# Offshore Wind Energy Permitting Processes in the European Union

## An examination of Danish, German, Scottish and Swedish permitting processes and case study of acoustic impact on marine mammals

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Stockholms universitet

# Preface

This Master's thesis is Truce Major Jack's degree project in Environmental Management and Physical Planning at the Department of Physical Geography, Stockholm University. The Master's thesis comprises 45 credits (one and a half term of full-time studies).

Cooperation with Naturvårdsverket.

Supervisors have been Åsa Elmqvist, Naturvårdsverket and Håkan Berg at the Department of Physical Geography, Stockholm University. Examiner has been Salim Belyazid at the Department of Physical Geography, Stockholm University.

The author is responsible for the contents of this thesis.

Björn Gunnarson
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# Abstract

The permitting process is an integral part of the successful expansion of offshore wind and renewable energy in the European Union. Many permit process studies, to date, have focused on limited methods and criteria and have been a comparison of two countries. This thesis was written in collaboration with a steering group's work on an updated marine synthesis report in the Swedish Energy Agency and Swedish Environmental Protection Agency's joint research programme, Vindval. It compares the permitting process and its effectiveness in 4 EU countries (Germany, Denmark, Scotland, and Sweden) with special emphasis on the acoustic impacts of wind turbine construction. 6 Key criteria that determine the outcome of a successful permit application were analysed: a) permit process maps b) quantity of actors c) consultation times d) ecological and environmental impact e) "planning vs permitting" and e) handling of acoustic impacts on marine mammals. Sweden's process was found to be the most cumbersome and ineffective among the 4 countries. Germany, Denmark, and Scotland have streamline processes, in part due to the successful employment of a 'one-stop-shop' mechanism. It is recommended that Sweden create a similar, singular, and centralized 'one-stop-shop' authority that has the power to dictate permitting processes. If the country is to meet its goal of 100% renewable energy by 2040, permitting policy should include: flexible permitting for rapidly changing technology, endorsement of continuous dialog between authorities, a limit on consultation time, the removal or amendment of municipal vetoes, and have clear demarcation of worthwhile explorable zones reserved for offshore wind.

### Nyckelord/Keywords

Permitting process, wind power, acoustic impact, environmental impact assessment, marine mammals, physical planning, ecology, offshore, EIA, juridiska förutsättningar, permit, tillstånd, tillståndsprocess.

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# Acknowledgements

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Thank you to all the experts in Germany, Denmark, Scotland and Sweden for taking your time to contribute insightful information, this work would not have been possible without it.

I would like to thank my internal supervisor, Håkan Berg, for his guidance with structure, refining my research, incredibly insightful feedback which encouraged me to make this work the best it could be and supporting me through the immense challenges of this last year.

Especially friends from Scotland and Stockholm for providing me with much needed support during the ups and downs. My eternal gratitude goes to my parents who have guided me, even a world away, especially after being abroad for 6 years.

This thesis is dedicated to my grandmother, Johanna Margarete Kresse Jack. Ich liebe Dich für immer Oma.

# 1. Introduction

Accurate wind power planning is key to the expansion of clean energy in the European Union (EU). According to the European Wind Energy Association, Wind Europe, there is currently 25 GW of installed offshore wind capacity in the EU, which equates to 5,402 grid-connected turbines across 12 countries (Wind Europe, 2021). The EU's ultimate goal is to have 300 GW by 2050 (Wind Europe, 2021b). For offshore wind growth to occur, each nation must comply with planning and permitting regimes, which differ from country-to-country. This thesis presents an analysis of the permitting processes of some of the largest offshore wind power producers in Europe: Denmark, Germany, Sweden, and Scotland[1], with a special emphasis on acoustic impacts. Permit processing for offshore wind needs improvement in EU member states, including Sweden. The EU's goal is to streamline permitting processes for energy infrastructure. Permit streamlining is currently hindered in the EU due to lack of enforcement of the **2018 Renewables Energy Directive, insufficient resources for permit application processing**[2] and the **lack of flexibility and synchronization between ever-changing technology** and the **permitting process** in each Member State (Jossart, 2020). While streamlining is strived for by the European Union, in an effort for increased centrism, Member States desire to have cooperation and maintain their integral differences (Grip, 2021, pers. com.).

In the permitting process, an environmental impact assessment (EIA) details the environmental conditions of a proposed development and the possible impact that a development may have on the physical and biological environment. Some of the **most significant impacts** to the biological environment include:

- avian collision risk (Band et al., 2007, Waterfowl and Wetlands Trust, 2014)
- avian physical displacement (Mendel et al., 2019, Peschko et al., 2020)
- physical disturbances of species that are sensitive to electro- or magnetic fields (Bailey, Brooks & Thomson, 2014)
- hearing damage and habitat exclusion from pile driving (acoustics) (Hammar et al., 2008)
- a positive "reef effect" which can promote an offshore wind turbine as an MPA (Marine Protected Area) (Rostin et al., 2013, Ashley et al., 2013)

**Sound is one of the most important negative impacts** (according to industry)**,** during the construction and decommissioning phases of offshore wind development, which can result in hearing damage and habitat exclusion for marine mammals (Bailey, Brooks & Thomson, 2014, Liebschner, 2021). This thesis provides a case study and comparison of the acoustic impact of pile driving (method used to install piles for marine and inland construction projects using high energy impact hammers) (Dahl et al., 2015) in the 4 European countries. Monitoring of underwater noise is a key part of the EU's Marine Strategy Framework Directive in striving towards "Good Environmental Status" for European seas (EU Commission, 2021).

In the **site investigation phase**, special consideration is given to an area network in the EU with great natural value, called Natura 2000 areas. These were established to protect certain species and their habitats, which are defined according to the EU Habitat and Bird Directives (Naturvårdsverket, 2012, 2020). A special assessment must be done if wind power projects are to be located nearby due to

[1] Scotland ceased to be a part of the European Union and contracting party to the European Economic Area on 31 January 2020. Despite this, EU nature legislation (such as that pertaining to Natura 2000 network areas) is transposed into national legislation. For the purpose of this study, the European Union designation still applies.

[2] *All terms in bold are made for emphasis.*

sensitivity of these Natura 2000 sites. The impacts on Natura 2000 areas, in Sweden, are evaluated and separate permits are issued for each individual species. For the purpose of this work, any impacts to Natura 2000 areas are collectively defined and are not species specific.

Each country has **different permitting processes** and **stakeholders** involved in offshore wind power planning. Most studies only evaluate one method for permissions and do not consider alternatives (Agterbosch et al., 2009). In addition, the studies lack details on the **importance of social and institutional conditions** (such as ineffective management by stakeholders and proper inter- and intra-governmental coordination) in the planning of wind power projects.

## 1.2 Aim

This thesis provides a comparison and evaluation of the offshore wind environmental permitting processes, focusing on wind energy installations nearest to Natura 2000 areas, in European countries (Germany, Sweden, Denmark and Scotland). The focus on installations nearest to Natura 2000 regions is warranted due to increased scrutiny of these areas and pressure to protect their threatened populations in the European Union. This thesis intends to identify points that can be modified and improved, in order to develop a model of a more streamlined, ecologically sound offshore wind planning process for Sweden and future offshore developments in the European Union (Europa, 2013). Currently, Swedish experiences with marine and coastal planning and management are limited and are mainly used sectorally (Grip, 2021, pers. com.). This leaves significant room for development and coordination for a larger, more comprehensive plan.

Insights gained from comparison of the permitting processes will allow for greater and more cohesive expansion of offshore wind installation in and between countries, in line with the European Union's assessment of projects that significantly affect protected areas (e.g. Natura 2000 sites) (European Union, 2001).

The acoustic impact on wind turbines in construction will be evaluated and compared in all countries (both quantitatively and qualitatively) in the hopes of recognizing best practices on measurement and mitigation. The assessment of acoustic impacts currently is multifaceted.

## 1.3 Research Questions

To answer the aim of this work, a few research questions were developed:

- What are the best practices for effective offshore wind power planning in the European Union?
    - How are Natura 2000 areas closest to wind power installations effected?
    - How is the acoustic impact of offshore wind evaluated in the different countries?
- How can the offshore wind power permitting process be improved for Sweden?

# 2. Background

## 2.1 Study Area

The areas that were examined for this study include the maritime areas of Germany, Denmark, Scotland and Sweden. This includes each country's territorial sea and Exclusive Economic Zone (EEZ).

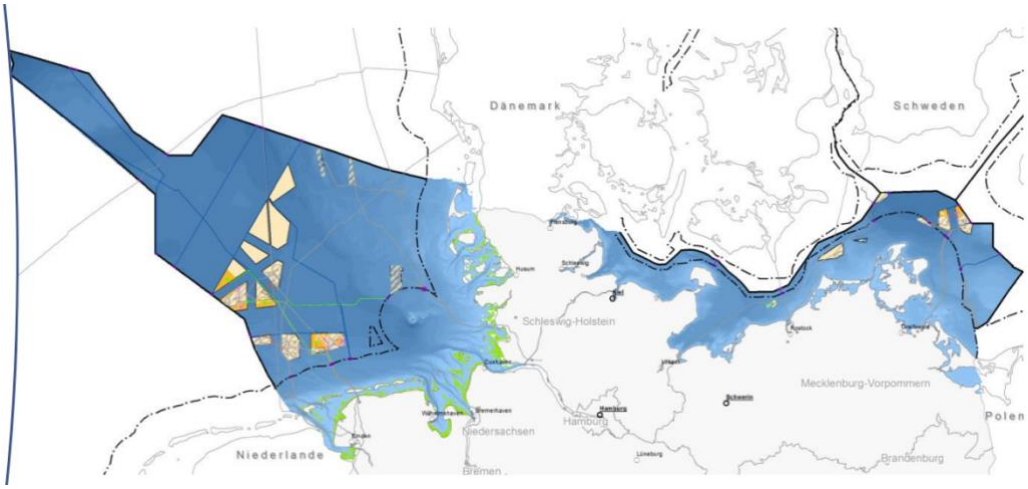


*Figure 1: Areas designated for the expansion of offshore wind power in the German EEZ (From: BSH, 2020b).*

There are 16 areas reserved in the Baltic and North Seas for the expansion of offshore wind (see figure 1). By the end of 2020, 7.7 GW had been installed. The BSH's aim is to install 30 GW by 2030. According to the BSH's Site Development Plan, there is approximately 2641 km$^2$ of the North Sea EEZ and 265 km$^2$ of the Baltic Sea EEZ reserved for offshore wind power (BSH, 2020b).

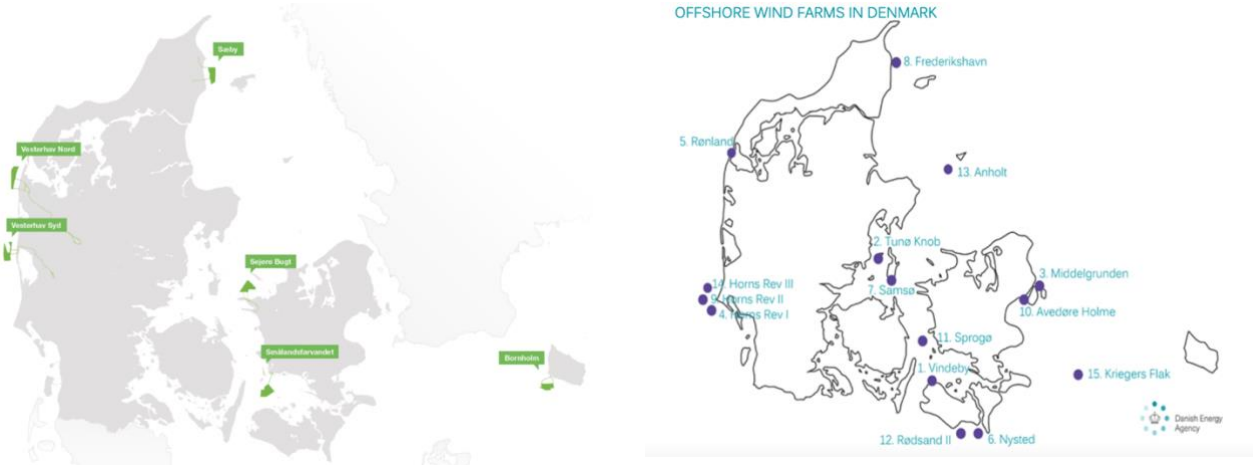


*Figure 2: Areas designated for the expansion of offshore wind power in Denmark (L), current location of wind farms in Denmark (R) (From: DEA, 2017, DEA, 2021d).*

In Denmark, there are six coastal areas with 350 MW of upcoming capacity and a total area of 323 km$^2$ (DEA, 2021a) (see figure 2). Currently, there is 2.31 GW of offshore wind produced in the country (DEA, 2021).

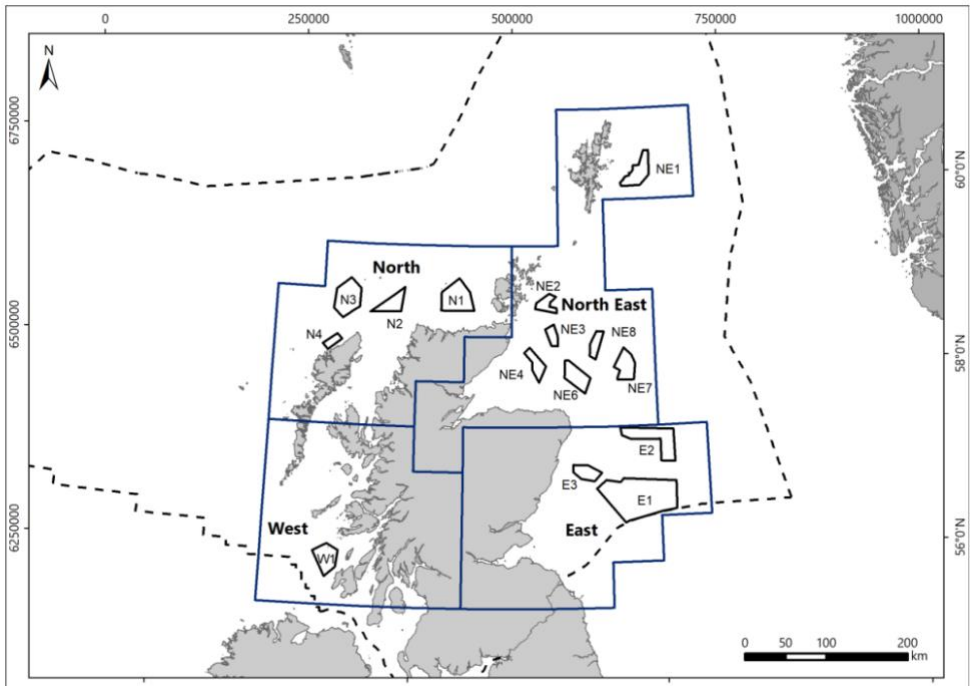


*Figure 3: Areas designated for the expansion of offshore wind power in Scotland according to MS' Sectoral Marine Plan (From: Marine Scotland, 2020a).*

Scotland has a current capacity of 894 MW installed, 5624.9 MW consented and 4.4 GW in the pipeline (Marine Scotland, 2020c). The Government's Sectoral Marine Plan has identified 15 areas, with an area of 12,810 km$^2$ available for the development of projects (see figure 3) (Marine Scotland, 2020a).


*Figure 4: Areas of interest for expansion of offshore wind power in Sweden (L). Overall area plan showing the three Sea Plans (From: HaV, 2019).*

Sweden does not have one single concrete statutory Marine Plan in place, but, as of writing, Hav och Vattenmyndigheten (HaV) currently has three draft marine spatial plans (Gulf of Bothnia, Baltic Sea and Skagerrak) (see figure 4). These marine plans can allow for 23 to 31 TWh of annual electricity production, with a maximum capacity of 50 TWh (Energimyndigheten, 2018, HaV, 2019), but spots are not necessarily chosen.

# 3. Methodology

The approach used to identify permitting differences was multifaceted.

3.2 Identified which authorities in each country were important to the research through a Google Search. Established contact with these authorities through a series of emails with questions about the permitting process. Further details about the process were discovered through informal video meetings and phone conversations. Documents were then requested, received and reviewed. A questionnaire was developed but found to be minimally successful due to hesitancy on behalf of stakeholders due to the sensitivity of information. The agencies below are responsible for permitting in each country:

- Germany: Bundesamt für Seeschifffahrt und Hydrographie (BSH)
- Denmark: Energisyrelsen (DEA)
- Scotland: Marine Scotland (MS, specifically the Marine Sectoral Planning department)
- Sweden: Naturvårdsverket (SEPA) & Havs- och Vattenmyndigheten, Länsstyrelsen, Mark och Miljödomstolen

3.3 Documents were selected based on suggestions from the informants at public authorities and from their webpages. These documents (e.g. municipal cases) were reviewed in order to select data for an overview of each country's process and to determine **key assessment criteria during permitting**. The following documents from Swedish, Danish and German authorities had to be translated (from their original languages to English) and reviewed.

- **Germany:** Planning documents (Site Development Plan), Planning and Environmental Law, Approval (i.e. decision) notice documents, EIAs

- **Denmark:** Planning and permitting documents (e.g. Wind Turbines in Denmark), Planning and Environmental Law, Approval (decision) notice documents (danish: vurdering), EIAs, Construction permits

- **Scotland:** Planning documents (MS' Consenting and Licencing Guidance: for process, legislation & requirements, the Sectoral Marine Plan), Planning and Environmental Law, Approval (decision) notice documents (Section 36 consents), EIAs

- **Sweden:** Planning guidance (from Boverket), Planning and Environmental Law (from the Environmental Courts), decision notice documents (swedish: beslut, from the Environmental Court

and municipalities), Natura 2000 permit decisions (from the Environmental Court and municipalities)

- For the ongoing cases (without decisions) in Sweden, the samrådsunderlag (Eng: "Consultation basis") was used (for Stora Midsjöbanken, Galatea Galene, Utposten, Gretas Klackar wind farms)

3.4 The following 5 criteria were deemed to be the most significant:

- **Quantity of stakeholders (e.g. public authorities) required for permitting in each country**
- **Environmental Impact and Physical planning laws and policies**
- **Consultation time for project comments and amendments**
- **Environmental and ecological impact**
- **Acoustic impact on marine mammals**

Motivation for selection of each of the 5 criteria:

The **quantity of stakeholders** was selected as a criteria, based on the analysis of several systems. It was concluded that the more actors involved in a country's process, the more confusing it can become. **Environmental impact and physical planning laws and policies** were included as criteria to provide an overview of each country's applicable jurisdiction, even though these cannot be easily modified. **Consultation times** provide a forum for informal and formal discussion and are very time consuming. Submission and processing during consultation time can vary and can significantly add to a project's timeline. **Environmental and ecological impact influencing the outcome of an application w**as included after review of all permit sections pertaining to a project's EIA to see if the environmental impact was the reason that the project was rejected or accepted.

A case study of **acoustic impacts** has been chosen as an example of varied approaches to one of the offshore wind industry's most pressing environmental issues.

The case study included questions that are integral to an acoustic impact assessment:

- Who defines these thresholds?
- What are the national thresholds?
- What are the assessment methods?
- What are the mitigation methods?

Diagrams of each county's permitting process were included to clearly illustrate the steps required in the process.

3.5 Analysis of each country's criteria for differences and similarities. The results will then be used to create recommendations for the improvement of Sweden's permitting process.

## 3.6 Data Limitations

There were several limitations and challenges, for the author of this publication, that occurred during data collection and processing. Google Translate was used to translate and interpret 3 languages. The original documents were written in German, Danish and Swedish. The author, fortunately, has a working knowledge of Swedish. The EIA documents from Swedish authorities were too large to send electronically and could not be sent to me by other means. The majority of German project EIAs were not accessible due to lack of digitized information available from the BSH's archives. In addition, some information was not freely accessible in the public domain. These required a Freedom of

Information Act request. After filing the request (which had a response time of > 2 weeks), the documents were deemed too effort intensive and large to scan. There were no limitations found in Scotland, as the authorities were more than able to supply everything needed. No limitations, similarly, were found in Denmark. Authorities were able to supply all permits that were unavailable on the DEA's website.

# 4. Results

## 2.1 Overview of the Permitting Processes

The following are charts and an explanation of each country's permitting process. Each chart gives a visual, step-by-step breakdown of the permitting process from inception to completion. While the designations on each chart have different names, and some have more than others, each country's process is essentially the same.

### 2.1.1 Germany's Permitting Process

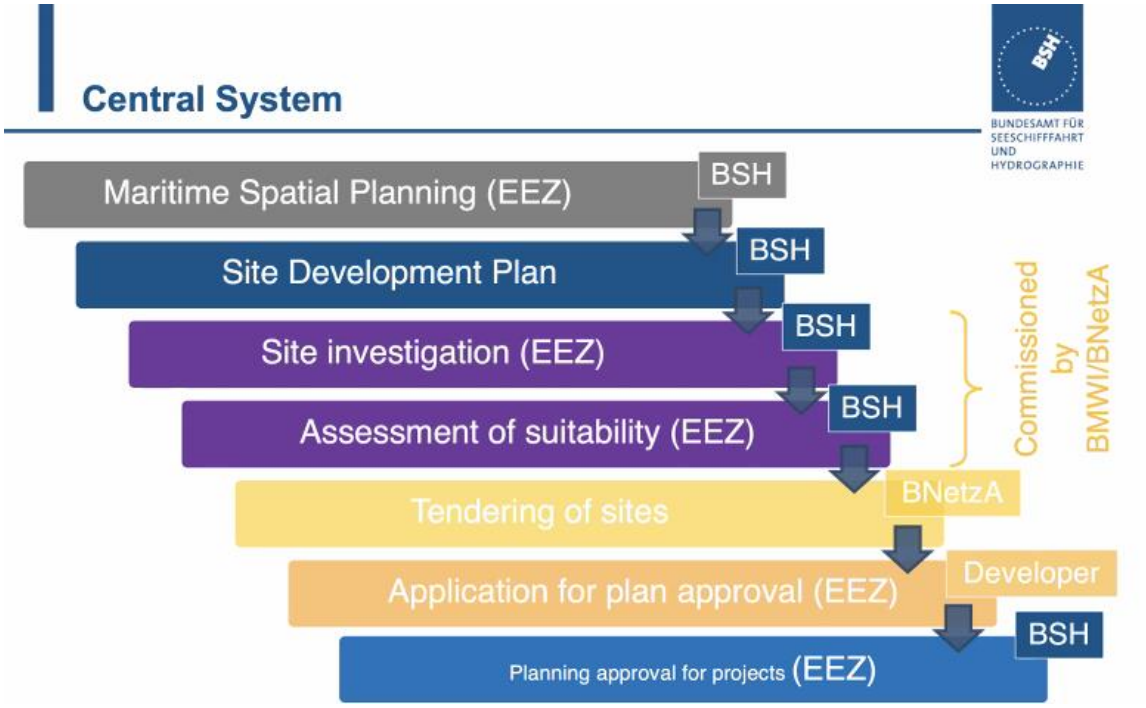


*Figure 5: Overview of German permitting process (BSH, 2020b, Trümpler, 2020, pers. com.).*

The German consenting system consists of several steps, mostly conducted by the Federal Maritime and Hydrographic Agency (BSH). This begins with an **investigation of the German Exclusive Economic Zone (EEZ)**'s marine spatial planning, ensuring that areas of economic and user interest are balanced with environmental protection. Divided areas in the EEZ include safety zones, so accidents and other conflicts are minimal (BSH, 2020a).

After the marine spatial plan is approved, a baseline investigation of the site (according to the **Site Development Plan**) is conducted. This includes the marine and reference environments (species

community analysis), subsoils, wind and oceanographic conditions and traffic suitability (BSH, 2020b). These investigations form the basis for the EIA, species, habitat and biotope protection law reports. They also determine the survey area, monitoring programme and reference area for individual conservation interests. The site investigation is completed in conjunction with the Federal Network Agency (BNetzA) and in consultation with the Federal Agency for Nature Conservation (BfN), the Directorate General for Navigation and Waterways (GDWS) and the federal states which contain the wind farm. There is a 4 week consultation period during this stage where various stakeholders can give comments (Trümpler, 2020, pers. com.).

If the BSH finds a given site suitable (according to given biological criteria for sites) for wind energy production, an executive order is issued and the results of the studies are sent to BNetzA, which decides whether to go through the tendering procedure (in accordance to section 23 of the WindSeeG (ibid)). This public auction (tender) offers developers the chance to submit bids for the exclusive rights to planning approval in a specific location, entitlement to a market premium of electricity and to grid connection (BSH, 2020b). It takes on average 5 years from the time of a call of tender to the year of commissioning (ibid).

The next step after a developer wins the tender rights to a site is to submit the application for planning approval (according to section 44 of the WindSeeG). This includes, among other things, the EIA (at least 8 months prior to construction), a specific description of the marine environment, a spatial and technical overview report (at least 6 months prior to construction), spatial planning coordinates and park layout graphs (at least 2 months prior to construction), an analysis of military/aviation/shipping matters and neighbouring use concerns (BSH, 2021).

In addition, the permit expires if the entire wind farm (or individual turbines) is not built within the stipulated completion dates without sufficient justification. The permit will also expire if it is not put into operation on a permanent basis, permanently decommissioned, or if individual systems are only operated sporadically. The developer must submit an extension of the park's operational permit 2 years before expiration (BSH, 2005).

Of the 19 projects examined that are closest to Natura 2000 areas, all but one have been approved by the BSH. While the majority of the projects were approved without condition, Nordsee 2 and Nordsee 3 were approved according to the Seeanlagenverordnung (Maritime Facilities Ordinance) in the version applicable from January 31, 2012.

138 applications had been submitted for approval of Offshore Wind Parks (OWPs) in the North Sea and Baltic Sea since 1999. 2 applications were rejected (due to nature conservation issues); 80 applications were cancelled by law as of 2017 (due to changes in the law and an "auction model" in the tender procedure has been introduced, 35 permits/plan approvals were issued (32 in the North Sea, 3 in the Baltic Sea) (Sänger-Graef, 2021, pers. com.).

### 2.1.2 Denmark's Permitting Process

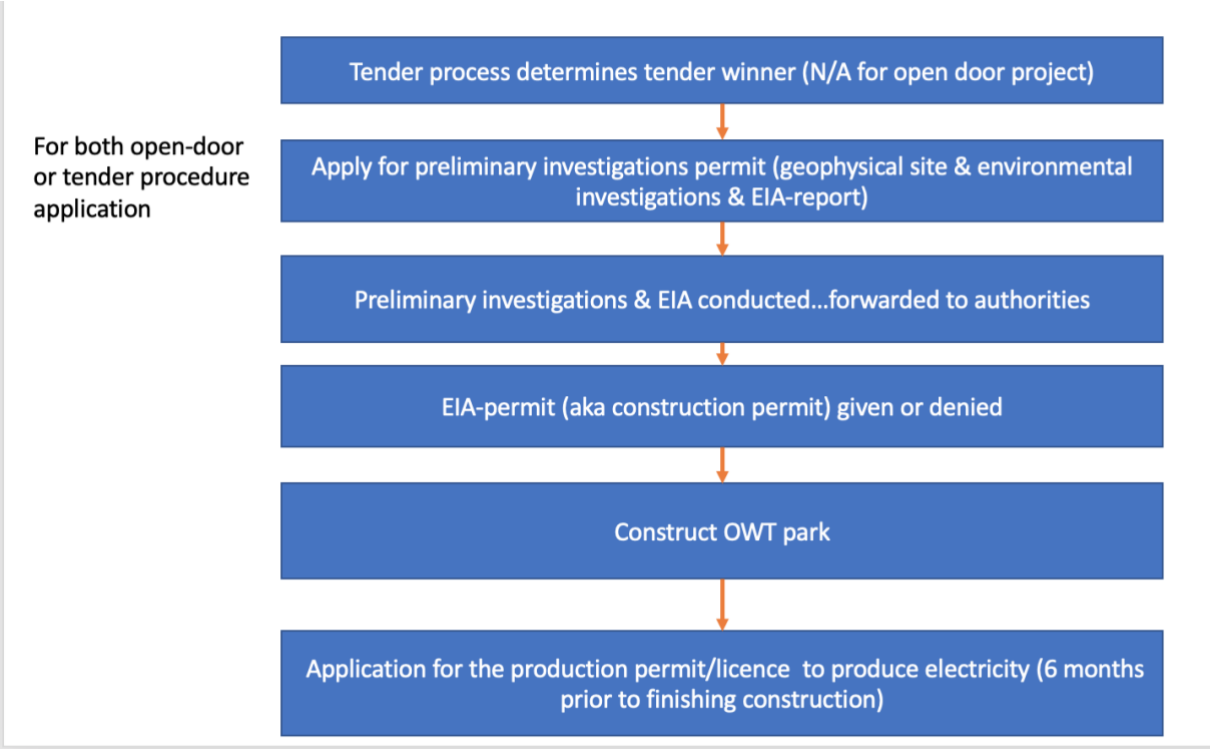


*Figure 6: Overview of Danish permitting process (produced with advice from Grinsted, 2021, pers. com.).*

There are 2 possible permitting and consent options for offshore wind power in Denmark: Open Door or Tender. Both of these result in an initial 25 year permit.

#### 2.1.2.1 Open Door Procedure

In the Open Door procedure, a developer, on their own initiative, can apply and establish a wind farm in a particular area (except for those that are pre-defined), after determining a location and given capacity (e.g. 2 MW). The application is submitted in pursuit of 3 initial licenses (preliminary investigation (aka feasibility study), construction and transmission of electricity) which are compulsory for a construction license (DEA, 2007). These are granted as long as the legal requirements are fulfilled and supplementary information is submitted within a given time frame (4 weeks from request). After submission, the EIA and supplementary information is submitted, the consultation response window is 8 weeks. A construction license is applied for 6 months after pre-investigation approval is granted (DEA, 2015). The permit to exploit an area's wind resources for electricity isn't issued until construction has started, but no later than the first turbine is connected.

The permit process begins once the DEA grants a feasibility study permit to the developer and work must be completed within one year. The application must have a description of the project, anticipated scope of the preliminary investigations (such as the EIA), size and number of turbines, and limits of the project's geographical siting (DEA, 2015). Since October 2019, public consultation (done by announcement on the DEA's website and in national/local newspapers) must be sought on the environmental impacts and draft establishment permit of the potential project (before approval of the feasibility study). Consultation opportunities must also be given to government bodies who clarify if there are any competing interests that may block the wind farm from being built (DEA, 2015). Under

this scheme, municipal veto is possible. For applications submitted prior to October 2019, public hearings had to be done before the first permit was issued (CMS, 2018). If any significant amendments to a permit are to be made, approval must be received from the DEA and must be started within 2 years of that approval (DEA, 2002).

#### 2.1.2.2 Tender Procedure

This procedure and bidding, in an open competition, is for projects in predetermined locations and of a specific capacity (i.e. 200 MW). The DEA must fulfill specific economic, financial and technical pre-conditions that have been presented to the Energy, Utilities, and Climate Committee of the Danish Parliament. These conditions are announced via the Supplement to the Official Journal of the EU. Prior to the bid deadline, the Danish national transmission system operator (Energinet) must conduct and submit several investigations. These investigations and the Danish Parliament's 2018 Energy Agreement form the terms (e.g. location & capacity) of the tender and wind farm's plan. A wind farm's plan is strategically assessed (through an SEA). This is according to the requirements of the Environmental Assessment Act (DEA, 2021a). Then, a large number of supplementary environmental studies are submitted, in order to identify potential risk areas that are pertinent to the wind farm. Projects can also require changes to municipal plans and local area plans where the municipality is the authority. The bidder with the lowest accepted tender price wins (which must be agreed upon by all Danish political parties behind the 2012 Danish Energy Agreement) (DEA, 2016a). After the bid deadline is passed, the winning developer must conduct an EIA of the project's offshore elements (e.g. platform, export cable, wind farm), which the DEA evaluates (WSCO, 2018).

As a part of further conditions from the DEA for the tender, the concession owner must sell electricity on the open market and receive a subsidy from the government to cover the difference between the offered bid price and reference price. The reference price is an average of the electricity prices in the previous calendar year. If the reference price is higher than the bid, the concession owner must pay the government for the gap. For large-scale projects, Energinet constructs, owns and maintains the transformer station and underwater cables.

As a part of the process, the government has an opportunity to supersede a municipality's planning and make the required spatial planning (called a "call-in") (Grindsted, 2021, pers. com.).

### 2.1.3 Scotland's Permitting Process

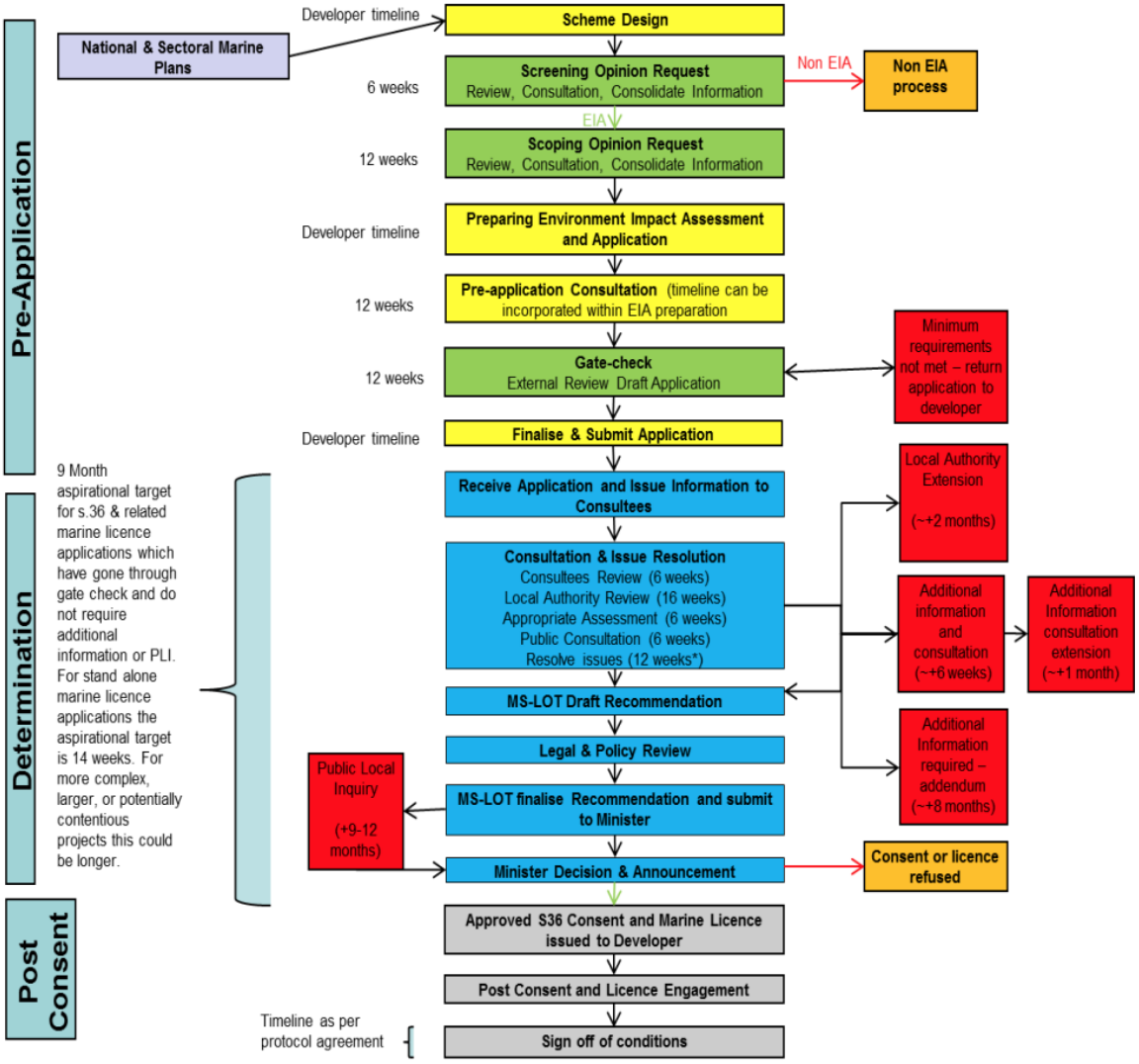


*Figure 7: Scotland's permitting process (From: Marine Scotland, 2018a).*

Scotland's consent procedure is rather straightforward and divided into 3 steps (pre-application, determination and post-consent). First, Marine Scotland requires design mock-ups of the proposed development. During drafting time, 6 weeks of screening and 12 weeks of scoping are requested, before preparation of the initial EIA. During prep of the EIA, 12 weeks of pre-application consultation with public authorities or charities is required. After the EIA is submitted, the developer can start a formal application which must be validated to check if all necessary documentation is included. It must then be advertised for 2 weeks in local newspapers (as a part of the consultation).

During the determination stage (about 9 months), there is dissemination of information to stakeholders, consultation and issue resolution, recommendations for the marine licensing draft and a legal & policy review (Marine Scotland, 2018a). At this stage, Ministers must consult the Planning Authority (Marine Scotland), Scottish Natural Heritage (SNH), and Scottish Environmental Protection Agency (SEPA) among others, to solicit their input and approval in the decision-making process (Marine Scotland, 2018b). Marine Scotland Licensing then finalises the authorities' inputs, draft recommendations and submits them to the Ministers for review. After submission, there is a public

local inquiry (PLI) (concerning the onshore element of the application), which gives local Planning Authorities (such as a county's council) the ability to object and Scottish Ministers the ability to use their discretionary powers to grant or deny a Section 36 consent (Marine Scotland, 2018b). The total timeline for the determination of section 36 and marine license applications is approximately 9 months unless more information is needed.

The application phases are: 'Pre-Application', 'Application', 'Determination', 'License', 'Post-consent'. According to Marine Scotland Information, of the 19 offshore wind power projects that are currently being assessed, 1 is in the application phase, 1 has a license, 3 are in the pre-application phase, 14 are post-consent (MS Information, 2021). None have been rejected.

### 2.1.4 One-Stop-Shop mechanism: Employed in Germany, Denmark and Scotland

Scotland, Denmark and Germany all have a "one-stop-shop" approach to their environmental permitting processes. If a developer wishes to develop an offshore wind project, the central "one-stop-shop" governmental agency handles all the necessary approval, licenses and orchestrates consultations between stakeholders (DEA, 2015, Marine Scotland, 2018a). In Denmark, the DEA is used as the authority for any guidance that developers may need when tendering concessions (DEA, 2015). In Scotland, the primary authority is Marine Scotland and in Germany it is the BSH.

The one-stop shop concept includes a public hearing of other government bodies to ascertain their concerns and objections. The central authority (such as the DEA in Denmark), then decides whether the area in the application can be developed. If the decision is positive, it issues an approval for the applicant to proceed with preliminary investigations, including an EIA (DEA, 2007).

### 2.1.5 Sweden's Permitting Process

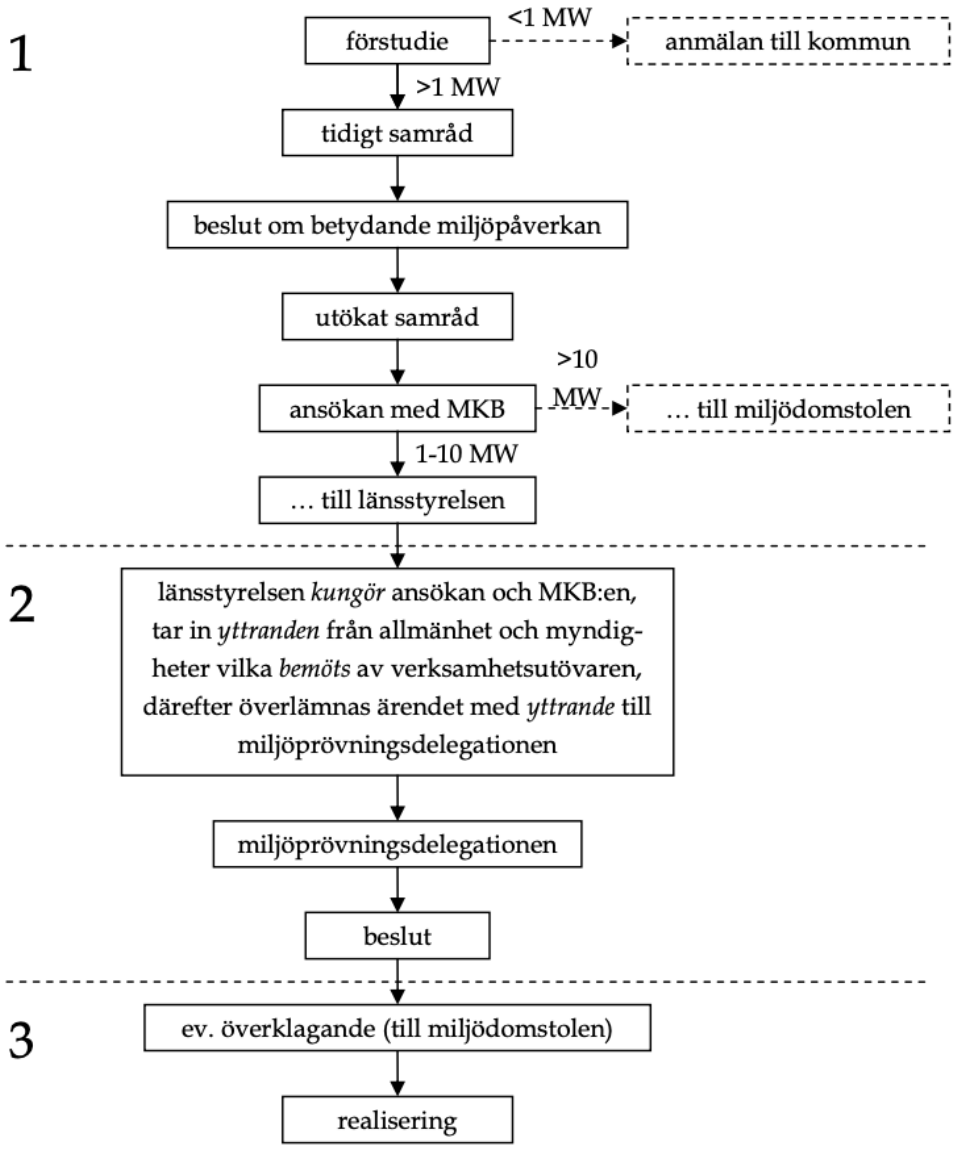


*Figure 8: Swedish permitting process according to the Environmental Code (From: Bengtsson & Corvellec, 2005)[3].*

There are relatively few steps to the Swedish consents process, but it has many actors (Energimyndigheten, 2020a). The first captures and describes the steps from a developer's background (feasibility) study until the submission of the application to the Mark and Miljödomstolen (MMD) (Bengtson and Corvallec, 2005). All components of the background study are compiled by the Länsstyrelssen (eng: County Administrative Board), before submission to the MMD. If a project is less than 1 MW capacity, the feasibility study is submitted to the municipality. If the project is greater than 1 MW, an early consultation, decision of significant environmental impact, and an expanded consultation must be undertaken by the developer. The consultation turns into the application with the addition of an EIA. For projects between 1-10 MW, the application goes to the Länsstyrelsen. If the project is larger than 10 MW in capacity, the application must be submitted to the MMD. If needed, the application will be submitted to the highest judicial level (the Regeringen eng: Government). It

[3] *The permitting process has changed since 2005. Submission of permit applications now in Sweden is directly to the Environmental Court, instead of the municipality. Will update graph when available.*

takes, on average, 31 weeks for the preparation to submission of the background study (Ramboll, 2012). According to the Swedish Windpower Association, the entire procedure takes 12 to 24 months.

During the second step, the Länsstyrelsen handles the application and EIA, processes the opinions of the public and authorities (which are answered by the developer) and then the case (with opinions and comments) is passed on to the environmental trial delegation who provide a decision. Step three is an eventual appeal (to the environmental courts) prior to the actual realisation of the project. The processing and eventual appeal can take anywhere from 6 to 24 months (Svensk Vindkraft, 2021). If the permission must be amended, the steps from the pre-studies until submission of the application takes 8 to 14 months. Processing and eventual appeal of the amendment takes 6 to 24 months (ibid).

According to several sources, of the 20 offshore wind power projects analysed: 3 had been granted (sv: beviljat), 5 are ongoing (sv: pågående, aktuella), 4 had been constructed (sv: uppfört) and approved, 2 had been rejected (sv: avslaget), 2 revoked (sv: återkallade), 2 appealed (decision still pending) (sv: överklagade), and 2 disassembled (sv: nedmonterat) (Energimyndigheten, 2020b).

Unlike all other systems, the Swedish system provides municipalities and other actors several different ways to submit comments (e.g. HaV (2014) (as seen in figure 5) and Energimyndigheten (2017a). The abundance of options significantly delays the timeline as the processing authority waits for a variety of individual responses. In contrast, other countries have 1 succinct and specific time period designated for consultation responses.

According to Västra Götlandsregion's Regional Development office, there are several points at which the process can be influenced. These are the early consultation (with issues such as animals or nature), consultation (with issues that can be highlighted in the MKB), the application (where authorities can submit comments to the MMD), and the decision (Västra Götalandsregion, 2017).

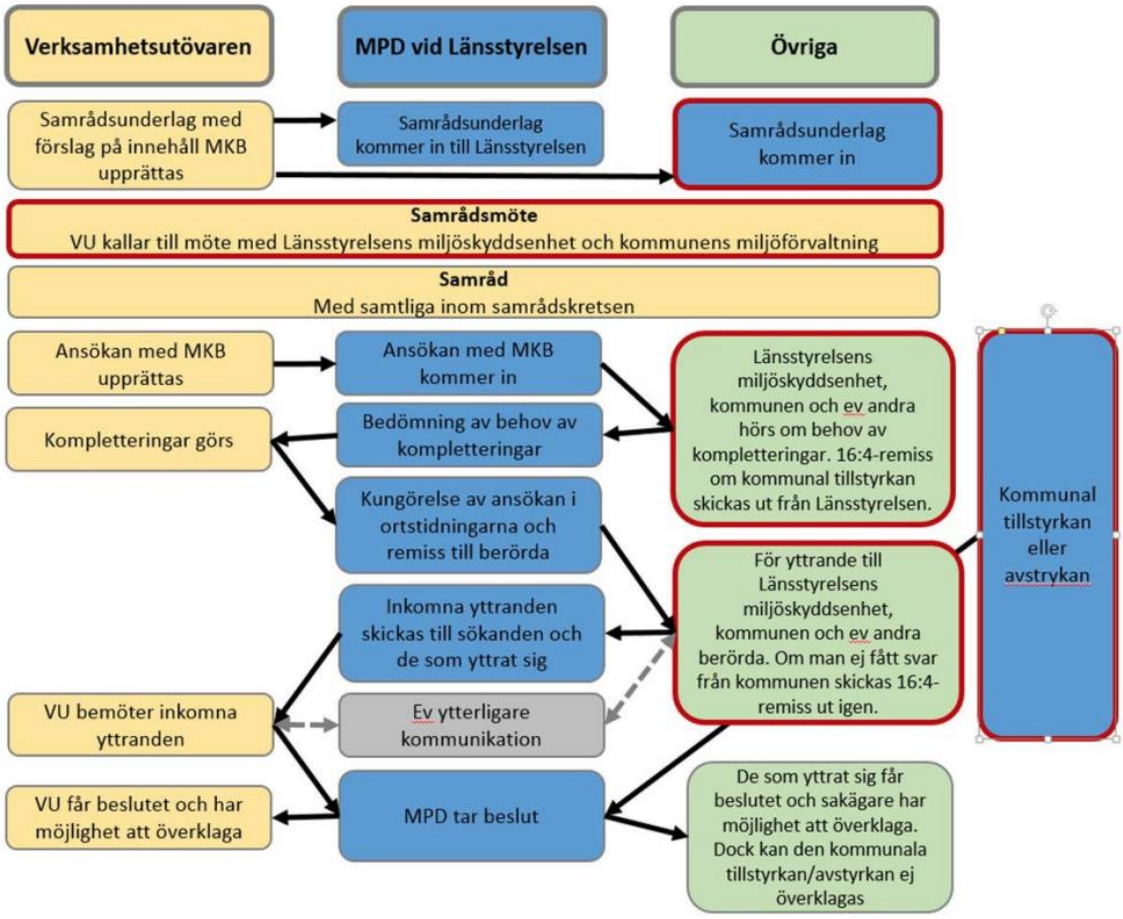


*Figure 9: The permitting process for wind power plants under the Environmental Code. The red marked boxes represent the formal occasions that a municipality can comment on land and water usage in the area in question. NB: The box on the lower right states that municipal approval can be appealed, but only according to legal review (From: Wallberg & Göthe, 2015).*

Balancing conflicts of special interests during a suitability test may result in clashes and cause a delay. For example, a conflict may arise when the location of a potential wind power plant (under the remit of Energimyndigheten) infringes upon protected nature or recreational areas (under the remit of Naturvårdsverket) (Bengtsson and Corvallec, 2005)**.** Under the direction of the Länsstyrelsen, a company does not have to double check with the permitting authority for the placement of each plant, which can lead to projects being placed in inappropriate areas. The Länsstyrelsen (as a stakeholder) also has the power of "municipal veto" to ultimately accept or reject the construction of a project within territorial waters (according to ch. 16 § 4 of the Miljöbalkan) (introduced in 2009). It ensures that the right of control of territorial waters remains under a municipality. A municipality's veto power does not apply to Sweden's EEZ. This gives municipalities the leverage to negotiate financial compensation from wind power companies (Darpö, 2020). The results of the veto are unpredictable, are used differently by several counties, and brings an element of uncertainty to the entire permitting process (Michanek, 2014). Marine spatial planning in the EEZ is the responsibility of the Swedish Agency for Marine and Water Management (HaV).

### 2.1.6 Derogation Process

In very special circumstances during the permitting process, a country may allow for the use of a Derogation Provision (found in Article 16 of the EU's Habitats Directive and Article 9 of the Birds Directive) to allow for a habitat to be impacted (UK MMO, 2020). A Derogation is an "exception to the prohibitions included in Article 5 of the Birds Directive and Article 12 of the Habitats Directive" (UK MMO, 2020), which allows for impact in a given area only if "there are no feasible alternative solutions, imperative reasons of overriding public interest, and if compensation for impact is sufficient" (European Council, 1992). For the majority of EU states, a proposed derogation must have a "negligible effect on species population dynamics", which equals 1% or less of annual species mortality. This is commonly referred to as the "1% rule" (Epstein et al., 2019). An exception to the scale of this rule is Germany, where the effect is assessed according to each individual, not in regards to the overall population level (Backes et al., 2018).

The Scottish application of the Provision is found in clause 6 of the HRA, which allows for a project that has undergone AA, to be built if there is suitable public interest and appropriate compensation for species (e.g. if you kill 100 birds, you must compensate by building bird nesting sites). It is a particular priority for Scotland to monitor the effects of the provision on bird species. Despite the provision being included in the Directive since its establishment in 1992, the first UK derogation did not occur until 2020 with the Hornsea Project 3 (Orsted, 2020, Milne, 2021, pers. comms.). Predicted impact will occur when Hornsea Three's cable protection is placed on the seabed and there may be risk that breeding kittiwakes may collide with the farm's rotor blades. In order to offset potential population loss, the developer will construct new nesting sites over the course of four years (Ørsted, 2020).

To date, the derogation process has not been implemented for any wind farms in Sweden (Modin, 2021, pers. comms.). In Germany, derogations have been used by BfN to issue an exception for the Butendiek wind farm regarding the impairment of divers (i.e. red-throated diver (Gavia stellata); and black-throated diver (Gavia arctica)) (van Leusen, 2021, pers. com., Hendrischke, O. and BfN, 2021). The derogation process has never been used in Denmark for offshore wind (Grinsted, 2021, pers. comms.).

## 2.2 Five Key Criteria influencing the outcome of a permit process

### 2.2.1 Stakeholders involved in the Permitting Process

Stakeholders are parties interested in wind farm construction and installation (e.g. public regulatory authorities, judicial and other governmental bodies and non-governmental organisations) and provide feedback on elements of an application. Germany has 1 regulatory body responsible for offshore wind construction (with 1 regulating natural areas), Denmark has 1 regulatory body, Scotland has 1 responsible authority (with 4 other consultees), Sweden has 3 authorities for assessment (with 8+ authorities that heavily influence the process). Details of the authorities and their exact rolls are in Appendix 2. In general, it was found that the more stakeholders, the more complicated and time intensive the process.

### 2.2.2 Environmental Impact and Physical Planning Laws and Policies

The Environmental Impact Assessment law governs the details of what must be included in a report on the potential impact an offshore wind development may have on the environment. Relevant chapters of these are found in the Appendix 2.

Physical planning laws pertain to legislation that governs the placement and licensing of offshore wind turbines and associated infrastructure. These laws and policies can not be easily modified, but are significant factors in determining the outcome and eventual success or failure of a permit and project. Relevant chapters of these are found in the Appendix 2.

While it is recognized that there may be potential for countries to identify and adapt laws and policies from one another, for the purposes of this report, it is assumed that this will not happen.

### 2.2.3 Consultation Times for Comments and Amendments

The formal and informal consultation times for discussions about a project differ significantly by country. The following clearly shows Sweden's permit processing time to be more than 4 times as long as Denmark (60 days versus 14 days).

- **Germany:** Approx. 28 days (Trümpler, 2020, pers. com.)
- **Denmark:** 14 days, but, sometimes extended to approx. 42 days (Grinsted, 2021, pers. com.)).
- **Scotland:** 42 days (Milne, 2021, pers. com.).
- **Sweden:** Approximately 60 days + (Algö, 2021, pers. com.)

### 2.2.4 Environmental and Ecological Impact

All countries require an EIA to be undertaken for offshore wind projects, due to potential negative environmental impacts. The specific conditions where a country requires an EIA are described in Appendix 3.

For all Danish and Scottish projects, the environmental and ecological impacts have been sufficiently mitigated and therefore resulted in the successful permitting of all projects. Two wind farm projects were rejected in Germany. They were located in bird protection areas that were important to the wintering and feeding habitats of the velvet and common scoter, common-eared grebe, red-necked grebe and black guillemot (Sänger-Graef, 2021, pers. com.).

In Sweden, the permit for Stora Middelgrund was compromised by a 2017 evaluation of the environmental risk (i.e. danger to cod & porpoise, unknown risk to seabirds, and definite overall habitat risk from turbines and cables). But, in 2018, this judgement was overturned and it was determined that the wind farm could be expanded without affecting protected areas and might even be beneficial for the area, due to a potential reef effect (Vänersborgs Tingsrätt, 2018 and Länsstyrelsen i Hallands län, 2018).

There have been a few projects that do not infringe on the protected areas but are adjacent to Natura 2000 areas (e.g. Galatea Galene (Länsstyrelsen i Hallands län, 2018), Blekinge Offshore, Taggen, Storgrundet wind farms). Others have minimal impact because the distance from the protected area is great and the effects of the incursions are insignificant (i.e. Gretas Klackar and Utposten 2, Finngrundet (Nacka Tingsrätt, 2013) and Kattegatt Offshore (Svea Tingsrätt, 2015)). In the latter case, it was determined that there is no requirement for a Natura 2000 permit. In the minority of cases, a few wind farms were erected before the requirement of a Natura 2000 was started in Sweden (2012), and as such, could not be held to this standard, such as the Lillgrund and Vänern wind farms (Karlsson, 2005).

### 2.2.5 Acoustic Case Study

There have been numerous studies done in multiple countries on the acoustic impact of wind farm construction on marine mammals. National thresholds for acoustic impacts vary by country and are determined by all countries' government (or associated) agencies, except for Sweden. The following sections compare who defines acoustic thresholds, what they are, and how they are assessed and mitigated.

#### 4.2.5.1 Who defines thresholds for impact?

- **Germany:** BnF & BSH (BSH defines the requirements for acoustic deterrence, hydro-sound measurement and harbour porpoise detection (C-PODs) at all locations)

- **Denmark:** Energistyrelsen, the Nature and Environment Appeals Board double checks the general noise standards (according to mathematical calculations) and possible noise reduction measures

- **Scotland:** There are no official thresholds, but most used are based on measurements by Southall et al., (2007) from the United States National Oceanic and Atmospheric Association (NOAA).

- **Sweden:** Currently uses the German standards, even though underwater sound is under the responsibility of Hav- och Vattenmyndigheten.

#### 4.2.5.2 What are the national thresholds?

While there is some significant variation in terminology across the four countries studied, it is fair to say that all assess the potential damage to multiple marine mammal species. Germany's threshold applies for all marine species, but mostly focuses on harbour porpoises. Denmark's thresholds vary by species. Scotland varies by marine mammal hearing group. Sweden has adopted the same thresholds as Germany. All countries do, however, agree that acoustic thresholds should not exceed 190 dB. NB: The measurement of sound levels (in decibels) is different in water than in air.

**Germany:**

The noise protection duel criterion for ramming (also known as percussive pile driving), found in the BSH approval notices, has been binding since 2008. At 750 metres from the centerpoint of pile-driving, the following limits must not be exceeded:

- unweighted broadband single event (impulsive) level (SEL) of 160 dB re 1µPa2s
- Sound Pressure peak level (Lp, pk) of 190 dB re 1µPa" (Müller et al., 2019, BSH, 2020c)

This is in accordance with an established avoidance and escape of porpoises that is triggered at a threshold level of SEL 140 dB re 1 µPa2s. In order to make sure developers are adhering to the limits, real-time monitoring of piling is specified in a standard (ISO 29400:2015) (ISO, 2020).

**Denmark:**

Sound thresholds are measured when impact driven piles are installed in the seabed. The maximum weighted accumulated threshold level ((called 'Sound Exposure Level' (SEL)) measured in decibels)) that may be reached is 190 dB. The calculation considers an estimation of the transmitted noise, a

site's bathymetry (depth profile), sound velocity during the expected installation and an estimation of the topmost seabed soils' acoustic properties (DEA, 2016b).

| Species | Fleeing speed (m/s) | Impact criteria | Metric | Threshold value |
|---|---|---|---|---|
| Harbour Porpoise | 1.5 m/s | PTS | $SEL_{C,24h}$ | 190 dB |
| | | TTS | | 175 dB |
| | | Behaviour | $SEL_{ss}$ | 145 dB |
| Phocid Pinniped | | PTS | $SEL_{C,24h}$ | 200 dB |
| | | TTS | | 176 dB |
| | | Behaviour | $SEL_{ss}$ | 145 dB |
| Cod | 0.38 m/s | Injury | $SEL_{C,24h}$ | 204 dB |
| | 0.9 m/s | Injury | | 204 dB |
| Herring | 1.04 m/s | Injury | | 204 dB |
| Larvae and eggs | - | Injury | | 207 dB |

*Table 1: The unweighted threshold criteria for marine mammals and fish. (From: DEA, 2016b, NIRAS, 2020).*

**Scotland:**

According to the *Protection of Marine European Protected Species from injury and disturbance: Guidance for Scottish Inshore Waters* document, "disturbance is highly context specific and currently there are no agreed thresholds" (Marine Scotland, 2020b, Scottish Government, 2020). Marine Scotland gives guidance for details that the thresholds should include (Marine Scotland, 2020b):

- Duration, frequency and intensity of the activity, as increased exposure is more likely to cause a disturbance
- Extent of the area where injury/disturbance thresholds could be exceeded, as chronic noise exposure increases the risk of an offence
- Combination effects (also called cumulative effects) are the presence of other concurrent, preceding or subsequent activities that may have an accumulative effect, increasing the risk of disturbance
- Species specific noise criteria (in either SPL or SEL) as outlined by Southall et al. (2007) aids in risk assessment:
    - A "do not exceed" exposure criterion of 180 dB re: 1 µPa for mysticetes and (recently) all odontocetes exposed to sequences of pulsed sounds, and a 190 dB re: 1 µPa criterion for pinnipeds.

According to updated criteria, marine mammal groups are split into hearing groups and the respective criteria levels are based on signal levels received by animals (i.e. what they hear), rather than signal levels at the sound source. Also, frequency-weighted SEL criteria are given (impulsive vs non-impulsive), not the dual exposure metric in Southall et al., (2007). These thresholds represent the

updated levels at which Temporary Threshold Shifts (TTS) and Permanent Threshold Shifts (PTS) are predicted to be harmful to marine mammals.

| Marine mammal hearing group | TTS onset: SEL (weighted) | TTS onset: Peak SPL (unweighted) | PTS onset: SEL (weighted) | PTS onset: Peak SPL (unweighted) |
|---|---|---|---|---|
| LF | 168 | 213 | 183 | 219 |
| HF | 170 | 224 | 185 | 230 |
| VHF | 140 | 196 | 155 | 202 |
| SI | 175 | 220 | 190 | 226 |
| PCW | 170 | 212 | 185 | 218 |
| OCW | 188 | 226 | 203 | 232 |
| PCA | 123 | 138 | 138 | 144 |
| OCA | 146 | 161 | 161 | 167 |

*Table 2: TTS and PTS thresholds for marine mammals exposed to impulsive noise. SEL thresholds dB re 1 µPa2 s under water and dB re (20 µPa) 2s in air...peak SPL thresholds in dB re 1 µPa under water and dB re 20 µPa in air (groups PCA and OCA only) (From: Southall et al., 2019).*

| Marine mammal hearing group | TTS onset: SEL (weighted) | PTS onset: SEL (weighted) |
|---|---|---|
| LF | 179 | 199 |
| HF | 178 | 198 |
| VHF | 153 | 173 |
| SI | 186 | 206 |
| PCW | 181 | 201 |
| OCW | 199 | 219 |
| PCA | 134 | 154 |
| OCA | 157 | 177 |

*Table 3: : TTS and PTS-onset thresholds for marine mammals and non-impulsive noise in dB re 1 µPa underwater and dB re 20 µPa in air (From: Southall et al., 2019).*

**Sweden:**

There are no national thresholds, even though underwater noise has been identified as a significant issue during construction and decommissioning phases (Almbring, 2020 pers comms.). According to an 2014 opinion document from Havs och Vattenmyndigheten to the Svea Hovrätt, HaV's "outlook" on thresholds is based on Germany's double limit of acoustic thresholds and their scientific knowledge of the piling effect on porpoises (Almbring, 2014): and can serve as a basis for assessment (according to the BMU).

> "SEL should not exceed 160 dB re 1 re 1µPa or SPL peak-peak should not exceed 190 dB 1µPa on 750m distance from the piling source. The limit that is reached first shall apply...in addition, these levels should be clearly regulated during the mating and lactation period which falls during 1 April - 31 December. (approximately March/April or September/October) ".

These sound levels have been employed loosely in all cases. For example, noise monitoring of project Utgrunden during the construction phase was found to fall below the hearing threshold of harbor porpoises at a distance of 25 meters, and was found to not have a barrier effect on migration, as long as the sound emitting sources were 500m apart (BSH, 2002). In addition, each county is responsible for a monitoring programme which is part of a permitting application. Länsstyrelsen i Hallands län (2017) states that piling (one foundation at a time) may only be conducted at certain months of the year (March-April and September-October) to circumvent sensitive periods for species. Outside of these times, piling is allowed without restrictions. A developer must demonstrate that the noise level will not exceed 150 dB dB re 1 µPa at a distance of 750 meters from the piling site. Piling work, however, must be preceded by acoustic scare methods which start with light blows so that fauna can escape the area. If noise values cannot be contained during the sensitive periods, monopile foundations will be replaced by gravity or other foundations that generate less noise (assuming the proposed design shows it to be possible).

Noise levels in permitting applications are species specific but can readily change which creates confusion. For instance, the Natura 2000 permit for Kriegers Flak states that the values below the water surface must not exceed single pulse SEL 131 dB weighted * re 1µPa2s for porpoises and single pulse SEL 144 dB weighted * re 1µPa2s for seals at a distance of 750 m from the sound source (Svensson, 2021). Whereas, the Natura 2000 permit for Kattegatt Offshore states that the sound limit is SEL 160 dB. Real time monitoring of noise values is regulated and can be changed accordingly.

#### 4.2.5.3 Assessment methods for acoustic impacts

Assessment methods are used to measure the impact on the marine environment. Each country's approach to assessment is presented below. All countries use CPODs and hydrophones to measure species abundances and acoustic signatures at given control distances (500, 750m).

**Germany:**

Measurements from hydro-sound and continuous porpoise detectors (CPOD) (specifically for harbour porpoises) are used for evaluation of acoustic impacts. The set up for the hydro-sound method includes 1-2 hydrophones at 750m, 1500m, further afield (e.g at POD station and/or nature conservation areas nearby) and at reference locations (4-6 positions). For the CPOD measurement, 4-5 single purpose detector (POD) stations, 1-2 mobile PODs at 750m, 1500m, and further afield (at a POD station or nature conservation area nearby) are needed (BSH, 2011).

**Denmark:**

The guidance to be followed for underwater noise ('Guideline for underwater noise – Installation of impact-driven piles') entails an estimated impact using given source levels, sound propagation losses and calculates the cumulative SEL experienced by a receptor (marine mammal). If the cumulative threshold isn't met, control measurements should be adjusted until the requirements are fulfilled. In addition, accurate measurement of transects is not only performed at a control distance of 750m, but also 375, 500, 1000, 1500 and 3000 m using omnidirectional hydrophones (DEA, 2020). The measurements shall also be performed at two different depths (66%, 33% ; but in no case less than 2 m below the sea surface), at a frequency range at least ranging from 12.5 Hz to 20 kHz (DEA, 2016b).

**Scotland:**

The primary sampling method for large scale studies uses arrays of CPODs and hydrophones. Small scale studies employ multi-hydrophone arrays, as used on PAMBuoy or other passive acoustic monitoring (PAM) systems. An MMO should also be on board when measurements are in progress. The choice of technology depends on the final study design, review of available systems, and logistic differences in mitigation and piling schedules (Thompson, 2015), such as Brooker et al., (2012).

It is important to note that the above applies to fixed wind turbines. Scotland is the only country in this study with current floating offshore wind farms. The installation of floating systems would not include piling. While construction noise is unlikely to cause a physical impact, fauna can still be provoked and exhibit a negative behavioural response.

**Sweden:**

The assessment methods in Sweden include hydroacoustic measurements, with CPODs, side-scanning and multi-beam sonar (SGU, 2020). A marine mammal observer (MMO) should be on board when measurements are in progress and work should cease when porpoises are approximately 500m from a ship.

#### 4.2.5.4 Mitigation methods for acoustic impacts

Acoustic impacts should be continuously managed so that they do not exceed thresholds. Each country's approach to mitigation is presented below. All countries use soft starts, bubble curtains, hydro-sound dampers and acoustic deterrent devices (pingers and scammers) as mitigation methods. All countries recommend seasonal restrictions for construction. Sweden and Scotland recommend the use of MMOs for monitoring purposes, while Germany and Denmark's guidance does not. Sweden and Scotland recommend the use of ADDs in conjunction with soft starts/ramp up as the safest practice for marine mammal protection.

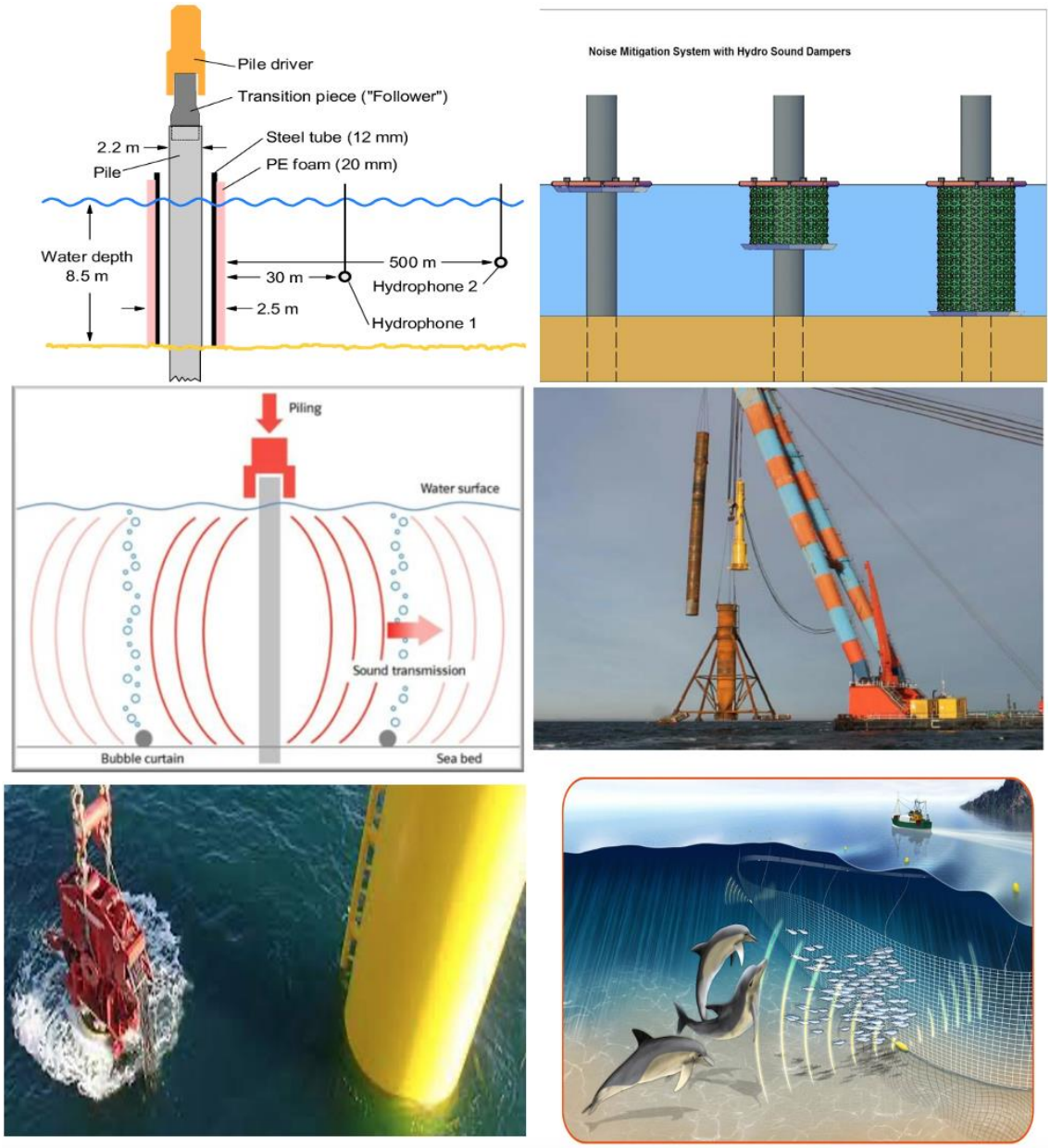


*Figure 10: Range of acoustic mitigation methods (from top left to right): use of pile sleeve during pile driving (From: Schultz-von Glahn et al. (2006)), hydrosound damper (From: Elmer & Savery (2014)), bubble curtain (From: E.On, 2011), cofferdam (From: Thomsen, 2012), vibro-piling (From: PVE Piling and Vibro Equipment, 2021), and a pinger (From: McLaughlin, 2019 in Fidra, 2019).*

**Germany:**

In order to mitigate the impact of wind farm acoustics on marine mammals during the construction phase, the BSH sets a limit that can not be exceeded. The primary sound mitigation method includes a 'soft start'. This, according to the BMU (2014), is described as "prolongation of impact contact time". This approach to mitigation is based on the insertion of a 'soft' intermediate layer (e.g. a steel cable) between the hammer and pile to prolong the contact time and so reduce the 'energy peaks' of the strike impact".

Deterrence and monitoring techniques used to keep the sound levels within this limit include: pingers and seal scarers for acoustic deterrence (before the start of piling), hydrophones (at 750m & 1500m), and CPOD measurements (Schorcht, 2015).
These can vary by wind farm. For instance, at Butendiek, the methods include: seal scarers & pingers (before pile driving) and a soft start procedure, double walled tubes (also known as pile sleeves) enclosing the monopile (lowering emitted noise) or a closed ring bubble curtain for jacket foundations (wpd, 2014).

Secondary mitigation methods in the Standard include the use of Bubble Curtains, pile sleeves, hydro-sound dampers (HSDs) and cofferdams. Bubble curtains are compressed air fed into perforated pipe or hose systems on the seabed or in the water column. The rising bubbles ideally extend an unbroken barrier at different distances and using small-diameter rings, pipes/hoses, or along a wall around the pile or foundation, depending on the size of the curtain used (small, big or a guided bubble curtain). HSDs are air-filled balloons that are connected in a net-like formation which is placed over the pile and then fastened to the seabed. The advantage of the HSD over a bubble curtain, is that the shape, size, number and arrangement of the bubbles in the HSD can be pre-determined. A cofferdam is a structure (such as a steel tube that can be drained) and built to have a dry, accessible area where the pile driving can occur. The use of a cofferdam results in a significant reduction in acoustics (estimated to be 22 dB) (BMU, 2014).

In a measurement of construction noise during pile driving for offshore platforms and wind farms, using bubble curtains during installation led to a reduced strike energy of 160 kJ (Matuschek and Betke, 2009), equivalent to 7 to 12 dB re 1 µPa (SEL) at around 30m depth with a single-row 'big bubble curtain' (BMU, 2014). Pile sleeves are physical sound barriers (sometimes containing insulation) that separate the monopile from the water column (van den Akker & van der Veen, 2013).

Currently the noise mitigation concept is being used in the North Sea, but development of a Baltic Sea noise mitigation concept is pending (Kuehl-Stenzel, 2021, pers. com.).

In addition to acoustic mitigation that utilizes equipment, observational methods based on the habitats and lifestyles unique to various marine species are employed. The German Butendiek wind farm, for instance, states that activities must not interrupt the sensitive mother-calf relationship of porpoises from May to September (BSH, 2002).

While these protections are significant, mitigations and regulations regarding disturbances from vessels and offshore wind parks in operation are lacking (Kuehl-Stenzel, pers. com., 2021). Sound disturbance from moving vessels where there is a high density of shipping traffic can cause significant physical displacement, altered behaviour (Wisniewska et al, 2018) and marine mammal hearing range reduction, up to >30 dB reduction (at 125 kHz) (Hermannsen et al., 2014).

**Scotland:**

Developers should follow the *JNCC guidelines for minimising the risk of disturbance and injury to marine mammals* which only require implementation in the event of "seismic surveys, pile driving or underwater explosives". These precautions are considered best practices that minimise the potential of noise exposure and injury.

Prior to construction, mitigation measures must be employed. A “mitigation zone” of a pre-agreed radius for an MMO/PAM to monitor must be established. The JNCC guidance also recommends soft-starts (ramping up of piling energy until full power is achieved, for at least 20 minutes) and Acoustic Deterrent Devices (ADDs) to discourage marine mammals from approaching the area of auditory harm (JNCC, 2010). Seasonal restrictions on piling operations may also have to be considered, based on the breeding and migration periods for species (ibid). Vibro (hammer) piling is recommended as an alternative to impact piling, which involves vibration of the pile that causes a reduction of soil resistance and allows the pile to sink into the seabed (instead of striking it into the seabed). If noise levels aren’t efficiently reduced, noise mitigation must be used.

The JNCC guidelines do not give strategies to mitigate the impact and effects of disturbances, but were developed to give guidance on how to lower the potential risk of injury for marine mammals around piling operations.

On the other hand, Big Bubble Curtains (BBC), the IHC Noise Mitigation System (NMS), the hydro-sound damper (HSD) and vibro-hammers have all been commercially deployed in OWF-projects (Verfuss et al., 2019). The BBC has been previously explained. The IHC NMS is a screen, casing or pipe that absorbs or reflects sound back to the pile and has been found to be equal to or exceed the noise reduction potential of a bubble curtain (OSPAR, 2014). Resonators are a newer alternative which consist of an array of resonating units deployed around the sound source that absorb the emitted sound from pile driving, and are not as sensitive to currents as bubble curtains. Vibrohammers, in shallower waters, are a better alternative than coffer dams or isolated casings (NMS) (JNCC, 2020).

While the current guidance recommends that ADDs be turned off immediately after piling has started, new guidance suggests that they should be used in conjunction with soft starts (Thompson and McGarry, 2015).

**Denmark:**

In Denmark, the Guidance (DEA, 2016b) states that seal pingers and subsequent seal scrammers must be used during the construction phase when piling, and further when the application goes to tender. The DEA must approve the type of seal scrammer and also provides the opportunity to adjust noise effects through soft start (Energinet.dk, 2015). The most popular mitigation measures used are: vibration pile driving (but, only for small monopiles), coffer dams and bubble curtains. Vibration piling (aka vibropiling) has noise reduction of 15 - 20 dB. Cofferdam reduction provides noise reductions up to 22 dB, while bubble curtains provide reductions around 10 - 13 dB (Maxon & Jensen, 2015). The Saeby wind farm, for example, primarily uses air bubble curtains, with a significant SEL-reduction (> 25 dB) depending on the frequency (Wisz et al., 2015).

**Sweden:**

The guidelines for mitigation used by some Länsstyrelssen are in line with the JNCC guidelines followed by Scotland:

2 Permit conditional on use of pingers that assures that marine mammals can not be harmed or disturbed.
3 The soft start and ramp-up methods will be used in each examination.
4 MMO operators shall be sufficiently numerous and located in such a way that they can observe the entire mitigation zone.
5 The surveys shall be carried out on days when good conditions prevail so that the observers have the opportunity to detect marine mammals.

> If marine mammals are detected [by a MMO] within the mitigation zone [500 m away from the ship] during an investigation, the investigation shall be terminated. (From: Algö, 2020, pg. 1 in JNCC, 2010).

Otherwise, Hav- och Vattenmyndigheten recommends that the German guidelines be followed. There are also seasonal prohibitions on piling (depending on the species affected). Significant attention is paid to the porpoise, which has a significant breeding and mating period from May to July. Swedish permitting uses modeling to demonstrate the relationship between an affected Natura 2000 area and the use of sound-absorbing equipment (e.g. a bubble curtain). For example, in the Kriegers Flak application for Natura-2000 permitting, only 2.5% of the total area of the Natura 2000 area will be affected by sound emissions from the location of a wind turbine (compared to 27% without sound-absorbing equipment) (Schön, 2018).

## 2.3 Key Criteria Summary and Comparison

*Table 4: Summary chart of the 5 Key Criteris (Source: Author).*

| **5 Key Criteria Summary** | **Germany** | **Denmark** | **Scotland** | **Sweden** |
|---|---|---|---|---|
| Stakeholders (# government assessors) | 1 | 1 | 1 | 3+ |
| Enviro. impact & physical planning laws | n/a | n/a | n/a | n/a |
| Consultation times, # days (gov, ngo, public, etc.) | 28 | 14 | 42 | 60+ |
| environmental impact (significant outcomes) | birds issue | mitigated | mitigated | Stora Middelgrund |
| acoustic impact (thresholds) | 190 | 190 | 190 | 190 |
| Acoustic impact assessment | CPODs (750m, 500m), hydrophones | CPODs, hydrophones (300 - 3000m), depths (33%, 66%)) | CPODs, hydrophones & PAM. | CPODs, hydrophones & MMO. |
| Acoustic impact mitigation<br><br>(soft start, bubble curtain, hydro-sound damper, ADD, seasonal restrictions) | Yes | Yes | Yes:ADD/soft start simultaneously) & MMO monitoring | Yes: ADD/soft start simultaneously & MMO monitoring |

The number of **stakeholders** who control the permitting process varies by country. Germany, Denmark and Scotland have 1 regulatory body responsible for offshore wind construction, while Sweden has 3 authorities for assessment (and 8+ authorities that heavily influence the process). The formal and informal **consultation times** for discussions about a project differ significantly by country. Sweden's consultation time is more than 4 times as long as Denmark (60 days versus 14 days). While the circumstances vary in each country, the regulation of **environmental (and ecological) impact** assessments seems to be working. Harmful impacts of OWT projects are being mitigated, and therefore have resulted in permit approval. National thresholds for **acoustic impacts** vary by country and are determined by all countries' government (or associated) agencies, except for Sweden. All countries assess the impact to multiple marine mammal species, agree that acoustic thresholds should not exceed 190 dB, use similar methods to measure the impact and that mitigation should be continuously managed and have seasonal restrictions. Denmark has species specific thresholds, Germany (and Sweden)'s threshold is primarily focused on harbour porpoises, and Scotland's threshold applies to multiple species.

# 6 Discussion

The following is a comparison of each country's permit processing issues, primarily focusing on Sweden. These issues include: processing times (including number of stakeholders), technological restrictions, delays in permit extensions, geographical location, "planning vs permitting", acoustic impact evaluation, and adaptation of the "one-stop-shop" mechanism. In addition, some recommendations for permit process improvement from the Swedish Wind Energy Agency (SWEA) and statistics for permit outcomes are included.

## 5.1 Delays in Processing Times

The abundance of stakeholders and disparate voices during consultation time and inconsistent decision making results in delays in Sweden versus a more streamlined process in Germany, Denmark and Scotland.

In Sweden, the environmental permitting process is a relatively long, laborious process, often taking several more months than it does in their 3 European counterparts. Sweden's permitting process has a history of significant governance and management difficulties. This often delayed and difficult process results in less wind farms being built. This is not in line with the EU's RED goals to shorten the process.

Sweden, by far, has the greatest number of agencies and public authorities (local, regional and national) involved in the marine spatial planning process (5 or more according to Boverket (2020)). This often creates logistical backlogs and timing delays. These multiple agencies are not coordinated, have inconsistent dialogue and many permitting decisions are, therefore, made at different times. Additionally, any government organization, NGO or the general public can submit an opinion (according to chapter 29, section B of the miljöbalkan) (Riksdagen, 1998) to the Länsstyrelsen regarding any aspect of the application. These opinions are processed in the order received and not ranked by significance.

This inefficient and cumbersome process results in significantly delayed approvals which delay the start and completion of projects. For instance, according to Fröberg & Lindholm (2020), although permission was announced in June 2006 (but, submitted in 2007), the decision on the network concession for the main electrical line did not become final until 2016, during which time construction could not take place. Sweden is unique because the developer takes all of the economic risk for development costs. In the opinion of Försvarsmakten (Swedish military), delays occur because referrals must be prepared according to the consultation framework as detailed in the Environmental Code (Försvarsmakten, 2020).

The following is an example of how inconsistent decision making has occurred. When trialling the Skåne havvindpark in 2010, the government (Regeringen) assumed that an investigation for a third area would be conducted by the Länstyrelssen when it awarded the permit. It simultaneously granted permission for the investigation of two of the three areas applied for, to the same developer without further review. But, the application for the third area was appropriately rejected due to negative impacts on the porpoise population (Darpö, 2020).

In addition, the procedure for evaluating special permits (such as the Natura 2000 permit) is different in Sweden. Evaluation of special and construction permits occur separately and concurrently. All other countries evaluate permits as a collective document, as required by EU law (Fröberg & Lindholm, 2020). Permissions for activities in the economic zone can be granted conditionally, based on the assurance that activities will be undertaken in a given time period and will protect national special interests (Riksdagen, 1992). Sweden's wind farm market is currently highly concentrated in the same geographic areas. During an area's site investigations, developers conduct costly calculations multiple (often two or three) times for different elements (e.g. porpoises, birds, bats, archaeology, etc.), which can result in significant delays in permit evaluation (Olsson, 2021, pers. com.). This in part is due to the inconsistencies and variance in requirements by local municipalities. Consistent and clear requirements would make for a more effective process. All other countries have standards which provide frameworks for developers that detail the minimal requirements for marine environmental surveys and monitoring (i.e. the BSH (2013)'s Investigation of the Impacts of Offshore Wind Turbines on the Marine Environment, Marine Scotland (2019)'s SEA of Sectoral Marine Plan for Offshore Wind Energy).

By contrast, Germany, Scotland and Denmark have one respective licensing authority (BSH, Marine Scotland and Energistyrelsen). This is often called the "one-stop-shop" approach. The one stop approach is more efficient and has historically resulted in more wind power project approvals. Section B (above) contains a comparison of the number of authorities for each country and clearly shows the differences. In Denmark, Germany and Scotland, there is one permit granting authority.

## 5.2 Technological Restrictions (inflexibility) in permitting

Delays in Sweden have also resulted from expired permits that had been deemed to be too technologically restrictive. For example, a permit may have significant restrictions on total height, rotor diameter or number of turbines, but the permit cannot be automatically changed to reflect changes in current technology. A new permit application must be submitted. This lack of flexibility results in permit cancellations and delays that could be avoided if the process was more adaptive. Examples of this include: 2011 Taggen (then modified in 2016 from 50 turbines to 150 turbines)/2018 Kriegers Flak modification from 170m to 280m turbine height (Pettersson, 2018)/Kattegat Offshore new height of 150m to 190m rejected by MMD (Svea Hovrätt, 2018)/Södra Midsjöbanken (Länsstyrelsen Blekinge län, 2017a, 2017b)/Störa Middelgrund height & extension adjustment (Johansson et al., Vattenfall, 2020)/Storgrundet number of turbines, height and amendment of area (wpd, 2020).

Danish, German and Scottish authorities, in contrast, manage to minimise technological delays in permitting by recommending that developers constantly consult them during the application process for the most current information relative to new technology.

## 5.3 Delays from Permit Extensions

Permit extensions in Sweden are unlimited, but must be applied for "in good time" before the expiration of a permit (irrespective of the beginning of construction) and last for a maximum of 10 years. Sweden's more generous and flexible 10 year timeline for amendments, has been a contributor to delays in permitting. Whereas in other countries, applicants only have two years to apply for an extension from the date of original construction, or an application is cancelled. Limits on extension maximums vary by country.

In Sweden, the majority of permit conflicts are due to amendments to approved permits and requests for extensions. In 2015, the MMD ruled that the operators of the Utgrunden II wind farm, MarCon Windpower, could not extend the permit for "working time" that was originally granted in 2005, but extended twice, in 2010 and 2015. They then sought a third extension, which was not granted on the grounds that an extension can be granted for only ten years (as ruled by the Växjö MMD on 2019-07-24; M 917-19) (Darpö, 2020). In 2017, the MMD deliberated on a permit to extend the start-up time and to further conditions on piling for Trolleboda, Karlskrona, Torsås wind farm, from 2012 to 2023. This application was rejected because it was received 1 month before the deadline of the existing permit (Darpö, 2020). Similarly, despite the initial permit being granted for Kriegers Flak, the company, Vattenfall Vindkraft, submitted an application for an extension (submitted in 2018) which aimed to increase the total turbine height to 280 m and prolong the deadline for construction to at least 2027 (Länsstyrelsen Skåne län, 2018). The extension was denied.

For the application at Södra Middsjöbanken, even though the application was originally filed for 300 turbines in 2012, the company (E.ON Wind) submitted several additions (as recently as 2017) (Länsstyrelsen Blekinge län, 2017) which delayed the overall decision. No decision on this case has been made at the time of this writing. The government stated that the company must first apply to the Länstyrelssen for a permit in accordance with Chapter 7, section 28b of the Miljöbalkan in order to complete the application before the end of the examination of the SEZ permit (Länsstyrelsen Blekinge län, 2017). The permitting process also does not specify a distinct time frame that a trial must take place (in particular for Natura 2000 areas).

In Germany, applicants can only notify the BSH of further expansion plans no later than 2 years after the commission of the original plans. If a notification isn't made during this time, the application is withdrawn. Applicants in Denmark also only have 2 years to begin any major plans for modifications, or the Danish Energy Agency cancels the application (DEA, 2002). Permissions can be extended for another 25 years (DEA, 2021c). In Scotland, the expansion policy is the same as Germany and Denmark (Marine Scotland, 2020a).

## 5.4 Issues with Geographic Location

According to Energimyndigheten (2021), the situation is further complicated because the wind power industry feels that there is a shortage of ideal locations and conditions for new wind power projects worthy of an application. Complications are further exacerbated due to jurisdictional issues with placement.

If a project in question is located in the Swedish economic zone (defined by the UN Law of the Sea and the Ordinance (1992:1226), multiple permits cannot be processed at the same time, because Sweden does not have full jurisdiction over the area (Fröberg & Lindholm, 2020). The Kriegers Flak wind farm, for example, is transboundary. This wind farm is at the intersection of the Danish, Swedish and German territories and the delay in permit processing was due to jurisdictional misinterpretations of the laws governing the laying of power cables. Regulations related to the handling of cables in the economic zone versus the territorial zone vary. Germany, Scotland and Denmark, have full jurisdiction and use their maritime space (including the EEZ). They have designated areas specifically for wind power and can process permits simultaneously.

Conflicts relative to wind farm placement in locations that are significant to special interests are an ongoing issue for the Government. There is a concern that the location of military interests described in the current proposed 'sea plan' by Hav och Vattenmyndigheten, may be used by the Government to

halt project development. NB: The importance of heeding military interests is described in Chapter 3, section 9 of the Environmental Code and locations covered in secrecy according to Chapter 15, Section 2 of the Public Access to Information and Secrecy Act (OSL 2009: 400).

## 5.5 ”Planning vs Permitting” approach

Different approaches to offshore wind planning produce different results. Currently in Denmark, Germany, and Scotland, individual areas from the Site Development Plan (or equivalent) are auctioned and wind industry developers bid for specific areas (BSH, 2020b, Kuehl-Stenzel, 2021, pers. comms.). This is different and more difficult in Sweden, where the developer applies for permits (such as the Natura 2000), then chooses a spot (to the best of their knowledge) and is responsible for all costs associated with construction. It has resulted in costly mistakes due to the incorrect placement of projects. Several had to be redrafted and begun anew.

In terms of marine spatial planning, Sweden’s MSP legislation is legally guiding, unlike all other countries which have legally binding legislation.

## 5.6 Acoustic Impact Evaluation

Sweden lacks nationally mandated acoustic threshold values that developers must adhere to, unlike Scotland, Germany, and Denmark. In Sweden, HaV, recommends the German Sound Protection Concept (which fulfills part of the requirement of offshore wind construction as per nature conservation law) (BMU, 2014). Certain measures (soft-start and ramp-up) are used as pile installation techniques in conjunction with a “double bubble curtain”. C-PODs are used for monitoring the presence of marine mammals in the vicinity of construction before, during and after piling (Fröberg & Lundholm, 2020). “Denmark and Germany have a much more ‘one stop shop’ approach to assessing impacts. Sweden assesses on a case-by-case basis” (Pettersen, pers. com., 2020).

## 5.7 Permit Statistics

The following provides some comparisons of wind farm permit applications, acceptances or rejections. According to the Swedish Energy Agency, approximately 7% of all wind farms (N.B. not separated by offshore vs onshore) are rejected due to the interests of the military (Boverket, 2021). These concerns are significant since wind turbines disturb radar signals (even beyond military designated areas) and live ammunition can damage wind turbines (Backer et al., 2013). At the same time, approximately 45% of the wind farms in Sweden are rejected by municipal veto and approximately 25% due to species protection (Energimyndigheten, 2021). In 2020, only 8 cases of offshore wind permits were evaluated in Sweden (Darpö, 2020). In Germany, of the 138 applications submitted since 1999 only 0.01% of applications were rejected and 57% of applications were cancelled as of 1.1.2017, and 25% were accepted (Sänger-Graef, 2021, pers. com.). This speaks to the efficiency of the German system. According to Marine Scotland, 0% of the projects were rejected and 73% are post-consent (MS Information, 2021).

| Country | Accepted | Cancelled | Rejected | In Progress/other | Total |
|---|---|---|---|---|---|
| Germany | 35 | 80 | 2 | 21 | 138 |

| | | | | | |
|---|---|---|---|---|---|
| Sweden | 7 | 2 | 4 | 7 | 20 |
| Scotland | 15 | 0 | 0 | 4 | 19 |

*Table 5: Number of permit applications accepted, cancelled and rejected in Germany, Sweden and Scotland (From: Sänger-Graef pers., com., 2021, Milne, 2021, Vindbrukskollen, 2021).*

## 5.8 One-Stop-Shop Mechanism

Common ground for permitting systems can be reached, by further **consultation/cross-border communication** and the continued **development of tools** such as the Marine Spatial Planning Platform and the **optimization of the European electricity network** through regulations such as the "new TEN-E". According to the Regulation, the Member States must have one of three strategies for the **employment of a 'one-stop shop' mechanism.** The **integrated scheme** is where a comprehensive, legally binding decision is issued by only the one-stop-shop authority, leaving other authorities to give inputs to the final decision. In the **coordinative scheme,** the one-stop-shop authority coordinates multiple legally binding decisions, to make up the final decision. In this scheme, the one-stop-shop authority has the right to overrule the input of other authorities or make decisions on their behalf. In the **collaborative scheme**, the one-stop-shop only has coordinating powers and does not have a right to override a decision from another authority (European Commission, 2016a).

The Swedish system, according to the Regulation, is a collaborative scheme, where the leading authority (it is unclear that there is a single authority) does not have the ability to prevent unnecessary delays created by other authorities' failure to make timely decisions, nor is it capable of resolving the problem of sequential authorisations, whereby delays in one area can stop the entire process (European Commission, 2016a).

Germany utilizes a dual process that is both collaborative and integrated; their integrated scheme applies for projects where the BSH issues the final decision (European Commission, 2016b).

In Denmark, although the European Commission mentions the use of all 3 schemes, final permits are granted using the collaborative scheme. The DEA cannot change or override decisions by other authorities (Energistyrelsen, 2013).

Under authority of the European Union's TEN-E project, Scotland follows the rules of the United Kingdom, where each nation has a different national authority, but they all use the collaborative scheme for permitting decisions (BEIS, 2013). This includes a rule to have pre-application plus statutory permit timing to not exceed 3 years and 6 months.

## 5.9 Permitting Issues Summary and Comparison

The following chart highlights the most significant similarities and differences:

| **Summary and comparison of Permitting Issues** | **Germany** | **Denmark** | **Scotland** | **Sweden** |
|---|---|---|---|---|
| | | | | |
| Delays in Processing time: | | | | |
| Authorities (number of government assessors) | 1 | 1 | 1 | 3+ |
| Consultation Opportunities (too frequent) | 1 | 1 | 1 | 4 |
| Additional Evaluation and Permit (N2000) | no | no | no | yes |

| | | | | |
|---|---|---|---|---|
| Technological Restriction (requirement to re-apply) | no | no | no | yes |
| Amendments (timeline to make changes) | 2 yr | 2 yr | 2 yr | 10 yr |
| | | | | |
| Other issues: | | | | |
| Geographic Location (State has control of territorial sea & economic zone) | Full control | Full control | Full control | Full control over terr. sea, not EEZ |
| Plan vs Permit (pre-determined planned areas vs undetermined) | plan | plan | plan | permit |
| One-Stop-Shop (singular binding governmental authority) | yes | yes | yes | no |
| Permit Approval (municipal veto) | none | none | none | 45% |

*Table 6: Summary and Comparison of Permitting Issues (Source: Author).*

## 5.10 Recommendations for Sweden

By reviewing permits, government documents and evaluating key criteria, best practices have been identified and are recommended to improve Sweden's offshore wind permitting process. A **central authority** with a **'one-stop-shop'** approach that coordinates all activities should be established. This includes incorporating **flexible permitting** that is sensitive to rapid changes in wind technology and other possible amendments. It requires **continuous dialog** between authorities at central, regional and local levels (Grip and Blomqvist, 2021) to **minimise conflicts**. A limited consultation time should be established by the central authority so each stakeholder can clearly declare their opinion (Boverket, 2021). The municipal veto should be removed or at least amended to be less influential in the outcome. There should also be a clear **demarcation of zones** reserved for offshore wind power to be auctioned off. All of these recommendations should help **reduce the time needed to secure a permit,** as per the 2018 Renewable Energy Directive. These recommendations are congruent to those of industry, according to Swedish Wind Energy Association (SWEA).

## 5.11 Additional Recommendations from Industry for Sweden

The SWEA has recommended the following actions that will additionally accelerate wind power expansion and help achieve Parliament's climate and energy targets. The Swedish Environmental Code should be updated to:

- prioritise the climate benefits of wind power in its decisions
- have rules that can adapt to changing technology
- modernise the regulations for grid concession (Regeringskansliet, 2019), which will minimise networking and establishment costs (according to Skånes vindkraftsakademi (2020))
- clearly specify exactly where and when connection can be established to the national grid
- increase funding for and communication between review agencies/courts (Svensk Vindenergi, 2019).

# 6. Conclusion

Permitting is key to the expansion of offshore wind power developments in the European Union. Each country has different permitting processes which impact the outcome of permits and this report has highlighted some of those differences. The 6 most significant differences found were: process time (including volume of actors/stakeholders), technological flexibility in permits, extension flexibility of permits, geographical location of farms, evaluation of acoustic impacts and different approaches to "planning vs permitting". Sweden was identified as having the most cumbersome and ineffective permitting system relative to the 3 other countries studied due to these differences. The other 3 countries analysed have a more streamlined, one-stop-shop approach. It is recommended that Sweden do the same by creating a central authority. This would have the power to coordinate and employ the best practices available for permit evaluation and implementation. A more transparent, simple and coordinated system will benefit all parties involved. Concerned individuals and organizations will be able to give input more effectively. OWT manufactures will be able to move projects forward more rapidly and accurately from inception to permitting to project completion. This will hopefully result in more permits being approved and the faster, and more accurately placed expansion of offshore wind projects in Sweden.

This work provides several potential opportunities for further research. Among the top opportunities to be explored:

- use of recommendations to develop further Swedish marine spatial and large scale planning
- prioritization of recommendations (e.g. cost, difficulty of implementation, time needed, etc.)
- development of a standard protocol for site investigations
- comparison of each country's post-construction environmental monitoring programmes.

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# 8. Appendices

## 8.1 Appendix 1: Abbreviations, Glossary of Terms, Industry Contacts and Translations

### 8.1.1 Abbreviations of Authorities

| Abbreviations | Definition |
|---|---|

| | |
|---|---|
| BNetzA | Bundesnetzagentur (eng: German Federal Network Agency) |
| BMU | Bundesministerium für Umwelt, Naturschutz und Nuklearesicherheit (English: Federal Ministry of the Environment, Nature Conservation and Nuclear Safety) |
| BfN | Bundesamt für Naturschutz (eng: Federal Agency for Nature Conservation) |
| BSH | Bundesamt für Seeschifffahrt und Hydrographie (eng: Federal Maritime and Hydrographic Agency of Germany) |
| DEA | Energistyrelsen (english: Danish Energy Agency) |
| EU | European Union |
| HaV | Hav och Vattenmyndigheten (eng: Swedish Agency for Marine and Water Management) |
| JNCC | Joint Nature Conservation Committee |
| MMD | Mark och Miljödomstolen (eng: Land and Environmental Court) |
| MS | Marine Scotland |
| MS | Marine Scotland |
| NABU | Naturschutzbund Deutschland = Nature and Biodiversity Conservation Union |
| OSPAR | Convention for the Protection of the Marine Environment of the North-East Atlantic |
| SEPA | Swedish Environmental Protection Agency (sv: Naturvårdsverket) |
| SGU | Sveriges Geologiska undersökning (eng: Geological Survey of Sweden) |

### 8.1.2 Abbreviations of Terminology

| **Abbreviation** | **Definition** |
|---|---|
| ADD | acoustic deterrent devices |
| BBC | big bubble curtain |
| EEZ | Exclusive Economic Zone |

| | |
|---|---|
| EIA | Environmental Impact Assessment |
| HF | High-frequency cetaceans |
| HSD | hydro-sound dampers |
| LF | Low-Frequency (LF) Cetacean Hearing Group |
| MKB | miljökonsekvensbeskrivning |
| MMO | marine mammal observer |
| NGO | Non-governmental organisation |
| NMS | IHC Noise Mitigation System |
| OCA | Other marine carnivores in air |
| OCW | Other marine carnivores in water |
| PAM | passive acoustic monitoring |
| PCA | Phocid carnivores in air |
| PCW | Phocid carnivores in water |
| POD | porpoise detector |
| PTS | Permanent Threshold Shifts |
| SEL | Single Level Event |
| SI | Sirenians |
| SPL | Sound Pressure Level |
| TTS | Temporary Threshold Shifts |
| VHF | Very high frequency cetaceans |

### 8.1.3 Translations of German Terms

| **Word** | **Translation** |
|---|---|
| Ausnahme | derogation |
| Beratung | consultation |
| Ergebnis | result |
| Ergebnis der Prüfung | result of examination |

| | |
|---|---|
| Errichtung und Betrieb | establishment and operation |
| FFH-Verträglichkeitsuntersuchung | Natura 2000 compatibility |
| Genehmigungsbescheid | Approval Notice |
| Meeressäuger | marine mammals |
| Meeresumwelt | marine environment |
| Meideverhalten | Avoidance behaviour |
| kumulative Auswirkungen | cumulative effects |
| Planfeststellungsunterlagen | plan approval documents |
| Umweltbericht | Environmental Report |
| Umweltverträglichkeitsstudie (UVS), Umweltverträglichkeitsprüfung (UVPG) | EIA |
| Verlängerung | extension |
| Verzögern | delay |
| Änderungsbescheid | notification of amendment |

### 8.1.4 Translation of Danish terms

| **Danish terms** | **Translation** |
|---|---|
| Afgrænsningsudtalelse | Delimitation statement |
| Forsinke | delay |
| Godkendelse af detailprojektet | approval of project |
| Høring | consultation |
| Natura 2000 konsekvensvurdering | Natura 2000 impact assessment (Appropriate Assessment) |
| Natura 2000 væsentlighedsvurdering | Natura 2000 screening |
| Tilladelse | permit |
| tilladelse bevillings ordning integreret, koordineret eller samarbejdende | permit granting scheme integrated, coordinated or collaborative |

| | |
|---|---|
| Tillæg til tilladelse | appendix to application |
| Udvidelse | extension |
| VVM-Tilladelse | EIA Permit |

### 8.1.5 Translation of Swedish terms

| **Swedish terms** | **Translation** |
|---|---|
| Ansökan om miljötillstånd | Application for environmental permit |
| Bedömningsgrunder | assessment criteria |
| Beslut | Decision |
| bilaga till ansökan | appendix to application |
| dom | verdict |
| förstudie | background study |
| Inledande samråd | initial consultation |
| Inskränkning | derogation |
| Länsstyrelsen | County Administrative Board |
| Miljökonsekvensbeskrivning (MKB) | Environmental Impact Assessment (EIA) |
| Regeringskansliet | Government Offices of Sweden |
| Riksdagen | Parliament |
| Samrådsunderlag | consultation document |
| Skyddsåtgärd | protective measures |
| Svensk Vindkraftförening | Swedish Wind power association |
| Tillståndsprövningen | permit examination |
| Tingsrätt | District Court |
| Utredning | investigation |

### 8.1.6 List of Industry Contacts

| **Contact** | **Position** | **Association** |
|---|---|---|

| | | |
|---|---|---|
| Kristin Blasche | Senior Project Lead | Ørsted |
| Anna Bohman | Development Project Manager | OX2 |
| Maria Brolin | Co-founder | Svea Vind Offshore |
| Göran Dalén | CEO | Dalénpower |
| Tobias Grindsted | Special Advisor | Energistyrelsen |
| Dr. Kjell Grip | Chairman | Vindval |
| Malin Hemmingson | Investigator in the environmental assessment unit | Hav och Vattenmyndigheten |
| Emilie Johansson | Project Manager | Svea Vind Offshore |
| Lovina Karlsson | Archivist in the Legal Unit | Länsstyrelsen i Kalmar |
| Dr. Aline Kühl-Stenzel | Policy Officer Marine Conservation | Nature and Biodiversity Conservation Union (NABU) |
| Alexander Liebschner | Biologist in Human influences, ecological questions in marine projects | Federal Agency for Nature Conservation (BfN) |
| Simone van Leusen | Officer in charge of Windfarm Licensing Procedures | Federal Maritime and Hydrographic Agency of Germany (BSH) |
| Ulrike Markwardt | Permit Manager - Kaskasi Offshore Wind Farm | RWE Renewable GmbH |
| Drew Milne | Marine Planning and Assessment Specialist | Marine Scotland |
| Mark Aarup Mikaelsen | Civil Engineer of Acoustics & Noise | Niras A/S |
| Gabriella Modin | Legal advisor | Swedish Environmental Protection Agency (Naturvårdsverket) |
| Hans Ohlsson | Senior Project Manager | OX2 |

| | | |
|---|---|---|
| Jannine Sänger-Graef | Head of Planning Approval and Execution | Federal Maritime and Hydrographic Agency of Germany (BSH) |
| Bettina Jensen Skovgaard | Consent Manager | Vattenfall Denmark |
| Lena Svensson | Administrator in the water unit | Länsstyrelsen in Skåne |
| Kai Trümpler | Head of Spatial Planning | Federal Maritime and Hydrographic Agency of Germany (BSH) |
| Dr. Manfried Zeiler | Deputy of Management of the Sea, Head of Assessment and Monitoring Division | Federal Maritime and Hydrographic Agency of Germany (BSH) |
| Anna Älgo | Administrator in the Environmental Protection Agency | Länsstyrelsen in Blekinge |

### 8.1.7 Examples in the "Technological Delays" section of the discussion:

- From Växjö Tingsrätt (2016): "All wind turbines must be of the same model, be colored in the same way and have the same rotational diameter and total height. The height and rotor diameter of these wind turbines must not deviate by more than 15% from the original plants. However, the permitted total height of 170 meters must not be exceeded (Växjö Tingsrätt, 2011)....modified to 220 m".

- "Existing condition allows wind turbines with a total height of 170 meters. Since current technology enables significantly higher turbines, and thus fewer would be required, Vattenfall intends to apply for an increased total height, up to 280 meters" (Pettersson, 2018).

- "The Land and Environment Court has ruled that the measure applied for in the area covered by the current detailed plan, in the case of plants up to a height of 190 meters, cannot be permitted on the grounds that the current detailed plan contains a planning provision stating that the total height of the wind turbines may not exceed 150 meters." (Svea Hovrätt, 2015).

## 8.2 Appendix 2: Expansion of Key Criteria answers

### 8.2.1 Stakeholders in the Process

**Germany:**

- Bundesamt für Seeschifffahrt und Hydrographie (BSH, Eng: Federal Maritime and Hydrographic Agency of Germany) is the regulatory authority for offshore wind projects

- Bundesamt für Naturschutz (BfN, Eng: Federal Agency for Nature Conservation) is the regulatory authority that identifies and selects N2000 areas

**Denmark:**

- Energisyrelsen (DEA, Danish Energy Authority) is the regulatory authority that determines whether an EIA is required and processes all of the offshore wind permits

**Scotland:**

- Marine Scotland ((Licensing and Operations (MS-LOT) is the permit granting authority

- Statutory consultees: Scottish Natural Heritage (SNH), Scottish Environmental Protection Agency (SEPA), Historic Scotland, National Lighthouse Board and the Maritime and Coastguard Agency

- Non-statutory consultee: RSPB Scotland

**Sweden:**

- Mark- och Miljödomstolen is Sweden's environmental court

- Länsstyrelsen is the regulatory authority that issues/rejects permits according to the Environmental Code

- Miljödepartment (Ministry of the Environment) is the authority that prepares issues regarding wind farms in the SEZ (Swedish Economic Zone)

- Naturvårdsverket is the regulatory authority on impacts on the environment

- Havs- och Vattenmyndigheten is the regulatory authority on marine environment impacts

- Försvarsmakten (Swedish Armed Forces) is the regulatory authority that designates areas of national interest (for defence purposes) in accordance with Chapter 3 Section 9 of the Environmental Code)) (Försvarsmakten, n.d.)

- Energimarknadsinspektionen is the regulatory authority for the country's energy markets

- Boverket (National Board of Housing, Building and Planning) is the authority that issued *the Planning and Trial of Wind Power on land and coastal water area*s

- Public bodies that are consultees: Naturskyddsföreningen (Swedish Society for Nature Conservation), SMHI (Swedish Meteorological and Hydrological Institute), small organisations as representatives to tourist facilities (e.g. tourist forening Falkenberg concerning Kattegat Offshore)

### 8.2.2 Environmental Impact Assessment Law

**Germany:**

- EIA Law:
  - Chapter 5 describes the Determination of Obligation of EIA (description of the planning area, proposal for investigations in line with the standard StUK)).
  - Chapter 7 is Preliminary Assessment for EIA Projects.
  - Chapter 7 paragraph 3
  - Chapter 9 paragraph 4,
  - Chapter 16 is description of the EIA report requirements).
  - Chapter 18/19 is Public Participation & Informing the Public.
  - Chapter 28 is Content of the decision on the approval or rejection of a project)

- BImSchG Law Umwelteinwirkungen durch Luftverunreinigungen, Geräusche, Erschütterungen und ähnliche Vorgängeundähnliche Vorgänge (Federal Emission Control Act) is the Chapter 10 (conditions for approval of the EIA), Chapter 16 (conditions of approval for sound and other hazardous substances).

- Offshore Installations Ordinance (SeeAnlV) (BMU, 1997). Section 2a, Clause 1 (Stipulation for an EIA to be carried out), § 3 Sentence 1 SeeAnlV (noise damage avoidance in the marine environment).

- BNatSchG (Federal Nature Conservation Act) (BJV, 2009) is the legislation that defines "conservation objectives" acc. to § 7 Paragraph 1 No. 9, §§ 32 is implementation of the Habitats Directive In the EEZ. According to § 57, the BfN is the designatory authority responsible for identifying and selecting the areas for the Natura 2000 network of protected areas. Chapter 34 is Compatibility and Inadmissibility of Projects {in Natura 2000 areas} in the marine environment. Chapter 38 is the legal basis and order for the naming and explanation of marine protected areas as part of the creation of a Natura 2000 network.

**Denmark:**

- VE Lov (Kap. 25/26): "Establishment of electricity generation plants that utilize water and wind, with associated internal pipelines in the maritime territory and in the exclusive economic zone as well as significant changes in existing plants can only be made with prior permission from the Minister of Energy, Supply and Climate.

  - Stk. (2) The permits are granted to applicants who have the right to utilize a preliminary investigation permit pursuant to section 24, subsection 1, 2 or 4 and which are estimated to have the necessary technical and financial capacity.

- Stk. 3. The Minister of Energy, Utilities and Climate may make the approval of these plants subject to conditions, including requirements for construction, layout, installations, erection, operation, dismantling and security for dismantling of plants, as well as economic, technical, safety and environmental conditions in in connection with establishment and operation, including residence and habitation.

- Stk. 4. Electricity generation plant mentioned in subsection 1, which is permanently anchored in the same place on the territorial sea, etc., is considered real estate for registration purposes. Registration of rights over such facilities takes place in accordance with the rules in the Real Estate Registration Act, section 19, subsection. 1, 2. Pkt." (VE Lov, 2018).

- Article 6(3) and (4) (of the Habitats directive) have been implemented Sec. 27 of the RE Act linking the Natura 2000 assessment requirement to the Sec. 25 permit for establishment.

- Bekendtgørelse (Executive Order) nr. 68 af 26. januar 2012…EIA for projects on the establishment of electricity generation plants at sea (DKEF, 2012).

- Executive Order on Impact Assessment regarding international nature conservation areas as well as protection of certain species in projects concerning the establishment of electricity generating facilities and electricity supply networks at sea (DKEF, 2010).

- Executive Order 408/2007 is the designation of Natura 2000 areas

**Scotland:**

- Electricity Works (EIA) (Scotland) Regulations 2017 = for all s. 36 consent in Scottish waters up to 200 nm.

- Section 36 Consent (Scotland) for wind power planning (for projects 1 MW in inshore waters, 50 MW further offshore).

- Regulation 8 of The Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2017 = for projects out to 0 - 12 nm.

- The Marine works (Environmental Impact Assessment) (Scotland) 2017 = projects that require an EIA for a marine license from 12-200 nm.

**Sweden:**

- Chapter 6 section 36 of Miljöbalkan is the section describing requirements you need for the case to be tried in environmental court of the Environmental Code.

- Chapter 7 Section 28 and 29 permit is the permit needed for works that may disturb an environment in a Natura 2000 area.

- Areas of importance in accordance with the Chapter 3 Section 9 Environmental Code.

- "16 § i förordningen (1998:1252) om områdesskydd enligt miljöbalken" is "Section 16 of the Ordinance (1998:1252) on area protection in accordance with the Environmental Code".

- Chapter 8 Section 4 on National Interests of Natura 2000

- Chapter 35 section 6 according to the options for different technology, size, scope, placement, restrictions due to influence of environmental effects.

### 8.2.3 Physical Planning Laws and Policies

Relevant Chapters of these are found in the Appendix. Physical planning law pertains to what laws must be abided by for the correct and just placement of offshore wind turbines.

**Germany:**

- WindSeeG (Gesetz zur Entwicklung und Förderung der Windenergie auf See) is the Offshore Wind Energy Act (aka Law on the Development and Promotion of Wind Energy at Sea). Such as Part 2 Section 1 (Chapter 4) outlining the purpose of the area development plan.

**Denmark:**

- Section 22 & 25 of Promotion of Renewable Energy Act (Energistyrelsen, 2009)...regarding Natura 2000 assessment requirements.

- Section 22a of the Electricity Supply Act (DTBM, 2013).

- Permits required for planning (Energistyrelsen, 2020):

    - Licence to conduct preliminary investigations

    - License to establish the offshore wind turbines (only given if preliminary investigations show that the project is compatible with the relevant interests at sea).

    - License to exploit wind power for a certain number of years, and an approval for electricity production (given if conditions in license to establish a project are kept).

**Scotland:**

- Maritime Spatial Planning Directive, Marine and Coastal Access Act 2009, Marine (Scotland) Act 2010) (Marine Scotland, 2018a).

- Sectoral Marine Plan: Regional Location Guidance (Marine Scotland, 2020a). The Scottish Government's policy on offshore renewable energy development, allocating areas at sea. The plan must be taken into account when consents are determined.

**Sweden:**

- Tillstånd till vattenverksamhet enligt miljöbalken för nedläggande av exportkabel innanför Sveriges territorialgräns (tillståndsansökan kan även komma att omfatta frivilligt tillstånd till åtgärder på land enligt 9. kap. miljöbalken) is the Permission for water works within the environmental code for laying of export cable inside Sweden's territorial boundaries.

- Tillstånd till etablering av vindkraftparken i Sveriges ekonomiska zon enligt lag (1992:1140) is "Permission for establishment of wind park in Sweden's economic zone"

- Inför ansökningarna om tillstånd samråder nu OX2 enligt 6 kap 29–32 §§ miljöbalken is "Before applying for a permit consult OX2 enligt 6 chapter 29–32 §§ Environmental Code".

- Tillstånd enligt 7 kap. 28 a § miljöbalken till åtgärd som på ett betydande sätt kan påverka miljön inom ett så kallat Natura 2000-område is the "Permit according to chapter 7, section 28 of the Environmental Code to a measure that can significantly affect the environment within a so-called Natura 2000 area".

- Tillstånd till utläggning av internt kabelnät respektive export kabel enligt lag (1966:314) om kontinentalsokkelen is the "Permission to lay internal cable network and export cable in accordance to the Law on the Continental Shelf".

- Ansökan om nätkoncession för linje enligt el-lagen (1997:857) is the "Application on the net concession for line according to the electricity law".

- MIlitary interests: Chapter 3, section 9 of the Environmental Code and locations covered in secrecy according to Chapter 15, Section 2 of the Public Access to Information and Secrecy Act (OSL 2009: 400)

## 8.3 Appendix 3: Requirements for an EIA in each of the countries

**Germany:**

According to Section 2a Clause 1 of the SeeAnlV, an EIA must occur in accordance with the Environmental Impact Assessment Act of 2001 (UVPG, Federal Law Gazette I, p. 2350) (BMU, 1997), if a project plans to have more than 20 turbines (which is the threshold value according to the UVPG law) and a negative impact on the environment (BJV, 2001).

**Denmark:**

According to section 2 of the VVM law, "An EIA must be available before permission is granted for the following projects, when they are assumed to have a significant impact on the environment: Projects on establishment of electricity generation plants that utilize water and wind, as described in section 25, subsection 1 of the Act on the Promotion of Renewable Energy".

**Scotland:**

The potential impact of a wind power development in Scotland is tested according to a Habitat Regulation Assessment (HRA) and undertaken by the developer (The Crown Estate, 2021). The HRA begins with a screening process to determine the "Likely Significant Effects" of a project on the

United Kingdom's network of special Natura 2000 sites. If deemed appropriate, the Scottish Government undergoes a "Appropriate Assessment" (AA), to see if there is an 'adverse effect on site integrity and key features' identified in the HRA. The "features" include key species and mitigation impacts, which are reported to Marine Scotland Science for further investigation (Milne, 2021, pers. comms.). If no adverse effect is determined, the Crown Estate can issue seabed rights (called an Agreement for Lease). If an adverse effect is determined, alternative solutions must be investigated.

**Sweden:**

In Sweden, the Environmental Code details the conditions for evaluation of protection of a Natura 2000 area if needed:

> **"**I 7 kap. Section 28 b MB states that a permit pursuant to section 28 may only be granted if the activity or measure alone or together with other ongoing or planned measures does not:
> 1. damage the habitat or habitats of the area intended to be protected,
> 2. cause the species to be protected to be exposed to a disturbance which may significantly impede the conservation of the species in the area kap. Section 29 of the Environmental Code states that, despite the provisions of section 28 b, permits pursuant to section 28 a may be granted, after the Government's permission, if:
>
> 1. there are no alternative solutions
> 2. the activity or measure must be carried out for overriding reasons such as a significant public interest and
> 3. the measures necessary to compensate for lost environmental values are taken so that the purpose of protecting the area concerned can still be met".

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