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Status quo report on offshore linear energy infrastructure planning in the North Sea Region

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Annex 1: Country profiles

1.1. Belgium

Status Quo

The Belgian grid is part of an interconnected system stretching from Portugal to Poland. Due to its central position in the European transmission system it has to cope with significant unscheduled physical flows (i.e. energy exchanges which are not governed by a commercial agreement between countries, but are simply due to the fact that energy moves freely through the grid without stopping at borders). Such flows are a major source of uncertainty when calculating the amount of energy that can be exchanged with neighbouring countries. Belgium has interconnectors linked with France, The Netherlands and Luxembourg.

Planning and licensing (priority areas, cable corridors)

Planning

In Belgium, the Federal Public Service (FPS) for Economy is the authority responsible for planning cables. Along with specific space allocated for energy generation i.e. offshore wind farms, space has also been designated for cables and pipelines New cables for electricity and telecommunication as well as pipelines for gas, are clustered as much as possible into 'corridors'. This way, they hinder the other activities such as sand and gravel exploitation, seabed fishing and shipping as little as possible. Areas have also been planned for future activities such as the 'plug at sea' which is a high-voltage station at sea to which cables run from several wind parks and from which cables run to the mainland. This way wind energy is landed efficiently.

Two energy atoll's have also been included in the future plan. These are doughnut shaped islands where energy is stored thanks to the level difference. When there is a surplus of (wind) energy, for example at night, this energy is used to pump sea water out of the basin. When there is too little (wind) energy, one atoll lets the basin be filled up again and the water passes through turbines, causing electricity to be generated.

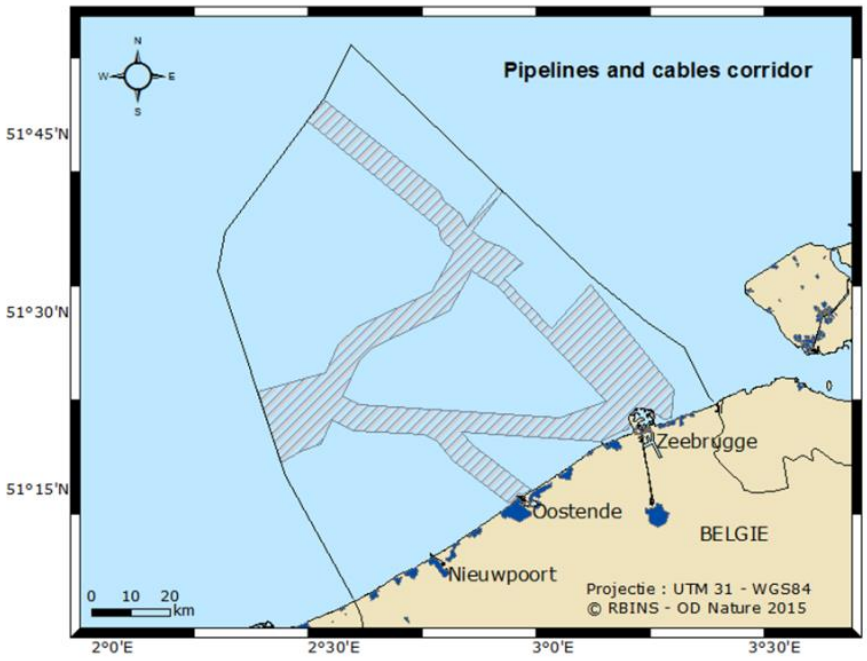


Figure 1. Pipeline and cable corridor designated in Belgian waters. Source: Marine Atlas

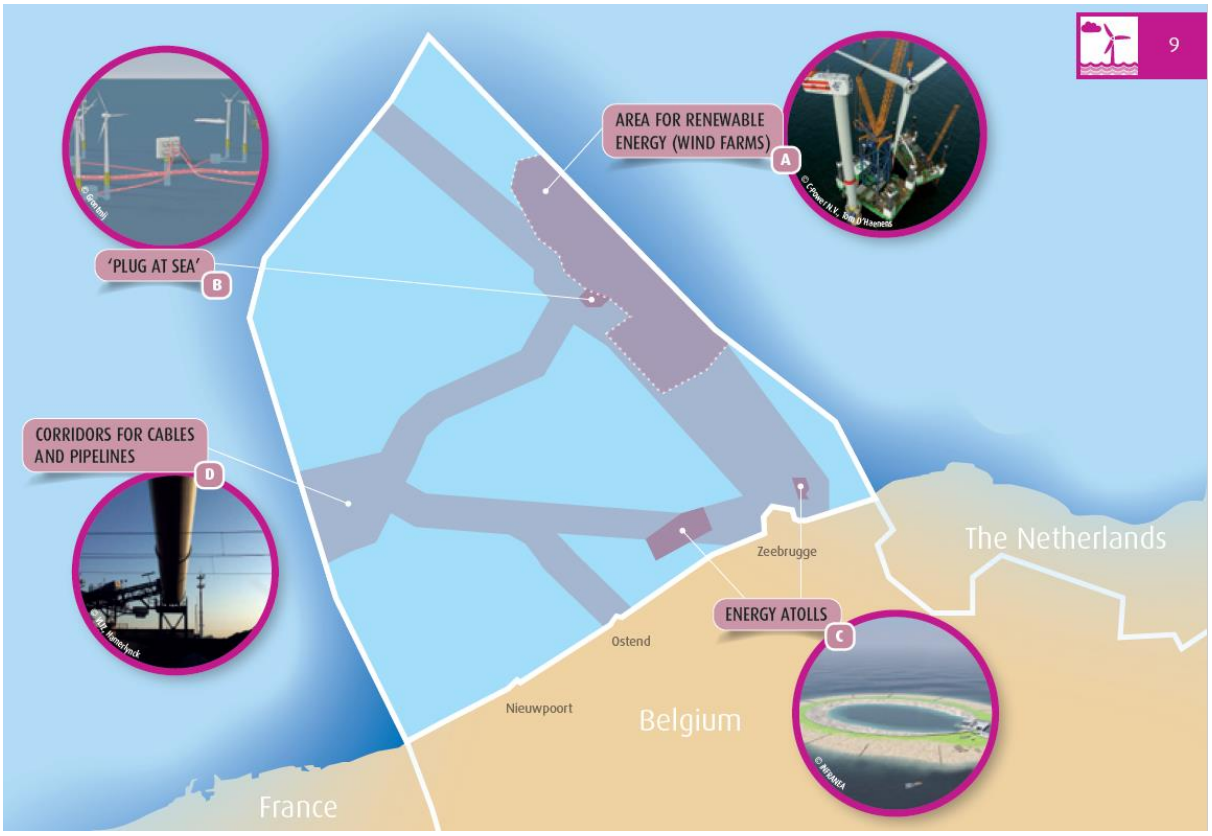


Figure 2. A marine spatial plan for the Belgian part of the North Sea: Energy, cable and pipelines map showing the locations of the pipeline and cable corridors, the energy atolls and the 'plug at sea'.

Licensing

The FPS for Economy is also the licensing authority for cables and pipelines in both the Belgium EEZ and national waters. Developers need to apply for a permit and an environmental impact analysis will be carried out on the cable/pipeline proposal.

The land/sea planning is also part of the licensing process and this is discussed with the energy provider, ELIA, who foresee the cable landing points on land.

In terms of the consultation process for cables, there is not cross border consultation process, other than the MSP consultation. It extra consultation is required, it would be on an ad-hoc basis and project specific.

Technical and spatial planning criteria

Technical

Electricity cables have to be dug in for at least one meter and four meter when passing a shipping lane.

Pipelines are buried between 70 cm and 2 meters under the seabed, and covered by a protective layer of gravel. These pipelines are only gas pipelines as there are no oil pipelines in the Belgian North Sea.

Spatial

Cables must be routed in the designated cable corridors identified in the marine plan. There has to be a minimum of 250 meters of free space on either side of the cable or pipeline.

Issues for marine planning, spatial incompatibilities and planning solutions

The main conflict for the development on cables in Belgian waters is the crossing of existing cables. There are some historic communication cables in their sea area that were laid prior to needing a permit. Due to this, any new wind farm companies are obligated to have a crossing agreement with the communication cable companies. However this has caused an issue, as these agreements are expensive to draw up so some companies refuse to sign them. The Belgian Government is currently trying to resolve this issue.

Future trends and spatial requirements

In terms of future trends in the linear infrastructure policy landscape and industry developments up to 2020, Belgium expect to see a raise in the demand for extra space for wind energy and also for grid interconnectors. They also expect more

testing to be carried out on alternative ways for extracting energy from the sea (solar, waves etc.).

From 2030 to 2050, Belgium expect there to be more development of alternative energy extraction and also the development of seaweed farming which could mean another potential conflict for space for linear energy infrastructure.

In terms of spatial requirements, Belgium have foreseen more space for wind farms in their new MSP. They have also identified space for test sites and facilities for testing new ways for energy extraction and new materials in order to accommodate new projects.

Database

The portal to the Belgian marine data and information is called Marine atlas (https://odnature.naturalsciences.be/marine-atlas/data). The portal is managed by the Belgian federal authorities through INSPIRE-compliant interfaces. Once the portal is fully updated, it will help to satisfy the international obligations from directives such as the MSFD and the MSP directive. The section on 'Energy, cables and pipelines' includes a map on pipeline and cable corridors.

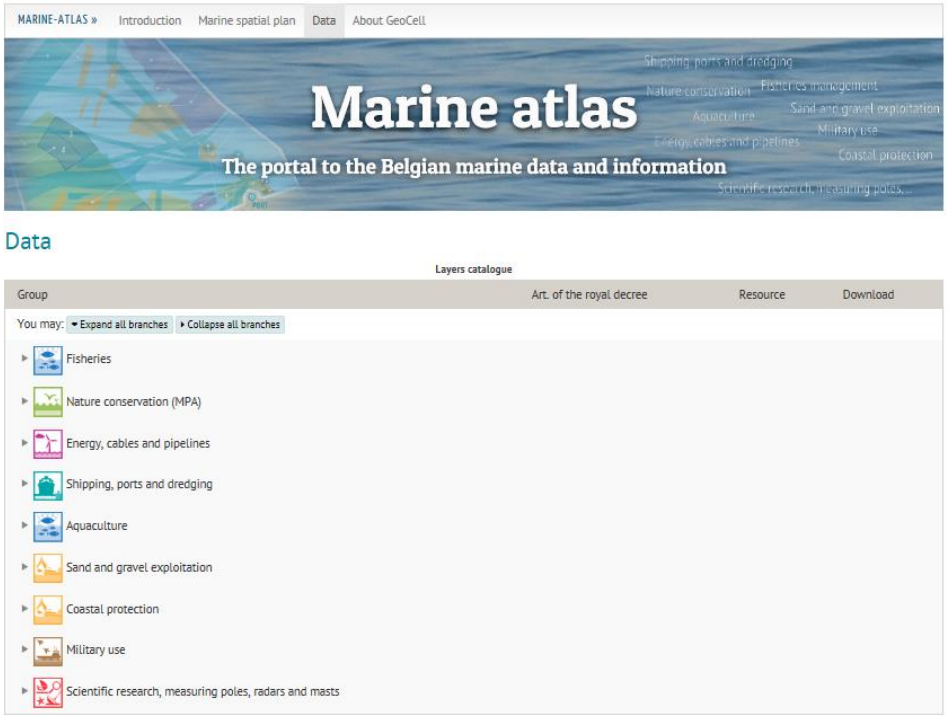


Figure 3. Belgium's portal for marine data and information, Marine atlas

1.2. Denmark

Information not provided

1.3. Germany

Status Quo

Germany has carried out a massive shift of its energy system from fossil fuels and nuclear power to renewable energy. However, the country's grid is not able to cope with the amount of renewable power Germany now generates.

In 2017, the German Offshore Network Development Plan 2017-2030 and the Spatial Offshore Grid Plan 2016/2017 were produced. In the future, the Spatial Offshore Grid Plan is to be replaced by the Site Development Plan, which will be produced by the Federal Maritime and Hydrographic Agency. The Site Development Plan meets planning stipulations for the EEZ, and can also make planning stipulations for the territorial sea. For the period from 2021 onwards, the Site Development Plan may provide offshore grid connection capacities available for areas in the EEZ and in the territorial sea on existing or in the following years still to be completed offshore grid connections, which can be allocated to pilot wind energy turbines at sea. The Offshore Network Development Plan will be merged into the Network Development Plan.

The Offshore Network Development Plan defines whether and when a grid connection for offshore wind farms must be implemented. This plan specifies the specific chronological order of implementation of the offshore wind farm grid connections for the next ten and at most 15 years. The total transmission capacity goal is 15 GW by 2030 in the North and Baltic Sea.

In accordance with Section 17a of the Federal Energy Act (EnWG) the Federal Maritime and Hydrographic Agency has set up an Spatial Offshore Grid Plan ("Bundesfachplan Offshore" - BFO) for the exclusive economic zone (EEZ) of the Federal Republic of Germany in consultation with the Federal Network Agency (BNetzA) and in coordination with the Federal Agency for Nature Conservation (BfN) and the coastal federal states. It is the goal of the Spatial Offshore Grid Plan[1] to spatially coordinate the existing grid infrastructure and grid topology, particularly in view of the offshore wind farm grid connections in the EEZ, within the parameters given, and to define them in the interests of forward-looking and coordinated overall planning**.** The plan contains cable routes for interconnectors and descriptions of possible cross connections. The goal is to increase the share of electricity generated from renewable energies in electricity consumption to**:**

- between 40 and 45 percent by 2025;
- between 55 and 60 percent by 2035; and
- at least 80 percent by the year 2050.

The gates serve as places where cross-border subsea cable systems cross the border between the German EEZ and the EEZ of the neighbouring country or territorial sea.

[1] Draft of Spatial Offshore Grid Plan for the German EEZ of the North Sea 2016/2017. Produced by BSH

For the area of the North Sea EEZ, this concerns Denmark, Great Britain and the Netherlands.

In German waters in the North Sea, there is currently one interconnector in operation, the NorNed interconnector which connects Norway to the Netherlands but passes through Germany's marine area. There are then two interconnectors currently under construction, the COBRAcable, which connects the Netherlands to Denmark and again travels through the German marine area as well as the NordLink interconnector between Germany and Norway. There are two further interconnectors, NorGer (Norway to Germany) and the VikingLink (UK to Denmark via Germany's marine area) which are planned.

There are several grid connections for offshore wind farms in the German EEZ of the North Sea with currently eight in operation (from clusters 2,3,4,5 and 6), two under construction (from clusters 2 and 8) and several others planned.

Pipelines: Norpipe, Europipe 1 and 2, Franpipe, Tyra-Nogat, Wintershall and Zeepipe.

In terms of landfall points, the cable corridors in the transnational area to the territorial sea are allocated as follows to submarine cables for the transport of power generation in the EEZ:

Border corridors I to IV (see **Figure 4** and **Figure 5**):

- routing towards Büsum (Schleswig-Holstein)
- routing towards Norderney/Hilgenriedersiel (Lower Saxony)
- Emscorridor towards Hamswehrum/ Krummhörn (Lower Saxony)
- further corridor to Lower Saxony

Border corridors V to XVII

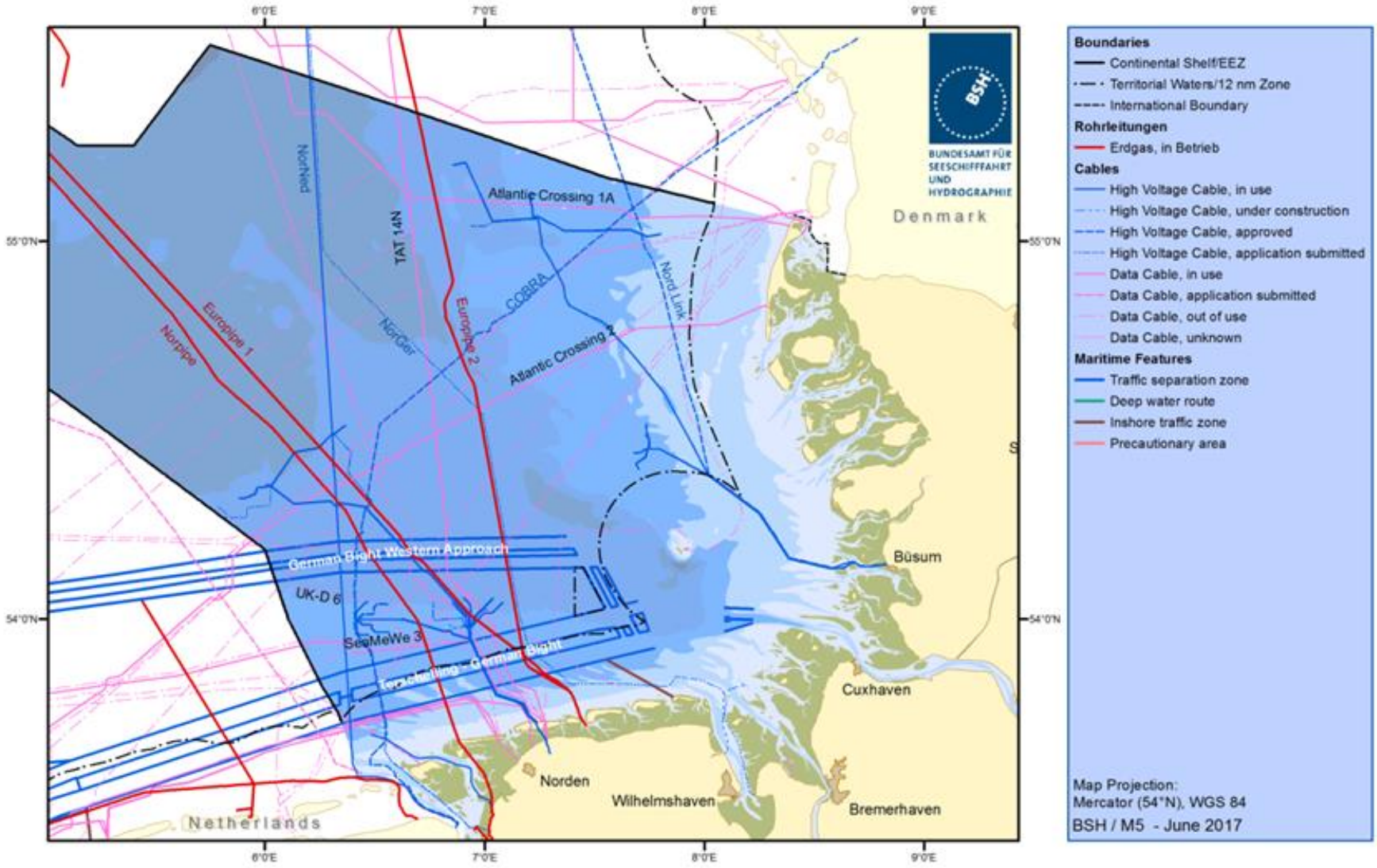


Figure 4. Subsea cable systems, Pipelines and Traffic Separation Scheme Description (BFO).

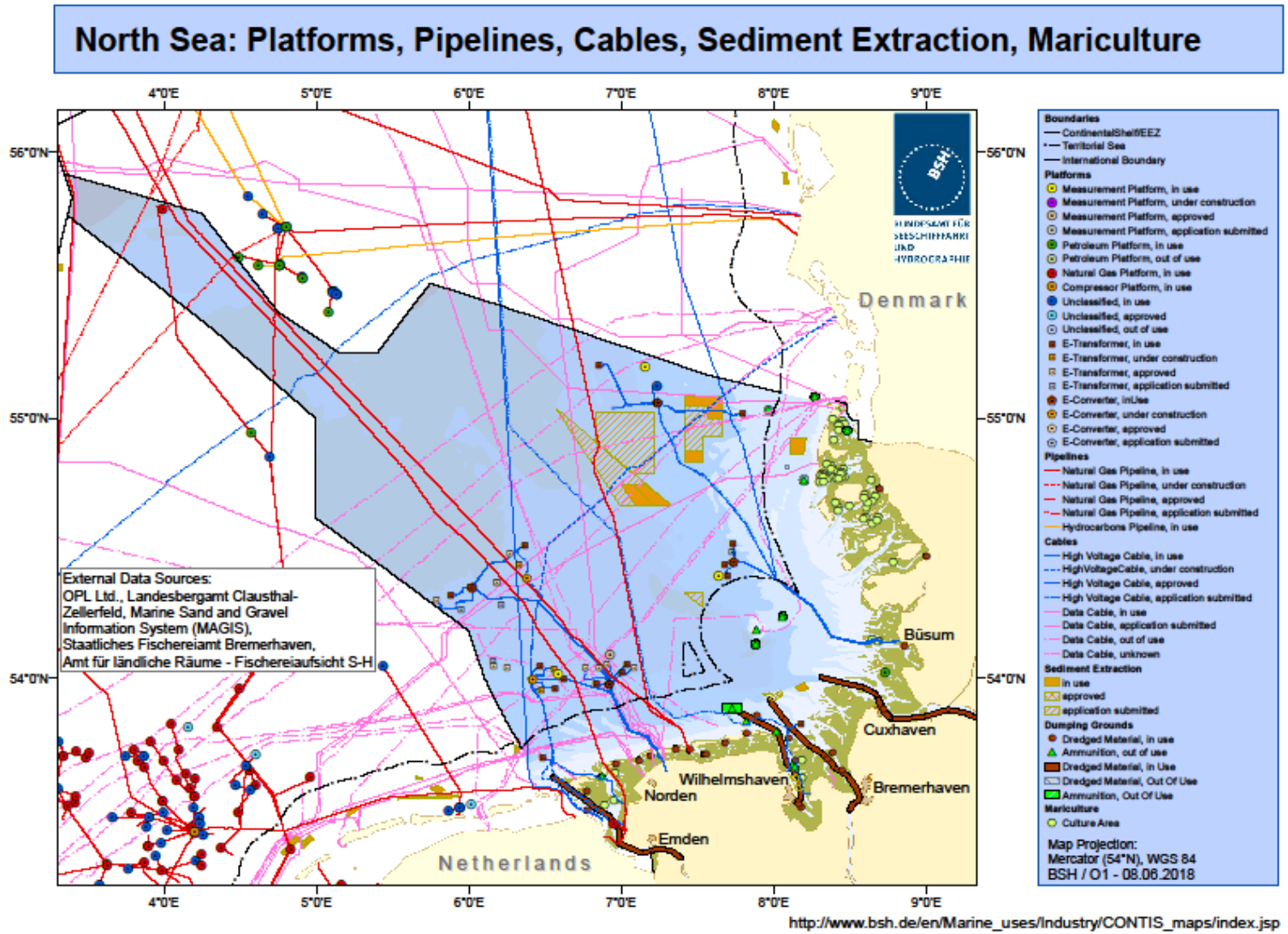


Figure 5. Platforms, pipelines, cables, sediment extraction and mariculture in the German marine area.

Energy policies and targets

In 2010, Germany adopted the Energy Concept (Government Decision), a comprehensive strategy covering both medium (2030) and long (2050) term strategies. The Renewable Energy Sources Act (EEG) formulates for offshore wind energy the targets of 6.5 GW in 2020 and 15 GW in 2030 (no split between Baltic and North Sea is made here).

The new German Government's coalition agreement has a target to reach a renewable energy amount of 65% by 2030.

On the 15th of June 2018, The Federal Network Agency (FNA) also approved a new Scenario Framework as a basis for the Network Development Plan. The Scenario Framework consists of different scenarios with the installed capacity of offshore wind energy. The different scenarios aim for between 17 GW and 20 GW of installed capacity of offshore wind energy by 2030. Therefore the scenarios deviate from the legal expansion targets.

On the planning horizon, the objectives of the Federal Government until 2020 and until 2030 is the expansion path of offshore wind energy which is regulated by an increase in the installed capacity of wind turbines at sea to 6,500 MW in 2020 and 15,000 MW in 2030. In addition to this, there are objectives set for a steady and cost-efficient expansion of wind energy at sea.

Planning and licensing

Planning

Spatial Offshore Grid Plan takes into account both the known plans of cross-border subsea cable systems as well as possible future projects.

The European transmission system operators published a Ten Year Network Development Plan. This plan contains trans-regional and international expansion measures which are significant for transboundary European energy transmission.
Planning authorities in Germany are split by the different sections of their marine area: EEZ, territorial sea and coastal regions.

For grid connections for offshore wind farms, BSH is the planning authority in the EEZ and the regional authorities responsible in the territorial sea and coastal regions.

For interconnections and pipelines, BSH are the planning authority in the EEZ, the State Authority for Mining, Energy and Geology (LBEG) in Clausthal-Zellerfeld are responsible in the EEZ and territorial sea, and then the regional authorities are responsible in the territorial sea and the coastal regions.

BSH as the authority for MSP and permitting offshore installations does plan the routes of grid connections/ interconnectors in the Spatial Offshore Grid Plan. The cable corridors and gates are an important element of their MSP as well of the Spatial Offshore Grid Plan and must be adhered to by developers. The new Site Development Plan (FEP) will also plan routes for cables.

Pipelines

Germany have designated priority and reservation areas for pipelines in their MSP. However most pipelines already existed before the spatial plan was developed and therefore they were inherited in the MSP process.

Land/sea planning process

There are different proceedings at sea and on the land but they need to be compatible in order for energy to be received into the grid. Cables that are routed to pass through the German marine area must enter via the gates in the border and then follow the designated cable corridors to land. Regional authorities are responsible in territorial sea and coastal regions and they will then liaise with authorities on land planning for grid connection.

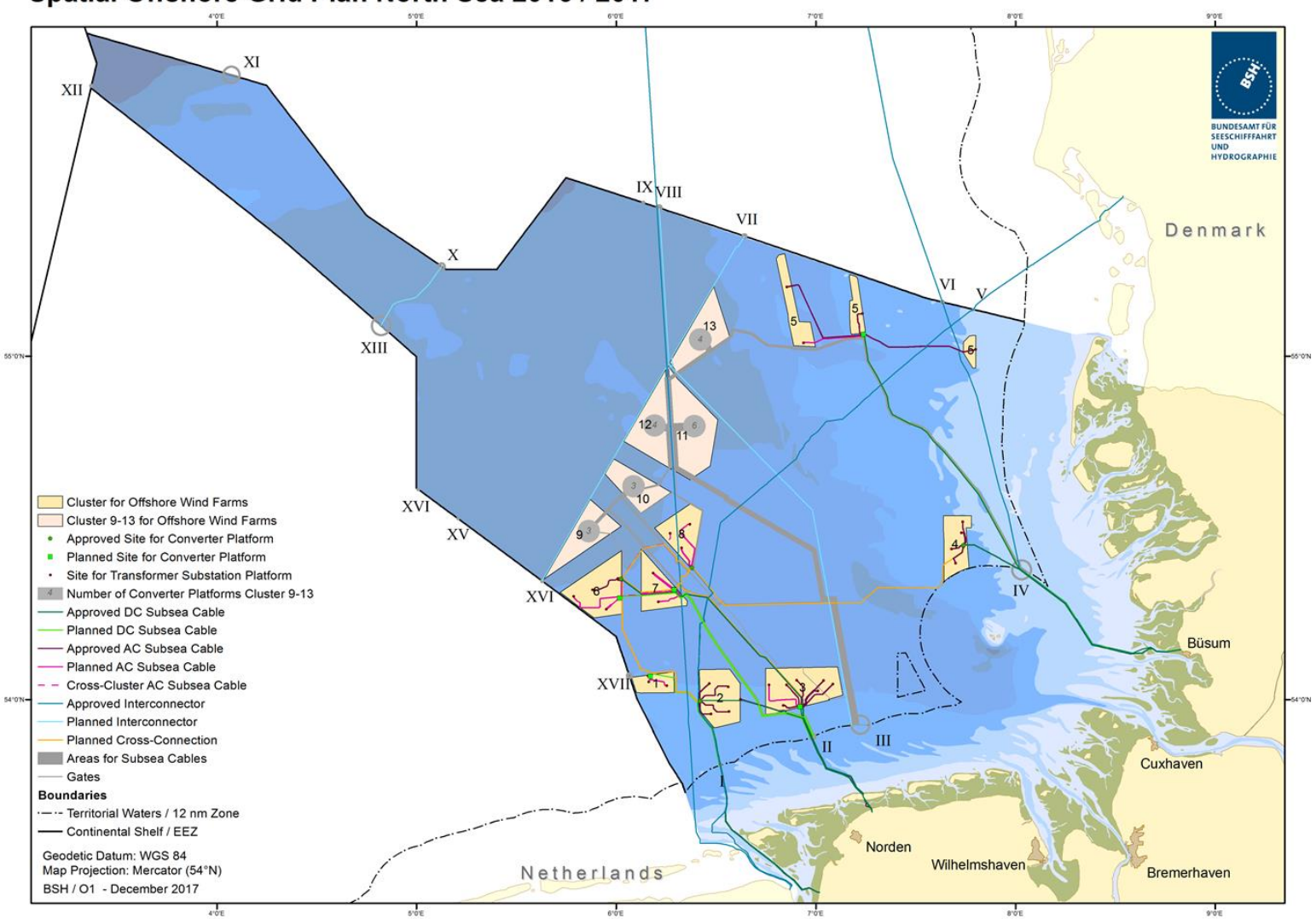


Figure 6. Germany's Spatial Offshore Grid Plan for the North Sea showing the offshore wind farm clusters and cable infrastructure that is approved and planned (2016/2017).

Licensing

a) Grid connections for offshore wind farms: WindSeeG

The licensing process for grid connections for offshore wind farms involves firstly, the project developer submitting an application. The extent, purpose and possible conflicts of the application are then reviewed and clarified. The BSH is responsible for the approval process in the German EEZ.

b) Interconnectors: BBergG

For interconnectors, the licensing process in the German EEZ consists of two approval processes according to the mining law (BBergG). The responsible authorities are the State Authority for Mining, Energy and Geology (LBEG) in Clausthal-Zellerfeld and BSH. In these approval processes, the effects of the project on other uses (especially environmental aspects) are verified.
These cross-border cables or pipelines have to follow the same restrictions or laws. In addition, they have to use the different gates to cross the border. These border corridors V to XVII are shown in map 14.

In terms of cross-border consultation for interconnectors, so far there has been no BSH-driven consultation process for an interconnector with neighbouring countries within the NSR.

Technical and spatial planning criteria

The Maritime Spatial Plan for the German North Sea EEZ has defined the targets and principles of Spatial Planning with regards to grid connections. These concern the laying, operation and removal of subsea cables. In addition, the Spatial Offshore Grid Plan contains standardised technical specifications and planning principles necessary to determine the spatial requirements for overall coordination.

Technical

In Germany there are some standardised technical specifications applied during the development of a cable project. For the North Sea, some of these include:

- Use of high voltage direct current (HVDC) technology: Voltage-sourced converter (VSC) transmission technology, standard transmission voltage +/- 320 kV, standard capacity 900 MW
- Use of three-phase high voltage alternating current (HVAC) technology for the connection of the converter platforms with transformer platforms of the offshore wind farms

Spatial

Spatial planning criteria in German waters has been set by the Government and is well established compared to other NSR countries.
The spatial criteria for both grid connections for offshore wind farms and interconnectors in the EEZ is:

- Maximum bundling of cables possible by parallel routing

- Distances in case of parallel routing: 100 m; 200 m after every second cable system
- Routing through gates I to IV (for grid connections of offshore wind farms)
- Crossing of priority and reservation areas for shipping by shortest route possible and as right-angled as possible
- Consideration of all existing and approved uses (construction with distance of 500 m, shipping routes 300 m distance)
- Avoiding of cable crossings and, if they are absolutely necessary, then crossing as right-angled as possible; distance between turning points 250 m
- Coverage/burial depth of cables is 1.5 m
- Routing as far outside of the Natura2000 areas/protected biotopes as possible
- Avoiding heating of sediment by power cables (maximal 2 K in a reference point 20 cm below seabed)
- Environmentally-friendly installation procedure
- Coordinated timing of the overall installation works
- Consideration of cultural assets and sites where munitions have been discovered
- Obligation to remove/decommission cable after they are no longer used. If the removal causes greater adverse effects than leaving them in situ, the removal must be completely or partly abandoned unless it is necessary for reasons of traffic safety and ease. If cables are left in situ, suitable monitoring measures should be arranged regarding possible future risks.

Issues for marine planning, spatial incompatibilities and planning solutions

There are several issues for grid planning in German waters which lead to spatial conflicts. The main conflict sources are offshore wind energy, shipping lines, nature conservation areas, fishing and military training areas. The main concern is the distance of cables to other activities and this is where spatial planning criteria is essential. Some areas are avoided if possible, for example fishing areas (trawling), military training areas and nature conservation, where cables are routed around these areas. However for other activities such as shipping lines and some fishing areas, cables can be buried to a minimum depth of 1.5 meters to avoid damage to the cables and snagging with bottom-contact fishing gear.

The German inshore region is already very congested with development and therefore any further planned linear infrastructure close to land will face difficulty in space allocation and ability to meet the planning criteria. In general, interconnectors crossing the German EEZ in an East to West direction and beyond the offshore energy clusters are non-critical. Export cables and interconnectors making landfall in Germany have to be channelled through the existing gates (I, II, III, and IV) and adhere to the planning criteria. It becomes increasingly difficult to accommodate additional cables & pipeline in the remaining space. The advantage of channelling linear infrastructure through gates (bundling for efficient space allocation, e.g. for crossing shipping lanes: approach to German Bight) is creating a bottleneck.

Another challenge for grid planning is finding landing points for cables due to the high geomorphology in the 12 nautical mile zone and nature conservation areas (e.g. Wadden Sea National Park) which are also close to shore. Cable routes have to be carefully planned to take the route of least constraint.

Germany has already adopted planning solutions in the form of designating cable corridors and gates. These corridors are planned to minimise impact on other marine activities and the gates are well-placed to enable international cables to transit through Germany's marine area also causing minimal impact. Another solution to efficient grid planning would be long-

term targets for offshore wind energy. Currently only short/medium-term targets have been set by Government with no real focus on the future.

Future trends and spatial requirements

To aid future grid planning, the German Government has published a Spatial Offshore Grid Plan. The expansion of wind power plants at sea and the expansion of the offshore grid connections are therefore to be coordinated with each other, taking into account the grid connection points on land, and a synchronization of the respective plans, approvals, erections and commissioning shall be achieved.

A Site Development Plan for offshore wind farms and grid connection lines as well as interconnectors will be set up in order to reach the target of 15 GW by 2030. The TYNDP is also considered in terms of planning interconnectors. A revision of the German MSP is also planned and this will take into account future grid plans.

In Germany, there is a desire for more powerful cables and development in the sector is expected to support this, however it is difficult to predict the timescales for this development. There will also be a large demand for grid interconnectors in German waters but it is difficult for BSH to plan for this, because the grid connection points will be defined at a late stage. BSH have suggested that a holistic North Sea view for planning grid interconnectors would be helpful. There might be the development of the connection concept which may result in a changed mains supply.

The energy transition in Germany from fossil fuels and nuclear energy to renewable energy sources has been a major driving force for the expansion of grid on land. Currently in Germany, most of the energy production of wind onshore and offshore takes place in the North of the country. In order to reduce the expansion of overhead power lines from the north to the south, connection points of offshore grid connections will be located further south. There is currently on-going work to determine how much infrastructure will be needed to transport the energy from the North to the South and also to ensure that it will be suitable for interconnectors by the Network Development Plan.

Space is limited in German waters and in order to use space more efficiently there is a keen ambition to reuse old infrastructure for the concept of repowering.

Databases

GeoSeaPortal, Contis WFS. Interactive map
https://www.geoseaportal.de/mapapps/?lang=en&stateId=83aa2d89-3018-403d-aa2d-893018503dff

1.4. The Netherlands

Status Quo

At present, the Netherlands has two international marine electricity connections (interconnectors), namely the cable between the Netherlands and Norway (NorNedkabel) and the cable between the Netherlands and Great Britain (BritNedkabel). At present, around 3,300 km of cabling (for communication and electricity) is in use.

In the case of existing wind farms and wind farms under construction, the wind farm operator is responsible for the connection to the national grid. Within the framework of the

Energy Agreement, it has been agreed that a grid will be created at sea wherever this is more efficient than connecting wind farms directly to the national high-voltage grid and that grid operator TenneT will be assigned responsibility for this. The Cabinet's decision on 18 June 2014 to appoint TenneT as grid operator to construct the requisite infrastructure at sea constitutes fulfilment of this agreement. This puts the grid in public hands. The same principle applies to the grid at sea as to the grid on land, namely that it is extremely important to have a reliable, affordable and renewable energy supply.

The Cabinet is fleshing out the task for TenneT as grid operator at sea in the legislative agenda STROOM, the announced revision of the Electricity Act 1998 and the Gas Act.

The starting point for the road map for the roll-out of offshore wind energy is that TenneT will create the connection by siting five standardised platforms of 700 MW, which will be connected to the national high-voltage grid using two 220kV cables. The wind farm's turbines will be connected to the platform directly. TenneT will expand on this within the framework of the offshore grid development plan.

The intended growth of the wind energy generation capacity will make demands on the grid on land. The implementation of major wind energy projects might compel TenneT to reinforce the national main transmission grid (>110 kV). The ambitiously generated wind energy capacity should ultimately be assimilated into the national high-voltage grid. The areas of Borssele and Coast of Holland will be connected to the national high-voltage grid at Borssele, Wateringen and Beverwijk. Separate spatial planning procedures will be followed to this end.

The Cabinet has commissioned TenneT to prepare interconnectors / 'plugs at sea' for the purposes of large-scale offshore wind turbine sites. Possible connection points are Borssele, Maasvlakte, Wateringen, Vijfhuizen (from 2018), Beverwijk and Eemshaven.

Since the introduction of oil and gas extraction, an extensive network of pipelines has developed in the North Sea. Gas pipelines (around 4,500 km) come ashore at Velsen, Maasvlakte, Callantsoog and Uithuizen. Oil pipelines come ashore at Hook of Holland and IJmuiden. As a result of the government's small field policy, the pipeline infrastructure is being further extended. In view of the prospects for oil and gas extraction in the North Sea, the number of pipelines may be expected to stabilise after 2020. If CO2 storage takes place at sea, then extra pipelines will be installed for that purpose.

Figure 7. Map of cables in the Netherlands marine area showing electricity cables (orange), telecom cables (green) and export cables (red). Source: North Sea Atlas

Energy policies and targets

Space for (wind) energy, oil and gas extraction and CO_2 storage, including requisite cables and pipelines, is of national interest. To promote efficient use of space in the North Sea, electricity cables, telecommunications cables and pipe-lines will be bundled to the fullest extent possible. As far as possible, decommissioned cables and pipelines will be removed, unless the benefits to society outweigh the costs to society. 'Plugs at sea' will have to ensure that the growing quantity of energy generated by wind farms is efficiently connected to the grid on land.

The Third National Structure Plan for Electricity Supply, Key Planning Decision Part 1 (SEV III, 2008) constitutes the spatial planning assessment framework for planning electricity works on land. It reserves space for large-scale production and transport of

electricity. The grid for wind energy projects at sea and the interconnectors should connect with the routes established on land in the SEV.

The Pipeline Structure Plan (Structuurschema Buisleidingen) establishes future routes for pipelines on land, which those coming in from the sea will connect to. In conjunction with the surrounding countries, further research will be carried out into an international network of renewable (wind) energy in the North Sea, connected by means of high-voltage cables. This research has been included as an action for the 2016-2021 planning period (see section 7.2).

Planning and licensing

Planning

The planning authority for cables and interconnectors is the Ministry of Infrastructure and Water Management (Rijkswaterstaat) and the planning authority for pipelines which are connected to a platform is the Ministry of Economic Affairs and Climate Change/State supervision of mines.

In terms of planning cable routes, the only priority routes are based around sand extraction areas as this is an important industry in The Netherlands. The integrated maritime spatial policy map shows preferred routes for cables and pipelines through sand extraction reserve areas. Also, for initiatives that take up a considerable area, the Central Government can prescribe a spatial reservation for future cables and pipelines.

TenneT has been asked to develop a plan to bundle offshore wind farm connections by means of standardised platforms instead of having a connection for each wind farm. Existing cables and pipelines will not be bundled due to the high costs associated with moving them.

In conjunction with the surrounding countries, further work will be done on creating an international network (grid) of sustainable (wind) energy in the North Sea for the long term. The plan includes a high-voltage cable between the Netherlands and Denmark (COBRA cable) at some point, there may be a second BritNet cable. It is also known that Belgium would like a connection with Norway, part of which will run over the Dutch continental shelf. Germany has designated specific locations in their part of the North Sea as proposed sites for grid connections at sea.

Licensing

The procedure for planning and licensing cables/pipelines within EEZ and national waters and cross border is the same. In general the procedure is as follows:

- Preliminary consultation;
- Request/application;
- Consultation/public participation (6 weeks);
- Permit (8 weeks);
- Appeal (6 weeks).

In terms of a consultation process for cross-border cables and pipelines, there is no standard procedure. However both countries planning authorities will work together to determine the best cable or pipeline route.

In the case of cables/pipelines in national waters/EEZ, consultation takes place when significant effects can be expected. This is part of ESPOO agreement.

Technical and spatial planning criteria

Technical

Cables and pipelines should be buried at a sufficient depth to ensure safe fishing and navigation. Burial depth of export cables should be 3 meters in the coastal zone and 1 meter outside the coastal zone.

Array cable protection measures include a burial depth of 1 meter or 1.5 meters depending on risks.

Spatial

- Ensure efficient use of space and cables and pipelines should obstruct other users as little as possible.

Cables and pipelines must be installed in such a way that they do not endanger or impede shipping and fishing.

New cables and pipelines are forbidden in anchoring locations.

Maintenance zone of 500 meters around cables and pipelines in the North Sea, and sand may not be extracted within this zone. Research has shown that in principle, when building wind farms, a 500-meters zone should be adhered to for pipelines and electricity cables and a 750-meter zone for telecommunications cables. With a view to efficient use of space, maintenance zones for cables and pipelines can be reduced where possible.

- Effort should be made to bundle cables and pipelines in consultation with the developer where possible.
- During the planning process for laying new cables and pipelines, efforts should be made to have routes run in parallel.
- Cables and pipelines should cross waterways in the shortest and straightest possible way.
- Preferred routes for passing through sand extraction zones should be considered based on the availability of extractable sand and selected where sand extraction is depleted or less attractive.
- Decommissioned cables and pipelines should be removed - this is particularly important for sand extraction, where cables and pipelines can pass through the relatively inexpensive sand reserves along the coast.

Issues for marine planning, spatial incompatibilities and planning solutions

All cables and pipelines together constitute a significant limitation of the available space for wind energy, sand extraction and anchoring locations.

There are large sand reserves along the coast of the Netherlands and sand extraction is an important marine industry. The sand reserves are largely situated close to shore which is beneficial for the industry in terms of short transportation distance and cheaper costs. However sand is not allowed to be extracted where there are cables and pipelines located and conflict arises when cables are routed through these areas to connect to the grid. It is therefore essential during the planning process for laying new cables and pipelines that efforts are made to avoid important sand extraction areas. There should also be consideration of grid connection points on land during planning. Routing cables and pipelines through some sand extraction areas is possible if they are depleted or less attractive.

Another conflict for grid planning is shipping. Ships are not allowed to anchor on locations where there are cables and pipelines as this could damage the cable. Shipping lines should be considered in grid planning and avoided if possible. Although a planning solution is to include new cables in shipping charts as quickly as possible so that shipping traffic are aware of the cable locations.

In the case of conflict the Cabinet will give priority to activities that are of national interest. These activities are:

- Oil and gas extraction: as much natural gas and petroleum as possible is being extracted from Dutch fields in the North Sea, ensuring that the most is made of the potential of natural gas and petroleum supplies.
- CO2 storage: sufficient space for storing CO2 in depleted oil and gas fields or in underground aquifers).
- Shipping: a whole system of traffic separation schemes, clearways and anchoring areas that can accommodate shipping safely and swiftly.
- Sand extraction: sufficient space for sand extraction for coastal protection, countering flood risks and sand for use on land.
- Generating renewable energy: sufficient areas for wind energy and other forms of renewable energy.
- Defence: sufficient military exercise zones in the North Sea.

With the aid of the assessment framework, the Central Government will evaluate permissions for sea-based activities.

Future trends and spatial requirements

The main future trends in the linear infrastructure policy landscape and industry developments that are expected in the Netherlands from 2020 to 2050 include:

- Increase in electricity cables and connection to shore due to increase in offshore wind energy development;
- Increase in telecom cables, and old cables might also be replaced by new ones;
- CO2 pipelines at sea for CCS in platforms; and
- Maybe in the long term also hydrogen pipelines from offshore wind farms.

With the opening up of the European electricity market, demand for interconnectors is on the rise, as is demand for connecting offshore (wind) energy farms with one another by means of a North Sea grid. In conjunction with the surrounding countries, further work will be done on creating an international network (grid) of sustainable (wind) energy in the North Sea for the long term. The plan includes a high-voltage cable between the Netherlands and Denmark, the COBRA cable, which will have a capacity of 700 MW and will be commissioned in early 2019. At some point, there may also be a second BritNet cable. It is also known that Belgium would like a connection with Norway, part of which will run over the Dutch continental shelf. Germany has designated specific locations in their part of the North Sea as proposed sites for grid connections at sea. Despite these additional interconnections, the Netherlands believe that the existing infrastructure will efficiently meet expected demand for communication connections and transport of gas, oil and electricity.

The Netherlands are also building more offshore wind farms which creates an additional need for electricity cables between the wind farms and the Dutch coast. The Cabinet has commissioned TenneT to prepare interconnectors / 'plugs at sea' for the purposes of large-scale offshore wind turbine sites. Possible connection points are Borssele, Maasvlakte, Wateringen, Vijfhuizen (from 2018), Beverwijk and Eemshaven. Also with the increase in electricity cables, the task is to continue making efficient use of space by means of bundling (partly in response to increasing demand for sand extraction) and a more detailed removal obligation.

Since the introduction of oil and gas extraction, an extensive network of pipelines has developed in the North Sea. Gas pipelines (around 4,500 km) come ashore at Velsen, Maasvlakte, Callantsoog and Uithuizen. Oil pipelines come ashore at Hook of Holland and IJmuiden. As a result of the government's small field policy, the pipeline infrastructure is being further extended. In view of the prospects for oil and gas extraction in the North Sea, the number of pipelines may be expected to stabilise after 2020. If CO_2 storage takes place at sea, then extra pipelines will be installed for that purpose.

Decommissioning

Under the water permit, there is a removal obligation for decommissioned cables and pipelines. A removal obligation for telecommunications cables within territorial waters applies under Section 5.2.8 of the Telecommunications Act (Telecommunicatiewet). The Mining Act stipulates that the Minister is entitled to issue an order for removal. Removal is desirable as old cables and pipelines can impede other uses of the seabed, such as sand extraction or installation of wind turbines.

Based on the assessment of the social costs and benefits, the environmental effects and safety aspects of leaving cables or pipelines in place versus removing them, pipelines are often left in place, whereas more recently decommissioned telecommunications cables are usually removed in practice. At present, there are around 268 km of abandoned pipelines and in excess of 3,000 km of abandoned cables on the North Sea bed.

Decommissioned pipelines that are not removed have to be cleaned by the owner and annually inspected (monitoring obligation).

Information on cables and pipelines in the Netherlands marine area can be found in the North Sea portal www.noordzeeloket.nl

1.5. Norway

Status Quo

The Norwegian power market is dominated by hydro power (approximately 96%) (NVE, 2016). A large proportion of the hydro capacity is associated with reservoirs, providing flexibility by being able to store energy until it is required. This large degree of flexible production enables suppliers to quickly and cheaply follow the demand, both in the short (minute-hourly) and medium (seasonal) terms. However, reservoir capacity is finite, meaning that reservoir levels, hydro generation and its flexibility, are strongly influenced by rainfall. Currently, Norway is typically a net exporter of electricity. In the future, the surplus of electrical energy in Norway is predicted to become even higher. In cases of an extremely dry year, or in long winters, Norway may need to import electricity.

The Norwegian power system is well connected with the other Scandinavian/Nordic power systems, both physically and as a single trading market. From this connectivity, the Norwegian grid can access northern European grids and markets. The neighbouring countries have a considerably lower share of hydropower and, therefore, are less flexible. Extensive renewables projects, which will provide a power surplus, are planned for the future in Scandinavian countries.

Norway has an open electricity market, integrated with the other Nordic countries. Export and import is routine over the direct power links to Sweden, Denmark and the Netherlands. The market is handled by NASDAQ OMX Commodities Europe and Nord Pool Spot.

There are currently two projects under construction; a 1400 MW interconnector between Norway and Germany and a 1400 MW interconnector between Norway and the UK. There is one planned project called NorthConnect which is an interconnector between Norway and Scotland.

Planning and licensing

Statnett, the Norwegian TSO, is responsible for grid planning in Norway. The Norwegian Water Resources and Energy Directorate (NVE) handles the applications and The Ministry of Petroleum and Energy (OED) is the licensing authority.

Licensing

The procedures for projects within EEZ and cross borders projects are similar. The Energy Act (Energiloven) - encompasses permits for building and operating all electrical infrastructure above 1 kV and higher, with regulatory authorities on national level for onshore

projects, including the Norwegian baseline. The Norwegian water and energy directorate (NVE) handles all applications for new overhead power lines, cables and substations. Structures, including buildings, related to energy production/transmission are exempt from the Planning and building act to avoid two authorities approving the same application. NVE is also responsible for securing that the requirements in the Nature Diversity Act (Management of Biological, Geological and Landscape Diversity) are followed as part of the licensing process according to the Energy Act.

Cross border cables also need a trading licence in addition to the construction and operation license. The planning and procedures for these to permits are coordinated by NVE. NVE gives an advice to The Ministry of Petroleum and Energy, who is the licensing authority for interconnectors.

The energy law require public hearing and cooperation to ensure regional and local participation. NVE (national authority) is responsible for the procedures and grants the license. Local and regional authorities must send their comments to NVE. After the applicant sends the application to NVE, NVE is responsible for the public hearing. If new areas of interest are affected, NVE will decide to have an open meeting for the public, the landowners and neighbors.

A substation in itself does not require a notification to announce a coming application. If the substation is part of a larger high-tension-line project, the rules for environmental impact assessment may apply. If the substation is part of a notification project, there are rules for at least two public hearings instead of the usual one.

The applicant comments all hearing statements before the authorities make their decision.

Power cables outside the baseline (within the EEZ) also need a permit according to the offshore energy act.

Technical and spatial planning criteria

There is a large focus on environmental issues in the licensing process for cables and pipelines. Aspects such as visual impact, biodiversity and land use are considered when planning. The socioeconomic benefits of all projects are also taken into consideration in the planning process, as well as the reliability of energy supply.

Issues for marine planning, spatial incompatibilities and planning solutions

The main conflict for grid planning in Norway's marine area is the abundance of other infrastructure at sea which restricts space and creates obstacles for development.

Some substations are located close to shore and therefore visibility is an issue for some local people.

Conflicts tend to be resolved during the planning and licensing process or by mitigating measures in the licence.

Future trends and spatial requirements

None identified

Decommissioning

None

Database

Most cable spatial data is held by local energy companies such as Statnett and NVE, however a database is also currently being created called NVE Atlas.

1.6. Sweden

Status Quo

The main cables are interconnectors to and from Sweden and within Sweden (Gotland, several cables). The international interconnectors relevant for MSP go to Denmark, Germany, Finland, Åland, Poland, and Lithuania. There are a few planned ones as well, i.e. an additional connector to Germany. The cable tracks and landfall points are inaccurate in the HELCOM layer, but possibly sufficient for the exercise. The Swedish TSO Svenska Kraftnät is the responsible authority for HV cables. There are power cables connecting the islands which can either be subsea or air cables.

The main pipeline is Nordstream 1 passing the Swedish EEZ and Nordstream 2 under construction. The pipelines have their landfall in Russia and Germany but are crossing the Swedish EEZ. Despite that there are several water pipelines, which are not collected centrally but by each municipality.

Energy policies and targets

Sweden are following the EU plans for interconnectivity and the Baltic Energy Market Interconnection Plan. National plans exist (Svenska Kraftnäts Systemutvecklingsplan 2018-2027) as well on how to implement and adjust to changes in consumption, production and volumes of electricity and with further electrification of the energy sector. No specific national targets for cables and pipelines.

Planning and licensing

HV power cables as part of Sweden's national grid which is operated by the Swedish TSO (Svenska Kraftnät), Transmission licenses are to be approved (but not centrally planned) by the Swedish Energy Markets Inspectorate for securing market competition. The planning authority for large petroleum pipeline projects is the Ministry of Enterprise and Innovation and for smaller projects, like in port terminals, the municipalities are the competent authority.

Cables are owned by the wind farm owner (more exact they are usually owned by a subsidiary of the wind farm owner as electricity production and transmission must be

separated). There is often the need to apply for two main permits, one related to the operation (such as net concession for power and telecommunication cables) and one for the physical changes due to the laying of cables, including environment and concurring business or operation. (miljötillstånd som nätkoncession) Applications for the environmental permit are handled by the county governments.

Typically, the TSO or DSO designates a connection point on land. To and from there, the various projects need to design the most suitable rooting, both onshore and in the water and apply for consenting for the route. There is also the need for environmental permit.

There are currently no defined planning/priority areas for cables and pipelines in Sweden's MSP but data exists in the plans background information to use in planning.

Technical and spatial planning criteria

Sweden is currently in the process of developing their first MSP and therefore they have not yet established technical or spatial planning criteria.

Issues for marine planning, spatial incompatibilities and planning solutions

Bottom-trawling fishing is a main conflict for grid planning where cables might get pulled or severed. There are the data layers from HELCOM that show the cables and pipelines in the Swedish EEZ. However, many of the cables have been moved by trawlers and anchors over time, so the maps are likely not reliable.

Future trends and spatial requirements

Further development of grid and increased interconnectivity are expected future energy trends in Sweden, along with the desire for smarter grids. However, this will require the need to renew some of the current infrastructure to ensure that it will suitable for future needs and demands. In terms of transportation of energy to shore, there are currently grid connection points close to nuclear power plants and these will become available when those power plants are closed down around 2040. Energy storage is also another focus of the Swedish Government.

Decommissioning

None

Database

None identified

1.7. UK - Scotland

Status Quo

Within the UK, the National Electricity Transmission System is operated by National Grid Electricity Transmission plc (NGET), who have responsibility for operating a transmission system which provides people with a safe and reliable energy supply. Generated electricity is fed into the transmission system and distributed around the UK as required. Currently, electricity cannot be stored efficiently in large quantities and so it is substantially only generated when required.

The Scottish transmission system is owned by Scottish Power Energy Networks (SPEN) and Scottish and Southern Energy Networks (SSEN). Any generators/suppliers requiring grid connections in Scotland do so under a regulated agreement with NGET, who work in collaboration with SPEN or SSEN.

The UK power system consists of a mix of different electricity sources. At present, thermal production capacity (burning fossil fuels primarily gas with some coal) and nuclear generation dominates. Wind power, solar power, hydro and bioenergy production are currently the main alternative sources of energy. Their proportion of the electricity mix has grown rapidly over the last 10 years and continues to increase (Ofgem, 2018).

In Scotland, there has been a dramatic increase over the last decade in the amount of renewable energy development and connection requirements to the electricity transmission system (Scottish Government, 2017a). This has resulted in planned and on-going large-scale improvements to the grid infrastructure, to expand upon the system's electricity transmission capacity. These improvements have included the strengthening of the existing transmission infrastructure (e.g. Dounreay to Beauly) and installation of new sections of overhead line and underground cabling (e.g. Beauly to Denny). In addition, subsea cables are required to strengthen the system including the Western Subsea HVDC project (linking Scotland to England), Caithness-Moray HVDC, Kintyre-Hunterston HVAC and links from the Western Isles, Orkney and Shetland to the UK mainland grid.

With changes in generation to more renewable sources, and the consequential change in the location of generation capacity to areas with good renewable resources, major network changes are required.

Electrical interconnection with other nations contributes to the UKs energy security, affordability and decarbonisation objectives. The UK electricity market currently has 4GW of interconnector capacity via 4 interconnectors:

- 2GW to France (IFA)
- 1GW to the Netherlands (BritNed)
- 500MW to Northern Ireland (Moyle)
- 500MW to the Republic of Ireland (East West)

In addition to current interconnectors, agreements have been made for a 1400MW interconnector to Norway and a 1000MW interconnector to Belgium. In terms of interconnectors in Scotland, these are displayed in Figure 8, where most serve as electrical connections between the numerous Scottish islands and the mainland. Scotland's main transnational interconnector, is the NorthConnect interconnector to Norway which is currently at concept/early planning stage. The cable will have a capacity of 1,400 MW and

will be approximately 655km in length. This transnational electricity link is intended to facilitate the trading of energy with Norway, UK, and continental Europe. The project aims to link hydro power from Norway with wind energy from Scotland and the cable is expected to be fully commissioned and operational by the end of 2022. The NorthConnect scheme was designated as a “Project of Common Interest” or PCI in 2013, within the legal framework of the European Union and Economic Area, of which Norway is also a signatory state. This indicates that NorthConnect is regarded as an important project for achieving Europe’s energy market and climate change targets.

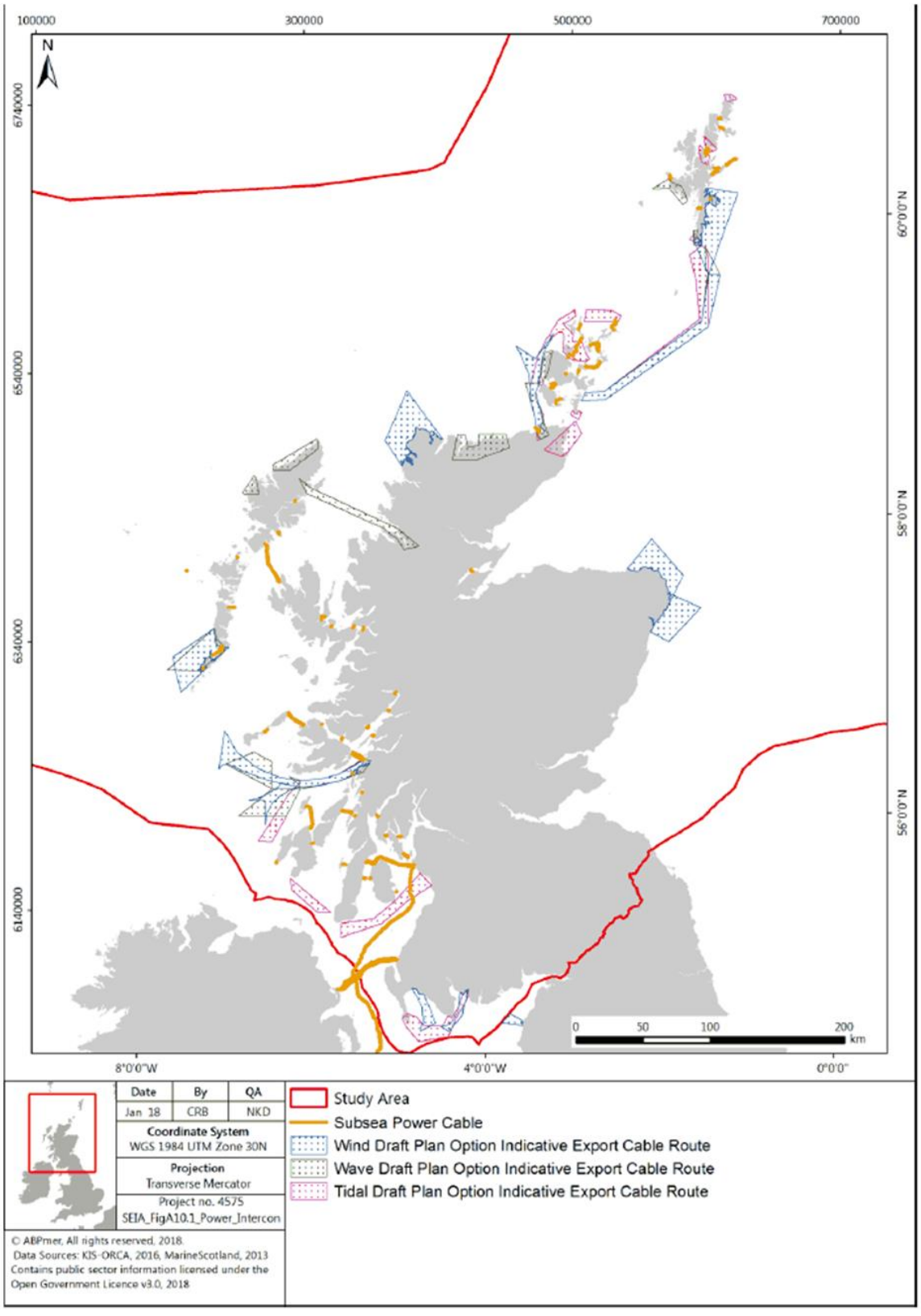
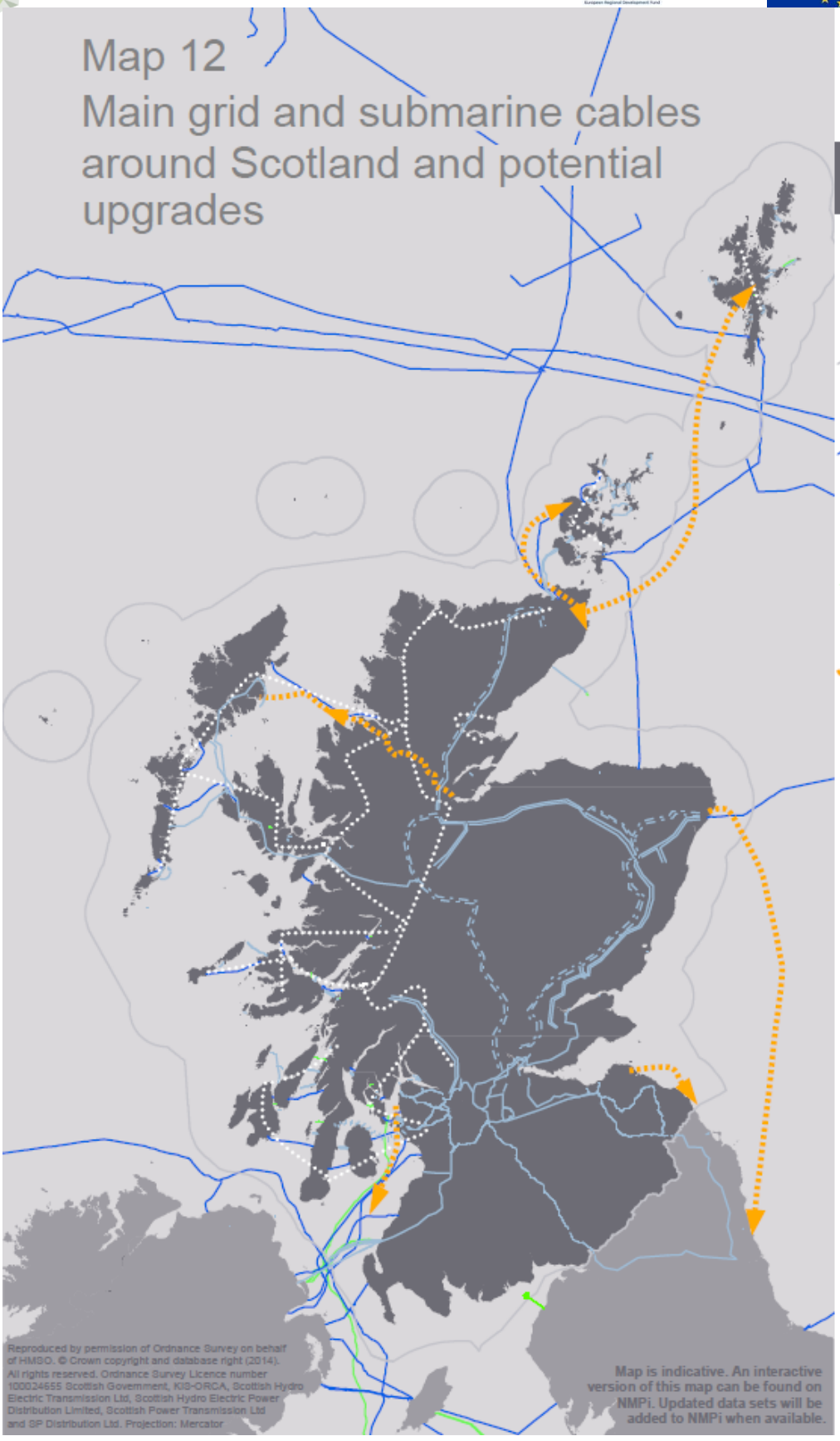


Figure 8. Power Interconnectors in Scotland

Map 12

Main grid and submarine cables around Scotland and potential upgrades



Detail Key

Submarine Cables

Key:

- 12 Nautical Miles
- Existing or Proposed Submarine Telecom Cables
- Existing or Proposed Submarine Power Cables
- Potential HVDC Link
- Grid Infrastructure (>132kV)
- Grid Upgrade
- A Digital Fibre Network

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Map is indicative. An interactive version of this map can be found on NMPi. Updated data sets will be added to NMPi when available.

Energy policies and targets

The European Union (EU) has set the target that 20% of Europe's energy requirements will be met by renewable sources by 2020 in the European Parliament Directive 2009/28/EC (European Parliament, 2009). The Scottish Government aims to exceed this target by achieving 100% of the demand within Scotland (gross consumption) for electricity being met from renewable sources by 2020 (Scottish Government, 2016). The Scottish Government set an interim target of 50% by 2015, which was achieved and hence Scotland is on track to meet the 2020 target. Further to this, Scotland continues to be a net exporter of electricity, exporting 29% of generation to other parts of the UK in 2016 (Scottish Government, 2017a). The Scottish Government updated its energy strategy at the end of 2017 (Scottish Government, 2017c). The Scottish Energy Strategy set two new targets for the Scottish energy system to achieve by 2030:

- The equivalent of 50% of the energy for Scotland's heat, transport and electricity consumption to be supplied from renewable sources; and
- An increase by 30% in the productivity of energy use across the Scottish economy.

The 2017 Scottish Energy Strategy also lays out a vision for 2050, which includes six priorities, one of which is renewable and low carbon solutions in which the Scottish Government stated their intention to continue to champion Scotland's huge renewable energy resource (Scottish Government, 2017c). Another priority is System Security and Flexibility, which highlights the requirement for Scotland's energy capacity to be flexible and resilient to maintain secure and reliable supplies of energy. Scotland's energy security can be enhanced while maintaining its ability to export and import energy through the interconnection between power markets and networks using interconnectors.

The 2012 Electricity Networks Strategy Group (ENSG) Report (ENSG, 2012) sets out a view of how the UK electricity transmission system needs to be reinforced to help meet these renewables targets for 2020. The electricity generation portfolio will move from the traditionally more predictable energy generation provided by coal / gas fired power stations and hydro, towards an increasing proportion from renewable sources. Consequently, the predictability in generation capacity will reduce. Investment in greater renewable capacity will therefore lead to a rise in demand for reserve generation capacity to supply the grid during periods when windfarms cannot meet demand.

The Scottish Government published the Electricity Generation Policy Statement (EGPS) 2013 (Scottish Government, 2013). This examines the way in which Scotland generates electricity, considers the changes which will be necessary to meet the targets which the Scottish Government has established, and reflects both views from industry and other stakeholders regarding developments in UK and EU electricity policy. It looks at the sources from which that electricity is produced, the amount of electricity which is utilised in Scotland and the technological and infrastructural advances and requirements which Scotland will require over the coming decade and beyond. The EGPS states:

"Scotland's renewables potential is such that, should the relevant technologies be developed successfully, it could deliver up to £46bn of investment and be much more than enough to meet domestic demand for electricity. The remainder could be exported to the

rest of the UK and continental Europe to assist other countries in meeting their binding renewable electricity targets". (Scottish Government, 2013).

Significant new investment will be needed both in electricity generation capacity and in the associated transmission infrastructure to facilitate the renewable goals. The transmission infrastructure will need to be improved to both deliver electricity across Scotland and to access the other markets which offer electricity generated from renewable sources.

The Scottish Government has designated energy efficiency as a National Infrastructure Priority, the cornerstone of which will be Scotland's Energy Efficiency Programme – a 15 to 20 year programme.

EU target of 10% of installed production capacity by 2020 as well as an aspiration of 15% interconnection capacity between member states by 2030. The UK currently has 5% interconnectivity and despite new interconnectors to Norway and Belgium, it seems unlikely to reach the 10% target by 2020. Being an island the UK faces greater challenges when compared to other EU member states since all interconnections would have to be established via submarine cables. Despite that, the target is clear and more connections will be needed if it is to be achieved.

Planning and licensing

Planning - Electricity cables

The planning authority for cables in Scottish waters is Marine Scotland. The planning of cables is considered within Scotland's National Marine Plan (NMP) and planning advice and guidance is captured within the plan's policies and objectives. For example, the NMP includes an objective to support the generation, distribution and optimisation of electricity from traditional and renewable sources to Scotland, UK and beyond. Other marine planning policies also include:

- cable and network owners should engage with decision makers at the early planning stage to notify of any intention to lay, repair or replace cables before routes are selected and agreed
- new cables should implement methods to minimise impacts on… other users
- cables should be buried… to reduce conflicts with other marine users
- a risk-based approach should be applied by network owners and decision makers to the removal of redundant submarine cables…
- when selecting locations for land-fall of power and telecommunications equipment and cabling, developers and decision makers should consider policies pertaining to flooding and coastal protection

Planning policies also exist for regional marine plans where it states that they should consider identifying suitable areas for land fall of submarine cables and integrate with spatial priorities for submarine cables within Local Development Plans.

There are indicative export cable routes for offshore wind, wave and tidal energy developments identified in Scotland's NMP but cable routes are largely proposed by

developers for Marine Scotland's review and the NMP is considered during the licensing process.

Licensing

Submarine renewable power cables are subject to licensing controls anywhere within 0-200 nautical miles. International power interconnectors and international telecommunication cables are also subject to licensing controls. Under the Gas Act 1986 and the Electricity Act 1989 certain activities concerning gas and electricity may only be carried out with a licence (or under a relevant exemption or exception). The Gas and Electricity Market Authority, Ofgem, determine the content of gas and electricity licences and grant licenses to successful applicants. For example, an electricity interconnector licence authorises a developer to operate an electricity interconnector but it is not an authorisation to construct the interconnector. Electricity licenses are assessed in accordance with published criteria and the licence contains conditions in relation to complying with industry codes and standards and terms for connection and access to energy networks. Electricity licenses include distribution, generation, interconnector, supply and transmission. In the case of interconnector licence conditions, there is a mechanism to facilitate regional cooperation.

The Marine Scotland Licensing Operations Team ("MS-LOT") on behalf of the Scottish Ministers, are the competent authority and one-stop shop for marine licensing of cables. The Terrestrial and Marine planning and licensing process is as follows:

1. Application submitted for converter station and cabling to substation
2. Approval of plans for converter and underground cabling
3. Application to Gas and Electricity Markets Authority for an electricity interconnector licence (application process takes 45 working days)
4. Electricity interconnector licence granted by Ofgem
5. Project granted eligibility to progress to the Initial Project Assessment (IPA)
6. Planning and site investigation – marine surveys of UK near shore
7. Planning – consent application submitted – sea-based part of the project
8. Developer proposes cable route to Marine Scotland for review and consideration
9. Developer undertakes an EIA and submits a scoping opinion and report
10. The developer seeks a licence from The Crown Estate - Under The Crown Estate Act 1961, The Crown Estate permission, in the form of a site lease/licence, is required for the placement of structures or cables on the seabed; this includes, power cables, telecommunications cables and offshore renewable energy installations including their ancillary cables (limited to within territorial waters for telecommunications and power cables). The Crown Estates rights to licence renewable energy generation on the UK continental shelf means their permission is needed for the full length of electricity cables (export cables) connecting offshore wind farms to shore and these rights are granted to either the associated wind farm developer or a dedicated Offshore Transmission Asset Owner (OFTO). TCE carry out a conflict check to highlight any potential conflict with other seabed users that may be impacted by the proposal.
11. New applicants are required to obtain crossing and proximity agreements from existing tenants in close proximity to the works and works restriction zone.
12. Construction and deposit marine licence from Marine Scotland - submarine renewable power cables are subject to licensing controls anywhere within 0-200

nautical miles. International power interconnectors and international telecommunications cables are also subject to licensing controls.

13. Cable installation - Developers are able to micro-site within the proposed cable route to account for physical, biological and geological constraints such as seabed type, depth and protected marine habitats. They are asked to provide as-built co-ordinates and a shapefile and then post build co-ordinate and shapefiles so that the location of the cable is accurate on the charts.
14. Operation/fully commissioned – grid connection agreement
15. Typical licence period is 20 years for a submarine cable

Licences differ between England and Scotland. Multiple licences are needed for systems transiting different jurisdictions.

In the event of cable crossing, there is a procedure to determine a cable crossing agreement. This procedure starts in the early stages of the route engineering process where existing and planned cables will be identified that the new system will closely approach or cross. Early consultation should take place with the maintenance authorities of these other cables in order to reach an agreement on the position and manner of the crossing. In most cases the cable owners should be able to come to an accord without a formal crossing agreement, this being effected by a simple exchange of letters – an 'agreement to cross'.

Oil and Gas pipelines

The Petroleum Act 1998 vests all rights to the UK's petroleum resources in the Crown, but the Oil and Gas authority can grant licences that confer exclusive rights to 'search and bore for and get' petroleum. The OGA's licensing system covers oil and gas within Great Britain, its territorial sea and on the UK Continental Shelf (UKCS).

The Pipeline Safety Regulations 1996 were introduced by the Health and Safety Executive; as part of a consolidation exercise, the Petroleum Act 1998 repealed and replaced the Petroleum and Submarine Pipelines Act 1975 and the Offshore Petroleum Production and Pipelines (Assessment of Environmental Effects) Regulations came into effect in 1999. All have had an impact on the offshore Pipeline Works Authorisation (PWA) process.

A pipeline works authorisation or variation should be in place before any pipeline or pipeline system construction or modification works begins. Before submitting an application, we recommend that, the prospective owner informally consults both the OGA Consents team and the Health and Safety Executive at the earliest possible opportunity, to discuss the proposed scheme and the regulatory requirements.

Where there are no objections, it takes approximately four to six months from receipt of a satisfactory application to issuing the authorisation. In the case of pipelines in respect of which an environmental statement is required under the Offshore Petroleum Production and Pipelines (Assessment of Environmental Effects) Regulations 1999, the procedure may take longer. Operators must therefore submit applications at least four to six months before construction begins.

In Scotland, The Crown Estate Scotland is responsible for managing:

- Leasing of virtually all seabed out to 12 nautical miles including agreements with cables and pipeline operators
- The rights to offshore renewable energy and gas and carbon dioxide storage out to 200 nautical miles

Technical and spatial planning criteria

Technical

- Renewable power export and array cables are typically in water depths of no more than 50 m to 60 m currently although this may increase in the future
- Cables should be buried but it locations where burial is unfeasible, then cable protection measures should be adopted i.e. concrete mattresses (Licensing authority led)
- Routing the cable to optimise burial in sediments
- Target trench/burial depth of 1 m

Spatial

Government-led criteria

- New cables should implement methods to minimise impacts on the environment, seabed and other users, where operationally possible and in accordance with relevant industry practice.
- During the pre-application and application phase, cable routes are checked spatially against other marine users and protected areas.
- When selecting locations for cabling and land-fall of cabling, policies pertaining to flooding and coastal protection should be considered

Industry-led criteria

- There should be a separation distance of 750 metres between wind turbines and existing submarine cables
- Cable maintenance vessel safety zone - all ships to keep at least 1NM clear whilst they are engaged in cable operations that restrict their ability to manoeuvre.
- Wind farm structure safety zone – 50m safety zone established around any wind farm structure
- Working zone – 500m either side of the existing subsea cable (Figure 10)
- hazard area – consideration begins at a minimum of 250m (Figure 10)

The on-going development of wind farms within UK Renewable Energy Zone (REZ) waters has resulted in the need for cross industry endorsed guidelines on the proximity of submarine cables and wind farms. These guidelines will address installation and maintenance operations of wind farm structures, associated cables and other submarine cables, where such structures and submarine cables will occupy the same or neighbouring areas of seabed. In response to this, a study has been commissioned by The Crown Estate as the client on behalf of a group of industry stakeholders to develop these guidelines in a report.

The report assessed the proximity impacts between renewable energy installations and submarine cables in a range of water depths up to 200 metres (m), i.e. depths with foreseeable potential for OREI development in the next 10-20 years. A large part of the UK REZ has water depths in excess of 50m and it is likely that advances in foundation design and installation techniques will result in developments in these water depths in the future. Renewable energy developments in depths beyond 200m will require a re-appraisal. Figure 9 shows the proximity guidelines developed by The Crown Estate and it bases the need for a proximity agreement on the spacing and distance between the existing submarine cable and the wind turbines. It advises that a proximity agreement is only required if the distance between the cable and the wind turbine is less than 1 NM. Dialogue is therefore required between both parties to determine a proximity limit.

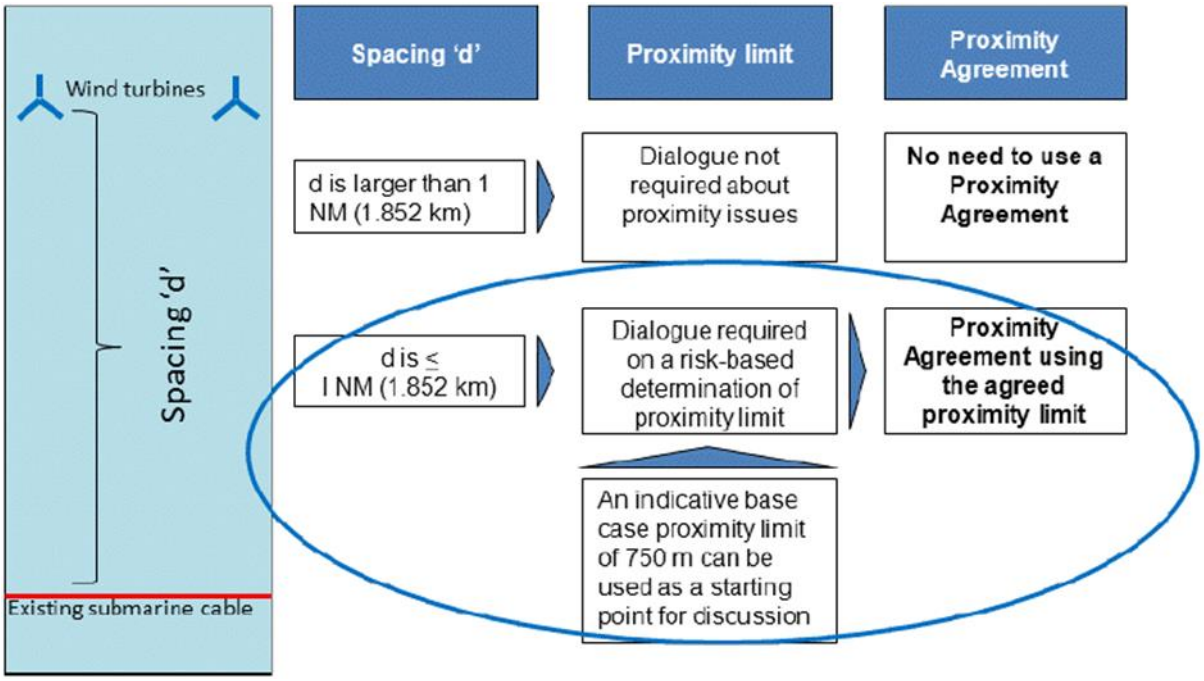

Figure 9. Proximity distances considered in UK guidelines

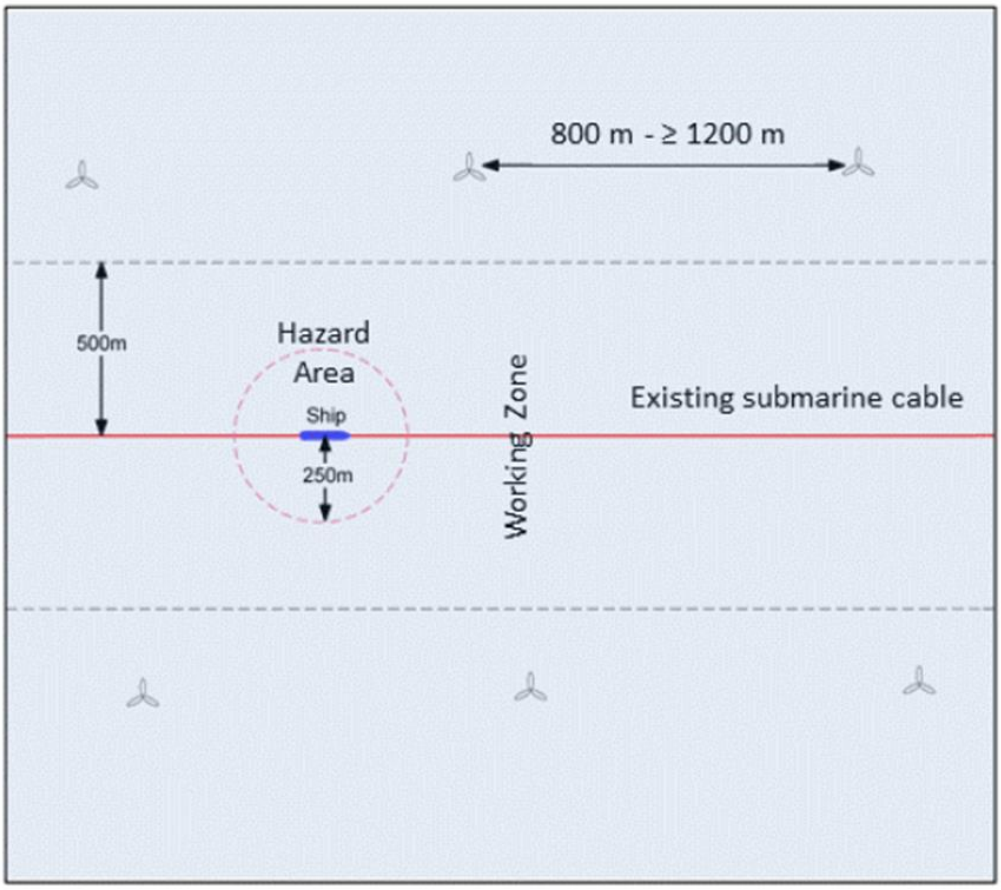

Figure 10. Working zone and Hazard area applied to a submarine cable repair vessel when operating on the cable line

Issues for marine planning, spatial incompatibilities and planning solutions

Growth in the cable industry and other marine sectors increases the risk of potential damage to cables and further interactions with other users, for example competition for space with oil and gas pipelines, fishing and shipping. A joined-up approach to development and activity will be needed to protect cables whilst promoting co-existence.

The Scottish Government supports the development of network infrastructure in the right places. New research and strategies will be undertaken to improve knowledge of the interactions between submarine cables and other activities. For example, as lead partner in the Irish-Scottish Links on Energy Study (alongside authorities in Ireland and Northern Ireland), the Scottish Government will seek to develop a spatial plan for an offshore electricity network that both supports development and ensures that impacts on other activities are fully understood and minimised. This process will include the opportunities for all such sectors to put forward views and information as part of a robust consultation.

Key interactions of relevance to marine planning include:

- **Marine and Offshore Renewables:** Interconnector and electricity power cables are integral to the successful delivery of offshore and marine renewable energy. A plan-led approach to the development of grid will provide the most efficient connections taking account of environmental and economic factors and other users. Potential interactions between cables and existing and planned offshore wind farms include:
    - Competition for space with potential future interconnectors

  - Cable crossings with existing interconnectors and future export cables
  - Increased difficulty of access at cable crossing points with existing/planned interconnectors
  - Competition for space with offshore wind
  - Competition for transmission capacity
- **Fishing Activity:** There is a risk of adverse interaction between seabed cables and fishing activity and this increases as activity levels rise. Submarine cables can cause obstruction to fishing practices and fouling a cable can be extremely hazardous to fishing vessels, whilst damage to submarine cables is expensive to repair and can cause disruption to power distribution and international telecommunications at a national level. Submarine cables should be buried, where feasible, or suitably protected, to reduce conflict with other users and prevent damage to cables. Engagement with affected stakeholders is supported to ensure appropriate awareness of the risks and consequences. The fishing sector can gain access to accurate and comprehensive information on NMPi on the majority of submarine cables within UK waters held by Kingfisher under the KIS-ORCA (Kingfisher Information Service - Offshore Renewable & Cable Awareness) project. This project provides free cable awareness charts; electronic route position lists and digital information for chart plotters to fishing vessels and legitimate marine stakeholders. Key fishing organisations and stakeholders are working with the sector to promote this project and assist with the local distribution of the data.
- **Marine Environment & marine historic sites:** Cable installation and operation of submarine cables, if suitably routed, cause minimal impacts on the marine historic and natural environment. Cable installation projects are subjected to considerable route engineering and conflicts mitigation from the outset, to minimise the risks in regard to sensitive habitats and other similar environmental constraints. Other potential impacts include:
  - During cable installation, sediment plumes may be generated. Potential risks to sensitive species can be further mitigated by planning the timing and direction of installation operations to minimise concerns.
  - Electromagnetic fields especially those from High Voltage Direct Current (HVDC) electrical power transmission cables may have some effects on electro- and magneto-sensitive species. Although research on potential impacts is ongoing, the current indication is effects could be minimal. High Voltage Alternating Current (HVAC) cables, where the fields are constantly changing, are thought to pose lower concerns. The potential for electromagnetic field impact is significantly reduced through burial of cables mitigated by modern cable design.

Future trends and spatial requirements

Submarine cables are an important part of Scotland's national infrastructure and will be vital for the foreseeable future. The power cable industry in Scotland is experiencing significant growth, with several new projects currently in the installation and planning phases. While investment in these activities will be affected by the recent downturn in the economy in the short term, long-term drivers for competitive electricity markets and

international energy cooperation are likely to maintain the impetus towards increasing the level of interconnector capacity (AECOM and ABPmer, 2015).

Submarine power and telecommunications cables are of national and international economic importance and support the growth sectors of energy and creative industries (as part of digital), identified in the Government's Economic Strategy.

Growth of the marine and offshore renewable energy sector will increase demand for upgrade and improvements to the power grid. A strategic plan for grid will be developed by the Scottish Government to ensure sustainable development of submarine power cables to support the offshore wind and offshore renewables sector. Based on scenario modelling undertaken by National Grid, peak UK electricity demand is expected to rise from around 62GW in 2016 to between 65-85GW by 2050.

Climate change

Climate change and associated sea level rise is expected to increase the incidences of coastal flooding and erosion which may have limited implications for the landfall of cables in the near-term. Changes in sedimentation and increase in currents due to climate change may change depositional regimes leading to potentially increased risks of exposure of previously buried cables.

Cable system life is around 25 years for telecommunications and approximately 50 years for power cables. Potential changes in storminess as a result of climate change may require more resilient infrastructure. However, prudent cable system planning and engineering normally mitigates these risks wherever possible at the project outset, as these factors are already a part of the standard consideration applied to cable planning. Risks are more likely to occur where the landing site for a cable is specifically constrained to a less-favourable site for other overriding reasons

Energy storage

As energy demand increases, there is an increasing desire to be able to store energy for times of limited production or supply. Scotland’s link to Norway in the form of the NorthConnect interconnector could solve this challenge. Scotland trades their wind generated power in exchange for Norway’s hydro power. This means that Norwegian hydropower stations could provide energy storage for the UK, in the form of pumped storage.

UK carbon dioxide storage

As the oil and gas industry starts to be replaced by greener forms of energy production, some oil fields and associated pipelines will reach end of life and be decommissioned. An opportunity has been identified here in the form of carbon storage where decommissioned pipelines could house this facility. The development of gas storage and carbon capture storage in former offshore fields may then result in new pipelines or possibly change in use for existing pipelines.

The OGA regulates offshore carbon dioxide storage and are the licensing authority who approves and issues storage permits. BEIS lead government policy on carbon capture, utilisation and storage.

When exercising its functions, under the Energy Act 2016, the OGA is required, so far as is relevant, to have regard to the development and use of facilities for the storage of carbon dioxide, and of anything else (including, in particular, pipelines) needed in connection with the development and use of such facilities.

The OGA will work with government, industry and other relevant stakeholders to identify synergies and promote opportunities where development of carbon dioxide storage can contribute to Maximising Economic Recovery of the UK's oil and gas resources (MER UK).

In terms of licensing, The Energy Act 2008 (the Act) provides for a licensing regime that governs the offshore storage of carbon dioxide. It forms part of the transposition into UK law of EU Directive 2009/31/EC on the geological storage of carbon dioxide. The Carbon Dioxide (Licensing etc.) Regulations 2010 (SI 2010/2221), which transpose many other requirements of the directive, came into force on 1 October 2010.

The regime applies to storage in the offshore area comprising both UK territorial sea and beyond designated as a gas importation and storage zone (GISZ) under section 1(5) of the Act.

The OGA is the licensing authority for offshore storage except within the territorial sea adjacent to Scotland, which Scottish ministers authorise. In addition to applying for a licence, developers must obtain a grant of the appropriate rights from The Crown Estate or the Crown Estate Scotland.

Decommissioning

Cables

The general principle that applies is that the Licensee will be required to remove cables on permanent cessation of use or expiry of the Licence. Applicants will be required to prepare an Initial Decommissioning Plan prior to Licence grant (which will be updated during the course of the Licence as appropriate), including an estimate of the likely cost. Prior to actual decommissioning a Final Decommissioning Plan will be prepared and agreed with The Crown Estate. On completion of satisfactory decommissioning, and the relevant notice, the Licence (and the fee) will cease. The Licensee will remain liable for any sections of cable left in situ and this will be documented in an Out of Service Deed. An Out of Service Fee will apply

A common issue with the decommissioning of cables that has been identified by KIS-ORCA, who collect data on the location of cables, is that numerous cables are being left in situ and classed as ‘Out of Service’. Developers will then not fully disclose the location of these cables so that they avoid responsibility for them.

Database

Marine Scotland Information and NMPi – cables and oil & gas pipelines

Common Data Access Limited (CDA) – Shared data solutions for the UK offshore oil industry

UK Oil and Gas Data

Theodora – UK and Ireland Pipelines map – crude oil (petroleum) and natural gas pipelines – includes cross-border, international pipelines

Kingfisher information service (KIS) – cable awareness – KIS-ORCA dataset

Data Available	Information Source
Power interconnectors and transmission lines (UK)	KIS-ORCA
UK Transmission network, including interconnectors	Ofgem website https://www.ofgem.gov.uk/electricity/transmission-networks/electricity-interconnectors Ofgem reports 2017; 2016

Figure 11. Information sources for the power interconnector sector