Regulating offshore wind energy

Nieuwenhout, C.T.

Published in:
Energy Law, Climate Change and the Environment

DOI:
10.4337/9781788119689.IX.45

Publication date:
2021

IX.45 Regulating offshore wind energy

Ceciel T Nieuwenhout[1]

Post-doctoral Researcher, Groningen Centre for Energy Law and Sustainability (GCELS), Faculty of Law, University of Groningen, The Netherlands

Abstract

Offshore wind has become a large component of the renewable energy ambitions of many coastal states. Whereas onshore wind energy has a large visual impact on the landscape, offshore wind farms have fewer problems of this nature. Although this technology has historically been more expensive than its onshore counterpart, the cost reductions are promising – in part due to the larger areas available offshore, which allow for large economies of scale to be reached. After providing the factual background of offshore wind development, the chapter provides an overview of international law applicable to offshore wind farms. As the majority of offshore wind farms are located in the EU, the chapter also gives an overview of applicable EU law, before providing examples of different legislative options available to states throughout the lifetime of an offshore wind farm, based on a comparative overview of different national legislative systems.

Keywords

Offshore wind, law of the sea, UNCLOS, wind energy, comparative overview, EU law, national law, environmental impact, decommissioning

Contents

[1] The research for this chapter is based on earlier work funded by PROMOTioN (Progress on Meshed HVDC Offshore Transmission Networks) <www.promotion-offshore.net>. This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 691714.

IX.45.1 Introduction

Although utilising onshore wind energy is essential for many states hoping to reach their energy transition targets, the large visual impact on the landscape that wind farms have has made finding locations to build them a difficult endeavour.[2] Fewer problems of this nature exist in relation to offshore wind, provided the wind farms are located sufficiently far from the coast. Moreover, the large scale of offshore wind projects allows for large quantities of renewable energy to be produced, while, as a general rule, the wind blows at higher speeds and for more hours at sea.[3] For these reasons, many countries with extensive coastlines have resorted to using offshore wind energy. While the technology behind offshore wind energy is more expensive than for onshore wind, cost reductions realised in recent years are promising for the sector.[4] In the North Sea especially, a large offshore wind energy sector has developed over the last few decades. The North Sea is popular for offshore wind due to its relatively shallow depths and favourable seabed conditions. Foundations for turbines can be safely drilled into the sand and mud of the seabed, with the area itself being relatively flat. Although the North Sea still boasts the largest offshore wind market, other offshore wind markets have emerged around the world.[5]

To enable further growth of the offshore wind sector, it is important to have a stable legislative framework at all levels. After a short factual background, this chapter explains the current legal framework at international, European and domestic levels, highlighting gaps in the existing legal framework. In section IX.45.3, questions of jurisdiction over offshore wind farms and international environmental law are discussed. As a large proportion of offshore wind energy is located in the territory of EU Member States (MSs), section IX.45.4 discusses the scope of EU law applicable to offshore wind farms, as well as looking at substantive EU law. Coastal states have many differences in their national jurisdiction concerning offshore wind, and these choices are highlighted and explained in section IX.45.5. To conclude, section IX.45.6 contains some insights on future directions of the offshore wind sector.

IX.45.2 Factual background

IX.45.2.1 Historical development

Vindeby (erected 1991, decommissioned 2017) was the world's first offshore wind farm, with the turbines located 1.5–3 km off the coast of Denmark.[6] During the 1990s and early 2000s, several North Sea coastal states experimented with small near-shore installations,

---

[2] See Chapter 37.

[3] Hau (2013) 677.

[4] WindEurope, 'World's first offshore wind farm without subsidies to be built in the Netherlands' (*WindEurope*, 20 March 2018) <https://windeurope.org/newsroom/press-releases/worlds-first-offshore-wind-farm-without-subsidies-to-be-built-in-the-netherlands/> accessed 10 December 2019; Algemene Rekenkamer (2018) 14, 17, 19.

[5] In 2017, China, Vietnam, Japan, South Korea, USA and Taiwan are the countries outside Europe that engage in offshore wind energy. GWEC, 'Global Cumulative Offshore Wind Capacity in 2017' (*GWEC* 2017) <http://gwec.net/wp-content/uploads/2018/04/6_Global-cumulative-Offshore-Wind-capacity-in-2017-1.jpg> accessed 10 December 2019.

[6] EWEA (2009).

with Denmark and the UK leading the way – continuously scaling up their offshore wind farms in terms of capacity, and the size and number of turbines.[7] The sector was given fresh impetus by the adoption of (binding) renewable energy goals,[8] which triggered North Sea coastal states to plan for the deployment of large-scale offshore wind farms over the following decades. At the same time, offshore wind expanded internationally, particularly in the USA, China, Vietnam, South Korea and Taiwan.[9] In 2018, an important milestone was reached: the large cost reductions realised for offshore wind (courtesy of technological innovation, economies of scale and developments in other industries, such as the offshore oil and gas sector and the financial sector) allowed for several wind farms to be commissioned and constructed without the need for any operational subsidies.[10]

IX.45.2.2 Technical background

To understand the legal situation of offshore wind farms, it is important to have a basic understanding of the technical background of the turbines and wind farms, especially concerning their foundations and their connection to the onshore electricity grid.

Offshore wind turbines are large, heavy constructions, requiring sturdy foundations to stand up to the barrage of strong waves, winds and currents that are thrown their way. The foundations can be either fixed or floating. Fixed wind turbines have a foundation drilled into the ground (monopile or tripod) or a heavy gravity-based foundation,[11] while floating wind turbines are attached to their location through anchors, mooring lines, or other cable constructions.[12]

The connection to the onshore electricity grid is, understandably, different for offshore wind farms than it is for onshore wind farms. Often, the distance to the nearest connection point is much farther. Moreover, this distance cannot be bridged by the overhead lines commonly used for onshore electricity transmission. Instead, cables must be buried in the seabed, with one (or multiple) 'substation(s)' – separate installations located near the wind farm itself – used to transform the electricity to a higher voltage. For distances beyond 80–100 km, a converter station is needed to switch the electricity from alternating current (AC) to direct current (DC), in order to minimise electrical losses on the transmission cable. Opinions and legal systems differ on the question of whether the electrical infrastructures needed to transmit the electricity to the onshore grid constitute part of the offshore wind farm or whether they are separate installations.[13]

---

7 ibid.
8 See Chapter 33 of this book.
9 Gao and Fan (2017).
10 WindEurope (n 4). These wind farms will still be supported through their cable connections, which are paid by the electricity consumers through the transmission tariffs). However, the fact that no operational aid per MWh will be given is still a breakthrough.
11 Passon (2015) 14 *et seq*.
12 Andersen (2016) 9 *et seq*.
13 For more on this, see Chapter 56 of this book. See also: Müller (2016).

IX.45.3 International law

IX.45.3.1 Jurisdiction over offshore wind farms

For the legal framework of *offshore* wind farms, it is important to understand the extent to which coastal states have the competence to adopt regulations – for instance by making their laws applicable to installations at sea. Offshore wind farms do not fall under the territorial jurisdiction that states have over their land territory (*terra firma*). The extent to which coastal states can manage offshore activities is regulated by the UN Convention on the Law of the Sea (UNCLOS).[14]

UNCLOS divides the sea into different zones, with legal implications corresponding to each zone. As a result, the extent to which coastal states have jurisdiction to establish a regulatory regime for offshore wind farms depends on the location of the wind farms. Areas up to 12 nautical miles (22 km) from the coastline are considered an extension of a state's *terra firma* territory; with states holding territorial sovereignty over activities within this zone, including the installation of wind turbines and cables.[15] The Exclusive Economic Zone (EEZ) spans from the end of the territorial sea up to 200 nautical miles from the coastline, with UNCLOS expressly stating that states have exclusive jurisdiction over the exploitation of natural resources in this zone.[16] One of the natural resources – the exploitation of which is covered under the exclusive jurisdiction of coastal states – is 'energy from the water, currents and the winds'.[17] This means that the development of offshore wind energy in the EEZ falls within the jurisdiction of coastal states.[18] It must be noted that this jurisdiction is not considered full jurisdiction: it is merely 'functional', granting coastal states jurisdiction only over activities necessary for the exploration or exploitation of the natural resources in the EEZ. Laws applicable onshore do not automatically apply offshore and must actively be made applicable to the EEZ. The legal framework concerning cables connecting offshore wind farms to the onshore electricity grid is discussed in a separate chapter.[19]

The rights of the coastal state to regulate the construction and the exploitation of offshore wind farms are, to a certain extent, limited by the rights of other states. All states enjoy the freedom of navigation (as well as several other freedoms) in the EEZ and on the high seas.[20] Due to the distance between wind turbines and the safety zone around them, wind farms stretch over large areas, and may form an impediment to the freedom of navigation. Coastal states must consider this when constructing wind farms.[21] In practice, any friction between the rights of the coastal state to exploit the wind resources and the freedom of navigation is minimised by opting not to commission wind farms in shipping lanes, and by allowing smaller vessels to sail through the affected area.

---

[14] United Nations Convention on the Law of the Sea (adopted 10 December 1982, entered into force 16 November 1994) 1833 UNTS 3 (UNCLOS).
[15] UNCLOS arts 2–3.
[16] UNCLOS art 56.
[17] UNCLOS art 56(1)(a).
[18] UNCLOS art 56. See also: Müller (2016) 35 *et seq*.
[19] Cf. Chapter 56 of this book.
[20] UNCLOS art 87.
[21] UNCLOS arts 56(2), 58(1), 87(1).

The existing legal framework for offshore wind is silent on the legal status of wind farms beyond the EEZ. At present, there are no offshore wind farms located at such distances from the shore, with construction and connection expensive – but this may change with technological advancements in floating turbine and transmission cable technologies. Beyond the 200 miles of the EEZ, the legal framework of the high seas is applicable.[22] Due to the principle of *mare liberum* (the free sea), no state may claim jurisdiction over this area. However, there are attractive wind resources which may be of interest to various states, potentially sparking a debate over the legal regime for wind energy on the high seas.[23]

Another interesting issue in international law is that, whereas the legal status of fixed offshore wind turbines in the EEZ is clear under international law, questions may arise regarding the various types of floating wind farms. The distinction as to whether floating wind turbines are to be classified as *ships* or rather as *installations* under the law of the sea influences the legal status of floating turbines. A similar discussion exists over the legal status of floating oil or gas production platforms.[24] Therefore, to address this question, the analogy to the offshore oil and gas sector will be made.

In the absence of a specific definition of *ship* in the law of the sea, it is helpful to look at the general understanding of the word, and to definitions from various national jurisdictions. Through this method, common criteria emerge; criteria such as 'able to transport goods or persons' and 'can be used for navigation', which, under some jurisdictions, can also be the case when a vessel is towed.[25] In the oil and gas sector, some platforms are designed to be able to navigate to the location where they will be used, either independently or towed by another vessel. They are classified as ships rather than as installations due to this design.[26] In the case of floating wind turbines, they are not designed to transport persons or goods (their shape is unsuitable for navigation), and they spend most of their lifetime anchored at the same position. Therefore, it is reasonable to classify a floating wind turbine as an *installation* rather than as a *ship*. This means that, in practice, coastal states will also have jurisdiction over floating wind farms in their EEZ.[27]

IX.45.3.2 International environmental law

International environmental law plays a role in offshore wind energy, with UNCLOS providing that states have a duty to protect and conserve the marine environment.[28] With regard to offshore wind energy, this entails limiting the impact of offshore wind farms on the marine environment. Following the life cycle of an offshore wind farm, this could have implications for wind farms near nature conservation areas at sea and, more generally, in sensitive habitats.[29] In the construction phase, the noise from the drilling of

---

22 UNCLOS part VII, art 86 *et seq*.
23 Elsner and Suarez (2019).
24 Esmaeili (1999). See also: Elsner and Suarez (2019).
25 ibid.
26 ibid.
27 ibid.
28 UNCLOS art 192.
29 European Commission (2011).

the turbine foundations may be limited, as the noise could disturb marine mammals.[30] During the operational phase, wind turbines could be switched off when a flock of birds or bats crosses the wind farm.[31] The current lack of clear guidelines for states on how to reduce the impact of offshore wind farms on the maritime environment represents a *lacuna* in international environmental law.

Per international environmental law, installations at sea must be removed when they are no longer in use.[32] The first reason for removal is safety of navigation,[33] with the health of fisheries and the protection of the maritime environment as secondary reasons. The removal of installations should take place according to generally accepted standards. These 'generally accepted standards', set by a competent international organisation, referred to in article 60(3), are available through guidelines adopted by the International Maritime Organisation (IMO).[34] Nevertheless, this document seems to refer to the oil and gas industry rather than to offshore wind farms. Concerning the North East Atlantic (including the North Sea), additional guidelines on the decommissioning of installations have been adopted under the OSPAR Convention[35] – although, as with the IMO standards, these guidelines have been drafted with the offshore oil and gas industry in mind.[36] While parallels can be drawn to the existing documents for the offshore oil and gas industry, some questions are specific to the offshore wind industry – such as the treatment of the cables between different turbines of the same wind farm after decommissioning the turbines, and the decommissioning obligations regarding the thousands of monopiles drilled into the seabed. Therefore, additional guidelines for the decommissioning of offshore wind energy installations would be a valuable addition to international environmental law.

IX.45.4 European law

For 84 per cent of the total installed capacity of offshore wind energy (2017),[37] an extra layer of legislation, EU law, is applicable. As EU law is applicable to such a large percentage of the sector, this extra layer warrants significant coverage.

---

30 Dähne and others (2017).

31 This can be done based on radar images. See: Fijn and others (2015).

32 UNCLOS art 60(3). Cf. Chapter 24 of this book.

33 Based on the text of UNCLOS art 60(3): 'Any installations or structures which are abandoned or disused shall be removed to ensure safety of navigation [. . .]. Such removal shall also have due regard to fishing, the protection of the marine environment and the rights and duties of other States'.

34 Resolution A.672(16), adopted 19 October 1989 'IMO Guidelines and Standards for the Removal of Offshore Installations and Structures on the Continental Shelf and the Exclusive Economic Zone'.

35 Convention for the Protection of the Marine Environment of the North-East Atlantic (adopted 22 September 1992, entered into force 25 March 1998) 2354 UNTS 67 (OSPAR Convention). For additional decommissioning guidelines, see: OSPAR Decision 98/3 on the Disposal of Disused Offshore Installations <www.ospar.org/documents?v=6875> accessed 10 December 2019.

36 Fleming, Mas and Nieuwenhout (2018).

37 GWEC (n 5).

IX.45.4.1 Scope of jurisdiction

It is important to note that the EU can only act in so far as its competences allow it to,[38] with these competences endowed to the EU by its MS through the founding treaties. It is necessary to ascertain the extent to which coastal states are able to confer their (functional) jurisdiction in the EEZ to the EU. Based on Court of Justice of the EU (CJEU) jurisprudence, as well as EU external relations law, the EU can exercise jurisdiction in so far as coastal states have jurisdiction, subject to the competences granted to it.[39] It follows that states cannot confer competences to legislate in areas in which they have no right to legislate.[40]

It is necessary to check how the competences relevant to regulating offshore wind ('energy'[41] and 'environment'[42]) are divided. Article 194 TFEU sets out the specific competences regarding energy, with it being expressed that Member States retain sovereignty over primary energy sources. Wind energy as such is therefore not regulated at EU level, although renewable energy more generally is.[43] Nevertheless, several topics of EU law are highly relevant for the legislative framework of offshore wind.[44]

IX.45.4.2 Substantive EU law

It is helpful to analyse the effect that EU legislation may have over the lifetime of an offshore wind farm. The first relevant legislation is in the areas of EU environmental law and maritime spatial planning law. The EU has had a long history of law-making in environmental law generally,[45] whereas offshore planning law is a relatively new topic.[46] The Strategic Environmental Assessment (SEA) Directive is applicable to public plans and programmes regarding offshore wind energy, as these are likely to set the framework for future development consent for such a project.[47] Moreover, the EIA Directive is applicable, which means that an environmental impact assessment (EIA) must be performed for every new wind farm or significant change to an existing wind farm when it is likely to have an impact on the environment by virtue of its nature, size or location, to be determined by national authorities.[48] Additionally, the Habitats and Birds Directives have an impact on offshore wind energy policy, especially when offshore wind farms are planned close to Natura 2000 areas, which are protected under these Directives.[49] An

---

[38] Consolidated Version of the Treaty on the Functioning of the European Union [2008] OJ C 115/47 (TFEU) art 5(2).

[39] Mehta (2012).

[40] Müller (2016) 68 *et seq*.

[41] TFEU art 194.

[42] TFEU arts 191–3.

[43] Long (2014) 699.

[44] ibid 701.

[45] Jans and Vedder (2012).

[46] Directive 2014/89/EU of the European Parliament and of the Council [2014] OJ L 257/135.

[47] Directive 2001/42/EC of the European Parliament and of the Council [2001] OJ L 197/30 (SEA Directive).

[48] Directive 2011/92/EU of the European Parliament and of the Council [2011] OJ L 26/1. Wind farms are mentioned in Annex II, which means that the Member States must determine whether they require an EIA.

[49] Council Directive 92/43/EEC [1992] OJ L 206/7 (Habitats Directive); Directive 2009/147/EC

interesting debate in environmental law surrounds the extent to which the interests of preserving the local maritime environment can be compromised in order to reach goals on renewable energy and CO_2 reduction, for which large-scale (offshore) wind farms are needed. As with other environmental law topics, this balance should be based on a solid (cumulative) environmental impact assessment.

Regarding the operational phase of offshore wind farms, there is a large body of EU law relevant to grid connection of offshore wind.[50] The general internal market rules, mandating that states follow rules on free movement of goods and services, are applicable – as are EU state aid rules, which impact how (financial) support for offshore wind farms may materialise.[51] Finally, there are several technical standards and safety rules applicable to offshore wind farm construction sites.[52]

IX.45.5 Approaches to regulating offshore wind under national law

Although international law (and, for EU states, EU law) creates the boundaries of the legal framework for offshore wind, the legislative choices made at the national level determine how the sector develops in different countries. This section elaborates on possible choices concerning legal frameworks for offshore wind. As before, it follows the lifetime of an offshore wind farm – from planning and permitting, to construction, operation and decommissioning.

IX.45.5.1 (Pre-)construction phase

An analysis of the legislative systems of different coastal states highlights several options for differentiation. The planning and permitting phase can be organised either centrally, with specific designated offshore wind energy areas, or based on an open-door system in which any interested party may file a proposal for the construction of an offshore wind farm. A centralised approach can be used to concentrate wind energy in less (ecologically or economically) valuable areas, whereas an open-door system will lead to offshore wind energy spread out over a larger area. Germany, Belgium and the Netherlands utilise centralised planning systems,[53] while Norway and Sweden have opted for complete open-door systems.[54] Denmark utilises both a centralised system and an open-door system, although the latter is barely used in practice. The UK takes a middle road, with certain designated areas available to interested parties in tender rounds.[55] In China, planning and permitting are organised by the coastal provinces via offshore wind power development plans.[56] In the US, leases for specific areas are made available to the market, and

---

of the European Parliament and of the Council [2009] OJ L 20/7 (Birds Directive). European Commission (2011) 5.

[50] For more on this topic, see Chapter 56 of this book.

[51] TFEU arts 34, 101–2, 106–7.

[52] Council Directive 92/57/EEC [1992] OJ L 245/6; Council Directive 89/391/EEC [1989] OJ L 183/1.

[53] Nieuwenhout (2017) 82, 92.

[54] ibid 102.

[55] ibid 106–7.

[56] Notice No. 29 [2010] of the National Energy Administration (China), Interim Measures for Management of the Development and Construction of Off-Shore Wind Power, 22 January 2010, chapter 2.

auctioned if multiple parties are interested.[57] The centralised planning approach is often preferred for large-scale offshore wind deployment in a relatively small area, whereas if only small-scale wind deployment is envisaged and plenty of space is available, an open-door regime will suffice.

Concerning the licences needed for the construction of an offshore wind farm, many different national systems exist. As a general trend, most countries require at least two different licences: a construction licence and an exploitation licence or concession. The construction licence is required for the construction of any installation, and often includes rules on the safety of the operation, environmental impact mitigation, and practical information such as how and where the construction will take place. The exploitation licence for the production of electricity from a wind farm typically includes the duration of the exploitation phase, information on the financial and technical capacities of the wind farm owner (assessing whether the company is technically and financially capable of operating a wind farm) and details of decommissioning requirements. A less complicated permitting system typically facilitates the construction of offshore wind energy, whereas a complex system can be perceived as a barrier.

IX.45.5.2 Operational phase

There are three main environmental law issues relating to the operational phase of offshore wind farms. Firstly, the maintenance of the wind turbines – carried out by the concession holder (the owner of the wind farm) or by a third party – can be organised in such a way that the environmental impact is minimised. This relates, for example, to the type of paint used on the installation, and could be included in the permit. Secondly, rules need to be adopted regarding co-existence with other activities, such as aquaculture and fisheries. As an example, the approach on fishing inside wind farm areas differs by country, with the environmental impact of combining these activities warranting further investigation. Thirdly, the rules on ecological impact mitigation differ per country, and sometimes even per concession. In some wind farms, it is required that turbines be switched off when a flock of birds or bats is close to the wind farm.

Besides these environmental issues, the coastal states' approaches on (financial) support for offshore wind and on the connection costs to the onshore grid, whether borne by the wind farm developer or socialised through taxes or through the national transmission company's tariffs, differ. These instruments are used to facilitate the deployment of offshore wind energy.

IX.45.5.3 End of lifetime

Decommissioning offshore wind farms deserves special attention in international environmental law. It is an upcoming issue, with hundreds of wind farms due to reach the end of their operational lifetime within the coming decade.[58] Whereas many states already have some provisions on decommissioning in place (for example the adoption of a

[57] Gao and Fan (2017) 154–5.
[58] Topham and McMillan (2017) 471; Fleming, Mas and Nieuwenhout (2018).

decommissioning obligation in the construction permit and/or the exploitation permit),[59] the exact obligations for the wind farm owners are still unclear in many countries.

Coastal states must decide the extent to which wind farms should be removed after usage, *i.e.* full removal and complete restoration of the area in its original state, or only removal of the parts of the wind farm above the seabed, leaving part of the foundations and cables in place. Where the phrase 'restoration in original state' is used, the appropriate decommissioning standard should be specified, with consideration of how this may be applied when the original state of an area has changed significantly – particularly when it has changed for the better, for example due to the 'artificial reef effect'.[60] The securing of finance for decommissioning through legal constructions such as bank guarantees is another topic important for the law of decommissioning offshore wind farms. Just as in the offshore oil and gas sector, funds for decommissioning need to be secured for instances where the ownership of the wind farm is transferred or when a bankruptcy occurs.[61]

IX.45.6 Conclusion

In just thirty years, the offshore wind sector has seen a large growth from small pioneer test sites to wind farms with a capacity of more than a gigawatt. The North Sea, as the birthplace of the offshore wind industry, still hosts the largest offshore wind capacity in the world. This is no surprise, as it is a shallow sea with densely populated areas around it, and the coastal states have high ambitions in terms of the production of renewable energy. Nevertheless, offshore wind energy is also emerging in other parts of the world.

With the significant development of offshore wind energy, the legal framework for offshore wind energy also had to develop. This chapter analyses the legal framework on international, European and national levels. In environmental law, the main tension exists between the impact on the local maritime environment (and especially maritime ecology) and the goals to reduce CO_2 emissions, while increasing the share of renewable energy. Another point of interest is the decommissioning of offshore wind farms and the environmental impact thereof, with the adoption of additional guidelines on decommissioning fast becoming a necessity. In the differing national legislative approaches to offshore wind, it is important to take environmental impact into account in each phase of the project: (pre-)construction; the operational phase; and decommissioning.

Looking to the future, it is expected that floating wind farms will develop further over the coming decades. This means that the geographical spread of offshore wind will likely become larger, as turbine location will no longer be confined to shallow seas such as the North Sea. The opportunity in the near future for offshore wind farms to be combined with other activities, such as aquaculture and energy storage or conversion (power to gas), will doubtless raise additional legal questions. With new activities within wind energy areas, new gaps in the legislative framework will have to be filled.

---

[59] Nieuwenhout (2017) 164–5.
[60] Langhamer (2012).
[61] See Chapter 24.

Bibliography

Algemene Rekenkamer, 'Focus op kosten windenergie op zee' (Algemene Rekenkamer 2018) <https://www.rekenkamer.nl/publicaties/rapporten/2018/09/27/focusonderzoek-kosten-van-windparken-op-zee> accessed 10 December 2019.

Andersen MT, 'Floating Foundations for Offshore Wind Turbines' (PhD thesis, Aalborg University 2016).

Dähne M and others, 'Bubble Curtains Attenuate Noise from Offshore Wind Farm Construction and Reduce Temporary Habitat Loss for Harbour Porpoises' (2017) 580 Marine Ecology Progress Series 221.

Elsner P and Suarez S, 'Renewable Energy from the High Seas: Geo-spatial Modelling of Resource Potential and Legal Implications for Developing Offshore Wind Projects beyond the National Jurisdiction of Coastal States' (2019) 128 Energy Policy 919.

Esmaeili H, 'The Legal Regime of Offshore Oil Rigs in International Law' (PhD thesis, University of New South Wales 1999).

European Commission, *Wind Energy Developments and Natura 2000* (1st edn, European Union 2011).

EWEA, 'Operational Offshore Wind Farms in Europe, End 2009' (*EWEA* 2009) <www.ewea.org/fileadmin/ewea_documents/documents/statistics/OperationalOffshoreFarms2009.pdf> accessed 10 December 2019.

Fijn RC and others, 'Bird Movements at Rotor Heights Measured Continuously with Vertical Radar at a Dutch Offshore Wind Farm' (2015) 157(3) International Journal of Avian Science 558.

Fleming R, Mas H and Nieuwenhout CT, 'Wind Farm Waste – Emerging Issues with Decommissioning and Waste Regulation in the EU, Denmark and the United Kingdom' (2018) 16(2) OGEL <https://www.ogel.org/article.asp?key=3756> accessed 10 December 2019.

Gao AM and Fan J (eds), *The Development of a Comprehensive Legal Framework for the Promotion of Offshore Wind Power: The Lessons from Europe and Pacific Asia* (1st edn, Wolters Kluwer 2017).

Hau E, *Wind Turbines: Fundamentals, Technologies, Application, Economics* (3rd edn, Springer 2013).

Jans JH and Vedder HHB, *European Environmental Law* (4th edn, Europa Law Publishing 2012).

Langhamer O, 'Artificial Reef Effect in Relation to Offshore Renewable Energy Conversion: State of the Art' (2012) The Scientific World Journal Article ID 386713 <https://www.hindawi.com/journals/tswj/2012/386713/cta/> accessed 10 December 2019.

Long R, 'Harnessing Offshore Wind Energy: Legal Challenges and Policy Conundrums in the European Union' (2014) 29(4) The International Journal of Marine and Coastal Law 690.

Mehta RS, 'The Continental Shelf: No Longer a "Terra Incognita" to the EU' (2012) 49(4) Common Market Law Review 1395.

Müller HK, *A Legal Framework for a Transnational Offshore Grid in the North Sea* (1st edn, Intersentia 2016).

Nieuwenhout CT, 'Legal Framework and Legal Barriers to an Offshore HVDC Electricity Grid in the North Sea' (2017) PROMOTioN deliverable 7.1 < https://www.promotion-offshore.net/fileadmin/PDFs/D7.1_-_Legal_framework_and_legal_barriers_to_an_offshore_HVDC_electricity_grid_in_the_North_Sea.pdf> accessed 10 December 2019.

Passon P, *Offshore Wind Turbine Foundation Design: Selected Topics from the Perspective of a Foundation Design* (1st edn, DTU Vindenergi 2015).

Topham E and McMillan D, 'Sustainable Decommissioning of an Offshore Wind Farm' (2017) 102 Renewable Energy 471.