GAP ANALYSIS

RULES AND REGULATIONS

DECOM TOOLS **2022**

Interreg
North Sea Region
Decom Tools
European Regional Development Fund

EUROPEAN UNION

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1. Introduction

Decommissioning is an important subject to address for the future of offshore wind parks in terms of sustainability. Like any large operation, decommissioning requires clear and strong regulations. In this gap analysis we will focus on international and national regulations, but not only regulations at large will be the focus: dismantling and repowering are also on focus in this discussion. We will start by first painting a picture of the national and international landscape regarding decommissioning and its regulation.

Before addressing regulations governing the dismantling and decommissioning of offshore wind energy structures, it will be important to highlight the differences between onshore and offshore electricity grids, as countries' rule making and rule enforcement competency differ between on- and offshore scenarios.

Onshore, the competence to make rules and to enforce them derives from the territorial jurisdiction of which a country has the competence to rule over all activities that take place on their territory.

Offshore, the rules on jurisdiction over different activities at sea are more international. They can, for example, be found in the so-called law of the sea. This legal commitment proved the starting notion of a coastal country's territory at sea. The United Nations Convention on the Law of the Sea, which was ratified and entered into force on the 16th of November 1994, also included an "Exclusive Economic Zone". A much wider range then the traditional known borders.

With the offshore situation in mind, a better understanding of rules and regulations in the use of the zones was required. To this end, understanding national and international regulations governing offshore electricity structures/plants in the North Sea region was necessary. More specifically, a more comprehensive approach to the different areas such as a territorial zone, exclusive economic zone and international waters was needed to understand who is responsible for issuing regulations and enforcing them. In this document, we will give attention to the different outcomes of the coastline nations and their interests along the North Sea Region.

By focusing on these different outcomes, we will try to unravel discrepancies to find the gaps between current regulations and required/desired regulation and produce a gap analysis. This in turn is meant to help in the search for a common ruling relating to the approach of wind park decommissioning in the coming future as it will be more of an international operation than a regional one. A lot of experience has already been acquired by companies working in the oil and gas industry. Building on this know-how is key for the development of business cases for the decommissioning of offshore wind parks.

2. International regulations

2-1 Introduction

Several international and regional agreements apply when it comes to the decommissioning of offshore wind structures. The two most important agreements applicable for the North Sea are:

- UNCLOS the "United Nations Convention on the Law of the Sea"
- OSPAR "the Oslo and Paris Conventions", covering the Northeast Atlantic.

Both agreements cover all potential wind farms subject for this report.

2-2 UNCLOS (United Nations Conventions on the Law of the Sea)

Originally, the Law of the Sea Convention (December 10, 1982) was intended to provide a comprehensive legal framework for the use of the oceans. As a result, the Law of the Sea Convention mainly contains general rules which are lacking for more specific scenarios. Several existing treaties, such as MARPOL or the OSPAR Convention, can be seen as a further elaboration of the general rules contained in the Law of the Sea Convention.

Under the United Nations Convention on the Law of the Sea (UNCLOS, 1982), territorial waters are seen as an extension of a nations' sovereignty into the sea. The limit of the territorial waters is 12 nautical miles from the coast of a nation, including seabed and subsoil. The full territorial sovereignty is extended from a Country's land to the territorial waters.

When it comes to the competence to make rules and enforce them, one can look at the 1994 law of the sea (UNCLOS under IMO). In 1994, UNCLOS was ratified between nations international regulations and national regulations. UNCLOS explains why territories and territorial waters, exclusive economic zones and international waters are interlinked.

The international agreement defines the rights and responsibilities of nations with respect to their use of the oceans. It contains guidelines for business, the environment, and the management of marine resources. One article is particularly interesting for decommissioning.

Article 60 states that, regarding installations and structures in the exclusive economic zone: "any installations or structures which are abandoned or disused shall be removed to ensure safety of navigation, taking into account any generally accepted international standards established in this regard by the competent international organization. Such removal shall also have to regard fishing, the protection of the marine environment and the rights and duties of other countries. Appropriate publicity shall be given to the depth, position and dimensions of any installation or structures not entirely removed".

Paragraph 4, of the Convention provides that appropriate measures can be taken within the safety zone to ensure the safety of both shipping and the installation. This safety zone is a maximum of 500 meters from the outer edge of the installation. The option offered by

international law to establish a safety zone at sea around a wind farm is included in Article 6.10, second paragraph of the Water Act.

The IMO (International Maritime Organization) is the aforementioned “competent international organization”. The IMO requires that the coastal country which has jurisdiction ensures that the abandoned offshore installations are decommissioned as soon as reasonably practicable and that, by default, the structures are removed entirely, in line with international agreements. Removal should be performed in such a way as to cause no significant adverse effects upon navigation or the marine environment.

For international regulation and decommissioning of offshore structures, the UN and IMO have laid down a set of rules and regulations:

After 1998, all installation in shallow waters (less than 100 meters from shore) and all installations weighing less than 4000 tons in air should be entirely removed.

In certain cases, it may be permitted to allow structures to remain at least partially in place if the removal processes are likely to cause more environmental damage than leaving them on site. In practice this condition is most likely to apply to piles, to buried cables, and to some scour protection. The decision on whether parts of a structure can remain is to be evaluated by the coastal Country with jurisdiction over the installation or structure on a site-by-site basis, according to the guidelines and standards set out by the IMO.

The coastal Country should make sure that the remaining structures are indicated on nautical charts, etc. and that the remaining materials will not move to prevent potential navigational hazards. The coastal country should also identify the party responsible for the remaining installation.

The UN Convention on the Law of the Sea of the United Nations distinguishes between sea inside and outside the jurisdiction of coastal countries. The North Sea falls entirely within the jurisdiction of the surrounding coastal countries. The boundaries were set out in a treaty with Countries surrounding the North Sea area in 1958.

While not technically sovereign land, the exclusive economic zone is the area of sea between 12 nautical miles and 200 nautical miles from a nations’ shore. This zone does not exist automatically but must be claimed by a coastal country. Claiming an EEZ gives coastal countries the right to exclusive economic exploration and exploitation of the natural resources in the waters, seabed and subsoil of that area. Claiming an EEZ does not lead to full sovereignty over this area, but only functional jurisdiction over the activities related to economic exploration and exploitation of natural resource e.g., wind. Beyond 200 nautical miles is considered international waters.

Within the exclusive economic zone, a nation has “sovereign rights for the purpose of exploring and exploiting, conserving and managing the natural resources” (art. 56.1(a)). However, coastal nations are not entirely sovereign and activities such as the decommissioning of energy installations is governed by the regulations of the International Marine Organization (IMO).

For territorial waters and exclusive economic zones, national and international laws are applicable, but national regulations must comply with international regulations. On the other hand a coastal country can issue stricter regulations than the international regulations.

2-3 OSPAR

The Oslo and Paris Convention (OSPAR, 1998) is an international convention for cooperation in the marine environment between the fifteen governments that surround the Northeast Atlantic. It provides an overarching legal framework for the protection of the marine environment in the North-East Atlantic region, which also includes the North Sea. The OSPAR Convention entered into force in 1998 with the aim of working together to protect the seas and, in turn, safeguard human health.

It contains the following parts which are especially relevant when it comes to decommissioning:

- Decision 98/3 on the disposal of disused offshore installations in the O&G sector
- Guidance on Environmental Considerations for Offshore Wind Farm Development

In the so called "guidance for Environmental Considerations for Offshore Wind Farm Development", we find the following information: "In line with OSPAR's policy on waste disposal at sea, the removed components of an offshore wind farm should generally be disposed of entirely on land taking into account the waste management hierarchy of avoidance, reduction, re-use, recycling, recovery and residue disposal. If the competent national authority decides that a component of the wind farm should remain at site, it should be ensured that they have no adverse impact on the environment, the safety of navigation and other uses of the sea. The status of remaining parts should be monitored and if necessary, appropriate measures should be taken."

For submarine cable systems that are redundant or have been taken out of service (OOS), the International Cable Protection Committee Countries, in relation to their Recommendation #1 for submarine cable installation, protection and maintenance, state that "under UNCLOS and customary international law" there is no requirement for the removal of OOS cables. If a coastal nation requires removal of undersea cables outside its territorial seas, cable owners need to request the jurisdictional basis. In the absence of a valid jurisdiction requirement, such a requirement is a violation of international law and may be challenged."

Next, focusing on financial assurance, the guidance piece continues: "In line with the polluter pays principle, the licensee or, if deemed appropriate, another suitable body should ensure that adequate financial reserves (e.g., bonds) are available to enable the appropriate removal and subsequent disposal on land (in the sense of the waste management hierarchy). Furthermore, the licensee should bear any costs for necessary monitoring of the status of components which remain at the site and costs for any associated necessary measures."

2-4 MARPOL

The International Convention for the Prevention of Pollution from Ships (MARPOL) is the main international convention covering prevention of pollution of the marine environment by ships from operational or accidental causes. Although not directly applicable to windmills, it is of interest because of the use of sea vessels in the decommissioning process. The use of ships could lead to the pollution of the surrounding sea, highlighting the importance of taking MARPOL into consideration.

Codes for design and construction standards have been developed by the IMO for the offshore wind sector. There are also equivalent arrangements in the convention for vessels of special design, construction or service and for which the requirements of the conventions are not considered to provide a sufficient international standard. These equivalent arrangements include alternative design and construction standards in addition to operational controls.

These are:

The International Code of Safety for High-Speed Craft (HSC Code). These are capable of operating at planning speeds (and are generally light constructed relative to conventional vessels). Provision is made for both cargo and passenger craft.

Code for the Construction and Equipment of Mobile Offshore Drilling Units (MODU Code) Recommended code for application of mobile offshore drilling units, including self-elevating (jack-up) and column-stabilized (semi-submersible) units.

Code of Safety for Special Purpose Ships (SPS Code) Recommended code application for vessels of unusual design and operational characteristics carrying special personnel who are neither members of the marine crew nor passengers and are carried on board in connection with the special purpose of that ship or because of special work being carried out aboard that ship.

2-5 Conclusions

Although laws complying with the preservation, accessibility and regulation of structures in the North Sea are not specifically written for the offshore wind industry, these regulating rules can be applied to it as they address the same issues.

All nations surrounding the North Sea have ratified the international laws as described in this document by importing them in domestic laws, rules and regulations. In such there are no discrepancies between the different nations on the basic requirements regarding decommissioning.


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3. National regulations

3-1 Introduction

Based on the international laws and agreements the countries have adapted their own national regulations. Aware of the fact that the decommissioning is a global issue, more than a local one, trying to find a common mode is ever more important. This means taking a closer look at the national regulations surrounding decommissioning and subjects relevant to decommissioning for the countries Denmark, Germany, The Netherlands, Belgium, Norway and The United Kingdom. They compare them to find discrepancies to be aligned to a comprehensible approach.

3-2 Denmark

The Danish Energy Agency is responsible for the regulation of offshore windfarms including development and decommissioning in Denmark. The Danish regulations for offshore windfarms are found in *The Law of Renewable Energy and Law of Electrical Distribution.*

The Law of Renewable Energy and Law of Electrical Distribution

The Electricity Supply Act (Consolidated Act No. 119 of 6 February 2020) and the executive orders issued thereunder are the regulatory framework applicable to developing, financing, operating and selling power in the renewable energy market, and implement the Renewable Energy Directive.

The Electricity Supply Act regulates the production, transport, trade and supply of electricity. The purpose of the Electricity Supply Act is to ensure that the supply of electricity is organised and implemented in the interests of security of supply, economics and the environment, and in order to protect consumers and secure equal access to low-priced electricity.

3-3 Germany

Germany has various systems in place that relate to the decommissioning of offshore windmills, such as:

- WindSeeG,
- 2017 Energy Act
- EIA Act.

WindSeeG

The Bundesamt für Seeschiffart und Hydrographie (BSH) (Federal Maritime and Hydrographic Agency) is the national level authority responsible for managing the development of offshore wind farms in German waters. 2017 marked a systemic change in the German offshore wind energy sector appointing BSH to undertake the task of central development and the investigation of sites for the construction and operation of offshore wind turbines. This is based on the Offshore Wind Energy Act – WindSeeG concerning the development and promotion of offshore wind energy.

Energy Act 2017 and EIA Act

The renewable Energy Act of 2017 and the Act Concerning the Environmental Impact Assessment (EIA Act) are also applicable for the site development and decommissioning of offshore wind farms.

The Bundesamt für Seeschiffart und Hydrographie (BSH)

The Bundesamt für Seeschiffart und Hydrographie (BSH) (Federal Maritime and Hydrographic Agency) is the national level authority responsible for managing the development of offshore wind farms in German Waters.

The BSH is responsible for the approval process for construction and operation of installations in the German EEZ but the BSH is not responsible for onshore elements of wind farms. The BSH issues and approves according its own design standards, the key standards are:

- "Standard Design of Offshore Wind Turbines" – this standard is intended to provide legal and planning security for development, design, implementation, operation and decommissioning of offshore wind farms within the scope of the Marine Facilities Ordinance.
- "Standard for environmental impact assessment (STUK4)". Within the framework of the approval procedure for offshore wind farms in the EEZ, potential adverse impacts of the planned facilities on the marine environment have to be assessed.

The STUK4 clearly states that "The wind turbines including their foundations have to be removed completely, with subsequent onshore disposal". However, in practice foundations can be allowed to be cut off to a depth that "will ensure remaining stumps are not exposed". The exact specification is likely to vary on a case by case basis but the principle is that foundations can be cut at a certain level below the seabed.

Regarding subsea cables, the Marine Spatial Plan requires pipes and cables to be decommissioned or removed after their use, unless the removal will cause more significant environmental effects than the abandonment and causes no impact to security or maritime traffic.

3-4 The Netherlands

Regulations for decommissioning of offshore wind farms in the Netherlands are set under different laws, decrees and regulations.

These are:

- The Offshore Wind Energy Act
- Regulations on implementation of offshore wind parks
- The Water Law Act
- The Water Decree
- The statutory act establishing an exclusive zone
- Nature Conservation Act

The Offshore Wind Energy Act

The Offshore Wind Energy Act provides an integral legal framework for the large-scale realization of offshore wind energy. The Offshore Wind Energy Act entered into force on 1 July 2015 and was amended in 2018.

The Act was implemented to simplify and accelerate the decision-making process for the realization of offshore wind projects in an effort to enable the country to meet its 2020 renewable energy targets.

Under the Act, the government takes over responsibility from offshore wind project investors regarding spatial planning arrangements and environmental assessment of the proposed plants. Additionally, the Act stipulates, that the responsibility for offshore grid connection falls on the government, not on the project developer. As a result, the government is responsible for choosing a location for the proposed plant and must assure that construction and operation of the plant is aligned with all governmental institutions and that it will receive grid connection. Project developers are obligated to obtain a permit for the realization of the project. Under the new law, participation of the project in the offshore wind tender is considered a part of that process.

The Water Control Act

The Water Act mainly regulates the management of water systems, including flood defences, surface water and groundwater bodies. The act is aimed at preventing / limiting flooding and water scarcity, the protection and improvement of the quality of water systems and the fulfilment of social functions by water systems.

The “Wet Beheer Rijkswaterstaat werken” (Water Control Act, part of the “Waterwet”) also contains rules for substructure removal. The regulation requires removal of the installation as to “not hinder other use or disrupt the environment”.

The Water Decree

A Decree (30 November 2009) containing rules on the management and use of water systems. In this Decree, general rules for the construction, operation and removal of wind farms at sea are included in Articles 6.16a to l.

This decree contains:

- The statutory act establishing an exclusive zone
- The Kingdom Act establishing an exclusive economic zone establishing an exclusive economic zone of the Kingdom for increased protection and better preservation of the marine environment (27 May 1999).
- Nature Conservation Act
- A law (16 December 2015) containing rules for the protection of nature (Nature Conservation Act.

This act contains:

- The implementation regulation for wind energy at sea
- The regulation of the Minister of Economic Affairs of 30 June 2015, no. WJZ / 15083277, containing rules for the implementation of the Offshore Wind Energy Act (Offshore Wind Energy Implementation Regulation)

3-5 Belgium

The national, regional and local legislative guidelines that are in place in Belgium provide the framework for the 3 required permits linked to an offshore wind farm. These permits are:

- the domain concession (linked to the turbines and OHVS),
- the marine protection authorization (linked to all structures and cables at sea)
- the submarine cable license (linked to all submarine cables).

EEZ act

The EEZ act comprises, among other subjects, the abandonment of installations or structures in the 'Exclusive Economic Zone (EEZ)'. The act states that disused infrastructure in the EEZ must be removed in order to secure safe shipping. In addition, all abandoned installations must be removed entirely if water depths are less than 75 meters and if the installations weigh less than 4000 tons (dry weight and excluding superstructure/deck area). These conditions are true for every offshore wind turbine in the Belgian EEZ. This act thus extends the UNCLOS decree for the Belgian EEZ.

Appointing responsibilities: Domain concession Royal Decree

The domain concession royal decree defines the conditions of being awarded a domain concession as well as the responsibilities of the holder of the domain concession with respect to the decommissioning aspects. The decree also defines the duration of the domain concession (i.e. maximum 20 years). The holder of the domain concession is responsible and required to secure and remove all infrastructure in the concession at the time of disuse. The decree allows for the use of novel decommissioning technologies subject to an agreement of the residing minister.

Marine protection and environmental impact Royal Decree

The marine protection authorization is a requirement for any offshore commercial structure and is defined in the marine protection Royal decree. This decree sets regulations for the protection of the marine environment and with the purpose of restricting and preventing marine pollution. The Act applies to vessels, vehicles, platforms etc. operating in the Belgium maritime area and implements the requirement for compliance on their machinery and equipment which may eventually pollute the sea. The requirements in order to obtain a marine protection authorization are stated in the 'environmental impact assessment' (EIA) Royal decree. Following a successful application of a marine authorization, the conditions with respect the monitoring tasks safeguarding the marine environment are defined.

Submarine cable Royal Decree

The decree specifically stipulates what the requirements and responsibilities for the installation of a submarine cable are. Generally speaking, new submarine cables must be laid as close as possible to existing installations and in such a way as to minimize the impact on the sea floor. However, no technical requirements are presented on the removal of disused submarine cables. Thus, practically the removal of submarine cables is only governed by the requirements of the marine protection authorization.

3-6 Norway

The Oil and Energy Ministry are responsible for the regulations of offshore wind farms. They have previous experience in the decommissioning of offshore oil and gas installation. The Norwegian regulations for offshore windfarms are found in the Offshore Energy Act.

There are:

- the offshore Energy Act
- the Petroleum Act
- the Pollution Control Act

The Offshore Energy Act.

The Offshore Energy Regulations were finalized on June 12, 2020 and entered into force on January 1, 2021. The Regulations describe the licensing process in detail, licences can only be obtained after the central government authorities have carried out a strategic environmental assessment and decided to open specific areas for license applications.

In addition to international regulations and the Offshore Energy Act, Petroleum Act and Pollution Control Act are relevant documents relating to the decommissioning of the offshore wind structures.

The Petroleum Act

Under this act, a plan for decommissioning must be submitted to the oil and energy department between two and five years before the oil production license expires, this plan consists of an impact assessment and plans for disposing of installations, including costs and environmental consequences. Decommissioning plans must consist of two parts, a disposal section, and an impact assessment, as set out in sections 43–45 of the Petroleum Regulations. The Climate and Pollution Agency is one of the bodies consulted in these matters and can provide input on ways of reducing pollution. Activities that may result in pollution during offshore dismantling and that are not covered by the general permit for the field must be dealt separately by the Climate and Pollution Agency.

Pollution Control Act

An onshore decommissioning yard for offshore installations is classed as a waste treatment plant and is therefore required under section 29 of the Pollution Control Act. When the pollution control authority decides whether to issue a permit or lay down conditions in a permit, it is required to consider any pollution-related nuisance. An overall assessment of all

advantages and disadvantages of the project is required. All releases of pollutants that may cause health or environmental damage are thoroughly assessed.

Other factors that must be closely monitored at decommissioning facilities include noise and releases to air in connection with metal cutting and other operations. Decommissioning contracts must ensure that the costs of handling hazardous waste are met by the offshore operators.

3-7 United Kingdom

In addition to international regulations, the most relevant documents relating to the decommissioning of offshore wind structures in the UK are:

- Energy Act 2004 and amendments made in Energy Act (2008)
- The Crown Estate (TCE) Lease.
- Planning consent.
- Marine licenses.

Energy Act 2004 and amendments made in Energy act (2008)

The Energy Act 2004 regulates all commodities concerning energy sources and management of these sources, including wind energy.

Chapter 3 gives rules and regulations on the decommissioning of offshore installations as windmills and powerhouses.

Department of Energy and Climate Change Guidance Note: "Decommissioning of offshore renewables energy installations under the Energy Act (2004)": guidance notes for industry": This Guidance notes to assist businesses in understanding their obligations in decommissioning offshore renewable energy installations.

The Crown Estate (TCE) Lease.

The Crown Estate owns much of the seabed in UK Waters and has the right to lease renewable energy activity out to EEZ. The UK Government and the Crown Estate work together to avoid any duplication with developers only required to submit one decommissioning plan, one financial security with no additional provisions provided by The Crown Estate.

It is worth mentioning that, whilst legislation is common throughout the UK, different regulatory bodies are responsible for issuing consents and applying decommissioning regulations. These bodies may apply the regulations differently depending on their policies.

Planning consent

Before constructing an offshore wind farm, planning consent is required from the relevant competent authority. Decommissioning requirements for onshore works are covered within these planning documents and are in line with standard onshore licensing conditions.

Marine licenses

A specific license is required to deposit, construct or remove anything from the seabed. This license is referred to as Marine License and for offshore wind is granted as part of the planning consent process.

- Specific guidance and regulations in Scotland:
- Scotland Act 2016 [1]
- Offshore renewable energy: decommissioning guidance:

Scotland Act 2016

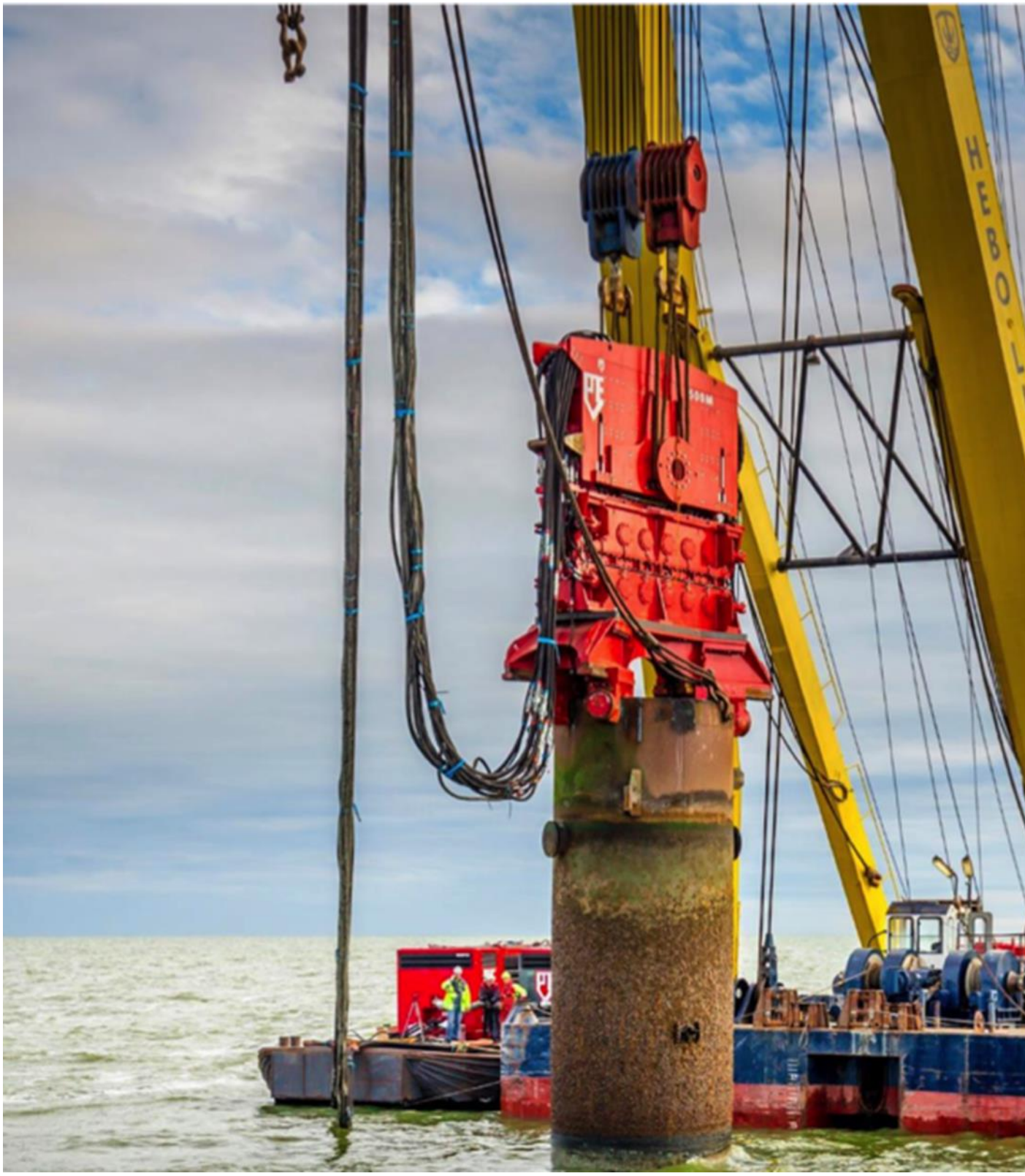
The Scotland Act 2016 amends various provisions of the Energy Act, effectively making the Scottish Ministers responsible as the 'appropriate Minister' (instead of the Secretary of State for the Department for Business Energy and Industrial Strategy ("BEIS") (the "Secretary of State")) for the administration of the decommissioning scheme which governs offshore renewable energy installations in Scottish waters on or after 1 April 2017. In Scotland, the Marine Scotland is responsible for both decommissioning and consenting aspects of OWFs in Scottish waters.

Offshore renewable energy: decommissioning guidance

Scottish guidance has been drafted for those installations, as well as any legacy installations which have transferred to Scottish Ministers in accordance with the memorandum of understanding between Scottish Ministers and the Secretary of State. The UK Government has produced separate guidance to cover decommissioning of installations in English and Welsh waters.

3-8 Conclusions

Considering all the legislation that is based on domestic and local laws of the countries, we can state that it is in line with the global treaties and agreements made between countries. Although small differences exist locally, most rules are on the same level. When decommissioning is eminent, companies will not have great difficulty to meet the demands put down in legislation.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4. Governing dismantling

4-1 Introduction

Governments, confronted with offshore wind parks, have tried to regulate the decommissioning. The basis for the different rules and regulations are being derived from earlier experiences with decommissioning of oil and gas rigs. Furthermore the decommissioning of onshore wind parks have given a reasonable insight in the way the offshore industry should handle the end of life of offshore wind parks. Paying extra attention to the time scale and the potential financial hazards in order to enhance securities.

Based on Environment Impact Assessments, mandatory in normal projects, a set of rules is adopted to guarantee minimal disruption of the environment at the scene during decommissioning. In this chapter the different measures and approaches of the countries surrounding the North Sea have been assembled to set boundaries and to address a common strategy for a sustainable way of removing the installation.

4-2 Denmark

Denmark has no specific decommissioning regulation or guidance note, but the concessionaire is legally obliged to restore the area to its former condition and to decommission the offshore wind farm in accordance with a plan approved by the Danish Energy Agency. Precedent is set and contained within the contract terms, part of the tender documents, that grant the developer rights to develop an offshore wind farm. However, a wind farm owner must present a decommissioning plan no later than two years before the end of a license. The decommissioning plan must contain an EIA (Environment Impact Assessment), an account of the removal of the offshore wind farm, an assessment of the plan's environmental, a safety related impact and the decommissioning schedule.

In previous projects, the decommissioning of the plant and a requirement "to restore the area to its former condition and to decommission the plant to a plan approved by the Danish Energy Agency" were explicitly mentioned in the tender. Furthermore, the concessionaire has to provide a guarantee document covering the dismantling of the plant in advance. The guarantee must be provided no later than 12 years after the first turbine is connected to the grid. Six months prior to this, the Concessionaire must submit a plan to the Danish Energy Agency with details of how the guarantee is provided.

The Concessionaire is obliged to carry out the necessary remediation and clean up in the area, as well as to decommission and dispose the electricity production power plant in accordance with the decommissioning plan approved by the DEA. The concessionaire must submit a plan for decommissioning the wind turbines and the cable links between the turbines no later than two years before expiry of the electrical production license or if one or more facilities are expected to have served their purpose. The concessionaire must also follow any regulations on EIA's in force at the time of decommissioning and submit a detailed assessment of any environmental impacts entailed by the decommissioning plan.

If only partial removal of the plant is required, this may be accompanied by a requirement that no remaining parts of the foundations become exposed as a consequence of natural, dynamic changes in the seabed sediment.

It should also be noted that, when using specific technology and practices, it is expected that the best available technology and environmental practice will be used to remove the plant.

4-3 Germany

In the Site Development Plan, the obligation to dismantle and security deposit are applicable to the decommissioning of offshore windfarms. Quote from the document: "After ceasing utilization, the offshore wind turbines, platforms and submarine cables should be dismantled". (*chapter 4.4 Planning Principles section 4.4.1.5)*

Should the dismantling pose greater environmental consequences than leaving the equipment, dismantling should not take place, or not to the full extent, unless it is required due to reasons of safety and ease of traffic. Should the equipment remain, suitable monitoring measures are to be taken concerning possible future hazards. If dismantling takes place, reuse of the components should be the aim before recycling, and recycling before thermal recycling or any other – proven – appropriate waste management on land. An assurance must be provided to meet the dismantling obligation.

The spatial planning guideline stipulates that stationary uses must be reversible. Examples including offshore wind turbines, platforms and submarine cable systems must be dismantled after their use has been discontinued. Looking at the structures from above, it is apparent that it is not necessary to completely remove the foundations for reasons of safety and traffic efficiency. Removal could have a greater impact on the marine environment than partial removal. However, dismantling must be carried out to such an extent that the upper edge of the remaining foundation lies below the moving lower edge of the sediment and below the area of contact with fishing gear. Leaving components in situ will require to take appropriate monitoring measures to ensure that there will be no risks for other uses, navigation and fishing in the future. This rule is in line with international regulations (UNCLOS).

- Concerning these acts, two different documents are especially relevant:
    - Standard Design
    - The connected technical codes of practice.

Standard design

The document "Standard Design. Minimum requirements concerning the constructive design of offshore structures within the Exclusive Economic Zone" concretizes several requirements for offshore structures.

Section 2.6 of the document deals with the decommissioning phase. When operations cease, the offshore structures generally have to be decommissioned. This requires a detailed plan to be drawn up and a verified version presented to the BSH for approval. The objective of the decommission instruction manual is to provide a plausible representation of all the processes involved and the condition for technical boundary.

The objective of the decommission instruction manual is to provide a plausible representation of all the processes involved and the respective technical boundary conditions. In addition, all "Technical codes of practice" are referenced. Furthermore, it is defined that all equipment, processes or materials used for the offshore work must comply with the German or European standards, regulations, etc. with regard to safety and environmental compatibility.

The technical codes of practice

The main technical code is DIN EN 1997 (EC7), with all references to design-specific characteristics of foundation elements. The requirements, verifications and documents to be submitted are based on project-specific requirements of previous releases, permits, approvals and orders of the BSH.

The following technical codes of practice, in their respective current version, as well as the current country of the art, shall apply:

- DIN EN ISO 19901-6 Petroleum and natural gas industries – specific requirements for offshore structures – part 6: marine operations
- DNV-OS-H101 DNV Offshore Standard, Marine Operation, General
- GL-IV-6 GL Rules for Classification and Construction, IV industrial services, Part 6 Offshore Technology
- API RP 2A-WSD American Petroleum Institute, Recommended Practice – Planning, designing and constructing fixed offshore platforms – working stress design
- GL-IV-2 GL Rules and Guidelines, IV industrial Services, Part 2 Guideline for the certification of offshore wind turbines
- DNV-OS-J101 DNV Offshore Standard – Design of Offshore Wind Turbine Structures
- DIN EN 1990 Basis of structural design
- ISO/DIS 29400 Ships and marine technology – offshore wind energy- port and marine operations
- Sections B2.6.4 and B2.6.5 list the documents that should be submitted to apply for the deconstruction permit and to complete the deconstruction phase. These include:
- Document Number Title/Description
- 260 Decommissioning instruction manual
- 261 Verification report pertaining to Doc. No. 260
- 262 Certificate of conformity pertaining to the decommissioning plan
- 263 Verification of the decommissioning depth to be obtained through suitable measuring procedures or a comparative assessment of the work logs, resp. daily reports
- 264 Confirmation of the appointed inspector with regard to the decommissioning work
- 270 Final as-built report
- 271 Inspection reports and certificate of conformity following the completion of the decommissioning work

While sections B4.6 (Decommissioning of Rotor/Nacelle) and B5.6 (Operation structure of offshore stations(topside)) refer to section B2.6, section B3.6 (Decommissioning of

foundation elements) describes the technical rules, requirements, and verifications as well as the documents to be submitted for decommissioning permits and final declarations.

4-4 Netherlands

Decommissioning should take place in accordance with a decommissioning plan which is provided by the wind park operator. The Directorate General for Public Works and Water Management (Rijkswaterstaat), the competent authority in relation to the Water Act, is responsible for the guidelines for decommissioning.

In accordance with the site decisions, decommissioning must be started within two years after the operation of the wind park is discontinued and must be completed ultimately 30 years after the date on which the wind permit has expired. The wind park operator is expected to provide a bank guarantee for decommissioning at the start of the construction of the wind park. This amount is annually indexed (resulting in an annual increase of 2% for the first 12 years). The amount and index are subject to a periodic review by the Minister of Economic Affairs.

In principle, old cables that are no longer in use must be removed. To do this, permits are granted (under the Mining Act). Exemption from this obligation can be granted where the benefits to society outweigh the costs. This removal obligation also applies to new control and telecommunications cables.

4-5 Belgium

Primary legislation in Belgium does not specify how offshore wind turbines must be decommissioned. The applicable framework is rather fragmented into e.g. Royal Decrees. The details of the articles in these decrees that specifically deal with the decommissioning of offshore wind turbines are detailed in this section.

Marine protection authorization

Articles in individual ministerial and royal decrees relevant to decommissioning offshore wind farms state that there is a firm requirement to restore the project site to its original condition (unless decided otherwise by the concerned minister). This restoration includes:

- The removal of the monopiles to a depth of at least 2 m below the seabed.
- The complete removal of both inter-array and export cables.
- The removal of wind measuring masts and other measurement infrastructure.
- The removal of OHVS stations.
- The recovery of all floating and sunken objects that ended up in the sea during decommissioning.
- The removal of all items that are part of the planned crossing arrangement.

In addition, the decrees state the need to form an advisory committee to coordinate and monitor the activity of the wind farm from start up to decommissioning. The committee needs to be composed of representatives of different federal public service agencies such as

Public Health, Food Chain Safety and Environment and MUMM.(*MUMM = the scientific service Management Unit of the Mathematical Model of the North Sea and is the scientific advice unit to the Minister for Marine Environment).*

Finally, the decrees state that at least 1 year before the decommissioning commences a restoration plan must be submitted to the advisory committee. The plan needs approval of the Minister for Marine Environment. No technical requirements or criteria on the contents of this plan are mentioned in the corresponding decrees. As such, a case-by-case evaluation of the decommissioning/site restoration plan is needed.

Financial provisions

The completion of the site restoration is determined by the release of financial securities by the concerned Ministers. The financial provisions are determined at the start of an offshore wind farm project and are set for both the domain concession (linked to the infrastructure), the marine protection license (linked to the foundations) and the submarine cable license (linked to the inter-array and export cables). The financial provisions can take different forms and can be settled in different manners. The raison d'etre for these financial provisions is that the concerned Ministers can rely on these provisions to ensure site restoration on behalf of the government in the event of non-compliance.

4-6 Norway

When decommissioning an offshore wind farm, the wind farm and old cables shall be removed. The holder of a license for energy facilities must submit a termination plan to the Oil and Energy Ministry in good time before the expiry of the license. The oil and energy department may waive the requirement for a termination plan.

4-7 United Kingdom

Consistent with IMO, the general idea in the UK is that installations should be completely removed and a decommissioning plan together with a financial plan should be delivered. Whilst recognizing there may be circumstances where parts may be allowed to remain, such decisions will be made on a case-by-case basis. Examples of where parts may be allowed to remain could be:

- Cables buried at a safe depth below the seabed where the potential impact of removal on the marine environment causes more damage or the financial costs of removal are excessive. Concerns may arise if the cables were to become exposed by natural sediment movements and potentially serve as a risk for fishing gears, anchors etc. The appropriate depth will depend on prevailing sea-bed conditions and currents. Cables left in-situ should be monitored beyond the life of the installation to assess the risk of cables becoming exposed after decommissioning. Contingency plans should be included in the decommissioning plan.
- Foundations and structures below seabed level. The installation's foundations extend some distance below seabed level. Removing the whole of the foundations may not be the best decommissioning option, given the potential impact of removal on the

marine environment, financial cost and technical challenges involved. The best solution might be to cut foundations below the natural seabed level at such a depth that any remains are unlikely to be come uncovered. The appropriate depth will depend on prevailing seabed conditions and currents. Contingency plans should be included in the decommissioning plan.

When it comes to scour protection materials, there may be a case for leaving them there. This could help preserve any marine habitat established over the life of the installation, where these materials do not have a detrimental impact on the environment, conservation aims, the safety of navigation and other uses of the sea.

4-8 Scotland

The decommissioning plan approval process in Scotland is different from those in other parts of the UK. For example, in Scotland, the decommissioning programme may be sent to the Scottish Parliament's Finance and Constitution Committee for scrutiny given that it has the potential. The decommissioning programme approval process depends on contingent liabilities and will only go to committee if the financial risk is above £2.5M. For the case of financial risk less than £2.5M, Scottish ministers can approve a decommissioning programme without the approval of the Scottish Parliament's Finance and Constitution Committee.

In Scotland, the decommissioning is an important issue and needs to be considered before the installation of OWF assets. This means that the owners/developers should provide the decommissioning programme when they seek approval for the installation. In other words, no installation operation will be allowed to start without an already approved decommissioning programme. They should also provide financial security alongside the decommissioning programme to protect the taxpayer against the possibility of having to pay for decommissioning in the event the developer/owner defaults on their obligations.

In Scotland, the Decommissioning programme consent process consists of 8 stages as follows:

Stage 1: Initial discussion between developer and Scottish Ministers:

The OWF developers should start to study the decommissioning of OWFs before the installation and consider the decommissioning costs. In order to ensure that the developers are familiar with their obligations regarding the different aspects of the OWF decommissioning, they should discuss their projects with the Scottish ministers. The decommissioning plan is a part of license approval for the OWFs in Scotland and should be submitted alongside the installation plans. The Scottish government has the power to forbid OWF installation projects to start until the decommissioning plan is fully approved by the Scottish ministers. Hence, the Scottish government will assess each OWF development project by considering their decommissioning attitudes. The draft version of the decommissioning programme of a new OWF should be submitted for approval at least 6 months before the start date of the OWF installation.

Stage 2: Issue of a Decommissioning Notice by Scottish Ministers

The Scottish government requires OWF developers/owners to submit the decommissioning programme as soon as possible. Hence, the developers/owners should start their discussion with the Scottish ministers as early as possible. Under the Energy Act, the Scottish ministers have the power to issue a notice for developers/owners to submit the decommissioning plan, which means that the OWF developers/owners must send the decommissioning programme in response to this notice.

Stage 3: Draft Decommissioning Programme

The decommissioning programme submitted in Stage 1 should be backed-up with an Environmental Impact Assessment (EIA) report, in which the expected environmental effects and the scale of decommissioning operations should be investigated and discussed in full detail. During the lifetime of the offshore assets, the OWF developers/owners should review and modify the EIA report in order to consider all potential risks of decommissioning to the environment at the end of the lifetime of OWFs.

Stage 4: Consultation with Interested Parties

The decommissioning operations of the OWFs can affect different parties. The Scottish government needs OWF developers/owners to be as transparent as possible in developing the decommissioning programmes. Therefore, these must be publicly available, and the developers/owners should undertake the required consultations with statutory consultees and interested parties provided by the Scottish government.

Decommissioning projects can potentially affect different industries and interested parties in many ways. Hence, the OWF developer/owners should discuss their decommissioning programs with the representatives of different parties, such as the fishing and shipping industries as well as other marine users. The list of consultees should be approved by the Scottish ministers. The developers/owners should consider the comments received from the interested parties as well as Scottish ministers during the review process of the decommissioning programme. This should be done by the explicit presentation of the addressed comments and related explanations in the draft version of the decommissioning programme.

The developers/owners need to submit the updated version of the decommissioning programme based on the aforementioned comments from the interested parties. Then, the Scottish ministers will consult the submitted updated version of the decommissioning programme with relevant Scottish Government Departments, the UK Government (BEIS) and the Crown Estate Scotland and provide a set of comments to developers/owners. The decommissioning programme should be updated based on the new comments received from the Scottish ministers.

Stage 5: Formal Submission and Approval of Decommissioning Programme

When the final draft of the decommissioning programme has been agreed upon with Scottish ministers, the developer/owner needs to formally submit it for evaluation. The submitted decommissioning programme is sent to Scottish Parliament's Finance and Constitution

Committee for scrutiny and debates in parliament, which means they can also provide some comments or reject the programme. The submitted decommissioning programme may be fully accepted, accepted under revisions, or rejected by the Scottish ministers. The Scottish ministers can also prepare another decommissioning programme themselves and recover the expenditure incurred from the owner/developer. The approved decommissioning programme should be made publicly available by the owner/developer. The developer/owner can redact the commercially sensitive contents in the decommissioning programme when they make it available to the public.

Stage 6: In-operation Updates and Reviews

The decommissioning programme will be reviewed by the Scottish Ministers from time to time. During the lifetime of the OWF, the owners/developers are responsible for regularly reviewing and modifying the approved decommissioning programme based on the obtained new information and any changes in market conditions, cost calculations, international standards, the regulatory regime, technology, and nearby infrastructure/navigational routes. For the OWF with more than 15 years of a predicted operational lifetime, the owners/developers need to prepare a "post-construction" report to Scottish Ministers no later than 1 year of installation, which should include any changes in decommissioning methods and costs.

During the lifetime of the OWF, the decommissioning programme should be annually reviewed by the owner/developers and changes should be reported to Scottish ministers. This is to make sure the financial security provision is on track to meet the expected costs of decommissioning.

Three years before the decommissioning start date, the owner/developer should perform more investigations on the environmental impact assessment and modify it if it is necessary. The final version of the decommissioning program should be submitted to Scottish Government at least 2 years before the decommissioning start date. These timings provide an opportunity for Scottish Ministers to assess the decommissioning programme against the latest environmental legislation.

Stage 7: Undertake Approved Final Decommissioning Programme

The final version of the decommissioning programme will be prepared after performing the reviews and consultations mentioned in Stage 6. For starting the removal operations, the owners/developers need to apply for the marine license from the Scottish Ministers. All asset removal operations should be in line with the fine decommissioning programme 35 initialized in Stage 6 and the owners/developers should convince Scottish Ministers. Using any Special Purpose Vehicle (SPV) for the decommissioning operations needs to be discussed with the Scottish Ministers as well.

Stage 8: Submission of successful post decommissioning report and conclusion of the Energy Act process

Once the decommissioning operations have been completed, the post decommissioning activities should be performed. The post decommissioning report needs to be submitted as a part of the Marine Licence obtained for the decommissioning project. The OWF site should be carefully monitored to identify any possible remains of the removed assets. The owners/developers should prepare a post-decommissioning report and send it to the Scottish Minister, in which the proposals for any required maintenance or remedial work after the decommissioning should be discussed. The post-decommissioning report should be verified by a third party and made publicly available.

4-9 Conclusions

Comparing the rules and laws of the different countries, it can be seen that each government has established some form of regulation regarding the decommissioning of the offshore wind industry. Most of the rules are related to economics, due to the costs of the process and the question of responsibility for the actual clean up when a park is to be dismantled.

Space is a rare commodity especially in the North Sea, with its dense shipping movements via lanes and the importance of the fishing industry. The oil and gas industry with its network of platforms, rigs, transport of gas and oil through pipelines can also not be overstated.

In that space several wind parks are built and even more are planned to fulfil the demand for electric power. Environmental issues make the urge to increase the power deliverance even more important.

Although ecological questions are part of the laws and regulations when building and maintaining these structures, it is not number one on the list. We are at the start of finding out the lasting consequences. Pollution is part of a long life strategy when these structures are in use over almost two decades. Disruption of the bottom area and the environmental hazards are still being researched. Different views on how to cope with it, when decommissioning a park, makes common legislation on the issue difficult.

More emphasis should be on recovery of the situation after decommissioning. Not for the sake of what was should be restored, but for the enrichment of the area with a stronger focus on bio-diversity.

At the moment costs and safety have the upper hand.

5. Repowering process

5-1 Introduction

Decommissioning has been defined as the process of dismantling the entire wind farm including removal of the foundations, removal of the wind turbines and cables, etc. However, some components of the wind farm usually have a longer lifespan. For instance, the foundations can last over 100 years (for gravity-based foundations) and the internal array and transmission cables can be used for more than 40 years. In addition, a two-year period of monitoring and remediation is required to ensure that the site returns to its pre-wind farm state. Hence, some wind farm owners may decide to repower the offshore wind farms to continue to use most of the original electrical system (and/or foundations) to install bigger wind turbines or change some components, such as drive trains or electronic devices which can improve the production efficiency.

The end-of-life scenario for offshore wind turbines can be summarized as life extension, repowering and decommissioning. Failure mode identification throughout the service life of an offshore wind farm is necessary for the end-of-life decision.

The two most commonly used repowering strategies are:

- partial repowering (refurbishment), the process of installing minor components within the wind farm such as rotors, blades, gearboxes, etc., which is similar to life extension.
- full repowering, which involves replacing the old turbines with newer, bigger ones to obtain higher energy efficiency.

Repowering is considered as an end-of-life decision for an offshore wind farm because it is sustainable and there is potential value in recycling or reusing the dismantled spares. It should also be considered that, by keeping the concrete structures under the sea, the least amount of damage is done to the marine environment.

Partial repowering shows only about 10% cost savings compared to full repowering, so it is not preferable unless advanced technology can be applied to promote generation efficiency or minimize operating costs.

Nevertheless, not all wind turbines will be decommissioned at the exact same time.

Full repowering, as research has shown, would be attractive after 20-25 years of operation. Before this time the benefits of repowering are insignificant.

A number of attributes are relevant in particular to repowering, such as:

- the cost of infrastructure,
- the environmental aspects,
- the regulatory framework,
- the logistics, insurance, etc.

An important issue when it comes to choices is the relation between energy production and additional investment. The replacement of just one wind turbine within a wind farm may cause changes in the wind conditions observed for the other wind turbines, due to changes in wakes. The wake losses in a mixed hub height wind farm should be estimated so that the profitability of the repowering decision can be properly analysed.

An offshore wind farm will normally be in operation for approximately 20 to 25 years (an offshore wind farm may operate for less than 20 years due to reasons such as wear and tear). After that, the wind farm owner should consider dismantling or repowering the wind farm. The potential of efficiency and sustainability when it comes to repowering would suggest that this would be the better choice. However, the conditions in each wind farm (wind condition, original wind turbine type, wind turbine layout, etc.) are different. Research is required to evaluate the profitability of repowering.

5-2 Germany

In the coalition agreement, the aim was to increase the share of renewable energies by 2030. In this context, it is not enough to realize the annual increase specified in the EEG. A greater effort is needed, including the repowering of wind turbines. According to the EEG, wind turbines built by the end of the year 2000 will lose their entitlement to reimbursement after the end of 2020. Turbines that cannot be replaced, are technically unsuitable for continued operation or are not economically viable must be successively dismantled without replacement. However, repowering is usually the aim. Repowering largely reduces the number of turbines, while the yield multiplies due to modern turbine technology. The guideline ("Regional Planning and Repowering - Planning Options") of the BWE (German Wind Energy Association) provides a number of instruments that politicians and authorities can use to enable and facilitate repowering. These include, for example, shortened distance criteria for replacement turbines or regional planning exceptions for repowering projects outside newly designated suitability areas. However, it is important to ensure that repowering is not supported at the expense of new planning.

Repowering is divided into site-maintaining and site-displacing repowering. According to BWE, site-maintaining repowering covers the dismantling of old wind turbines and the subsequent installation of new turbines on the original site areas or at a distance of no more than three times the rotor diameter. Site-relocating repowering merely ties the construction of the replacement turbine to the dismantling of one or more turbines, without a close spatial relationship between dismantling and construction. This should only be done if site-maintaining repowering is not possible.

The BWE guidelines on re-powering do not specifically mention offshore wind farms - a more precise distinction would be desirable.

5-3 Netherlands

One of the sector's key challenges is the safe and efficient decommissioning of offshore wind park infrastructure. While the focus is currently on the creation of wind parks in the Dutch zone, it may be wise to already start thinking ahead.

There is an opportunity to reduce decommissioning costs, while at the same time improving the quality and safety of decommissioning in a sustainable way through a coordinated response from the industry. Furthermore, as the economy is moving towards a renewable future, there is also an opportunity to re-use existing infrastructure to complement renewable investment before eventual safe and efficient decommissioning.

Thus, in order to maximize the value of a wind farm investment, repowering should always be a part of the end-of-life considerations. A weighing of the pros and cons is important if repowering or refurbishing is an option that can help efficiency in the day to day running of the wind energy park. There should always be a comparison between the costs and benefits of fully decommissioning or partly/full repowering of the existing wind park foundation.

The repowering option must be quantitatively analysed. If a recycled wind farm project can be launched, it would encourage more investors to participate. The proposed strategy requires less capital investment and construction time compared to the construction of a new wind farm, which may otherwise not only be a barrier for some investors who do not have enough funds, but might also cause an increase in the levelized cost of wind energy.

The outcomes of the research seem clear, repowering is both cost-effective (the proposed repowering approach would ultimately lower the cost of wind energy) and more beneficial for the environment. This may be true both on a micro- and mesoscale, as the local marine life may have already acclimatized to the foundations.

It should also be noted that, besides the economic analysis and the marine environment, severe weather conditions, vessel limitations and a lack of operational experience are all also potential concerns surrounding a repowering strategy.

For example, aspects which should be considered are:

- The cost of wind turbines and foundations, which should be a major focus
- O&M costs to be included in the total commitment and decision-making procedure.
- The potential issue of transportation between wind turbines and cabling.
- Regulatory issue such as transmission limit, repowering capacity limit, etc.
- The environmental impact. For instance, if there is a requirement to replace the original wind turbines with fewer, bigger wind turbines to reduce acoustic and visual influence, then the proposed strategy could be modified to cope with this issue.

5-4 Belgium

Rather than entirely decommission an offshore wind farm, project developers will assess the opportunity to extend the service life of the project (with potentially an updated O&M scheme) or so-called 're-power' essential components effectively started a new project with minimal effort. The Belgian legislation provides guidelines towards these actions. Below a (simplified) overview of these guidelines are given for the 3 required permits.

Extension of service life

Table 1 Overview of the considerations on lifetime extension in Belgium

	Domain concession	Marine protection	Submarine cable license
Duration	20 years, extension up to 30 years	20 years, extension up to 30 years	No maximum duration set
Request time	> 2 years before expiry	Linked to domain concession	> 6 months before expiry

Given the available framework on lifetime extension, it has become common practice for the offshore wind farms in Belgium.

Repowering

Table 2 Overview of the considerations on repowering in Belgium

	Domain concession	Marine protection license	Submarine cable license
Magnitude of change implication	Repowering = change in domain concession	Repowering = alteration	Repowering = significant change = ministerial decision potential impact
Resulting action	New domain concession application	New or revised license application	Approval if impact is minimal, new license if significant

The above overview illustrates that the definition and implications of the repowering process are of the utmost importance to assess the permit requirements. Generally speaking however, a sizeable repowering of an offshore wind farm in Belgium requires a similar process as an new offshore wind farm with the potential exception of the submarine cable license.

5-5 Norway

Norway has no experience with the repowering with offshore wind farms. According to Energy Act, the Oil and Energy Ministry may waive the requirement for a termination plan if an application for an extended license is applied for.

5-6 United Kingdom

In the currently available regulations, it seems that the repowering of offshore wind farms is in the early development stages. The current regulations asses the repowering projects on a case-by-case basis. In the document entitled 'Offshore renewable energy: decommissioning guidance' [1] published by the Scottish government, it is stated that:

"*In the future, it is possible that certain projects will be repowered (subject to the necessary regulatory consents). Any amendment of decommissioning programmes as a result of a proposed repowering will be considered on a case-by-case basis. Early engagement with Scottish Ministers on such matters is advised*."

5-7 Conclusions

Repowering of wind parks is an issue that deserves more attention in the long run.

The life span of the existing parks, for most of the coastal countries, is not yet at its end. The turbines are made to function for 20 – 25 years, but as it stands, maintenance wise, they could operate for 40 years or longer.

Even so, plans for the possible replacement of wind turbines by higher capacity variants are important to take into consideration. the MW's per machine for the windmills that are currently being designed are still increasing . Effectiveness and output is a major reason to repower.

The exploitation of a wind park is related to a certain number of years it is allowed to operate. licenses and leases are fixed. The one who owns and exploits the wind park is not the owner of the sea bottom it stand on. Contracts have a limited life time. Due to this, repowered wind parks, may not have enough time to earn the costs within the time left in a contract.

It is not clear whether the same owner is still there at the end of the contracts. Therefore contracts and plans to repower sites must be adjusted to the different occurring situations.

Momentarily, due to contract restrictions, stream prices and to prevent losses when repowering is at hand, it is more cost effective to extend the licences of existing wind parks.

6. Sustainability of licensing decommissioning

6-1 Introduction

Once a wind park is considered “end of life” and must be decommissioned it is the responsibility of the park owner to arrange its refurbishing or removal. As many wind parks are being built now this will be a huge operation in the coming future, with an expected peak in the period 2030-2040. Therefore regulation and licensing is of the utmost importance to prevent chaos.

The governments of the surrounding nations have an important regulating task. No wind park can be decommissioned without approval from the authorities that have jurisdiction over the area. Licensing of the process is their prerogative.

The running of the park is up to the consortium or company that develops, maintains and exploits the wind park. They own the park, but they are not the owner of the ground below. As the time they have the permit to exploit the area is limited, it only gives them access for the contract period. After that time the consortium or company is obligated to leave the site if no extension of lease is granted.

This also means that the governments have the obligation to be the safeguard for quality when decommissioning is at hand.

Sustainability is also an important criterion for a wind park owner and it is part of the contract between the park owner and the government. This includes the removal of all or parts of the wind park. In decom tools we have the focus on decommission in line with these obligations and efforts.

6-2 Denmark

Danish law does not include specific requirements regarding decommissioning of offshore wind farms. Decommissioning liabilities are regulated in the construction licence and in the electricity production authorisation issued by the DEA, as well as in the concession agreement (if the wind farm is established following a tender procedure).

During a near shore tender process the DEA indicated that it is not possible to exhaustively determine detailed decommissioning requirements, as the environmental requirements will have to be assessed at the time of decommissioning. Furthermore, there is no practical experience and only little knowledge on decommissioning, as no large offshore wind farms have been decommissioned in Denmark so far.

The construction licence and the electricity production authorisation usually include conditions under which the owner of the wind farm (the licensee) is obliged, on their own account, to restore the area to its former condition, including remediation and clean-up of the area. Further requirements may apply pursuant to a decommissioning plan prepared by the owner of the wind farm which is subject to the approval of the DEA. In addition, the DEA may require the wind farm to be removed in full or in part in accordance with a timetable

stipulated by the DEA. It may be required that the owner of the wind farm provides an adequate financial guarantee for the decommissioning of the wind farm.

6-3 Germany

The equipment, procedures or materials used for offshore work must in all cases comply with German and European standards, regulations, etc. concerning safety, environmental compatibility, etc. If this is not the case, the approval of the BSH is required.

Logistics for all major components and disassembled parts from the installation site to the base need to be presented accordingly and a reduced danger to individuals, equipment and environment must be verified as much as possible.

According to SeeAnlV §5 (6) no.2 the plan can only be approved if the marine environment is not endangered, especially on the subject of pollution of the marine environment. Pollution of the marine environment according to the United Nations Convention on the Law of the Sea means the direct or indirect introduction of substances of energy by man into the marine environment. Included are estuaries from which adverse effects result or may result, such as harm to living resources and to the flora and fauna of the sea, endangerment of human health, obstruction of maritime activities, including fishing and other legitimate uses of the sea, impairment of the utility value of seawater, and diminution of the amenities of the environment (§ 1 section 1 no. 4, BGBl. 1994 II S. 1798, 1799). Also the decommissioning manual needs evidence of purity of the seabed and proper disposal of waste and waste water.

6-4 Netherlands

In the Netherlands, the fundamental principle is that objects should be removed once a permit has reached the end of its term. This is due to environmental protection measures which prohibit dumping. This removal obligation ensures more space is freed up for other projects. The representative authority communicates the removal obligation to the initiator before issuing the permit and lays down specific details regarding this obligation in the permit. The authority may even demand financial security for the costs of removal.

It should also be mentioned that the legislation concerning the removal of cables is similar to wind farm decommissioning. Cables for the transmission of electricity from wind farms are subject to the same removal obligation as the wind farms themselves. This also applies to new control cables and telecommunications cables.

6-5 Belgium

Similar to the Netherlands, the fundamental principle for an end of life offshore wind farm is that all infrastructure should be removed to ensure redevelopment of the area. In addition, all removed materials should be processed onshore. To that end, prior to granting a domain concession, the relevant ministry evaluates the technical and financial provisions for the treatment and removal of installations when they are taken out of service permanently. These provisions include, in particular, the establishment of a reserve levied on the operating results

and monitored by the commission with a view to ensure said redevelopment of the area. The applicant of a domain concession must thus already draw up a proposal (both technical and financial) for decommissioning.

The conditions for obtaining the marine protection license are somewhat different. The license is obtained when the impact of the project development is found to be acceptable. The evaluation of said impact and the corresponding environmental impact assessment ('EIA') aim to preserve the inherent nature, biodiversity and integrity of the marine environment through measures to protect it and through measures to prevent, reduce and remedy damage and environmental disruption, in particular through sustainable management and enforcement measures. As such, the license comes with an explicit requirement to remove all infrastructure at the end of life and to restore the site to its original condition. However, neither the environmental impact assessment nor the legislation defining the licence prescribe or regulate *how* the decommissioning should be done. The acting minister at the time of decommissioning however can impose ad-hoc measures that need to be met. Following a successful removal of the infrastructure, a site survey and clearance report needs to be submitted to the relevant authorities.

In a comparable fashion, the submarine cable license levies on the OSPAR convention to state that at the moment of disuse, all marine cables should be removed. In addition, the corresponding legislation demands for the decommissioning activities to be carried out in optimum and safe conditions with due regard for the environment. Upon being awarded the submarine cable license, no technical guidelines on the decommissioning activities are required or provided.

6-6 Norway

The fundamental principal in Norway is that subsea objects should be removed once a permit has reached the end of its term. Offshore facilities that will not be reused on the field must be transported to shore and handled at an approved onshore facility for scrapping and recycling or disposal.

The petroleum industry, there is no requirements to remove the pipelines. (Pipelines are not covered by OSPAR Convention). On the wind farms cables are subject to the same removal obligation as the wind farms themselves.

6-7 United Kingdom

Before starting any removal operations in an OWF decommissioning project, a Marine License is required. In the following subsections, different removal operations will be briefly discussed. The focus is on the Scottish situation for having a leading role in the UK.

Site Clearance

Based on the document entitled 'Offshore renewable energy: decommissioning guidance' published by the Scottish government, the wind farm site should be cleared after the decommissioning operations to return it to its original state. The document emphasizes that:

Following decommissioning, it will be important for the developer/owner to confirm that, where full removal of installed infrastructure has been stipulated, the site has been cleared, in accordance with the approved decommissioning programme, and to provide evidence that this has been achieved.

The area covered for debris clearance will be decided on a case-by-case basis, taking account of the guidance for oil and gas installations which specifies a 500m radius around any installation as the minimum area to be covered for debris clearance.

The Scottish Ministers would expect to see an element of independent, third party involvement in providing evidence that the site has been cleared. Decommissioning programmes should set out the developer's proposals for achieving this.

Removal Operations

Regarding the offshore removal operations, the document doesn't provide specific requirements. It only states some general requirements for the removal methods as follows:

Best Practicable Environmental Option (BPEO), that is the option which provides the most benefit or least damage to the environment as a whole, at an acceptable cost, in both the long and short term. (In essence, the choice made should involve balancing the reduction in environmental risk with the practicability and cost of reducing the risk):

- Safety of surface and subsurface navigation
- Other uses of the sea
- Health and safety considerations

Waste management

When it comes to waste management, the Scottish government is very strict and doesn't accept any disposal of waste at sea. The document stresses that waste management must be carried out in accordance with all relevant legislation at the time, including control of any hazardous wastes.

Post-decommissioning Survey/Report

Following the removal operations, the offshore wind developers must perform a full seabed survey to make sure that there is no debris left on the seabed. The decommissioning operations should not generate any debris that can put the other marine users or the marine environment at risk. To this end, a full post-decommissioning report should be provided to the Scottish government, including the following information:

- Independent third-party verification that decommissioning took place in accordance with the approved decommissioning programme (e.g. statement from a third-party contractor or an independent observer)
- Evidence (e.g. photographic evidence of infrastructure out of the water, or survey footage of the seabed) that all infrastructure that was due to be removed, according to the decommissioning programme, has been removed

- If infrastructure is left in situ, evidence that it has been cut off/buried/otherwise treated in accordance with the decommissioning programme
- References to compliance with relevant environmental impact assessment / appropriate assessments
- References to any future monitoring and maintenance set out in the decommissioning programme
- A cost breakdown to enable Scottish Ministers to understand the actual cost of decommissioning compared to the predicted cost.

The submitted post-decommissioning report should be as stated in the decommissioning programme and will be assessed by Scottish government ministers to make sure that the process has been performed as predicted.

Post-decommissioning Monitoring

In order to make sure that the decommissioning operations will not pose any risk to the marine environment and other users, the Scottish government necessitates some monitoring activities after the decommissioning operations. Depending on the wind farm, the site should be surveyed within some time intervals after the last decommissioning operations, e.g., three years and eight years. The OWF developers/owners are responsible for monitoring the infrastructure that has been allowed to remain in the site. The results obtained from the surveys should be submitted to the Scottish ministers.

6-8 Conclusions

We realize ourselves that in the field of sustainable development, when the existing parks were built, the focus was not on the sustainability but on economics and most of all on realizing it technically. Although financial buffers were requested to make a structural decommission possible, there was no exact idea who would be the decommissioning partner and how this should be organized. The ownership of the seabed lies with the relevant government, the owner of the wind park is mostly a company or group of companies. Making it difficult to know who the decommissioning partner would be when “end of life” is an issue.

An extra difficulty is the fact that several countries are involved in the North Sea and many different companies are working in the same field. Due to the international development of wind energy technology the companies are not aligned to a single country.

The laws and regulations for decommissioning must be in line with the area, in this case as diverse as the North Sea. Seeing the different solutions the countries have made already, it will be not a big step to organize a sole rule model in the entire North Sea Region.

Given the results of the different approaches in the surrounding countries it is possible to find a common mode to be able to arrange a North Sea license model for decommissioning. The different rules and regulations have a high percentage of similarity and are based on the different international accepted treaties. The UK and especially Scotland have an advanced system put in motion for a regulated decommissioning that can be adapted in the home rule of the different border states surrounding the North Sea.

7. Other issues

7-1 Introduction

The programme “Decom Tools” is focused on the decommissioning period, end of life, of wind parks offshore. There are many external factors that influence the way the park is being decommissioned. Even during the operational period we have to consider the changes that occur and can influence the use of the sea after a wind park is removed.

Therefore special attention is given towards these subjects in the following chapters.

We have focused on:

- Shipping
- Fishing
- Environmental issues
- Waste management
- Safety

7-2 Shipping

The North Sea is one of the busiest seas in the world. Because of the intensive traffic shipping lanes are installed to be able to make save passage. In this environment the wind parks and other installations have a protected area in which they can operate.

For the decommissioning a special permit is needed to enter the park and assist in the work. Heavy lifting cranes, transport vessels and barges have to pass through the shipping lanes to get to the parks. Within the park protection is guaranteed by the rules set by UNCLOS. The travel between the wind park and the connecting port is guarded to be on the same level of control as the ordinary sea traffic. For each country in the North Sea Region the rules and regulations are implemented in line with the common agreement laid down in various treaties.

Germany

Offshore installations, such as wind turbines, form artificially created obstacles to shipping from a nautical traffic and shipping policy point of view, which restrict the open sea space. This creates new dangers for the safety and ease of shipping, which must be minimized through appropriate measures. This also applies to the laying and operation of submarine cables and comparable submarine installations in areas relevant to traffic.

The responsibility for ensuring the safety and ease of navigation and maintaining the navigable condition of federal waterways lies with the Federal Waterways and Shipping Administration in accordance with §1 section 2, §3 section 1 and §24 section 1 SeeAufgG.

Safety zones are established in the exclusive economic zone around the facility to ensure the safety of navigation as far as this is necessary. The establishment of the safety zones requires the agreement of the Directorate-General for Waterways and Shipping. The established

safety zones are announced by the planning approval authority and entered into the official nautical charts.

The Offshore Installations Guideline of the Waterways and Shipping Administration provides the principles for the assessment of potential sites for offshore installations and also the consideration of submarine cables and pipelines.

According to this guideline, the construction and operation of offshore facilities must not interfere with shipping routes and is not permitted where shipping itself or the use of designated traffic routes used by shipping are impaired. There is a basic safety zone of 500 m radius around offshore installations (measured from the outer boundary of the installation). If offshore installations are in direct spatial connection, the groups are combined into closed blocks. Corridors which, taking into account the conditions possible at sea, do not ensure safe passage are to be avoided. Depending on the traffic frequency and structure, a corridor of at least 2 nm (nautical miles) width (plus 2 x 500 m safety zone) is generally required as a passage width between two or more blocks.

Netherlands

In accordance and in consultation with the direct stakeholders (wind installation permit-holders and the shipping sector), the Ministry of Infrastructure and the Environment has developed a proposal for a revision of the shipping lanes off the Dutch coast. Revision is necessary to ensure the safety of shipping, to improve the accessibility of the main ports and to bring about more efficient use of the North Sea. The proposal was approved by the International Maritime Organization (IMO) in November 2012 and the revised shipping lanes became effective on August 1st 2013. The revised shipping lanes form the starting point for the designation of wind energy areas within the Holland Coast search area. The National Water Plan and the associated Policy Document on the North Sea states that wind energy area designation should adhere to the principle that no permanent construction is permissible within two nautical miles (nm) of a shipping lane. At the detailed planning stage, the application of this requirement can be adapted to particular circumstances. However, a zone of 500 m. should always be kept clear between a wind farm and a shipping lane. (The UNCLOS allows a coastal country to establish a safety zone of up to 500 m. around an installation, and this maximum 500-meter zone has been incorporated into Dutch law.) Following adoption of the National Water Plan, ways of adapting the safety zone principles for application in the context of the North Sea were investigated in consultation with the shipping sector.

Where clearways (routes connecting formal shipping lanes) are concerned, the safe separation distances are incorporated into the width of the clearway. Where anchoring areas and precautionary areas are concerned, the same safe separation distances can be applied for as in a traffic management system.

Belgium

To prevent collisions and other accidents with offshore wind turbines, it is important that a safety perimeter is established around the turbines. A Royal Decree on Safety Distances has therefore been issued and stipulates that no vessel may approach the wind turbines closer than 500m. Fishing is therefore not allowed within this area. An exception is only made for vessels that have received prior authorization from the Coast Guard, including the work vessels of wind farm operators, vessels with a control or monitoring assignment and rescue vessels. If a vessel sails closer to the wind turbines without permission and therefore does not respect the safety distance, this is punishable by law. One speaks then of an intrusion in the wind farms. These intrusions are monitored by the Coast Guard, and the holder of the domain concession.

The Belgian offshore wind farm owners also contributed to drafting the first file for the International Maritime Organization (IMO). This file led, among other things, to the adjustment of the initially demarcated energy zone, balancing existing shipping routes and the area that can be reserved for wind farms. The Belgian stakeholder charged with ensuring safe navigation at sea and guaranteeing free passage is after all responsible for drawing up national legislation and implementing international regulations. The precautionary safety zone (precautionary area) around the wind farms was also realized at the IMO (Sub-Committee on Navigation, Communications and Search and Rescue). Currently work is being done to convert this safety zone into a more strictly regulated 'Area To Be Avoided'.

Norway

According to the offshore energy act (Havengergilova), there must be safety zone of 500 m around and above the installation. The safety zone can be extended in special situations. The safety zone is not applicable for cables.

United Kingdom

The UK government published a guidance entitled ‘Offshore renewable energy installations: impact on shipping’, in which the impacts of offshore renewable energy infrastructure on navigational safety and emergency response have been addressed. Based on this guidance, the ships should be aware that there is no right of access to any type of offshore renewable energy infrastructure.

However ships, passing through the OWF sites, are allowed to do so. Access to an offshore renewable energy infrastructure requires skill and is limited by the state of the sea, and should only be undertaken in controlled circumstances by trained personnel.

When planning a voyage, mariners should assess all hazards and associated risks, including the proximity of wind farms and turbines, for example:

- Spacing - wind farm turbines are usually spaced 500 meters or more apart depending on the size of the turbine

- Depth of water - most wind turbines operate in relatively shallow water though new generations of the wind farm will be constructed in deeper water, possibly restricting navigable channels
- Seabed changes - wind farm structures could, over time, affect the depth of water in their vicinity thorough scouring of the seabed making depth information unreliable
- Tidal streams - wind farm structures may obstruct tidal streams locally, creating eddies nearby
- Small craft - vessels involved in turbine maintenance and safety duties may be encountered or obscured within or around a wind farm - fishing vessels may also operate and be obscured in the area
- Shore marks - in coastal areas shore marks may also be obscured by wind farm structures
- Electrical transformer stations - can be found in or adjacent to larger wind farms
- Rotor effects - can change the flow of the wind and impact on a vessel

In addition, there are a few safety zones in place around some UK offshore wind farms which are assigned for the construction and decommissioning of offshore wind farms. The safety zones should be avoided by mariners.

Meanwhile, the OWF developers/owners should consider the Coast Protection Act (CPA) 1949 [2] on the safety of navigation [3]. This includes a set of provisions on safety of navigation. This applies to Scotland, not to England and Wales [4].

7-3 Fishing

Fishing is still part of the daily routine in the North Sea region and as such an industry to be reckoned with. In the past the fishing industry had a widely spread access to the Nort Sea Region. Commercial shipping was a competitor through which by the establishment of sea lanes and corridors restrictions came about. After the commercial use by erecting oil and gas and wind energy platforms and reservation of whole patches of the North Sea for this use, the room to manoeuvre got smaller. In the near future this will increase as more wind parks are being build and planned. Although decommissioning does not affect the fishing industry more than other activities, it is important to know the rules and regulations in the different countries in line with fishing trawlers using the area of the wind park or the sea nearby.

Germany

During the decommissioning of an offshore wind turbine, there are various factors that have a negative impact on fish fauna. For example, the sediment stirring up during foundation work can lead to the gill apparatus becoming stuck and also to the spilling of fish spawn. Additionally, various noise emissions can have a deterrent or attractant effect. Other pollutants that are released and thus affect water quality also lead to direct damage and mortality of fish stocks. Habitat alteration due to sealing, land development, etc., and associated changes in feeding, refuge, and spawning areas can lead to changes in fish assemblages in terms of production, diversity, and species composition. In order to reduce mortality of economically exploited and non-exploited fish species and to allow fish stocks to

recover, fishing bans on refuge areas occur. These issues interact with each other and also impact marine species higher up the food chain.

Netherlands

In 2015 the government decided multi-use options for the use of the sea surrounding the wind parks were to be considered. These options would allow ships to pass through offshore wind farms and they would also allow some types of fishing to occur. The Dutch Government (Rijkswaterstaat) carried out a risk assessment, a package of mitigating measures in consultation with relevant stakeholders, including wind farm owners. The wind farm owners also carried out their own risk analyses and introduced them into the process. This led to a regulation proposed by the Dutch Government (Rijkswaterstaat) on how to integrate other uses and vessel transit into offshore wind farms. For fisheries the following regulations were designed to limit hazards while providing opportunities:

- Transit of the wind farm safety zones by professional fishers is allowed when their bottom- disturbing fishing gear is carried in a position above the waterline, where it is visible
- Bottom-disturbing activities, like anchoring or dragging of fishing gear, are forbidden within the wind farm safety zone
- Professional fishing is allowed if, and only if, the fishing gear is specified as permissible by the Dutch government. This will be written in a framework in which the risks for wind farms, ecological risks, economical potential and enforcement possibilities are taken in consideration.

The Dutch government decided to open the offshore wind farms on the 1st of May 2018, implementing the restrictions proposed for the activities in the 2015 legislation. The Dutch government has made arrangements with the wind farm owners on monitoring, incident management and policy evaluations.

Belgium

Following a successful marine protection authorization and receiving the domain concession, the owner of the (to be built) offshore wind farm has exclusive rights in the awarded domain concession. This implies that activities not related to the wind farm such as fishing are not allowed in the entire zone designated to the wind farm owner. This strategy should improve the food supply for the present fauna and stimulate the growth of their population and biodiversity.

Norway

According to the Petroleum Act there must be a safety zone of 500 m around and above the installation. Fishing can take place in the zone or parts of the zone, if the activity is not threatening safety or not disturbing activities on the offshore installation. The oil and energy department may, nevertheless, decide that fishing may take place in the safety zone.

According to the Offshore Energy Act (Havengergilova): If the fishermen in Norway have financial losses due to pollution, energy plants seizing fishing ground or damage caused to

fishing boats by energy plants, fishermen can demand compensation for these types of financial losses.

United Kingdom

According to the Energy Act 2004 published by the UK government, the owners/developers of OWFs should consult with the representatives of the fishing industry and other related parties who may be affected by the offshore decommissioning operations. According to the 'Offshore renewable energy: decommissioning guidance' published by the Scottish government, the list of consultees should be agreed with the Scottish ministers.

In addition, according to the UK Energy Act 2004, any changes in decommissioning plan during the project should be provided to the Kingfisher Information Service at the Sea Fish Industry Authority, Hull (Seafish), which enables relevant information to be provided to the fishing industry. In addition, aids to navigation must be provided for any remains after the decommissioning project which protrude above the seabed. The necessity and type of the aids to navigation should be discussed with the representatives of the fishing industry.

7-4 Environmental issues

The offshore wind energy use can have a negative impact on the marine environment. Offshore wind farm owners have to take critical items into consideration, such as environmental and social impacts. These items are subject to legal challenges. Examples of environmental impact relate to pollution caused by redundant material. Noise damage, due to machines operating in the area, can effect marine mammals during the decommissioning process. Other topics relate to aesthetic considerations, decommissioning requirements, the impact on tourism, fishing, navigation and transportation arise in the planning operation when the "end of life" decommissioning of an offshore wind project is planned.

Germany

The impact on the protected nature is leading. Approval to decommission is only granted if this is thoroughly researched and in line with the expected adverse effects. In the approval procedures, severity thresholds are of particular importance. The marine environment will be affected very severely. The thresholds for offshore wind energy are used to distinguish whether or not there is a risk to the marine environment in the environmental impact assessment (EIA) according to SeeAnlV. The Federal Maritime and Hydrographic Agency (BSH) must demonstrate in the environmental report that no significant impacts will result from the planning. It will be provided as part of a strategic environmental assessment (SEA). In addition, it is not permissible to significantly affect species or areas protected under the Habitats Directive and the EC Birds Directive. This is monitored by the BSH.

The Federal Environment Agency has produced a document listing the various impact factors and how these affect the protected habitat. Here below are some examples of these impact factors on the environment.

Laying the foundations of the wind turbine and the transformer station leads to sediment resuspension and transport, turbidity and pollution through remobilization of pollutants and nutrients bound in the sediment. For fish, this results in gill gumming, scouring or attraction, and spilling of fish spawn due to sediment resuspension. On marine mammals, sediment resuspension can also lead to scouring effects (indirect changes in the distribution of food organisms). In addition, hearing impairment (proximity of noise source) or behavioral changes (greater distance) can occur here.

The Netherlands

Governmental legislation is also being created. The government is going to develop an Ecology and Accumulation Framework, setting out the cumulative ecological impact and the mitigating measures to be taken. The purpose of the Framework will be to indicate how the cumulative ecological impact may be determined more effectively and more clearly.

To analyse and - if necessary - deal with the economic, social, and ecological impacts of the wind farm(s), the site decisions are legally subject to an environmental impact assessment (EIA), commissioned by the Netherlands Enterprise Agency on behalf of the Ministry of Economic Affairs and Climate Policy and the Ministry of Infrastructure and Environment. The EIA results are published in the site decision, available for public inspection (and appeal), after which it is finalized and cannot be appealed anymore.

Belgium

Additional governmental legislation is planned to minimize the environmental impact of decommissioning activities. Recall that obtaining a marine protection license follows the evaluation of an environmental impact assessment ('EIA') similar to other NSR countries such as the Netherlands or Germany. This EIA aims to preserve the inherent nature, biodiversity and integrity of the marine environment.

The environmental impact during construction of offshore wind farms is becoming common knowledge and is well-documented. Essentially the soil disturbance and the temporary increase in underwater sound levels slightly impact the surrounding habitats. Similarly, during exploitation scour around the monopile and the increase in underwater sound levels are the main factors impacting the local biotope. However, the introduction of hard substrates leading to an increase in the food supply compensates said factors.

In general it can be said that the effects of the decommissioning phase will be similar to those of the construction phase, but that the intensity of occurrence will be much lower. Sound disturbance will continue to occur, but will be limited to the sounds produced by the relevant shipping and decommissioning activities such as for example cutting off turbines up to 2 m below the seabed during the removal of the foundations. The significant noise disturbance as a result of pile driving during the construction phase is during the dismantling phase no longer present. The loss of biotope and the associated loss of organisms is limited to the surfaces that are effectively disturbed during the dismantling phase. The effects vary from almost no effect to a minor negative effect, depending on the considered alternative.

Norway

There are many environmental concerns to be considered throughout the decommissioning process, from planning and carrying out shutdown operations on to waste disposal. Experience shows that most of the unexpected environmental problems arise when demolition starts onshore.

Various marine organisms start to grow on platform legs and other subsea structures after they have been in the sea for only a few months, and the quantity of fouling is much larger after 30–40 years in the sea. Mussels, barnacles, benthic algae and sea cucumbers quickly colonize installations, followed by soft corals and after some years colony-forming stony corals. The species that colonize an installation will depend on a number of factors such as recruitment potential, currents, water depth, distance from land and latitude. In some cases, the quantity of fouling organisms on underwater structures has been somewhat overestimated when calculating the weight to be lifted. However, it is clear that large quantities of organic material are involved. Much of the material has a very high-water content (for example sea cucumbers and soft corals) and dries out/decomposes quickly, but calcareous shells and skeletons of organisms such as mussels and stony corals may be deposited in the recipient at the decommissioning facility, on land or in a landfill.

United Kingdom

The Nature Scot, previously known as Scottish Natural Heritage, published guidance for the decommissioning of onshore wind farm assets in Scotland [1,2], which is focused on natural heritage issues. This guidance is also applicable for the repowering projects of onshore wind farms. There is no guidance on nature preservation specifically designed for offshore wind farm decommissioning projects. However, the Energy Act 2004 [3] published by the UK government advises that the decommissioning owners/developers in the UK should always consult with representatives of different nature conservation parties, such as the Joint Nature Conservation Committee, Natural England, the Countryside Council for Wales or Scottish Natural Heritage, and the Environment Agency or the Scottish Environment Protection Agency. Again, the list of consultees should be prepared under the Scottish Ministers' advises.

7-5 Waste management

Germany

Pollutants are considered to be an impact factor, including pollutants released by accident. In case of ship accidents carrying wind farm components, damage or sinking of the ship may occur and thus can result in fuel leakage or loss of cargo. There is also a risk of leakage of gear, hydraulic and transformer oils from the wind turbine or wind farm substation. Particularly serious environmental consequences (e.g. tanker accidents) are usually primarily due to inadequate technical standards of the ships used, in addition to human error.

Pollutants in the water lead to the impairment of water quality through contamination (are substance and concentration specific). The impact on water quality leads to direct

damage/mortality of benthic organisms or to an indirect effect through accumulation of pollutants during feeding. For fish, this also results in direct harm/mortality or an indirect effect with substance and case specific impacts. Both resting birds/foraging visitors and marine mammals are exposed to direct poisoning or indirect effects through the accumulation of contaminants through the food chain. They are also impacted by litter. The Federal Environment Agency has produced a document listing the various impact factors and how these construction phases affect the various protected goods

Netherlands

The treatment of all waste can be found in the National Waste Prevention Plan LAP3. Where LAP3 prescribes "recycling" as the minimum standard for metals, the situation with regard to fiber-reinforced composite is more complicated. The LAP3 establishes that the minimum waste treatment method is "recovery, including main use for fuel". Specifically, for thermoset plastics (including composites), LAP3 states "If the cost of processing thermoset plastics is so high that the cost of disposal by the producer/consumer would exceed EUR 205/ton, the minimum standard is 'primary use as a fuel (as a form of recovery)' within facilities where emission controls are regulated in specific regulations and/or permits based thereon".

Belgium

With respect to managing waste related to the decommissioning of offshore wind turbines, Belgium currently follows the strong European framework stipulated in the EU Waste Directive. In addition, local regional legislation mentions that any substance or object which the holder discards or *intends* to discard, is required to be discard. Unless a second hand market is expected for offshore wind farm components, decommissioned parts of an offshore wind turbine are considered waste.

No additional legislation which was specifically made for offshore wind turbines has been created yet in Belgium.

Norway

Marine fouling should be removed from the installation while it is still offshore if this is technically possible. The open sea usually functions as a satisfactory recipient where the material decomposes naturally. Studies have also shown that disposing of fouling material in open fjords does not cause problems. In more enclosed, shallow waters, however, this may result in an excessive load of organic material and oxygen depletion on the seabed. Disposal of the material on land and composting is a possibility, but often results in odour problems.

Other considerations regarding decommissioning facilities must be equipped to deal with many different types of waste. In addition, they must be able to control releases of pollutants to air, water and soil, including:

- releases from metal cutting operations
- dust
- run off to water and soil

United Kingdom

Every offshore wind farm decommissioning project should meet the Environmental Impact Assessment regulations published by the Scottish government. Regarding waste management, the recycling process of offshore wind farm assets should be in line with the Environmental Protection Act 1990 of the UK government, which describes the fundamental structure and authority for waste management and control of emissions into the environment. In addition, the Waste Management Licensing (Scotland) Regulations 2011 should also be considered, if applicable.

The environmental impacts of OWF removal, recycling and left-in situ operations can be potentially assessed based on terms of the Pollution Prevention and Control Regulations. The Pollution Prevention and Control Regulations are about the environmental impacts of industrial projects, such as emissions and water pollutions. Hence, OWF developers should also take into account the environmental considerations in the Pollution Prevention and Control Regulations. These regulations are available for England and Wales and for Scotland.

In addition to the abovementioned regulations, all decommissioning activities in UK should also be aligned with other related regulations, such as:

- Food and Environment Protection Act (FEPA) 1985
- Water Resources Act 1991
- Environmental Impact Assessment (EIA) Regulations
- Pollution Prevention and Control Regulations
- Hazardous Waste Regulations 2005
- Food and Environment Protection Act (FEPA) 1985

For the depositing of any substances or materials in UK waters, the decommissioning projects should consider the provisions in the Food and Environment Protection Act (FEPA) 1985 [6].

The Water Resources Act 1991 states that "*it is an offence in England and Wales to cause or knowingly permit any poisonous, noxious or polluting matter or any solid waste matter to enter any "controlled" waters*". The Control of Pollution Act 1974 (COPA) provides a similar statement which should be considered in OWF decommissioning projects.

The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017 should be considered during the EIA preparation for an OWF in Scotland. The Electricity Works (Environmental Impact Assessment) (England and Wales) Regulations 2000 applies for OWF in England and Wales.

The environmental impacts of OWF removal, recycling and left-in situ operations can be potentially assessed based on terms of the Pollution Prevention and Control Regulations. The Pollution Prevention and Control Regulations are on the environmental impacts of industrial projects, such as emissions and water pollutions. Hence, OWF developers should also take

into account the environmental considerations in the Pollution Prevention and Control Regulations. These regulations are available for England and Wales and for Scotland.

In England and Wales, the waste materials with hazardous properties should be managed by considering the terms in The Hazardous Waste (England and Wales) Regulations 2005.

7-6 Safety

Health and safety requirements are always a top priority when working at sea or elsewhere. It makes no difference whether a wind turbine is being built or decommissioned. Rules and knowledge should be applied throughout the whole process of decommissioning a wind farm. A solid communication plan with authorities is a key factor for safety and sustainability.

One important aspect is personnel. Only trained, certified and competent personnel may be deployed during decommissioning. The spheres of responsibility when it comes to the personnel for the operation of tools must be clearly defined. It is crucial that a “responsible” person is appointed who monitors safety during the decommissioning and prevents any work which compromises safety from being carried out. All personnel that observe an unsafe working condition are obliged to stop the job until the situation is rectified.

It is also important to look at Health and safety. Health and safety requirements must be included according to national legislation. Risk assessments are recommended.

Denmark

The municipality typically sets the conditions for decommissioning in the initial building and operating permit. Decommissioning must start 1 year after the wind farm has stopped operating at the latest.

Germany

The decommissioning of wind turbines is regulated through the Renewable Energy Sources Act, 2017. Some provisions are also made in the Building Code.

In order to examine the grounds for refusal under the SeeAnlV, i.e. the risk to the marine environment as a result of a ship collision and, above all, the risk to the ease and safety of shipping traffic, the applicants must submit comprehensive risk analyses.

Descriptions of the evidence relating to the proper disposal of construction-related waste and effluent must be provided in the dismantling manual. In addition, a deconstruction phase plan including the essential work steps and the securing of the deconstruction site must be submitted.

Furthermore, all essential components and assembly or disassembly from the site of dismantling to transport to the port must be outlined in order to minimize hazards. These must be verified in the same way as for the construction phase.

Despite all preventive measures, an accident can still occur. In order to meet the special challenges and requirements of offshore operations, a rescue system has been developed in

recent years. In addition to the comprehensive protection and safety concepts (SchuSiKos) for preventive accident avoidance, the main focus is on emergency medical rescue by helicopter (Helicopter Emergency Medical Services (HEMS)), which is financed by the operators of the offshore wind farms.

Together with other non-governmental actors such as the Johanniter or private emergency control centres, and in interaction with governmental institutions such as the Havariekommando, the emergency tugs or the Seenotleitung Bremen (MRCC), it was possible to develop an above-average safety network for more than 1100 persons on work duty in the German offshore wind farms. (source 5)

Netherlands

The dismantling of wind turbines falls under the Building Decree 2012. The decree gives rulings on the decommissioning of structures. The emphasis lies on the rules for safety and can to be translated to the different tasks needed to make a safe demolition possible. The general rules have been made applicable to the decommissioning of offshore wind turbines. Furthermore the European rules and regulations on working in a sea environment are followed up and this is in line with the other countries around the North Sea.

The “SodM (Staatstoezicht op de Mijnen)” and “RWS (Rijkswaterstaat)” together with the “Coast Guard” and the “Inspection for the living environment” are controlling bodies for safe and healthy work situations offshore. They operate to make sure the specific applied laws are followed: “de Wet windenergie op zee” and “the Waterwet”.

Belgium

The safety during the decommissioning of onshore wind turbines is regulated by national and European building codes. Offshore however, many other factors play a role and the rules of maritime conduct apply. Belgium boast a well-defined framework of health and safety requirements, communication planning, to ensure safety at sea. This is exemplified in the contribution to SafeSeaNet which is European Maritime Information Network and managed by the European Maritime Safety Agency (EMSA) and the European Directive 2002/59 / EC.

With the rise of new technologies that can be linked to decommissioning of offshore wind turbines, the above mentioned rules and guidelines might need to be revised.

Norway

The construction, operation and decommissioning of energy facilities shall be carried out with high level of safety. Oil and Energy Ministry has requirements for emergency preparedness, work permits and qualifications for workers.

United Kingdom

Decommissioning requirements are set in the planning conditions for each project that has received the permission to start. Most projects will have agreed on a “decommissioning bond” with the local planning authority at the point of planning consent to cover the costs of decommissioning, usually in the form of a planning condition.

During the different stages of the offshore wind farm decommissioning projects, the OWF owners/developers should consider and understand the Health and Safety at Work Act 1974 of the UK Parliament. The Health and Safety at Work Act 1974 [1] describes the fundamental structure and authority for the encouragement, regulation and enforcement of workplace health, safety and welfare within the UK. In addition, the OWF installation and decommissioning projects should take into account the regulations in the Construction (Design and Management) Regulations 1994, in which the responsibilities of different parties for health and safety involved in these projects have been stated.

The Construction (Health, Safety and Welfare) Regulations 1996 also provides safety requirements for constructional sites which can be potentially used to assess the OWF sites in decommissioning projects. Moreover, the Management of Health and Safety at Work Regulations 1999 provides the requirements of health and safety risks in workplaces. These regulation should also be considered in OWF decommissioning projects. The lifting operations in OWF decommissioning projects can potentially fall within the terms of the Lifting Operations and Lifting Equipment Regulations 1998 LOLER), which provides the safety standard for these types of operations in different industries.

- Health and Safety at Work
- Construction (Design and Management) Regulations 1994
- The Construction (Health, Safety and Welfare) Regulations 1996
- Provision and Use of Work Equipment Regulations 1998 (PUWER)
- Lifting Operations and Lifting Equipment Regulations 1998 (LOLER)
- Management of Health and Safety at Work Regulations 1999

The safety measures during the OWF decommissioning projects in UK should comply with terms in the Health and Safety at Work etc. Act 1974.

The OWF installation and decommissioning projects should take into account the regulations in the Construction (Design and Management) Regulations 1994, in which the responsibilities of different parties for health and safety involved in these projects have been stated.

The Construction (Health, Safety and Welfare) Regulations 1996 provides safety requirements for constructional sites which can be potentially used to assess the OWF sites in decommissioning projects.

The Provision and Use of Work Equipment Regulations 1998 (PUWER) provides instructions for a safe utilisation of different equipment. It also states the responsibilities of different involved parties.

The lifting operations in OWF decommissioning projects can potentially fall within the terms of the Lifting Operations and Lifting Equipment Regulations 1998 (LOLER), which provides the safety standard for these types of operations in different industries.

The Management of Health and Safety at Work Regulations 1999 provides the requirements of health and safety risks in workplaces. These regulation should also be considered in OWF decommissioning projects.

7-7 Conclusions

The different approaches from the North Sea countries are based on the European directives. Although every country is building its own laws, a broad acceptance of the general approach by European institutions is guiding the different regulations when working at sea.

Most of the knowledge has come from nautical experiences with ships and vessels at sea. The industry for gas and oil has also contributed. This has led to a common set of rules for the operation of installations when working in a sea environment.

Ecological standpoints have been adopted from experiences with working at sea. New methods to reduce pollution are implemented. The latest developments in noise reduction are being introduced to prevent problems with the animal life in the direct vicinity of the decommissioning.

The results of all these developments are noticeable in the different national decrees and directives. They apply to all partners.


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8 Conclusions

8-1 Introduction

Offshore wind parks have developed from an experimental phase to a situation in which they operate like a normal industry. This comes with obligations and regulations to process the use and to manage it in all phases of their lifespan. The energy companies have ownership of the parks they have built, but they do not own the ground below the parks. Only the agreed contract period gives them rights to operate. Rules and regulations, based on laws are needed to give the property owners, hereby the countries that owe that part of the sea in their economic zones, a guideline on how to govern this. Decommissioning is a key issue.

When an offshore asset has reached the end of its useful life, the owner needs to manage the decommissioning in a way that is environmentally secure, safe and within budget. It is mandatory that this is part of the plan development at the design stage. The process can, in general, be described as the installation process in reverse.

The overall decommissioning project will involve offshore dismantling of the major elements and onshore disassembly of sub-components. A major part of the decommissioning activity is the environmentally neutral removal of offshore substructures and foundations.

The removal and processing of the synthetic materials, such as the blades and the nacelle, have to be addressed. The advance effort of dealing with synthetic materials as blade recycling, helps reducing the wind energy carbon footprint and makes the process more sustainable.

Scenarios of decommissioning are still rare. Only a very limited number of offshore windfarms have undergone decommissioning activities. Most of them near shore. However, some of the early-stage windfarms in Europe are now near the end of their original design life. This highlights the importance of the analysis and preparation of decommissioning.

The process of decommissioning itself is no problem due to the experience available of the oil and gas industry. The organisation of the process, however, comes with major challenges which have to be analysed individually.

8-2 Gaps identified

The decommissioning of offshore wind farms lacks an all including regulatory framework. This negatively affects concepts such as liabilities. It also strongly impacts other fields like the planning of the process and the resulting environment.

The gap analysis is therefore a guide line for covering the most important difficulties that can confront parties taking on a successful decommissioning.

These are:

- the regulations,
- the planning of the process,
- the vessels' availability
- the environmental impact

The regulations

As stated in the research work on the gap analysis there should be a one rule approach. Working for different park owners or countries should not be different in laws and regulations. By promoting this, a more coherent decommissioning of wind parks could be established and more unity could be reached in the method of removing the parts of the mills. The North Sea Region can be a model for this kind of solution, because the park owners operate in all country states. Even so the countries surrounding the North Sea already have brought most of the domestic laws and regulations in line with the international treaties.

Planning of the process

Offshore wind farm owners often lack specific guidelines that could help ease their decommissioning planning. Such guidelines should ideally be included as part of the development phase. In the earlier days there was less attention for the moment of decommissioning. The assembly of the mill was not directly aimed at the possibility of disassembly.

Especially recycling of material (wings, nacelle and lubricants) is difficult to be handled according to the current demands. Sometimes it is not certain what sort of material is used to construct the wind mill. It has to be without question that this is of utmost importance when decommissioning is due to happen and this can be done by instigating the introduction of a "parts and material" logbook for each mill. This must include an assembly protocol to be able to know how the assembly was done (including occurring problems and solutions).

The vessels availability

The decommission process and the chosen method depends on the availability of the hoisting equipment and ships. As we now see that the equipment is getting larger and better accustomed to the ever growing size of the wind mills, it should not be a problem to decommission old wind mills. They were built in a time the mills were less complex, with smaller blades. The method of decommissioning is the opposite to the process of assembly. Special attention will be needed for schooling on health and safety procedures next to the necessary skills of the trade. With an ever more international workforce the schooling has to be part of the process. Coordination and alignment of the schooling demands should be promoted and acknowledged by the countries involved and is obligatory. No admittance without the correct certificates.

The environment impacts

With regards to the environmental impacts, the absence or limited dedicated maritime regulations may lead to decisions that can harmfully disturb the marine environment. At the moment there is still some discrepancy in the different countries on how to manage waste spill over. An all-inclusive regulation on spoils and spill due to removing parts of the mills is a necessity when working to dismantle and remove wind mill parts and lubricants. It should also be part of the wind mill logbook.

8-3 Goals

To achieve a common model for the decommissioning of “end of life” wind parks there are three subjects:

- Development of an integrated infrastructure or “one-stop shop”
- Stimulating knowledge development
- Development of decommissioning and waste management at regional, national and international level

8-4 Topics to achieve cooperation and knowledge transfer.

With the importance of proper decommissioning in mind, it will be important to ensure the most effective and efficient execution on the decommissioning tasks ahead.

Priority topics should be:

- A decommissioning platform should be established, with a clear mandate from the governments surrounding the North Sea.
- A knowledge database centre should be established to gather all the technical and maintenance information on the different types of wind mills, the sort of materials used and the building techniques.
- The platform’s second task should be to bring the different wind park components technology in a database
- The database should provide an (anonymized) clustered view of the asset base and decommissioning horizon to facilitate planning and collaboration
- Regulations on maintenance and decommissioning should be developed by the platform and implemented by the different governments
- The platform should prepare efficient and effective regulations to ensure that the industry will deliver safe, efficient and cost responsible decommissioning and re-use activities
- Ensure an environment of industry collaboration to coordinate the work field for most effective and efficient execution
- Promote high quality, cost-effective standardization of decommissioning to ensure high quality outcomes whilst avoiding high costs

- Stimulate innovative decommissioning approaches and technologies to create world class decommissioning outcomes
- Mechanisms to share lessons should be set up, both local and internationally Following the priority topics, to ensure decommissioning execution in terms of safety, sustainability and cost efficiency
- Build on international experiences to ensure the decommissioning market reflect the industry's best practices.

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10 Presentation Gap Analysis (Esbjerg meeting)

1 INTERNATIONAL LAWS

UNCLOS

- UNITED CONVENTIONS ON LAW OF THE SEA
- INTERNATIONAL CONVENTION TO PROVIDE A COMPREHENSIVE LEGAL FRAMEWORK

OSPAR

- OSLO AND PARIS CONVENTION
- INTERNATIONAL CONVENTION FOR COOPERATION ON THE PROTECTION OF MARINE ENVIRONMENT IN THE NORTHEAST ATLANTIC

MARPOL

- INTERNATIONAL CONVENTION FOR THE PREVENTION OF POLLUTION BY SHIPS

IMO DIRECTIVES

- INTERNATIONAL MARITIME ORGANIZATION
- LONDON PROTOCOL ON POLLUTION

Interreg
North Sea Region
Decom Tools
European Regional Development Fund
EUROPEAN UNION

1 INTERNATIONAL LAWS CONCLUSIONS

- **SITUATION:**
  - TOTAL OBLIGATION TO REMOVE STRUCTURES
  - DISPOSAL OF WASTE MATERIAL ON LAND
  - SPECIAL SITUATION FOR CABLES AND SCOUR PROTECTION

- **CONCLUSION:**
  - RULES ARE FULLY APPLICABLE FOR OFFSHORE WIND
  - LAWS ARE BINDING FOR ALL
  - NO CONFLICT WITH DOMESTIC REQUIREMENTS

2 NATIONAL REGULATIONS

PARTICIPATING COUNTRIES:

- DENMARK
- GERMANY
- THE NETHERLANDS
- BELGIUM
- NORWAY
- THE UNITED KINGDOM

BASED ON ISSUES CONCERNING:

- REQUIREMENT
- PLANNING
- ECONOMICS
- SPACE
- RECYCLING AND REUSE
- SUSTAINABILITY
- ENVIRONMENT

2 NATIONAL REGULATIONS CONCLUSIONS

- **SITUATION:**
  - TENDERING IS VERY REGIONAL
  - CONTRACTORS ARE VERY INTERNATIONAL
  - LIFETIME DIFFERS
  - DIFFERENT ACCENTS OF APPROACHES PER COUNTRY

- **CONCLUSIONS:**
  - LAWS AND REGULATIONS IN LINE WITH INTERNATIONAL LAWS
  - ADAPTION OF LEGISLATION BETWEEN NATIONS IS POSSIBLE

3 GOVERNING DISMANTLING

END OF LIFE SCENARIOS:

- ENVIRONMENT IMPACT ASSESSMENT
- TIME SCALE
- FINANCIAL SECURITIES
- RESTAURATION

CONSTRUCTIONS:

- LIFETIME ASSESSMENT
- DECOMMISSION PLAN
- FINANCIAL GUARANTEES
- CONTRACTS

3 GOVERNING DISMANTLING CONCLUSIONS

- **SITUATION:**
  - BUILD MOSTLY ALL BASED ON ECONOMIC REASONS
  - REUSE OF MATERIAL NOT AT THE TOP OF THE LIST
  - ECOLOGICAL ISSUES NOT ALWAYS PROMINENT
  - LEARNING BY DOING
  - EVERY COUNTRY HAS SOME SORT OF REGULATION
  - SOME UNCERTAINTY ABOUT WHO IS RESPONSIBLE FOR DECOMMISSIONING

- **CONCLUSIONS:**
  - RULES AND REGULATIONS IN LINE WITH INTERNATIONAL LAWS AND NEIGHBOURS
  - UPHOLDING LAWS AND REGULATIONS SHOULD BE MORE DEVELOPED.
  - SPACE IS A DIRE COMMODITY

4 SUSTAINABILITY AND LICENSING

SUSTAINABILITY

- END OF LIFE RESPONSIBILITY
- ENVIRONMENTAL PRECAUTIONAL MEASURES
- REUSE OF THE MATERIALS
- RECYCLING OF THE MATERIALS

LICENSING

- PARKOWNER VERSUS LANDOWNER
- LIMITED PERMIT TO OPERATE
- AUTHORITIES GIVE APPROVAL FOR DECOMMISSIONING

5
GAP ANALYSIS IDENTIFIED

- **IMPORTANT ISSUES:**
- WINDPARKS EVOLUTION HAS EVOLVED FROM EXPERIMENT TO A NORMAL INDUSTRY.
- ENVIRONMENTAL NEUTRAL REMOVAL IS ESSENTIAL
- OVERALL SCENARIOS OF DECOMMISSIONING MUST BE DEVELOPED DUE TO VARIETY OF WINDMILL TYPES
- CARBON FOOTPRINT REDUCTION BY PROCESSING SYNTHETIC MATERIAL IS TRUMP
- REGULATORY FRAMEWORK IS IMPORTANT TO MATCH LIABILITIES
- GOVERNING GUIDELINES NEEDED TO MANAGE THE PROCESS TO COME TO A COORDINATED APPROACH
- ONE RULE APPROACH SHOULD BE ESTABLISHED

5
GAP ANALYSIS IDENTIFIED

- **GOALS**
  - DEVELOPMENT OF AN INTEGRATED INFRASTRUCTURE OR**ONE-STOP-SHOP**
  - DEVELOPMENT OF DECOMMISSIONING AND WASTE MANAGEMENT AT REGIONAL, NATIONAL AND INTERNATIONAL LEVEL
  - STIMULATING KNOWLEDGE DEVELOPMENT

5 GAP ANALYSIS TOPICS TO ACHIEVE GOALS

Interreg North Sea Region Decom Tools
European Regional Development Fund
EUROPEAN UNION

- **COOPERATION**
  - EUROPEAN PLATFORM ON DECOMMISSIONING SHOULD BE ESTABLISHED
  - DEVELOPMENT OF TURBINE LOGBOOK
  - EDUCATION STANDARD

- **KNOWLEDGE TRANSFER**
  - DATABASE ON TECHNICAL AND MAINTENANCE DATA
  - COMPONENT TECHNOLOGY IN DATABASE