Exploration of potential collaboration on preventive, mitigation and compensation measures

Offshore wind & ecology

Rijkswaterstaat

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Project Leader	M. van der Kamp MSc
Project Director	L.G. Turlings MA
Author(s)	M. van der Kamp MSc, M. Brekelmans MSc, L. Verweij MSc
Checked by	M. van der Kamp MSc
Approved by	M. van der Kamp MSc
Paraph	

Address

Witteveen+Bos Raadgevende ingenieurs B.V. | Deventer
Daalsesingel 51c
P.O. Box 24087
3502 MB Utrecht
The Netherlands
+31 30 765 19 00
www.witteveenbos.com
CoC 38020751

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Glossary

Compensation measures: measures taken to make up for the loss of, or permanent damage to, biological resources by providing new values in another area.

Effect: the direct or indirect consequence or outcome of an intervention on the environment (see impact for example).

Impact: the influence of the intervention on the quality or state of an ecosystem/population/individual. For example, the effects of pile-driving are, among others, disturbance of the sediment. This effect of pile-driving impacts benthic life.

Mitigation measures: measures taken to avoid or reduce negative impacts.

Nature enhancing measures: measures that help maintain and improve ecological health and (native) biodiversity in ecosystems.

Offset measures: measures taken to fully compensate for biodiversity impacts.

Preventive measures: measures to be taken to protect the environment at an early stage to prevent effects.

OFFSHORE WIND & ECOLOGY

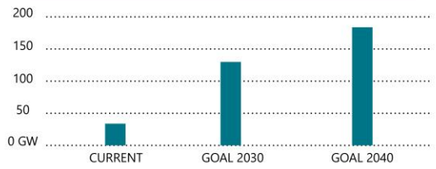
Exploration and collaboration on preventive, mitigating and compensation measures

Rijkswaterstaat
Ministerie van Infrastructuur en Waterstaat

Witteveen+Bos

FACTS & FIGURES

Current state and goals North seas countries



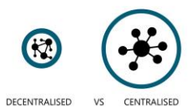
Governance

Tender publishing

In all North seas countries MSP and permitting is government led.

Tender criteria

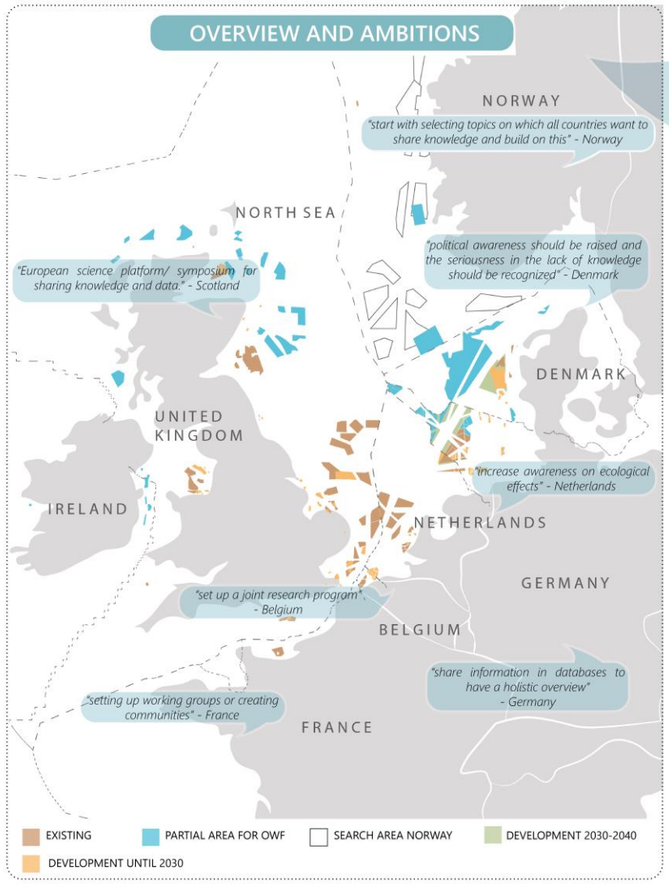
In one third of the North seas countries the market is in the lead for setting up the baseline for ecology.



EIA assessment

In France the EIA assessment is decentralised.

OVERVIEW AND AMBITIONS



SUGGESTIONS FOR INTERNATIONAL COOPERATION AND POINTS OF ATTENTION

Future cooperation wishes

Coordination in spatial planning and temporal development

Knowledge and data sharing
- Ecosystem functioning
- Location specific ecological effects of offshore wind
- Environmental Impact assessments
- Mitigation measures and their effectiveness
- Platform for knowledge and data sharing

Assessing and mitigating impacts in standardized ways

Joint research initiatives

Points of attention

Different stages of development and energy goals

Different government bodies involved

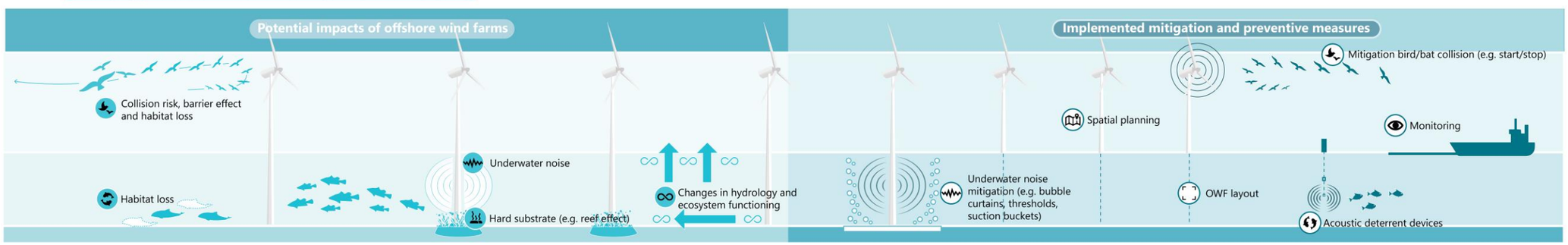
Delay in development of offshore energy

Language barrier

Different ways of gathering information

EU/non-EU countries

IMPACTS, PREVENTIVE AND MITIGATION MEASURES



Summary

Introduction and goal of the project

North Seas countries have ambitious goals for offshore wind energy in order to achieve climate neutrality goals and meet the increasing demand for electricity. The EU strategy on offshore renewable energy sets targets of at least 120GW of offshore wind energy by 2030 and 300GW by 2050. The North Seas Energy Cooperation (NSEC) supports and facilitates the implementation of these ambitions including the offshore grid developments in the North Seas. The large-scale installation of offshore wind energy potentially has (significant) impacts on the ecology of the North Seas both in the installation- and in the operational phase. As such, countries have independently carried out research and have taken efforts to implement measures to prevent, mitigate or compensate adhere effects. In order to achieve effective prevention, mitigation or compensation of the environmental impact of offshore wind energy it is necessary to account for the transboundary nature of ecological impacts. This requires a coherent prevention, mitigation and compensation strategy. As such, it is necessary to assess what is the current state of development, what research has been done, what measures are currently being implemented by North Seas countries and investigate whether there is a need for cooperation.

This project contributes by mapping the preventive, mitigation and compensation measures in place and future ambitions of wind development in NSEC and allied countries (Norway, Denmark, the Netherlands, Germany, France, Belgium and Ireland, and including the NSEC guest the UK). Additionally, it explores if there is broad support for further cooperation between these countries. Although not all countries are in the same stage of offshore wind development, all countries are concerned about cumulative effects of the increasing amounts of offshore wind energy. Information was gathered by performing interviews with offshore wind energy experts from the above mentioned countries in August and September 2023. In those interviews the focus was on the governance setting, research and monitoring, applied and planned preventive, mitigation and compensation measures and wishes for international cooperation.

Governance

In all 9 interviewed countries there is a recognition of the impact of offshore wind energy on the marine environment and in each country environmental protection regulations are in place. Environmental regulations in each of the EU Member states are based on EU legislation in the form of the EU Directives. EU Directives, including the Habitat Directive (HD), Environmental Impact Assessment Directive (EIAD) and Marine Strategy Framework Directive (MSFD) are the main policy frameworks in place. All countries have their own national implementation of these Directives, including additional policy elaborations. For example, the Netherlands has the Framework for Assessing Ecological and Cumulative Effects (KEC) installed and Scotland has a similar tool in development called the Cumulative Effects Framework.

The institutional setting and governance process differs strongly per country. However, there is 1 huge similarity: the leasing process (tender publishing and opening of lots) is actively managed by the government in all North Sea countries. However, once the tender is published and the further procedure starts, countries use a different methodology - in most countries the tender procedure and the assignment for drafting up the Environmental Impact Assessment (EIA) is government-led, but there are also countries who leave this to the market. As a result the ecological criteria and the way the assessments are done (EIA) and assessed differ strongly between countries.

Research and monitoring

In most countries there is a common awareness that offshore wind can have a strong impact on ecology, and it is therefore crucial to have a good understanding of the functioning of the ecosystem, the potential impacts and effective preventive, mitigation and compensation measures.

Hence, research and data gathering are getting more attention. Most countries have both governmental and market financed research initiatives. 4 main research themes related to the impacts of offshore wind are appointed by the North Sea countries:

1 The effect of underwater noise on marine mammals.
2 The risk of collision, habitat loss and barrier effect on birds and bats.

3 The effect of anthropogenic structures in and on the seafloor (e.g. Hard substrate and artificial solutions) on benthos.
4 Ecosystem effects, including settlement of hard substrate species, hydro morphological effects and population effects on higher trophic species.

Preventive, mitigation and compensation measures

Commonly applied preventive, mitigation and compensation measures are ecological monitoring, marine spatial planning, technical measures to reduce collision risk of birds (e.g. start/stop, changes in wind park design such as larger/fewer turbines, shut down of turbines in migration corridors and increasing hub height) and noise mitigation for marine mammals (e.g. use of bubble curtains). Some countries are still in the phase of research and data collection in order to devise effective measures. Although not all countries are in the same stage of wind development, all countries are concerned about cumulative effects of offshore wind energy. Therefore, there is a need to identify these cumulative effects. However, at this moment the main obstacle identified for national development, and thus also identifying cumulative effects, is the lack of knowledge and missing of data. By extension of this knowledge gap there is currently insufficient insight into the effectiveness of different ecological preventive, mitigation and compensation measures which hampers the identification and implementation of best practices.

International cooperation

Most countries see a need for intensifying international cooperation, mostly in the form of knowledge exchange and coordination of spatial planning and temporal development. There is a particular interest in sharing data and information on cumulative effects, migratory species (mainly birds, but also marine mammals), ecological/ hydromorphological/ geomorphological effects, effectiveness of implemented preventive, mitigation and compensation measures, and results of EIAs. Further wishes for international cooperation are:

- Research collaboration through joint research initiatives on a European level and creation of knowledge sharing platforms.
- Standardization of thresholds and preventive, mitigation and compensation measures.

Several points of attention are also mentioned that may influence or hamper cooperation efforts, namely:

- Countries are at different developmental stages with regard to offshore wind development and/or the implementation of preventive, mitigation and compensation measures.
- A delay in development of offshore wind can occur due to cooperation issues as a result of e.g. organisational differences.
- Different countries have different ways of gathering data, which may affect the comparability of this data;
- The language barrier between countries can affect the ease of cooperation.
- There is a difference in government bodies that are involved in the development procedures. In each country different types of government departments may be involved. There can also be a difference in governmental levels (i.e. national vs. regional).
- Not all countries are member of the European Union, which may hamper (the ease of) cooperation.

1

INTRODUCTION

Background

The European offshore wind industry is rapidly expanding. The increasing effects of climate change and the urgency to radically transform the energy system is fuelling a transition away from fossil fuels towards renewable energy sources. Recent geo-political tensions have even emphasized the need of energy independency of west Europe. Wind power is one of the lowest-cost electricity sources per unit of energy and has a high potential in northern-latitude countries, with the North Seas area being one of the windiest areas in Europe.

The planned offshore wind capacity for the North Seas is now set at 120GW by 2030 and 300GW by 2050[1]. Collaboration of renewable energy rollout in the North Seas is organized through The North Seas Energy Cooperation (NSEC), which 'supports and facilitates the development of the offshore grid development and the large renewable energy potential in the region'.

There is increasing attention towards the ecological effects of offshore wind energy. In a recent report the European Court of Auditors (ECA) has warned against the risk of large-scale offshore energy development with regard to ecological conditions. Introduction of novel structures in the North Seas may impact current oceanographic conditions and, as such, interfere with the functioning of established ecosystems. Furthermore, there is an increased risk of bird collisions and displacement, damage to the seafloor and noise pollution. The large scale at which offshore energy will be implemented in the North Seas and around in the coming years make it essential to consider the ecological impact of offshore infrastructure across the entire basin. According to the ECA, although the EU offshore strategy demands accounting for biodiversity in offshore energy, there is currently insufficient attention to the broader effects of offshore energy on marine life, population structures, invasive species, food availability and migration patterns[2].

The impacts of offshore wind on nature are increasingly being recognized by wind developers, governments and knowledge institutes. Different countries have their own unique policy frameworks and approaches with regard to offshore wind development. NSEC countries have expressed interest in mapping the current state of implementation of preventive, mitigation and compensation measures for offshore wind energy, as well as assessing whether there is interest in cooperation between North Seas countries in this regard.

[1] Government of the Netherlands (2023). Ostend Declaration of Energy Ministers on the North Seas as Europe's green powerplant.
[2] European Court of Auditors (2023). Offshore renewable energy in the EU – ambitious plans for growth but sustainability remains a challenge.

Goal

The goal of the project is to explore the need for international cooperation with regard to the deployment of preventive, mitigation and compensation measures for ecological effects by offshore windfarm developments. In doing so, it is important to find out which environmental impacts are seen as the most important by different countries, the extent to which research is taking place and which preventive, mitigation and compensation measures the participating NSEC and allied countries are already taking or will take in the future. Furthermore, the motivations behind these measures, relevant governance structures and policy motives will also be determined. The spatial scope of preventive, mitigation and compensation measures will only focus on the wind farm itself, not the interconnecting infrastructure.

Method

Information was obtained through conducting interviews with a public servant involved in spatial planning and licensing procedures for offshore renewables for each country (Belgium, Denmark, France, Germany, the Netherlands, Norway, Ireland, the UK and Scotland), resulting in a total of 9 interviews (see Appendix I). The interview sessions were held for a duration of maximally 2 hours.

The results of these interviews were summarized and structured into minutes according to the following structure:

- General overview offshore wind per country.
- Governance.
- Ecological measures.
- Cooperation.
- Future prospects.

These minutes were sent for review to the interviewees.

Reading guide

The report contains the following chapters:

1 Chapter 2 contains the main results of the interviews with:
   - Section 2.1 contains a general overview of the current state of NSEC countries with regard to offshore energy development. This is followed by a summary for each country.
   - Section 2.2 details the governance structure and the investments in research. This is followed by a summary for each country.
   - Section 2.3 details the main findings with respect to current preventive, mitigation and compensation measures that are in place, followed by a summary for each country.
   - Section 2.4 outlines potential areas of cooperation between NSEC countries with regard to preventive, mitigation and compensation measures. This entails current frameworks or networks for cooperation (i.e. NSEC, OSPAR), perceived barriers for cooperation and, more importantly, preferred themes for cooperation between countries.
2 Chapter 3 details the conclusions of the interviews and contains recommendations for the future.

2

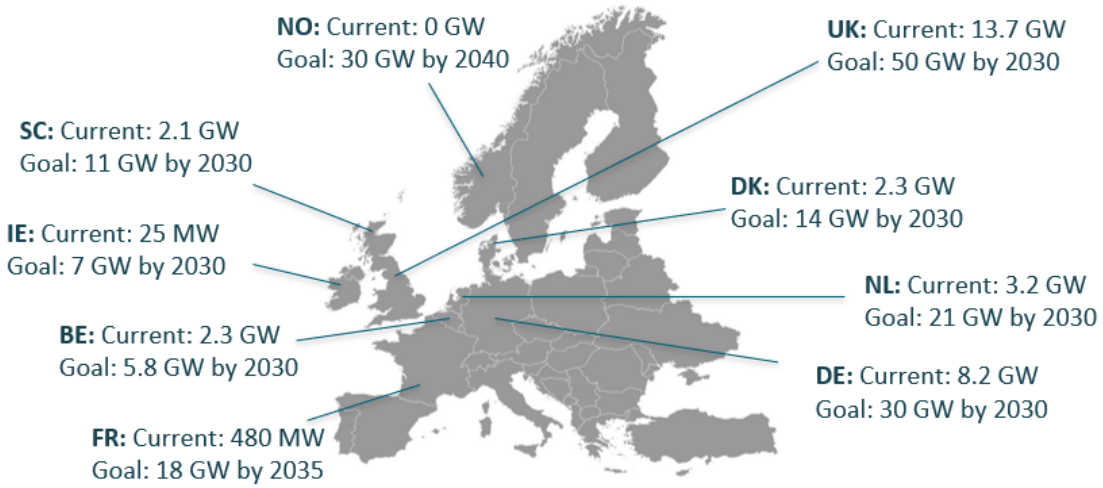
WIND DEVELOPMENT AND ECOLOGICAL MEASURES

2.1 Current state of development

Countries are at different stages in their offshore energy development (see Figure 3.1). While some countries already have over 20 years' experience with offshore wind, others are in the process of installing their first offshore wind park. For example, the UK installed their first wind offshore wind turbines in 2000 and have since then grown to a capacity of 13.7 GW. Therefore, they currently have the highest offshore wind capacity of all countries addressed during this project. Denmark, Scotland, the Netherlands, Germany and Belgium also already have some experience with offshore wind farms with capacities ranging from 2.3 GW up to 8.2 GW. In contract, France, Ireland and Norway are still very much at the start in their offshore wind development. For example, Norway is right now in the process of awarding their first offshore wind area to a developer. Nonetheless, they have set very ambitious goals as they want to reach a capacity of 30 GW by 2040.

Figure 2.1 Impression offshore wind

Figure 2.2 Current state of offshore wind development and future ambitions of all 9 NSEC countries



In the textbox below an overview per country of the current state of offshore wind energy development is provided.

Denmark

The current capacity of the Danish offshore energy industry is 2.3 GW. This has been realised over a period of 32 years. Hence, Denmark already has a long history within the field of offshore energy. Denmark has the ambition to upscale to 9GW and potentially up to 14GW by 2030. This includes the establishment of Bornholm as an energy island and the development of new sites. In addition, 1-2 GW are under construction, have been authorized or are at a late stage of planning. In Table 2.1 an overview of the current state and goals for offshore energy is given.

Table 2.1 Current state Denmark

	Offshore energy goals	Notes
present	current capacity 2.3GW - realised over a period of 32 years	1-2 GW are under construction, have been authorized or are at a late stage of planning
present - 2030	ambition to upscale to 9GW and potentially up to 14GW	includes the establishment of Bornholm as an energy island and the development of new sites

France

In France there is so far 1 fully operational OWF (Saint-Nazaire, November 2022), but the state wants to accelerate the deployment of OWF's and multiple tenders have therefore been launched. In 2010 the first processes of planning started, in which areas were considered that may be suitable for the construction of OWF's. This process took place between different departments within the state after which the results were shared with the industry/public. Right now the state is trying to make a plan for OWF development over a longer period of time (10 years) in order to be more efficient and also to be able to issue permits. The goal is to have 5GW of offshore wind energy by 2028 and 40GW by 2050. In Table 2.2 an overview of the current state and goals for offshore energy is given.

Table 2.2 Current state France

	Offshore energy goals	Notes
present	one fully operational OWF in France (Saint-Nazaire, November 2022)	In 2010 the first processes of planning started, in which areas were considered that may be suitable for the construction of OWF's
present - 2030	goal to achieve up to 5 GW of installed offshore wind generation by 2028	making a plan for OWF development over a longer period of time (10 years)
post 2030	goal to achieve 40 GW by 2050	

Norway

The Norwegian government's ambition is to award areas of 30GW of offshore wind production in Norway by 2040. To achieve this goal, 20 potential new areas for offshore wind development have been identified. Currently, only some offshore test turbines are in place in the Marine Energy Test Centre (METCentre), in addition to Hywind Tampen floating offshore wind farm that is concerned to the Snorre- and Gullfaks oil fields in the North Sea. A competition for the awarding of a project area of 1,5 GW in the Sørlige Nordsjø II area (phase 1), and for 3 areas of 500 MW in the Utsira Nord area (floating wind), will be held this fall. The government has announced that the next round of awarding areas will be in 2025. Next to that, 18 areas are selected as potential sites for later opening rounds. In Table 2.3 an overview of the current state and goals for offshore energy is given.

Table 2.3 Current state Norway

	Offshore energy goals	Notes
present	some offshore test turbines are in place in the Marine Energy Test Centre and there is the Hywind Tampen offshore floating wind farm	this year 1,5 GW in the Sørlige Nordsjø II area (phase 1) and 3 areas of 500 MW in the Utsira Nord area (floating wind) will be awarded
present - 2040	goal to achieve up to 30 GW of installed offshore wind generation by 2040	20 potential new areas for offshore wind development have been identified

Germany

Germany has set the ambition to realize 30GW of offshore wind energy by 2030, 40GW by 2035 and 70GW by 2045. These ambitions have been laid down in the Offshore Wind Energy Act (WindSeeG), which entered into force on the 1st of January 2023. Germany currently has an offshore wind capacity of around 8.1GW, which is comprised of 1539 wind turbines. The majority of these turbines are located in the North Sea. In Table 2.4 an overview of the current state and goals for offshore energy is given.

Table 2.4 Current state Germany

	Offshore energy goals	Notes
present	Germany currently has an offshore wind capacity of around 8.1GW	A total of 1539 offshore turbines have been installed of which most are located in the North Sea
present - 2030	goal to achieve up to 30 GW of installed offshore wind generation by 2030	ambitions have been laid down in the Offshore Wind Energy Act
post 2030	goal to achieve 40 GW by 2035 and 70 GW by 2045	

Netherlands

In 2022, the Dutch government increased offshore wind capacity targets from 11 to 21 GW by 2030/2031. The North Sea Agreement is an important starting point for getting more energy from offshore wind. It states that we agree to carry out the 3 transitions on the North Sea (energy transition, nature transition, food transition) in balance with each other. The Offshore Wind Energy Roadmap outlines the sequence of wind areas, while the plot decision outlines the conditions under which construction is allowed. The North Sea Energy System Development Programme should ensure that new technologies and policy frameworks are available in time to realise the ambitions for further growth of offshore wind energy after 2030. Currently, the Netherlands has 3.2. GW. In Table 2.5 an overview of the current state and goals for offshore energy is given.

Table 2.5 Current state Netherlands

	Offshore energy goals	Notes
present	the Netherlands currently has an offshore wind capacity of around 3.2 GW	at least 4.5 GW's worth of offshore wind turbines need to be in operation by 2023
present - 2030	goal to achieve up to 21 GW of installed offshore wind generation by 2030	the Dutch government increased offshore wind capacity targets from 11 to 21 GW by 2030/2031
post 2030	goal to achieve 50 GW of offshore wind in 2040 and approximately 70 GW in 2050	the North Sea Energy System Development Programme should ensure that new technologies and policy frameworks are available to realise further growth

Belgium

Offshore wind development in Belgium started in the 1990s. The earliest wind farms were developed by the industry, who proposed to develop an offshore wind plan. The first offshore wind project was realised in a zone close off the Belgian coast. This zone has been fully developed and holds a capacity of 2.2GW with 400 wind turbines. The current OWF's have been realised in the period 2009 to 2020. The capacity is expected to reach 5.8GW by 2030. In Table 2.6 an overview of the current state and goals for offshore energy is given.

Table 2.6 Current state Belgium

	Offshore energy goals	Notes
present	Belgium currently has an offshore wind capacity of around 2.2 GW with 400 turbines	this has been realised in the period 2009 to 2020
present - 2030	goal to achieve up to 5.8 GW of installed offshore wind generation by 2030	capacity to be installed at 2nd offshore wind zone (Princess Elizabeth zone)

UK

Wind power (both onshore and offshore) is the main source of renewable energy in the UK. The Offshore Wind Enabling Actions Programme was originally set up in response to a commitment between the offshore wind industry and the UK government to deliver 40 GW of offshore wind by 2030. This was the original government target. However, in response to the war in Ukraine, the UK government published the British Energy Security Strategy. Hence, the offshore energy target has been raised to 50 GW by 2030. The current offshore energy capacity in the UK is around 13 to 14 GW. This means that the UK proposes a significant increase in capacity in the upcoming years. In

Table 2.7 an overview of the current state and goals for offshore energy is given.

Table 2.7 Current state UK

	Offshore energy goals	Notes
present	the UK currently has an offshore wind capacity of around 13 to 14 GW	There are now 50 wind farms in UK waters which are either operating or under construction
present - 2030	goal to achieve up to 50 GW of installed offshore wind generation by 2030	the original target was 40 GW, but because of the war in Ukraine, the UK government has increased their goal

Ireland

Ireland has on the moment only 1 operating OWF of 25 MW (7 turbines) - Arklow Bank Wind Park, which was commissioned in 2004. However, Ireland has a very ambitious plan to be a net energy exporter to the continent, set out in policy documents including in the National Policy Statement on Electricity Interconnection. Therefore, Ireland has set the goal to achieve up to 5 GW of installed offshore wind generation by 2030 in its Climate Action Plan. In addition, the Programme for Government commits to developing a long-term plan to utilise a potential 30GW of offshore floating wind power in Atlantic waters. At the moment offshore wind development in Ireland is progressing in 3 phases:

- Present: fixed wind developments under consideration on the east coast and development at the west coast in the shallower area.
- Present - 2030: Designated Maritime Area Planning. This planning regime aims to close the gap between those projects currently under consideration, which were originally put in through the old consenting regime and being transferred into the new regime, and what should be done by 2030.
- Post 2030: for the south coast there are plans of establishing a mix of floating wind to the west and fixed wind to the east. For floating wind Ireland hopes to benefit from expertise from Scotland, Portugal and Spain. In Table 2.8 an overview of the current state and goals for offshore energy is given.

Table 2.8 Current state Ireland

	Offshore energy goals	Notes
present	Ireland has only 1 operating OWF of 25 MW (7 turbines) - Arklow Bank Wind Park, which was commissioned in 2004	fixed wind developments under consideration on the east coast and 1 development at the west coast
present - 2030	goal to achieve up to 5 GW of installed offshore wind generation by 2030	designated Maritime Area Planning will determine the broad area where offshore renewable energy projects can be developed, and will act as a management plan
post 2030	for the south coast there are plans of establishing a mix of floating wind to the west and fixed wind to the east	floating wind is new to Ireland and therefore they can learn from other countries

Scotland

Scotland started its offshore wind energy development back in 2010 on the southwest coast - this was the Robin Rigg site with a capacity of 174MW. Currently, Scotland has and offshore capacity of around 10GW. Offshore energy in Scotland is being developed through leasing rounds. ScotWind Leasing is the first round of leasing to come up in Scottish waters. It is a multibillion-pound investment opportunity and a major fulfilment in meeting Scotland's renewable energy targets. Offshore energy developers are invited to tender for separate plots. Once developed, these plots have a potential capacity of up to 27.6 GW over 20 new sites by 2033. There is also the TOG Programme (targeted oil and gas decarbonization). This programme should contribute a further 5.4 GW. In Table 2.9 an overview of the current state and goals for offshore energy is given.

Table 2.9 Current state Scotland

	Offshore energy goals	Notes
present	Scotland currently has an offshore wind capacity of around 10 GW	through leasing rounds new areas are being awarded to developers
present - 2030	goal to achieve up to 27.6 GW of installed offshore wind generation by 2033	There is also the TOG Programme (targeted oil and gas decarbonization). This programme should contribute a further 5.4 GW

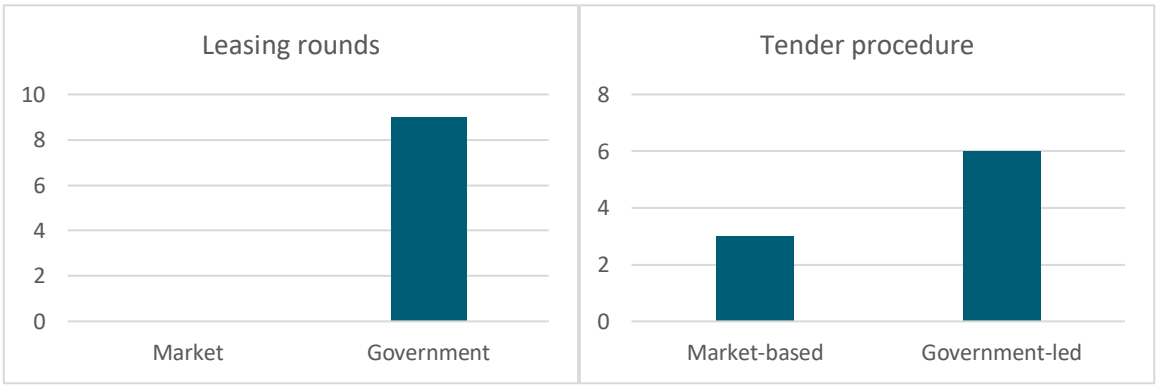
2.2 Governance setting

Governance and policy

In all 9 North Sea countries there is a recognition of the impact of offshore wind energy on the marine environment and in each of them environmental protection regulations are in place. In all North Sea countries that are EU members, EU Directives, including the Habitat Directive (HD), Environmental Impact Assessment Directive (EIAD) and Marine Strategy Framework Directive (MSFD), are the main policy frameworks in place. Nonetheless, all countries have their own national implementation of this framework.

Leasing rounds and Marine Spatial Planning (MSP) are conducted by the government in all North Sea countries. However, while the tender procedure in most countries is government-led, there are also countries that have a market-based approach (Figure 3.2). When the government is in the lead tender criteria are drafted by the government. These criteria are often based on the SEIA assessment, which is carried out by consultancy firms before the leasing rounds on behest by the government. In countries that apply a market-based approach, the developers of the offshore wind farms are responsible for prescribing criteria for ecology and carrying out the EIA. The assessment of ecological risks involved with obtaining project permits then thus fully lies with the developers.

Figure 2.3 Leasing rounds (left) and tender procedure (right)



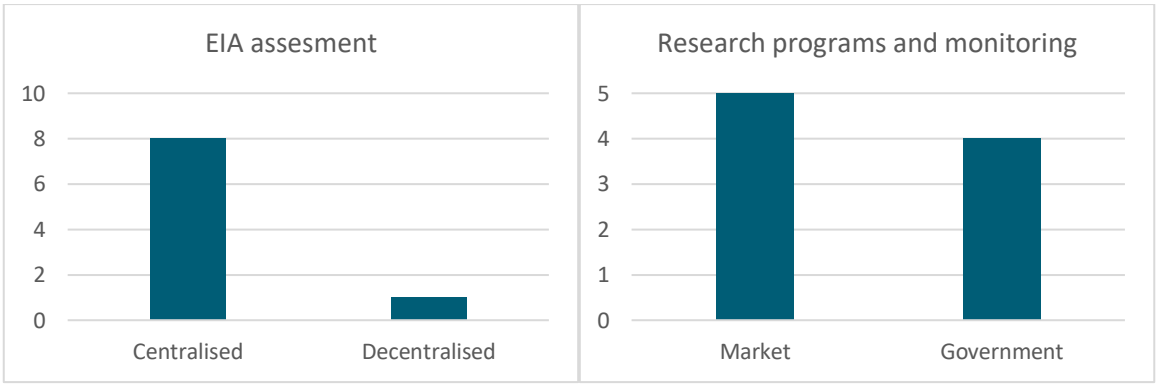
EIA assessment is centralized in 8 out of 9 countries, meaning that there is 1 body responsible for the assessment of the EIAs. France is the only country in which the assessment of the EIA is decentralised (Figure 3.3). In France the EIA is assessed by the Interregional Sea Directorate, which contains different governmental bodies per coastal zones (facades)). The EIAs are carried out by research institutes or consultants at the behest of the government or developers.

Research

In 4 North Seas countries ecological research programs and monitoring are organised by the government (Figure 3.3). For example, in Norway there are 3 main governmental programs focusing on different themes

which are of concern for offshore wind development (the seabed, geology and sub-soil and seabirds). Another example is Belgium, which has a unique environmental monitoring system as the main monitoring program is state-funded (WINMON). Results of those research and monitoring programs can be used for the EIA and by developers for setting up their plan for the wind farm site. In the other 5 countries the market is mainly responsible for gathering information and data. This includes universities and research institutes. But it is also possible that developers are responsible for gathering data, which is done by contracting external organisations. This doesn't mean that these countries don't have any governmental research programs. As for example the Scottish Government is contributing to the development of a new tool called the Cumulative Effects Framework which tries to bring all the different impact pathways together for birds and mammals.

Figure 2.4 EIA assessment (left) and research programs and monitoring (right)



In the textbox below an overview per country of the governance setting is provided.

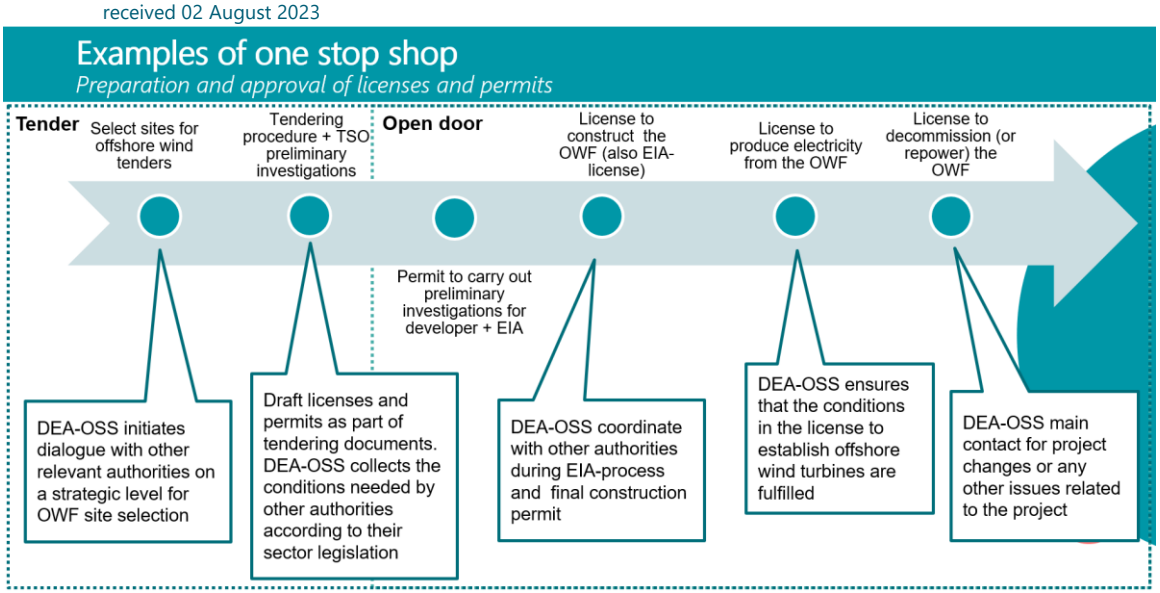
Denmark

The Danish government is in the lead regarding the spatial planning and permitting process of offshore wind (one stop shop). Currently, issuing of permits occurs through government-led tendering processes. Formerly, there were 2 ways to get permits/licenses for the construction of offshore wind farms in Denmark:

1 Through the government by tenders.
2 Open Door Procedure - the project developer takes the initiative to establish an offshore wind farm.

Getting permits through open door was put on hold in February 2023 because issuing wind farms at certain locations could be in violation of EU law due to significant negative effects on for example birds. The Danish government decided to regulate the process in order to increase the success rate of developments. In principle, the same permit is issued through the open door procedure or government tendering process (see figure 3.4). All future developments will be governmental lead. The Danish Renewal Energy Act (under Danish Ministry of Climate, Energy and Utilities) details the process of permitting.

Figure 2.5 Steps that need to be taken to get licenses and permits through government tenders and open door procedures (presentation DEA offshore wind, pre-investigation site selection and permitting process (one-stop shop), received 02 August 2023



France

The planning and permitting process in France is governmental led and decentralized. The Interregional Sea Directorate is responsible for planning and permitting per stretch (French: façade). Permits for OWFs will be issued by maritime prefects. Hence, assessing EIAs and setting out criteria for mitigation measures takes place on a regional level. Although national guidance exists, the fact there is no centralized reviewing, criteria and evaluations may therefor differ per zone.

Norway

The Norwegian government is in the lead regarding spatial planning, permitting process and research of offshore wind developments. The main policy frameworks in Norway are regulated by the Norwegian Offshore Energy Act, which is for the most part aligned with the EIAD. However, Norway has a policy in which is stated that everything outside 12 nautical miles is not EIAD obligatory. As offshore developments take mostly place outside 12 nautical miles, planned OWF are in Norway not EIA applicable. Nonetheless, ecology/ environmental impacts are integrated in the planning and permitting process. Suitable areas will be selected based on a strategic environmental impact assessment (SEIA). Most probably some parts of the areas will be excluded after the SEIA due to negative ecological impacts or conflict of interest with other users of the sea. Hence, the Norwegian government regards the SEIA process as an important preventive measure and a tool for marine spatial planning. Norway has next to that, an extensive research programme on investigating current ecological state and effects of offshore developments. Norway can benefit from offshore knowledge development resulting from a long history of the petroleum industry.

Germany

The German government is in the lead of the spatial planning and permitting process through the Bundesamt für Seeschifffahrt und Hydrographie (BSH). Thus the whole process is being coordinated by this governmental body. Spatial planning in the German EEZ in the North Sea and Baltic Sea is laid down in the Maritime Spatial Plan (MSP). In 2019, BSH published the site development plan (Flächenentwicklungsplan (FEP)) in accordance with the Offshore Wind Energy Act for the first time and carried out a SEIA. The FEP specifies the plots that are allocated for offshore wind development. This is followed by a determination of suitability of the plots by the BSH, based on preliminary site investigations. The BSH pre-finances the preliminary investigations.

After the site investigation has been carried out, the sites determined to be suitable for offshore wind energy are put out to tender by the Federal Network Agency (BnetzA). The results of the preliminary investigations

and the SEIA are provided to the bidders (wind developers). The costs of the investments made in the pre-planning phase will be paid by the developer that obtains the plot. After the approval process has been completed, the winning bidder can build the wind farm on the site and may use the capacity on the grid connection.

Netherlands

The Dutch government (cooperation of Ministry of Agriculture, Nature and Food Quality (LNV)1, Ministry of Economic Affairs and Climate (EZK)2 and Ministry of Infrastructure & Water (I&W)3), is in the lead of the spatial planning and permitting process. With the Rijksdienst voor Ondernemend Nederland (RVO) as a substitute on behalf of the Ministry of EZK responsible for the application procedure (tender) and assessments for wind developments. The Dutch government insists on the one-stop-shop principle for attaining permits for offshore wind development. This means that the government is in the lead of the MSP (selecting suitable locations) and provides requisite information to offshore wind developers.

In the Netherlands the North Sea Programme deals with the spatial planning of the North Sea and achieving good environmental status. Part of spatial planning is the designation of wind energy areas as a first step towards the construction of wind farms. The follow-up process (subdivision) will determine in more detail where within these areas wind farms will be located. In 2015, a road map for the roll out of Wind Energy at Sea was launched as part of this programme including search areas for development. On the plan level a SEIA was carried out which resulted in the depiction of suitable plots for development. Both the SEIA (plot decision) and project EIA (specific project effects) are carried out under jurisdiction of the government, speeding up processes and reducing the risk for developers. For the assessment of ecological effects a separate framework has been created, namely the Framework for Assessing Ecological and Cumulative Effects (KEC) which looks at the effects of all wind farms (in the Netherlands and internationally) together on ecology. More precisely, KEC examines what the cumulative ecological effects are of existing, under construction and future OWF's until 2030. The KEC is an interpretation of the EU directives and is drafted and regularly updated by Rijkswaterstaat using new insights from the research programme (Wozep).

The Netherlands is the first North Sea country to challenge bidders in the tendering process on the topic of ecology. In 2 of the made available plots wind developers can attain the plot by maximizing its proposal regarding measures for ecology. This includes both technical measures (mitigation and nature enhancement) as well as setting up monitoring and research programs. Next to that the Dutch government has drawn up an extensive research program (WOZEP), which includes investigating effects on marine mammals, birds and bats, benthic fauna, fish and ecosystem-level effects.

Belgium

The Belgium government is in the lead regarding spatial planning, permitting process and research of offshore wind developments. In Belgium the first Marine Spatial Plan (MSP) was developed between 2012 and 2014. The first zone, which has already been fully developed with 1.2GW capacity, was later embedded into this framework. In the revised MSP of 2020 a new zone of 280 square kilometres was proposed, the Princess Elisabeth Offshore Wind Zone. This zone is publicly tendered based on technical and environmental requirements. The Ministerial Cabinet for the North Sea takes the initiative regarding planning based on the MSP. In Belgium developers are responsible for initiating the EIA, which are carried out by consultancy agencies. The Royal Belgian Institute of Natural Sciences (RBINS) checks whether research is sound and in compliance with existing regulations.

The Marine Strategy Framework Directive (MSFD), EU Habitat Directive (Natura 2000) and EIAD are the main policy frameworks in place in Belgium to prevent and mitigate ecological impacts of offshore wind. The MSFD is the leading framework for assessing the environmental impacts of offshore wind in Belgium. The quantitative criteria in this framework are explicitly considered. The main issue is the lack of scientific

[1] Ministry of Agriculture, Nature and Food Quality (LNV): responsible for achieving North Sea goals in terms of ecology and therefore, looks more broadly at North Sea use than just offshore wind.

[2] Ministry of Economic Affairs and Climate (EZK): mainly focuses on achieving the goals for energy at sea and thus realizing the roadmap. They do this in coordination with the Ministry of LNV and the Ministry of Infrastructure and Water Management (I&W). They are also responsible for drawing up the tender criteria and the permits.

[3] Ministry of Infrastructure & Water: responsible for spatial planning and the designation of wind areas in Program North Sea.

knowledge on some criteria to be able to establish ecologically sound thresholds. The current MSP (that is relevant until 2026) does not specifically address impacts on the marine environment. For the new development zone gravel beds are considered to be a sensitive habitat (N2000). There are plans to allow wind farms to overlap with this area, but the way in which this will be done is still unknown. The EIA for the area will be delivered later this year.

The ministerial cabinet writes up an advice to the federal government whether the permit can be awarded. The federal government can deviate from this advice but only with substantiation regarding the judgement by RBINS. Research and monitoring are state-funded and organized in the WINMON program. In this programme, plot developers pay the government for executing this program. Monitoring of all wind farms is in this way brought together under a single research and monitoring program. This way of monitoring organization allows for flexibility with regard to what is being monitored over time, depending on research interests.

UK

The UK government is in the lead regarding the spatial planning and permitting process. Within the entire development process responsibilities are allocated to different government and non-government bodies:

- The leasing of the seabed is done by The Crown Estate. This is a body separate from the government. The Crown Estate determines which areas will be available for development.
- The Secretary of State and The Department for Energy Security and Net Zero are the main agents responsible for granting consent for the construction of offshore wind farms.
- The Department for the Environment, Food and Rural Affairs is the body responsible for policy relating to protection of the marine environment. They have a program called the Offshore Wind Enabling Actions Programme (OWEAP).
- A series of statutory nature conservation bodies who are part of the broader Department for Environment. They give the actual advice (statutory nature advice) on the consenting (assessments of EIA) as part of the consenting process e.g. Natural England.
- The Marine Management Organisation provides a marine license as part of the consenting process. This body is also responsible for the marine spatial planning.

Offshore wind development is organized through leasing rounds – the next will be Round 5. After granting consent for construction the plot is open forbidding. In the bidding process the developer carries out the SEIA. If the SEIA is completed and it seems likely that a project is going to have a significant effect on the marine environment, developers will be required to undertake a Habitats Regulations Assessment (HRA), which is a more detailed assessments on the impact of the specific project. In case of significant impact the developer must propose compensation measures to the UK government. The UK government will review the suggested compensation through its statutory nature conservation bodies. Within the OWEAP program a standardized method for environmental mitigation is currently in development to avoid disagreement between statutory nature conservation bodies. The current time between project conceivement and lease granting is approximately 4 years. During these 4 years the developer is responsible for putting together their application for consent, including attaining sufficient data for drafting up a SEIA or HRA. To speed up development the British government is trying to reduce procedural time to 1 year through OWEAP. The marine plans will be renewed through a new program called Marine Spatial Prioritisation (MSPri). This program tries to balance competing needs for all relevant sectors.

Ireland

The Irish government is in the lead regarding the permitting process of offshore wind and other offshore activities. In 2021 Ireland updated its marine management legislation through the Maritime Area Planning (MAP) Act. This new legislation creates an improved platform for decision making on offshore renewables in Ireland and consenting projects. 2 main bodies are of interest for OWFs under the MAP Act:

1 The Maritime Area Regulator Authority (MARA). The MARA will assess the area of interest and the suitability 19uet o offshore project, but also the applicants themselves are assessed. And after the project set-up, MARA will do the monitoring and enforcement if needed.
2 National planning body called An Bord Pleanála. They are responsible for assessing the planning application itself and will prescribe project level mitigation.

Previously, (wind) developers could apply for every location they were interested in through an open door procedure. With the new legislation they Irish government is in the lead of the planning process. In the planning process areas are depicted in which developments can take place. Developers can explore opportunities in these areas (plan-led). The marine planning structure in Ireland provides for a national plan, the National Marine Planning Framework (NMPF). As part of this framework, public bodies can establish sector and / or area-based Designated Maritime Area Plans (DMAPs) that provide additional detail. This provides overarching policy for all activities In Ireland's maritime area. The EIA will be part of the DMAP process through SEIA and Appropriate Assessment (AA). The SEIA and AA will be used as input for the project level EIA and AA at a later stage.

Scotland

The Scottish government is in the lead regarding the spatial planning and permitting process. The Scottish Government is, in terms of policy around offshore wind, in close cooperation with the UK government, but in the end fully responsible. Within Scotland the majority statutory conservation advisers are the Offshore Wind Directorate and the Marine directorate, both part of the Scottish Government, and Nature Scott (previously called Scottish Natural Heritage). The Crown Estate Scotland is responsible for the leasing. The leasing process is entirely government-led.

Developers are responsible for the environmental consenting process once they obtain their lease. The risk for getting consent for the project is thus fully with the developers. This consenting process takes multiple years. First, developers will go through a scoping round where the developers propose what will be investigated in the EIA. The Scottish government (science team) and Nature Scott will assess and comment on this plan. The developer will be responsible for carrying out the EIA. In the EIA developers often need to collect additional data, If the SEIA is completed and it seems likely that a project is going to have a significant effect on the marine environment, developers will be required to undertake a Habitats Regulations Appraisal (HRA), which is a more detailed assessments on the impact of the specific project. Add the end of the consenting process in Scotland a minister takes the decision to grant consent or not. A consent can be granted if the project has significant negative effects. In Scotland this hasn't occurred so far. The grant contains 2 licenses. One is the consent under the Electricity Act and the other is the marine license which is needed for the construction work.

In Scotland there is a National Marine Plan which is made by the Scottish Government. Additionally, there are spatial plans for each leasing round. The Marine Spatial Plan was developed and published in 2020. At this moment the government is in the executive plan review process to update the plan. The marine spatial plan helps to identify the potential lease areas and the potential capacity for offshore wind. Ecology is incorporated in the review process. Existing knowledge and data on the occurrence of marine seabirds, mammals, fish and benthos is incorporated.

2.3 Application of preventive, mitigation and compensation measures

Research topics

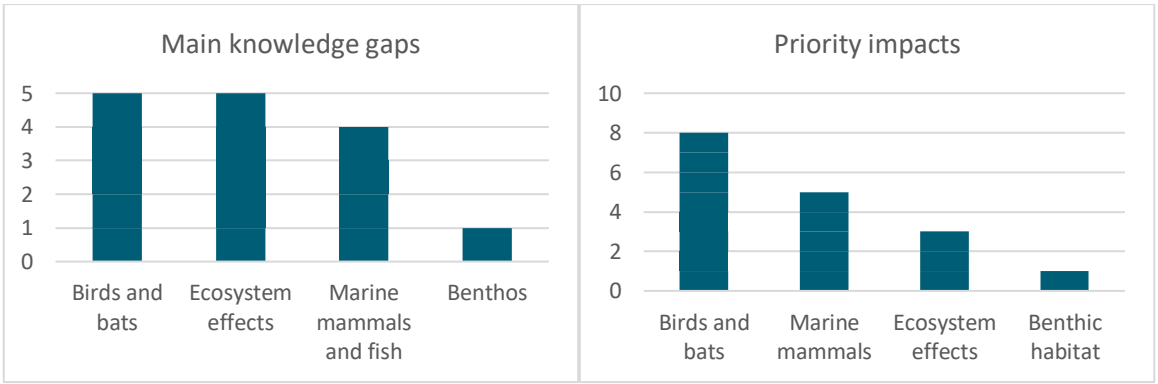
In most countries there is a common awareness that offshore wind can have a large impact on ecology, and it is therefore crucial to have a good understanding of the functioning of the ecosystem, the potential effects and effective preventive, mitigation and compensation measures. 4 main research themes were identified during the interviews with regard to preventive, mitigation and compensation measures:

1 The effect of underwater noise on marine mammals.
2 The risk of collision, habitat loss and barrier effect on birds and bats.
3 The effect of anthropogenic structures in and on the bottom (e.g. hard substrate and artificial solutions) on benthos
4 Cumulative (ecosystem) effects, including settlement of hard substrate species (including reef effects of invasive species), hydromorphological effects and population effects on higher trophic species.

Figure 2.6 Harbour porpoise, common guillemot, plaice and anemones and weeds

These research themes correspond to the main knowledge gaps that have been identified and the themes that are currently under consideration regarding ecological effects of offshore wind. Ecological effects on birds and bats were identified as a priority impact, due to possible negative cumulative effects.

Figure 2.7 Main knowledge gaps and priority impacts



Cumulative effects

Although not all countries are in the same stage of wind development, all countries are concerned about cumulation of offshore wind effects on the marine environment (cumulative effects). Cumulative effects occur across the entire North Seas Basin as a result of offshore wind farms under different national jurisdictions. These effects occur in every impact category simply due to the additional effect of another wind farm. An example is the effect of noise; as the amount of wind turbines increase in a certain area, the additional effects of noise will lead to a larger area being avoided by mammals. Different forms of cumulative effects were mentioned during the interviews as being the most significant on the longer term.

These effects are more significant due to the cascading impacts they have across trophic levels, thereby impacting more components of an ecosystem:

- Ecosystem effects including trophic cascading:
  - Reef effects that occur due to the introduction of artificial substrate. This can have a bottom-up impact on ecosystems by providing substrate for novel (foundation) species. The presence of such species can induce trophic cascades that affect the entire ecosystem structure.
- Changes in hydromorphology in the entire water column.

Application of preventive, mitigation and compensation measures

The aforementioned research themes provide a comprehensive overview of the main effects of offshore winds on the marine environment. These effects are addressed by means of different measures. These can be preventive, by avoiding the effect before realisation of the wind farm, or mitigating, by alleviating or reducing the effect through certain techniques or constructions. Another way in which measures can be taken is compensation. In this case, any effect of offshore wind on a certain impact indicator will be compensated by means of another measures, for example through the creation of a certain type of habitat that is lost as a result of construction activity.

Marine spatial planning is in most countries applied as a preventive measure. In Denmark for example a new project was funded in 2022 which focusses on spatial planning and sensitivity mapping. France, Norway Germany, the Netherlands, the UK and Scotland have also seen an increased focus on spatial planning over the years. Spatial planning is in all countries carried out by a governmental body. Commonly applied mitigation measures are ecological monitoring, and technical measures to reduce collision risk of birds (e.g. Start/Stop measures, changes in wind park design such as larger/fewer turbines, shut down of turbines in migration corridors and increasing hub height) and noise mitigation (e.g. use of suction buckets and bubble curtains).

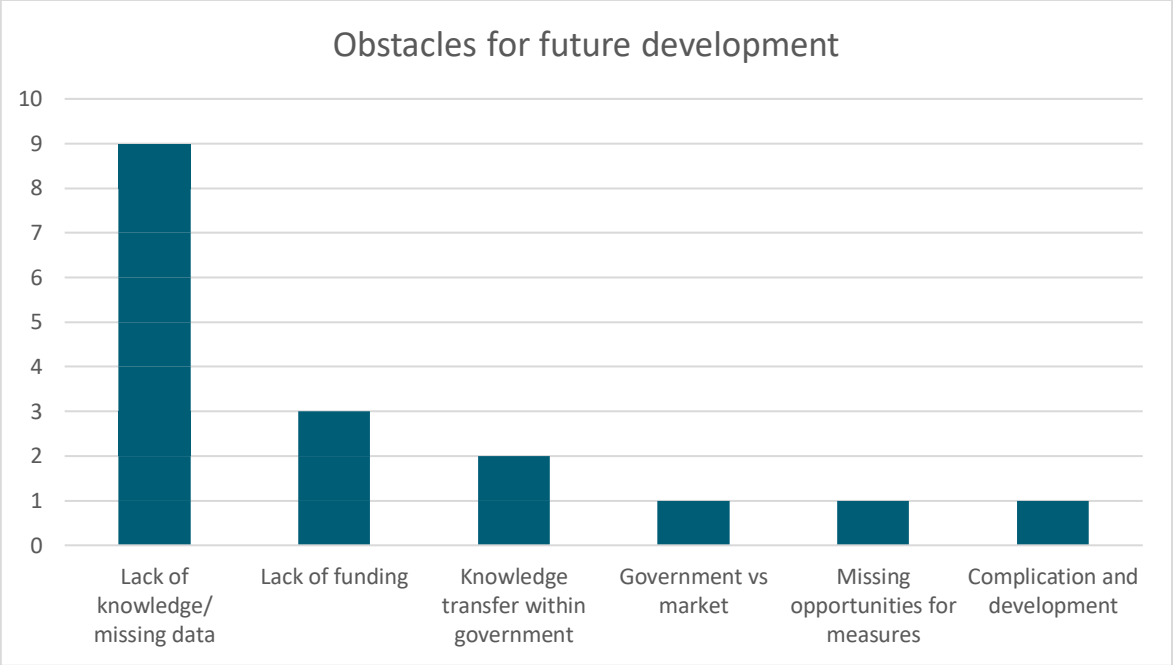
Compensation measures are in place in the UK, Germany and Scotland. Examples of compensation measures are: marine litter removal, predator reduction and artificial nesting structures for kittiwakes. Most countries are still at the stage of exploring preventive, mitigation and compensation measures through data collection.

Obstacles for further development

The scale and nature of (cumulative) effects is still not fully known. As a result, countries are unsure how to address these and how to implement effective and well-studied preventive, mitigation and compensation measures. Therefore, there is a need to identify and assess these (cumulative) effects. However, at this moment the main obstacle identified for national development and thus also identifying these (cumulative) effects is the lack of knowledge and missing of data. This is therefore also the main obstacle for future national development. Other identified obstacles were (Figure 2.8):

- Lack of funding for research,
- Knowledge transfer within the government.
- Discussion of ecological effects between government and market.
- Missing of opportunities for measures due to the size and complexity of projects.
- Complexity due to incorporation of novel approaches/ technologies to make sure that installations are as nature friendly as possible will necessitate longer consenting times.

Figure 2.8 Obstacles for future development



In the textbox below an overview per country of the application of measures is provided.

Denmark

For Danish OWF's, mandatory use of mitigation measures for commissioned OWF's will – if considered necessary – be incorporated in the specific OWF authorization. So far only mitigation measures for underwater noise are in place. Constructors are obligated to adhere to a certain noise threshold. No significant negative effects have yet been found/ described in EIAs for bats and birds. Hence, no mitigation measures have been incorporated for these groups. However, in Denmark they are aware that this may very well be necessary in the future, due to the scale of next developments also with regard to developments of neighbouring countries. 2 recent Danish permits for small/mid-size OWF's do have extra demands for bird monitoring with the purpose of the authorities being able to set up demands for mitigation measures in the case that bird data turns out that significant negative effects may be likely. In future leasing rounds strict monitoring requirements will be implemented. Moreover, a new governmental led research project was funded in 2022 which focuses on spatial planning and cumulative effects (sensitivity mapping). This project evaluates cumulative effects of potential offshore wind areas in Denmark on the marine environment (including birds, bats and marine mammals). The results will be delivered in 2025. Next to mitigation negative ecological effects, Denmark desires to attain a net positive impact on ecology. In 2024 2 new projects will have requirements for a positive environmental impact, including nature enhancement measures. Developers will be stimulated to incorporate nature inclusive design. Primary obstacles in Denmark regarding the application of preventive and mitigation measures are that (1) current knowledge is still insufficient and (2) there is a lack of funding for research and (3) there is a lack of international cooperation, mostly in relation to cumulative effects of planned parks.

France

Different guidelines are available, regarding EIA process for OWF and the implementation of the mitigation hierarchy at sea, in French. Nonetheless, no real mitigation/ offset measures have been implemented in accordance with the principal ecological equivalence required by the French law[1].

[1] Ecological gains produced by offsetting should correspond to the ecological losses caused by the impacts of a development project. In this case the development of offshore wind farms.

The 2 types of offset measures that are implemented for OWF impacts are:
1 Reducing pressure on seabird colonies (predation, invasive species).
2 Awareness-raising initiatives (e.g. avoid areas where seabirds and marine mammals rest at sea).

The few examples of offset measures can be explained by:
- The results of a previous EIA stated that there is no significant ecological impact.
- Technical experience of the implementation of offset measures is lacking and knowledge of contractors from other countries is therefore used.
- In other maritime projects, the implementation of the mitigation hierarchy relies strongly on the experiences of individuals within permitting authorities and on the decision-making processes, as such most probably not the latest knowledge is incorporated.

In the upcoming EIA's there will be more focus on monitoring, to give a better insight in potential negative effects and the need for preventive and mitigative measures For this purpose, there are some studies performed/in progress about migration routes/corridors of marine birds which have already provided new insights (programmes 'MIGRALION' and 'MIGRATLANE'). Accordingly, mitigating adverse effects on birds, bats and marine mammals and possible cumulative ecosystem effects were mentioned as a top priority. Nonetheless, there is still a big lack of proposals to find out what the negative impacts are of OWF's on the marine environment and how to mitigate these impacts.

Norway
Current preventive and mitigation measures that are in place are monitoring of birds at the offshore test turbines and at possible OWF areas (arising from the obligation of marine management plans). Mitigation measures for future OWF's will be selected when negative effects are stated in the EIA. Suitable measures will be decided upon during the licensing process of a specific area. It is expected that mitigation measures will differ per site and region (south and north), due to different natural characteristics and locality of (migrating) species. However, as the Norwegian North Sea area is quite large, the Norwegian government expects that some challenges can be reduced/avoided by good marine spatial planning (example - placing the OWF's further apart). Moreover, Norway sees it as an advantage that they have already a lot of experience with the Petroleum offshore industry. Relevant knowledge gained within this industry can be used for the construction of OWF's, although there will also be different aspects to consider.

The SEIA is planned to be executed based on results from recent research. In Norway there are 3 main governmental programs through which important research is carried out and collected. In addition, NVE has recommended to the MPE to let the Institute of Marine Research investigate species in the water column (nr 4):
1 Mareano Programme. Examines and maps the seabed outside the Norwegian coast.
2 Norwegian Petroleum Directorate. Examine the geology and the sub-soil of the seabed.
3 Seatrack and Seapop. Big programme's on (migratory) seabirds, which are connected into the international research programmes.
4 Institute of Marine Research investigate species in the water column (i.e. fish and marine mammals) by monitoring and counting to make for example time series. This is not currently in place but is recommended by NVE to be included in the SEIA.

Germany
The major policy framework for preventive and mitigation measures is included in the MSP by accounting for the spatial distribution of sensitive habitats and sensitive species distributions. The MSP 2021 contributes to the protection and enhancement of the marine environment, including the achievement of a good status of marine waters, taking into consideration climate protection through:
- Appropriate spatial designations for the marine environment.
- Designations for avoiding or mitigating harmful impacts and pollution resulting from marine uses.

Mitigation measures to be implemented are detailed in the site development plan 2031[1]:

1 Principle 6.1.1: Overall time coordination of the construction and installation work: To avoid or reduce cumulative impacts, overall time coordination of the construction and installation work shall be ensured, taking into consideration the project-specific framework conditions.
2 Principle 6.1.5: Deconstruction obligation and security deposit: After permanent cessation of use, offshore wind turbines, platforms, subsea cables, and plants for other forms of energy generation shall be removed in accordance with Section 80 Offshore Wind Energy Act.
3 Principle 6.1.7: Observance of environmental and nature conservation framework conditions: […] For the monitoring of bird collisions with wind turbines, state-of-the-art collision detection systems shall be installed at several representative turbines in offshore wind farms within all areas for other forms of energy generation designated in the Site Development Plan. […] this requirement also applies outside the bird migration corridors. The exact configuration of the collision monitoring (e.g. the locations, number, and technical specifications of the detection devices) shall be coordinated with the BSH on a procedure- and site-specific basis.
4 Principle 6.1.9 Noise mitigation: For the foundation and installation of a turbine, the Project Developer shall use the working method that is as quiet as possible under the circumstances found according to the state of the art. In the individual project approval procedures, a maximum sound exposure level (LE) of 160 dB re 1µPa^2 s and a peak sound pressure level (Lpeak-peak) of 190 dB re 1µPa at a distance of 750 m from the pile driving site are regularly specified, irrespective of the pile diameter.

The government has a mandatory monitoring program in place to assess the effects of offshore wind on habitats and species, which is laid down in Art. 77 Offshore Wind Energy Act: During the construction phase and during the first 10 years of operation of the OWF, monitoring of the construction- and operation-related effects on the marine environment is to be carried out and the data obtained is to be transmitted to the BSH and the BfN without delay. The guidance document "Standard Investigation of the impacts of offshore wind turbines on the Marine environment"[2] describes the scope and methodology for ecological surveys for benthos, fish, resting birds, bird migration and marine mammals. The aim of this guidance is to standardize the monitoring methods and metrics to be used as well as the presentation of the results for offshore wind farms in Germany. Data from baseline studies are used as input for the EIA, which is part of the permit from the licensing authority in Germany (BSH). Data from monitoring during the construction of an offshore windfarm and from the operational phase are used to validate estimates of potentially significant effects from the EIA.

Germany has expressed concern with regard to cumulative effects within the North Seas and the fact that there is a spatio-temporal delay between OWF realisation and the resulting ecological effects. As Germany is avoiding sensitive habitats and conduct noise mitigation, they believe no cumulative effects for the German North Sea will be experienced directly.

Netherlands

In the Netherlands some mitigation measures are proposed. It includes measures focusing on the reduction of collision victims (birds and bats), habitat loss, barrier effect and underwater noise. Next to that there is an attention for nature inclusive design including nature enhancement measures. Within the tender process, developers are encouraging to take ecology into account and to draw up ecological measures. Within the plot decision are mandatory measures and limits that developers must adhere to. These include start/stop, monitoring obligations and limits for underwater noise. Avoiding significant negative effects on birds/bats and sea mammals is of serious concern. Hence, most attention with regard to mitigative measures is paid to bird and bat collision victims (Natura 2000) and effects of underwater noise on harbour porpoises and seals (MSFD; Natura2000). There is also growing attention for ecosystem effects, but there is no legal framework for this yet. Wake effects are not taken into account in any policy and within the Ministry of EZK there is thus far not much attention for these effects. However, they are aware within the ministry that this should get more attention and they do worry about it. Also cross boundary cumulative effects so far receive less attention.

Within the Netherlands, there are 2 interconnected governmental research programs dealing with research into the effects of use of the North Sea on ecology, with 1 focusing on offshore wind energy:

- The Offshore Wind Energy Ecology Programme (Wozep). The purpose of Wozep is to map the effects of offshore wind energy but also with a perspective to the plot decision and to what measures can be taken to reduce effects. Within Wozep, there are 6 themes: ecosystem effects, birds, marine mammals, bats, benthos and fish.
- The Monitoring Research-Nature Enhancement-Species Protection Programme (MONS). MONS is an 'overarching' research programme and deals with much broader research in the North Sea and is not applied to 1 use specifically. It focuses on the ecological state of the North Sea, aiming to answer the central question whether and how the changing use of the North Sea fits within the ecological carrying capacity.

There is also the start/stop project (EZK project) in which knowledge is being gathered about bird migration in the North Sea and based on that knowledge, develops a measure that makes turbine shutdowns (cost-) efficient. In this way, the number of bird collision victims can be reduced. Next to that, a separate project is rum on Nature enhancement.

Belgium

In Belgium there are still few preventive and mitigation measures in place for existing wind farms. This has to do with the fact that these permits have been granted before the existence of the MSP, where there was a) not as much knowledge on the environmental impact of OWF as today and b) because environmental considerations were not considered explicitly in the permitting procedure. However, given the fact that recent research (since the first wind farms were installed) demonstrates the effects on marine mammal populations more effectively. Thus regulations regarding underwater noise thresholds have been implemented for later additions of wind farms. No specific requirements regarding the environmental aspects of scour protection and type of foundation have been included in past wind parks. The same goes for standstill measures to mitigate the effects on birds. Belgium expects more mitigation measures will be necessary in upcoming developments.

Belgium has a unique environmental monitoring system compared to other countries. The main monitoring program is state-funded (WINMON). In this system the industry pays the government for executing the monitoring program. Monitoring for all wind farms is a such brought together under a single research programme. In this way it allows for flexibility as to what will be monitored and to retrieve new insights for implementation impacts in new environmental permit requests. There is comprehensive data available that serves as input for EIA procedures. The Belgian part of the NS is relatively small and there is detailed insight into the distribution of animals and the distribution of benthic habitats. Much of this information is publicly available (MarineAtlas.be). Belgium regards the monitoring program as an important preventive measure for future developments.

UK

Currently, in the UK no mitigation measures are in place. They however have the ambition to implement measures in upcoming leasing rounds as they recognize the impact on the marine environment. The UK raises concerns regarding:

- Noise: pile driving during construction.
- Seabirds: collision, displacement and lack of access to foraging grounds.
- Cabling: cabling that goes through some of the Marine Protected Areas (MPA) can impact the seabed (habitat destruction).
- Cumulative effects. They particularly worry about the impact of noise in the Southern North Sea as this part of the sea is getting crowded.

[1] BSH - Flächenentwicklungsplan.

[2] BSH - Publikationen - Standard Untersuchung der Auswirkungen von Offshore-Windenergieanlagen auf die Meeresumwelt (StUK 4)

The UK therefore started a research program with the objective to adhere adverse effects. The program contains 5 work streams:

- Streamlining the environmental assessment process for offshore wind.
- Implementing offshore wind environmental standards including a noise decibel limit.
- Establishing a mechanism for delivering strategic environmental compensation (beyond project level).
- Setting up a new Marine Recovery Fund to enable developers to pay into to discharge their compensation requirements.
- Setting up strategic monitoring for offshore wind.

In the work stream - Offshore Wind Environmental Standards they look at ways to standardise methods of environmental mitigation for offshore wind and to standardise the methodology of the impact assessment. In this way, the UK aims to ensure better mitigation measures and less compensation will be needed. The UK government believes that with the current knowledge they can standardise some mitigation measures. Standardised measures could for example the air gap height, buffer zones, avoiding certain irreplaceable habitats, using specific scour protection or cable protection that is ecologically more similar to the benthic habitat and a decibel limit for pile driving. This decibel limit is one of the main topics of focus. With the help of the Offshore Wind Evidence and Change Programme, funded by The Crown Estate, some of the more novel ideas will be tested. Currently, in the UK wind parks are developed by means of derogation (consenting wind parks with significant negative effects), in which compensation measures are taken. Examples of compensation measures are: marine litter removal, predator reduction and artificial nesting structures for kittiwakes. Pressure reduction is also something that is being discussed within the UK government.

Ireland

Ireland has limited experience with preventive and mitigation measures, and none under the current regime under the MAP Act (2021). Through the SEA of the Offshore Renewable Energy Development Plan II (OREDP II) an overview of the expected impact per technology type has been made. This suggests how mitigatable an impact might be for different technologies at a national scale. Which mitigation measures might be necessary and appropriate at project scale will become clear through the EIA process which is the responsibility of the applicant.

In Ireland limited research has been carried out directly related to OWF impacts, but a range of marine research and monitoring processes that are already in place may be helpful. There is however and awareness that an improved and shared understanding of potential impacts on the marine environment is needed. Ireland however, has the philosophy that experienced international offshore developers will most probably be developing Irish waters, it is expected that as experienced international wind developers will be developing Irish waters, their experience on effective measures and good practice in other jurisdictions will be reflected in Ireland. Detailed mapping of the seabed is available through the INFOMAR programme. Additionally, a good level of environmental knowledge is available through Ireland's work on the Marine Strategy Framework Directive reporting. Annual reporting on fish stocks and related management recommendations are also available. There will be an obligation on OWF applicants to use the best available information in EIA processes.

Scotland

In Scotland there are moment a limited number of measures in place as of yet. Examples regarding measures for birds are using fewer, larger turbines and raising hub heights. There is limited research available on the effectiveness of measures. Hence, the focus is mostly on getting better measures in place through the collection of more data. Mitigation measures for the effects of underwater noise on marine mammals have been installed by developers. Instead of pile driving, developers used some other foundation such as suction buckets or gravity bases. Acoustic deterrents are in place.

Ecological effects on birds and marine mammals were identified as the most pressing. For marine mammals this is mostly with regard to effects of underwater noise. For birds effects of offshore wind in the Special Protection Areas (SPAs) are now at a level that cannot tolerate any further additional impact from offshore wind development. If developments want to take place, it will be granted on the basis of derogation and the application of compensative measures. Another issue that has received more attention recently and is of

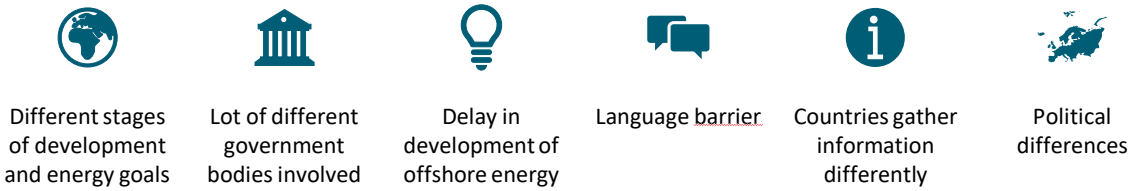
concern to oceanographers is the effect of offshore wind farms further offshore and their effects on mixing and stratification. Next to that Scotland is interested in obtaining more knowledge of the effects of operating wind farms. Also with regard to the effectiveness of mitigative measures. In Scotland there is quite a lot of research going on about what compensatory measures might be ecologically practical. Furthermore, also research on mitigation measures and on cumulative effects is carried out. With regard to the assessment of cumulative effects a new tool is being developed called the Cumulative Effects Framework. This framework tries to bring all the different impact pathways together for birds and mammals.

2.4 International cooperation

Most countries see a need for intensifying international cooperation. At this moment international cooperation already takes place through different cooperation networks such as NSEC, Greater North Sea Basin Initiative (GNSBI), OSPAR, Atlantic Strategy. Moreover, there is a general obligation of states to notify and consult each other on major projects under consideration that are likely to have significant adverse environmental effects across boundaries. This general obligation is laid out in the Espoo convention[1]. However, beyond this general obligation to inform each other, there are other obligations for more in depth international cooperation. There are a few points of attentions when international cooperation will take further shape (also see Figure 2.9):

- The fact that countries are at different developmental stages with regard to offshore wind development and/or the implementation of preventive, mitigation and compensation measures.
- A delay in development of offshore wind can occur due to cooperation issues as a result of e.g. organisational differences.
- Different countries have different ways of gathering data, which may affect the comparability of this data.
- The language barrier between countries can affect the ease of cooperation.
- There is a difference in government bodies that are involved in the development procedures. In each country different types of government departments may be involved. There can also be a difference in governmental levels (i.e. national vs. regional).
- Not all countries are part of the European Union, which may hamper (the ease of) cooperation.

Figure 2.9 Points of attention for international cooperation

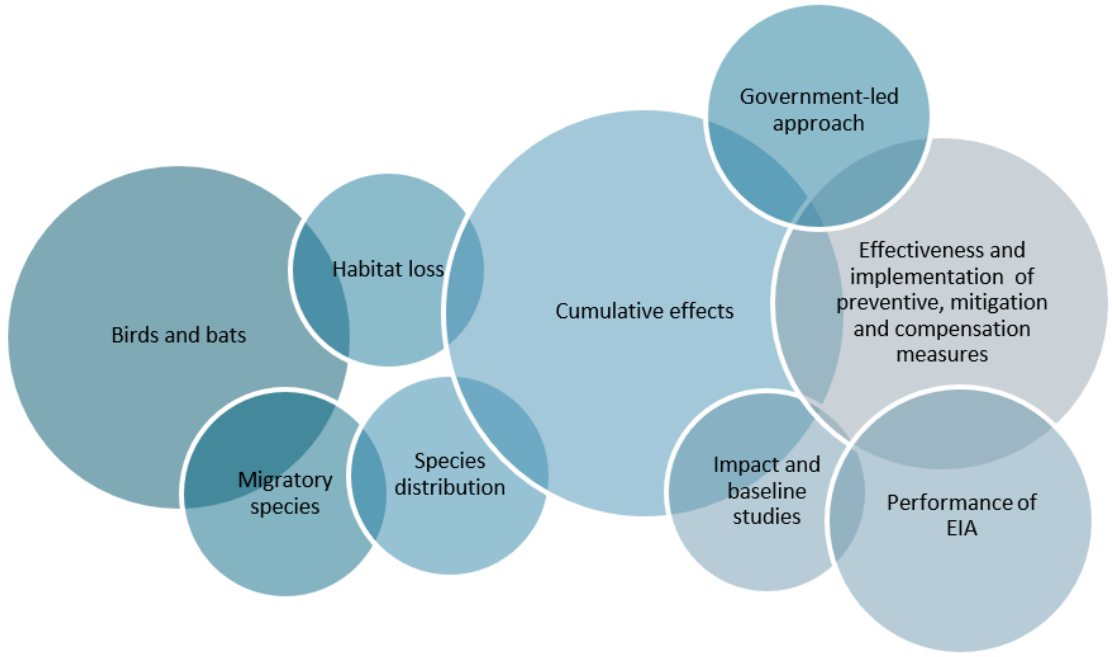


[1] More on the Convention | UNECE.

All countries see a need for international cooperation, mostly in the form of knowledge exchange. There is a particular interest in sharing data and information on (also see Figure 2.10):

1 Cumulative effects. In order to developed targeted and effective preventive, mitigation and compensation measures, there is a need for the combined effects of all offshore wind farms in the North Seas.
2 Migratory species (mainly birds, but also marine mammals). These species migrate across the national waters of different jurisdictions. Knowledge of their presence and spatial migration patterns is necessary for effective measures.
3 Ecological/ hydromorphological/ geomorphological effects. These are especially relevant in the context of cumulation, as they become more significant with the increasing number of wind farms.
4 Effectiveness of implemented preventive, mitigation and compensation measures. This allows for iteration of these measures to increase their effectiveness.
5 Habitat loss. Many habitat types are present across multiple jurisdictions.
6 Species distribution.
7 Impact and baseline studies.
8 Results of environmental impact assessments.

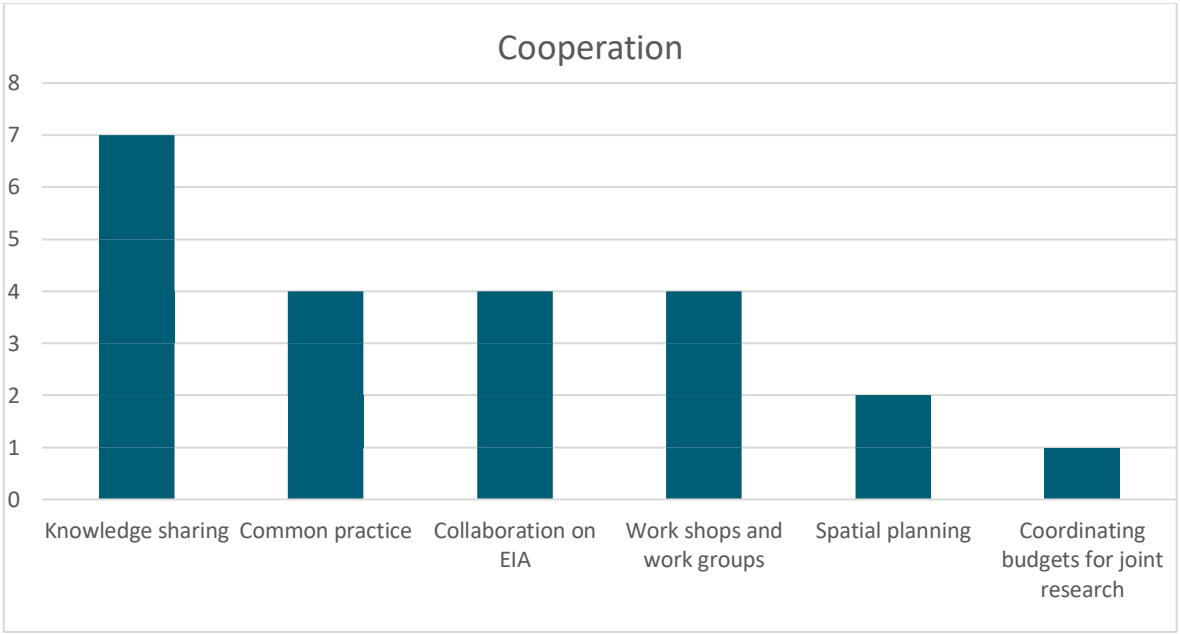
Figure 2.10 themes of interest for sharing knowledge and data



Further wishes for international cooperation are (also see Figure 2.11):

- Research collaboration through joint research initiatives on a European level and creation of knowledge sharing platforms.
- Standardization of preventive, mitigation and compensation measures through common practices.
- Collaboration on environmental impact assessments.
- Coordination of budgets for joint research.
- Coordination of marine spatial planning and temporal development of offshore wind development.

Figure 2.11 Wishes for cooperation



Future steps

Countries proposed different approaches to come to this international cooperation. The main first steps mentioned were raising awareness for ecology and sharing of knowledge by setting up platforms and organising symposiums. Further steps of collaboration comprise setting up joint research programs and setting communal baselines for (the assessment of) ecology. In Figure quotes are given of all 9 countries about the first step towards establishment of international cooperation.

Figure 2.12 Quotes of all 9 countries about the first step towards establishment of international cooperation

In the textbox below an overview per country is given about the further needs and wishes for cooperation.

Denmark
Denmark is in favour of in increasing international cooperation. Denmark stated that they find it really important to cooperate and find common ground to assess cumulative assessments. This would require coordination, international agreement and funding. 4 main levels from which they find cooperation valuable are:

1 EU common spatial planning.
2 sharing data and research outcomes. Amongst others on distribution of species and impacts and base-line studies.
3 collaboration on EIA, including data sharing and making EIAs available. Possibly AI could be used for this.
4 sharing what mitigation measures could be implemented and what the impacts are of these measures.

In order to establish international cooperation, the mandate of international collaboration needs to be formalised and all participating countries should be willing to address the same problems. This could possibly be reached by having a more formal anchoring of SG2 collaboration and a legal requirement to produce coherent spatial plan on sea basin level.

France
France is in favour of international cooperation. France would benefit from knowledge exchange with other countries, definitely with countries that are already further along the development of OWF. Topics of interest include knowledge exchange on experience with mitigation measures for offshore wind, set-up of EIA, implementation and effects of mitigation measures, nature-based solutions/ eco-design for OWF construction and foremost cumulative effects. However, it was recognized that there is a language barrier as not all people in France speak English. This makes it more difficult but doesn't neglect the need of data sharing and knowledge exchange. It was furthermore proposed to set up working groups, realize summary or publication in co-authorship (expertise group) or create a community.

Norway
The Ministry of Petroleum and Energy and NVE do see possibilities for cooperation between North Sea countries. Mostly they are interested in sharing knowledge on migratory species, noise pollution, protected species, cascading- and cumulative effects and effects of mitigation measures. In regard to this it should be considered in which forms to share this information (i.e. shapefiles, reports etc.). It is important to consider what information already exists. Nonetheless, Norway sees the ability to access and assess information and research from other countries as a priority., They also see workshops/ workgroups to exchange information/ collaborate on mitigation measures as a valuable way of retrieving and sharing information.

Germany
Germany is in favour of international cooperation. A major concern for Germany with regard to mitigating negative effects on nature are effects of windfarms on birds. The cumulative effects with offshore wind farms in neighbouring countries (i.e. windfarms in the Netherlands, Sweden, Denmark, etc.) are accounted for when assessing effects on birds. For migratory birds, cooperation is needed, as 1 country cannot set measures for the entire migration route and it needs timely and practical coordination. Mentioned areas of potential cooperation include:

1 Data sharing on species distribution (temporal and spatial).
2 Exchange of best practice on parameters for curtailment (including monitoring, thresholds et cetera).
3 Identifying priority areas of sensitive species to avoid habitat loss.
4 Best practice on efficient and appropriate measures.
5 Measures to reduce wind-farm related effects, such as reduced speed of service traffic.
6 Nature enhancement strategies.

Netherlands
The Dutch Government sees the importance of international cooperation, mainly in the field of spatial planning and knowledge sharing. They see a need to look at a bigger scale and thus to draw up international guidelines and measures. Moreover national OWF's as well as international OWF's should be included in the EIA. It seems logical to them to conduct the EIA in a similar way in all countries. They also see the point in using equal thresholds for underwater noise and instituting equal measures. The Dutch see the first step towards international cooperation to raise awareness for ecology. In addition, more concrete steps will have

to be taken. Mainly, knowledge needs to be shared. By having a clearer picture of internationally ongoing studies and expected results, knowledge gaps can be identified. Finally, the importance of ecology in politics also needs to be recognised. The Dutch see the fact that countries are at different stages in the development of offshore wind and that countries set different ambitions as an obstacle in cooperation.

Belgium
The Belgium government is in favour of increasing international cooperation. A major area of interest for international cooperation would be to further asses the ecosystem level impacts of offshore wind, which is seen as the most important effect of OWF in Belgium. The fact that countries make their individual OWF plans is seen as a missed opportunity to consider a more effective, basin-wide OWF scheme focusing on energy revenue as well as ecosystem-level impacts. A way to set up collaboration as envisioned by Belgium, is by coordinating budgets according to JPI collaboration (Joint Programming Initiative). In a JPI countries interested in collaborating on a research theme make an agreement on how this research programme is being set up, after which financial contributions per member state will be determined. Another way could be to let the industry invest in research focusing on biodiversity impacts. The North Sea Basin Initiative is an example of how this could be organised for biodiversity. Finance is seen by Belgium as a prominent obstacle to set up any kind of collaboration initiative.

UK
The UK envisions that being able to work together across national borders is going to be really important. Foremost, they see the need to share knowledge on best practices with the objective to learn what other countries are doing. They also see a need to share knowledge on research that is carried out. This could be organized through a common database of research. Moreover, the UK appoints that it is really interesting for them to learn from countries that have a more government-led approach and a more zoned approach to spatial planning. The UK recognizes that everyone is dealing with the same issues and working together is key. A first step towards international cooperation could be to compile a list of regulators and governments of all North Sea countries involved in offshore wind energy. Also a meeting (face-to-face) in which specific themes around offshore wind would be discussed is something the UK would be interested in.

Ireland
Currently, for OWFs, the government of Ireland is most frequently in touch with other countries on a formal basis through Strategic Environmental Assessment (SEA) notifications. Recently, this has been reflected in notifications from the Government of Wales requesting comments on developments in their waters. Moreover, Ireland is involved in the Atlantic Strategy, NSEC and OSPAR. At this early stage of OWF development in Ireland there is a need to spend some time normalising processes under the new legislation and get decision making structures up and running. After that there will be better basis to evaluate systems and work towards cooperation with other countries. Therefore, the Government of Ireland does believe that in the future it would be advantageous to work towards common standards around data sharing.

Scotland
The Scottish Government would like to have more international cooperation, especially with regard to data and knowledge sharing and sharing of methods (i.e. suitable measures, EIA set-up). Moreover, the Scottish Government believes that there should be more coordination on spatial planning with regard to migrating species, for example the bottlenose dolphins, but also on seabird species. They see EU/non EU membership as a potential barrier to international cooperation with the NSEC countries. There is also point forward that there are a lot of complexities associated with data sharing: how that data can be used and how to make it a benefit to multiple bodies. 'There should be mutual benefit in place in order for people to take the time and make data available to other people'.

The Scottish Government believes that a very helpful first step could be to have some kind of European science platform/symposium for sharing knowledge and data. This should be specified and targeted to offshore wind. During such a symposium lesson learned from the last year could be presented. In this way new findings and new methods can be shared. This symposium should have virtual attendance as an option to make it more accessible for all countries.

3

CONCLUSIONS AND RECOMMENDATIONS

Main question: *to what extent is there a need for further cooperation between North Seas countries with regard to the prevention and mitigation of adverse ecological effects due to offshore wind developments?*

The majority of the interviewed countries have expressed an interest in and need for further international cooperation with regard to decreasing ecological impacts and finding suitable preventive, mitigation and compensation measures for offshore wind developments. The primary obstacle pointed forward for further development of offshore wind with regard to the application of preventive and mitigative measures is a lack of knowledge regarding various ecological research themes. This hampers the development of effective preventive, mitigation and compensation measures that are based on sound scientific knowledge and data. As a result, the main areas for cooperation which are pointed forward are 1) knowledge and data exchange, 2) joint research, 3) alignment of practices and spatial planning and EIA collaboration (sharing and setting a common baseline including criteria and thresholds).

Knowledge and data sharing has been mentioned as the primary area of interest for cooperation, as the main obstacles identified for the implementation of effective preventive, mitigation and compensation measures are the lack of knowledge and missing of data. So far, countries have independently implemented ecological research and monitoring programs to inform the implementation of preventive, mitigation and compensation measures. However, given the scale of exploitation of the North Seas for offshore wind development in combination with the transboundary nature of ecological effects that occur as a result it is necessary to consider the results across the entire North Seas area and beyond. This will enable the implementation of more effective preventive and mitigative measures. To this end, the first steps in future cooperation should aim at identifying research themes that are of main interest for each country, based on themes that are considered priority effects and contain the main knowledge gaps. These have been identified in this research as:

1 The effect of underwater noise on marine mammals.
2 The risk of collision, habitat loss and barrier effect on birds and bats.
3 The effect of anthropogenic structures in and on the bottom (e.g. Hard substrate and artificial solutions) on benthos.
4 Ecosystem effects, including settlement of hard substrate species (including reef effects of invasive species), hydromorphological effects and population effects on higher trophic species.

A second aspect of cooperation could focus on **identifying possibilities for coordination and alignment of marine spatial planning**, although approximately 30GW has been developed , 120GW has been planned and proposed to be installed by 2030. Next to that, current parks might be decommissioned in the near future. The development and decommissioning pose both a threat and an opportunity for ecology.

EIA collaboration and alignment of practices for offshore wind development between countries allows for a closer coordination of preventive, mitigation and compensation measures. Alignment of marine spatial planning can account for ecological impacts that occur across countries' borders, for example by avoiding bird, marina mammal migration corridors or sensitive habitats. In this way, offshore wind energy production can be optimized for effective prevention of ecological impacts. Common marine spatial planning initiatives may also result in cooperation with regard to EIAs and common preventive, mitigation and compensation practices.

A third and final recommendation is to **explore possibilities for joint research initiatives** to align knowledge development and make knowledge more accessible. Joint research initiatives can address current ecological knowledge gaps by countries and the market collaborating more closely on common research themes of interest. Joint research efforts likely require a closer cooperation than knowledge exchange programmes and may include coordination of budgets and a more intensive cooperation between the responsible organizations and/or authorities in each country.

Bottle necks for cooperation

The interviewed countries have expressed a number of bottlenecks that may affect effective cooperation between countries. First and foremost, as each country is at a different stage of offshore wind energy development and has different offshore energy targets there may be a mismatch in terms of preventive, mitigating and compensating strategies. Countries at an earlier stage of development have more opportunities for prevention than countries that have already. Secondly, cooperation between countries may be complicated by the fact that different government departments and organizations are involved in OWF development procedures, in some cases at different levels of government. Third, countries have different ways of gathering information which may result in comparability issues of knowledge and data. These issues are **points of attention** that need to be addressed in future cooperation efforts. **First steps** that were proposed to come to this international cooperation were raising awareness for ecology and sharing of knowledge by setting up platforms and organising symposiums.

Appendices

APPENDIX 1: INTERVIEWS COUNTRIES AND INTERVIEWEES

Table I.1 Interviewees

Country	Name(s)	Institution
Belgium	Steven Degraer	Royal Belgian Institute of Natural Sciences
Denmark	Tobias Grindsed, Alf Skovgaard	Danish Energy Agency
France	Celine Jacob, Adeline Bas, Sylvain Pioch	CEREMA, IFREMER, University of Montpellier
Germany	Marie Dahmen	Bundesamt für Seeschiffahrt und Hydrographie
Ireland	Tom Woolley	Government of Ireland
The Netherlands	Maike Brinksma	Ministery of Economic Affairs and Climate Policy
Norway	Christine Birkeland, Ola Hermansen	Norwegian Water Resources and Energy Directorate (NVE), Ministry of Petroleum and Energy (MPE)
UK	Cassie Rist, Ruth Stubbles	Department for Environment, Food and Rural Affairs
Scotland	Kate Brookes, Sue O'Brien, Zoe Hutchison	Government of Scotland

APPENDIX 2: INTERVIEWS QUESTIONS

Questions:

Offshore wind generalistic

- What does the current development of offshore wind energy look like in your country?
- What attention is there for ecological impacts and prevention on mitigation in your country?
- Has there been international cooperation and alignment with Belgium, Spain and the UK?

Policy

- What are the main policy frameworks regarding preventing and mitigating ecological impacts of offshore wind energy?
  - Natura areas.
  - Species.
  - Ecosystem functioning.
- Do you have any guidance on applying measures (incl. spatial planning, monitoring, technical, specifications…)?
- In your written answer you explained that mandatory use of mitigating measures for commissioned OWFs will be incorporated in the specific OWF cooperation: can you explain how this would go into practice? Does it involve opening up contracts or is in the currents contracts space for extra demands deployed?

Ecological measures (documenten delen in chat)

- What do you see as the most pressing ecological impacts regarding the (upscaling of) offshore wind energy in the North and Baltic Sea according to your country?
  - Nature areas/ habitat.
  - Marine mammals.
  - Birds.
  - Bats.
  - Fish.
  - Shellfish.
  - Food web including effects on hydromorphological processes.
- Which ecological impacts should be prevented and/or mitigated according to national expectations?
  - Nature areas.
  - Marine mammals.
  - Birds.
  - Bats.
  - Fish.
  - Shellfish.
  - Food web.

- What ecological preventive- and mitigating measures are currently in place in your country?
  - Prevention, including spatial planning.
  - Technical mitigation measures.
  - Monitoring.
  - Compensation.
- Where are these measures applied?
- Are the measures applied in coherence with each other?
- Are there examples of successful preventive or mitigating measures?
- Why do you regard these measures as a success?
- What could be potential ecological preventive- and mitigating measures for your country?
  - Prevention, including spatial planning.
  - Technical mitigation measures.
  - Monitoring.
  - Compensation.
- What has been done in terms of research on the subject of mitigating measures in your country?
- Qualitative.
- Quantitative.
- Which policy frameworks are on the basis of these measures?
- What obstacles do you see regarding the application of ecological preventive- and mitigating measures?

Cooperation

- Do you see (the lack of) international cooperation as an obstacle?
- What is your need in terms of international cooperation?
- What does current cooperation between NSEC countries regarding offshore wind look like?
- What NSEC countries does your country currently work with regarding offshore wind energy?
- What do you think is the importance of cooperation among NSEC countries?
- How can international cooperation/coordination be shaped as an opportunity for implementing ecological measures?
- How would you like to see this cooperation?
- Where do you see opportunities in collaboration?
- Which mitigating measures or parts thereof are able to benefit from international cooperation and/or coordination?
- What are potential bottlenecks/challenges in terms of international cooperation/coordination for these measures?
- What would be willingness to cooperate from your country?
- What do you see as first steps?

Future

What are the future plans on the subject of prevention and mitigation in your country?