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"The Benelux cooperation and offshore wind energy in the North Sea"

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Ai miei genitori, per tutto il loro supporto,

e a mio nonno.

Preface

Offshore wind energy is becoming the cornerstone of the energy transition in Europe and at the global scale. Many Member States of the European Union have plans to deploy more offshore wind as a way to reach their 2020 and 2030 renewable energy targets, including Belgium and the Netherlands – both countries with important targets.

In an ever-closer European Union, where Member States share more and more products and services, including electricity, the aspect of regional, cross-border cooperation is assuming increasing relevance. The North Sea is the first sea basin in Europe in terms of offshore wind energy capacity installed, and Europe is the first continent globally in terms of capacity installed, even though facing growing international competition. Belgium and the Netherlands both have coastlines in the North Sea and are already cooperating with the other Member States of the sea basin to understand how more wind energy can be installed in a more cost-efficient way, through an institutionalized arena called the North Sea Energy Forum.

The Benelux is part of this Forum, hence being the example of a regional cooperation mechanism within another regional cooperation structure. What emerged from a first targeted literature review and collection of various institutional information, nevertheless, is the fact that Belgium, the Netherlands and Luxembourg are carrying on independently their own national policies on energy and environment and are participating in the Forum in their individual capacity. This individualism might result surprising if one considers that one of the key pillars of the Benelux Union cooperation is energy, with particular emphasis on renewable sources. Hence, the willingness to dig in this topic.

From a first analysis of these apparently contrasting elements a series of questions arose: is the Benelux Union active and proactive in the domain of renewable energy? What are the tangible elements of this activity? If Benelux is not participating in the North Sea Energy Forum as a Union, what is the role of Luxembourg – the only country with no access to the sea? And again, should further cooperation in the field of renewable energy, and particularly offshore wind energy, be implemented, what form would it take? And ultimately, how could the Benelux Union be a trigger to develop more offshore wind in the North Sea?

To my knowledge, this work is a first-of-a-kind attempt to answer the questions above and I hope it can represent a contribution to further research in the domain.

For the content-related support received, I need to extensively thank all of those who helped and inputted my research – their individual contribution is acknowledged at the end of this work.

Less content-related but still extremely important, the support received by my family and friends throughout the completion of this Masters' Degree: a huge *thank you*, all.

Abstract

This work investigates the role of the Benelux Union in supporting deployment of offshore wind energy in the North Sea. Offshore wind energy is a fast growing technology that plays a pivotal role in the attainment of the EU 2020, 2030 and 2050 decarbonisation objectives and both Belgium and the Netherlands have ambitious plans for installations. To achieve these objectives, the EU significantly relies on regional cooperation instruments and offshore wind energy emerges as a technology that may strongly benefits from closer cooperation across countries. The Benelux Union in itself is a solid, already existing platform of cooperation focusing on energy as per its institutional mandate, and the Benelux countries are all part of larger network for cooperation on renewable energy, including the North Sea Energy Forum led by the European Commission and boosting offshore wind in the North Sea.

If the Benelux Union could emerge as an ideal platform for an important, enhanced cooperation on offshore wind energy, what emerges from the analysis is that today's Benelux Union cooperation on energy does not focus on this domain, despite the countries' ambitious plans for installations of wind turbines off their coasts. The key aspects of cross-border cooperation in offshore wind are rather discussed with other countries, in the framework of the North Seas Energy Forum by Luxembourg, Belgium and the Netherlands but without the Benelux Union being represented as a single entity. In fact, the three countries seem to run completely independent energy policies. On the legal side of the analysis, nothing seems to prevent Benelux from starting a closer collaboration within its structure that aims at deploying more efficiently offshore wind in the North Sea.

Luxembourg does not have access to the sea but actively participates in all the institutional discussions. This work considers that one way the Grand Duchy could benefit from offshore wind installations is the so-called 'statistical transfer' of the electricity produced offshore – a cooperation mechanism envisaged by the EU to support countries reaching their renewable energy targets.

In exploring what role could the Benelux Union have in the future to support effective offshore wind deployment in the North Sea, expert industry representatives have been asked what areas for a future Benelux cooperation they foresee as a priority, and their replies are gathered in the final chapter of this work. A joint Marine Spatial Planning, coordination on the timeline of offshore installations, ports facilities, common training and formation, a regional CO2 floor price and even the suggestion of building a joint cross-border pilot project are all areas identified as a priority to boost cost-efficient offshore wind installations in the future. An enhanced Benelux cooperation in these areas could probably pave the way for further cooperation and harmonization at the European level.

Résumé

Ce travail étudie le rôle de l'Union Benelux dans le soutien au développement de l'énergie éolienne offshore en mer du Nord. L'énergie éolienne offshore est une technologie en pleine croissance qui joue un rôle central pour atteindre les objectifs de décarbonisation de l'UE en 2020, 2030 et 2050 ; et la Belgique et les Pays-Bas ont des projets ambitieux en termes d'installations.

Pour réaliser ces objectifs, l'UE s'appuie sur des mécanismes de coopération régionale, dont certains sont prévus dans la dernière directive sur les énergies renouvelables. Par ailleurs, l'Union Benelux est une plate-forme de coopération renforcée de longue date, qui se concentre sur l'énergie depuis le traité fondateur et autres programmes de travail. De plus, les pays du Benelux font tous partie du Forum sur l'énergie de la mer du Nord, dirigé par la Commission européenne et les gouvernements du pourtour de ce bassin maritime. Tous ces éléments réunis ont contribué à la formulation de la question incipit.

Il ressort de l'analyse que la coopération actuelle de l'Union Benelux en matière d'énergie ne se concentre pas sur l'énergie éolienne en mer, malgré les plans ambitieux des pays membres et l'intérêt général de poursuivre l'exploration de ce secteur. Les principaux aspects de la coopération transfrontalière dans le domaine de l'éolien offshore sont surtout discutés au sein du Forum sur l'énergie des mers du Nord, sans que le Benelux ne soit représenté comme une entité à part entière. Au lieu de cela, les trois pays sont représentés indépendamment et mènent des politiques énergétiques indépendantes. L'Union Benelux a annoncé son intention de mettre l'accent sur une coopération étroite pour la création des plans 2030 Énergie et Climat prescrits par le règlement sur la gouvernance de l'UE, qui doivent être soumis à la Commission d'ici la fin de l'année. Le Luxembourg n'a pas d'accès à la mer mais participe activement à tous les forums susmentionnés.

Le transfert statistique de l'électricité produite en mer (mécanisme de coopération prévu dans la RED) serait un moyen de tirer parti des installations éoliennes offshore. Avec ce mécanisme, le Luxembourg prendrait une place plus centrale et la coopération de l'Union Benelux placerait ainsi les trois pays sur un pied d'égalité. Sur le plan juridique de l'analyse, rien ne semble empêcher l'Union Benelux de coopérer en vue de déployer davantage d'éoliennes en mer du Nord.

Dans le cadre de cette recherche, les représentants de l'industrie éolienne en mer ont été interrogés sur les domaines de priorité de leur coopération future avec le Benelux. Leurs réponses sont rassemblées dans le dernier chapitre de ce rapport. Une planification spatiale marine conjointe, une coordination au niveau de la chronologie des installations en mer, et portuaires, des formations conjointes, un prix

plancher régional pour le CO_2, une harmonisation des normes techniques et même la possibilité de développer un projet pilote commun, sont tous des sujets identifiés comme prioritaires pour stimuler l'installation de projets éoliens offshore rentables. Une coopération renforcée au sein du Benelux pourrait donc ouvrir la voie à une coopération et à une harmonisation plus accrue au niveau européen.

Contents

List of acronyms, abbreviations and units

BEMIP – Baltic Energy Market Interconnection Plan

BOP – Belgian Offshore Platform

CH4 – Methane

CO2 – Carbon Dioxide

CO2eq – Carbon Dioxide Equivalent

DG Clima – Directorate-General for Climate Action of the European Commission

DG Energy – Directorate-General for Energy of the European Commission

EEZ – Exclusive Economic Zone

EIA – Environmental Impact Assessment

EU - European Union

ENTSO-E – European Network of Transmission System Operators for Electricity

ETS – Emissions Trade System

GDP - Gross Domestic Product

GHG – Greenhouse Gas

GWO – Global Wind Organisation

HV – High Voltage

H&S – Health & Safety

IEA – International Energy Agency

IEM – Internal Energy Market

IFIs - International Financial Institutions

IRENA – International Renewable Energy Agency

kton – Kilo Tonne

LCoE – Levelized Cost of Energy

MS - Member States of the European Union

MSP – Marine Spatial Planning

MSPD – Marine Spatial Planning Directive

NECPs - National Energy & Climate Plans

NSEF – North Seas Energy Forum

NSCOGI –North Sea Common Offshore Grid Initiative

N2O – Nitrous Oxide

OECD - Organisation for Economic Co-operation and Development

OWF – Offshore Wind Farm

O&M – Operation and Maintenance

PFC – Perfluorocarbons

RED – Renewable Energy Directive

RED I – Renewable Energy Directive 2009

RED II – Renewable Energy Directive 2018

SEA – Single European Act

TEU – Treaty on the European Union

TFEU – Treaty on the Functioning of the European Union

TSO – Transmission System Operator

UN – United Nations

UNCLOS – United Nations Convention on the Law of the Seas

UNFCCC- United Nations Framework Convention on Climate Change

Introduction

Research question. In an attempt to decarbonize its economy and meet the international obligations to fight climate change, the European Union is leading an important energy transition process that sees the development of renewable energy as a fundamental component. Because of its advantages as compared to other technologies, offshore wind energy is becoming increasingly relevant in the European and national energy discussions and is acknowledged by the European Commission and other international organisations as being on the way to become one of the dominant renewable power generation technologies in Europe by 2050.

On the way to mid-century accomplishments, the European Union and its Member States are setting shorter-term renewable energy targets with main benchmarks in the years 2020 and 2030. In order to reach these targets, cross-border cooperation mechanisms are envisaged in EU secondary legislation and dedicated *fora* for collaboration exist. One of these platforms is the North Seas Energy Forum that looks into cost-effective deployment of offshore wind in the North Seas and to which the Benelux countries are part.

Given the importance of cross-border cooperation in the deployment of offshore wind energy – by nature highly reliant on transboundary planning, infrastructures and supply chains -, this work tries to investigate to which extent the current Benelux cooperation is supportive of offshore wind power development. The question originates from various considerations: primarily, Benelux is the forerunner of today's EU internal market and the Benelux Union treaty explicitly mentions that energy is one key cooperation area. Secondly, both the Netherlands and Belgium have ambitious plans as to the deployment of offshore wind energy and are already in constant dialogue with the European Commission and other Member States surrounding the North Sea basin in the North Seas Energy Forum. Thirdly, in the context of this institutionalized Forum, the Benelux Union could potentially work as an enhanced cooperation union within a more extended cooperation. Fourth, Luxembourg participates in the North Seas discussions even if it lacks access to the sea. All these elements together are an indicator that a cooperation exists, but what form it takes today and how it could evolve in the future is the topic of this research.

Structure. To address the main research topic, it is necessary to break down the work into different sub-topics. The first chapter provides an overview of the wider European context that supports the pathways towards decarbonisation. It introduces the competences and targets that the EU and its Member States - particularly the Netherlands, Belgium and Luxembourg - have on renewable energy and explains the role that regional cooperation plays in boosting renewable energy deployment, particularly offshore wind energy. Importantly, the first chapter also introduces the current status of the Benelux Union collaboration on energy. The second chapter explains what is the role of the offshore wind energy technology in decarbonizing the wider energy system and, by large, the European economy. It analyses the main advantages and disadvantages of deploying more offshore wind power and provides an overview of the latest status of installations at the European and global levels. The third chapter outlines the legal frameworks for offshore wind installations in Europe, with a look at Belgium and the Netherlands, trying to understand if and what sort of cooperation in offshore wind energy amongst the three Benelux countries is currently in place. In this chapter, attention is paid to the advantages that Luxembourg could receive from an enhanced cooperation on offshore wind despite not having a territorial sea. The fourth chapter is an attempt to consider what shape the Benelux cooperation could take in the future: with the help of industry representatives, it lists areas of cross-border collaboration that are considered important for a cost-efficient deployment of offshore wind in the Belgian and Dutch seas over the next years.

***Ex-ante* methodology considerations.** This thesis is a compilation work. The first three chapters build primarily on desk research and literature review. The main sources of information are: International, EU and national legislation and soft law, institutional websites (particularly for the first and third chapters), textbooks, scientific papers, specialized magazines (particularly for the second chapter). The fourth chapter is built on input provided by industry representatives, who were requested to identify priority areas where they would welcome a closer Benelux cooperation, particularly between the Netherlands and Belgium, as a way to ease the development of their business. This chapter is particularly important in trying to address the main research question that investigates if and how the Benelux cooperation can support the development of offshore wind energy in the North Sea. The question to the industry was left open on purpose (i.e. not channeled into pre-defined questions), in order to gather as many considerations as possible with the aim of reflecting the variety of aspects that could be tackled by an enhanced Benelux cooperation on offshore wind energy in the future. A pre-defined set of questions would imply that the focus of the research shifts since the beginning to one specific area of cooperation instead of providing the broad spectrum of possibilities, which is not the aim of this work. This is the reason why the fourth chapter should be read as a starting point for future research in the domain.

1. The Energy Union and cross-border cooperation on energy

1.1 An introduction to the European political and legal frameworks

In the context of the international negotiations on climate change the European Union has, on several occasions, stated its willingness to be at the lead of the energy transition. One recent important episode took place during the COP24 dialogue in Katowice, Poland's most famous coal region, in December 2018. On that occasion, the COP parties were called to approve unanimously the IPCC 1.5 Special Report[1] highlighting the climate urgency and the need for a rapid global action. A block of countries fiercely opposed to the unanimous approval of the Report[2]. In response, EU Commissioner for Climate Action Miguel Arias Cañete called on the High Ambition Coalition, a group of countries – including the EU - that share the highest ambition in fighting climate change, originally formed during the Paris talks in November 2015[3], to take the lead of a counteraction. Commissioner Cañete and the High Ambition Coalition officially released a statement urging other Governments and civil society organizations to follow their lead and step up climate ambition[4], started promoting important messages in all climate-related political discussions, used massively social channels.

That episode can be read as a strong confirmation of a belief and of a leadership grown over the past decades. The European Union has a well-established climate policy that puts environmental and climate protection are at the heart of important initiatives on various fronts.

One of the most powerful tool to limit CO2 emissions in Europe is the so-called Emissions Trading Scheme (ETS). It consists of a EU-wide cap-and-trade system where participants are large industrial installations, selling and buying allowances in the market[5]. One allowance corresponds to one ton of CO2eq[6] - covering

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[1] UNFCC, Intergovernmental Panel on Climate Change, 'Global warming of 1.5°C - An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty*', Summary for Policymakers,* 2018, https://www.ipcc.ch/sr15/ (accessed May 2019).

[2] D. Parthasarathy, 'COP24: Countries struggle to muster political will to tackle climate crisis', *Climate Network* [website], http://www.climatenetwork.org/press-release/cop24-countries-struggle-muster-political-will-tackle-climate-crisis (accessed February 2019).

[3] *Climate Dictionary* [website], http://www.climatedictionary.com/high-ambition-coalition/ (accessed February 2019).

[4] High Ambition Coalition, 'Statement on Stepping Up Climate Ambition', December 2018*, European Commission* [website], https://ec.europa.eu/clima/sites/clima/files/news/20181211_statement_en.pdf (accessed February 2019).

[5] I. Scrase and G. MacKerron, *Energy for the future – A New Agenda*, London, Palgrave MacMillan, 2009, p. 185.

[6] The CO_2 eq is a measure used to compare the emissions from various GHG based on their global warming potential. The global warming potential for methane, CH4, over 100 years is 21. This means the proportion between CH4 and CO2 emissions is 21:1, or methane global warming power is 21 times that of the same amount of CO2 emitted. See

CO_2 emissions but also N_2O and PFCs primarily from aluminum production[7]. The idea behind is that companies would be allocated a maximum amount of allowances (the "cap"). The environmentally virtuous ones would be able to sell the unused quotas on the market whereas those needing to emit more GHGs would be able to buy them from the others.

In the context on nature protection, the European Union has adopted major policies on biodiversity conservation. This is the case of the Natura 2000 network of protected natural areas around Europe. For wind energy operators, the European Commission has drafted some important Guidelines that aim at coordinating the coexistence of renewable energy projects and related human activities with the protection of biodiversity and natural environment. Wind turbine installations are not *a priori* precluded in the Natura 2000 areas but Member States need to conduct a thorough Environmental Impact Assessment (EIA) that is significantly more burdensome than the one required for areas under no particular conservation process[8].

The European Union has also adopted several frameworks regarding maritime policies too, both for the protection of the marine ecosystems and for the development of renewable energy sources therein, such as tidal, wave energy and offshore wind energy. The main legal act is the Marine Strategy Framework Directive adopted in 2008 and aiming at achieving Good Environmental Status (GES) of the EU's marine waters by 2020, protecting the marine biodiversity and the natural resource base upon which human economic and social activities depend[9].

Additionally to the above-mentioned examples of the important European environment and climate-related action, the reader should consider that the main European policies addressing and regulating power generation from offshore wind energy and other renewable energy sources are those referring more specifically to the promotion of renewables and the functioning of the European electricity markets. The next section provides an overview of the policies and laws implemented throughout the 28 Member States of the Union.

OECD, 'Carbon Dioxide Equivalent', *Glossary of Statistical Terms*, [website], https://stats.oecd.org/glossary/detail.asp?ID=285 (accessed February 2019).

[7] European Commission, *DG Clima*, https://ec.europa.eu/clima/policies/ets_en (accessed May 2019).

[8] European Commission, *Guidance Document - Wind energy developments and Natura 2000*, 2011, https://ec.europa.eu/environment/nature/natura2000/management/docs/Wind_farms.pdf (accessed December 2018).

[9] Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy, OJ L 164 [2008] (Marine Strategy Framework Directive).

1.1.1 A European target for renewable energy

The Treaty of the Functioning of the European Union (TFEU)[10] provides the legal bases for the European Union to adopt laws and policies in the environment and energy fields. At present, however, the European Union does not have a coherent and fully integrated framework that governs the offshore wind energy sector across all Member States[11], and this is primarily due to the overarching principles of proportionality and subsidiarity stemming from the founding Treaties12 and preventing the EU from deciding over the energy choices of its Member States.

According to Art. 4 of the TFEU, energy is a shared competence between the European Union and its Member States, both having the power to issue binding legislation in the domain[13.] Art. 194 TFEU goes further in specifying what role the European Union should take via-à-vis Member States in leading the environmental and energy policy, considered an important pillar for the correct functioning of the internal market:

"[…] *Union policy on energy shall aim* […] to: […] *ensure security of supply in the Union; promote energy efficiency and energy saving and the development of new and renewable forms of energy* […]; *promote the interconnection of energy networks*. […] *Such measures shall not affect a Member State's right to determine the conditions for exploiting its energy resources, its choice between different energy sources and the general structure of its energy supply* […]".

It emerges that the EU is responsible for providing the general framework and direction of the European energy policy whereas Member States remain exclusively competent for their national energy mixes. National governments are free to decide what energy generation technologies they want their systems to rely on.

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[10] Consolidated version of the Treaty on European Union, OJ C326/13 [2012] (TEU). Consolidated version of the Treaty on the Functioning of the European Union, OJ C326 [2012] (TFEU).

[11] R. Long, 'Harnessing Offshore Wind Energy: Legal Challenges and Policy Conundrums in the European Union', *The International Journal on Marine and Coastal Law*, Vol. 29, 2014, p. 699 and 703.

[12] Art. 5 of the TEU states that "the use of Union competences is governed by the principles of subsidiarity and proportionality". According to the same article, under the first principle, in those areas that do not fall within the exclusive competence of the Union, the legislator can act only if the objectives of the proposed action cannot be reached by the Member State(s) alone. The second key principle, that of proportionality, states that the action of the Union cannot exceed what is necessary to achieve the objectives laid down in the Treaties.

[13] Following the principle of subsidiarity stemming from the TEU, Art. 5 (3), a shared competence allows the EU to act "only if and in so far as the objectives of the proposed action cannot be sufficiently achieved by the Member States, either at central level or at regional and local level, but can rather, by reason of the scale or effects of the proposed action, be better achieved at Union level".

The European Union as a whole is leading an important energy transition process where renewable energy sources are playing an increasingly important role in almost all EU 28 Member States. The EU is bound by international agreements on climate change and environmental protection, mostly deriving from its being a Party to the United Nations Framework Convention on Climate Change[14] (UNFCCC). This Convention gave birth to important international agreements and annexed protocols over the years, such as the Kyoto Protocol[15] and the more recent Paris Agreement – all of them sharing the aim of limiting GHGs trying to keep global warming at a low level. The Paris Treaty in particular entered into force on 4 November 2016 and urges the international community to keep the global increase in temperature "well below 2°C above pre-industrial levels" and to pursue every effort to stay below a 1.5°C increase[16].

In the context of the obligations stemming from these international commitments, in 2007 the European Council proposed that the EU would be an important player in the international arena to fight global warming leading by example[17]. Under the push of the Council, in 2009 the EU adopted a package of binding legislation, the so-called 'energy and environmental package', with the long-run aim to reduce GHG emissions by 80 % by 2050 as compared to 1990 levels. In the shorter run, the package sets a series of targets to be achieved by 2020[18] in different environment and energy domains:

- Reduce GHG emissions by 20 % as compared with 1990 levels;
- Increase to 20 % the share of energy from renewable sources in the EU's gross final energy consumption;
- Improve the EU's energy efficiency19 by 20 %.

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[14] United Nations Framework Convention on Climate Change, 1992, FCCC/INFORMAL/84. The UNFCCC is an international environmental treaty negotiated and signed at the so-called United Nations Earth Summit, held in Rio de Janeiro in June 1992.

[15] Kyoto Protocol to the United Nations Framework Convention on Climate Change, 1998, (The Kyoto Protocol). The Kyoto Protocol is an international agreement within the UNFCCC that commits its signatories by setting internationally binding emission reduction targets. The Protocol was adopted in Kyoto, Japan, on 11 December 1997 and entered into force on 16 February 2005. The key principle lies in "common but differentiated responsibilities", acknowledging that the most polluting countries are the developed ones, carrying the burden of centuries of industrial activity. More information available at: UNFCCC, *What is the Kyoto Protocol?*, [website], https://unfccc.int/kyoto_protocol%26from%3D (accessed April 2019).

[16] United Nations Framework Convention on Climate Change, Paris Agreement, 2015.

[17] For an in-depth analysis of the negotiations between the EU and the UNFCCC on the Kyoto Protocol and subsequently adopted EU acts, see B. Delvaux, M. Hunt and K. Talus, *EU Energy Law and Policy Issues*, Brussels, Euroconfidentiel S.A., 2008, p. 196-197.

[18] Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources, OJ L140/16 [2009], (RED I).

[19] F. P. Sioshansi, *Energy Efficiency – Towards the End of Demand Growth*, Oxford, Elsevier, 2013, Introduction. Energy Efficiency is defined as the ability of using energy to deliver energy-based services while using as little energy as possible and wasting less in the overall process. The European Parliament defines Energy Efficiency as "the

With the Paris Agreement entering into force, in 2014 the upcoming European Commission legislature led by Jean-Claude Juncker declared that one of the key priorities for his new mandate would be to enhance energy security and independence in Europe[20] and began the Energy Union pan-European project[21]. The Energy Union builds on five pillars (or policy areas)[22]:

- Energy security, lowering the EU's energy dependence from third countries, boosting renewable energy deployment;
- A fully integrated internal energy market, enabling energy to flow freely across EU countries with no technical or regulatory barriers;
- Energy efficiency, lowering the energy needed for a same output;
- Climate action, decarbonizing all sectors of the wider EU economy;
- Research, competitiveness and innovation, supporting technological development that contributes to decarbonisation[23].

In this context, between 2018 and 2019 the EU has adopted a package of legislation regulating energy and environmental issues and setting a higher level of ambition for the Union after 2020. The so- called *Clean Energy for All Package* – also known with the abbreviation of *Clean Energy Package* – consists in eight different pieces of legislation of which four are directly relevant for the wind energy industry[24]. These are:

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amount of energy output for a given energy input and listed as a percentage between 0% and 100%, for example the amount of mechanical energy that an electric motor produces for a given input of electrical energy". European Parliament, *Understanding Energy Efficiency* [website], 2015, http://www.europarl.europa.eu/RegData/etudes/BRIE/2015/568361/EPRS_BRI(2015)568361_EN.pdf (accessed February 2019).

[20] R. Long, 'Harnessing Offshore Wind Energy: Legal Challenges and Policy Conundrums in the European Union', *International Journal of Marine and Coastal Law*, Vol. 29, 2014, 690 - 711.

[21] European Commission Communication, *A Framework Strategy for a Resilient Energy Union with a Forward-Looking Climate Change Policy*, 2015, COM(2015)80 Final.

[22] European Commission, *Energy Union and Climate Priorities,* [website], 2018, https://ec.europa.eu/commission/priorities/energy-union-and-climate_en (accessed November 2018).

[23] European Commission, *Third Report on the State of the Energy Union*, [website], 2017, https://ec.europa.eu/commission/sites/beta-political/files/third-report-state-energy-union_en.pdf (accessed February 2019).

[24] The Clean Energy Package is not the first of its kind. The EU has been introducing 'energy packages' since the 1990s with the aim of progressively liberalize the energy markets all across EU MS and start a free flow of energy, particularly gas and electricity. More information is available at: European Parliament, *Factsheet on the Internal Energy Market*, [website], https://www.europarl.europa.eu/factsheets/en/sheet/45/internal-energy-market (accessed May 2019).

the Renewable Energy Directive[25], the Governance Regulation[26], the Electricity Regulation[27] and the Electricity Directive[28]. The latter two set rules primarily relate to the electricity transmission across the EU and to the functioning of the electricity markets, while the Governance Regulation and the Renewable Energy Directive are particularly important in terms of setting new European 2030 decarbonisation objectives and boosting renewable energy deployment across the Member States. These pieces of legislation will be an important reference throughout this work.

The 2018 Renewable Energy Directive establishes a new EU-wide target of renewable energy in the final energy demand of 32%[29]. This pan-European target translates into nationally determined contributions at the Member State levels that are calculated following objective criteria listed in the Directive itself, including the attainment of the 2020 nationally-binding targets and the countries Gross Domestic Product[30]. In order to make sure that the 32% target is collectively reached, the Governance Regulation obliges Member States to adopt National Energy and Climate Plans (NECPs), outlining the key measures national governments will adopt to ensure the fulfilment of the obligations stemming from the Clean Energy Package. There will be occasion to consider that an important role to play is foreseen for wind energy towards the end of the next decade in most of the Member States plans. The National Energy and Climate Plans of Luxembourg, The Netherlands and Belgium will be analysed in more detail further in the text. Chapter 2 will then try to explain the pathway that has brought the wind energy technology to play such a pivotal role in the decarbonisation scenarios for Europe and worldwide.

1.1.2 An integrated European Electricity Market

The Energy Union strongly promotes the cross-border flow of electricity and the integration of the different EU energy markets, with the aim of creating a properly functioning Internal Energy Market (IEM) based on the principles of free flow of goods within the EU borders and reducing limitations on cross border access to energy resources[31] . As stated in the preamble of the Energy Union strategy paper, "[The EU] vision is of an integrated continent-wide energy system where energy flows freely across borders,

[25] Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources, OJ L328/82 [2018] (RED II).
[26] Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on the Governance of the Energy Union and Climate Action, OJ L328/1 [2018] (Governance Regulation).
[27] Regulation (EU) 2019/943 of the European Parliament and of the Council of 5 June 2019 on the internal market for electricity, OJ L158/54 [2019] (Electricity Regulation).
[28] Directive (EU) 2019/944 of the European Parliament and of the Council of 5 June 2019 on common rules for the internal market for electricity, OJ L158/125 [2019] (Electricity Directive).
[29] RED II, Art. 3.
[30] Governance Regulation, Annex II.
[31] Legal basis in Article 194 and Article 114 of the TFEU.

based on competition and the best possible use of resources, and with effective regulation of energy markets at EU level where necessary”. It continues pointing out that “[the EU] vision is of the Energy Union as a sustainable, low-carbon and climate-friendly economy that is designed to last”.

The EU single market construction dates back 1987, when the Single European Act (SEA) entered into force in that year required Member States to remove barriers – of a physical, legal and fiscal nature – to cross-border flow of services, goods, capital and labor[32]. With the aim of enhancing market competition within the EU, the SEA also required the termination of state-run monopolies and in many Member States the electricity sector was state-owned due to the technical complexities behind the management of transmission and distribution of the electricity load[33]. With the liberalization of the electricity sector, the idea that electricity is a commodity subject to EU single market rules on par with other goods and services started to gain terrain – and so did the idea of a EU-wide energy market that began to be relevant on the EU political agenda.

In those years, different measures were progressively implemented to ensure the EU would move towards an integrated energy market regime. The Electricity Regulation and the Electricity Directive approved as part of the 2018 Clean Energy Package represent one step forward towards the integration of renewables in the market and the cross-border flow of electricity. They set the rules for an adequate EU electricity infrastructure to be put in place – an essential prerequisite for the IEM to properly function. As cross-border trade in electricity is constrained to those areas where the electricity infrastructure exists, the proper functioning of the IEM depends on the build-out of cross-border transmission lines[34].

Large volumes of offshore wind energy need electricity networks able to absorb the electrical output. Renewable energy integration in the energy system is a fundamental aspect to be tackled. Because of their nature, wind and solar energy are considered variable[35] energy sources: there are some challanges related to the predictability of the resource and their physical integration in the electricity networks[36].

[32] Single European Act, OJ L 169 [1987].
[33] R. J. Serrallés, ‘Electric energy restructuring in the European Union: Integration, subsidiarity and the challenge of harmonization’, *Energy Policy*, Vol. 34, 2006, p. 2542-2543.
[34] A. Werner, ‘Cross-border trade in electricity’, *Journal of International Economics*, Vol. 101, 2016, p. 42-51. Available from: Science Direct (accessed March 2019).
[35] As compared to the predictability of conventional power plants, typically thermal, that can be ramped up or down following the balance needs of the energy system [Course *Energie: Ressources at Environnement*, Prof. M. Huart]. See also: International Energy Agency, *2018 World Energy Outlook*, 2018, p. 303, https://www.iea.org/weo2018/ (accessed May 2019).
[36] J. Cochran, L. Bird, J. Heeter, D. J. Arent, *Integrating Variable Renewable Energy in Electric Power Markets: Best Practices from International Experience*, NREL, 2012, Introduction. Available from: UNT Digital Library (accessed March 2019). See also ENTSO-E, *Developing Balancing Systems to Facilitate the Achievement of Renewable Energy*

Since an electricity system needs to be balanced at all times, a proper energy transition that relies on larger shares of variable renewable energy need to rely on a flexible power system[37] - that is to say, a system able to promptly adjust demand and supply to create equilibrium between them at all times, while incentivizing the penetration of renewable energies[38].

Renewable energy benefits might outweigh the potential difficulties deriving from their variable nature – difficulties that are less and less so, thanks primarily to technological development[39] – including in the meteorological forecast that is now able to predict the wind and solar resource in great detail over several days[40].

For the purpose of this work, which does not aim at entering the technical aspects behind generating, integrating, transmitting and dispatching renewable energy, it is worth remembering that the Clean Energy Package and the whole Energy Union project aim at addressing the aspects above. This is essential to the overall objective of achieving the 32% EU renewable energy target by 2030, with wind energy generating most of the renewable power by then[41].

1.2 Renewables in the EU energy and electricity systems

In 2016 the Union consumed 1,640.6 Mtoe[42], the equivalent of 19,073,200 GWh[43], or 19,073 TWh. 34.6% of this energy consumption has been satisfied by petroleum and derived products, whereas 23.4% by

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Goals, 2011, p. 4, https://www.entsoe.eu/fileadmin/user_upload/_library/position_papers/111104_RESBalancing_final.pdf (accessed February 2019).

[37] M. McPherson, L. D. Danny Harvey, B. Karney, 'System design and operation for integrating variable renewable energy resources through a comprehensive characterization framework', *Renewable Energy*, Vol. 113, 2017, p. 1019-1032, Introduction. Available from: Elsevier Science Direct Journals (accessed May 2019).

[38] International Renewable Energy Agency, *Power System Flexibility for the Energy Transition*, 2018, p. 6, 10-11, https://www.irena.org/publications/2018/Nov/Power-system-flexibility-for-the-energy-transition (accessed May 2019).

[39] International Renewable Energy Agency, *Power System Flexibility for the Energy Transition*, 2018, p. 12.

[40] See for instance Clean Energy Wire, *Volatile but predictable: Forecasting renewable power generation* [website], 2016, https://www.cleanenergywire.org/factsheets/volatile-predictable-forecasting-renewable-power-generation, (accessed February 2019). Recent research projects are working on the optimization of weather forecasts for variable renewables, see for instance Deutscher Wetterdienst, *Weather forecasts for renewable energy - a challenge* [website], 2016, https://www.dwd.de/EN/research/weatherforecasting/num_modelling/07_weather_forecasts_renewable_energy/weather_forecasts_renewable_energy_node.html (accessed February 2019).

[41] International Energy Agency, *2018 World Energy Outlook*, 2018, p. 76.

[42] European Union, *EU Energy in Figures 2018*, 2018, p. 179, https://publications.europa.eu/en/publication-detail/-/publication/99fc30eb-c06d-11e8-9893-01aa75ed71a1/language-en/format-PDF/source-79929745 (accessed February 2019).

[43] International Energy Agency, *Unit Converter*, [website], https://www.iea.org/statistics/resources/unitconverter/ (accessed February 2019).

gases, and 14.7% by solid fuels. Renewables and nuclear energy provided 13.2% each of the total energy consumption[44]. The role renewable energy plays today in the EU energy system is still marginal, despite expected to grow significantly over the next decades. Other estimates indicate that in 2017 the amount of renewable energy sources in the final EU energy demand corresponded to 20% out of a total energy demand of 13,098 TWh/year[45].

As far as the power sector is concerned, coal is still an important source of electricity in many countries of the EU. There are over 300 coal-fired power plants in the Union, and almost half of the Member States rely on coal as primary or secondary source of electricity[46]. Significant steps have been taken to decarbonize the electricity sector over the past years, with the consequence that CO2 emission intensity for electricity production has significantly decreased[47]. Renewables in the power sector accounted cumulatively for 34% of the total electricity demand in 2017, with wind energy alone covering 12% of the demand[48]. The transport and heating & cooling (H&C) sectors have a huge potential for decarbonisation: they account for 32% and 46% of Europe's final energy demand respectively[49]. 94% of the total transport energy demand is covered by oil products and only 8% by renewables, whereas the H&C sector relies by 80% on fossil fuels and 18% on renewables[50].

In its 2019 electricity markets status report, the European Commission reported that in the first quarter of the year renewable generation confirmed its rising trend in the EU power mix, with wind power providing most of the electricity generation[51].

Still, the EU is heavily dependent on imports of natural gas and fossil fuels for energy consumption. The European Commission reports that overall the EU imports 55% of all the energy it consumes, at the cost

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[44]European Union, *EU Energy in Figures 2018*, 2018, p. 47.

[45] WindEurope, *Breaking New Ground*, 2018, p. 25, https://windeurope.org/wp-content/uploads/files/about-wind/reports/WindEurope-breaking-new-ground.pdf (accessed May 2019).

[46] CANEurope, *Interactive coal map of Europe*, [website], 2017, www.coalmap.eu (accessed May 2019). See also CANEurope, 'Coal Phase Out', *Factsheet Coal Power in Europe*, [website], http://www.caneurope.org/docman/coal-phase-out/3117-factsheet-coal-power-in-europe/file (accessed May 2019).

[47] European Environmental Agency, 'Electricity Generation – CO2 Emission Intensity map', *Data and Maps*, [website], https://www.eea.europa.eu/data-and-maps/daviz/co2-emission-intensity-5#tab-googlechartid_chart_11_filters=%7B%22rowFilters%22%3A%7B%7D%3B%22columnFilters%22%3A%7B%22pre_config_ugeo%22%3A%5B%22European%20Union%20(current%20composition)%22%5D%7D%7D (accessed February 2019).

[48] WindEurope, *Breaking New Ground*, 2018, p. 25, https://windeurope.org/wp-content/uploads/files/about-wind/reports/WindEurope-breaking-new-ground.pdf (accessed May 2019).

[49] *Ibidem*.

[50] *Ibidem*.

[51] European Commission, DG Energy, 'Quarterly Report on European Electricity Markets', *Market Observatory for Energy*, Vol. 12, Issue 1, 2019, Introduction.

estimate of EUR 266 Bn per year[52]. With more detail, out of each fuel's total consumption (domestically produced *and* imported), the EU imports: 87% of its crude oil; 70% of its natural gas; 40% of its solid fossil fuels and 40% of its nuclear fuels. These inflows come from various global markets, but most significantly from Norway and Russia.

As mentioned above, energy security is one of the key pillars of the Energy Union strategy. Energy security is a notion that relates to various dimensions, ranging from the procurement of energy to the stability of supply, and for this reason hard to define. Academic definitions of energy security refer to it as the concept with the *four A's*: *Availability, Affordability, Accessibility and Acceptability* of energy or energy projects[53]. Other dedicated literature define the concept of energy security as "the absence of, protection from or adaptability to threats that are caused by or have an impact on the energy supply chain"[54] but also as the continuous supply of energy commodities[55].

In this latter shade in particular, the notion of energy security is significantly interlinked with that of energy dependency, which shows how much the EU imports in terms of energy commodities coming from outside its borders. Being energy a fundamental pillar of the functioning of a modern society, a high import rate translates into a high dependency from other countries to satisfy its domestic energy needs while at the same time being exposed to the volatility of fossil fuel prices, become particularly unstable after year 2000[56], and sudden changes in the international political dynamics.

A country able to produce energy domestically and satisfy part or all of its energy demand with its own production would be less or not exposed to import needs. As renewable resources are local and free, they are an essential asset in the process of decreasing dependency from third countries. Wind and solar energy in particular are responsible for generating positive effects to the society: not only do they drastically reduce the imports of fossil fuels but they significantly promote economic growth, improving trade balances and a greater economic stability[57]. At the local scale, benefits to the society might relate

[52] European Commission, *Energy Security*, [website], https://ec.europa.eu/energy/en/topics/energy-security (accessed May 2019).
[53] K. Szulecki (ed.), *Energy Security in Europe – Divergent Perceptions and Policy Challenges*, London, Palgrave McMillan, 2018, Introduction.
[54] C. Winzer, 'Conceptualizing Energy Security', *Cambridge Working Paper in Economics*, No. 1151, 2011, p. 24.
[55] *Idem*, 4.
[56] I. Scrase and G. MacKerron, *Energy for the future – A New Agenda*, London, Palgrave MacMillan, 2009, p. 79.
[57] T. A. Rule, *Solar, Wind and Land – Conflicts in renewable energy development*, New York, Routledge, 2014, Introduction.

to the economic participation of local communities into the renewable energy projects, local investments in infrastructures such as roads and ports, job creation[58].

Acknowledging the positive and important contribution that wind energy and other renewable energy sources bring to European citizens, the 2050 Decarbonisation Strategy recently proposed by the European Commission foresees that wind energy will be the dominant power generation technology by mid-century, with around 1,200 GW of installed capacity of which more than 400 GW offshore, cumulatively generating more than 50% of the European electrical power by then[59].

To achieve these ambitious volumes, Member States will need to cooperate closely.

1.3 The role of regional cooperation in energy

At the global level, regional cooperation is very important. One could define it as collaboration amongst member states with a certain geographical proximity, usually sharing some common characteristics and aiming at reaching a certain goal. This is true for the European Union that is in itself an example of regional cooperation amongst 28 states.

Regional cooperation is considered a powerful source in the global economy as reflected in several global trans-border agreements on trade and wider social objectives such as technology cooperation, energy and climate[60]. Regional cooperation on energy encompasses several options and instruments such as harmonized laws and regulations, joint development of energy resources and infrastructure sharing – such as electricity network or development or trade platforms such as power pools - and transfer of expertise[61].

Regional cooperation on environment, climate and energy can be particularly useful to tackle global issues in these fields if paired with the right legal instruments in an enforcement mechanism – such as the European Union, its above-mentioned Renewable Energy Directives and other sources of secondary

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[58] Deloitte and WindEurope, *Local Impact, Global Leadership – The impact of wind energy on jobs and the economy, 2017,* p. 6-7, https://windeurope.org/about-wind/campaigns/local-impact-global-leadership/#report (accessed April 2019). See also APERe and RESCoop, 'Report on Innovative Financing Models for wind farms', *WISE Power Project*, 2015, http://wisepower-project.eu/wp-content/uploads/20150209WISEPower_Deliverable_3-1_v3_Final.pdf (accessed May 2019).
[59] European Commission, *A Clean Planet for all - A European long-term strategic vision for a prosperous, modern, competitive and climate neutral economy,* 2018, COM[2018]773.
[60] S. Agrawala at al., *Regional Development and Cooperation*. In: *Climate Change: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [O. Edenhofer et al.], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA 2014, p. 1086-1088, https://www.ipcc.ch/site/assets/uploads/2018/02/ipcc_wg3_ar5_chapter14.pdf (accessed April 2019).
[61] *Ibidem*.

legislation on energy efficiency, biofuels, sustainable transport and many more[62]. The EU ETS as such can be seen as a good example of regional cooperation mechanism to tackle global warming and climate change[63]. Most of the regional initiatives are built on informal voluntary cooperation mechanisms, therefore with a more limited impact as compared to institutional constructions with enforcement mechanisms[64].

Within the EU there are several initiatives of regional cooperation related to energy & environment. Several of these initiatives led by the EU have as objective the reduction or removal of barriers to the free energy flow across boundaries, reinforcing the Internal Energy Market – an important component of the completion of the EU single market. The EU itself has an obligation to contribute to establishing and developing cross-border energy infrastructures and electricity networks across the 28 Member States[65]. Throughout Europe there are regional power pools for electricity trade, such as the Nord Pool - the common market for electricity in the Nordics that covers Denmark, Sweden, Norway and Finland[66], the Central Eastern Europe electricity market (Czech Republic, Hungary, Poland, Romania, Slovakia, Slovenia), the Central Western Europe pool (Austria, Belgium, France, Germany, the Netherlands, Switzerland)[67]. Regional initiatives may also aim at boosting renewable energy installations in view of attaining the national and European targets, while reducing the EU energy dependency from third countries. This is the case of the Baltics or the North Seas Energy Forum that will be further explored in the next sections.

Referring to offshore wind energy in particular, there are several benefits brought by a regional approach as compared to individual Member States acting solo. The predominant advantage is related to considerations of cost-effectiveness: planning the development of offshore wind in one sea basin allows

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[62] Referring, *inter alia*, to: Directive (EU) 2018/2002 of the European Parliament and of the Council of 11 December 2018 amending Directive 2012/27/EU on energy efficiency, OJ L328 [2018]. Directive 2009/30/EC of the European Parliament and of the Council of 23 April 2009 amending Directive 98/70/EC as regards the specification of petrol, diesel and gas-oil and introducing a mechanism to monitor and reduce greenhouse gas emissions, OJ L140 [2009].
[63] I. Butzlaff, N. Grunewald and S. Klasen, 'Regional Agreements to Address Climate Change: Scope, Promise, Funding, and Impacts', *IDEAS Working Series Papers*, 2013, p. 8. Available from: ProQuest Central (accessed April 2019).
[64] N. Uddin, R. Taplin, 'Regional cooperation in widening energy access and also mitigating climate change: Current programs and future potential', *Global Environmental Change*, Vol. 35, 2015, p. 497-504. Available from:Elsevier Science Direct Journals (accessed April 2019).
[65] Art. 170 (1) TFEU.
[66] N. Uddin, R. Taplin, 'Regional cooperation in widening energy access and also mitigating climate change: Current programs and future potential', *Global Environmental Change*, Vol. 35, 2015, p. 497-504. Available from:Elsevier Science Direct Journals (accessed April 2019).
[67] European Commission, DG Energy, 'Quarterly Report on European Electricity Markets', *Market Observatory for Energy*, Vol. 7, Issue 3, 2014, p. 15.

to pool resources together and use them better at a minor cost[68]. It allows for example to better plan activities in support of the offshore wind industry, such as infrastructure developments in port facilities or the build-out of dedicated manufacturing facilities for the production of wind turbines. Regional approaches also allow for a better planning of the grid infrastructure that would be able to absorb large volumes of offshore wind energy avoiding grid congestion as the power can be evacuated in different directions[69]. Cooperation across Member States greatly helps also avoiding conflicts deriving from the multiple uses of a same space, typically experienced for instance in the co-existence of wind farms with naval routes[70].

In the renewable energy field, there are several regional cooperation approaches that it is worth mentioning. The Baltic Energy Market Interconnection Plan (BEMIP) is one EU-led forum for regional cooperation on renewable energy, with the primary aim of increasing energy security in the EU. As better explained in the section below, BEMIP has a strong focus on offshore wind energy as a way to secure energy independence while un-tapping the huge offshore wind potential the Baltic Sea has to offer. Despite focusing geographically on the Baltic Sea area (hence excluding Benelux), this institutionalized Forum is worth mentioning as an example of cross-border initiatives relating to energy security as part of the broader Energy Union project. Other two *fora* are good examples: the North Seas Energy Forum is a Government- and EU-led initiative gathering the Member States surrounding the North Sea basin and aiming at collaborating on various aspects of renewable energy development and grid connection. The Pentalateral Energy forum represents the framework for regional cooperation in Central-Western Europe whose scope is to enhance security of supply and electricity market integration. The Benelux is part of the latter two.

1.3.1 The Baltic Energy Market Interconnection Plan

One important exercise to increase the Union's energy security while decreasing dependency from Russia is currently taking place in the Baltic States, under the framework of a regional cooperation forum established between the European Commission and the Member States surrounding the Baltic Sea named Baltic Energy Market Interconnection Plan[71]. This forum is providing a platform to Member States to

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[68] R. Long, 'Harnessing Offshore Wind Energy: Legal Challenges and Policy Conundrums in the European Union', *International Journal of Marine and Coastal Law*, Vol. 29, 2014, p. 712-713.
[69] *Ibidem*.
[70] *Ibidem*.
[71] Participant countries are Denmark, Germany, Estonia, Latvia, Lithuania, Poland, Finland, and Sweden. Norway participates as an observer. See European Commission, Memorandum of Understanding on

cooperate on important energy issues and to have an integrated regional electricity market between the Baltic countries, ending the isolation of the three Baltic States[72]. Currently, the power systems of Latvia, Lithuania and Estonia are closely connected with the Russian and Belarus power system[73] but isolated from the rest of the EU. The European Commission and other key European players, such as the European Network of Transmission System Operators for Electricity (ENTSO-E)[74], are conducting studies to de-synchronize the Baltic electricity system from the Russian one and connect it to the European system. The BEMIP regional cooperation platform is not only working on energy network aspects, but is also looking into a common approach to install more renewable energy off the coasts of the EU MS surrounding the Baltic Sea basin.

1.3.2 The Pentalateral Energy Forum

Another important forum of regional cooperation focusing on security of supply within the EU is the Pentalateral Energy Forum composed of seven countries in Central Western Europe – Austria, Belgium, France, Germany, Luxembourg, the Netherlands and Switzerland. The forum was originally created in 2005 by Benelux, France and Germany and joined in 2011 by the Netherlands and Switzerland.

The political cooperation involves key actors from those seven countries responsible for balancing the energy system ensuring security of supply, namely public authorities and other bodies such as TSOs, energy regulators and market players such as power exchanges[75]. The Benelux Secretariat in Brussels ensures the running of all Pentalateral Energy Forum activities, functioning as the Secretariat of the Forum itself.

The Forum provides an important platform for exchange of information, expertise and to perform common assessments on the network infrastructure needs and responses in case of electricity crisis and

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the reinforced Baltic Energy Market Interconnection Plan, 2015, https://ec.europa.eu/energy/sites/ener/files/documents/ROMANAD_2016.02.08_11.32.52_5C4N2560_1.pdf (accessed May 2019).

[72] See European Commission, Directorate-General for Energy, 'Baltic Energy Market Interconnection Plan, Energy Topics', [website], 2019, https://ec.europa.eu/energy/en/topics/infrastructure/high-level-groups/baltic-energy-market-interconnection-plan (accessed May 2019).

[73] ENTSO-E, *Baltic Synchronisation*, [website], 2016, https://tyndp.entsoe.eu/2016/insight-reports/baltic-synchronisation/ (accessed May 2019).

[74] ENTSO-E is a body established by the EU in 2009 and grouping all TSOs around Europe. The body has a legal mandate to operate and innovate the European power system, addressing present technological and regulatory challenges and with the ultimate goal of creating a well-functioning Internal Energy Market. See ENTSO-E, *About*, [website], https://www.entsoe.eu/about/inside-entsoe/objectives/ (accessed June 2019).

[75] G. Erbach, 'Understanding electricity markets in the EU – Briefing', *European Parliament Research Service*, 2016, p. 2-3, http://www.europarl.europa.eu/RegData/etudes/BRIE/2016/593519/EPRS_BRI(2016)593519_EN.pdf (accessed February 2019).

any further energy supply issue. In this context, in 2017 the Governments of the Pentalateral Energy Forum have signed a Memorandum of Understanding to maintain and strengthen their existing energy cooperation thorough, *inter alia*, a common system adequacy assessment[76], timely reinforcement of cross-border and national grid infrastructure and an optimized use of existing interconnections[77].

1.3.3 The North Seas Energy Forum

The first – and probably the most important – regional cooperation forum related to the development and deployment of offshore wind energy is the North Seas Energy Forum (NSEF), an initiative led by the European Commission to which all states surrounding the North Sea basin take an active part. Being Benelux an integral part of the Forum, Luxemburg has a stake in there too.

The NSEF was initiated in 2016 with a Political Declaration, i.e. a voluntary cooperation agreement signed between member states due to end in June 2019[78]. Showing willingness to deploy significant volumes of wind power installations in their seas by 2050, on 20 June 2019 the North Sea Energy Ministers - including Belgium, Netherlands and Luxembourg – signed a joint declaration renewing and extending the 2016 Political declaration and supporting the EU's 2050 decarbonisation strategy and targets[79].

The preamble of the Declaration is particularly important as it acknowledges the current bottlenecks to a cost-efficient development and deployment of offshore wind energy. These are "[…] The need to reduce costs in the offshore wind sector, notably through exploiting the potential that regional cooperation offers in this respect, in particular […] exploiting benefits of scale". The need to mobilise funds to support upfront investments in the sector; "The need for stable and transparent framework conditions for project developers and their supply chains, including having a steady pipeline of offshore wind projects to avoid

[76] EWEA, *Wind Energy The Facts*, [website], 2009, https://www.wind-energy-the-facts.org/security-of-supply-and-system-adequacy.html (accessed May 2019). Definition of system adequacy: "The way in which the power system can match the evolution in electricity demand is expressed as 'system adequacy'. System adequacy measures the ability of a power system to cope with its load in all the steady states it may operate under standard conditions. This adequacy has different components: a) the ability of the generation assets to cover the peak load, taking into account uncertainties in the generation availability and load level; and b) the ability of the transmission system to perform, with the flexibility provided by interconnection and import and export flows".

[77] Benelux Secretariat, Memorandum of Understanding of the Pentalateral Energy Forum on Emergency Planning and Crisis Management for the Power Sector, Brussels, 2016, http://www.benelux.int/files/7515/1749/6862/Penta_MoU_emergency_planning_and_crisis_management_in_power_sector_signed.pdf (accessed May 2019).

[78] Benelux Secretariat, Political Declaration on energy cooperation between the North Seas Countries, 2016, http://www.benelux.int/files/9014/6519/7677/Political_Declaration_on_Energy_Cooperation_between_the_North_Seas_Countries.pdf (accessed May 2019).

[79] Belgian Offshore Platform, *Delivering 450 GW of offshore wind by 2050 is feasible,* [website], 2019, https://www.belgianoffshoreplatform.be/en/news/delivering-450-gw-of-offshore-wind-by-2050-is-feasible/ (accessed June 2019).

periods of industry idling". The Declaration continues stating the need to "cost-effectively integrate offshore wind energy into the existing and future energy system" and "the important long term potential benefits of further interconnection and market integration offered by the development of the North Seas as a single energy resource for all countries in the region"[80].

The cooperation on energy in the North Sea dates back 2009 with the North Sea Countries Offshore Grid Initiative (NSCOGI) to develop the grid in a way that it could absorb large volumes of renewable electricity and promote interconnection between the different countries. The final aim was to maximize the efficient and economic use of the renewable energy resources as well as infrastructure investments. When the NSEF started with the signature of the political declaration amongst North Seas Governments in 2016, the NSCOGI was absorbed by it[81]. Today, via its Ten Year Network Development Plan (TYNDP), ENTSO-E identifies every two year the gaps in network infrastructure from a European perspective and informs decision-makers in Member States accordingly. The North Sea is one region where this assessment is performed, taking onboard part of the work initiated by NSCOGI[82].

Development and regulation of offshore grids and other offshore infrastructures are today the focus of one of the four dedicated Support Groups in the NSEF (SG2). The other three topical groups are: marine spatial planning (SG1); regulatory framework and finance for offshore wind projects (SG3); standards, technical rules and regulations in the offshore wind sector (SG4). All together, these are the four priorities of the Forum whose main focus is a cost-effective deployment of offshore wind energy. Each of the Support Groups is chaired by one Government and co-chaired by the relevant European Commission services. In the case of the second to fourth Support Group, the Directorate-General for Energy is responsible for co-chairing whereas the first Group, the one dedicated to Marine Spatial Planning, is co-chaired by the Directorate-General for Maritime Affairs (DG MARE).

These Support Groups meet regularly both in a close-door set-up or involving industry stakeholders and other authorities, such as TSOs, to primarily discuss the needs for changes in EU or national legal and/or regulatory frameworks that currently may hinder a cost-effective deployment of large volumes of offshore wind in the sea basin.

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80 Benelux Secretariat, Political Declaration on energy cooperation between the North Seas Countries, 2016, http://www.benelux.int/files/9014/6519/7677/Political_Declaration_on_Energy_Cooperation_between_the_North_Seas_Countries.pdf (accessed May 2019).

81 Marine Spatial Platform EU, North Seas Country Offshore Grid Initiative, [website], https://www.msp-platform.eu/practices/north-seas-countries-offshore-grid-initiative-nscogi (accessed May 2019).

82 ENTSO-E, Ten Year Network Development Plan, [website], 2018, https://www.entsoe.eu/about/system-development/#the-ten-year-network-development-plan-and-regional-investment-plans (accessed May 2019).

By way of a practical example, within SG3 the European Commission has assessed the benefits of cooperation between North Seas Member States in providing support to offshore wind energy[83]. As previously mentioned, Member States can provide public support to energy sources, particularly renewables, to accompany the development of these technologies in view of a smooth energy transition[84]. They can do so through competitive bidding processes, in full compliance with the State Aid Guidelines on Energy and Environment, whereby, in general terms, Member States announce the willingness to build a certain wind energy capacity within their territory and call for wind farm developers to make offers on the level of public support (EUR/MWh) they would like to receive[85]. The award criterion is normally the price – i.e. the lowest bid wins[86]. In a non-coordinated scenario, each Member State tenders its own volumes at the preferred timing. In its study, the European Commission has pointed out the societal losses this individual approach leads to: suboptimal tender outcomes with higher support level requested.

The study goes further in detail explaining that this situation can for instance arise when large capacities (volumes of installations) are tendered at the same time by two or more Member States or when the construction deadlines of several Member States coincide. In particular:

"*Spreading out the deadlines for receiving bids* [by the Member States] *will allow project teams* [in the wind industry, i.e. wind farm developers] *to work continuously on the preparation of projects, evening out peaks and slow periods, which would require the assignment of staff to other tasks. Scheduling sufficient time between the selection of the winner of one auction and the deadline for bids of the following auction, would allow project developers to decide whether to participate or not based on whether they were successful in the previous auction.*

Coordinated construction deadlines provide for the resources in the supply chain to be used more efficiently. If peaks and slow periods are spread out evenly, stop-and-go investment cycles are avoided and workers, specialised equipment, such as vessels, and turbine factories, can work continuously and more

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[83] European Commission, Directorate-General for Energy, 'Coordination of tenders for offshore wind in the North Seas', *North Seas Energy Forum*, 2017, https://ec.europa.eu/energy/sites/ener/files/documents/171207_sg3_paper_coordination_of_tenders_for_offshore_wind_final.pdf (accessed May 2019).
[84] B. Bartniczak, 'State aid as a tool encouraging production of energy from renewable sources', *Copernican Journal of Finance and Accounting*, Vol. 3, N. 1, 2014, Introduction.
[85] European Commission, *Guidelines on State aid for environmental protection and energy 2014-2020* (2014/C 200/01), OJ 28/06/2014 [2014]. See also International Renewable Energy Agency, *Renewable Energy Auctions – A guide to design*, 2015, Introduction, https://www.irena.org/publications/2015/Jun/Renewable-Energy-Auctions-A-Guide-to-Design (accessed April 2019).
[86] *Idem*, 39-40.

efficiently. No additional investments in means of production are needed to respond to demand spikes. Furthermore, a steady and predictable tender pipeline ensures that there will be sufficient competition in the market which should be reflected in the bids received. This contributes to reducing the overall costs of offshore wind[87]".

On the basis of the key considerations above, the SG3 of the NSEF serves today as a platform for the coordination of the bidding timing between the North Seas countries. This is a significant achievement and is in line with the offshore wind industry recommendations to Governments on the need to align the timeline of bidding processes to allow flexibility and sustainability for the supply chain[88].

The potential to achieve a significant cost-reduction in offshore wind in the North Sea via cooperation mechanisms is huge also in the other Support Groups. For instance, in SG1 there is a significant margin of improvement as to the collection and sharing of data on spatial planning and as to the change of national regulations to allow a better co-use of space for instance with the fisheries sector, the military, wildlife conservation[89]. In SG2, cooperation as to offshore grid development is essential to anticipate and support the growth of the offshore wind energy sector and to make sure the right infrastructure stands ready to evacuate the power produced. It is demonstrated that wind (and solar) electricity output is much less volatile at an aggregated level and extremely high and low values disappear[90]. In case of overproduction from variable renewables such as offshore wind, there is less need for electricity to be curtailed in order to balance the system since that electricity can be exported to neighboring countries[91]. In SG4, technical standards and rules have a huge potential to be harmonized throughout the North Seas countries, in terms of standards for the manufacturing of the wind turbines and their top coating but also mutual recognition and harmonization of rules for crew and technicians in the North Seas, waste disposal operations,

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[87] European Commission, Directorate-General for Energy, 'Coordination of tenders for offshore wind in the North Seas', *North Seas Energy Forum*, 2017, https://ec.europa.eu/energy/sites/ener/files/documents/171207_sg3_paper_coordination_of_tenders_for_offshore_wind_final.pdf (accessed May 2019).
[88] WindEurope, *Offshore wind energy in the North Sea: Industry recommendations for the North Seas Energy Forum,* 2017, p. 14, https://windeurope.org/wp-content/uploads/files/policy/position-papers/WindEurope-Offshore-wind-energy-in-the-north-sea.pdf (accessed May 2019).
[89] R.H. Jongbloedn, J.T. van der Wal, H.J. Lindeboom, 'Identifying space for offshore wind energy in the North Sea. Consequences of scenario calculations for interactions with other marine uses', *Energy Policy*, Vol. 68, 2014, p. 332. Available from: Elsevier Science Direct Journals (accessed May 2019).
[90] Fraunhofer IWES, *The European Power System in 2030: Flexibility Challenges and Integration Benefits. An Analysis with a Focus on the Pentalateral Energy Forum Region*, 2015, p. 8. Analysis on behalf of Agora Energiewende. Available from: Elsevier Science Direct Journals (accessed April 2019).
[91] *Ibidem*.

possibility of navigation through the wind farms for small vessels - and another series of important aspects[92].

The North Seas Energy Forum is particularly important for the offshore wind energy sector because it tries to tackle all the issues above and because it is the largest sea basin for offshore wind energy capacity in Europe. This means that any success in the NSEF to bring the agenda forward will be an important showcase for the entire European offshore wind industry.

The Benelux is part of the North Seas Energy Forum. Its Secretariat in Brussels plays an important role in the preparation of the meetings and by rendering its premises available for the actual gathering[93].

1.3.4 Regional cooperation initiatives on energy at the global level

Europe is not the only continent where regional cooperation initiatives in the energy sector take place. Because of the advantages listed above, several countries around the world with geographical proximity pool resources to address common challenges.

Grid connection is by definition a transboundary activity, because rarely an energy system is isolated from the neighboring countries. This is why many initiatives in Europe and beyond encompass regional platforms to trade and exchange electricity. In the United States for instance, it is the objective of the Southeast Power Pool[94].

There are other partnerships that are less focused on power exchange – despite it being an essential component of all energy-related cooperation agreements - and more on broader climate objectives. One example is the Energy and Climate Partnership of the Americas (ECPA) that involves cooperation between the United States, Brazil, Canada, Chile, Costa Rica, Mexico, Peru, and Trinidad and Tobago and promotes renewable energy and other sustainable energy innovations[95]. South and Central America already have

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[92] WindEurope, *Offshore wind energy in the North Sea: Industry recommendations for the North Seas Energy Forum,* 2017, p. 14, https://windeurope.org/wp-content/uploads/files/policy/position-papers/WindEurope-Offshore-wind-energy-in-the-north-sea.pdf (accessed May 2019).

[93] Benelux Secretariat, Political Declaration on energy cooperation between the North Seas Countries, 2016, p. 7, http://www.benelux.int/files/9014/6519/7677/Political_Declaration_on_Energy_Cooperation_between_the_North_Seas_Countries.pdf (accessed May 2019).

[94] N. Uddin, R. Taplin, 'Regional cooperation in widening energy access and also mitigating climate change: Current programs and future potential', *Global Environmental Change*, Vol. 35, 2015, p. 497-504. Available from: Elsevier Science Direct Journals (accessed April 2019).

[95] *Ibidem*.

an energy mix that is the least carbon-intensive in the world due to already installed high shares of hydropower and other renewable energy sources[96].

Another important regional platform is the Association of South East Asian Nations (ASEAN), comprising Indonesia, Thailand, Philippines, Malaysia, Singapore, Brunei, Cambodia, Laos, Myanmar and Vietnam. ASEAN countries have abundant renewable resources in the form of hydro, geothermal, biomass, solar, and wind but despite this significant potential, the use of renewable energy sources to generate electricity is very low[97]. Because of this scarce utilization of renewable energy, fossil fuel imports are significant, rendering the whole region dependent on them: the demand is expected to rise from 76% in 2011 to 80% in 2035[98]. Because of heavy energy dependency rates, the focus of the ASEAN region partnership is primarily driven by concerns of energy security and independence[99].

In 2015, ASEAN countries created the ASEAN Economic Community (AEC) with energy security and sustainability as major goals for advancing the energy sector and economy[100]. Energy security issues in ASEAN countries should be considered different from European ones, because of energy and electricity poverty, i.e. the lack of – or uneven distribution of – electricity connection for many users especially in rural areas. The political agendas of the different Asian countries are looking into the 2030 objective of securing energy for all and regional cooperation will be key in supporting this aim, especially through regional interconnections, given that no single market can meet this target by its own[101].

There are several other initiatives of regional cooperation for energy-related matters around the world, either with an energy-security focus or particularly aiming at boosting renewable energy technologies. This is the example of APEC (Asia-Pacific Economic Cooperation) or the Renewable Energy and Energy

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[96] L. de Souza Noel Simas Barbosa, D. Bogdanov, P. Vainikka, C. Breyer, 'Hydro, wind and solar power as a base for a 100% renewable energy supply for South and Central America', *PLoS-ONE*, Vol. 12(3), 2017, Introduction.
[97] Y. Chang, Y. Li, 'Renewable energy and policy options in an integrated ASEAN electricity market: Quantitative assessments and policy implications', *Energy Policy*, Vol. 85, 2015, p. 39–49. Available from: Elsevier Science Direct Journals (accessed May 2019).
[98] M. Mofijur, H.H.Masjuki, M.A.Kalam, S.M. Ashrafur Rahman, H.M. Mahmudul, 'Energy scenario and biofuel policies and targets in ASEAN countries', *Renewable and Sustainable Energy Reviews*, Vol. 46, 2015, p. 51–61. Available from: Elsevier Science Direct Journals (accessed June 2019).
[99] N. Uddin, R. Taplin, 'Regional cooperation in widening energy access and also mitigating climate change: Current programs and future potential', *Global Environmental Change*, Vol. 35, 2015, p. 497-504. Available from: Elsevier Science Direct Journals (accessed April 2019).
[100] S. Tongsopit, N. Kittner, Y. Chang, A. Aksornkij, W. Wangjiraniran, 'Energy security in ASEAN: A quantitative approach for sustainable energy policy', *Energy Policy*, Vol. 90, 2016, p. 60–72. Available from: Elsevier Science Direct Journals (accessed May 2019).
[101] R. Nangia, '*Securing Asia's energy future with regional* integration', *Energy Policy*, Vol. 132, 2019, p. 1268. Available from: Elsevier Science Direct Journals (accessed May 2019).

Efficiency (ECREE) under the Economic Community of West African States (ECOWAS)[102]. For the purpose of this work it is not relevant to list all of these initiatives – but it is worth considering that because of its cross-boundary nature, (renewable) energy is a field where regional cooperation matters, in Europe and beyond.

1.4 The Benelux energy cooperation

The three Benelux countries have all relatively high emission profiles and therefore, in compliance with the EU objectives seen above, they have started national pathways to decarbonize their economies[103].

The Benelux cooperation started after the Second World War, after the three countries were excluded from the negotiations about the new post-war world order and started to realize that they were too small to play a dominant role in the international arena[104].

In 1943 the first negotiations regarding a monetary agreement between the three countries started and in 1944 the customs union agreement was signed[105] (*Union Douanière Benelux*). The Treaty of Benelux Economic Union (*Union économique Benelux*), which extended beyond the customs union by creating dedicated Union international institutions, was signed in 1958 and entered into force in 1960[106].

A new Benelux agreement was signed in 2008, when the organization was renamed the Benelux Union (*Union Benelux*). The treaty entered into force in January 2012 and since then regional cooperation focused on three priority areas: internal markets and economic union, sustainable development, justice and internal affairs[107].

Despite sustainable development being at the core of the mandate, the Benelux as institutional cooperation does not have a comprehensive policy towards green growth and low-carbon policies: the

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[102] APEC, [website], https://www.apec.org/ (accessed March 2019); ECOWAS – ECREE, [website], https://www.ecowas.int/climate-change/the-agriculture-department/ecree/ (accessed March 2019). See also N. Uddin, R. Taplin, 'Regional cooperation in widening energy access and also mitigating climate change: Current programs and future potential', *Global Environmental Change*, Vol. 35, 2015, p. 497-504. Available from: Elsevier Science Direct Journals (accessed April 2019).
[103] Martinez-Fernandez, C. et al., 'Green Growth in the Benelux: Indicators of Local Transition to a Low-Carbon Economy in Cross-Border Regions', *OECD Local Economic and Employment Development (LEED) Working Papers*, 2013/09, 2013, p. 24.
[104] A. Verdoes, 'Explaining the Emergence of International Parliamentary Institutions: The Case of the Benelux Interparliamentary Consultative Council', *Parliamentary Affairs*, gsy054, 2019, p. 1-23. Available from: Oxford University Press Journals Current (accessed June 2019).
[105] *Ibidem*.
[106] *Ibidem.*
[107] L. Siitonen, 'Regional and sub-regional effects on development policies: The Benelux and the Nordic countries compared', *Regions & Cohesion*, Vol. 7, Iss. 2, 2017, p. 34-69.

three different countries are moving forward individually[108]. This approach is due to the fact that Belgium, the Netherlands and Luxembourg did not transfer supranational powers to the Benelux Union, differently to what Member States have done with the European Union for certain areas of action[109]. Cooperation within the Benelux Union is strictly inter-governmental and therefore has a strictly voluntary character[110].

The Belgian Federal Minister for Energy, Mrs Marie-Christine Marghem, stated that "the Benelux Cooperation on energy matters is beneficial for energy security but also has a positive effect on electricity prices for the industry and all consumers while allowing for a better integration of the renewable energy sources"[111].

The energy cooperation in the framework of the Benelux regional cooperation seems to rely primarily on the larger *fora* seen above, namely the North Seas Energy Forum and the Pentalateral Energy Forum, both where the Benelux acts as Secretariat facilitating meetings and exchanges. In the North Seas Energy Forum the Governments of the Netherlands, Belgium and Luxembourg participate on an individual basis. None of the meeting reports nor other official documentation reports on a Benelux position or treats the three countries together as a Union within the Forum. Nonetheless, the fact that Luxembourg, despite lack of access to the sea and therefore lack of territorial waters, fully participates in the dialogue of the North Sea might mean that the Benelux is acknowledged as participant in the Forum. In the 2016 Political Declaration founding the North Seas cooperation, the word 'Benelux' only appears in its role of acting as Secretariat for the Forum[112].

The Luxembourg participation might also be explained by the fact that its electricity network is interconnected with the surrounding States, particularly Belgium and the Netherlands[113], and has plans

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[108] Martinez-Fernandez, C. et al., 'Green Growth in the Benelux: Indicators of Local Transition to a Low-Carbon Economy in Cross-Border Regions', *OECD Local Economic and Employment Development (LEED) Working Papers*, 2013/09, 2013, p. 18.

[109] S. Marinai, *La funzione giurisdizionale nelle organizzazioni di integrazione regionale*, Torino, Giappichelli Editore, 2012, p. 13-14.

[110] J. De Vries, 'Venturing Into Unknown Territory: The Preparation and Formulation of the Second Benelux Structural Outline', *European Journal of Planning Studies*, Vol. 16, Issue 6, 2008, p. 853-876. Available from: Taylor & Francis Social Science and Humanities Library (accessed May 2019).

[111] Benelux Secretariat, *Newsletter - June 2015*, [website], 2015, http://www.benelux.int/files/1915/0703/1254/Newsletter_Energie_juin_DEF_-_FR.pdf (accessed June 2019).

[112] Benelux Secretariat, Political Declaration on energy cooperation between the North Seas Countries, 2016, http://www.benelux.int/files/9014/6519/7677/Political_Declaration_on_Energy_Cooperation_between_the_North_Seas_Countries.pdf (accessed May 2019).

[113] See for instance data on cross-border physical flow provided by ELIA, the Belgian Transmission System Operator. ELIA, *Cross Border Flows*, [website], https://www.elia.be/en/grid-data/interconnections/cross-border-flows (accessed June 2019). See also ENTSO-E, *High Voltage Interconnection Map*, [website], https://www.entsoe.eu/data/map/ (accessed June 2019).

to further increase the network interconnection and cooperation through the Fora mentioned above – NSEF and Pentalateral – and through the general enhanced interconnection targets put forward by the European Union with the recent package of legislation[114].

The lack of access to the sea means that in practice Luxembourg has no direct experience in the field of offshore wind energy. The Renewable Energy Directives (both the 2009 and the 2018 ones) allow Member States to use special cooperation mechanisms to invest in renewable energy outside their territory. This might be the case for Luxembourg, as it will be explained later in this work.

Probably surprisingly, there is no biding legislation in the field of energy – nor by consequence renewable energy - between the three Countries of the Benelux Union[115]. The cooperation in this area seems to happen primarily on a voluntary basis, despite the transition to a low-carbon economy being high in the political agenda and one of the pillars of the renewed Benelux Treaty. The Treaty also clearly states that energy is one of the key areas of cooperation across the three parties.

Importantly though, the Benelux Secretariat acknowledges that additional cooperation could be made in aligning the previously mentioned National Energy and Climate Plans required by the Renewable Energy Directive[116]. These plans will be discussed in more detail in the next section.

Ultimately, on the attainment of climate objectives Benelux acts as a platform for participatory dialogue across the three Countries and as part of the broader UNFCCC Talanoa Diaalogue exercise. The NECP of Luxembourg explicitly mentions that the Benelux Talanoa Dialogue is used as a platform for promoting cross-border cooperation in climate and energy, but the sub-sectors involved are sustainable mobility, energy and resource efficiency, green finances and the broader international topic of a just social transition towards decarbonisation[117]. Belgium, the Netherlands and Luxembourg signed a joint declaration to strengthen interregional cooperation in order to achieve the targets of the Paris Agreement.

[114] As explained further in the text, the target for cross-border electricity interconnectivity for each Member State of the European Union is set at 15% of its internal power generation capacity by 2030.

[115] Extensive research has been performed in the *Volet Juridique* of the Benelux Union, the database of binding and non-binding laws issued by Benelux. The absence of binding law in the domain has been also confirmed by the Benelux Secretariat in Brussels. Benelux Union, *Volet Juridique*, [website], http://www.benelux.int/fr/volet-juridique/instruments-juridiques (accessed May 2019).

[116] Benelux Union, *Internal market*, [website], www.benelux.int (accessed June 2019).

[117] European Commission, 'National Energy and Climate Plan for Luxembourg', 2018, p. 17, https://ec.europa.eu/energy/sites/ener/files/documents/ec_courtesy_translation_lu_necp.pdf (accessed May 2019).

1.4.1 The main institutions

The Benelux institutions are the Committee of Ministers, the Council, the Parliament and the Court of Justice[118].

The Committee of Ministers (*Comité des Ministres*) is the supreme organ of the Benelux Economic Union: it supervises the correct implementation of the founding Treaty and can issue binding law such as directives, decisions and conventions that need to be abided to by the three Governments, in most cases via transposition into national legislation[119]. The Committee can also issue recommendations that are not legally binding. It is made by at least one representative at the Ministerial Level of each of the three countries, and the Minister can vary depending on the topics of discussion. The Ministers also define the direction and areas of cooperation of the Benelux Union.

The Benelux Council (*Conseil Benelux*) is composed by high-level civil servants of the different Ministries competent for the topics discussed in the meeting. Their main function is to prepare the dossiers for the Ministers who participate in the Committee of Ministers.

The Benelux Secretariat-General (Secrétariat général Benelux) ensures the smooth running of all the Benelux activities and particularly ensures the collaboration between the three Countries in the areas of energy. As it was previously stated, the Secretariat plays an important role in the North Seas Energy Forum and the Pentalateral Energy Forum.

The Interparliamentary Council (*Conseil interparlementaire consultatif de Benelux*) is the Benelux Parliament and counts 49 members coming from all three States: 21 from Belgium, 21 from the Netherlands and seven from Luxembourg. These members are elected and appointed by the national parliaments[120]. Their main function is to advise their Governments, through recommendations, on the subjects related to the Benelux cooperation – including energy[121].

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118 The description of the institutions composing the Benelux Union in this section is taken from the official website of Benelux, unless otherwise stated. Benelux Union, *Who we are*, [website], www.benelux.int (accessed March 2019).

119 E. D .J. Kruijtbosch, *Benelux Economic Union – College of Arbitrators and Court of Justice*, Amsterdam, Elsevier Science Publishers, 1983, Introduction. See also Treaty of Benelux [1958], Art. 6 (2).

120 A. Verdoes, 'Explaining the Emergence of International Parliamentary Institutions: The Case of the Benelux Interparliamentary Consultative Council', *Parliamentary Affairs*, gsy054, 2019, p. 1-23. Available from: Oxford University Press Journals Current (accessed June 2019).

121 Convention entre le Royaume de Belgique, le Grand Douché de Luxembourg et le Royaume des Pays-Bas concernant l'Assemblée Interparlementaire Benelux [2015]. Available from : http://www.benelux.int/files/7514/2183/4828/Verdrag_Trait__AIB_20_01_2015.pdf (accessed May 2019).

The Benelux Court of Justice has the key role of ensuring uniformity in the application of the Benelux legislation: in case of doubts in the application at the national level of a Benelux law, the national competent courts need to raise a question of interpretation to the Benelux Court of Justice, which then issues a legally binding ruling for interpretation. The members of the international Court are chosen amongst the representatives of the highest national courts.

Benelux operates with a rotating presidency and a four-year work plan proposed by the Secretariat-General and formally approved by the Committee of Ministers[122]. Currently (2019), the presidency is hold by Luxembourg.

It is important to mention that the Benelux Union has a very limited international legal personality, deriving from the lack of transfer of supranational powers from the three States to the Union[123]. This limitation translates into the inability to conclude international agreements on behalf of the Union but does not prevent enhanced cooperation within the Union and vis-à-vis external dimensions, such as the NSEF or Pentalateral regional cooperation *fora*.

1.5 The national energy & climate plans in Benelux

As mentioned above, all 28 Member States of the EU need to achieve nationally binding targets of renewable energy in their energy consumption by the end of 2020 so that collectively the EU would reach 20% by the end of this decade. In February 2019, the European Commission declared that 11 Member States[124] of the European Union have already achieved their 2020 nationally binding targets and overall the share of renewables in the European final energy demand equaled 17.5% at the end of 2017[125].

By 2030, the EU as a whole needs to achieve the target of 32% of renewable energy in the final energy demand. The target has to be reached collectively by all Member States, which have to present to the European Commission by December 2019 their National Plans detailing how they intend to do so. In other words, the 2030 National Energy and Climate Plans are the framework for Member States to outline their climate and energy goals, policies and measures to be implemented from 2021 to 2030 (i.e. after the 2020

[122] S. Marinai, *La funzione giurisdizionale nelle organizzazioni di integrazione regionale*, Torino, Giappichelli Editore, 2012, p. 13-14.
[123] *Ibidem*
[124] European Commission and EUROSTAT, 'Share of renewable energy in the EU up to 17.5% in 2017', *press release 27/2019 of 12 February 2019*, [website], https://ec.europa.eu/eurostat/documents/2995521/9571695/8-12022019-AP-EN.pdf/b7d237c1-ccea-4adc-a0ba-45e13602b428 (accessed June 2019). These states are Sweden, Finland, Denmark, Estonia, Croatia, Lithuania, Romania, Bulgaria, Italy, Czech Republic and Hungary.
[125] *Ibidem*.

targets are reached). The development of these Plans is a legal requirement stemming from the Governance Regulation adopted in December 2018.

Below is an overview of the national measures impacting or related to offshore wind development in Belgium, the Netherlands and Luxembourg.

1.5.1 The draft National Energy and Climate Plan of Belgium

The Belgian territory surface is not particularly big as compared to other Member States, but the country is quite densely populated with 11.267.910 inhabitants counted in 2016 (363 habitants/km²).

In 2016, the final energy consumption of Belgium amounted to 36.33 Mtoe, of which 15.30 provided by petroleum and petroleum products, 9.73 gases and 7.04 electricity[126]. In terms of gross electricity generation, nuclear was the main power source (43.52 TWh), followed by gases (24.36 TWh) and renewables (15.29 TWh)[127].

As percentage points, petroleum products still represent the main energy source (52%), followed by natural gas (24%) and electricity (17%). The residential sector is the biggest primary energy consumer (32.2%), followed by industry (25.8%) and transport (21.5%)[128].

For Belgium, the 2020 renewable energy target is set at 13% of the total energy demand[129]. In 2016, renewable energy sources represented 8.65% of the final energy consumption[130].

On the 2030 target and as required by the Governance Regulation, Belgium presented its draft National Energy and Climate Plan by the end of 2018. The Plans submitted to the European Commission were four: one for each Region (Wallonia, Flanders and Brussels-Capital) plus the Federal one. Since offshore wind energy is competence of the Belgian Federal Government, plans to further develop this technology are contained in the Federal Plan, which takes inspiration from the federal energy strategy approved in March 2018. Belgium has a 2030 federal target of 18.3% renewable energy in the final energy consumption that would translate into 40.4% of renewable-based electricity[131].

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[126] European Union, *EU Energy in Figures 2018*, p. 179.
[127] *Idem*, p. 180.
[128] European Commission, National Energy & Climate Plan of Belgium (Federal), 2018, p. 5, https://ec.europa.eu/energy/en/content/national-energy-and-climate-plans-necps-belgium (accessed May 2019).
[129] RED I, Annex I.
[130] European Commission, National Energy & Climate Plan of Belgium (Federal), 2018, p. 6.
[131] *Ibidem*.

At the end of 2018, Belgium had 3,360 MW[132] of wind energy capacity installed, of which 1,186 MW[133] offshore. The Belgian part of the North Sea covers an area of 3,454 km^2[134]. Considering also the offshore wind farms under construction and those that will start construction soon, the Belgian sea can count on already operational wind farms: Seastar, Mermaid, Northwester 2, Belwind, Nobelwind, Northwind, Rentel, C-Power, Norther[135]. It is estimated that by 2020 the capacity installed offshore will equal 2.3 GW, producing averagely 8 TWh a year, satisfying around 10% of the total Belgian electricity demand[136]. The Belgian Government has ambitious plans as to the development of offshore wind energy over the next years, with 4 GW of offshore wind installed cumulatively in the Belgian sea by 2030[137].

As prescribed by the Governance Regulation, the NECPs of the 28 Member States need to detail measures foreseen for reinforcing and expanding their grid connection[138]. For cross-border projects, these measures are based on the Ten-Year Network Development Plan proposed by ENTSO-E – a plan on how to expand the electricity transmission infrastructure in Europe, establishing interconnection across Member States and in some cases between the EU and neighboring countries.

Over the next years, with an offshore wind energy target of (cumulatively) 4GW by 2030, Belgium has projects for several offshore interconnectors with other Countries. One, already operational, is the Nemo Link that connects the UK and Belgium's electricity systems via subsea cables, allowing the two countries to trade electricity[139] with a capacity of 1GW. Other interconnectors planned will allow Belgium to

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[132] WindEurope, *Wind energy in Europe – Trends and statistics 2018*, 2018, p. 10, https://windeurope.org/wp-content/uploads/files/about-wind/statistics/WindEurope-Annual-Statistics-2018.pdf (accessed May 2019).

[133] WindEurope, *Offshore wind in Europe – Key trends and statistics 2018*, 2018, p. 12, https://windeurope.org/wp-content/uploads/files/about-wind/statistics/WindEurope-Annual-Offshore-Statistics-2018.pdf (accessed June 2019).

[134] Belgian Federal Government, Federal Public Service (FPS) Health, Food Chain Safety and Environment, and European Commission, Directorate-General for Climate Action, *Action Plan on Marine Litter*, [website], p. 6, https://www.health.belgium.be/sites/default/files/uploads/fields/fpshealth_theme_file/action_plan_marine_litter.pdf (accessed June 2019).

[135] Belgian Offshore Platform, *Projects* [website], https://www.belgianoffshoreplatform.be/en/projects/, (accessed May 2019).

[136] Belgian Offshore Platform, *Offshore wind energy in the Belgian Part of the North Sea*, [website], 2019, https://www.belgianoffshoreplatform.be/en/news/offshore-wind-energy-in-the-belgian-part-of-the-north-sea-up-to-4000-mw-by-2024/ (accessed May 2019).

[137] European Commission, National Energy & Climate Plan of Belgium (Federal), 2018, p. 27, https://ec.europa.eu/energy/en/content/national-energy-and-climate-plans-necps-belgium (accessed May 2019).

[138] Art. 4, Governance Regulation.

[139] Nemo Link Project, [website], https://www.nemo-link.com/ (accessed May 2019).

exchange power with Germany (ALEGrO, 1GW), France (two interconnection projects with a total capacity of 1.5 GW) and the Netherlands (1GW)[140].

1.5.2 The draft National Energy and Climate Plan of the Netherlands

As of 1 July 2018, the Netherlands had 17,103,623 inhabitants, with a population density of 411.7 inhabitants/km².

The Netherlands final energy consumption in 2016 amounted to 49.52 Mtoe, primarily satisfied by gases (17.86 Mtoe), petroleum and derivate products (17.67 Mtoe) and electricity (9.08 Mtoe), the latter primarily produced by gases (56.57 TWh), solid fuels (36.72 TWh) and renewable energy sources (14.73 TWh)[141].

The 2009 Renewable Energy Directive foresees that The Netherlands reaches a 14% target share of energy from renewables in its gross final consumption of energy by 2020[142].

By 2030 and according to the proposed draft National Plan, the Netherlands should have 32% of renewable energy in the final energy demand, with renewable electricity representing 66% of the final electricity consumption[143].

Offshore wind energy represents a great tool to reach these targets. At the end of 2018, the Netherlands already had a cumulative wind energy capacity installed of almost 4.5 GW, and more precisely 4,471 MW[144], of which 1,118 MW[145] installed at sea. There are four wind farms already operational in the Dutch waters: Egmond aan Zee; Prinses Amalia; Luchterduinen; Gemini (actually made of two different wind farms: Buitengaats and Zee-Energie), plus a number under development and others to be tendered soon[146]. The plan is to reach 11.5 GW of offshore wind installations by 2030. This target is based on the recently approved New Offshore Wind Energy Roadmap that outlines where new wind farms will be built in the North Sea between 2024 and 2030, for a total capacity of 7 GW, and the previous Dutch Energy

140 WindEurope, *Industry position on how offshore grids should develop*, 2019, p. 12, https://windeurope.org/policy/position-papers/industry-position-on-how-offshore-grids-should-develop/ (accessed June 2019).
141 European Union, *EU Energy in Figures 2018* [2018], p. 215-216.
142 RED I, Annex I.
143 European Commission, National Energy & Climate Plan of the Netherlands, 2018, p. 8, https://ec.europa.eu/energy/sites/ener/files/documents/netherlands_draftnecp_en.pdf.pdf (accessed May 2019).
144 WindEurope, *Wind energy in Europe – Trends and statistics 2018*, p. 10.
145 WindEurope, *Offshore wind in Europe – Key trends and statistics 2018,* p. 12.
146 Netherlands Enterprise Agency, *Offshore Wind Energy*, [website], https://english.rvo.nl/subsidies-programmes/offshore-wind-energy (accessed May 2019). The Netherlands Enterprise Agency (RVO), operating under the Ministry of Economic Affairs and Climate Policy, is responsible for the concessions related to offshore wind energy.

Agreement that has an intermediate objective of reaching 4.5 GW of total offshore installed capacity by 2023[147].

In terms of offshore interconnection capacity for exchange of electricity with other countries, the Netherlands has in the pipeline two projects with Germany, for a total capacity of 1.8GW, and one with Denmark, the so-called COBRA cable with a capacity of 700MW[148].

1.5.3 The draft National Energy and Climate Plan of Luxembourg

With 613,894 inhabitants, Luxembourg is a small state and not particularly rich in terms of local energy resources[149]. Luxembourg imports much of its energy, and particularly relies on petroleum products that account for the significant share of 63% of the total energy available in the country[150].

The final energy consumption of Luxembourg in 2016 was equivalent to 4.04 Mtoe, of which 2.59 satisfied by petroleum and its products, 0.63 gases and 0.55[151] by electricity primarily produced by hydropower and gas[152].

As mandated by the 2009 Renewable Energy Directive, the target for share of energy from renewable sources in Luxembourg gross final consumption of energy by 2020 is 11%. In February 2019, European Commission official statistics portal (EUROSTAT) reported that Luxembourg is on track to meet its 2020 objectives.

By 2030, Luxembourg aims at having 23-25% of renewable energy in the final national energy consumption – a percentage that would translate into 33.60% renewable electricity in the final electricity demand.

At present, Luxembourg has only 120 MW of wind energy installed[153], all of it onshore due to lack of access to the sea and therefore lack of a territorial sea.

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[147] Netherlands Enterprise Agency, *Offshore Wind Energy*, [website], https://english.rvo.nl/subsidies-programmes/offshore-wind-energy (accessed May 2019).
[148] WindEurope, *Industry position on how offshore grids should develop*, 2019, p. 11, https://windeurope.org/policy/position-papers/industry-position-on-how-offshore-grids-should-develop/ (accessed June 2019).
[149] Grand Duchy of Luxembourg, *Country Statistics*, [website], 2018, https://statistiques.public.lu/en/ (accessed May 2019).
[150] EUROSTAT, *Infographics on Energy*, [website], 2017, https://ec.europa.eu/eurostat/cache/infographs/energy-2017/bloc-2a.html (accessed December 2018).
[151] European Union, *EU Energy in Figures 2018* [2018], p. 206.
[152] *Idem*, p. 210.
[153] WindEurope, *Wind energy in Europe – Trends and statistics 2018*, p. 10.

The Luxemburg Government Coalition Treaty for the period 2018-2030[154] is looking into the "maximum exploitation of the renewable energy potential" as a way to accompany Luxembourg in its energy transition. In the Treaty, Luxembourg very openly states its opposition against nuclear energy throughout Europe and rather praises an energy policy that heavily relies on renewable energy, particularly solar power and wind energy. The document goes further in stating that in the domain of offshore wind energy, Luxembourg will rely on the Benelux Union regional cooperation.

1.6 Conclusions of the first chapter

Chapter 1 provides an introduction of the current European political and legal framework within which offshore wind energy fits. The European and national frameworks support and proactively encourage a significant growth of the renewable energy sector and see a predominant role played by wind energy.

In line with the international agreements within the UNFCCC framework and the obligations stemming therefrom, in particular the 2015 Paris Agreement, the EU needs to increase its climate action efforts, aiming potentially at a debated carbon neutrality by mid-century. Over the years, the EU has issued soft and hard law in several domains that can be considered directly relevant in the protection of the environment and in enhancing climate ambition: important examples encompassed the EU Emissions Trading Scheme, the Marine Framework Strategy (that will be better approached further in the text), the Natura 2000 network for biodiversity conservation. Importantly, though, the energy sector, and in particular the power sector, is responsible for a significant portion of the GHG emissions and decarbonizing this area has become a huge priority for the Union and its Member States.

The so-called EU long-term strategy recently presented by the European Commission to the European Parliament and Council and looking into perspectives to reduce emissions by 2050 foresees that wind energy installations by mid-century will cover more than 50% of the total power demand. The cumulative capacity installed is in the range of 1200 GW – of which more than 400 GW offshore and almost 800 GW onshore.

The European Union has mid-term benchmarks that contribute to the attainment of the longer-term decarbonisation objectives. The 2018 Renewable Energy Directive sets targets for the end of the next decade: 32% of renewable energy in the final energy consumption by 2030. Here too, it is noteworthy the relevance the wind power technology assumes in the energy transition because of the well-acknowledged important socio-economic benefits it brings along. Further considerations on the role this technology

[154] Grand Duchy of Luxembourg, Accord de Coalition 2018 – 2023 [2018], p. 167, https://gouvernement.lu/dam-assets/fr/publications/accord-coalition/2018-2023/Accord-de-coalition-2018-2023.pdf (accessed in January 2019).

assumes in the power system, the positive effects as well as the negative externalities will be entirely the subject of the next section.

This first chapter has the fundamental task of explaining that the energy transition cannot be performed by Member States individually, but rather needs to be a shared effort that crosses boundaries, particularly the physical ones. The idea behind the creation of an Internal Energy Market and an Energy Union - where security of supply is one of the five pillars - passes necessarily through the abatement of barriers to the physical flow of electricity across Member States. Larger renewable energy volumes integrated into the electricity networks need more cross-border cooperation.

The European Union acknowledges the importance of transnational cooperation, particularly at the regional level, and leads important initiatives aiming at boosting renewable energy while securing the process towards an energy transition is smooth, cost-efficient and socially inclusive. Regional cooperation in the energy domain relies on various tools, such as the harmonization of regulations, the joint development of energy projects, infrastructure sharing. All of them will be subject of consideration in the next chapters.

One of the key initiatives concerning cross-border cooperation for the promotion of offshore renewable energies is the North Seas Energy Forum, to which the three Benelux countries are parties. As explained in the chapter, the Forum is particularly relevant because of its well-defined structure, aiming at filling the gap between political action and industry needs through a continuous dialogue, and its ongoing work in areas that are acknowledged by both sides as being the trigger for a future efficient development of the wind power sector.

Besides understanding to which existing cross-border cooperation fora on energy the Benelux Countries are part of, the first chapter is entrusted with the role of understanding whether the Benelux Union in itself does constitute an enhanced regional cooperation platform. It emerges that the three Benelux countries do not transfer any supranational power to the Benelux Union, hence maintaining individuality of powers in all energy-related discussions. Energy is envisaged by the founding Benelux Treaty as an area of close cooperation but the Union does not have a comprehensive policy towards low-carbon objectives. Luxembourg, the Netherlands and Belgium are moving forward individually. The consequences of this approach on the offshore wind energy sector will be explored in Chapter 3.

2. Offshore wind energy and the EU decarbonisation targets

2.1 Offshore wind energy – an overview of the technology

Offshore wind energy is a source of clean electricity. The principle behind the functioning of a wind turbine is that the blades capture the wind and the kinetic energy it contains, converting it into electricity. The essential elements of on- and offshore wind turbines are the blades, the nacelle, the rotor, the generator, the tower and the electrical cables[155]. Commercial scale wind turbines consist of a three-bladed rotor in horizontal axis[156].

The tower allows the wind turbine to stand high to capture the best winds. This component of the turbine is typically made of steel and provides access to the highest parts of the turbine, i.e. the nacelle and the blades. The blades capture kinetic energy from the wind and transfer it to the rotor. The rotor converts this energy into rotational energy in a drive train. The nacelle supports the rotor and protects the generator, which converts the rotational (mechanical) energy transmitted by the drive train into electricity. The nacelle also contains the control system that is the 'brain' of the turbine and provides supervisory control, in compliance with technical capacities of the turbine but also with external legal requirements (such as compulsory switch-off of the turbine imposed, for example, for reasons of oversupply of electricity in the energy system). The electrical cables, placed under the sea level, evacuate the electricity produced[157].

Several wind turbines gathered together form an offshore wind farm. The way the turbines are placed, and particularly the distance between them, is calculated using numerical models and following the laws of aerodynamics: the interaction between them, the so-called wake-effect whereby a wind turbine placed close to another deviates and weakens the wind that the other wind turbine would capture to produce electricity, has to be kept to a minimum[158]. Offshore wind farms (OWFs) normally occupy maritime spaces

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[155] BVG Associates on behalf of the Crown Estate, *Guide to an Offshore Wind Farm,* 2019, https://www.thecrownestate.co.uk/media/2860/guide-to-offshore-wind-farm-2019.pdf (accessed February 2019).
[156] A. P. Schaffarczyk, *Introduction to wind turbine aerodynamics*, Berlin, Springer, 2014, Chapter 3.
[157] *Ibidem.*
[158] S. De Gendt, 'Legal challenges concerning offshore wind installations along the coastline of the North Sea', Master Dissertation, University of Ghent, 2018, p. 17.

for a period of 20 to 30 years, considering that the average operational lifetime of a wind farm is between 20 and 25 years[159]. The lease or concession on the seabed is normally given on an exclusive basis[160].

In a wind farm, one pivotal element is the substation, or more properly called offshore transformer platform. Its role is to collect and export all the electricity generated by the wind farm through the marine cables, stabilizing and maximizing the power voltage, transforming it from 33kV up to the 220kV high voltage for transfer to land[161].

In 1891, the Danish engineer Poul LaCour was the first to build a wind turbine able to generate electricity[162]. The development of the first commercial offshore wind farm dates back to 1991 and was deployed in Vindeby, Denmark. It consisted of 11 wind turbines of 0.45 MW each, for a total power generation capacity of 4.95 MW[163]. Since then, the technology has significantly evolved and so has the public perception on the important role wind energy plays in decarbonizing the energy system. The world's biggest offshore wind park was born in the course of 2018 and is installed off the coast of the United Kingdom - the biggest European market in terms of offshore wind energy capacity: Walney 3 extension counts 657 MW[164].

The average size of a newly installed offshore wind turbine today is above 6 MW, with the largest wind turbine connected to the grid having a nominal capacity of 8.8 MW[165]. In 2018, the average size of wind turbines newly installed in the European waters was 6.8 MW – a 15% increase in size as compared to the previous year[166]. Several companies are already launching on the market offshore wind turbines larger than 10 MW[167].

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[159] L. Zieglera, E. Gonzalez, T. Rubert U. Smolkaa, J. J. Meleroc, 'Lifetime extension of onshore wind turbines: A review covering Germany, Spain, Denmark, and the UK', *Renewable and Sustainable Energy Reviews*, Vol. 82, 2018, Part 1, 1261 – 1271, Introduction. See also WindEurope, *Wind Energy in Europe: Scenarios for 2030*, 2017, p. 16, https://windeurope.org/about-wind/reports/wind-energy-in-europe-scenarios-for-2030/ (accessed May 2019).

[160] R. Poudineh, C. Brown, B. Foley, *Economics of Offshore Wind Power: Challenges and Policy Considerations,* London, Palgrave McMillan, 2017, p. 112-113.

[161] See Fig. 1 in Annex. Description and illustration of the Belgian Rentel offshore wind farm available at Rentel Project, *The project*, [website], https://www.rentel.be/en/the-project (accessed May 2019).

[162] T. Ackermann, L. Söder, 'Wind energy technology and current status: a review', *Renewable and Sustainable Energy Reviews*, Vol. 4, 2000, p. 315-374.

[163] Jos Beurskens, *Converting Offshore Wind into Electricity*, Amsterdam, Eburon Academic Publishers, 2011, p. 19.

[164] WindEurope, *Offshore Wind Energy in Europe – 2018 Statistics*.

[165] MHI Vestas Offshore Wind, Model V-164 – indicating the rotor diameter of 164 meters. Information available in WindEurope, *Offshore Wind Energy in Europe – 2018 Statistics.*

[166] WindEurope, *Offshore Wind Energy in Europe – 2018 Statistics*, p. 9.

[167] It is the case for instance of the 12 MW offshore wind turbine named Heliade X from General Electrics. General Electrics, 'Heliade X offshore wind turbine', *Renewable Energy*, [website]

The offshore wind energy technology is currently undergoing rapid evolutions, not only in size and nominal power increase but also in park layout, improved weather forecasting (extremely important as the electrical output of a wind turbine is extremely sensitive to wind speed[168]) and general ameliorations in the supply chain that supports wind energy deployment and evolution. As reported by the International Renewable Energy Agency (IRENA)[169] and as an example, average offshore wind turbine rotor diameters in 2001 were 80 meters large whereas in 2015 this figure increased to 130 meters on average. Larger turbines capture more wind energy and produce more electricity but also represent a bigger challenge for the vessels and cranes that anchor them to the seabed. The same study shows that an average offshore wind farm in 2001 would be built at a water depth of 10 meters, whereas in 2015 an averagely newly built wind farm would see its foundations at 25 meters below the sea level. This evolution indicates how the installation services behind the build-out have improved and developed over the years.

Today, bottom-fixed offshore wind turbines are installed in waters deep approximately 60 meters but not deeper[170]. Beyond this threshold, installing the turbines is considered economically unviable because of the great distances to shore and harsher natural conditions, including a more difficult seabed[171]. The latest technological developments include the uptake of a different type of offshore wind turbine technology, the so-called floating offshore wind. By not being fixed to the seabed, the floating technology brings some advantages and cost-reductions in terms of installations and subsequent operations, including decommissioning[172]. Moreover, it is estimated that 80% of the offshore wind resources in Europe are located in waters of more than 60 meter depth and, generally speaking, the farther from the coast, the more stable and powerful the wind resource is[173].

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https://www.ge.com/renewableenergy/wind-energy/offshore-wind/haliade-x-offshore-turbine (accessed May 2019).

[168] B. Dessous, *Déchiffrer l'Energie*, Paris, Belin, 2014, p. 155 -156. Quoting the textbook: « the instant power of a wind turbine is directly proportional to the squared diameter of its blades and to the cube of the speed the generator receives. […] A generator that has a nominal power of 300 kW with a wind speed of 14 m/s would have an actual nominal power of 120 kW with a wind speed of 9 m/s and 4 kW if the speed further decreases to 5 m/s […]".

[169] IRENA, *Innovation Outlook – Offshore Wind,* 2016, p. 24, https://www.irena.org/publications/2016/Oct/Innovation-Outlook-Offshore-Wind (accessed May 2019).

[170] WindEurope, *Floating offshore wind energy: a policy blueprint for Europe*, 2018, p. 3, https://windeurope.org/wp-content/uploads/files/policy/position-papers/Floating-offshore-wind-energy-a-policy-blueprint-for-Europe.pdf (accessed June 2019).

[171] *Idem*, p. 4.

[172] *Idem*, p. 4.

[173] *Idem*, p. 4.

2.1.1 Financing offshore wind

Wind energy is a highly capital intensive technology as it requires significant initial investment. The costs related to the operational life of the turbine after installation are less significant, as wind energy does not bear any fuel costs over its entire lifetime[174].

The biggest cost components for offshore wind installations are the cost of the turbine (~48% of the total investment costs), the foundations (~20%) and the transformer and cable to channel the electricity to coast (~16%)[175].

The cost components of an offshore wind farm – or of a wind farm in general – can be divided between the costs of the wind farm in terms of capacity installed and the cost of wind power per output produced. The first comprises the total of capital costs and variable costs per capacity installed, normally measured in MW, whereas the latter takes into account the wind resource and therefore expresses the cost of wind power per MWh produced (EUR/MWh)[176].

The second type of cost calculation represents the common methodology to assess the costs of different energy- (including therefore power-) generation technologies, and is the so-called Levelized Cost of Energy (or Electricity), abbreviated as LCoE. The LCoE is defined as the total lifetime cost of an investment divided by the cumulated generated energy by this investment[177]. This calculation allows to compare different technologies as it considers the direct costs incurred specifically by each technology– such as the initial capital investment, the costs of financing the investment, the O&M costs, the fuel costs – over the average lifetime and results in the cost to produce one unit of energy (electricity)[178].

The LCoE of offshore wind at the global level has drastically reduced over years: starting from approximately USD220/MWh in 2012, it reached the level of USD120/MWh in the second half of 2018[179],

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[174] IRENA, *The power to change: solar and wind cost reduction potential to 2025*, 2016, p. 73-74, https://www.irena.org/publications/2016/Jun/The-Power-to-Change-Solar-and-Wind-Cost-Reduction-Potential-to-2025 (accessed May 2019). See also P. Jamieson, *Innovation in Wind Turbine Design*, New York, John Wiley & Sons 2011, p. 164. See also IRENA, *Renewable power generation costs in 2017*, 2018, p. 99-100, https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2018/Jan/IRENA_2017_Power_Costs_2018.pdf (accessed May 2019).

[175] J. K. Kaldellis, D. Zafirakis, 'The wind energy (r)evolution: A short review of a long history', *Renewable Energy*, Vol. 36, 2011, p. 1887 – 1901. Accessible from: Elsevier ScienceDirect Journals (accessed April 2019).

[176] M. I. Blanco, 'The Economics of Wind Energy', *Renewable and Sustainable Energy Reviews*, Vol. 13, 2009, p. 1372–1382. Accessible from: Elsevier ScienceDirect Journals (accessed April 2019).

[177] I. Pawel, 'The Cost of Storage – How to Calculate the Levelized Cost of Stored Energy (LCOE) and Applications to Renewable Energy Generation', *Energy Procedia*, Vol. 46, 2014, p. 69.

[178] International Energy Agency, *2018 World Energy Outlook*, 2018, p. 295.

[179] Global Wind Energy Council, *Global Wind Report 2018*, 2019, p. 17, https://gwec.net/wp-content/uploads/2019/04/GWEC-Global-Wind-Report-2018.pdf (accessed April 2019).

which corresponds to approximately EUR102/MWh[180]. Today, onshore wind is regarded in many countries as one of the cheapest forms of power generation technology in Europe, and offshore wind – considering its rapid cost reduction – seems not far behind: the industry is expecting that offshore installations will reach LCoE levels of €64/MWh by 2020 and €60/MWh by 2025[181].

As mentioned above, wind farm fuel costs are zero, and this is an important difference in terms of cost profile between wind energy and conventional electricity generators: it is estimated that in a natural gas power plant 40% to 60% of the costs are related to fuel and Operation and Maintenance (O&M) against a mere 10% for onshore wind energy[182].

As for offshore wind, studies show that the logistics related to installing and operating a wind farm represents an important cost component. It is estimated that this cost component may amount to 18% of the LCOE of an offshore wind farm[183].

Offshore wind turbines have to be designed, installed and to operate under extremely severe natural conditions, such as – non-exhaustively - waves, water salinity, high wind speeds[184]. Building and operating an offshore wind farm requires more resources than doing so onshore. The supply chain is also vaster than onshore wind energy as it encompasses vessels equipment, ports infrastructures and other marine facilities[185].

The whole process of installing wind turbines at sea is highly weather-dependent, meaning that it can be performed only under certain conditions[186]. This is a general requirement due to the actual impossibility to carry out installation actions under bad weather conditions but also to minimize risks for workers in the sector. As an example, the impossibility to perform operations at sea rapidly translates into a

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[180] European Commission, DG Budget, InfoEuro, [website], http://ec.europa.eu/budget/graphs/inforeuro.html (accessed April 2019). Exchange rate USD-EUR calculated for September 2018, as an indication of the second half of 2018.

[181] WindEurope, *Wind energy is the cheapest source of electricity generation*, 2019, [website], https://windeurope.org/policy/topics/economics/ (accessed April 2019).

[182] M. I. Blanco, 'The Economics of Wind Energy', *Renewable and Sustainable Energy Reviews*, Vol. 13, 2009, p. 1372–1382. Accessible from: Elsevier Science Direct Journals (accessed April 2019).

[183] C. Bay Hasager, T. Poullens, 'How Expensive Is Expensive Enough? Opportunities for Cost Reductions in Offshore Wind Energy Logistics', *Energies*, Vol. 9(6), N. 437, 2016, p. 20.

[184] Jos Beurskens, *Converting Offshore Wind into Electricity*, Amsterdam, Eburon Academic Publishers, 2011, p. 22.

[185] T. Poulsena, R. Lemab, 'Is the supply chain ready for the green transformation? The case of offshore wind logistics', *Renewable and Sustainable Energy Reviews*, Vol. 73, 2017, p. 758 – 771. Accessible from: Elsevier Science Direct Journals (accessed April 2019).

[186] E. Ursavas, 'A benders decomposition approach for solving the offshore wind farm installation planning at the North Sea', *European Journal of Operational Research*, Vol. 258 (2), 2017, p. 704. Accessible from: Elsevier Science Direct Journals (accessed April 2019).

significant increase in the timing of the project completion process but also in the renting cost of specialized vessels, raising the overall costs.

Being an effective means to produce zero-carbon electricity and being not yet fully competitive with other forms of power generation[187], offshore wind energy in Europe is financially supported by Member States, in different ways according to their national regimes. The legal grounds for public support to renewable energy are primarily laid down in the Energy and Environment State Aid Guidelines[188] and in the Renewable Energy Directives[189]. Following these legislative texts, public support can be given to renewable energy operators in a way that is non-distortive of the internal energy market and needs to be allocated through a transparent and competitive bidding process.

Competitive bidding processes, together with the significant recent evolutions in technology and the growing economies of scale across the sector allowed for a sharp cost reduction over the past years. Europe is still world leader in the offshore wind energy sector, retaining most of the capacity installed[190]. Academia and industry are working together in R&I to make sure the old continent can still preserve its leadership status despite growing competition coming from the US, China and other important emerging Asian markets such as Taiwan or Japan.

2.1.2 Advantages and disadvantages of offshore wind energy

As compared to onshore wind energy, offshore wind energy has a series of advantages and policy makers in Europe are becoming increasingly aware that placing turbines at sea is extremely important to reach the decarbonisation objectives of the European Union.

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[187] D. MacKinnon et al., 'Path creation, global production networks and regional development: A comparative international analysis of the offshore wind sector', *Progress in Planning*, Vol. 130, 2019, p. 1-32.

[188] Guidelines on State aid for environmental protection and energy 2014-2020 (2014/C 200/01), OJ 28/06/2014 [2014]. The Guidelines are *de facto* binding over Member States despite them being soft law. The European Commission is the only Institution that can assess and approve the compatibility of certain measures with European internal market rules (Art. 107 TFEU). The Directorate-General for Competition has the power not only to investigate cases potentially breaching EU law in the field, but also to impose fines if the outcome of the investigation is positive. European Commission, *European Competition Policy in Action*, 2017, https://publications.europa.eu/en/publication-detail/-/publication/b11a5d15-c5ca-11e7-9b01-01aa75ed71a1 (accessed April 2019).

[189] RED I and RED II.

[190] GWEC, *Global Wind Report 2018*, p. 23.

Primarily, wind resource conditions at sea are better than those on land[191], for the main reason that winds are more constant and stable offshore. Offshore wind turbines therefore averagely have higher capacity factors[192], resulting in much higher electricity production than onshore wind turbines.

The higher capacity factor is also the result of the bigger size of offshore wind turbines as compared to the turbines on land. The latter are limited in size due primarily to road transportation constraints, whereas offshore turbines are transported and erected at sea, using specialized vessels[193].

As it will be explained in the next section, most of the wind energy capacity installed today is onshore but as technology evolves and urban areas increase creating land scarcity, offshore wind seems an increasingly good solution to overcome space constraints. Coastal areas are often urbanized and productive, with a high electricity demand, meaning that installing wind turbines off the coastlines requires less transmission cable to bring the energy on land[194].

Offshore wind energy can be installed efficiently in a limited amount of time. Studies report that only 6 months are needed for manufacturing a turbine, transporting and installing it, and only a few months for dismantling the turbine after its end of life (approximately 25 years after installation) [195]. This estimates only take into account the industrial availability and techniques but does not count for the permits and concessions that need to be obtained prior to installation, which can be extremely lengthy in Europe[196].

Looking at the environmental perspective, this technology has a limited environmental footprint as compared to other power generation technologies – and onshore wind even less so. Certain types of wind

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[191] An interesting tool to assess the wind energy resource in different geographical areas in the world is the Global Wind Atlas, a database gathering data and measurements of wind speeds at different heights and in different on-land and coastal zones. *Global Wind Atlas*, [website], https://globalwindatlas.info/ (accessed April 2019).

[192] The United States Nuclear Regulatory Commission defines Capacity Factor as "The ratio of the net electricity generated, for the time considered, to the energy that could have been generated at continuous full-power operation during the same period". United States Nuclear Regulatory Commission, 'Capacity Factor', *Glossary*, [website] https://www.nrc.gov/reading-rm/basic-ref/glossary/capacity-factor-net.html (accessed February 2019).

[193] M. Bilgili, A. Yasar, E. Simsek, 'Offshore wind power development in Europe and its comparison with onshore counterpart', *Renewable and Sustainable Energy Review*, Vol. 15 (2), 2011, p. 905 – 915. Available from: Elsevier Science Direct Journals (accessed April 2019).

[194] *Ibidem*.

[195]Jean-Marc Lechêne, 'Développer l'énergie éolienne dans un contexte réglementaire mouvant', *Annales des Mines - Responsabilité et Environnement*, N. 78, 2015, p. 58. Available from : CAIRN Journals (accessed April 2019).

[196] G. Ellis, R. Cowell, C. Warren, P. Strachan, J. Szarka, 'Expanding Wind Power: A Problem of Planning, or of Perception?', *Planning Theory & Practice*, Vol. 10, 2010, p. 524.
Joint Research Center of the European Commission, *The regulatory framework for wind energy in EU Member States*, 2015, p. 35, http://publications.jrc.ec.europa.eu/repository/bitstream/JRC93792/d1_regulatory_framework_wind_energy_in_ms_march_2015%20(2).pdf (accessed May 2019).

turbines contain rare earth materials and some of the turbine components, such as the blades made of fiber reinforced polymers, are difficult to recycle at present[197]. Wind energy carbon and water footprints nevertheless are limited in the production cycle[198].

Wind energy has very good socio-economic benefits at the local level, in terms of turnover and job creation. Given the size and mass of the turbines and most of its components, it can be challenging and economically unviable to transport wind turbines over long distances. For this reason, wind turbines and components are often manufactured locally or relatively close to the areas of installation[199]. In 2017 there were over 250'000 people employed in the European wind industry[200]. These numbers encompass workers in the entire supply chain, from the conception and design of the turbines to the operations of control and maintenance after they are built and installed.

The offshore wind energy supply chain is very vast and is growing, primarily because of the rapid boost in capacity we are witnessing over the past years. The supply chain that serves the North Sea offshore wind industry is developing rapidly enough also because it builds on an already-existing offshore marine service industry, such as support vessels for the installations (so-called jack-up barges), cranes, multipurpose platforms, marine construction, civil engineering that is inherited from the oil & gas industry[201].

Despite all the positive aspects mentioned so far, there are some disadvantages linked to wind energy as a power generation technology, either in absolute terms or in comparison with other power generation technologies. One, already mentioned earlier in the text, is the need for a conspicuous initial capital investment, which means that companies investing in offshore wind energy need to have strong balance

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[197] European Technology & Innovation Platform for Wind Energy, *Strategic Research and Innovation Agenda,* 2018, p. 17, https://etipwind.eu/wp-content/uploads/2018-Strategic-Research-Innovation-Agenda.pdf (accessed May 2019).

[198] European Wind Energy Association, *Saving water with wind energy*, 2014, Introduction, https://windeurope.org/fileadmin/files/library/publications/reports/Saving_water_with_wind_energy.pdf (accessed April 2019). Regarding the CO2 footprint, see R. C. Thomson, G. P. *Harrison, Life Cycle Costs and Carbon Emissions of Wind Power*, 2015, Executive Summary, https://www.climatexchange.org.uk/media/1459/life_cycle_wind_-_executive_summary_.pdf (accessed May 2019).

[199] J. M. Lechêne, 'Développer l'énergie éolienne dans un contexte réglementaire mouvant', *Annales des Mines - Responsabilité et Environnement*, No 78, 2015. A map of the European wind industry is available at WindEurope, *Local Impact Global Leadership*, [website], 2017, www.windeurope.org/about-wind/campaigns/local-impact-global-leadership [accessed June 2019].

[200] Deloitte and WindEurope, *Local Impact, Global Leadership – The impact of wind energy on jobs and the economy, 2017,* Executive Summary, https://windeurope.org/about-wind/campaigns/local-impact-global-leadership/#report (accessed April 2019).

[201] P. Dannemand Andersen, N. E. Clausenb, T. Cronínb, K. A. Piirainena, The North Sea Offshore Wind Service Industry: Status, perspectives and a joint action plan, *Renewable and Sustainable Energy Reviews*, Vol. 81, 2018, p. 2676.

sheets. It was said that offshore wind is even more expensive than its onshore counterpart, due primarily to the marine foundations.

Another potential disadvantage relates to grid integration. It was previously mentioned that wind energy, together with solar power, is by definition a natural variable resource. Offshore wind has a higher power generation profile as compared to onshore wind, therefore very large amounts of variable renewable energy have to be injected in the grid. Sometimes coastal areas have weak grids that need to be reinforced to absorb the electricity output[202]. This could also increase the risk of transmission bottlenecks. Importantly, wind energy is not necessarily generated where the load is and this increases the need for new transmission lines[203]. Since the responsible authority is normally the TSO, which is generally a semi-public entity, this process translates into higher costs for the society.

Over the years, technological innovation improved both in terms of site planning studies that allowed for a better understanding of the site specificities and resources available therein, but also as far as meteorology forecast are concerned[204]. Improved better forecasting is important in a systemic view because - as it was previously stated - an energy system needs to be always very well balanced between offer and demand and therefore predictability of all its energy sources is crucial for its functioning.

In this context, opponents to wind energy argue that because of its variability nature this technology might contribute to lowering wholesale electricity prices in periods where these prices are already very low. This is because variable renewables normally have priority access to the grid: if they produce because the resource is abundant, other (conventional) power plants have to lower their production or shut down, depending on the electricity demand levels and considering that as said the system needs to be balanced

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[202] M. Bilgili, A. Yasar, E. Simsek, 'Offshore wind power development in Europe and its comparison with onshore counterpart', *Renewable and Sustainable Energy Review*, Vol. 15 (2), 2011, p. 905 – 915. Available from: Elsevier Science Direct Journals (accessed April 2019).

[203] J. Cochran, L. Bird, J. Heeter, D. J. Arent, *Integrating Variable Renewable Energy in Electric Power Markets: Best Practices from International Experience*, NREL, 2012, Introduction. Available from: UNT Digital Library (accessed March 2019).

[204] Clean Energy Wire, *Volatile but predictable: Forecasting renewable power generation* [website], 2016, https://www.cleanenergywire.org/factsheets/volatile-predictable-forecasting-renewable-power-generation, (accessed February 2019). Recent research projects are working on the optimization of weather forecasts for variable renewables, see for instance Deutscher Wetterdienst, *Weather forecasts for renewable energy - a challenge,* [website], 2016, https://www.dwd.de/EN/research/weatherforecasting/num_modelling/07_weather_forecasts_renewable_energy/weather_forecasts_renewable_energy_node.html (accessed February 2019).

at all times[205]. If the wholesale electricity prices are negative, following the logic of the normal supply-demand curve, the supply of electricity exceeds the demand. Therefore, if more power is produced and sold on the market to be injected into the national grid, power prices would be decreased even more, possibly resulting into negative prices that ultimately do not reward power producers – not even the renewable energy ones. It is worth pointing out that the negative price phenomenon happens only under a few, peculiar circumstances and for a limited amount of hours per year[206]. Other views point out that negative power prices often occur irrespective of the abundancy of the wind resource, in countries where conventional power plant operate because of must run obligations or because shutting them down would be even more costly than letting them produce under negative prices[207]. The discussion is complex and certainly goes beyond the scope of this work. Nevertheless, these considerations are important and therefore deserve to be listed in the disadvantages related to wind power.

Wind turbines projects may bring along issues of public acceptance, which depends primarily on the environmental impact of the turbines such as the visual and noise impact or the impact on biodiversity[208]. The so-called *Not-in-my-backyard* (NIMBY) movements are frequent in certain countries, such as the United Kingdom[209], as wind turbines have visual impacts on the landscape, particularly on land. One could think to the phenomenon of shadow-flicker, defined as the periodic shadow-and-light effect caused by the rotation of the blades of the turbine[210]. To overcome issues such as the shadow-flicker effect and for safety reasons, national or local regulations require that wind turbines are built distant enough to houses

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[205] M. Bilgili, A. Yasar, E. Simsek, 'Offshore wind power development in Europe and its comparison with onshore counterpart', *Renewable and Sustainable Energy Review*, Vol. 15 (2), 2011, p. 905 – 915. Available from: Elsevier Science Direct Journals (accessed April 2019).

[206] EPEX Spot, *Q&A on Negative Prices*, [website], https://www.epexspot.com/en/company-info/basics_of_the_power_market/negative_prices (accessed April 2019).

[207] WindEurope, *Sustaining a cost-efficient energy transition in Europe*, 2018, p. 8, 10-11, https://windeurope.org/wp-content/uploads/files/policy/position-papers/WindEurope-Sustaining-a-cost-efficient-energy-transition-in-Europe.pdf (accessed May 2019).

[208] T. Ackermann, L. Söder, 'Wind energy technology and current status: a review', *Renewable and Sustainable Energy Reviews*, Vol. 4, 2000, p. 315-374.

[209] K. Burningham, J. Barnett, G. Walker, 'An array of deficits: unpacking NIMBY discourses in wind energy developer's conceptualizations of their local opponents', *Society and Natural Resources*, Vol. 28(3), 2015, p. 246-260. See also C. R. Jones, J. R. Eiser, 'Understanding local opposition to wind development in the UK: How big is a backyard?, Energy Policy, Vol. 38(6), 2010, p. 8. Available from: Elsevier Science Direct Journals (accessed April 2019).

[210] UK Government, Department of Energy and Climate Change, *Update of UK Shadow Flicker Evidence Base*, Executive Summary, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/48052/1416-update-uk-shadow-flicker-evidence-base.pdf (accessed April 2019).

and buildings not to have any repercussion of this sort[211]. As for the environmental impacts on biodiversity and by way of an example, several rules apply so that the developers of the windmill need to avoid birds migratory routes to lower the risk of collision and birds death[212]. It is important to note that in order to get the permit to build a wind farm, all developers need to obtain an authorization that is granted only after having assessed that the interference with the natural environment is kept to a minimum, via the so-called Environmental Impact Assessment (EIA) procedure[213].

Ultimately, a downside of wind energy relates to the end of life of the turbine. Today, already 80-85 % of a wind turbine is recyclable but several components are not, such as the fiber glass used for the blades[214]. When the machine is dismantled and decommissioned, questions arise as to what could be done in order to improve the sustainability of the wind energy sector in a fully circular-economic view.

2.2 Status update in Europe

At present there are 189 GW of wind energy installed in Europe, satisfying 14% of the total European power demand[215]. Out of this volume, 18.5 GW are deployed offshore[216]. In 2018 Europe installed 2.6 GW of new offshore wind energy.

The market is very geographically concentrated, with the UK and Germany accounting for 85% of all 2018 annual installations with 1.3 GW and 969 MW respectively deployed in their national waters. The UK represents the first market in terms of offshore capacity installed, with more than 8 GW corresponding to nearly 2,000 turbines installed[217].

Most of the offshore capacity currently installed in Europe is in the North Sea. This sea basin has particularly good and stable wind resources and other very favorable conditions. Offshore wind farms need to be located in places where both the wind resource and the possibility to transmit the electricity

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211 S. Larwood, C. P. van Dam, 'Wind turbine rotor fragments: impact probability and setback evaluation', *Clean Energy Technologies and Environmental Policy*, Vol. 17, Issue 2, 2014, p. 475-484. Available from: SpringerLink Journals Complete (accessed March 2019).

212 E. C. Kelsey et al., 'Collision and displacement vulnerability to offshore wind energy infrastructure among marine birds of the Pacific Outer Continental Shelf', *Journal of Environmental Management*, Vol. 227, 2018, p. 229 – 247. Available from: Elsevier Science Direct Journals (accessed April 2019).

213 Directive 2014/52/EU of the European Parliament and of the Council of 16 April 2014 amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment, OJ L124 [2014], (EIA Directive).

214 WindEurope, *Background paper on the environmental impact of wind energy – A contribution to the circular economy discussion*, 2017, https://windeurope.org/wp-content/uploads/files/policy/topics/sustainability/Circular-Economy-paper-20170418.pdf (accessed May 2019).

215 WindEurope, *Wind energy in Europe – Trends and statistics 2018*, Executive Summary.

216 WindEurope, *Offshore wind in Europe – Key trends and statistics 2018*, Key Findings.

217 *Ibidem*.

produce to shore are optimal, and this is not necessarily an easy task as there might be several regulatory and legal limitations as to the possibility to build offshore wind farms[218]. The North Sea offers proximity of its coasts that allow for reduced grid connection cables between offshore wind farms and the States surrounding its waters. The North Sea also offers a shallow seabed that, as previously mentioned, is a fundamental element for allowing offshore wind installations.

As reported in more detail earlier in the text, Belgium and the Netherlands are playing an important role in developing offshore wind energy in this sea basin. They both rely heavily on this low-carbon power generation technology for their energy systems and broader economies, and have ambitious plans for installations over the next years.

2.3 Status update at the global level

The International Energy Agency estimates that the global energy demand will grow significantly – more than a quarter as compared to today - over the next 20 years, with significant economies such as India, China driving the increase in demand, together with a general increase in the world's population size[219]. An essential role in supplying this increased demand will be played by electricity, estimated to increase by approximately 60% (15,000 TWh) between 2017 and 2040, with renewables playing a major role in the power mix and slowly pushing coal – the main electricity source at the global level - out of the game[220].

Wind energy was the fastest growing power generation technology in the 1990s as percentage of yearly growth installed capacity per technology source and at the global level. This growth however was not evenly distributed around the world: at the end of 1999 around 69% of the global wind power capacity was installed in Europe, a further 19% in North America and 10% in Asia and the Pacific[221].

Today, Asia and North America are playing a much bigger role in the global market. The latest statistics from the Global Wind Energy Council report that The Chinese onshore market installed 21.2 GW in 2018 and has been the leading market since 2008. China at the end of 2018 counted on 206 GW total onshore installations and is the first market globally to have more than 200 GW installed[222]. In terms of offshore wind installations, China had 4.58 GW installed at the end of 2018[223], with new installations in the course

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[218] R.A. Mehdi, W. Ostachowicz and M. Luczak, *MARE-WINT: New materials and reliability in offshore wind turbine technology*, London, Springer, 2016, p. 6-7.
[219] International Energy Agency, *World Energy Outlook 2018,* 2018, www.iea.org, p. 38-40.
[220] *Idem*, p. 44.
[221] T. Ackermann, L. Söder, 'Wind energy technology and current status: a review', Renewable and Sustainable Energy Reviews, Vol. 4, 2000, p. 315-374.
[222] GWEC, *Global Wind Report 2018*, p. 23.
[223] *Idem*, p. 29.

of 2018 amounting to 1.8 GW – a figure that seems small in itself but if compared to the biggest offshore global market, the United Kingdom, shows that China has installed more on a yearly basis than the latter. The US is another very important fast-growing market, with a total of 96 GW installed onshore at the end of 2018[224] and another 30 MW offshore[225], but with a build-out pipeline of 5.4 GW over the next few years[226]. India and other Asian countries started to express interest for developing offshore wind over the next years[227]. Europe, with almost 18.5 GW installed in its waters, remains at the forefront globally for the time being.

Less fast growing economies than those mentioned above are looking into wind energy as a way to decarbonize their power systems. Several International Financial Institutions (IFIs) are helping emerging countries supporting international investments in renewable energy. In particular, the World Bank (WB) and its private branch, the International Finance Corporation (IFC) have recently launched a dedicated programme for the deployment of offshore wind energy in developing countries such as Brazil, Indonesia, India, the Philippines, South Africa, Sri Lanka, and Vietnam[228].

2.4 Conclusions of the second chapter

Today Europe has 189 GW of wind power installed, of which almost 18.5 GW off its coasts and installed primarily in the North Sea basin. All together, these 189 GW satisfy 14% of the total European power demand.

Offshore wind energy is a source of clean electricity that uses the kinetic energy of the wind to produce electrical power. Commercial-scale offshore wind turbines consist of a three-bladed rotor in horizontal axis. The first of this kind of offshore wind turbines were installed at sea in 1991 in Vindeby, Denmark. Each of them had a capacity of 0.45 MW and all together the eleven wind turbines formed a park of 4.95 MW. Today, the average size of a newly installed offshore wind turbine is above 6 MW, namely bigger than the first wind farm as a whole.

Technological improvement is a constant and is driven primarily by economies of scale and Research & Innovation. These drivers in turn have been rendered possible over the past years by favorable national

[224] GWEC, *Global Wind Report 2018*, p. 23.
[225] Idem, p. 29.
[226] Offshore Wind Business Network, *Market Overview*, [website], https://www.offshorewindus.org/about-offshore-wind/usmarketoverview/ (accessed May 2019).
[227] GWEC, *Global Wind Report 2018*, p. 32-33.
[228] World Bank, *New Program to Accelerate the Expansion of Offshore Wind Power in Developing Countries*, [website], https://www.worldbank.org/en/news/press-release/2019/03/06/new-program-to-accelerate-expansion-of-offshore-wind-power-in-developing-countries (accessed May 2019).

and European policies encouraging renewable power installations. Today offshore wind energy is still supported by Member States, through direct financing but also creating favorable conditions for investments, providing regulatory stability. Regional cooperation initiatives such as the North Seas Energy Forum, of which the Benelux countries, as seen, are parties, are looking into cross-border coordination for an even more cost effective deployment of offshore wind energy.

Public support to offshore wind energy and renewable energy in general is provided because of the enormous benefits renewables bring to the society that would not be exploited if only a market-based logic was used. Particularly in the case of offshore wind energy, recent downwards cost trends confirm that cost-competitiveness towards other power generation technologies is going in the favorable direction. Due to harsher installation and operation conditions, the turbines installed at sea are still more expensive than their onshore counterpart. Nevertheless, wind energy is the electricity generation technology that has experienced the most important cost reduction over the past years and the LCOE of both onshore and offshore wind energy installations are rapidly decreasing, as previously mentioned.

In terms of advantages brought by the technology, primarily wind resources at sea are better than on land because the winds are more constant and stable offshore. This advantage translates into higher capacity factors than onshore turbines, thanks to the generally higher size of the turbines that do not suffer from transportation constraints as in the case of onshore wind, resulting in a significantly higher electricity output. Importantly, there are a series of socio-economic benefits that the offshore wind industry generates, not only in terms of carbon savings but also relating to the vastness of its supply chain: thousands of jobs created, investments in local infrastructures such as roads and ports for the transportation of the components and the installation of the turbines.

Alongside the benefits, downsides deserve some attention, too. On the financial side, offshore wind energy is a technology requiring a high upfront capital investment, a condition that limits the market to companies with strong expertise and balance sheets, potentially decreasing competitiveness - but also meaning the margins for further cost reductions might be high.

Considering the resource integration in the energy system, wind power is a variable renewable energy source and, as such, its variability needs to be well forecasted and managed to ensure the energy system stays perfectly balanced at all times. Additionally, literature revealed that the integration of large volumes of offshore wind energy in coastal areas where the grid infrastructure might be too weak is likely to pose integration and congestion problems.

More on the benefits and downsides of offshore wind energy is reported in the body of the chapter. What is worth taking away from the second chapter is that the EU and the Governments surrounding the North Sea basin acknowledge the importance of the offshore wind energy technology and its advantages. As stressed several times, the role offshore wind is expected to play in Europe (and beyond) over the next years is significant. Acknowledging also that the technology is relatively new, the margins for further cost reductions and for a more effective deployment across Member States is significant, particularly looking into the harmonization of policies and laws across Member States of geographical proximity. Regional cooperation initiatives, such as the North Seas Energy Forum, look into how to narrow these margins.

3. Offshore wind development in the Benelux Union at present

3.1 An introduction to European and International maritime law

3.1.1 The international landscape

The principle of exclusive sovereignty and therefore exclusive use of energy resources located over the national territory of one State developed under international customary law and closely related to the idea that the sovereign State has a right to exploit natural resources for an economic return[229]. This is how the first unwritten rules of the international community started to define the principle that States with access to the Sea could have exclusive rights over the resources located in their continental shelf[230].

The first encoding in written law happened in the '50s, following the 1958 Convention on the Continental Shelf[231] and after a series of other regional agreements were signed[232]. At the time, when sustainability and green energy were topics ranking lower than today in the political agenda, the conventions were aiming at regulating the exploitation of oil and gas resources.

The United Nations Convention on the Law of the Sea (UNCLOS) was signed in 1982, entering into force in 1992 and from that moment onwards represented the major international convention dealing with the use of sea[233]. The ultimate aim of the Convention is to protect the marine environment while regulating the human activities that can take place therein. Art. 197 of the UNCLOS convention assumes particular relevance for regional cooperation, since it is an open call for international institutions and other national and local public authorities to cooperate towards the protection of the marine environment[234].

The UNCLOS is important because it still defines today the rights and obligations of States when using their maritime resources, including with the aim of deploying offshore wind energy.

The UNCLOS convention establishes that, beyond the territorial waters of one State, there are two other important territories that are the Exclusive Economic Zone (EEZ) and the Continental Shelf.

The EEZ is defined in Art. 55 of the UNCLOS as "[…] an area beyond and adjacent to the territorial sea […] under which the rights and jurisdiction of the coastal State and the rights and freedoms of other States

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[229] F. Buonomenna, *Diritto internazionale dell'energia – Sovranità territorial e governance internazionale*, Napoli, Editoriale Scientifica, 2012, p. 28-29.
[230] T. Scovazzi, *Elementi di Diritto Internazionale del Mare*, Milano, Giuffrè Editore, 2002, p. 56-57.
[231] United Nations Geneva Convention on the Continental Shelf [1958].
[232] B. K Guthrie and C. G. Hioureas, 'Sovereignty disputes and offshore development of oil and gas', Journal of Energy & Natural Resources Law, Vol. 36 (3), 2018, p. 361-363. Available from: Taylor & Francis Social Science and Humanities Library (accessed April 2019).
[233] United Nations Convention on the Law of the Sea [1982] (UNCLOS).
[234] T. Scovazzi, *Elementi di Diritto Internazionale del Mare*, Milano, Giuffrè Editore, 2002, p. 125. See also Art. 197 UNCLOS.

are governed by the relevant provisions of this Convention"[235]. These rights are specified in the subsequent articles and can be summarized as the right to use exclusively the natural resources, as well as the exclusive right to undertake economic activities for the exploration or exploitation of the area, such as for the production of energy from the sea[236]. These rights cannot prevent other States to use the EEZ for lawful activities such as navigation or deployment of submarine cables[237] – for example for energy uses such as the electricity cables. Art. 57 further specifies that "The exclusive economic zone shall not extend beyond 200 nautical miles from the baselines from which the breadth of the territorial sea is measured"[238].

The continental shelf is defined as comprising the seabed and its subsoil beyond the territorial sea of a State and until the natural end of the territory of this State, i.e. its continental margin, or until 200 nautical miles from the baselines from which the breadth of the territorial sea is measures if the external border of the continental margin extends for a lower distance. It seems emerging as customary law that for those states that are geologically very favorite by having an extended continental platform, there is a limit to their continental shelf corresponding to a maximum of 350 nautical miles from the baselines[239]. Beyond the 200 miles, the coastal States need to pay for the exploitation of the resources[240].

As far as offshore wind energy is concerned, the same rights of the EEZ apply: the coastal state has the exclusive right to use the resources and initiate economic activities in the continental shelf. Importantly, installations cannot be placed in the trajectory of essential international navigation routes and in no case can the State owning the continental shelf define a no-go zone around the installation of more than 500 meters[241].

3.1.2 European maritime law relating to offshore wind energy

Since 2008, the European Union has a comprehensive Marine Strategy Framework Directive[242] that regulates marine environmental policy at the EU level. The aim of the Directive, as explained in Art. 1, is to "establish a framework within which Member States shall take the necessary measures to achieve or maintain good environmental status in the marine environment by the year 2020 at the latest". This 'good

[235] Art. 55 UNCLOS
[236] H. Caminos, 'Law of the Sea', *The Library of Essays in International Law*, 2001, p. 163-164.
[237] Art. 58 UNCLOS
[238] Art. 57 UNCLOS
[239] T. Scovazzi, *Elementi di Diritto Internazionale del Mare*, Milano, Giuffrè Editore, 2002, p. 56-57.
[240] The discipline behind the definitions of the areas and obligations stemming from the use of resources as prescribed by international customary and Treaty law of the sea is surely more complex than what is reported in this short introduction. See H. Caminos, 'Law of the Sea', *The Library of Essays in International Law*, 2001, p. 163-164.
[241] T. Scovazzi, *Elementi di Diritto Internazionale del Mare*, Milano, Giuffrè Editore, 2002, p. 58-59.
[242] Marine Strategy Framework Directive.

environmental status' is defined by Art. 3 (5) as "the environmental status of marine waters where these provide ecologically diverse and dynamic oceans and seas which are clean, healthy and productive within their intrinsic conditions, and the use of the marine environment is at a level that is sustainable, thus safeguarding the potential for uses and activities by current and future generations".

Importantly, the Directive requires that Member States cooperate at the regional level, whereby regional cooperation is defined as "cooperation and coordination of activities between Member States and, whenever possible, third countries sharing the same marine region or sub-region, for the purpose of developing and implementing marine strategies"[243].

Throughout the Directive, underwater noise emerges as an element potentially conflicting with the good environmental status objective[244] and wind turbines cause such noise during the installation phase - as the monopile or other foundations are hammered in the seabed, causing disturbance for marine mammals and other species[245]. Even if following this logic offshore wind energy installations should be prohibited, the Directive allows for derogation in case of overriding public interest that outweighs the negative impacts[246]. Given the focus on the development of clean electricity sources, and particularly offshore wind energy, that the European legislators have promoted over the past years and are still promoting towards 2030 and 2050, it should not be controversial that offshore wind energy can be part of this exception.

Another European Directive is important in the field of offshore wind energy, and it is the Maritime Spatial Planning Directive (MSPD) adopted in 2014[247]. The Directive obliges Member States to adopt national MSP plans by 2021[248] and cooperate among each other to prepare the plans[249].

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[243] Art. 3 (9) Marine Strategy Framework Directive.

[244] See for instance Art. 3 (8) of the Marine Strategy Framework Directive on the definition of pollution: "pollution means the direct or indirect introduction into the marine environment, as a result of human activity, of substances or energy, including human-induced marine underwater noise, which results or is likely to result in deleterious effects such as harm to living resources and marine ecosystems, including loss of biodiversity […]".

[245] S. Degraer, R. Brabant, B. Rumes, L. Vigin (Eds), 'Environmental Impacts of Offshore Wind Farms in the Belgian Part of the North Sea', *Memoirs on the Marine Environment*, 2018, Royal Belgian Institute of Natural Sciences, p. 16, https://odnature.naturalsciences.be/downloads/mumm/windfarms/winmon_report_2018_final.pdf (accessed April 2019).

[246] Art. 1 (30) Marine Strategy Framework Directive.

[247] Directive 2014/89/EU of the European Parliament and of the Council of 23 July 2014 establishing a framework for maritime spatial planning, OJ L257 [2014], (Maritime Spatial Planning Directive).

[248] Art. 4 and Art. 15 Maritime Spatial Planning Directive.

[249] Art. 11 Maritime Spatial Planning Directive.

MSP is particularly important as a way to boost offshore wind energy development. Offshore wind resources might be located in areas that are already used for other activities, some of them not necessarily compatible with the deployment of offshore wind energy or with potential of interference, such as for instance aviation uses[250]. Moreover, multiple uses of marine areas may harm the achievement of environmental protection goals promoted by the laws mentioned above and more generally by the framework to protect the environment adopted by the European Union and the international community over the last decades. In this context, Maritime Spatial Planning emerges as an important tool to foster a wise and cautious use of the ocean space[251].

UNESCO and the Intergovernmental Oceanographic Commission define MSP as a "process of analyzing and allocating the spatial and temporal distribution of human activities in marine areas to achieve ecological, economic, and social objectives that usually have been specified through a political process"[252]. The definition further specifies that "[m]arine spatial planning is not an end in itself, but a practical way to create and establish a more rational use of marine space and the interactions among its uses, to balance demands for development with the need to protect the environment, and to deliver social and economic outcomes in an open and planned way"[253].

3.2 Legal frameworks for offshore wind deployment in the Benelux countries

In all EU Member States in order to build and operate an offshore wind farm it is necessary to obtain permits and authorization to do so by the relevant national competent authorities. The procedures vary greatly across Countries and so do the profiles of actors involved.

In general terms, four types of actors are involved in the build-out of an offshore wind farm and its grid connection. The first one is the offshore wind farm developer, responsible for the development of the offshore wind farm and in some cases of the grid. The second actor, already seen above, is the TSO that –

[250] Studies show that wind turbines may interfere with the radars used for traffic control, see for instance EUROCONTROL, *Guidelines for Assessing the Potential Impact of Wind Turbines on Surveillance Sensors*, 2014, Introduction, https://www.eurocontrol.int/sites/default/files/2019-05/20140909-impact-wind-turbines-sur-sensors-guid-v1.2.pdf (accessed May 2019).

[251] M. Young, 'Building the Blue Economy: The role of Marine Spatial Planning in Facilitating Offshore Renewable Energy Development', *International Journal of Marine and Coastal Law*, Vol. 30, N. 148, 2015, p. 174. Available from: EBSCOhost Academic Search Premier (accessed May 2019).

[252] UNESCO and the Intergovernmental Oceanographic Commission, *Marine Spatial Planning Programme*, [website], http://msp.ioc-unesco.org/about/marine-spatial-planning/ (accessed June 2019). See also M. Young, 'Building the Blue Economy: The role of Marine Spatial Planning in Facilitating Offshore Renewable Energy Development', *International Journal of Marine and Coastal Law*, Vol. 30, N. 148, 2015, p. 174.

[253] UNESCO and the Intergovernmental Oceanographic Commission, *Marine Spatial Planning Programme*, [website], http://msp.ioc-unesco.org/about/marine-spatial-planning/ (accessed June 2019).

whether publicly or privately owned, or both – generally has the monopoly to own and operate the national onshore grid and in some cases also part of the offshore network. The third stakeholder is the offshore transmission owner, which is generally a company that develops, owns and operates the part of the offshore grid assets. Finally, the national regulatory authority is responsible to supervise the behaviors of the other market participants so to ensure that market practices are in line with national, European and International laws[254].

The process of an offshore wind farm development can be divided into different steps: the zone identification, normally responsibility of the public authority in the context of the definition of multiple uses of the sea (i.e. marine spatial planning); the site selection; the site investigation; the actual permitting process; and finally the construction of the project. Each of these steps is undertaken by different players in the context of different regulatory regimes in Europe[255].

The same can be said for the grid application and planning process and the actual network infrastructure build-out, which is responsibility of different players across Europe[256].

3.2.1 Belgium

The development of offshore wind energy in Belgium is a federal competence, based on the Electricity Act and subsequent amendments regulating the organization of the electricity markets[257]. Even though in principle the federal and regional authorities have a joint responsibility in the definition and implementation of the national energy policy[258], the federal government has full powers over the Belgian part of the North Sea[259]. As far as energy transmission is concerned, HV networks are exclusively operated by Elia under federal mandate, whereas low voltage lines are responsibility of the regions, which are also responsible for renewable energies -excluding the offshore wind farms[260].

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[254]WindEurope, *Industry position on how offshore grids should develop*, 2019, 13.
[255] *Ibidem*.
[256] *Ibidem*.
[257] Loi relative à l'organisation du marché de l'électricité, 29 April 1999 [1999]. See Art. 6.
[258] Special Institutional Reform Act of 8 August 1980 [1980]. See also ELIA, *Legal Frameworks*, [website], https://www.elia.be/en/about-elia/legal-framework (accessed May 2019).
[259] Joint Research Center of the European Commission, *The regulatory framework for wind energy in EU Member States*, 2015, p. 35-36, http://publications.jrc.ec.europa.eu/repository/bitstream/JRC93792/d1_regulatory_framework_wind_energy_in_ms_march_2015%20(2).pdf (accessed May 2019).
[260] *Ibidem*. See also ELIA, *Legal Frameworks*, [website].

With reference to the steps listed above, in Belgium the identification of the zone for wind farm development is done by BSH, the national maritime authority. Currently, the developer is responsible for all the subsequent steps, from the site selection to the actual construction of the wind farm[261].

The permitting process phase requires the obtainment of three permits and licenses: the domain concession, the marine protection permit (environmental permit) and the cable permit[262]. The environmental permit includes a number of conditions intended to minimise or mitigate the impact of the project on the marine ecosystem and is linked to a strict monitoring system[263].

Belgium has very recently (in April 2019) put forward a new law that amends the 1999 Electricity Act and regulates competitive bidding processes for the next offshore wind farms to be built[264]. With the new provisions, the permits and authorizations should be automatically granted to the winners of the competitive bidding process[265].

Belgium adopted its Marine Spatial Plan in 2014 and does so every 6 years. On 8 February 2017, Belgium's Federal Secretary of State for the North Sea, Philippe De Backer, has launched a review process of the marine spatial planning (MSP) for the Belgian part of the North Sea, given that the current Plan expires in 2020 and by then the new plan, in line with the Belgian 2030 objectives, needs to kick-in[266]. The MSP allowed to identify and design the new areas for offshore wind farm deployment, close to the French border[267].

As far as the offshore grid construction and connection are concerned, Elia is responsible by law for connecting the offshore power plants to the existing grid infrastructure, even though the developer pays for the connection to shore[268]. The actual construction needs to be done by the TSO.

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[261] WindEurope, *Industry position on how offshore grids should develop*, 2019, p. 13.
[262] S. De Gendt, 'Legal challenges concerning offshore wind installations along the coastline of the North Sea', Master Dissertation, University of Ghent, 2018, p. 30.
[263] S. Degraer, R. Brabant, B. Rumes, L. Vigin (Eds), 'Environmental Impacts of Offshore Wind Farms in the Belgian Part of the North Sea', *Memoirs on the Marine Environment*, 2018, Royal Belgian Institute of Natural Sciences, p. 16, https://odnature.naturalsciences.be/downloads/mumm/windfarms/winmon_report_2018_final.pdf (accessed April 2019).
[264] Allen & Overy, *Belgium adopts legal framework on tenders for new offshore electricity production installations*, [website], 2019, http://www.allenovery.com/publications/en-gb/Pages/belgium-adopts-legal-framework-on-tenders-for-new-offshore-electricity-production-installations.aspx (accessed May 2019).
[265] *Ibidem.*
[266] Belgian Offshore Platform, '4 GW of wind energy in the Belgian part of the North Sea', *News*, [website], http://www.belgianoffshoreplatform.be/en/news/4-gw-of-wind-energy-in-the-belgian-part-of-the-north-sea/ (accessed May 2019).
[267] See Figure 2 in Annex.
[268] WindEurope, *Industry position on how offshore grids should develop*, 2019, p. 13.

To accompany the increase in offshore wind energy capacity, Elia has announced the plans to develop a modular offshore grid in the North Sea. This grid would connect the existing and future wind farms to allow the electricity produced to flow to different connection points and potentially use less cables, allowing more flexibility to the whole energy system[269]. One should consider that today the wind farms are typically connected in a radial way, which means one wind farm is connected to one offshore cable directly connected to land[270].

This exercise carried out by the Belgian TSO fits within the broader scope of the North Seas Energy Forum cooperation. As seen earlier in the text, the Support Group 2 of the NSEF is in charge of studying the potential for a HV super-grid in the North Sea to be ideally built by 2030[271].

3.2.2 The Netherlands

The Dutch system for authorizing offshore wind farms is different than the Belgian one as it uses a so-called centralized model. The responsible agency for the zone identification, the site selection, the site investigation and the permitting is a single one and it is the above-mentioned RVO, the Dutch Enterprise Agency headed by the Ministry of Economic Affairs.

In particular, The Netherlands Enterprise Agency is responsible for the collection of the all site data which provide information for all relevant feasibility and environmental studies and allow for the competitive bidding processes – and therefore for the build-out of wind farms – to take place.

The studies performed need to be very detailed – this is true not only for the Dutch case obviously but in all sites where offshore wind farms have to be built. For instance, RVO conducts the studies related to the soil conditions (e.g. geophysical, geotechnical and geological studies), those related to the unexploded ordnances (abbreviated as UXOs) present also in the North Sea[272] and to the potential archeological ruins under the seabed, the studies related to the wind resource assessment and to the meteorology and oceanography conditions (so called met-ocean studies)[273].

[269] ELIA, 'ELIA completes all main construction contracts for modular offshore grid', *Newsroom*, March 2018, [website], http://www.elia.be/en/about-elia/newsroom/news/2018/20180313_Press-release_MOGcontracts (accessed May 2019).

[270] The North Seas Countries' Offshore Grid Initiative, Working Group 2, *Final Report*, 2012, p. 8, http://www.benelux.int/files/9014/0923/4547/regulatory_and_market_challenges.pdf (accessed May 2019).

[271] *Ibidem*.

[272] A. M. von Benda-Beckmann et al., 'Assessing the impact of underwater clearance of unexploded ordnance on harbour porpoises in the Southern North Sea', *Aquatic Mammals*, Vol. 41(4), 2015, p. 503-523, Abstract. Available from: ProQuest Central (accessed June 2019).

[273] Netherlands Enterprise Agency, *Offshore Wind Energy*, [website], https://offshorewind.rvo.nl/ (accessed May 2019).

Regarding the construction of the grid infrastructure, RVO and the Dutch TSO, TenneT[274], work together for the planning and the permitting phases, whereas like in several other Member States the actual infrastructure is built by the TSO[275]. The TSO is ultimately responsible for the connection of the offshore wind farm to the grid[276].

3.2.3 Offshore wind farms in the Benelux

The wind farms built today in the territorial waters of Belgium and the Netherlands are all connected to national shore with radial systems. At present no wind farm of a country in the North Sea is connected to the territory of another State. A first project that aims at interconnecting a German wind farm with a Danish one is currently under construction in the Baltic Sea – the Kriegers Flak project[277].

As seen before, there are different cooperation requirements in the field of renewable energies at the European level. The Renewable Energy Directive is asking Member States of the European Union to cooperate via several possible mechanisms, such as joint development of renewable energy projects or joint competitive bidding processes to share support schemes. The European Union is asking Countries to increase the level of interconnection across their borders to 15% of the total domestically produced electricity by 2030, from the threshold of 10% to be reached by 2020[278].

From the point of view of an electricity physical flow within Benelux, all of the three countries are connected via onshore networks. Luxembourg has cross-border electricity flows with Belgium and other neighboring countries (i.e. Germany and France), Belgium has further interconnection capacity with Germany, France, the Netherlands and the United Kingdom and the Netherlands electricity grid is further linked to Germany, Denmark, Norway and the United Kingdom[279]. There seems to be therefore no physical obstacle to cross border flow of electricity within the Benelux Union.

Belgium and the Netherlands both have access to the sea – whereas Luxembourg has none. This does not mean that the *Grand Duchy* does not have anything to gain from offshore wind deployment in the North

[274] Netherlands Transmission System Operator, TenneT, *Home Page*, [website], https://www.tennet.eu (accessed May 2019).
[275] WindEurope, *Industry position on how offshore grids should develop*, 2019, p. 13.
[276] Holland Home of Wind Energy, *Development of offshore wind in the Netherlands: a close public-private cooperation*, 2017, http://jwpa.jp/pdf/20171010_OffshoreWindDevelopmentNL.pdf (accessed May 2019).
[277] Danish Transmission System Operatos, Energinet, *Infrastructure Projects*, https://en.energinet.dk/Infrastructure-Projects/Projektliste/KriegersFlakCGS (accessed May 2019).
[278] European Commission Communication on strengthening Europe's energy networks, COM (2017) 718 [2017].
[279] ENTSO-E, *Cross-border electricity map*, [website], https://www.entsoe.eu/data/map/ (accessed May 2019).

Sea. The electrons produced by offshore wind farms off the Belgian and Dutch coasts could feed into the Luxembourg one given the interconnectivity.

Luxembourg might have other advantages than the mere provision of green electricity. As said, the Renewable Energy Directive provisions foresee mechanisms that allow countries cooperate closely to set-up and operate jointly renewable energy projects in order to achieve the 2030 targets. One of these mechanisms is the so-called statistical transfer of electricity and Luxembourg could experience it with further development of offshore wind energy in the North Sea.

3.3 What Luxembourg might gain from offshore wind: statistical transfer of electricity

Art. 6 of the 2009 Renewable Energy Directive[280] already foresaw that, in order to achieve the 2020 decarbonisation and renewable energy objectives, countries of the European Union should implement measures of cooperation. One of these measures was the so-called statistical transfer of electricity, also envisaged in the new (2018) Renewable Energy Directive as a means to accelerate the European energy transition.

The European Commission defines statistical transfers as an accounting procedure with no actual physical energy exchange necessarily involved: the amount of renewable energy of a certain Member State is deducted from the State's progress towards its domestic renewable energy target and is added as percentage point to another Member State's target, in exchange for payments[281]. Reasoning on this definition, one Member State with some important renewable energy resources that would not be fully exploited domestically would be incentivized to invest in the actual deployment of renewable energy projects to un-tap these resources, while at the same time contributing to greening the energy system of another country. The European Union idea behind this cooperation mechanism is indeed that countries would be incentivized to exceed their renewable energy targets because they can transfer, even if merely on paper, the excess of renewable energy to other States against compensation.

In the case of Belgium and the Netherlands, the offshore wind energy resource is abundant and this is the reason why both countries have set ambitious targets to develop this power generation technology over the next years. In the case of the Netherlands[282], some of the latest competitive bidding processes

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[280] RED I.

[281] European Commission, *Renewable Energy Directive Cooperation Mechanisms*, [website], https://ec.europa.eu/energy/en/topics/renewable-energy/renewable-energy-directive/cooperation-mechanisms (accessed April 2019).

[282] It was previously considered that Belgium has not yet had a competitive bidding process for the allocation and deployment of offshore wind energy.

launched for receiving public support to offshore wind projects resulted in the developers' request for zero public support to develop the wind farms, hence confirming that the offshore wind industry is undergoing a significant cost-reduction process and that those sites in the Netherlands would be able to produce clean electricity at the least cost for the society. This phenomenon could be read as the confirmation that if the renewable electricity is produced at a lower cost in another Member State rather than domestically, a cooperation mechanism such as the statistical transfer would greatly help boosting renewable energy in Europe where it is more convenient to do so. In the case of Luxembourg, a state with no particularly good renewable energy sources, this mechanism could greatly help avoiding falling short in the achievement of its own targets – and probably in a more cost-effective way than by relying on its domestic means only[283].

Even though a statistical transfer of renewable energy is technology neutral by definition[284], this mechanism could theoretically have the effect of boosting the development of offshore wind energy and other renewable energy generation in Belgium and in the Netherlands.

In 2017, Luxembourg has been the first Member State of the EU to strike a statistical transfer agreement with Lithuania in order to buy the latter's surplus of renewable energy[285]. In the same year, Luxembourg stroke a deal also with Estonia that became a contributor to the 2020 – and by extension 2030 – renewable energy target of the Grand Duchy[286]. Estonia's national renewable energy target for 2020 is 25%, but this target was already exceeded in 2015 with 28.6% of renewable energy in Estonia's final energy consumption[287]. Luxembourg's national renewable energy target for 2020 is 11%. Luxembourg achieved a 5% renewable energy share in its gross final energy consumption in 2015.

In its draft NECP, Luxembourg states that national resources will not be enough to reach the 2030 renewable energy targets and therefore the country will rely on cooperation mechanisms with other

[283] European Commission Staff Working Document SWD (2013) 440 Final [2013], *Guidance on the use of renewable energy cooperation mechanisms*, Introduction.
[284] Ecofys, *Cooperation under the RES Directive. Case study: statistical transfer between Estonia and Luxembourg, 2014,* https://res-cooperation.eu/images/pdf-reports/2014_Cooperation_under_the_RES_Directive_Case_study_Statistical_Transfer_Estonia_Luxembourg.pdf (accessed March 2019).
[285] EURACTIV, Luxembourg buys surplus of energy to hit renewable energy target, *News*, [website], https://www.euractiv.com/section/energy/news/luxembourg-buys-up-surplus-energy-to-hit-renewable-target-in-eu-first/ (accessed May 2019).
[286] European Commission, Second Statistical Transfer between Estonia and Luxembourg, *News*, [website], https://ec.europa.eu/info/news/second-agreement-statistical-transfers-renewable-energy-amounts-between-estonia-and-luxembourg-2017-nov-13_en (accessed May 2019).
[287] *Ibidem*.

countries. Statistical transfers will continue to play a crucial role but – importantly - the development of joint renewable energy projects in the framework of Benelux and/or the North Sea and the Pentalateral Energy *fora* will be key. The plan does not go as far as saying what technologies are envisaged[288].

Statistical transfers and other cooperation mechanisms do not come without question marks, particularly related to the social acceptability of these cooperation tools. One country that develops renewable energy projects – with all positive but also negative aspects related to these projects[289] – and publicly financially supports these renewable energy projects, might encounter social opposition when the electricity is statistically transferred to another country's sheet[290]. An analysis of the possible limitations to statistical transfers falls outside the scope of this research work. Nevertheless, being potential social opposition an important aspect, it is worth being mentioned not to give the false impression that this solution would come without any obstacles.

3.4 Collaboration between Belgium and the Netherlands: is it already happening?

As said, cooperation across Member States of the European Union is envisaged in the new Renewable Energy Directive and other important energy-related legal tools as a way to reach the decarbonisation objectives. On the other hand, so far not many cooperation mechanisms have been triggered by the Member States of the Union[291]. This is probably due to the fact that the mechanisms as prescribed by both the 2009 and the 2018 Directives are conceived to be used to attain the 2020 and 2030 targets respectively. At the time this thesis is being written, Member States are making their own calculations for the achievement of the 2020 targets and are still finalizing their National Energy and Climate Plans towards 2030.

The topic of cross-border cooperation is mandatory in the NECPs. Member States are requested by the Governance Regulation to detail, amongst a multitude of other elements, what measures they are willing to put in place to enhance cooperation with their neighbors.

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288 National Energy & Climate Plan of Luxembourg, p. 39.

289 Reference to Chapter 2 of this work.

290 Ecofys, *Cooperation under the RES Directive. Case study: statistical transfer between Estonia and Luxembourg, 2014,* https://res-cooperation.eu/images/pdf-reports/2014_Cooperation_under_the_RES_Directive_Case_study_Statistical_Transfer_Estonia_Luxembourg.pdf (accessed March 2019).

291 N. Caldés, Y. Lechon, I. Rodriguez, P. del Rio, *Analysis of the barriers to the use of the cooperation mechanisms for renewable energy in the EU*, 2018, Introduction and Chapter 2, http://mustec.eu/sites/default/files/reports/MUSTEC%20D4.1_Barriers%20for%20cooperation%20mechanisms.pdf (accessed May 2019).

In this context, in the relevant section on cross-border cooperation, the draft Belgian NECP[292] mentions the word Benelux 9 times, describing it as an important forum for collaboration, together with the Pentalateral Forum and the NSEF. The plan reports that initiatives of cooperation and consultation on the drafting of the NECPs are taking place within the Benelux and the Pentalateral Forum: Belgium has organized in June 2018 a first '2030 Energy & Climate Regional Dialogue'. The Plan further specifies that for certain energy sub-sectors, such as energy efficiency and transport, some "pathways have been explored for an enhanced cooperation in the future within Benelux"[293]. One could consider that this reference to potential future action is vague and does not refer to any power generation, leaving the reader with the idea that offshore wind energy deployment does not fall within the domain of enhanced cooperation.

Further on cross-border cooperation in the energy domain, the Belgian plan stresses that the country has bilateral agreements with other Governments, such as a protocol signed with the Netherlands on enhanced cooperation for electricity[294], and one with Luxembourg on natural gas. These, nevertheless, are bilateral agreements that as such do not account for a Benelux-wide cooperation on energy.

Under the section on regional cooperation, the NECP of the Netherlands echoes the initiatives already mentioned by the Belgian and the Luxembourgish – both reported previously in the text - energy & climate plans.

Apart from cross-border electricity infrastructures – that could be defined as a technology neutral infrastructure from the perspective of the power generation technology used - and sharing information in the existing *fora*, cooperation in actual offshore wind energy projects deployment is not yet occurring within Benelux. What seems to emerge from literature review and current practice is that the three countries follow their own individual nationally defined energy policies. This is true extensively for the whole North Sea basin, since as of today no renewable energy joint project has been realized there.

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[292] National Energy & Climate Plan of Belgium (Federal), 2018.

[293] *Idem,* p. 24-25 [*quoting*] « Pour un certain nombre de domaines d'action spécifiques (transports, efficacité énergétique et des matières premières, financement et transition équitable), des pistes ont été explorées pour une coopération plus étroite dans le Benelux à l'avenir ».

[294] This agreement aims at better using the cross-border electricity transmission lines and building new ones. ELIA, *Cross border interconnections*, [website], 2016, http://www.elia.be/en/about-elia/newsroom/news/2016/19-10-2016-Elia-and-TenneT-are-striving-to-upgrade-electricity-transmission-between-Belgium-and-the-Netherlands (accessed March 2019). Quoting: "Strengthening cross-border interconnections is also in line with the bilateral cooperation agreement signed by the Belgian and Dutch energy ministers in April 2016. One aim of this *Politieke Verklaring inzake Energiesamenwerking tussen Nederland en België* is to make better use of interconnections and maybe expand them. The same aim was set in Belgium's 2015-2025 federal development plan (approved by Minister of Energy, Marie Christine Marghem in November 2015)".

One should consider that the offshore wind energy sector is relatively new. With increasing cost-reduction trends and technological innovation, it is emerging now as a mainstream technology to decarbonize the energy system. Despite there being broad consensus with regards to its central role for the completion of the energy transition, cross-border cooperation on energy might take some time to focus on offshore wind as such. Also, the exercise of drafting the National Energy and Climate Plans for the decade 2021 - 2030 is not over yet. As said, Member States have to submit the final Plans to the European Commission by the end of December 2019, which means that theoretically more actions in the section dedicated to regional cooperation could be added, including actual joint deployment of renewable energy projects as envisaged by the various cooperation mechanisms prescribed in the Renewable Energy Directives.

3.5 Conclusions of the third chapter

The deployment of offshore wind energy at sea is regulated by international law. In particular, the UNCLOS convention entered into force in 1992 defines the maritime boundaries of States, which have in principle exclusive competence to build an offshore wind farm in their territorial waters, EEZ and continental shelf – even though great distances to shore might not be economically viable for the technology, as seen in Chapter 2.

The ultimate goal of the UNCLOS convention is to preserve the marine environment and its biodiversity while regulating the multiple uses of the sea: in increasingly busy waters, the space dedicated to renewable energy generation needs to be weighted against other uses such as fisheries, aviation, naval transportation.

In this context, European Union follows the direction of international law in the sector. The 2008 European Marine Strategy Framework Directive aims at achieving by 2020 a good environmental status of marine waters, defined by Art. 3 as the status whereby oceans are clean, healthy and productive at a level that is sustainable for present and future generation uses.

Following the objective set by the Framework Directive, Marine Spatial Planning in Europe assumes particular relevance to coordinate the various uses of the sea. The 2014 Marine Spatial Planning Directive obliges Member States to adopt spatial plans by 2021, coordinating cross-border in the making. The Plans will be of particular relevance to offshore wind energy development, particularly in the North Sea that is known for being one of the busiest sea basins in the world and in countries, like Belgium, with a limited offshore area. The wind resources might be located in areas already used or dedicated to other activities, not necessarily compatible with wind turbine installations. As it will become more evident in Chapter 4, MSP can avoid conflicts and exploit the best resource areas, even if cross-border, bringing benefits to the different coastal countries involved.

In this framework fits national legislation, too. The wind farm authorization process, concession granting, the building responsibility and ownership of the offshore grid assets might vary across EU Member States – and does, between the Netherlands and Belgium. Differences in national procedures nevertheless do not necessarily have to result in obstacles to cross-border cooperation. Sharing information on the nationally-determined MSP plans for instance, as requested by the EU MSP Directive, would be a first step towards closer cross-border collaboration and would not entail any changes in legislation since the authorization and installation national regimes cover the actual deployment of the renewable projects and not aspects of multiple uses of the sea.

One might recall from the first chapter that the Benelux countries – here meaning Netherlands and Belgium - are already sharing information within Support Group 1 of the NSEF on their respective marine plans. Literature review and conversations with stakeholders, as will be better explained in Chapter 4, do not indicate any particularly enhanced cooperation taking place within the Benelux Union in this sub-field. The question remains therefore open as to whether Belgium and the Netherlands could improve in this aspect given their geographical proximity and the existence of the Benelux Union within the North Seas Forum.

Luxembourg might have a limited role in the definition of the areas dedicated to offshore wind energy given its lack of access to the sea, but could gain significantly in terms of renewable electricity transfers. In its Renewable Energy Directives the EU has foreseen a series of cooperation instruments between Member States, supporting them in reaching the 2020 and 2030 binding renewable energy targets. One of these cooperation mechanisms is the so-called Statistical Transfer of renewable energy, whereby a Member State developing a renewable energy project may renounce to a share of renewable energy in its final energy consumption and give it to another Country in exchange for payments. This transfer is called ‘statistical’ because it relies on an accounting procedure without need of an actual electricity exchange.

As of today, Luxembourg has two statistical transfer agreements – one with Estonia and one with Lithuania. One could argue that a process of enhanced cooperation in the offshore wind sector in the Benelux Union could consider Luxembourg in its role of a ‘statistical’ consumer of the electricity produced by turbines off the Belgian and Dutch coasts. This role would probably grant Luxembourg more weight in the decision process around the power generation from the North Sea. Investigating the actual functioning of such decision-making structure as well as the economic and technical implications of a renewable statistical agreement within the Benelux Union does not fall within the scope of this work, but would be an interesting pathway to explore with further research.

The first three Chapter of this work have traced the *current* lines for cross-border cooperation in the development of offshore wind energy in the Benelux Union: the European context and its objectives, the role of the technology in reaching these objectives, the status of collaboration between the Netherlands, Belgium and Luxembourg. They rely primarily on extensive literature review and information publicly available on Government channels. Chapter 4, differently, looks at the potential for future Benelux cooperation and relies on the involvement of industrial stakeholders in this exercise.

4. Future cooperation in offshore wind deployment in the Benelux Union

It has emerged from the previous sections that both at the European and regional levels frameworks supporting cross-border cooperation in the renewable energy field exist. The European Commission is pushing for collaboration across Member States through cooperation mechanisms envisaged under the Renewable Energy Directive. The North Sea Countries have a dedicated Forum to investigate how to overcome important obstacles that today prevent them from fully un-tapping the offshore wind energy potential, by means of a regionally coordinated approach. The Pentalateral Energy Forum looks into how to ensure energy security across its participant countries. The Benelux Union Treaty foresees cooperation in the field of energy but for the time being offshore wind energy does not emerge as a cornerstone of the Union's cooperation agreement.

The OECD acknowledges that the existing structure of the Benelux is "well-established and equipped" to allow for the future development of cross-border harmonized policy-objectives and governance models that would "help develop horizontal projects for the Benelux region"[295]. This statement is of particular relevance as it seems to confirm that so far no actual horizontal project across the three countries in the field of renewable energy has been deployed.

If the political and legal instruments for cooperation already exist but have not been exploited so far, it is useful to understand how these tools could be triggered and what they should focus on. This chapter aims at gathering the views of the industrial stakeholders on what the Governments in the Benelux countries, and particularly Belgium and the Netherlands, could do in order to enhance the existing cooperation in a way that is supportive of further deployment of offshore wind energy in the North Sea.

The question asked to the offshore wind industry representatives was formulated along these lines: *within the context of an enhanced cooperation between the Netherlands and Belgium in offshore wind energy, what do you see as a key priority area of action to ensure a fast and more cost-effective deployment of this technology*? Because the views gathered are very diversified and cover different aspect of the offshore wind energy supply chain, they are reported below as a list of separate items. Each item represents the elaboration of a specific response provided.

[295] Martinez-Fernandez, C. et al., 'Green Growth in the Benelux: Indicators of Local Transition to a Low-Carbon Economy in Cross-Border Regions', *OECD Local Economic and Employment Development (LEED) Working Papers*, 2013/09, 2013, p. 14.

The name of the companies that contributed to formulate the Chapter is reported in the Acknowledgments section at the end of this work but is not attributed to a specific response obtained primarily for two reasons. First, for the aim of this exercise there is little or no interest in attributing the name of the company representative to the specific idea. Secondly, the views gathered do not represent the official views of the companies but rather the individual opinion of the experts working in the field willing to help in my research.

The reader should also keep in mind that, as explained in the introductory considerations, the next chapter wants to provide ideas on potential topics for future cooperation between the Benelux Union because they are identified as key priority areas by industry representatives. It does not have the ambition to explore in-depth each of those areas nor to propose a functioning structure for this cooperation. This is a pathway to be considered for a future potential continuation of this research work.

4.1 What priorities for an enhanced cooperation? An exchange with the industry

Several different answers to the same question have been given, showing that the number of areas of potential cooperation within the Benelux Union, and particularly the Netherlands and Belgium, is significant.

Special thanks for the creation of this Chapter go to the associations and companies that have spent some time discussing or writing their thorough thoughts and considerations. In alphabetical order: Netherlands Wind Energy Association, NWEA; Ørsted; Vattenfall; WindEurope. The exchange with WindEurope representatives consisted in meetings, whereas for the other companies the exchange took place in written form via e-mail exchanges.

To the question: "*What would be a key priority area for a cooperation in the Benelux that would ensure a more cost-efficient and rapid deployment of offshore wind energy in the North Sea*?" the answers are listed below, in no particular order of relevance.

4.1.1 Coordination of the timeline of offshore wind projects

It was already previously explained how the NSEF is considering that great efficiencies and cost-reduction might stem from coordination of the timeline of the offshore wind installations across Member States, and by consequence also the alignment of the calls for competitive bidding process launched by the Governments of the North Sea to support offshore wind energy. As explained in the first chapter, coordination is crucial because it essentially allows for the industry and its entire supply chain to plan investments in advance and be ready when needed. It was also mentioned that the Benelux Union does not appear as a single legal entity in the discussions within the North Sea Forum, and that Belgium is currently in the phase of development of its plan to support via competitive bidding processes the deployment of offshore wind energy. Therefore, one priority area for the Benelux Union – and in this case particularly for Belgium and the Netherlands – would be to fully align on the dates for the calls for bids and in general to pre-align on the discussions taking place in the North Sea Energy Forum.

4.1.2 Joint MSP for Belgium and the Netherlands

Cooperation in the field of MSP is seen beneficial for several reasons. The most important considerations probably refer to the possibility of abating costs for the industry. Not all the sites across seas have the same wind resources and environmental conditions needed to exploit these resources, such as the sea bed or the distance to shore. Site conditions that are better than others translate into less difficulties in installing and operating the wind turbines, while producing more wind energy output that in turn translates into more electricity sold in the market. Cooperation in maritime spatial planning across different coastal states of geographical proximity, such as Belgium and the Netherlands in Benelux, would mean that the best sites for installations - irrespective of which territorial waters they are located in – could be used for installations while providing power to all the locations needed[296] in the Benelux area.

This process would be a huge advantage as compared to the current nationally-defined MSP. It was previously mentioned that the MSP Directive does require that the EU Member States cooperate in exchanging information on their MSP, and to the maximum possible extent in drafting them, but there is no obligation stemming from any EU law to develop the plans jointly, particularly in terms of renewable energy power generation. In this context, one should remind that also all the cooperation mechanisms stemming from the Renewable Energy Directives are also on a voluntary basis.

Should the Netherlands and Belgium decide to plan and harness together the best offshore wind resources available in their waters, a series of other steps towards a closer cooperation would be necessary in order to fully exploit this possibility. One would be, for instance, the build-out of cross-border connections to make sure the electricity produced is efficiently transported (with reference to the next section for further considerations).

4.1.3 Setting up of a joint offshore wind farm project

Some industry representatives consider that the Benelux countries could identify and set-up a common testing area, for instance across the borders of the Dutch and Belgian territorial waters, to see how the

[296]BVG Associates, *Unleashing Europe's offshore wind energy potential – A new resource assessment*, 2017, p. 10, https://windeurope.org/wp-content/uploads/files/about-wind/reports/Unleashing-Europes-offshore-wind-potential.pdf (accessed April 2019).

joint delivery of one renewable energy project could work in practice. This approach would be strictly related to the previously-mentioned cooperation mechanisms prescribed by the European Union in the recently recast Renewable Energy Directive: joint support schemes, joint projects and statistical transfers across countries.

Leaving aside the last point that has already been extensively explained in Chapter 3, the European Commission defines joint projects as two or more EU countries that can co-fund a renewable energy project (in electricity in this case) and share the resulting renewable energy for the purpose of meeting their targets towards 2020 and 2030[297]. The project can involve electricity flow between the countries or not (i.e. relying in this case on statistical transfers).

Joint support schemes occur when two or more EU countries can co-fund a support scheme to boost renewable energy production in one or both of their territories[298]. This form of cooperation can involve measures of support that are compatible with the European Commission State Aid Guidelines on Environment and Energy[299].

As mentioned earlier in the text, this type of cooperation across Member States will be essential for the achievement of the 2020 and 2030 targets but has not been yet extensively used by Governments to attain their targets. Probably the only successful example of a cooperation mechanism is the joint renewable energy support scheme between Sweden and Norway, whereby the Governments in 2012 have implemented a common green electricity certificate system[300]. The Benelux could be a first pilot in paving the way and considering what might work well and what does not.

A common cross-border testing area could be of utmost relevance for other aspects as well. For instance, setting a common framework for a cross-border cumulative impact assessment would be particularly important. It was considered previously that the EIA procedure is implemented at the national level as a necessary step in order to gain authorization to build the offshore wind energy infrastructure – a process that differs across Member States. Both Belgium and the Netherlands perform individual impact

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[297] European Commission, *Guidance on the use of renewable energy cooperation mechanism - Accompanying the document Communication form the Commission Delivering the internal electricity market and making the most of public intervention*, Commission Staff Working Document SWD (2013) 440 [2013].
[298] *Ibidem*.
[299] Guidelines on State Aid for environmental protection and energy 2014-2020, OJ C200/1 [2014].
[300] Ministry of Enterprise, Energy and Communications of Sweden, *Common Swedish Norwegian certificate market for renewable electricity*, 2013, Introduction, http://ec.europa.eu/competition/state_aid/modernisation/centeno-lopez_en.pdf (accessed May 2019).
See also IEA, *Norway-Sweden Green Certificate Scheme for electricity production*, [website], https://www.iea.org/policiesandmeasures/pams/norway/name-21865-en.php (accessed May 2019).

assessments to grant the permits to build offshore wind farms in their respective waters, but in view of the potential for future joint MSP (see section above), having a common EIA procedure might be useful. The European Commission is exploring now the possibility of establishing a framework for cooperation on assessing the cross-border impacts of renewable energy projects[301].

Secondly, there might be room for testing a modular offshore grid – one of the tasks of Support Group 2 of the NSEF: the transmission of electricity would physically occur between the part of the offshore wind farm located in Belgium and the part located in the Netherlands, allowing in practice the first cross-boundary wind farm to transmit electricity to two different national markets. So far, being the offshore wind energy sector relatively new in its upstream role, there has been no need to develop cross border electricity cable. The capacity of installations grew only over the past few years and in all countries offshore wind energy is used to satisfy the internal demand[302]. Moreover, the way public support to renewable energy sources is designed today in Europe obliges Member States to feed in the electricity produced in the national grid[303].

Several additional considerations regarding the coupling of electricity markets and market trading across countries would probably deserved to be made. Nevertheless, this would fall outside of the scope of this research as it would require extensive research on the functioning of these markets, including trading timing and exchange platforms, electricity price formation mechanisms that in turn greatly depend on the national energy mix and interdependence with other countries, and so forth. What is probably sufficient to consider for the aim of this work is that, as seen in the previous chapters, as of today there is no offshore wind farm in Europe nor network connection departing from it shared across different Member States. The North Seas Energy Forum, and particularly its Support Group 2 on Offshore Grid Connection, are

301 European Commission, *Guidance on the Application of the Environmental Impact Assessment Procedure for Large-scale Transboundary Projects*, 2013, https://ec.europa.eu/environment/eia/pdf/Transboundry%20EIA%20Guide.pdf (accessed May 2019). See also Directive 2014/52/EU of the European Parliament and of the Council of 16 April 2014 on the assessment of the effects of certain public and private projects on the environment, OJ L 124 [2014]. Art. 7 foresees a limited cooperation mechanism (more a notification process) in case the project in the territory of a country has adverse effects in the territory of another country.

302 A. K. Müller, M. M. Roggenkamp, 'Regulating offshore wind energy sources in the North Sea – Reinventing the wheel or need for more coordination?', *The International Journal of Marine and Coastal Law* N. 29, 2014, p. 716 – 737.

303 Guidelines on State Aid for environmental protection and energy 2014-2020, OJ C200/1 [2014].

looking into solving the regulatory and technical barriers to the development of a pan-European offshore grid integrating the electricity produced at sea[304] and limiting the amount of cables placed in the seabed.

4.1.4 Ports servicing the offshore wind energy industry

The role of Ports in supporting the development and deployment of the offshore wind energy sector throughout Europe is key. Ports are increasingly adapting to accommodate the industry needs and provide the right infrastructures for large wind turbines components, vessels needed for installations and other operations and an increased number of other related activities[305]. One should consider that they do not only provide infrastructures and services for the installation but also for the O&M and the dismantling of the turbines once their life-cycle is over[306]. Ports ever more often offer testing facilities and they host training centres, offices and operation centres for manufacturers, developers and other important players in the supply chain[307].

Not all ports specialize in the same services to offshore wind energy operators, though. Some of them might have terminals dedicated to the assembly of components, some others vessels dedicated to certain other operations for wind farms. Wind industry representatives suggest that the Benelux cooperation could focus on the alignment and collaboration across different port authorities to serve efficiently several different wind farms across countries – the Netherlands and Belgium in this case, but not excluding their neighboring countries that might benefit from an enhanced cooperation. This translates into the ability of Ports to specialize in different fields so that competition is reduced amongst themselves while at the same time the offshore wind farm lifecycle phases are covered at best within a (cross-border) geographical area.

Cooperation amongst Port authorities today exist, also within the Netherlands and Belgium – particularly in the context of Eemshaven (Netherlands), Esbjerg (Denmark) and Oostende (Belgium). It is nevertheless taking place at a single port level, whereas a more systemic approach would be more beneficial for further deployment of offshore wind energy.

Some other industry representatives have pointed out that agreements on the diversification of business activities with a subsequent split-up of the market could lead to issues of competition as potentially able to violate the internal market provisions – and would therefore probably need approval from DG

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304 Benelux Secretariat, Political Declaration on energy cooperation between the North Seas Countries, 2016, http://www.benelux.int/files/9014/6519/7677/Political_Declaration_on_Energy_Cooperation_between_the_North_Seas_Countries.pdf (accessed May 2019).
305 WindEurope, *A statement from the offshore wind ports*, 2017, p. 5.
306 *Ibidem.*
307 *Ibidem*.

Competition. This area is not explored in this work but should be in case of continuation of this research as it might constitute an important barrier to cooperation in this particular area.

4.1.5 Common training programmes and facilities

The offshore wind power industry requires specialized skills, some of them highly qualified such as engineering with special formation and training in the marine sector or other work profiles necessary for the operation and maintenance of the wind turbines. Because the industry itself is young[308], also the professional figures related to its development are taking shape. The deployment of an offshore wind farm relies on various different professional figures that are not only dealing with the mechanics, engineering and operational aspects of the turbine[309] but also, for instance, with the protection of the marine biodiversity – figures such as marine scientists[310]: geologists, oceanography specialists, specialized biologists.

With the current rapid growth in wind energy installations all over Europe (and at the global level) it is expected that the number of jobs will significantly increase over the next years. The highest demand for workers is expected to be in the O&M sub-sector, where skills to be able to perform safely checks on the turbines are requested[311].

The offshore workplace in itself is a dangerous sector, particular for the O&M on-field operations: employees need to satisfy some psychological and physical conditions due to the particularly harsh conditions at sea. They need to be able to perform different sorts of manual labors, including climbing at important heights, they must cope with uncomfortable situations such as high temperatures and continuous noise and vibration, and they must be professionally prepared to face potential hazards[312]. The work of operation and maintenance in particular is normally done over different days and employees can stay on the servicing vessel for weeks, depending on the number of turbines to be

[308] SkillWind Project, *Wind Energy Sector Skills in Europe*, 2015, https://skillwind.com/wp-content/uploads/2017/11/IO1_Wind-Energy-sector-skills.pdf (accessed June 2019), p. 11.

[309] US Federal News Service, 'University of Massachusetts Amherst graduate program aimed at offshore wind energy is training its first class of students', *News & Media Relations* [website], 2012, https://www.umass.edu/newsoffice/article/umass-amherst-graduate-program-aimed-offshore-wind-energy-training-its-first-class-students (accessed May 2019).

[310] BVG Associates on behalf of the Crown Estate, *Guide to an Offshore Wind Farm,* 2019, https://www.thecrownestate.co.uk/media/2860/guide-to-offshore-wind-farm-2019.pdf (accessed February 2019).

[311] European Wind Energy Technology Platform, *Workers Wanted: The EU wind energy sector skills gap*, 2013, p. 4-5, https://etipwind.eu/files/reports/TPWind-Workers-Wanted.pdf (accessed May 2019).

[312] A. M. Preisser, R. V. McDonough, V. Harth, 'The physical performance of workers on offshore wind energy platforms: is pre-employment fitness testing necessary and fair?', *International Archives of Occupational and Environmental Health*, Vol. 92, Issue 4, 2018, p. 513–522.

checked and the work to be performed. By reason of these precarious conditions, Germany and other EU States, including the Netherlands, have developed guidelines for the physical aptitude testing of offshore wind energy employees, in order to prevent incidents and in general potentially dangerous situations[313].

Considering not only the exponentially growing O&M sub-sector, research has pointed out that the growth in jobs will touch on the entire supply chain supporting offshore wind energy[314]. The competences requested by the industry are very horizontal and dedicated MSc-level courses could be envisaged in universities[315].

Representatives of the wind industry highlight how in Europe the coordination across Member States on the training offer is lacking at present and could represent an interest pathway for the future, starting from Benelux as a sort of incubator for this novelty. At the national level, there are examples of areas that have massively invested in the formation of the workers in this sector, primarily because they have invested in the sector itself and therefore have created industrial and formation hubs around it. One example comes from the UK, East Anglia region, which has created a regional cluster investing in the creation of a network of centres of innovation excellence for offshore wind in coordination with port facilities and other key local players[316].

With the growth in capacity installed, the offshore wind industry estimates that over the next years there will be a significant increase in the number of jobs in the sector[317]. Cross-border cooperation might be an important element to coordinate the regional development of the offshore wind industry and its supply chain.

4.1.6 A common carbon floor price

Industry representatives have pointed out that the Benelux Union could explore cooperation opportunities aiming at setting a common CO2 floor price for the electricity sector as an effective way to boost renewable energy development. As mentioned in the first chapter, the ETS is the instrument used

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[313] *Ibidem*.
[314] European Wind Energy Technology Platform, *Workers Wanted: The EU wind energy sector skills gap*, 2013, p. 4-5, https://etipwind.eu/files/reports/TPWind-Workers-Wanted.pdf (accessed May 2019).
[315] *Ibidem*.
[316] New Anglia Wind Cluster, *Norfolk and Suffolk Offshore Wind Cluster*, [website], 2019, https://newanglia.co.uk/wp-content/uploads/2019/03/New-Anglia-Wind-Cluster-Brochure-FINAL.pdf (accessed May 2019).
[317] International Renewable Energy Agency, *Renewable Energy and Jobs - Annual Review 2018*, 2018, p. 10-11, https://irena.org/-/media/Files/IRENA/Agency/Publication/2018/May/IRENA_RE_Jobs_Annual_Review_2018.pdf (accessed May 2019).

by the European Union to price CO2 emissions, even if covering only approximately 45% of the total EU GHG emissions[318]. Due to the global economic crisis, an oversupply of carbon allowances has been stagnating in the ETS market over the past years with the result that the price for each allowance, representing one ton of CO2eq, has remained generally low and subject to volatility[319]. The UK is one of the few countries in Europe having introduced a floor price that guarantees the CO2 price does not fall under a certain threshold, therefore contributing to keep a minimum level necessary to discourage emissions while incentivizing the energy transition[320].

One recent study shows that keeping a minimum level of CO2 price for the electricity sector at the regional level would work as a guarantee against volatility, therefore boosting investments in renewable energy, particularly offshore wind energy that more and more relies on electricity prices that in turn depend on the price of the CO2 allowances[321].

This are of potential cooperation is in a certain way different from the previous ones listed, as it is not directly related to the actual deployment of a wind farm project but rather at policies aiming at increasing and stabilizing the price of GHG emissions with the indirect impact of providing certainty over offshore wind energy investments. Because less linked to offshore wind deployment, this domain of cooperation would probably put the three Benelux countries on a level-playing field in terms of expertise involved, as compared to other areas where the lack of access to the sea might have prevented Luxembourg from developing in-depth knowledge in the field. On the other hand, this topic would deserve further considerations and exploration because of the complexity of the technical and economic aspects involved.

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318 European Commission, DG Clima, *EU Emission Trading System*, [website], https://ec.europa.eu/clima/policies/ets_en (accessed February 2019).

319 Various sources, including: S. Evans, 'Will the reformed EU Emissions Trading System raise carbon prices?', *Carbon Brief*, [website], 2017, https://www.carbonbrief.org/qa-will-reformed-eu-emissions-trading-system-raise-carbon-prices (accessed February 2019). R. Betz, *What is driving price volatility in the EU ETS?*, 2006, http://www.ceem.unsw.edu.au/sites/default/files/uploads/publications/PagesfromAETFReviewOctNov06_web-2-1.pdf (accessed February 2019). Thomson Reuters Point Carbon, 'Analysts raise EU carbon price forecasts, warn of short-term Brexit jitters', *Reuters poll,* [website], 2019, https://www.reuters.com/article/uk-eu-carbon-poll/analysts-raise-eu-carbon-price-forecasts-warn-of-short-term-brexit-jitters-reuters-poll-idUSKCN1PA1CM (accessed February 2019). For tracking the CO2 price under the ETS system, see Sandbag, *Carbon Price Viewer,* [website], https://sandbag.org.uk/carbon-price-viewer/ (last accessed June 2019).

320 UK Parliament*, Carbon Price Floor (CPF) and the price support mechanism*, [website], 2018, available at: https://researchbriefings.parliament.uk/ResearchBriefing/Summary/SN05927 (accessed February 2019).

321 FTI Consulting, *A climate and socio-economic study of a multi-member state carbon price floor for the power sector*, 2018, https://orsted.com/-/media/WWW/Docs/Corp/COM/News/FTI-CL-Energy-CPF-Executive-Summary.pdf (accessed February 2019).

4.2 Conclusions of the fourth chapter

This chapter has built on the expertise of the offshore wind industry in the field of cross-border cooperation. The experts were asked to point out what areas they would consider a priority for cooperation within the Benelux Union, and particularly the Netherlands and Belgium, in order to deploy offshore wind volumes in the North Sea in a more efficient way. The rationale behind this question is that, as shown in the previous chapter of this work, regional cooperation plays a crucial role in the development of the industry and therefore ultimately in the European decarbonisation process and fight against climate change.

The key priority areas identified by the industry as being core for an enhanced cooperation across the Benelux Union countries in the offshore wind energy domain are the following – in no particular order of relevance:

- Coordination across countries of the timeline of the calls for allocating public support to offshore wind energy, which is the main procedure for granting concessions to build offshore wind farms in EU Member States. This would essentially provide the offshore wind supply chain with enough visibility over the investments to make and plan its resources accordingly.
- Joint MSP between the Netherlands and Belgium to define the areas to dedicate to offshore wind energy projects. One advantage emerging amongst all is that the best resources could be exploited and the electricity so produced transmitted to both country coasts, irrespective of the territory where the actual project is deployed. This would apparently greatly decrease costs and would ensure better exploitation of the territory.
- Coordination across Ports servicing the offshore wind industry and the wind farms, so that ports in the same sea basin could potentially benefit from a planned diversification of the services provided to the industry by each of them. It is worth mentioning that this might nevertheless pose serious issues of competition at the EU level.
- Set up common training programmes and facilities, also at the academic level, trying to cope with the increasing and increasingly specialized demand in skills in the sector and with the forecasted job growth.
- Set up a Benelux Union common CO_2 price floor, with the aim of providing more certainty against the volatility of the CO_2 price under the current pricing regime, the EU ETS, which in turn should result in supporting investments in renewable energy, particularly offshore wind.

- Set up a joint cross-border pilot offshore wind farm to test cooperation in further areas, such as a joint grid connection that powers both the Dutch and the Belgian coasts. This would represent a substantial advancement as compared to the current situation where wind farms are only installed in one territorial sea and the electricity generated is transmitted to the coast of the same state where the project is located.

One should note that the list covers a broad variety of topics, meaning that the cooperation potential for the future is significant. One question worth asking in the conclusion of this chapter is whether these areas fit within the Benelux Union legal and political framework for cooperation.

As the current situation stands, the Benelux Union Treaty identifies energy as a key cooperation area and subsequent Work Programmes, as already mentioned, focus on renewable energy as a pivotal element of this cross-border collaboration. There appears to be no obstacles preventing the three states from implementing a closer and more structured cooperation in the area of offshore wind energy. As energy is one of the key areas upon which the Benelux Union cooperation builds, one could say that further cooperation in the field is actually envisaged.

From the EU Treaties perspective, Art. 350 of the Treaty on the Functioning of the European Union prescribes that "[t]he provisions of the Treaty shall not preclude the existence or completion of regional unions between Belgium, Luxembourg and the Netherlands, to the extent that the objectives of these regional unions are not attained by the application of the Treaties". It was seen in the first chapter that energy is a shared competence between the Union and the Member States, which remain exclusively competent for their national energy mixes though. Under this Article is seems that further closer cooperation within the Benelux Union would on offshore wind energy would not be constrained.

Conclusion

As stated at the beginning, this thesis has investigated the role the Benelux Union could play boosting offshore wind energy in the North Sea. The interest for this investigation emerged from different preliminary observations. First, offshore wind energy is an important resource for the energy transition towards decarbonisation but is also a relatively new technology and, as such, not necessarily followed by developments in legislation running at the same pace than technological evolution. Secondly, the EU decarbonisation targets towards 2020, 2030 and 2050 rely significantly on cross-border cooperation, so that mechanisms for promoting this cooperation have even been formally introduced in recent secondary legislation, i.e. the Renewable Energy Directives of 2009 and 2018. The Benelux Union, existing since long time and with the recently renewed mandate to cooperate on energy, might represent an ideal structure where to experience an enhanced cooperation in the domain - hence the question arose as to whether this potential is already being harnessed. The Benelux countries are already discussing cross-border issues within the North Sea Energy Forum, an EU-led initiative where Governments of all the states surrounding the sea basin plus Luxembourg gather and discuss priorities for cross-border collaboration in offshore wind. Thirdly, if Luxembourg already plays a role in the North Sea Energy Forum despite lack of access to the sea, it has potentially something to gain from a closer cooperation of its neighbors in the offshore wind energy sector. Fourthly, current intergovernmental cooperation in the North Sea Energy Forum as well as industry and academia all seem to agree on the fact that closer cooperation can only be beneficial for further cost-effective deployment of the offshore wind sector. All these elements emerging from preliminary assessments and literature review have contributed to the formulation of the research question of how can the Benelux Union cooperation support the deployment of offshore wind in the North Sea. A first assessment of what areas should be prioritized in this cooperation and what role the Benelux Union plays and could play as a driver in this process has been the purpose of this work.

The first chapter provides an overview of the political and legal frameworks surrounding the development of offshore wind energy in the European Union. It emerges that the EU is implementing several policies for combating climate change, decarbonizing its wider economy while preserving its environment. In these policies, a fundamental role is played by renewable energy with on- and offshore wind energy in particular expected to represent, together, the first source of power generation in the EU in 2050. On the way towards mid-century goals, the EU has set 2020 and 2030 targets of 20% and 32% of renewable energy sources in the final EU energy consumption. Each of the Member States are in the process of drafting the National Energy & Climate Plans that, as mandated by EU law, have to outline the measures and targets individual countries will adopt on the way to collectively achieve the 32% EU-wide target by

2030. Belgium and the Netherlands in their plan have ambitious volumes for offshore wind energy development.

To make sure all Member States are in the position to achieve their national targets, the European Union has enshrined in legislation the possibility to implement some cooperation mechanisms. In the attainment of the targets, the EU relies on voluntary cooperation *fora* as well, such as the above-mentioned North Seas Energy Forum. The North Sea is the first sea basin in Europe in terms of offshore wind energy capacity installed, and Europe has more capacity installed than the other continents, even if it faces growing international competition. This is probably why the North Sea Energy Forum assumes particular relevance and importance in the sector as a platform to discuss and test potential for collaboration.

The Benelux is part of this Forum, hence being an example of regional cooperation within the regional cooperation. What emerges from the analysis, though, is that the three Benelux Countries participate independently in the North Sea Forum discussions. This is probably due to the fact that they did not transfer any supranational power to the Benelux Union, which therefore cannot be represented in the Forum as a single entity. Luxembourg, the Netherlands and Belgium are moving forward individually with their climate and energy policies. The Benelux Treaty nevertheless considers energy as an important area of cooperation across the three countries. Recent statements have confirmed that the Benelux Union countries will cooperate in the finalization of their National Energy & Climate Plans, but this cooperation does not emerge from a reading of the draft plans submitted to the European Commission so far. The deadline for the finalization of the plans is December 2019, so the question remains as to whether this closer cooperation will be evident in the upcoming Plans, and what it entails.

If the first chapter paves the way to understanding the importance of regional cooperation in the decarbonisation debate, the second chapter aimed at explaining why the offshore wind technology is gaining visibility amongst other renewable energy power generation technology. Today Europe has 189 GW of wind power installed, of which almost 18.5 GW off its coasts and installed primarily in the North Sea basin. All together, these 189 GW satisfy 14% of the total European power demand. Offshore wind energy is expected to grow exponentially, primarily because its costs are falling sharply, following technological development and economies of scale. The technology has a series of advantages: wind resources at sea are better than on land because the winds are more constant and stable offshore. This translates into higher capacity factors than onshore turbines due also to generally higher size of the turbines, resulting in a significantly higher electricity output. Offshore wind generates important socio-economic benefits, such as carbon savings, jobs creation, investments in local infrastructures.

Alongside the benefits, there are some important downsides. Offshore wind energy is a technology still requiring a high upfront capital investment and much more expensive than its onshore counterpart, due to the harshness of the installation and operation conditions but also to the costs related to the network infrastructure. Another element to consider is the variability of the resource, which might create difficulties in its integration in the energy system as compared to conventional power, which is programmable. Literature review has also revealed that the integration of large volumes of offshore wind energy in coastal areas where the grid infrastructure might be too weak is likely to pose congestion problems.

Despite these downsides, the technology is expected to grow fast and be one of the drivers for decarbonizing the power sector in Europe. Relevant international agencies such as IRENA and IEA expect further significant cost reductions in the sector, primarily due to the fact that the technology is still relatively new and therefore significant margins for exploiting economies of scale are present. Regional cooperation seems to emerge as the tool able to narrow these margins, looking into the harmonization of policies and laws across Member States of geographical proximity.

The third chapter provides a general overview of the current regime for offshore wind installations in Belgium and the Netherlands and looks into the status of cooperation in the Benelux Union with regards to this sector. What emerges from the analysis is that Belgium, the Netherlands and Luxembourg are collaborating within the framework of the North Sea Energy Forum and with the other North Sea countries but are not exploiting the existing Benelux Union to create a closer cooperation platform for offshore wind energy, that would be beneficial for the advancement of the sector.

In terms of national legislation, Belgium and the Netherlands have different procedures and laws in force at the national level for the installation of wind farms in their territorial waters. The wind farm authorization process, concession granting, the building responsibility and ownership of the offshore grid assets vary across all EU Member States and vary between these two countries too. Differences in national procedures nevertheless do not necessarily have to result in obstacles to cross-border cooperation though. As the scope of this work is not to enter the details of the differences in national legislation, this statement needs to be carefully considered and possibly explored in further researches.

The North Sea is known for being one of the busiest sea basins in the world, therefore planning the use of its seabed is necessary for ensuring that different activities such as fisheries, tourism, naval shipping can co-exist. Current EU legislation prescribes that Member States mandatorily adopt Marine Spatial Plans by 2021, exchanging with the neighbors while drafting them. The cross-border coordination in spatial planning seems to assume particular relevance for the offshore wind energy sector because potentially it allows to un-tap the best wind resources irrespective of where they are located in the territorial seas, allowing all coastal states involved to receive the benefits. A cross border cooperation on Marine Spatial Planning that is able to exploit the better resources disregarding the national borders of the waters would probably entail the creation of a *joint* Marine Spatial Plan across countries – Belgium and the Netherlands in this case. The idea of using the Benelux Union as an attempt to something that has been identified by the industry as being a key priority area for a Benelux cooperation.

The offshore wind industry experts' considerations constitute the foundations of the last chapter of this work. Companies active in the Dutch and Belgian parts of the North Sea were kindly asked to reflect on what areas they consider as a priority for cooperation within the Benelux Union, and particularly the Netherlands and Belgium, in order to deploy offshore wind volumes in the North Sea in a more efficient way. The priority areas identified by the industry for a potential enhanced Benelux Union cooperation cover a very diversified and broad spectrum of topics, reported in the following paragraphs with no particular order of relevance.

As previously mentioned, the set-up of a joint Marine Spatial Planning to identify areas to dedicate to offshore wind energy projects would represent a significant improvement. It would allow the best wind resources to be exploited and the electricity so produced transmitted to the coasts of Netherlands and Belgium, irrespective of the territory where the actual project is deployed. According to the industry and literature review, this would greatly decrease costs while ensuring a better exploitation of the seabed. In the context of this research the role that Luxembourg could have in the definition of the Marine Plan is not explored.

Another key priority area is the coordination on the timeline for the installations of offshore wind projects. As mentioned in the first chapter, this area is also the object of coordination efforts amongst the countries of the North Sea Energy Forum. The industry claims that having visibility over the timeline of the installations allows for a better planning of the whole supply chain that supports the offshore wind energy sector, such as the turbine component manufacturers, the cable manufacturers, the vessels and cranes needed for heavy lifting operations, the port facilities.

The ports play indeed an important function as basis for installations and operations of the wind farms. A third cooperation area has been identified in the potential for Belgian and Dutch ports to coordinate and diversify the services offered to the industry so that potentially each of them could gain from specializing in one area. This might nevertheless pose serious issues of competition at the EU level that might be worth exploring in case of further research on this topic, as ports might be seen as unfairly dividing the market up.

Because the offshore wind industry is fast growing and projections indicate that the job demand will increase substantially throughout Europe, another domain indicated as important for an enhanced Benelux Union cooperation is that of training. Belgium, the Netherlands and Luxembourg could work closely together with the aim of setting up common training centres and programmes to develop the skills needed in the future, even at the academic level.

Another important area identified as a priority that could boost offshore wind energy is the creation of a common CO2 price floor that would provide certainty against the volatility of the CO2 price under the current pricing regime, the EU ETS, which in turn should result in supporting investments in renewable energy, particularly offshore wind.

Finally, industry representatives have indicated that the Benelux countries could set up a joint cross-border pilot offshore wind farm to test cooperation in further areas, such as joint grid connection that powers different nations, in this case both the Dutch and the Belgian coasts. This would represent a novelty because at present wind farms in the North Sea are only installed in one territorial sea and the network connection transmits the electricity output to the coast of the same state where the project is located.

The variety of answers provided represents such a broad range that is probably an indication of the fact that the cooperation potential for the future is significant.

The role that Luxembourg may play in a Benelux enhanced cooperation structure deserves some attention. The state does not have access to the sea but, as said, is an active member of the North Sea Energy Forum whose focus is the cost-efficient deployment of offshore wind energy via cross-border cooperation. Therefore, this research tried to investigate what Luxembourg could gain from a closer cooperation envisaging more offshore wind installations. What emerges is that Luxembourg could gain significantly in terms of renewable electricity transfers, at least on paper. In its Renewable Energy Directive the EU foresees a series of cooperation instruments between Member States in an attempt to support them in reaching the 2020 and 2030 binding renewable energy targets mentioned above. One of these mechanisms is the so-called Statistical Transfer of renewable energy that allows one Member State developing a renewable energy project to renounce to the corresponding share of renewable energy in its final energy consumption and give it to another Country in exchange for payments. This transfer is called 'statistical' because it relies on an accounting procedure without the need for an actual electricity exchange. As of today, the Grand Duchy already has statistical transfer agreements with Estonia and Lithuania.

One could argue that, from further installations of wind energy off the coasts of the Netherlands and Belgium, Luxembourg could gain in terms of reaching its renewable energy targets while using a technology that is particularly efficient for green electricity production and to which the state would not have access otherwise. Because in this process the Benelux Union would consider Luxembourg in its role of a 'statistical' consumer of the electricity produced by turbines off the Belgian and Dutch coasts, the Grand Duchy would probably have more weight in the decision process around offshore installations in the North Sea.

Beside the conclusions drawn through the individual chapters, there are important final considerations of a more horizontal nature to make. Firstly, the role of regional cooperation in driving the energy transition, and particularly further development of the offshore wind energy sector, is undisputed. Both industry representatives and policy makers seem to acknowledge that the deployment of offshore wind projects is better done through cross-border participation. Its importance is therefore given for granted throughout this thesis.

Secondly, what emerges from the research is that the Benelux cooperation in the (renewable) energy domain is essentially on a voluntary basis and carried out via *fora* that include other parties. Research in the Benelux *Volet Juridique* shows no record of binding legislation in the energy domain, and this has been kindly confirmed also by the Benelux Secretariat during our exchanges. This probably derives from the nature of the Benelux Union, which is not a supranational institution but rather an intergovernmental one. The participation in *fora* such as the North Sea one is not on behalf of the Benelux Union as a single entity: Belgium, Luxembourg and the Netherlands participate as three independent countries. In spite of its voluntary nature, enhanced collaboration across the three countries is already implemented on various important areas, such as the interconnectivity of the electricity networks. Nevertheless, offshore wind energy does not emerge as a domain in which the Benelux Union is working within its established cooperation structure. The Benelux Union could have the ambition to be a frontrunner for a tangible, enhanced cross-border cooperation that aims at working effectively on offshore wind energy matters, within the North Sea Energy Forum and more broadly in the European Union context.

Overall, this work shows that a close Benelux cooperation in offshore wind energy has the potential to bring benefits to all three Benelux countries, similarly to the North Sea Energy Forum cooperation bringing benefits to its participants but with the advantage that Benelux, smaller in number of participants, would have more facility in the coordination of its work. Belgium and the Netherlands would probably be direct beneficiaries of some benefits more than Luxembourg, particularly those related to local job creation such as services of O&M that would probably need to be headquartered on the coast. In all three countries, offshore wind could be pivotal to the attainment of the 2030 decarbonisation targets: Belgium and the Netherlands already have ambitious plans for wind installations, and Luxembourg could buy its statistic share, generating more demand for offshore energy installations off the coasts of its other two partner states. This consideration implies that offshore wind energy is considered a cost-efficient decarbonisation technology not only by Belgium and the Netherlands, which have inserted it significantly in their NECPs, but also by Luxembourg. The research does not go as far as considering the different options on the table to decarbonize the Luxembourgish energy system and its wider economy, nor is it considering the LCoE and other cost-related aspects of energy sources to which Luxembourg might have direct or indirect access. The scope of this research is limited to understanding whether there is potential for a closer Benelux cooperation in the field and the answer from a theoretical perspective seems to be yes.

Additionally, in a closer Benelux Union cooperation, the weight that the three countries have individually in international *fora* would increase in case of joined forces. All together they would represent a bigger block with a more powerful voice.

***Ex-post* methodological considerations**. The specific research question raised by this work does not seem to have been investigated elsewhere. The reason is probably that large-scale offshore wind energy deployment has happened recently, therefore both European and national legislations are still adapting to the novelty and certain dynamics of regional cooperation are starting being investigated now.

As far as the literature review goes and in general terms, the most precious source of information proved to be scientific journals and academic papers, particularly for the second and third chapter. Their brevity and “concentration” of information probably fits better the fast-changing landscape of the topics approached by this thesis. Official websites, primarily of institutions, have been extremely useful for this research: the role of regional cooperation in offshore wind energy in Europe is a very specific topic that does not rely yet on extensive literature. The first chapter is built primarily on international and European legislation and soft law whereas the fourth one on exchanges with sectorial stakeholders.

Information on the Benelux Union and its accomplishments since its foundation proved hard to find. One would have the impression that the boundaries of the Benelux project have slightly blurred while being absorbed by the European Union over the years. There are some areas, for instance security matters, where the Benelux seem to have a close and efficient cross-border cooperation. Research on the role of Benelux cooperation in energy matters, though, has evidenced that very few literature exists on the topic despite being a central pillar of the Benelux Union cooperation by founding agreement. It has also pointed out one of the preliminary findings of this work, i.e. that the Benelux Union as such is not implementing within its own structure an enhanced cooperation on offshore wind energy.

The fourth chapter, as said, builds on industry views. The interaction with industry representatives has primarily taken a written form and the question asked ("*What priorities do you see for a Benelux Union cooperation in the offshore wind sector*?") has been left on purpose open to all sort of replies. Primarily, because the idea behind this work was to provide some input for future possible cooperation areas while trying to answer the main research question, without prioritizing one against the other. The variety of input received is probably an indicator in itself of the current status of cooperation and of the future possibilities. Secondly, the nature of the theme investigated by this work is peculiar because of its two co-existing streams, one deeply technical and the other one very political. One aspect may prevail over the other in certain companies but not in others. Thirdly, a questionnaire would probably have discouraged some respondents.

Importantly, as mentioned above, the answers gathered in the fourth chapter have been extremely diverse in their nature and this shows how many different domains could be the focus of an enhanced Benelux Union cooperation. This diversification was rather unexpected: given the similarity of the profile of the stakeholders involved in the research, my expectation was that one priority area would have emerged above all the others subject to consideration.

The main limit of this research is probably also its strongest asset: its scope is not to explore in depth the priority areas identified by the industry but at the same time it would be extremely interesting to do so. Hopefully this work provides the incipit for further academic research in the domain.

Annex

1. Cabling of offshore wind turbines in the Rentel wind farm (BE)

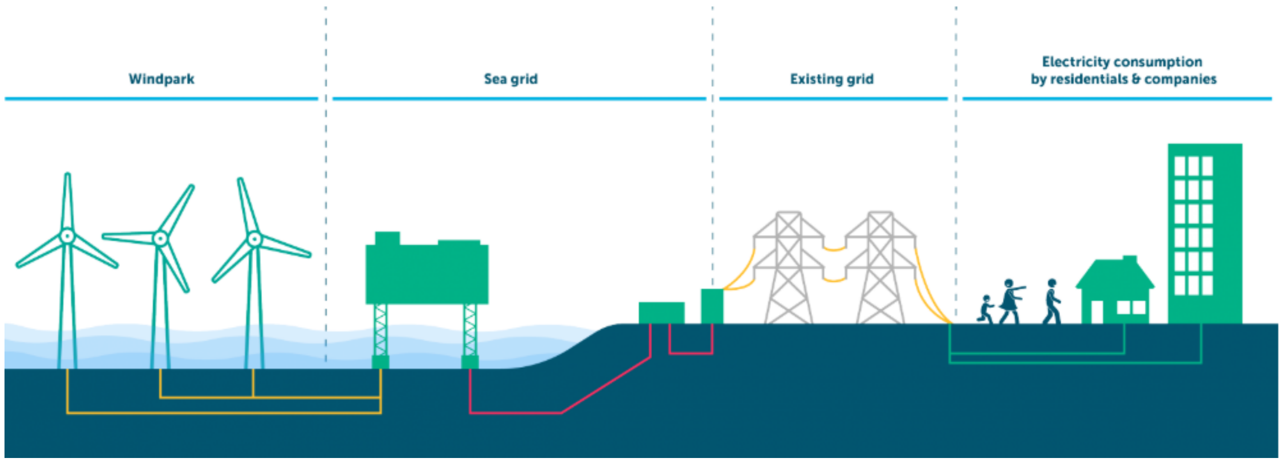

Figure 1 - Cabling of offshore wind turbines in the Rentel wind farm. Source: Rentel wind farm, www.rentel.be/en/the-project

2. Areas dedicated to further offshore wind energy development in Belgium.

Figure 2 - Areas dedicated to offshore wind energy in Belgium. Source: Allen & Overy Law Firm

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