5 Energy (including cables and pipes)

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5.1 Offshore wind energy

Europe is the world leader in offshore wind energy production. By 2020, 5,402 wind turbines were installed and connected to the grid in European seas, with a total installed capacity of 25,014 MW[1]. These turbines are spread across 116 wind parks in 12 different countries (Offshore wind in Europe: Key trends and statistics 2020). Most wind turbines are located in the North Sea, with the United Kingdom, Germany, the Netherlands, Belgium and Denmark as the main European players in the production of offshore wind energy.

In Belgium, at the end of 2020, eight wind parks were operational (C-Power, Belwind, Nobelwind, Northwind, Rentel, Norther, Seamade and Northwester 2), consisting of 399 wind turbines spread over an area of 238 km² and accounting for a total installed capacity of 2,262 megawatt (MW). This puts us in 2020 in fourth place within Europe (behind the United Kingdom, Germany and the Netherlands) and fifth worldwide, behind China. When the production capacity is compared to the number of inhabitants, Belgium is second in the world, behind Denmark (BOP 2021). This capacity corresponds to 10% of the total Belgian electricity consumption and about 50% of the electricity consumption of households (BOP, MUMM, Van Quickenborne 2020, Rumes and Brabant 2020). With the marine spatial plan 2020-2026 (MSP 2020-2026, RD of 22 May 2019, see also Verhalle and Van de Velde 2020), a new zone for offshore energy production of 281 km² was demarcated in 2020. This zone, the Princess Elisabeth zone (composed of: Fairybank, Noordhinder-Noord, Noordhinder-Zuid), should increase the offshore wind capacity on the Belgian part of the North Sea (BNS) to at least 4,000 MW (figure 1) (BOP, Coastal Portal, MSP 2020-2026, Rumes and Brabant 2020). By installing more powerful turbines, the target is to obtain a total capacity between 5,400 and 5,800 MW of offshore wind energy by 2030 (website federal minister for Energy).

5.1.1 Policy context

On 19 November 2020, the European Commission published its strategy on exploiting the potential of renewable offshore energy (COM (2020) 741) within the framework of the European Green Deal (COM (2019) 640). To achieve the overarching EU goal of climate neutrality by 2050, the Commission aims to increase offshore wind capacity from the current level of approximately 12 gigawatt (GW = 1,000 MW)) to at least 60 GW by 2030 and to 300 GW by 2050 (excluding UK) (DG Energy). The Commission intends to complement this with 40 GW of ocean (wave and tidal) energy production by 2050. The EU climate targets are now legally binding following the adoption of the Climate Law (see below).

Prior to this strategy, the EU already took other measures to promote renewable energy production (see **5.1.1.1 The development of offshore wind energy – bottlenecks and measures**). A Strategic Energy Technology Plan (SET-Plan) has been drawn up to try to achieve these energy objectives. The implementation of this plan is driven by European Technology and Innovation Platforms (ETIPs). With regard to (offshore) wind energy, there is ETIPWind, which focuses its activities on offering a public platform for wind energy. Its activities focus on providing a public platform for stakeholders in the sector to share common research and innovation priorities (R&I) and promote breakthrough innovations in the sector.

In the National Energy and Climate Plan 2021-2030, Belgium envisages a renewable energy production of 17.5% of the gross final energy consumption by 2030, as well as an increase in the offshore wind production to at least 4 GW, paired to a strengthening of the role of the North Seas Energy Cooperation (see **5.7.3 Societal interest**) (federaal regeerakkoord 2020, Van Quickenborne 2020).

The BNS falls largely under federal jurisdiction. Consequently, the policy on the production of electricity from water, currents or winds and the transmission grid at sea is drawn up by the federal minister responsible for energy and the federal minister (or state secretary) responsible for the North Sea (FPS Economy, SMEs, Self-employed and Energy)[2]. More information on the division of authorities can be found in the National Energy and Climate Plan 2021-2030. An overview of the European and national legislation relating to the electricity market is given on the website of the CREG and the FPS Economy, SMEs, Self-employed and Energy.

5.1.1.1 The development of offshore wind energy – bottlenecks and measures

On the European level, some policy initiatives have already been taken to promote the development of wind energy, including offshore. These include:

[1] The production capacity within EU27 is 14,583 MW.
[2] The offshore energy policy framework for the North Sea region is summarised on the website of the NorthSEE project.

- The Strategic Energy Technology Plan (SET-Plan, COM (2007) 723) – A strategic plan to accelerate the development of cost-effective low-carbon technologies. Ideas for a new, integrated strategy for the coming years were communicated in 2015 (C (2015) 6317);
- In the framework of the Integrated Maritime Policy (COM (2007) 575), a long-term strategy for more sustainable growth in the marine and maritime sectors (Blue Growth, COM (2012) 494) was developed. Specifically for the blue energy sector (including offshore wind energy), COM (2014) sets out eight measures for exploiting the potential of energy in Europe's seas and oceans by 2020 and beyond. A new approach in realising a sustainable Blue Economy has been communicated in (COM (2021) 240), here the expansion of offshore wind, in combination with making maritime transport and port activities more sustainable, play an important role in achieving European climate neutrality;
- COM (2016) 860 on Clean Energy for All Europeans Package (CEP) - Communication of a European regulatory framework to achieve the transition towards clean energy (including offshore), based on three pillars (energy efficiency, renewable energy leadership and affordable energy for consumers);
- In 2016, the countries of the North Sea region signed a political declaration in which they agreed to pursue a cooperation policy. Within the North Seas Energy Cooperation (NSEC) (see **5.7.3 Societal interest**), the aim is to facilitate the cost-effective deployment of wind energy and to improve the interconnection of the power grid between the North Sea countries;
- In support of the European energy policy, the Horizon Europe research and innovation funding programme and at the request of the European Commission, ETIPWind (initiative of the SET Plan) developed a Strategic Research and Innovation Agenda (SRIA 2018). It sets out visions for reducing costs, facilitating network integration, maintaining technological leadership and retaining expertise in Europe;
- Directive (EU) 2018/2001 concerns a revision of Directive 2009/28/EC and tightens the renewable energy targets for the EU to 32% of total energy consumption by 2030. This Directive contains provisions that simplify authorisation procedures in order to encourage the start-up of renewable energy projects, while also taking into account the concerns of citizens and the environmental effects;
- European strategy to harness the potential of offshore renewable energy (COM (2020) 741). EU strategy aiming at 300 GW of offshore wind and 40 GW of ocean energy production by 2050;
- COM (2021) 218 concerns an amending proposal of Directive (EU) 2018/2001 to increase the renewable energy targets to 40% of the total energy production by 2030. This communication fits within the EC fit for 55 package, which encompasses a set of policy measures to realise the target stipulated by EU's Climate Law (Regulation (EU) 2021/1119) (55% CO_2-reduction by 2030 compared to 1990-levels).

Furthermore, at the European level, research into offshore wind energy is being promoted (COM (2008) 534, EC). For instance, there are several funding instruments that support projects addressing the different aspects of offshore wind, from development to decommissioning. Horizon Europe, the world's most ambitious research and innovation programme, is also strongly committed to the climate and energy issue. As part of the Horizon Europe programme, the Commission has launched Mission Starfish 2030: Restore our Ocean and Waters. This Mission aims to make the European Green Deal a reality by restoring ecosystems and biodiversity, eliminating pollution and making the Blue Economy carbon-neutral and circular (see also thematic chapter **Integrated maritime policy**). Finally, in 2021, the European Commission, European Parliament and EU leaders agreed on a recovery plan to address the socio-economic damage caused by the Corona pandemic and lay the foundation for a greener, more digital and more sustainable Europe. The majority of the funds will be dedicated to the fight against climate change, including the development of renewable energy.

In addition to measures at EU level, the federal government has taken a series of measures to promote power production from renewable energy in the BNS:

- The Electricity Act of 29 April 1999 provides the possibility of adopting market organisation measures to ensure the sale of a minimum volume of power from renewable energy sources - at a minimum price. Among other things, this Act states that the transmission system operator shall finance one-third of the cost of the submarine cable connecting the turbines to the coast with a ceiling of 25 million euro per project (see also **5.7 Pipes and cables**). This Act was amended by the Act of 12 May 2019 to introduce a competitive tendering procedure for the construction and operation of generation facilities in the Princess Elisabeth zone (see **5.1.2 Spatial use** - **5.1.2.1 Procedure**);
- The RD of 16 July 2002 provides for a system for granting certificates of guarantee of origin and green certificates (GCs) for power generated from water, streams or wind in the BNS. The Commission for the Regulation of Electricity and Gas (CREG) grants the GCs to producers who hold a domain concession and a certificate of guarantee of origin. Minimum prices are set for the resale of certificates issued in connection with green power production. The transmission grid operator is obliged to purchase the GCs of offshore wind producers at a minimum price if requested to do so:
    - › For the Belwind, C-Power and Northwind wind parks, this is set at 107 euro/MWh for the production

that follows from the first 216 MW installed capacity. This minimum price drops to 90 euro/MWh for production from an installed capacity above the first 216 MW;

› For Nobelwind, the minimum price is 107 euro/MWh for the first 45 MW installed capacity and 90 euro for the remaining 120 MW;

› For Rentel, Norther, Seamade and Northwester 2, the minimum price per GC depends on the power price. The minimum price is set by the CREG in accordance with the applicable provisions of the RD of 16 July 2002[3]. It provides for an LCOE (levelised cost of energy) of 124 euro/MWh for Norther and 129.8 euro/MWh for Rentel. For the Seamade and Northwester 2 wind parks, the LCOE amounts to 79 euro/MWh for a maximum of 17 years or 63,000 full-load hours, which is also variable with correction factors, as determined by the CREG. The support period and purchase obligation is set at 19 years for Rentel and Norther and at 17 years for Seamade and Northwester 2.

Furthermore, several platforms and clusters have been established to represent the interests of the sector and promote the research- and innovation development of offshore (wind) energy:

- Belgian Offshore Platform (BOP) unites the main Belgian actors that invest in renewable (wind) energy on the BNS (concession holders and direct investors). The BOP wants to promote further development by, among other things, representing the interests of its members to the government, utility companies and other bodies or persons;
- Belgian Offshore Cluster (BOC) wants to promote the interests of the offshore industry (suppliers) and ensure that Belgian expertise is represented and put on the international map. The BOC wants to create a broad and independent (industrial) support base that maintains the necessary links between the sector, the government and international institutions with a view to improving the quality of the offshore industry and achieving relevant results for the Belgian offshore industry;
- The Blue Cluster (DBC), a spearhead cluster of the Government of Flanders for sustainable and innovative economic developments at the BNS, has included Renewable Energy and Freshwater Production as one of its innovation domains. The cluster facilitates numerous offshore energy projects and also acts as a network organisation for the Blue Economy in Flanders and supports the offshore energy sector in this capacity. After the termination of the three-year support for the Innovative Business Network (IBN) Offshore Energy, the activities of this network were taken over by the Blue Cluster;
- OWI-Lab, a partnership between Sirris, Vrije Universiteit Brussel (VUB), and Ghent University (UGent) with the aim of supporting the Belgian wind energy value chain in their industry-driven research, development and innovation through open platform operation. As a research- and technology organisation, OWI-lab wants to play a leading role in both fundamental and applied research. It has specific test- and monitoring infrastructure for this purpose and also coordinates and participates in various projects to reduce the cost of offshore wind energy along the entire value chain (from development to decommissioning) through research and innovation. The consortium also provides courses (master classes) and workshops to share its knowledge with the industry.

There are also other entities that support the development of the offshore wind sector and facilitate innovation from a regional perspective:

- West Flanders Development Agency (POM West-Vlaanderen) and TUA West aim to connect companies, scientific institutions and governments. The focus is on selected knowledge domains within West Flanders, including Blue Energy. These knowledge domains are part of the Factories for the Future programme - an initiative of POM West Flanders (Dangreau 2014). The West Flanders Development Agency also runs the Blue Accelerator test platform, a multifunctional maritime innovation and development platform that allows companies, organisations and knowledge institutions to carry out tests at sea;
- Ostend Science Park in the inner port of Oostende is an initiative of Port Oostende, West Flanders Development Agency and UGent, and focuses on the theme of Blue Growth. The park operates on the interface between policy, science and industry and also houses Bluebridge. Ostend Science Park has several test facilities, including a Coastal Ocean Basin (see below) for testing new technologies at sea.

Finally, in recent years, specific training courses in an academic and non-academic context related to offshore renewable energy have emerged, such as the continued training Offshore Wind (UGent, UGain, OWI-Lab, TUA -West) and the 'Introduction to Onshore and Offshore Wind Technicians' (SBM).

[3] The (last) offshore support regime was included in the RD of 16 July 2002, which was promulgated and ratified on 9 February 2017. This is a guaranteed minimum price whereby the amount of aid decreases as the price of electricity increases. The calculation of the minimum price is now based on the following formula: minimum price = LCOE - [(electricity reference price x (1 - correction factor) + the value of the guarantees of origin) x (1 - grid loss factor)].

5.1.2 Spatial use

The European strategy on offshore renewable energy (COM (2020) 741) states that offshore renewable energy can and should be developed alongside other marine user functions. Member states should take this approach into account when drawing up a marine spatial plan, taking a comprehensive, multifunctional and multiple (space) user perspective.

The MSP 2020-2026 puts sustainable offshore energy production with maximum utilisation of compatible green energy forms at the forefront with a minimum environmental impact as a precondition. In addition to preserving the first zone for offshore energy production (RD of 20 March 2014), a new zone, the Princess Elisabeth zone, has been demarcated[4]. This demarcation covers ca 281 km² and is located 35-40 km off the western part of the coastline (see figure 1 and table 1). Within this demarcation, three zones have been designated: Fairybank, Noordhinder-Zuid and Noordhinder-Noord. Once fully developed, this zone should realise the objective of at least 4 GW of offshore generated energy by 2030 (National Energy and Climate Plan 2021-2030, Law of 22 April 2019 amending the Law of 29 April 1999). The future wind parks in the Fairybank and Noordhinder-Zuid zones require a Natura 2000 permit for commissioning, as these zones partly overlap or are in the immediate vicinity of the Flemish Banks Habitat Directive area. The reconciliation of renewable energy production with the protection objectives of the area is currently the subject of research (Rumes and Brabant 2020). Space is also provided in the Princess Elisabeth zone for the necessary reinforcement of the transmission grid (see **5.7.3 Societal interest**). A safety zone of 500 metres from the external borders is established around each energy construction, from the moment construction starts until the energy construction is completely decommissioned (RD of 4 February 2020). Within the current legislature (2020-2025), in addition to the further expansion of offshore wind energy production, attention will also be paid to the possibility of storing energy offshore (see **5.6 Energy storage and green hydrogen**).

Parallel to the production of offshore renewable energy, different types of multiple use of space are theoretically conceivable, as long as they are in line with the long-term vision and regulations, provided that they are thoroughly researched and that the existing regulations are evaluated accordingly (MSP 2020-2026). For example, research is undertaken on whether offshore wind energy can be combined with wave and tidal energy or the installation of floating solar panels (Van Quickenborne 2020, Van der Straeten 2020, Unlocking the potential of the North Sea). The way in which multiple use of space in offshore wind parks can be organised in our North Sea has already been reflected upon within the framework of the vision platform Noordzeevisie 2050, the Think Tank North Sea and in the innovation roadmap renewable energy and freshwater production - DBC 2020.

Table 1. An overview of the location and utilised area of the domain concessions for wind turbines in the BNS (2020) (MUMM, BOP, FPS Economy, SMEs, Self-employed and Energy, see also figure 1).).

Project	Location	Total area (excl. safety zone) (km²)	Water depth (m)	Capacity density (MW/km²)	Distance to coast (km)
C-Power	Thornton Bank	19.8	12-28	16.4	30
Belwind	Bligh Bank	17.0	15-37	10.1	49
Northwind	Lodewijk Bank	14.5	16-29	14.9	37
Nobelwind	Bligh Bank	18.0	15-37	8.3	47
Rentel	Southwest Schaar	22.7	26-36	13.6	33
Norther	South of Thornton Bank	44.0	14-30	8.4	23
Seamade-Mermaid	Northwest of Bligh Bank	16.7	24-50	14.1	54
Seamade-Seastar	Between the Lodewijk Bank and the Bligh Bank	18.4	22-38	12.9	40
Northwester 2	Northwest of Bligh Bank	11.7	24-40	18.3	51
Total area reserved for wind parks (incl. safety zones)		**238.0 km²**		**9.5 (Avg.)**	

[4] The Belgian wind parks are bordered on the Dutch side by the wind parks under construction in the Borssele Wind Energy Area (*Noordzeeloket*). On the French side, there are plans to build a wind park off the coast of Dunkirk (FPS Public Health, Food Chain Safety and Environment).

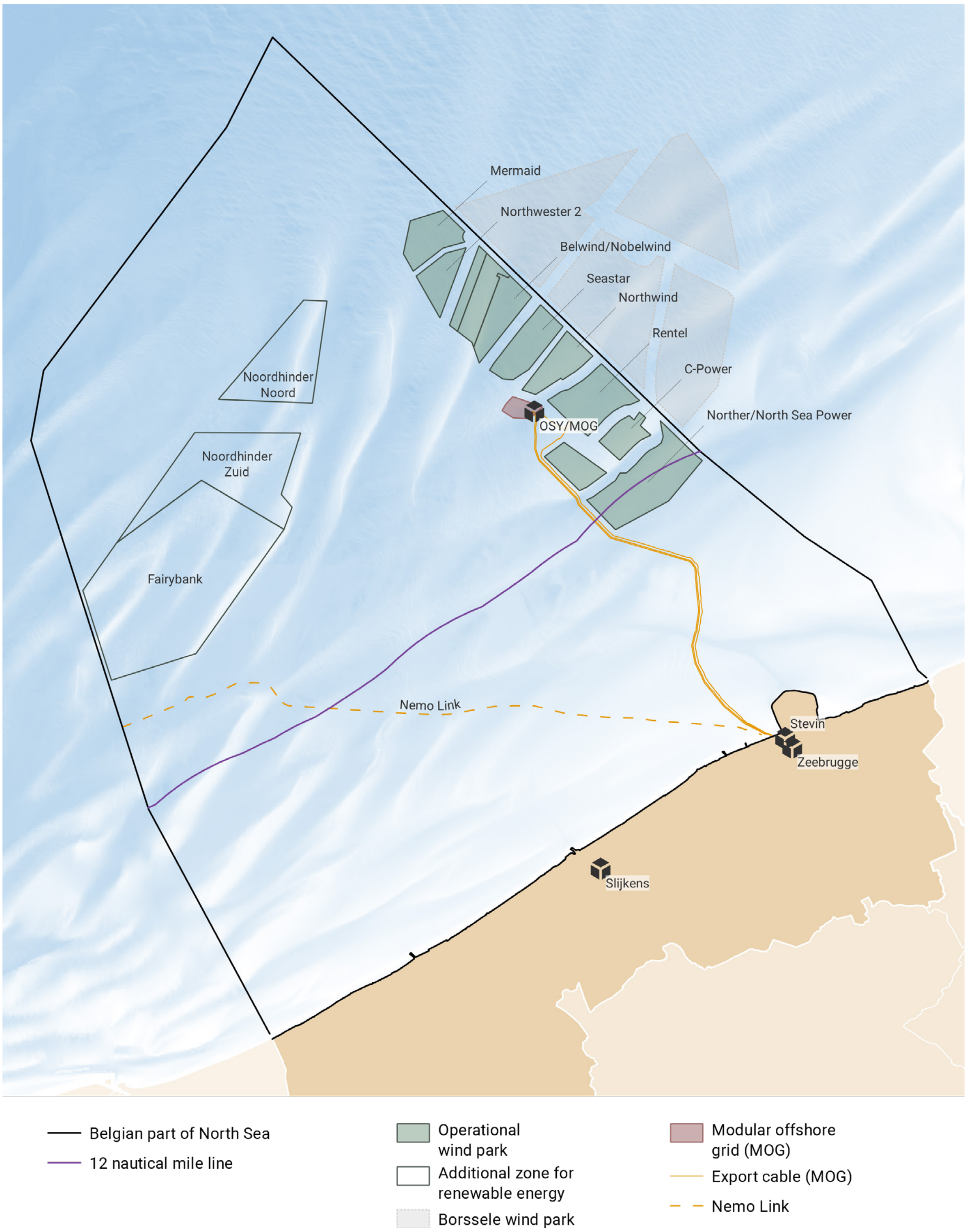

Figure 1. Overview of the current and planned concession zones for offshore renewable energy production, including onshore connections and adjacent wind parks (Source: Flemish Hydrography, Elia, RBINS-MUMM, Emodnet Human Activities, Coastal Portal)

5.1.2.1 Procedure

In order to realise an offshore wind park, the project must have several permits. The following federal permits are required:

- A ministerial decree (MD) for the award of a domain concession by the federal minister for Energy and the federal minister for the North Sea;
- A MD by the federal minister for the North Sea to, following a positive advice from the Management Unit of the Mathematical Model of the North Sea (RBINS-MUMM) and an environmental impact assessment (EIA), grant an authorisation for the construction of the wind park (including cabling) and a licence for its operation (for more details see Heylen et al. 2018);
- A MD for the granting of a permit for the installation of offshore cables by the federal ministers for Energy and for the North Sea (see also **5.7 Pipes and cables**).

So far, all wind parks in the BNS were developed with state aid obtained through a negotiation procedure. Belgium is an exception among the offshore wind producing countries in Europe. The procedure for granting a domain concession for the wind parks that have already been built has been laid down in the RD of 20 December 2000 (MUMM, CREG, FPS Economy, SMEs, Self-employed and Energy). The domain concessions awarded based on this RD can only be changed based on this decree. The concessions are valid for a period of 20 years, but are renewable (Norther up to 22 years, Mermaid-Seastar and NorthWester 2 up to 25 years). The procedures for obtaining a domain concession and an environmental permit within the framework of the marine spatial plan 2014-2020 were described in detail in the previous version of this thematic chapter (Heylen et al. 2018).

In the Princess Elisabeth zone, domain concessions will be awarded through a competitive tendering process. The concession is awarded for a period of 30 years - from installation to decommissioning. The outlines of this new regime were set out in the Electricity Law (Law of 29 April 1999 on the organisation of the electricity market) through the Law of 12 May 2019. This legal framework must allow the federal government to realise the 4 GW offshore renewable energy target (including already operational or planned wind parks) as described in the Interfederal Energy Pact, by 2030 at the latest[5]. This new law seeks to achieve the largest possible share of additional offshore energy production capacity from renewable energy sources after 2020 at the lowest possible cost to society and to optimise its transmission to the transmission grid. In addition to maximising offshore energy production, the federal government wants this framework to significantly reduce the financial support for the development of future offshore electricity production. Measures such as the aforementioned competitive tendering procedures, as well as putting larger lots on the market and conducting preliminary studies at the company's own expense should make this possible.

After the preliminary study phase (UXO-studies (unidentified ordnance), all environmental studies in the context of the environmental impact report (EIR), as well as geotechnical studies and the transmission aspects carried out by the system operator), a MD will determine the location, size and number of plots that will be subject to a competitive tendering procedure (the main conclusions of the preliminary studies will, in principle, be published as an annex to this decree). The winner of the competitive tendering procedure will receive the most comprehensive package of permits possible, together with the permission to use the lots concerned for the construction and private operation of offshore electricity production facilities.

However, the conditions and criteria for eligibility and granting are to date (late 2021) still to be determined by RD. It is planned that these will be laid down before the preliminary studies are completed (Belgian offshore wind energy - 4 GW by 2030 | FPS Economy). Meanwhile, guidelines have been adopted at EU level (Coordination of tenders for offshore wind in the North Seas - EC, Support schemes for offshore wind – Emerging best practices | EC, AURES project).

5.1.3 Societal interest

5.1.3.1 Energy production by offshore wind parks

The European strategy on offshore renewable energy (COM (2020) 741) foresees to increase the production capacity of offshore wind to 60 GW by 2030 and further to 300 GW (excl. UK) by 2050 (see **5.1.1 Policy context**). These targets would form a cornerstone of the European pathway to climate neutrality.

[5] Keeping in mind technological advances, the aim is to increase the total wind energy production to 5.4-5.8 GW by 2030 by installing more powerful turbines (cabinet federal minister for Energy).

In the Belgian North Sea, eight wind parks were operational in 2020 with a total installed capacity of 2,262 MW for 399 turbines (MUMM, BOP). The estimated annual production capacity provides power for more than 2.3 million households (table 2). As a result of this increase, approximately 18.6% of the Belgian electricity mix is renewable and new production records have been set in recent years (BOP, Elia 2021).

Table 2. An overview of the status, number of turbines and total power of the wind parks in the BNS (MUMM, BOP, 4C Offshore, see also EIRs of the respective parks at **5.1.4 Impact on the marine environment**).

Project	Status	Number of turbines	Power/turbine (MW)	Total power (MW)	Annual production
C-Power	Operational since 2013	54	6	325	1,050 GWh/year (power for 300,000 households)
Belwind	Operational since 2011 + GE Haliade (6 MW) (2013)	56	3,1	171	560 GWh/year (power for 160,000 households)
Northwind	Operational since 2014	72	3	216	875 GWh/year (power for 250,000 households)
Nobelwind	Operational since 2017	50	3,3	165	679 GWh/year (power for 194,000 households)
Rentel	Operational since 2018	42	7,4	309	1,140 GWh/year (power for 300,000 households)
Norther	Operational since 2019	44	8,4	370	1,340 GWh/year (power for 400,000 households)
Seamade-Seastar	Operational since 2020	30	8,4	252	power for 263,000 households
Seamade-Mermaid	Operational since 2020	28	8, 4	235	power for 263,000 households
Northwester 2	Operational since 2020	23	9,5	219	770 GWh/year (power for 220,000 households))

5.1.3.2 Employment

The European offshore wind sector currently employs about 210,000 people (European Parliament 2020), and it is estimated that this might triple by 2030 (COM (2021) 240). The offshore employment can be divided into the construction phase (including preliminary research and development) and the exploitation phase. The FTE (full-time equivalent) during the construction phase, direct and indirect, comes to approximately 6,600 per wind park. The FTE for the existing projects (in operation phase), come to approximately 235 per year. The estimate for the parks that still need to be exploited is 500 FTE per year, for 20 years of operation (appendix 1 - MSP 2020-2026). It is estimated that in 2020, some 14,000 people were working (directly + indirectly) in the Belgian offshore wind sector (BOP 2021). If a scenario is followed in which production capacity is increased to 6 GW by 2030, this would result in additional employment for 10,000 people (BOP 2021). In addition to an increase in employment, there are also noticeable positive effects on the economic added value and the trade balance (CLIMACT 2017, on behalf of BOP). For example, the economic added value in the long term (2024-2030) is estimated to increase by over 1 billion euro in GDP/year (CLIMACT 2017, BOP 2021). This trend is expected to continue in the future as maintenance, decommissioning or repowering[6] activities increase. Work is also being carried out to strengthen the transmission grid or activities within new international projects. If the production capacity is increased to 4.4 GW by 2030, this would result in an economic added value of approximately 9 billion euro (BOP 2021). More figures on the socio-economic side of Belgian offshore wind, can be found in CLIMACT (2017) and BOP (2021).

The construction of offshore wind turbines also creates new jobs in the ports, with port Oostende specifically profiling itself as a renewable energy port (Mathys et al. 2013, Port Oostende 2020). For example, in 2020, the port recorded more than 6,000 calls linked to wind park activities and the port counts 622 FTEs active in the Blue Economy (see also thematic chapter **Blue Economy and Innovation**). In addition to port Oostende, economic activities relating to offshore wind parks are also developed in the Port of Zeebrugge (Maatschappij van de Brugse Zeehaven 2020).

[6] Strategy where old wind turbines are partly or completely replaced. Repowering usually provides a cheaper and more sustainable alternative to the complete decommissioning of the wind park (Gokhale 2021).

5.1.4 Impact on the marine environment

The presence of wind parks in the BNS brings forth various positive and negative effects on the ecosystem and users of the sea (table 3). The RD of 9 September 2003 on environmental impact assessment (EIA) stipulates which effects on the marine environment must be dealt with in the environmental impact report (EIR) and the EIA. The EIRs, EIAs and any additional documents and amendments can be consulted on the relevant website of the RBINS - Operational Directorate Natural Environment (RBINS-OD Nature). A non-exhaustive overview of the scientific knowledge on the environmental impact of offshore wind energy is given in table 3. A holistic overview, not specific to the Belgian situation, of the environmental impact of wind energy and ocean energy can be consulted via the Thetys research database.

Table 3. A non-exhaustive overview of scientific studies on the environmental effects of offshore wind parks and other users with the BNS as focus area.

Impact on the environment/other users	Literature
Effects on the hydrodynamic regime	De Wachter and Volckaert 2005 (GAUFRE project BELSPO), Van den Eynde et al. 2010, Van den Eynde et al. 2013, Vanhellemont and Ruddick 2014, Baeye and Fettweis 2015
Effects on sediment transport and geomorphology	De Wachter and Volckaert 2005 (GAUFRE project BELSPO), Van den Eynde et al. 2010, Verhaeghe et al. 2011, Van den Eynde et al. 2013, Vanhellemont and Ruddick 2014
Underwater noise	De Wachter and Volckaert 2005 (GAUFRE project BELSPO), Norro et al. 2010, Norro et al. 2011, Norro et al. 2012, Norro et al. 2013, Haelters et al. 2013a, Debusschere et al. 2014, Debusschere 2016, Norro 2017, Norro 2018, Norro 2019, Kok et al. 2019, Norro 2020, Rumes and Degraer 2020, Kellet et al. 2021
Effects on fish and benthos (introduction of hard substrate, loss of habitat, disturbance, etc.)	De Wachter and Volckaert 2005 (GAUFRE project BELSPO), Reubens et al. 2010, Coates and Vincx 2010, Derweduwen et al. 2010, Kerckhof et al. 2011, Reubens et al. 2011b, Van Hoey et al. 2011, Verhaeghe et al. 2011, Kerckhof et al. 2012, Vandendriessche et al. 2012, Coates et al. 2013a, Vandendriessche et al. 2013a, De Mesel et al. 2013, Vandendriessche et al. 2013b, Reubens et al. 2013, Reubens 2013, Rumes et al. 2013, Coates 2014, Debusschere et al. 2014, De Mesel et al. 2015, Debusschere et al. 2016, Kerckhof and Degraer 2016, Derweduwen et al. 2016, Vandendriessche et al. 2016, Derweduwen et al. 2016, De Backer et al. 2017, Colson et al. 2017, De Backer and Hostens 2017, Kerckhof et al. 2017, ICES Interim Report WGMBRED 2017, De Backer and Hostens 2018, De Backer and Hostens 2018, Lefaible et al. 2018, Kerckhof et al. 2018, Lefaible et al. 2019a, Lefaible et al. 2019b, Kerckhof et al. 2019, Buyse et al. 2020, Braeckman et al. 2020, De Backer et al. 2020, Mavraki et al. 2020
Effects on birds and bats	Stienen et al. 2002a, Stienen et al. 2002b, De Wachter and Volckaert 2005 (GAUFRE project BELSPO), Everaert and Stienen 2007, Stienen et al. 2007, Vanermen et al. 2009, Brabant and Jacques 2009, Vanermen et al. 2011, Verhaeghe et al. 2011, Brabant et al. 2012, Vanermen et al. 2013a, Vanermen et al. 2013b, Vanermen et al. 2013c, Brabant et al. 2015, Vanermen et al. 2016, Brabant et al. 2016, Brabant et al. 2016, RAVEN project BELSPO, Vanermen et al. 2017, Brabant and Degraer 2017, Vanermen et al. 2018, Brabant et al. 2018, Vanermen et al. 2019, Vanermen et al. 2019, Vanermen and Stienen 2019, Brabant et al. 2019, Brabant and Vanermen 2020, Vanermen et al. 2020
Effects on marine mammals	Stienen et al. 2002a, De Wachter and Volckaert 2005 (GAUFRE project BELSPO), Evans 2008, Haelters et al. 2010, Haelters et al. 2011, Verhaeghe et al. 2011, Haelters et al. 2012, Haelters et al. 2013a, Haelters et al. 2013b, Haelters et al. 2014, Haelters et al. 2016, Rumes et al. 2017, Rumes and Debusschere 2018, Rumes et al. 2019
Impact on water and air quality	Maes et al. 2004 (MARE-DASM project BELSPO), De Wachter and Volckaert 2005 (GAUFRE project BELSPO), Verhaeghe et al. 2011, De Witte and Hostens 2019
Disruption of the seascape	De Wachter and Volckaert 2005 (GAUFRE project BELSPO), Vanhulle et al. 2010, Houthaeve and Vanhulle 2010, Di Marcantonio et al. 2013
Maritime safety	De Wachter and Volckaert 2005 (GAUFRE project BELSPO), van Iperen and van der Tak 2009, Verhaeghe et al. 2011 (see also thematic chapter **Maritime transport, shipping and ports**)
Spatial impact (including bottlenecks with other users)	Maes et al. 2004 (MARE-DASM project BELSPO), De Wachter and Volckaert 2005 (GAUFRE project BELSPO), Vandendriessche et al. 2011, Verhaeghe et al. 2011, Vandendriessche et al. 2013, Vandendriessche et al. 2016, North Sea Vision 2050-Multiple Use of Space (2018), De Backer et al. 2019, Degraer et al. 2020

5.1.5 Sustainable use

5.1.5.1 Measures concerning the impact on the marine environment

At the international level, OSPAR has produced a guide (OSPAR 2008) dealing with the impact of wind turbines on the marine environment. Within the framework of the ASCOBANS agreement the impact of wind turbines on marine mammals was assessed (Evans 2008). In 2009, a resolution was issued against the adverse effects on marine mammals due to underwater noise caused by the construction of installations (driving turbine foundations into the seabed, burying sea cables, etc.) for the generation of renewable energy at sea. Following this, reports were published with possible guidelines to reduce underwater noise (Prideaux 2016, Koschinski and Lüdeman 2020, CMS Guidelines 2020, Kellet et al. 2021). For example, all environmental permits issued from 2013 onwards contain a seasonal ban on piling from 1 January to 30 April in order to protect marine mammals in the BNS. Conditions and recommendations are also linked to the permit with the aim of minimising the impact (e.g. use of a bubble curtain) (Rumes and Degraer 2020).

The European strategy on offshore renewable energy (COM (2020) 741) states that offshore energy development must be in line with the European environmental legislation in force and the integrated maritime policy. Offshore energy development must be sustainable and compatible with the protection of biodiversity, taking into account the socio-economic impact on sectors that rely on a healthy marine ecosystem. In this respect, several existing legislative and policy instruments are relevant: the Habitats Directive (92/43/EEC), the Environmental Liability Directive (2004/35/CE), the Aarhus Convention (2005/370/EC), the Marine Strategy Framework Directive (MSFD, 2008/56/EC), the Birds Directive (2009/147/EC), the Maritime Spatial Planning Directive (2014/89/EU), the Circular Economy Action Plan (COM (2015) 0614), the Biodiversity Strategy (COM (2020) 380), etc. The MSFD is the main pillar of the European marine environmental policy (see thematic chapter **Nature and environment**), the Directive therefore provides a framework to reduce or avoid the impact of offshore wind parks. For example, energy inputs, including underwater noise, are identified as one of the descriptors for good environmental status (descriptor 11, Tasket et al. 2010). Other descriptors in the MSFD that are applicable to the siting of offshore wind turbines are: descriptor 6 (Seafloor integrity, Rice et al. 2010), descriptor 2 (Non-indigenous species introduced by human activities, Olenin et al. 2010), and descriptor 7 (Hydrographical Conditions, website EC).

In Belgium, a condition that by default is included in the environmental permit concerns the monitoring of the effects on the ecosystem (Degraer et al. 2020). In Belgium, this is monitored for all the parks combined by a consortium of research institutes under the coordination of the research group Ecology and Management of the Sea (*Ecologie en Beheer van de Zee*) (RBINS-MARECO).This monitoring has a twofold objective:

- Adapt, reduce or even stop the activities if there is extreme damage or a threat of extreme damage to the marine environment;
- Gaining a good understanding of the impact on the environment of offshore wind turbines in order to support policy, management and design of future wind turbines.

The monitoring programme studies both the physical, biological and socio-economic aspects of the marine environment (see monitoring reports MUMM) compared to a reference state (e.g. Van den Eynde 2005, De Maersschalck et al. 2006, Henriet et al. 2006). In the future, this monitoring will also increasingly be done remotely (Bilsen et al. 2019) and internationally (CEAF). For example, the North Sea countries are working together on a Common Environmental Assessment Framework (CEAF) for the assessment of cumulative ecological impacts of offshore renewable energy development.

5.1.5.2 Combination with other user functions

The MSP 2020-2026 leaves the possibility open for multiple use of space within the zones reserved for the construction and operation of infrastructure for the production, storage and transmission of energy from renewable sources (see also **5.1.2 Spatial use**). E.g., within the framework of the AQUAVALUE roadmap, the EDULIS project has already cultivated mussels between the C-Power and Belwind wind parks (Bilsen et al. 2019). In addition, within the Wier en Wind project, work is being done on a seaweed farm within the Norther concession zone. Some Belgian partners also investigate within the UNITED project whether nature restoration (e.g. oyster beds) and aquaculture are feasible within offshore wind parks and within the MARCOS project the potential of large-scale offshore aquaculture (LSOA) is investigated and analysed (see also thematic chapter **Marine aquaculture**). Furthermore, within some entities there are reflections on the multifunctional use of space in wind parks, such as in the Blue Cluster's innovation roadmap renewable energy and freshwater production 2020, Langetermijnvisie Noordzee 2050 and the Think Tank North Sea. However, the possibilities of certain activities are somewhat limited given the high density of the wind parks (9.5 MW/km², Rumes and Brabant 2020) (table 1).

5.2 Wave and tidal energy

Ocean energy (energy from waves, tides, salinity and temperature gradients) is the world's largest source of renewable energy, but is as yet hardly exploited (IEA, World energy resources marine energy 2016, OES 2019). Sector organisation Ocean Energy Europe (OEE) forecasts that, with the right research and development climate, ocean energy could provide 10% of Europe's power by 2050, creating 400,000 jobs (DG Research and Innovation, SETIS Ocean Energy). The European strategy on offshore renewable energy (COM (2020) 741) aims at 40 GW of ocean energy production by 2050. Under a high-growth scenario and, providing an adequate policy framework, it seems realistic to generate 2.6 GW of ocean energy from waves and tides within Europe in the medium term (2030) (OEE 2020).

Specifically for ocean energy, as part of the implementation of the SET-Plan, an advisory body, ETIPOcean, was established by the EC. This body consists of a working group of ocean energy experts and organises its activities around identifying research and innovation priorities for the ocean energy sector and promoting solutions to the industry and European and national policy makers. To this end, the working group draws up a Strategic Research and Innovation Agenda (SRIA Ocean Energy 2020). The coordination is done by Ocean Energy Europe.

Similar to offshore wind energy (see **5.1.1 Policy context**), the development of ocean energy has already been promoted in the past, notably through the European Commission's Blue Growth Strategy (DG MARE) (COM (2012) 494), including a communication of measures to make optimum use of the technique's potential (COM (2014) 8). However, with small exceptions, ocean energy production in European waters is still limited, as the technology, unlike wind energy, is still in the development phase. By the end of 2020, 11.2 MW of wave and tidal energy were operational in European waters, of which 10.1 MW of tidal energy (OEE 2020 key trends and statistics). For the time being, most activities focus on research and development (DG Research and Innovation, OEE). The status of research, production, projects and policies at the national level is monitored in the Annual Report Ocean Energy Systems (OES 2019).

At the Belgian level, the Blue Cluster (spearhead cluster of the Flemish innovation policy) is involved in the European ELBE project and facilitates the BluERA project. Within the ELBE project, the partners involved are trying to build a pan-European Blue Energy cluster to stimulate, among others, the development of wave and tidal energy. The BluERA project aims to build up a digital ocean energy atlas as well as an energy yield evaluation tool. To introduce wave and tidal energy in Flanders, the Gen4Wave action plan was developed in the past by partners from academia, industry and government. Gen4Wave resulted, under impulse of the Hydraulic Laboratory (WatLab, MOW), KULeuven and UGent, in the construction of a coastal and ocean basin (COB) as part of the Flanders Maritime Laboratory located in the Ostend Science Park. This basin provides testing opportunities for developers of wind, wave and tidal energy and land-sea interactions, etc. (Troch et al. 2017). The COB test infrastructure is complementary to the capabilities of the Blue Accelerator, a broadly deployable test platform at sea near port Oostende (MER Blue Accelerator 2017). This test platform has already been used within the NEMOS project project for the guidance and control of a wave energy convector. Furthermore, the development of wave energy is also supported by Fabriek voor de Toekomst Blue Energy of the West Flanders Development Agency (Dangreau 2014, Vanden Berghe 2014).

In the zones in the BNS reserved for energy production, the construction and operation of installations for the production of electricity from water and currents is also permitted (RD of 20 December 2000). In the Seamade zone for example, the possibilities of conducting a pilot project with wave energy converters with a capacity of 20 MW for commercial use, were examined (Application Mermaid 2014). However, due to the limited commercial feasibility of wave energy convectors at the time being, the deployment of such installations in this zone(s) is not expected in the near future (Rumes and Brabant 2020). Research also showed that the BNS is primarily suitable as a test site given its low wave climate (estimated potential within the first wind park concession zone 4.5 - 5.8 kW/m). Table 4 lists publications and research projects related to the development of ocean energy in the BNS. A general overview of the potential environmental impact of ocean energy technologies is compiled in Vanaverbeke and Coolen (2019) and the OES Environmental State of the Science Report (2020).

5.3 Solar energy at sea

Floating solar panels are a new innovative technology to produce offshore renewable energy, which Europe is stimulating by a.o. supporting R&D projects (COM 2020 (741). Also in the BNS the potential implementation is being considered (Van Quickenborne 2020). The production technology is still fully in the R&D phase, but several field tests in the BNS are on its way. For instance, within the MVPAqua project (2019-2022), research is being done into the feasibility of a possible commercial application in the BNS. Provided the results of this research are favourable, the aim is to install floating solar panels between the Belgian offshore wind parks within five to ten years. Given that this technique is still in its early testing phase, it will not be discussed in more detail in this edition of the thematic chapter.

Table 4. An overview of the research being conducted into wave and tidal energy at the BNS.

Research topic		Literature
Wave energy	Technological and operational aspects	Mathys et al. 2009 (OPTIEP-BCP project BELSPO), De Backer et al. 2008, Beels 2010, Mathys et al. 2012 (BOREAS project BELSPO), De Backer 2009, Van Paepegem et al. 2011, Stratigaki 2014, BlueERA project
	Economic aspects	Beels 2010, Mathys et al. 2012 (BOREAS project BELSPO)
	Ecological aspects	MER Mermaid and Northwester 2, Rumes et al. 2015 – MEB Mermaid, Rumes et al. 2015, MER-NEMOS 2016, Haelters et al. 2017 – MEB NEMOS, MER Blue Accelerator 2017
	Potential (wave climate BNS)	Mathys et al. 2009 (OPTIEP-BCP project BELSPO), De Backer et al. 2008, Beels 2010, Fernandez et al. 2010, Mathys et al. 2012 (BOREAS project BELSPO), De Backer 2009, BlueERA project
	Prototype development	FlanSea project (FlanSea, Van In 2014), Laminaria (prototype tested on the North Sea), NEMOS, MER-NEMOS 2016
Tidal energy	Technological and operational aspects	Mathys et al. 2009 (OPTIEP-BCP project BELSPO), Mathys et al. 2012 (BOREAS project BELSPO), BlueERA project
	Economic aspects	Mathys et al. 2012 (BOREAS project BELSPO)
	Potential (tidal climate BNS)	Mathys et al. 2009 (OPTIEP-BCP project BELSPO), Mathys et al. 2012 (BOREAS project BELSPO), BlueERA project

5.4 Renewable energy in the coastal zone

Unlike energy at sea, renewable energy production on land concerns a Flemish competence (from the landward side of the baseline). The Flemish energy policy relies heavily on the European policy on energy and climate and is largely determined by the Energy Decree of 8 May 2009 and the Energy Decree of 19 November 2010 (Department of Environment and Spatial Development, Vlaamse beleidsnota energie 2019-2024, VREG). The Flemish Energy and Climate Agency (*Vlaams Energie- en Klimaatagentschap*) (VEKA, a merger between the Flemish Energy Agency and part of the Energy, Climate and Green Economy division of the Department of Environment and Spatial Development) implements this policy. An extensive overview of the laws and regulations concerning renewable energy can be found on the website of the VEKA.

Flanders is working towards a decentralised low-carbon energy system (based on local production, storage and consumption) that will increasingly rely on renewable energy sources such as wind and solar energy (National Energy and Climate Plan 2021-2030). In this respect, the coastal zone has natural advantages that make it an attractive region for the aforementioned forms of energy. For example, a study of average wind speeds in Flanders revealed (Een windplan voor Vlaanderen) that the coast has a significantly higher wind regime (see also Dehenauw 2002 and Debrie 2017). In our wind climate, a production factor[7] of ±11% inland, ±23% near the coast and ±38% at sea can be expected for wind power (Brouwers et al. 2011, BOP). In addition, measurements show that the duration of sunshine in the coastal zone averages 1,700 hours a year, compared to 1,550 hours in Uccle (inland). The differences are greatest in the summer half-year when the coast can monthly receive up to 20 more hours of sunshine (Dehenauw 2002). In the Royal Meteorological Institute's (RMI) climate atlas, parameters such as sunshine duration and solar radiation are given for Belgium, in which the increased values for the coast are clearly visible. The coastal zone hence has an increased solar energy potential. Other forms of energy production are also present in the coastal zone (e.g. biomass, biogas, etc.). However, as the coast does not constitute a specific climate for these, the techniques will not be discussed further here.

To stimulate the green energy transformation, the Government of Flanders offers incentives in the form of green certificates (GC) (VLAIO). In 2020, there were 61 incentive-granting green power and cogeneration power plants in the coastal zone (coastal municipalities and hinterland municipalities). The majority of the installed capacity is located in Bruges and Ostend (energiesparen.be).

[7] The production factor indicates, as a percentage of the maximum power, the average power by which energy is produced. It is used in determining the effective power (installed power x production factor).

In the coastal zone, 210 MW of solar energy was generated by the end of 2020 (grid operators - energiesparen.be) out of a total of 33,714 installations. This means that per inhabitant of the coastal zone in 2020 some 492.9 W of green power was produced from solar panels, or 623 W per installation (Rijksregister, energiesparen.be). In terms of wind turbines, 102.9 MW of energy was produced by onshore turbines in the coastal zone in 2020. This capacity accounts for approximately 7.5% of the Flemish onshore wind in that year. These turbines are located on the territory of Bruges, Diksmuide, Gistel, Knokke-Heist and Middelkerke. It concerns 52 onshore wind turbines that generate approximately 241.5 W per inhabitant of green electricity (Rijksregister, energiesparen.be). Notably on the territory of the Port of Zeebrugge additional wind turbines are planned in the near future. For instance, a cooperation of companies is planning the construction of the largest onshore wind park in Belgium (Maatschappij van de Brugse Zeehaven 2020).

5.5 Natural gas installations Zeebrugge

Belgium depends on natural gas for approximately one quarter of its energy supply. To this end, our country relies on a highly developed natural gas network that is connected to neighbouring countries by no fewer than 18 interconnection points. Belgium is hence a hub for natural gas transport in northwest Europe. (National Energy and Climate Plan 2021-2030). More than 19 kilotonnes (Ktonnes) of oil eq. are imported annually (Statbel), mainly from the Netherlands, Norway and Qatar (FEBEG). In addition, about half of the natural gas import is destined for border-to-border transmission. This concerns Dutch and Norwegian natural gas for France and Spain, British natural gas for continental Europe and, among others, Russian natural gas for the United Kingdom. The Port of Zeebrugge plays an important role in this respect, with a landing capacity corresponding to approximately 10% of the total border capacity needed to supply the European Union (België als aardgasdraaischijf voor Noordwest-Europa: de weg vooruit 2010). The Port of Zeebrugge has two jetties at the liquefied natural gas (LNG) terminal, allowing the simultaneous handling of small and large LNG ships and a storage capacity of 566,000 m³ LNG spread over five storage tanks (Fluxys, Niet-technische samenvatting MER uitbreiding Fluxys LNG, Port of Zeebrugge).

5.5.1 Policy context

At the European level, the energy policy is developed by the DG Energy of the EC. The legal framework is a.o. provided by Directive No 2009/73/EC and Regulation (EC) 715/2009. A summary of the relevant (EU) legislation on natural gas is given on the website of the CREG and the FPS Economy, SMEs, Self-Employed and Energy.

The federal government (FPS Economy, SMEs, Self-Employed and Energy) is responsible for (large) energy storage, transmission and production infrastructures. The transport of gaseous products is regulated by the federal Law of 12 April 1965 (the Gas Law) and by a number of RDs relating, among other things, to safety, rates and the more technical aspects of network access (code of conduct) (CREG, Fluxys, FPS Economy, SMEs, Self-Employed and Energy, VREG). In addition, there is the federal regulator, the Commission for the Regulation of Electricity and Gas (CREG), which *inter alia*, sets the rate policy for the operators (in this case Fluxys and Fluxys LNG). The Regions are competent for, a.o., the public distribution of gas, which is managed by the intermunicipal companies, and the rational use of energy (special Law on institutional reform (BWHI) Law of 8 August 1980) (more information: FPS Economy, SMEs, Self-Employed and Energy, CREG).

5.5.2 Spatial use

The LNG terminal is located in the eastern part of the outer Port of Zeebrugge. The peninsula on which the LNG terminal is located covers an area of approximately 32 hectares. The site has two jetties and five storage tanks with a total capacity of 566,000 m³ and infrastructure allowing bi-directional transshipment (also between vessels), regasification and distribution on the gas grid (Fluxys, Open season: second capacity enhancement of the Zeebrugge LNG-terminal. Binding phase: offer description 2011, Non-technical summary EIR extension Fluxys LNG, Zeebrugge, Port of Zeebrugge). There are also plans for further expansion of regasification capacity (Fluxys). The MSP 2020-2026 provides space for the expansion of the Port of Zeebrugge, where in addition to the LNG terminal, the terminals of the Zeepipe and Interconnector gas pipes are located (see **5.7 Pipes and cables**).

5.5.3 Societal interest

The Port of Zeebrugge is a cornerstone in the security of supply of natural gas to Northwest Europe. In addition to the LNG terminal and the Zeepipe and Interconnector gas pipe terminals (see **5.7 Pipes and cables**), the Zeebrugge

Hub is one of the most important short-term markets in Europe (België als aardgasdraaischijf voor Noordwest-Europa: de weg vooruit 2010, Brouwers et al. 2011). The facilities of the Zeebrugge LNG terminal are operated by Fluxys and are capable of unloading and loading LNG, bunkering LNG or regasifying LNG for international transport or storing LNG on trucks. After a fifth storage tank became operational in 2019, the terminal now has an annual throughput capacity of 11 billion m³ of liquefied natural gas (Indicatief Investeringsprogramma Fluxys 2017-2026). In 2019, approximately 7.6 million tonnes of natural gas were loaded or unloaded at the Zeebrugge LNG terminal (Maatschappij van de Brugse Zeehaven 2020).

Fluxys has also opted for a cooperation model for the development of an LNG terminal in Dunkirk and is participating in the project for 25%. The two terminals will be connected through an interconnection point in Alveringem and Maldegem, enabling up to 8 billion m³ of gas to be brought to Belgium and elsewhere in Europe from the Dunkirk LNG terminal.

5.5.4 Impact and sustainable use

The installation of the natural gas facilities in Zeebrugge entails a certain impact, both on the environment and on other users. These effects are dealt with in the relevant environmental impact reports (see EIR-databank Government of Flanders, Niet-technische samenvatting MER voor uitbreiding van de NV Fluxys LNG te Zeebrugge). In these EIRs, various measures have already been proposed to mitigate or avoid the impact of the LNG terminal on the surroundings.

The use of natural gas as an energy source brings a number of environmental advantages over other fossil fuels (Fluxys). In the National Energy and Climate Plan 2021-2030, for example, natural gas is still considered a “transition fuel” for the foreseeable future. The use of natural gas is also attractive in the maritime sector because of its lower pollutant emissions (especially sulphur) than diesel or heavy fuel oil (Margarino 2014, In-Focus LNG as ship fuel 2015, De Backer 2017, Safetysaf4Sea, Port of Zeebrugge see also thematic chapter **Maritime transport, shipping and ports**). However, the ultimate climate gain appears doubtful in view of the greenhouse gas potential of methane (Pavlenko et al. 2020).

5.6 Energy storage and green hydrogen

For some renewable energy sources, such as wind energy, there is a discontinuity in the amount of energy generated at a given time. To ensure a continuous supply of offshore energy that matches the temporal variation in use and production, options for the storage of power must be sought. One possible option in this context is the construction of an offshore energy island off the Belgian coast for hydroelectric energy storage (Federaal Ontwikkelingsplan van het transmissienet 2020-2030). The conditions and the procedure for awarding the domain concessions for such an energy island have already been laid down in the RD of 8 May 2014 implementing the Law of 29 April 1999. Two zones were defined for this purpose in the MSP 2014-2020 (RD of 20 March 2014) (Federaal Ontwikkelingsplan van het transmissienet 2020-2030). In the MSP 2020-2026, these zones have not been retained, but zones have been set aside for commercial and industrial activities (CIA zones) within which multiple use of space is pursued and energy storage is one of the possibilities. In the previous edition of this thematic chapter (Heylen et al. 2018), hydroelectric energy storage in the BNS was discussed in more detail. For this edition of the thematic chapter, we opted to further highlight another energy storage principle, power to gas.

A surplus of energy can also be used for the conversion of one energy carrier into another (Power to X). One promising option is the production of renewable (green) hydrogen by this principle, the so-called ‘Power-to-Gas’ principle (Unlocking the potential of the North Sea 2020).

Hydrogen (H_2) is considered a versatile, environmentally friendly fuel alternative and is being considered as a substitute for fossil fuels by various economic sectors worldwide. Interest in hydrogen as a means of making economies carbon-neutral is growing year on year, and more and more countries are taking steps to enable the production, transportation and management of hydrogen (IRENA 2019, Kosturjak et al. 2019). This is also the case in Europe, where hydrogen is an important component in policy strategies aimed at decarbonising the transport and energy sector (EU Green Deal (COM (2019) 640), strategy on offshore renewable energy (COM (2020) 741) and the Renewable Energy Directive (EU) (2018/2001)). Specifically for hydrogen, Europe recently unveiled its Hydrogen Strategy (COM (2020) 301) which can contribute to the realisation of the Green Deal objectives. In concrete terms, Europe wants to take a leading role in the production of green hydrogen and, through a number of measures, the EC is aiming for a smooth but systematic market integration of the technology (see **5.5.1 Policy context**). The sector is represented at EU level by Hydrogen Europe, and the development of green hydrogen is in turn supported by the European Clean Hydrogen Alliance.

At the national level, in the framework of the National Energy and Climate Plan 2021-2030, hydrogen is recognised as an essential technology in the Belgian energy transformation, especially since this energy carrier offers flexibility to companies that cannot (completely) electrify. An additional advantage of hydrogen is that it, barring minor adjustments, can be transported relying on existing natural gas infrastructure (Fluxys). The seaports and pipes in the BNS offer opportunities here (see **5.7 Pipes and cables**). The intention to produce green hydrogen and energy storage is also reflected in the federal Coalition Agreement (federaal Regeerakkoord 30 September 2020), where there is talk of shaping a hydrogen backbone and the adaptation of the legislative and regulatory framework is prioritised (repeated in the federal Coalition Agreement on Energy (Van der Straeten 2020)). Finally, the Policy Statement of the minister of the North Sea states that within the current legislature, attention will be paid to the technological developments that enable the storage of energy, including through conversion into hydrogen (Van Quickenborne 2020). Space is also provided for this in the MSP 2020-2026 within the zones reserved for commercial and industrial activities (CIA zones).

Flanders, too, is focusing its energy policy on greening the energy landscape and is pursuing a pioneering role in the hydrogen economy (Demir 2019). At the Flemish level, the feasibility and valorisation of the Power to Gas technology was already investigated by the former Innovative Business Network (IBN) 'Platform Power to Gas' within the 'Power-to-Gas' project (2014-2020) (Power-to-Gas Roadmap for Flanders 2016). This network now continues as the Hydrogen Industry Cluster and is coordinated by HydrogenNet. The cluster brings together some 60 industrial partners with knowledge institutes and governments who wish to cooperate on hydrogen as a storage medium for renewable energy and its use in industrial or social applications. A bottom-up vision with concrete ambitions of hydrogen companies for Flanders has been drawn up (Vlaamse Waterstofstrategie 2025-2030 – WIC 2020).

Within the coastal zone there are specific plans for (pilot) projects that should make the production of green hydrogen possible. For instance, within the Hyport project, Port Oostende, a private company and *Participatie Maatschappij Vlaanderen* (PMV) are working together on the construction of the world's first commercial power plant that will realise the production of green hydrogen by 2025 (Hyport project, Port Oostende 2020). The energy supply should be covered by power from the wind parks still to be built in the Princess Elisabeth zone.

In addition to the Hyport project, Port Oostende is involved in a number of European projects concerning hydrogen. In the ISHY project it is investigated how three types of ships can sail on green hydrogen. In the H2SHIPS project ports, industry partners, ship builders and knowledge institutions are investigating, together with Hydrogen Europe the added value of green or blue hydrogen for inland navigation[8].

In the Port of Zeebrugge too, activities concerning green hydrogen take place. For example, there was earlier collaboration with the Province of West Flanders and the West Flanders Development Agency in the project Hydrogen Valleys. This project aimed at accelerating the European market integration of hydrogen. The port is also involved in the Greenports study project with the aim of providing optimum technical solutions, as well as outlining economic preconditions and the legislative framework that will make the integration of large-scale power-to-gas installations into the energy system in Flanders/Belgium possible in an economically viable way (HydrogenNet, Maatschappij van de Brugse Zeehaven 2020). In cooperation with HydrogenNet, the Green Octopus/HyFLOW project examined the possibility of cooperation between Flemish and Dutch ports in the field of green hydrogen production. WaterstofNet is also working within a so-called 'hydrogen import coalition' on a pioneering study into the large-scale intercontinental import of hydrogen. The aim is to map out the financial, technical and regulatory aspects of the various links in the logistic chain (Benelux Energy Expertise Network). The feasibility study was recently positively assessed (Hydrogen Import Coalition 2020, Port of Zeebrugge). Finally, Eoly, Parkwind and Fluxys plan to build a plant at the Port of Zeebrugge that will use 25 MW of green electricity to produce hydrogen, the so-called Hyoffwind project (Fluxys, offshoreWIND). The feasibility study for this project was also evaluated positively and, by the end of 2021, the final investment decision is awaited.

Finally, North Sea Port Flanders is also active in the field of (sustainable) hydrogen. With the SeaH2Land project, the port aims to become one of the world's largest producers of green hydrogen in cooperation with the Danish Orsted. This hydrogen will be transported between Denmark and Belgium by pipeline. Power will be supplied by a yet-to-be-built offshore wind park in the Dutch North Sea. There are also plans to construct a network of pipes for the transport of hydrogen, CO_2 and heat through the port (Fluxys).

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[8] The greening of shipping via hydrogen was previously explored in the LeanShips project where, among other things, the potential of hydrogen-produced methanol, a denser and more stable fuel than traditional marine fuel, was investigated.

5.7 Pipes and cables

In the OSPAR area (North-East Atlantic Ocean and the North Sea), more than 1,350 oil and gas platforms are connected by a network of over 50,000 km of pipes (OSPAR QSR 2010, OSPAR). In the BNS, there are three submarine pipes with a total length of 163 km that regulate the transport of gaseous products to our country (Verfaillie et al. 2005 (GAUFRE project BELSPO), Brouwers et al. 2011, MSP 2020-2026, Coastal Portal):

- The Seapipe-pipe (with a diameter of 40") connects the Gassco AS-terminal in the Port of Zeebrugge with a pipe in the Norwegian Sleipner area and has a total length of 814 km. Seapipe has been in operation since 1993 and has an annual capacity of approximately 13 billion m³ with a daily capacity of 42 million m³;
- The Franpipe-pipe (formerly Norfra) is an 840 km long pipe (with a diameter of 42") between the Norwegian Draupner E-platform and the French port of Dunkirk that partly crosses the BNS (Maes et al. 2000). This pipeline only passes through the BNS and does not call at a Belgian port. Franpipe has been in operation since 1998 and has an annual capacity of approximately 15 billion m³;
- The Interconnector-pipe is 215 km long (with a diameter of 40") and is operated by Interconnector UK Limited (IUK). This pipe has been transporting gas between the South coast of the United Kingdom and Zeebrugge since October 1998. The pipe is bidirectional and can therefore be used for the import/export of gas from/to England. In winter, gas is imported from England with a capacity of 20 billion m³ per year (personal communication, FPS Economy, SMEs, Self-employed and Energy) and in summer, gas is exported to England with a capacity of approximately 25.5 billion m³ per year.

In addition to gas pipes, the North Sea and the North-East Atlantic are intersected by telecommunication and power cables. Telecommunication cables are mainly found in the southern part of the North Sea, the Celtic seas and the transatlantic corridor. On the Belgian Continental Shelf (BCP), a total of 27 telecommunication cables are present, 16 of which are actively used, representing a length of 914 km (Verfaillie et al. 2005, GAUFRE project BELSPO). Power cables are mainly found in the North Sea and Celtic seas (OSPAR QSR 2010). The amount of power cables is increasing, linked to the implantation of new offshore wind parks. Since 2020, all existing wind parks in the BNS are connected to the power grid. This concerns power cables from C-Power, Norther, Northwind and Belwind that directly connect the wind park to the coast (landing in Ostend for C-Power, other parks in Zeebrugge). The Rentel, Seastar, Mermaid and Northwester 2 wind parks are connected to the Modular Offshore Grid (MOG) (see **5.7.3.1 Modular Offshore Grid I & II**). The MOG is connected to the coast via three cables that are connected to a power plant in the Port of Zeebrugge, after which the power is distributed onshore via a high-voltage connection (380 kV) between Zomergem and Zeebrugge, the so-called Stevin project (Elia - Stevin project, Rumes and Brabant 2020, Federaal ontwikkelingsplan van het transmissienet 2020-2030).

Finally, there is the NEMO Link, a submarine and underground power cable for the exchange of power between Belgium and the United Kingdom (Federaal Ontwikkelingsplan van het transmissienet 2020-2030) (see also **5.7.3 Societal interest**).

5.7.1 Policy context

The procedure for the installation of cables in the BCP is laid down in the RD of 12 March 2002 (see also MD of 8 May 2008) (FPS Economy, SMEs, Self-employed and Energy). Applications are addressed to the federal minister responsible for Energy or his delegate. The dossier is accompanied by the assessment of the environmental impact and the advice of all the administrations concerned. Authorisation is granted by a motivated MD, which particularly takes into account the conclusions of the EIA. The environmental impact is assessed by the Management Unit of the Mathematical Model of the North Sea on the basis of an EIR (RBINS-MUMM).

The procedure for the installation of pipes was laid down in the Law of 12 April 1965 on the transport of gaseous products and others by pipes. This basic law was supplemented by dozens of implementing decrees (FPS Economy, SMEs, Self-employed and Energy).

The Law of 13 May 2003 approved the agreement between Norway and Belgium relating to the Franpipe gas pipe and the Law of 19 September 1991 relating to the Seapipe gas pipe. The Law of 26 June 2000 provides consent to the agreement relating to the Interconnector pipe between the United Kingdom, Northern Ireland and Belgium. For an overview of the regulations concerning cables and pipes in the BNS, see the Codex Coastal Zone, theme Cables and Pipes and the annexes to the RD of 22 May 2019 establishing the MSP 2020-2026.

5.7.2 Spatial use

In the MSP 2020-2026, a zone (corridor) has been defined in which cables and pipes must be bundled as much as possible. Activities that endanger the installation or operation of these cables and pipes are prohibited in this zone. The spatial use around power cables in the BNS is further elaborated in the RD of 12 March 2002 (table 5). By analogy with the spatial regulations for electricity cables, there are also special provisions for the use of space around pipes (RD of 19 March 2017, table 6).

Table 5. An overview of the spatial use around power and telecom cables in the BNS (RD of 12 March 2002).

Spatial use around power and telecom cables (RD of 12 March 2002)	
Protected zone (250 m on either side)	Reserved zone (50 m on either side)
Anchoring prohibited	No installation, no construction of cable or pipe
No activity that poses a risk to the cable (except for the installation of another cable under specific conditions)	
Exception: interventions of cable owner for exploitation	Exception: single-pole cables at the same safety switch, arrival and departure cables to a wind turbine in parallel with other cables, arrival and departure point to an installation with one or more cables, convergence point of several cables forming part of the same return mechanism to the mainland, cables which have undergone repair

Table 6. An overview of the spatial use around offshore pipes in the BNS (RD of 19 March 2017).

Spatial use around offshore pipes (RD of 19 March 2017)	
General provision	**Explanation**
Protected zone (1,000 m on either side)	Each zone divided into two zones (500 m on both sides)
First zone reserved for exploitation and maintenance by the permit holder	Derogation granted subject to ministerial approval and written approval of the permit holder
Second zone can allow static structures (pipes, power and telecommunication cables, installations for the generation of power by wind, hydropower or sea waves and artificial islands having no influence on the stability on the seabed	Provided that written consent of the permit holder is obtained
The above provisions do not apply in the landing zone. There, a minimum distance of 0.50 m is respected between the submarine structures, both in case of crossing and in case of parallel route, in order to allow inspection and maintenance works. Crossings with another operator's pipes must be requested and approved in writing by the operator of the crossed pipes.	

5.7.3 Societal interest

5.7.3.1 Modular Offshore Grid I and II

Due to the increasing importance of offshore energy production (see also **5.1.3 Offshore wind energy - Societal interest**), there is a growing demand for submarine power cables for the transfer of power to land. The development of wind energy and, by extension, offshore energy in the BNS was initially accompanied by separate connections to the onshore grid. With the installation of a Modular Offshore Grid (MOG) for the Rentel, Seamade and Northwester 2 wind parks, this was done in a more clustered manner, which brought technical, economic and ecological benefits. The MOG can be seen as a meshed offshore power network, or 'plug at sea', by which the aforementioned wind parks in the first place, but also future other alternative energy sources, can be connected to high-voltage substations which subsequently connect to the onshore transmission grid (Elia, Federaal ontwikkelingsplan van het transmissienet 2020-2030, North Seas Energy Cooperation, offshoreWIND). This facilitates the further development, internationalisation and guaranteed supply of offshore energy via the BNS.

The MOG in its current configuration consists of one so-called Offshore Switch Yard (OSY) at the Rentel concession zone (figure 2) and installations located on the Rentel Offshore High Voltage Station, in Rentel's domain concession. The platform contains a 220 kV substation and is connected to the Stevin high-voltage station in Zeebrugge via two submarine cables and one cable connected to the Rentel platform (Tant 2014, Federaal ontwikkelingsplan van het transmissienet 2020-2030, Elia). The construction of the MOG happened modular and, after two years of construction, was completed at the end of 2020 with the last wind parks becoming operational (vision Elia Offshore Grid 2012, MER - Belgian Offshore Grid 2013, Aanvraagdossier Belgian Offshore Grid 2013, Durinck 2017, Rumes and Brabant 2020, Federaal ontwikkelingsplan van het transmissienet 2020-2030, OffshoreWIND).

To facilitate the development of offshore wind energy at the BNS within the Princess Elisabeth zone, Elia launched the MOG-II project (Modular Offshore Grid II) in order to create additional offshore grid capacity (Elia, DMS projects, Federaal Ontwikkelingsplan van het transmissienet 2020-2030). The construction and location of the MOG-II project is currently in a conceptual phase, but the intention is to make MOG II a multifunctional energy island for the connection of power from the Princess Elisabeth zone, the Nautilus cable and the cable to and from Denmark (see **5.7.3.2 Interconnections**).

5.7.3.2 Interconnections

A safe and reliable power supply is essential. A sufficiently large and reliable production park that can meet the demand for power at all times is indispensable for this. To achieve this, the development of international connections is examined (Federaal Ontwikkelingsplan van het transmissienet 2020-2030).

Herein lies an important role for the Nemo Link. This cable is a submarine HVDC-connection (a high voltage direct current connection of about 1,000 MW) between Zeebrugge and Richborough (United Kingdom) (Milieueffectenrapport - NEMO LINK 2012, Mathys et al. 2013, Elia, Federaal ontwikkelingsplan van het transmissienet 2020-2030, Nemo Link). The Nemo Link is the first power link between the UK and Belgium and provides an improved connection between the UK's high-voltage grid and continental Europe. Economic studies have shown the value of such a link and its development was selected by the EC as a 'Project of Common Interest' within the framework of the Trans-European Energy Infrastructure (TEN-E, Regulation (EU) 347/2013). Grid integration on the Belgian side took place via a connection to the Gezelle high-voltage substation in Bruges (Federaal Ontwikkelingsplan van het transmissienet 2020-2030). The construction of the Belgian section of the Nemo Link began in 2018, with the cable becoming operational in 2019. Currently, the feasibility of a second HVDC-interconnection between the UK and Belgium in the so called Nautilus project is being looked into (Volckaert and Durinck 2018, Rumes and Brabant 2020, Elia, Federaal Ontwikkelingsplan van het transmissienet 2020-2030). The EC has already designated the project as a PCI project. Elia is currently carrying out a feasibility study together with National Grid Ventures (NGV) into the possible location, route, capacity, etc. of the project (Elia, Federaal Ontwikkelingsplan van het transmissienet 2020-2030). For the Nautilus project, the possibility of realising a hybrid interconnection (i.e. transmission and interconnection) is also being investigated, by which the interconnector can fulfil a double role: connecting offshore wind and connecting the two countries.

A connection can also be made with other North Sea countries. In a recently launched study, Elia and Energinet (the Danish high-voltage grid operator) are examining the technical and economic feasibility of a 500 km long hybrid interconnector that could transport 1.4 GW of green power from a Danish offshore wind energy island to Belgium by 2030 (Elia). The first results suggest that the multi-billion project is both technically and economically feasible. At the end of November, an agreement on the construction of the Triton Link was closed by the federal minister of Energy (De Tijd).

5.7.3.3 Onshore connections

The onshore connections of the power cables from the offshore wind parks are localised in Oostende (Slijkens) (C-Power) and Zeebrugge (Belwind, Norther, Nobelwind en Northwind). Rentel, Seamade and Northwester 2 connect to the Stevin station (Zeebrugge) (figure 2).

Realisation of the Stevin high-voltage line between Zeebrugge and Zomergem (Federaal Ontwikkelingsplan van het transmissienet 2020-2030) constituted the first step in the expansion of the 380 kV grid towards the coast. The development of this power connection was necessary to be able to connect the first Belgian offshore energy production zone (eight wind parks in total) and the first interconnection (Nemo Link) with the United Kingdom to the Belgian high-voltage grid. Now that the first offshore production zone is fully operational, the capacity of the Stevin high-voltage link is fully used, transporting up to 3 GW of electrical power inland. Power production and import from the BNS hence constitutes a major share of the Belgian power supply.

To connect the power generated by the yet to be build wind parks in the new concession zone to the Belgian power grid, an additional high-voltage connection between the hinterland and the coast has been included in the Federaal Ontwikkelingsplan van het transmissienet 2020-2030. This project, the Ventilus project, will connect to the existing Stevin station in order to increase the reliability of the high-voltage grid in West Flanders and thus improve a guaranteed power supply in Belgium. The procedure to draw up the regional spatial implementation plan is currently ongoing (Department of Environment and Spatial Development 2019). The intention is to submit the environmental permit application in 2023 and to complete the construction in 2028 (Elia, Federaal Ontwikkelingsplan van het transmissienet 2020-2030).

In addition to the Ventilus project, Elia is pursuing a similar objective with the Boucle Du Hainaut project. The project provides for the construction of a new high-voltage aboveground connection between the high-voltage substations of Avelgem and Courcelles. The majority (1,400 MW) of the offshore capacity of the Princess Elisabeth zone will be distributed via Boucle du Hainaut (Boucle Du Hainaut, Elia, Federaal ontwikkelingsplan van het transmissienet 2020-2030).

5.7.3.4 North Seas Energy Cooperation

As part of the creation of a European integrated energy network (COM (2010) 677), Europe already stimulated the development of a North Sea Offshore Grid between the ten North Sea countries (Mathys et al. 2009, OPTIEP-BCP project BELSPO, Offshore Electricity Grid Infrastructure in Europe 2011). A first initiative in this direction was the establishment of the North Sea Countries Offshore Grid Initiative (NSCOGI). In this context, Belgium, Denmark, France, Germany, Ireland, Luxembourg, the Netherlands, Norway, Sweden and the United Kingdom concluded a Memorandum of Understanding (MoU) to evaluate the possibility of a coordinated development of an offshore grid in the North Sea and associated onshore connections. This with a view to ensure economic viability and meeting the renewable energy targets in 2020 (Offshore Electricity Grid Infrastructure in Europe 2011). The progress of the initiative was tracked in progress reports (Benelux – NSEC). The initiative for intensive regional cooperation on affordable European offshore energy has received a new impetus under the North Seas Energy Cooperation[9],[10] (Federaal Ontwikkelingsplan van het transmissienet 2020-2030). The intention of closer cooperation has already been confirmed in a political declaration (2016). The current work programme (2020-2023) places a strong emphasis on concretising international offshore wind and grid projects in order to rationalise the use of space and resources. Furthermore, in July 2020, a joint statement called for a European offshore wind framework that would address the current obstacles slowing the efficient and effective development of international hybrid (production + transmission + interconnection) offshore wind projects. *Inter alia*, it was advocated that this framework should provide guidance to EU countries on project implementation, electricity market regulation and efficient EU funding. The work of the North Seas Energy Cooperation was also taken into account in the new European strategy on offshore renewable energy (COM (2020) 741).

Furthermore, the EU Green Deal (COM (2019) 640) also mentions the importance of international cooperation in the field of renewable energy. In addition, the Promotion project recently investigated how the European offshore power network can be further stimulated. Finally, it should be noted that there is already a long tradition of international cooperation on offshore energy in the North Sea Region that is multifaceted and thus does not only envision a connected energy landscape (NorthSEE-Energy).

At the national level, recent policy documents show a continued intention and concretisation to integrate the Belgian offshore power grid into a European power grid with direct current connections (MSP 2020-2026, National Energy and Climate Plan 2021-2030, Van Quickenborne 2020). Such connections make it possible to transport larger capacities over longer distances and hence secure the power supply.

5.7.4 Impact on the marine environment

The installation and exploitation of cables and pipes has both a temporary and permanent impact on the environment in the direct vicinity of the cable or pipe. This impact is included in the EIRs that must be attached to permit applications for cables and pipes. Furthermore, a number of studies and EIRs that deal specifically with the environmental impact of cables and pipes are listed in table 7. Taormina et al. (2018) provides a general overview of the potential environmental impact of submarine power cables.

[9] Regarding the Brexit, the European Commission decided that it will invoke Article 128(5) of the Withdrawal Agreement of the North Seas Energy Cooperation Declaration. This means that, by rule, the UK can no longer be part of this group, but that in exceptional cases of European interest, the UK can be invited to participate.
[10] The chairmanship of the NSEC was held by Belgium in 2021.

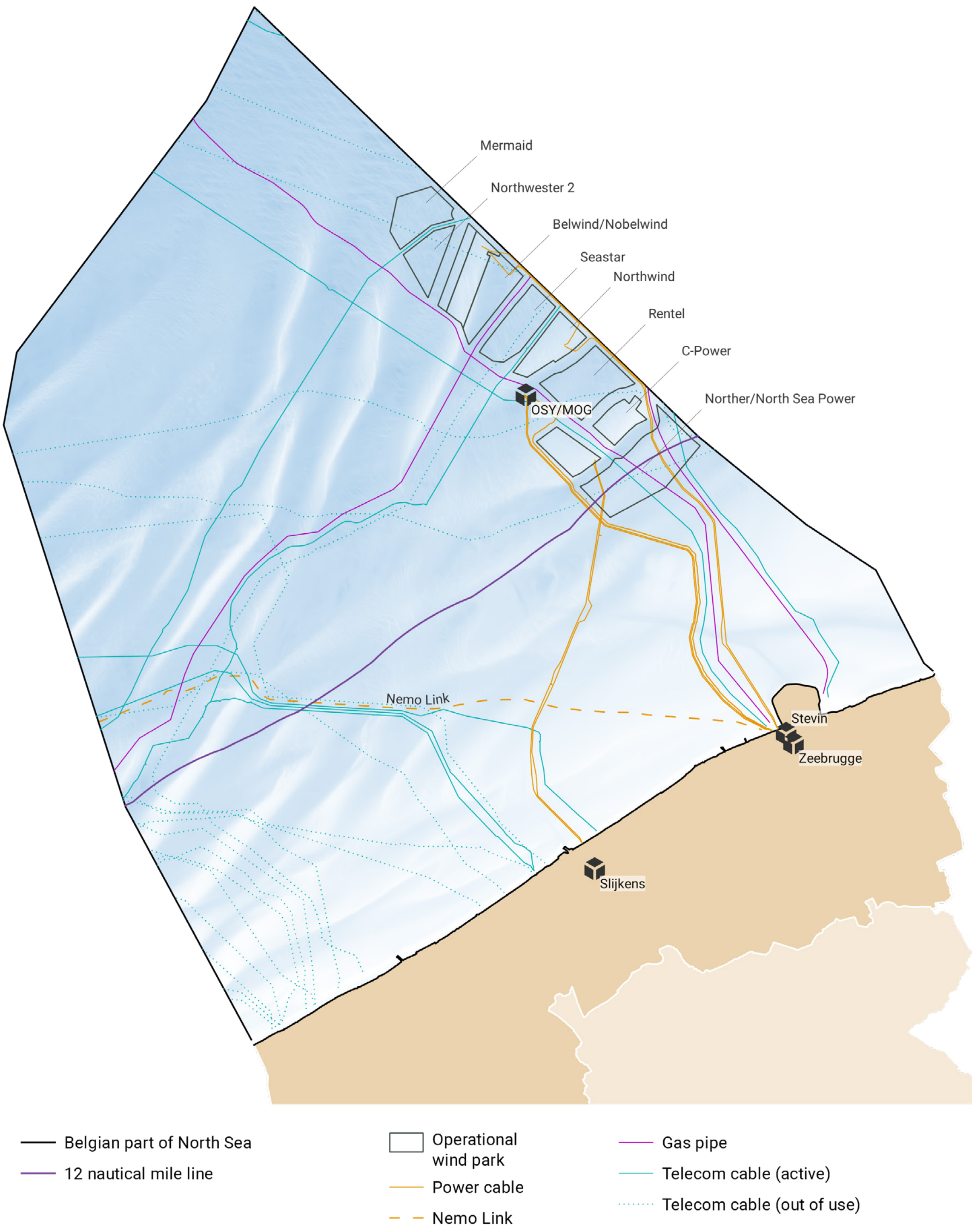

Figure 2. Geographic location of the submarine pipes and cables on the BNS (Source: RBINS, MarineAtlas.be (based on RD of 22 May 2019 (MSP 2020-2026), Flemish Hydrography, Elia, Marine Environment division, Emodnet Human Activities, Coastal Portal).

Table 7. An overview of the environmental effects of the installation and exploitation of cables and pipes in the BNS.

Impact	Literature
Toxic pollution from zinc-coated pipes	Maes et al. 2004 (MARE-DASM project BELSPO)
Introduction of hard substrate on the seabed (pipe) => non-indigenous species	Maes et al. 2004 (MARE-DASM project BELSPO), OSPAR QSR 2010, MER - Belgian Offshore Grid 2013, Rumes et al. 2014 – MEB Belgian Offshore Grid, Durinck 2017
Sediment disturbance during construction and removal of cable/substrate (including increased turbidity and release of pollutants adsorbed to soil particles)	MER - NEMO LINK 2012, MER - Belgian Offshore Grid 2013, Van den Eynde et al. 2013, Rumes et al. 2013 – MEB NEMO, Rumes et al. 2014 – MEB Belgian Offshore Grid, Durinck 2017
Effect on temperature of the surroundings	OSPAR QSR 2010, Environmental Impact Report - NEMO LINK 2012, MER - Belgian Offshore Grid 2013, Rumes et al. 2013 – MEB NEMO, Rumes et al. 2014 – MEB Belgian Offshore Grid, Durinck 2017
Elektromagnetism	OSPAR QSR 2010, MER - NEMO LINK 2012, MER - Belgian Offshore Grid 2013, Rumes et al. 2013 – MEB NEMO, Rumes et al. 2014 – MEB Belgian Offshore Grid, Durinck 2017
Underwater noise when installing cables/pipes	MER - NEMO LINK 2012, MER - Belgian Offshore Grid 2013, Rumes et al. 2013 – MEB NEMO, Rumes et al. 2014 – MEB Belgian Offshore Grid, Durinck 2017
Impact on other users	Verfaillie et al. 2005 (GAUFRE project BELSPO), MER - NEMO LINK 2012, MER - Belgian Offshore Grid 2013, Rumes et al. 2013 – MEB NEMO, Rumes et al. 2014 – MEB Belgian Offshore Grid, Durinck 2017

5.7.5 Sustainable use

5.7.5.1 Measures to address the impact on the marine environment

At the international level, there is the International Cable Protection Committee (ICPC) that is committed to the realisation of SDG 14[11] by promoting sustainable practices in the submarine cable community and by pointing seabed users and policy makers to the importance and practical implications of the provisions of UNCLOS for submarine cables and for the protection and preservation of the marine environment. A report with best practice guidelines as well as a scientific analysis of the impact of cables on the marine environment are under preparation (ICPC).

To date, no common programmes or measures exist at the international level to address the impact of pipes and cables on the marine environment (OSPAR QSR 2010), but states do often opt for a certain licensing procedure, such as a necessary environmental permit. OSPAR has, however, developed guidelines to allow the most sustainable installation of submarine cables (OSPAR 2012). In addition, non-cable specific measures may be applicable, such as noise reduction measures in offshore activities OSPAR 2016 (see also **5.1.5 Sustainable use**).

At the European level, however, the MSFD (Directive 2008/56/EC) can be seen as a framework to monitor and counteract the negative impact of submarine cables and pipes. This Directive contains, a.o., the following descriptors for a good environmental status of the marine environment: descriptor 11 (Energy, including Underwater Noise), descriptor 6 (Seafloor integrity) and descriptor 2 (Non-indigenous Species). In 2017, however, a reference environmental assessment study was prepared at the request of the EC for the development of power production, energy storage and power cable projects in the North Sea and Irish Sea (BEAGINS 2017). In addition to analysing the risks and potential limitations, the study also included recommendations for mitigation to provide a framework to ensure that environmental issues are properly considered in the development of offshore energy systems.

At the Belgian level, the effects of power cables on the marine environment are addressed in the EIAs and monitoring programmes of the different cables for wind parks (MUMM, monitoring reports MUMM). The assessment of potential environmental impacts during the installation of pipes is reflected in the relevant EIRs.

[11] Sustainable Development Goal 14: Promotes the conservation and sustainable use of the ocean and its resources by implementing the international law as reflected in UNCLOS, which constitutes the legal framework for the conservation and sustainable use of the ocean and its resources, as stated in paragraph 158 of The Future We Want.

Legislation reference list

Overview of the relevant legislation on international ('Year A': adoption; 'Year EIF': entry into force), European, federal and Flemish level. For the consolidated European policy context see Eurlex. The national legislation can be consulted on the Belgian official journal and the Justel-database, the Flemish legislation is available on the Flemish Codex.

International conventions and agreements			
Acronyms	**Title**	**Year A**	**Year EIF**
UNCLOS	United Nations Convention on the law of the sea	1982	1994
ASCOBANS	Agreement on the conservation of small cetaceans of the Baltic, North East Atlantic, Irish and North Seas	1991	1994
OSPAR	Convention for the protection of the marine environment of the North-East Atlantic	1992	1998

European legislation and policy context			
Document number	**Title**	**Year**	**Number**
Decisions			
Decision 2005/370/EC	Council Decision on the conclusion, on behalf of the European Community, of the Convention on access to information, public participation in decision-making and access to justice in environmental matters (Aarhus Convention)	2005	370
Communications / opinions			
COM (2007) 575	Communication from the Commission - An Integrated Maritime Policy for the European Union	2007	575
COM (2007) 723	Communication from the Commission - A European strategic energy technology plan (SET-plan) - 'Towards a low carbon future'	2007	723
COM (2008) 534	Communication from the Commission - A European strategy for marine and maritime research : a coherent European research area framework in support of a sustainable use of oceans and seas	2008	534
COM (2010) 677	Communication from the Commission: Energy infrastructure priorities for 2020 and beyond - A Blueprint for an integrated European energy network	2010	677
COM (2012) 494	Communication from the Commission: Blue Growth opportunities for marine and maritime sustainable growth	2012	494
COM (2014) 8	Communication from the Commission: Blue Energy Action needed to deliver on the potential of ocean energy in European seas and oceans by 2020 and beyond	2014	8
COM (2015) 614	Communication from the Commission: Closing the loop - An EU action plan for the Circular Economy	2015	614
C(2015) 6317	Opinion of the European Economic and Social Committee on the 'Communication from the Commission - Towards an integrated Strategic Energy Technology (SET) Plan: accelerating the European energy system transformation	2015	6317
COM (2016) 860	Communication from the Commission: Clean Energy For All Europeans	2016	860
COM (2019) 640	Communication from the Commission: The European Green Deal	2019	640
COM (2020) 301	Communication from the Commission: A hydrogen strategy for a climate-neutral Europe	2020	301
COM (2020) 380	Communication from the Commission: EU Biodiversity Strategy for 2030 Bringing nature back into our lives	2020	380
COM (2020) 741	Communication from the Commission: An EU Strategy to harness the potential of offshore renewable energy for a climate neutral future	2020	741
COM (2021) 240	Communication from the Commission on a new approach for a sustainable Blue Economy in the EU Transforming the EU's Blue Economy for a Sustainable Future	2021	240

European legislation and policy context (continuation)			
Document number	**Title**	**Year**	**Number**
COM (2021) 557	Proposal for a Directive amending Directive (EU) 2018/2001 of the European Parliament and of the Council, Regulation (EU) 2018/1999 of the European Parliament and of the Council and Directive 98/70/EC of the European Parliament and of the Council as regards the promotion of energy from renewable sources, and repealing Council Directive (EU) 2015/652	2021	557
Directives			
Directive 92/43/EEC	Directive on the conservation of natural habitats and of wild fauna and flora (Habitats Directive)	1992	43
Directive 2004/35/EC	Directive on environmental liability with regard to the prevention and remedying of environmental damage	2004	35
Directive 2008/56/EC	Directive establishing a framework for Community action in the field of marine environmental policy (Marine Strategy Framework Directive)	2008	56
Directive 2009/73/EC	Directive concerning common rules for the internal market in natural gas and repealing Directive 2003/55/EC	2009	73
Directive 2009/147/EC	Directive on the conservation of wild birds (Birds Directive)	2009	147
Directive 2014/89/EU	Directive establishing a framework for maritime spatial planning (MSP Directive)	2014	89
Directive (EU) 2018/2001	Directive on the promotion of the use of energy from renewable sources	2018	2001
Regulations			
Regulation (EC) 715/2009	Regulation on conditions for access to the natural gas transmission networks and repealing Regulation (EC) No 1775/2005	2009	715
Regulation (EU) 347/2013	Regulation on guidelines for trans-European energy infrastructure and repealing Decision No 1364/2006/EC and amending Regulations (EC) No 713/2009, (EC) No 714/2009 and (EC) No 715/2009	2013	347
Regulation (EU) 1119/2021	Regulation establishing the framework for achieving climate neutrality and amending Regulations (EC) No 401/2009 and (EU) 2018/1999 (the 'European Climate Law')	2021	1119

Belgian and Flemish legislation		
Dates	**Title**	**File number**
Decrees		
Decreet of 8 May 2009	Decreet houdende algemene bepalingen betreffende het energiebeleid (Energiedecreet)	2009-05-08/27
Royal Decrees		
RD of 20 December 2000	Koninklijk besluit betreffende de voorwaarden en de procedure voor de toekenning van domeinconcessies voor de bouw en de exploitatie van installaties voor de productie van elektriciteit uit water, stromen of winden, in de zeegebieden waarin België rechtsmacht kan uitoefenen overeenkomstig het internationaal zeerecht	2000-12-20/35
RD of 12 March 2002	Koninklijk besluit betreffende de nadere regels voor het leggen van kabels die in de territoriale zee of het nationaal grondgebied binnenkomen of die geplaatst of gebruikt worden in het kader van de exploratie van het continentaal plat, de exploitatie van de minerale rijkdommen en andere niet-levende rijkdommen daarvan of van de werkzaamheden van kunstmatige eilanden, installaties of inrichtingen die onder Belgische rechtsmacht vallen	2002-03-12/37
RD of 16 July 2002	Koninklijk besluit betreffende de instelling van mechanismen voor de bevordering van elektriciteit opgewekt uit hernieuwbare energiebronnen	2002-07-16/39
RD of 9 September 2003	Koninklijk besluit houdende de regels betreffende de milieu-effectenbeoordeling in toepassing van de wet van 20 januari 1999 ter bescherming van het mariene milieu in de zeegebieden onder de rechtsbevoegdheid van België	2003-09-09/30

Belgian and Flemish legislation (continuation)		
Dates	**Title**	**File number**
RD of 8 May 2014	Koninklijk besluit betreffende de voorwaarden en de procedure voor de toekenning van domeinconcessies voor de bouw en de exploitatie van installaties voor hydro-elektrische energie-opslag in de zeegebieden waarin België rechtsmacht kan uitoefenen overeenkomstig het internationaal zeerecht	2014-05-08/28
RD of 19 March 2017	Koninklijk besluit betreffende de veiligheidsmaatregelen inzake de oprichting en de exploitatie van installaties voor vervoer van gasachtige producten en andere door middel van leidingen	2017-03-19/07
RD of 22 May 2019	Koninklijk besluit tot vaststelling van het marien ruimtelijk plan voor de periode van 2020 tot 2026 in de Belgische zeegebieden	2019-05-22/23
RD of 4 February 2020	Koninklijk besluit tot instelling van veiligheidszones in de zeegebieden onder Belgische rechtsbevoegdheid	2020-02-04/12
Ministerial Decree		
MD of 19 November 2010	Besluit van de Vlaamse Regering houdende algemene bepalingen over het energiebeleid (Energiebesluit)	2010-11-19/05
Laws		
Law of 12 April 1965	Wet betreffende het vervoer van gasachtige producten en andere door middel van leidingen	1965-04-12/30
Special Law of 8 August 1980	Bijzondere wet tot hervorming der instellingen	1980-08-08/02
Law of 19 September 1991	Wet houdende goedkeuring van de overeenkomst tussen de regering van het Koninkrijk België en de regering van het Koninkrijk Noorwegen inzake het vervoer per pijpleiding van gas van het Noorse Continentaal Plat en uit andere gebieden naar het Koninkrijk België, en van wisseling van brieven inzake de uitlegging van artikel 2, §2 van deze overkomst, ondertekend te Oslo op 14 april 1988	
Law of 20 January 1999	Wet ter bescherming van het mariene milieu en ter organisatie van de mariene ruimtelijke planning in de zeegebieden onder de rechtsbevoegdheid van België	1999-01-20/33
Law of 22 April 1999	Wet betreffende de exclusieve economische zone van België in de Noordzee	1999-04-22/47
Law of 29 April 1999	Wet betreffende de organisatie van de elektriciteitsmarkt, inzonderheid op artikel 6	1999-04-29/42
Law of 26 June 2000	Wet houdende instemming met de Overeenkomst tussen de Regering van het Koninkrijk België en de Regering van het Verenigd Koninkrijk van Groot-Brittannië en Noord-Ierland inzake het vervoer van aardgas door middel van een pijpleiding tussen het Koninkrijk België en het Verenigd Koninkrijk van Groot-Brittannië en Noord-Ierland, ondertekend te Brussel op 10 december 1997	2000-06-26/57
Law of 13 May 2003	Wet houdende instemming met de Overeenkomst tussen de Regering van het Koninkrijk België en de Regering van het Koninkrijk Noorwegen inzake het leggen van de « Norfra » gaspijpleiding op het Belgische continentaal plat, en de Bijlagen 1, 2 en 3, ondertekend te Brussel op 20 december 1996	2003-05-13/40
Law of 22 April 2019	Wet tot wijziging van de wet van 29 april 1999 betreffende de organisatie van de elektriciteitsmarkt, teneinde een capaciteitsvergoedingsmechanisme in te stellen	2019-04-22/21