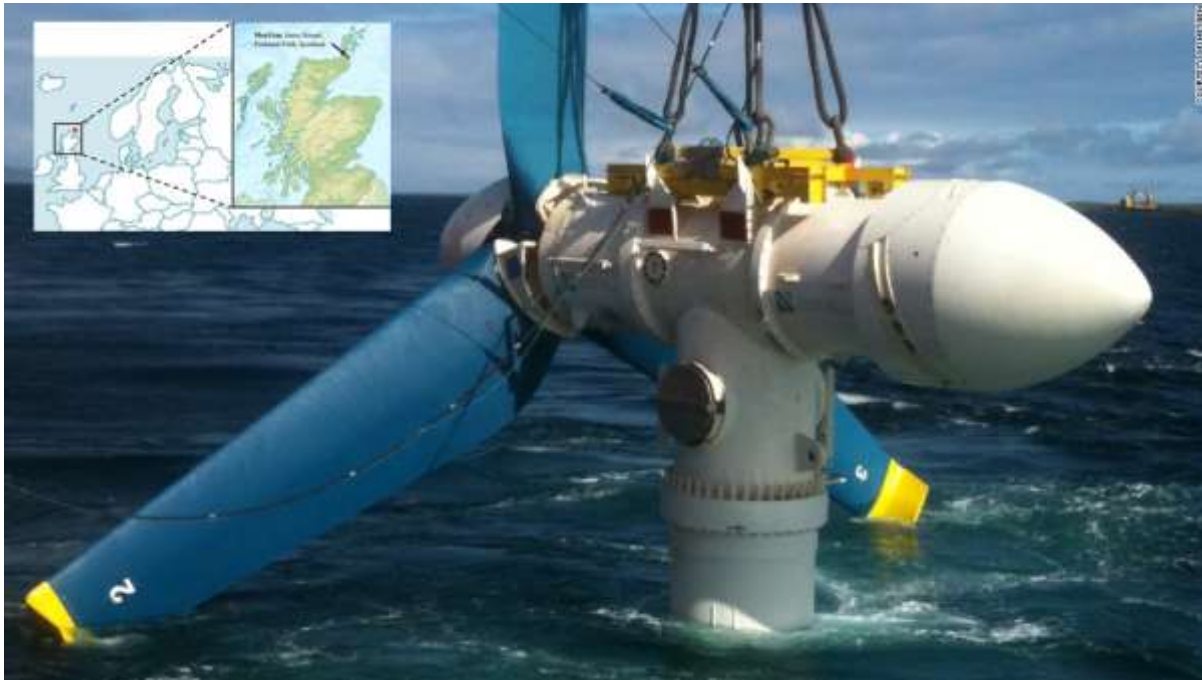
- Floating wind unlocks deeper water sites and virtually inexhaustible resource potential around the North Sea.
- A positive policy environment around floating wind must be developed to improve the outlook of the technology and to attract more investment for the industry to aid its commercial deployment and cost competitiveness against fixed foundations.
- Floating wind turbines are also expected to be able to support larger wind turbines, for example 12-15 MW, which is consistent with the trend of increasing capacities of wind turbines.
- For MSP this means that there will be less spatial conflict with congested inshore marine users but potentially more spatial conflict with other marine users e.g. shipping.

### 4. Increased development of tidal and wave energy

Tidal and wave energy has been slower to progress than wind energy. Wave energy is still within experimental phases within the North Sea. However, tidal energy is slowly starting up with 6 projects fully commissioned in the NSR.

Despite the slower progress, tidal and wave energy bring the significant benefit of offering an alternative solution to traditional grid-connected applications. Alongside utility-scale deployment, ocean energy devices can plug into local and isolated energy markets. Smaller-scale wave or tidal energy devices can already compete with systems using diesel generators; meeting the power demand of an island, powering a desalinisation plant or fish-farm out at sea.

Tidal energy projects of single devices are fully commissioned in The Netherlands, Norway and UK (Scotland). Scotland is leading the way with the most projects. The world's first commercial tidal energy farm, the MeyGen Tidal Stream Project has been built in the Pentland Firth, Scotland (**Figure 33**). Phase 1A consists of 4 tidal turbines which are all currently deployed and Phase 1B, a further 4 turbines has been given consent in June 2017. The MeyGen project currently has consent for up to 86 MW capacity but have future plans for a 398 MW capacity project.



**Figure 33:** The world's first commercial tidal energy farm, MeyGen Tidal Stream Project in the Pentland Firth, Scotland (Source: CNN<sup>5</sup>).

The North Sea has not yet been regarded as prime area for wave energy development in Europe except in Denmark and Germany [16]. The reason is the relatively low energy density in the waves compared to waves in the Atlantic coast regions. Despite significant appetite for developing wave energy in Scotland, Scottish sites with the appropriate physical conditions are all found in the west coast (Atlantic side). However with plans to build a super grid connecting all the wind sites with major consumers around the North Sea, opportunities may open up for wave energy in the long term.

Competition for space is an issue for wave energy developments as they will have to compete with offshore wind farms. However, most wave devices are preferably deployed in deeper waters than offshore wind farms. Even if wave devices are within the same area as offshore wind farms, there may be opportunities for many wave devices to coexist with offshore wind.

### Conclusion and effect on MSP

- For MSP, tidal and wave energy will have to compete with offshore wind energy for space and grid connection. Whether or not they will be a future energy trend will depend on their ability to compete with the energy production and efficiency of offshore wind.

<sup>5</sup> <http://edition.cnn.com/2014/12/11/tech/innovation/scotland-underwater-turbines/index.html>

## 5. Multi-Use developments

Due to increasing demands on ocean resources as well as increasing pressure on use of marine space within most North Sea Countries planning areas, a future trend may be to have Multi-Use (MU) developments. MU is the shared use of marine resources in same marine area/close proximity. Some examples of Multi-Use developments in the North Sea is the co-use of marine space between offshore wind facilities and the production of food (fisheries/aquaculture) and Marine Protected Areas within Offshore Wind Farms. Some novel technology ideas of Multi-Use are combining wind and wave energy developments or wind and aquaculture on the same structure. A Horizon 2020 funded project which is looking into the concept of Multi-Use developments in European Seas is the MUSES Project<sup>6</sup>. The introduction of Multi-Use developments would be spatially advantageous to countries such as Belgium who, unlike Scotland, cannot afford to have single use areas for offshore energy developments due to limited available space in their EEZ.

### Conclusion and effect on MSP

- For MSP, multi-use is a spatial benefit as more than one marine user will occupy less total area, therefore increasing spatial efficiency.
- Multi-Use developments will help to overcome barriers and conflicts, minimise limitations and maximise synergies between two (or more) maritime activities.

## 6. Offshore Energy Renewable Developments Decommissioning

Most offshore wind farms in the North Sea have a marine licence for 25 years. After this period, the marine licence will expire and the development will be decommissioned. In Scotland for example, it is a legal requirement for developers to prepare a fully-costed decommissioning programme prior to licence award. The programme details how the developer intends to remove the installation when it comes to the end of its useful life and how the costs of doing so will be funded. This gives the project financial security and protects against developers failing to pay the decommissioning costs and not being liable for the removal of the infrastructure, resulting in it being left on the seabed.

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<sup>6</sup> <https://muses-project.eu/>

### Conclusion and effect on MSP

- A fully-costed decommissioning programme agreed prior to licence award will benefit MSP as it will ensure that any offshore energy development infrastructure will be decommissioned and removed from the seabed after 25 years when the marine licence expires. This will free up marine space and reduce conflicts with other marine users.

## 7. Oil and Gas infrastructure decommissioning

One of main trends in the next 10 years within the North Sea will be the decommissioning of oil and gas infrastructure. The cost implications for hydrocarbon recovery from the mature North Sea basin effects all oil and gas producing countries. Consequently the timing of decommissioning will be similar across the North Sea. However, decommissioning will need to be balanced with the current low oil price and access to infrastructure.

Cessation of production results in an asset entering its decommissioning phase. In the UK for example, the cost of decommissioning is signed off once this has been agreed with the Oil and Gas Authority. Decommissioning costs are based on the tax regimes in place during the life of the asset. The costs are met by the operator by forward taxation through the reduction in production taxes equivalent to the annual decommissioning charge.

Financial risks associated with operators and their decommissioning commitments are being identified in order to minimise the exposure of the UK Government to the possibility of taking on the financial responsibility as a last resort. This may result in commercial decommissioning security agreements (DSA) between operators with joint liability for decommissioning of an asset. This could take the form of security held in a trust to cover the operator's share of the decommissioning costs.

Platforms are regulated by OSPAR decision 98/3 which has a base case for the complete removal of the platform infrastructure. Derogations do exist for concrete gravity based platform structures and steel jackets above a certain weight threshold. However, pipelines are not covered by decision 98/3 and are left to individual member states to remove. The trans-boundary issues associated with oil and gas infrastructure can be considered in terms of direct and indirect effects.

The hydrocarbon infrastructure that has a direct trans-boundary component will be dominated by pipelines. North Sea pipelines are estimated to be 40,000 km in length making up a network transporting and exporting hydrocarbons, as well as the supply of chemicals and hydraulic fluids. Because of the inter-connectivity of the pipeline network, decommissioning needs to consider how this takes place to ensure



the maximum economic recovery of residual hydrocarbons for all countries producing hydrocarbon in the North Sea.

Indirectly, pipeline decommissioning approaches adopted by member states will influence how the residual infrastructure will interact with other legitimate uses of the sea (in particular demersal fishing). Different mitigation methods may be adopted by different member states for the same infrastructure. Consequently fishing safety over the same infrastructure in different sectors of the North Sea may pose different risks to the European fleet operating in the North Sea. Also this information may be recorded differently on different navigation charts or fishing friendly software e.g. Fishsafe. Similar “inconsistencies” may also arise in relation to decommissioning and maintaining/improving environmental objectives of designated conservation sites resulting from European Directives implemented by member states.

Individual countries have the potential to influence the decommissioning process for certain types of infrastructure. This in turn could influence the expectation of decommissioning across the North sea e.g. Shell’s Brent concrete gravity based platform decommissioning will have implications for other similar structures on the UK Continental Shelf as well as those in Norwegian waters.

Transportation of decommissioned infrastructure could result in vessels passing through national waters in order to reach their final destination. What would happen if the vessel sank or lost control of the towed infrastructure? Would the expectation be to ensure the recovery of the infrastructure from the seabed if it did not pose a threat to other legitimate users of the sea or the environment? How would member states maintain a consistent approach with the recovery of vessels lost in national waters? There are a variety of approaches that could be explored further and adopted, including:

- Joined up international regulatory consultation for decommissioning decisions involving trans-boundaries.
- Adopt a more strategic view for decommissioning oil and gas infrastructures, in particular pipelines, across the North Sea and how they would interact with other legitimate users of the sea and marine conservation objectives.
- Collating and sharing infrastructure data is essential for understanding the scale of the problem and the consequences of regional regulatory decommissioning decisions.
- Take guidance on managing the recovery of decommissioned infrastructure at sea.
- Review the transportation requirements for towing infrastructure through national waters in light of the Transocean Drill Rig incident.



### Conclusion and effect on MSP

- Inconsistencies within decommissioning legislation – pipeline decommissioning should be consistent with legislation for decommissioning platforms.
- Issue for MSP if pipelines are left in-situ. Conflicts with other marine users such as snagging with commercial fishery nets.

## 8. Environmental protection of oil spills

Hydrocarbon spills have the potential to extend beyond national boundaries. An oil spill can be managed in a number of ways which may differ from one member state to another due to different legislation, country geography (how the spill could impact on different member states e.g. open water or shoreline), different member states may have different prioritisation of environmental receptors within their national waters e.g. fishing may be seen of greater importance than certain environmental receptors, and lastly member states may have different approaches regarding the use of dispersants or maintaining a registered list of dispersant that is different to other member states.

There is a strong link between oil spill risk analysis (OSRA) and MSP where a flow of key information is required for successful management of coastal and marine areas [17]. MSP generates large amounts of data that is vital to OSRA and in turn, OSRA informs MSP on areas of high risk to oil spills. This allows marine planners to redefine planning objectives and relocate marine activities in order to increase the ecosystem's health and resilience.

A potential approach to can be to apply agreements, such as NorBrit plan (a bilateral contingency plan between the UK and Norway), during oil spill training exercises for trans-boundary incidents to fully engage with the emergency response command structures for other member states.

### Conclusion and effect on MSP

- Oil spills can occur across national boundaries and a co-ordinated action is required across all countries in order to tackle the incident.
- In terms on MSP, oil spill response and risk analysis forms a critical part of the management of coastal and marine areas.
- Oil spill risk analysis informs MSP on areas of high risk to oil spills allowing a redefinition of planning objectives and relocation of marine activities.

## 9. Brexit links to Energy

The withdrawal of the UK from the EU could impact the UK's ability to maintain current levels of electricity generation and may make the UK more vulnerable to energy shortages in the event of extreme weather or unplanned generation outages. Trans-boundary issues may arise regarding energy supply, in particular gas. The UK imports approximately 40% of its gas supply principally from Norway and Qatar (LNG). The UK produces 30% of its electricity supply from burning gas. Germany, France and Italy have significant gas storage capacity, much larger than the UK storage capacity. Access to the gas storage in the time of a crisis may become more difficult for the UK as priority will be given to EU member states. The distribution and production of nuclear energy could also be under threat from Brexit forcing alternatives to be considered to ensure the security of energy in the UK. Offshore wind is currently the only renewable source today that has the commercial scaling necessary to deliver the same amount of energy as nuclear plant within the necessary timeframes.

### Conclusion and effect on MSP

- The implications of Brexit are still largely unknown.
- Transboundary cooperation between EU countries should still be maintained.

## 10. Multi-rotor offshore wind turbines

The up-scaling of the conventional single rotor offshore wind turbines to multi-rotor offshore wind turbines has progressed onshore with Denmark's Vestas single tower with 12 blades mounted on four separate rotors. Plans are beginning to move towards implementing the multi-rotor system offshore with the European project, Innwind [18] who have designed a concept 20 MW, multi-rotor system comprising of 45 rotors.

Multi-rotor wind turbines have several benefits such as increased energy capture, reduced cost of energy through fewer maintenance sites, fewer foundations causing less environmental impacts such as benthic disturbance and displacement for fish and marine mammal species and reduced extent of electrical interconnectors per installed megawatt of wind farm capacity.

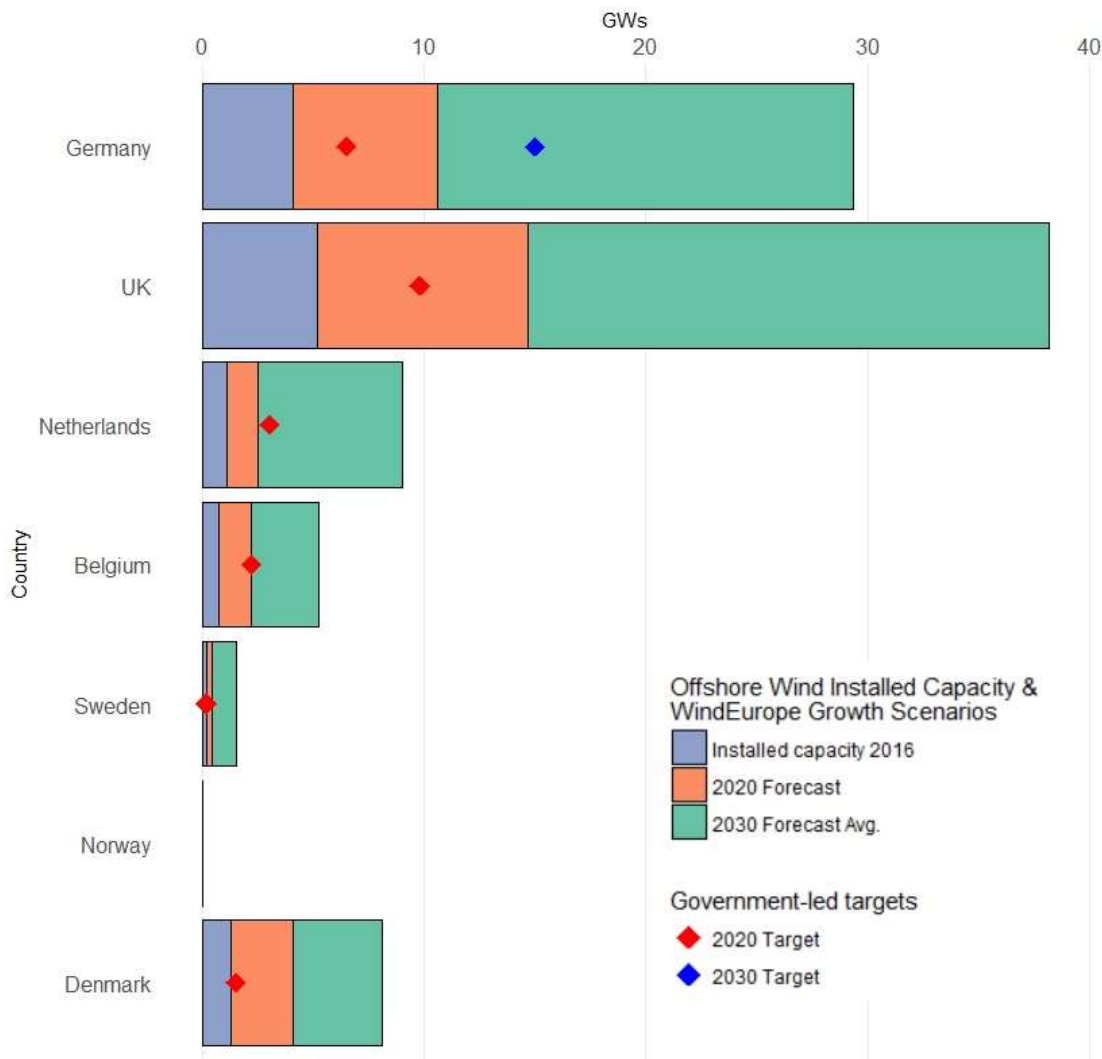
### Conclusion and effect on MSP

- For MSP, multi-rotor turbines would reduce the footprint and space requirements of offshore wind farms. However they could lead to increased aerial navigation and safety concerns and bird collisions without proper planning and consultation.

## 3.4. Analysis of future outlook

This section compares government-led (**Section 3.1**) and industry-led targets and growth aspirations (**Sections 3.2** and **3.3**) for 2020 and 2030. Furthermore, considerations of the space requirements needed for meeting industry forecasts for 2020 and 2030 are presented.

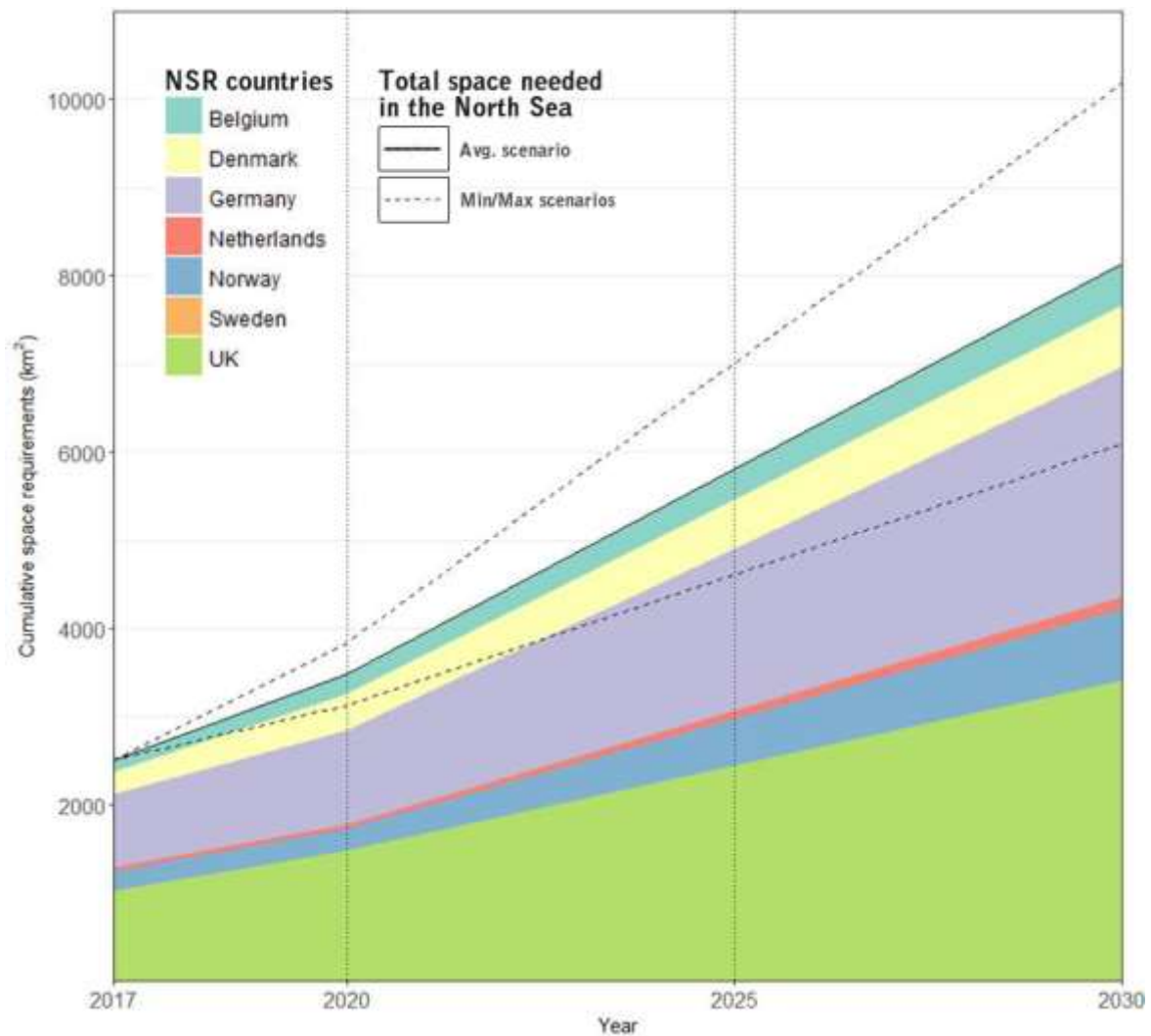
According to the information presented, there appears to be a mismatch of the level of aspirations between government and industry (**Figure 34**). Most governments (with the exception of Belgium), have set a lower 2020 national target of installed offshore wind capacity in comparison to the one industry is advocating via WindEurope trade body. Apart from Germany, no other NSR country has set a 2030 national target, introducing uncertainties post 2020.



**Figure 34:** WindEurope's offshore wind installed capacity forecasts for 2020 and 2030, compared to national government targets of the countries of the North Sea.

WindEurope's Central scenario for offshore wind installed capacity, as presented in **Figure 34**, is the best forecast to fulfil North Sea's 'Blue Growth' highest potential, in terms of largest installed capacity at the shortest time period (see also **Figure 27** and **Figure 28**). Under any growth forecast, large offshore space will need to be identified for the further deployment of offshore wind farms in the North Sea Region by 2020 and 2030.

The NorthSEE consortium focused on WindEurope's central scenario to estimate the space requirements for fulfilling 2020 and 2030 growth targets in the NSR. Assuming that the spacing of wind turbines will remain at 1 km distances in the years to come, space requirements were calculated for incremental offshore wind turbines size scenarios (7 MW to 15 MW; see **Annex 5**). **Figure 35** shows the resulting cumulative space requirements under an average scenario. The North Sea is roughly 750,000 km<sup>2</sup> in total and the total space occupied by offshore wind farms is ca. 3,500 km<sup>2</sup> by 2020 and over 8,000 km<sup>2</sup> by 2030.



**Figure 35:** Cumulative space requirements by North Sea country to realise WindEurope's offshore wind installed capacity forecasts by 2020 and 2030

### Chapter 3 Summary

- There are wide differences in NSR countries policies, objectives, targets and timelines.
- Most offshore wind farms are within UK and German waters. Scotland is leading on wave and tidal energy developments.
- Most energy targets and commitments only run up to 2020 and then there is a lack of medium term (2030) targets. The remaining targets are aspirational targets running up to 2050.
- It is important to take future timelines of wind energy projects into account in sectoral planning considerations, including upcoming competitive tenders and the regulatory framework.
- The 2020 outlook for wind energy is promising in terms of achieving energy policy commitments and targets.
- Future energy industry trends include larger, more powerful offshore wind turbines further offshore in deeper waters, floating wind, multi-rotor turbines, increased ocean energy developments, multi-use developments, and decommissioning of Oil & Gas platforms . These trends will all have spatial implications for MSP.
- Future outlook for 2020 and 2030 for offshore wind shows a mismatch in the level of aspirations between government and industry.
- Space requirements are needed to be considered carefully for meeting offshore industry growth forecasts for 2020 and 2030 in the North Sea.



## 4. Conclusion

### 4.1. Main findings

- **Differences in national MSP approaches**

This report highlights the numerous differences in the MSP processes and planning approaches of all of the North Sea countries. This is largely results from different countries policies, aspirations, timelines and targets. Despite all EU countries having the same target of having maritime spatial plans in place by 2021, differences still remain in countries progress with achieving this goal, for example Scotland and Germany are going through their MSP revision process, where Denmark and Sweden have no MSP in place as of yet.

- **Best practice to designate spatial areas for offshore energy in MSP**

With the exception of Norway and Sweden, most NSR countries have planned and designated spatial areas for offshore renewable energy and their Governments have set goals to meet renewable energy targets. No zones have been opened in Norway yet, but areas have been identified, and no specific target goals or spatially designated areas have been set in Sweden. Strategically planning and designating spatial areas for offshore renewable energy will allow energy targets to be met, make it easier to balance conflicts and synergies with other marine activities, such as shipping and allow sustainable management and protection of the marine environment. It will also aid planning and identifying suitable locations for future offshore energy industry infrastructure such as floating wind.

- **National approaches to MSP and sectoral planning affected by country history, priorities, and geography**

Differences in the size of national marine area influence the MSP process and in particular sectoral planning for offshore renewable energy. For example, Scotland has a very large marine area and there are plan option areas which are designated to host either offshore wind, wave or tidal energy developments. In comparison to this, Belgium has a much smaller marine area and therefore cannot afford to have single use areas, and has identified technology-neutral marine sites (areas are just designated as renewable areas and can be wind, wave or tidal developments). Due to space restrictions, Belgium is also keen to encourage multi-use developments in order to maximise use of space and generate more energy out of a smaller space.

- **Importance of using and maintaining existing data infrastructure and encouraging industry to submit their data to portals**

Numerous data infrastructures contain gaps and there are differences in the level of data that each contain. Contributing to and maintenance of data portals has many advantages for maritime users and planners, such as easy access to up-to-date information held in one common place. Gaps can also be identified more easily and everyone can benefit from shared resources. A recommended database to contribute to is the “EMODnet<sup>7</sup> human activities” portal which is based on free, open-source technology and aims to collect, harmonise, and make available data relevant to human activities. It is also vital for industry to be encouraged to submit their data to portals and a recommended route for submission and contribution is via the EMODnet data ingestion portal<sup>8</sup>. This portal will become the reference point for all those European marine data holders. Data is collected on European coastal and ocean waters to help governments, industry and policy makers to make informed decisions.

- **There is no over-arching body or mechanism for MSP coordination and cooperation in the North Sea, despite the call to do so via the EU MSP Directive**

Despite all of the transnational cooperation that is demonstrated in Section 1.6 via different MSP projects and joint initiatives, at the moment there is currently no over-arching North Sea MSP body or mechanism that could coordinate effort and facilitate cooperation after the lifetime of the NorthSEE project. Currently there are only transnational consultations of national plans but this does not necessarily account for cooperation. National strategic environmental assessment of MSPs follow the ESPOO Convention<sup>9</sup> which lays down the general obligation of States to notify and consult each other on all major projects under consideration that are likely to have a significant adverse environmental impact across boundaries. However, spatial planning has no over-arching cooperation mechanism despite the call to do so via the EU MSP directive. The question remains how a NSR-wide body could provide coordination with the national MSPs being under national mandates and jurisdiction. A proposed solution for the NSR would be to create a similar approach to VASAB<sup>10</sup> in the Baltic Sea. VASAB is intergovernmental multilateral co-operation of 11 countries of the Baltic Sea Region in spatial planning and development, guided by the Conference of Ministers responsible for spatial planning and development, steered by the Committee on Spatial Planning and Development of the Baltic

<sup>7</sup> <http://www.emodnet.eu/human-activities>

<sup>8</sup> <http://emodnet.eu/welcome-new-emodnet-data-ingestion-portal-turn-your-data-valuable-asset-marine-and-maritime>

<sup>9</sup> <https://www.unece.org/env/eia/eia.html>

<sup>10</sup> <http://www.vasab.org/index.php/about-vasab>

Sea Region (CSPD/BSR) composed of representatives of respective ministries and regional authorities.

- **Terminology barriers hinder transnational cooperation in the North Sea**

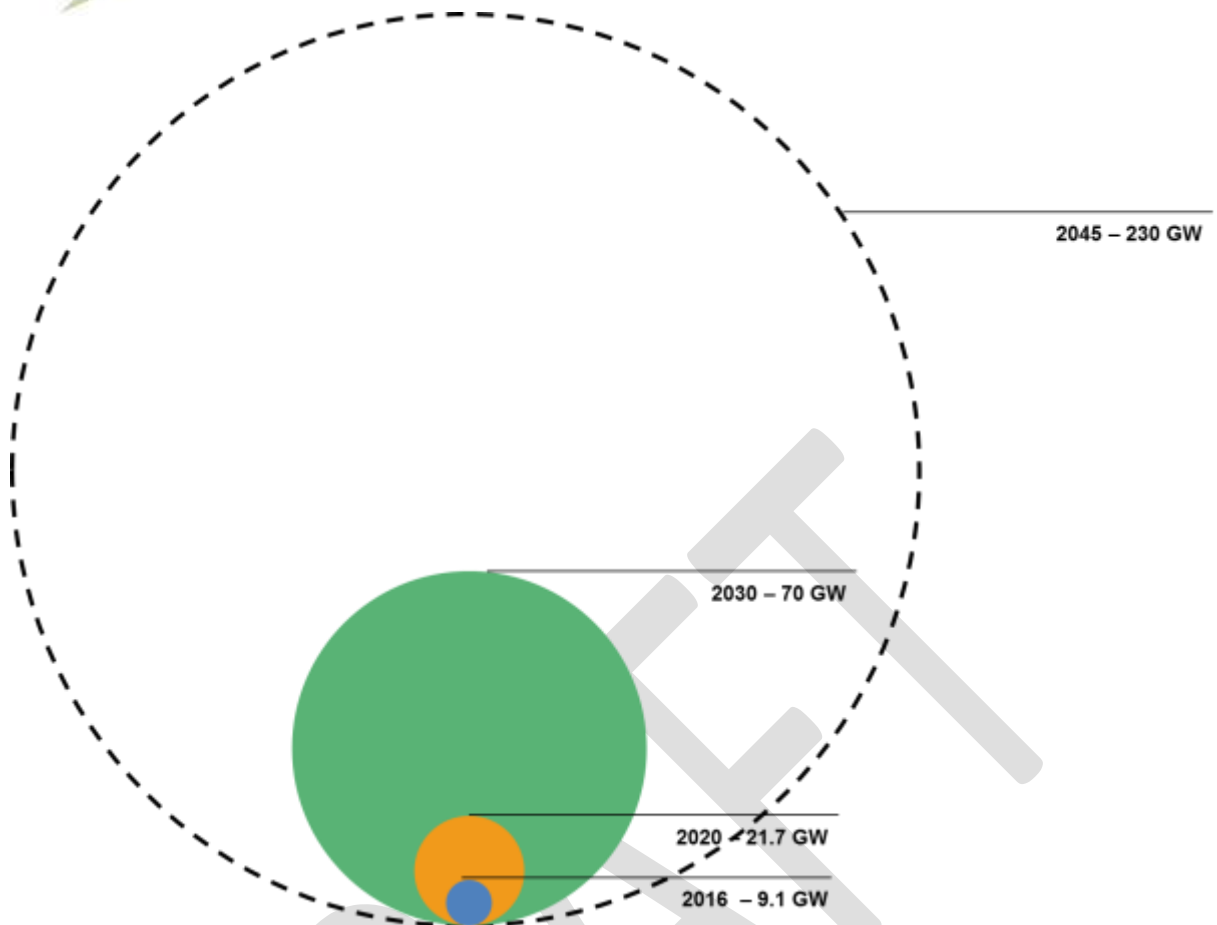
Transnational cooperation between North Sea countries is made difficult by countries using different terminology in their MSP process and also different terms to describe the status of their offshore renewable energy developments. This lack of consistency of terminology across countries creates a barrier to transnational cooperation and hinders countries understanding of their neighbouring countries. The consequences of this can be conflicts in the spatial planning of border areas between countries and impacts to activities with a transnational nature such as offshore linear energy infrastructure and shipping. There is also an issue with terminology for joint data layers where there needs to be agreement on terminology and a common understanding.

- **Strong offshore energy industry growth by 2020; Risks post-2020**

New installations will remain relatively strong until the end of 2020, but policy uncertainty and lack of ambition for the post-2020 climate and energy framework could have a significant negative impact on the sector. A concrete roadmap to achieving 2050 targets is required. Only a handful of Member States have provided visibility and regulatory certainty. With only 5 countries among the EU-28 announcing auctions plans, there is a lack of certainty on revenue stability for investors.

- **Spatial implications of future trends need to be explored further**

Multi-use energy developments have been identified as a future energy industry trend, along with trends for larger, more powerful and further offshore wind farms, floating wind and increased wave and tidal energy developments. However there is currently no link between future energy trends and spatial policies. **Figure 36** gives a simplistic spatial indication of the predicted future growth of offshore wind in the North Sea according to targets set from 2016 to 2045. The size of the circle represents the area required to produce the energy.



**Figure 36:** Spatial indications of future growth targets and predictions for offshore wind in the North Sea.

- Partner countries are on track to achieving EU carbon reduction targets**  
 Partner countries are on track to achieving GHG 2020 targets, and interim renewable energy targets have been met. In terms of long term targets, most countries lack of 2030 targets and any existing 2030 targets lack clarity in terms of national targets. In order to meet 2050 targets, this will involve increased energy efficiency, renewable energy, nuclear energy and carbon capture and storage. Currently, only the UK has set targets related to CCS. Overall, more European internal energy market integration and commitment to the Energy Union is needed in order for countries to keep on track with achieving EU targets.
- Lessons learned from countries with MSP in place**  
 MSP is key to efficiently managing human activities and in turn, their impact to the marine environment. It is also essential for setting the spatial framework for blue growth as well as a whole host of social and economic benefits. In terms of transnational consultation, it is sometimes dealt with quite informally, or undertaking ad-hoc consultation quite late in the MSP process. Advice would be to include transnational consultation as part of the formal consultation process and to engage with bordering countries at an early stage of the process.

Transnational issues should also be discussed cooperatively and not in isolation. It is also encouraged to join and/or form regional sea basin forums, as well as cooperate in transnational projects, such as the NorthSEE project, as an opportunity to improve coordination of a number of aspects related to MSP.

## 4.2. Recommendations

### Energy

1. Create a concrete national energy policy roadmap to achieving 2050 energy targets.  
Target group: ministries
2. Energy policy targets should be translated into the same units for all NSR countries. This will allow a comparison between countries.  
Target group: ministries
3. Support the integration of the European internal energy market.  
Target groups: ministries and energy industry sector

### MSP

4. Designate spatial areas for offshore renewable energy to safeguard space for future wind parks in suitable locations. This also supports possible cross-border developments of energy production and transmission.  
Target groups: ministries and planning authorities
5. Include transnational consultation as part of the formal consultation process and to engage with bordering countries at an early stage of the process.  
Target groups: planning authorities, maritime administrations, and energy industry sector
6. Determine spatial implications of future energy industry trends, including growth of offshore wind production, technical developments of wind turbines, distance to shore, multi-use renewable energy developments, developments in ocean energy, oil and gas and offshore wind farm decommissioning.  
Target groups: research and research and development projects
7. Development of harmonised planning and technical design criteria for offshore wind farms across all North Sea countries. This will support the harmonisation of

planning approaches, especially for future cross-border developments of energy production and transmission.

Target groups: planning authorities, research and research development projects, data hosts and energy industry sector

8. Identify planning areas and issues for linear infrastructure and develop planning criteria and proposals for interconnector routes and gates to be integrated in national MSPs.

Target groups: ministries, planning authorities, research and research development projects and energy industry sector

9. Develop suggestions for streamlining SEA/EIA processes across the NSR.

Target groups: planning authorities and research and research development projects

10. Stronger links need to be made between national marine planning and regional marine planning to determine the need for the involvement of regional and local government in MSP and the range of their maritime issues.

Some confusion currently exists surrounding local authorities and their role within MSP. To help avoid this confusion, relevant local authority contacts and MSP issues should be mapped around the North Sea.

Target group: planning authorities

Good practice example: The links between regional marine planning and national marine planning are explained in a Scottish example with an International North Sea dimension. Relevant local authority contacts will be mapped around the NSR and MSP issues identified. This report will be uploaded to outputs library section of the NorthSEE webpage (<http://www.northsearegion.eu/northsee/>) on completion.

#### Future energy industry trends

11. Encourage and support multi-use developments in order to use space more efficiently and sustainably.

Target groups: planning authorities, ministries and energy industry sector

12. Suitable locations should be identified for floating wind across countries in the North Sea.

Due to the depth profile of the North Sea, the available space able to host fixed foundation offshore wind farms is limited. Floating wind therefore offers a promising alternative.

Target groups: ministries, planning authorities, research and research projects



Good practice example: Scotland is working on a report detailing their experience in identifying suitable locations for floating wind in Scotland, in terms of sharing good practice with other North Sea countries. The report will include an international dimension and explain why floating wind would be an interesting option for the North Sea, and what would be needed for such an approach to be transferable to other nations. This report will be uploaded to outputs library section of the NorthSEE webpage (<http://www.northsearegion.eu/northsee/>) on completion.

13. A transnational oil spill contingency plan should be set up across all NSR countries to aid trans-boundary incidents and fully engage with the emergency response command structures for other member states.

Target groups: planning authorities and maritime administrations

14. Identify demand for grid connections, interconnector routes and gates, grid and connection points on land.

In line with growth targets of offshore renewable energy, the demand for grid connection is set to increase.

Target groups: planning authorities and energy industry sector

#### Data

15. Use and maintain existing data infrastructure and encourage industry to submit their data to both national data portals and other portals such as EMODNED.

Target groups: data hosts, planning authorities and energy industry sector

16. Contribute data to the MSP Challenge Game in order to help generate simulations of the future energy industry trends to determine available marine space.

Target groups: data hosts, planning authorities, research and research and development projects, maritime administrations and energy industry sector

17. Share data relevant to oil spill contingency with all NSR countries to aid a fast and efficient response to oil spill emergencies.

Target groups: data hosts, planning authorities, research and research projects

#### Whole project recommendations

18. Carry out a comparative analysis of the different MSP approaches and processes between NSR countries to foster the understanding of other national MSP processes to enhance cross-border cooperation.  
Target groups: research and research and development projects
19. Establish an over-arching North Sea MSP body or mechanism that can coordinate efforts and facilitate cooperation between NSR countries after the lifetime of the NorthSEE project.  
Target groups: ministries and planning authorities
20. Create a MSP dictionary which defines general terms to make terminology comparable to facilitate a better understanding of each other's MSP processes.  
Target groups: planning authorities, ministries, policy-makers, research and research and development projects
21. Define general steps in an MSP process, where countries can put their specific MSP activities in a timeline. This process timeline will allow a comparison of where countries are with respect to their MSP preparations or revisions. This supports countries to better time their process steps and harmonise any planned transnational consultations.  
Target groups: planning authorities, ministries, research and research and development projects
22. Cooperate in projects such as the NorthSEE project as an opportunity to improve coordination of a number of aspects related to MSP.  
Target groups: planning authorities, maritime administrations, energy industry sector, data hosts, research, research and development projects

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