Industry position on how offshore grids should develop

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CONTENTS

RECOMMENDATIONS

The European Commission's Long term decarbonisation strategy foresees more than 400 GW of offshore wind by 2050. This requires accelerating deployment and, crucially, an ambitious approach to developing grid infrastructure. To this end WindEurope recommends:

Planning – EU-level

- The EU should elaborate a high-level strategy to achieve the grid infrastructure needed for more than 400 GW of offshore wind included in its long term decarbonisation strategy, with support from Member States, industry and grid operators;
- This strategy should include the optimisation of existing grid infrastructure and the support of new technologies and approaches as means to plug the ambition gap in the pipeline of projects to 2030 and beyond;
- The EU should further elaborate the regulatory framework to allow project developers to build grid connections for cross-border hybrid projects with a smooth and streamlined process;
- The EU should use the InvestEU initiative to start an ambitious infrastructure programme for the development of both the onshore and offshore European grid in the long-term;

Planning – Member States

- Member States should include clear plans for a coordinated offshore grid development in their National Energy and Climate Plans to 2030 including an assessment of investment needs and sources of finance to deliver them;
- Member States should amend the regulatory framework to include the option of opening investments in offshore grid assets to new players;

Execution

- Offshore wind farm developers should be given a larger role in developing the offshore grid;
- National regulatory authorities should consider opening for competition the rights to build and operate offshore grid transmission assets;
- Auctions for offshore wind energy should open the development of transmission assets (to shore) to offshore wind developers;
- In the short term, the EU should increase the funding and coordinate with Member States to accelerate the execution of Projects of Common Interests on- and offshore;
- Offshore wind developers and TSOs must keep acting with a long-term focus on quality and reliability when building the grid.

INTRODUCTION

In 2009 WindEurope put forward a 20-Year Offshore Network Master Plan as a way of exploiting the abundant resource potential of offshore wind in the North Seas[1]. At the time, there were 2 GW of offshore wind and the first political declaration on energy cooperation in the North Seas, NSCOGI, was in the making[2]. Europe's forthcoming infrastructure plans were promising, with the European Commission setting the pathway to achieve the €200bn investments in transmission networks needed to meet the 2020 renewable energy targets[3].

Offshore wind has since grown from 2 GW to 18.5 GW, at a compound annual growth rate of 24%. The industry has attracted annual average investments of €9.4bn, fuelling the development of a thriving sector, creating local jobs and exporting equipment, skills and services worldwide. In the same period offshore wind energy transitioned to auctions, and over the last three years it has delivered outstanding cost reductions. Recent offshore wind projects are cheaper than new nuclear power capacity and gas-fired power plants.

But the progress made in offshore wind development has not been matched with offshore grid development.

The amount of investments needed have sometimes daunted governments, and there has been insufficient coordination of grid investments across borders. Instead, Governments have taken nationally-driven approaches to connect offshore wind farms. Cross-border interconnector investments have also been insufficient. As a consequence, the European onshore and offshore grid infrastructure is a limiting factor for the expansion of offshore wind energy.

This paper recaps the state of play of how offshore wind farms are connected to the grid and provides recommendations on how the multitude of initiatives and ideas over the last 10 years should come together to accelerate the pace of grid infrastructure build-out.

[1] EWEA (2009) *Oceans of Opportunity Harnessing Europe's largest domestic energy resource*.
[2] BENELUX (2009) *Political_declaration_on_the_North_Seas_Countries_Offshore_Grid_Initiative*.
[3] European Commission (2010) *Energy infrastructure priorities for 2020 and beyond-A blueprint for an integrated European energy network*.

STATE OF PLAY

To date, the deployment of offshore wind projects and grids has been driven on a national basis. Each country develops its own sea area based on national sovereignty, often without considering a larger sea-basin perspective or coordinating with neighbouring countries. Each country has its own regulatory regime, renewable energy development plans, support mechanism, timing and process for tendering and auctioning power capacity, maritime spatial planning, grid development plans, and technical and environmental standards and assessment methods.[4]

This legal and regulatory patchwork means offshore wind and grid projects develop independently from country to country as there are no appropriate frameworks to connect them. Nor are there any incentives to pursue the most evident synergies from cross-border cooperation. National projects are prioritised to the detriment of potentially more optimal international solutions.

In addition, each country has transposed the European unbundling rules[5] differently for its electricity transmission system operators (TSOs). The ownership model of TSOs has a strong influence on the way offshore grids are planned, financed, built, and operated. Most TSOs are publicly owned: more than half of Member States have 100% public ownership. The UK and Portugal have full private-owned TSOs. 7 of Member States have a mix of public and private ownership[6].

OFFSHORE GRID DEVELOPMENT PLANNING

At European level, the ENTSO-E Ten-Year Network Development Plan (TYNYP) is the master plan for grid development. It aims to coordinate electricity system planning across 43 TSOs. In its 2018 version, currently being assessed by ACER, it foresees up to €114bn (€10.4bn/year) of investments for grid infrastructure[7] to 2030. Out of this, €27bn are for 21 individual projects that would develop into a "Northern Seas Grid Infrastructure"[8]. ENTSO-E believes that offshore grids will be developed using a range of all available AC and DC technologies and will comprise a combination of all currently proposed designs: radial connections, hubs, hybrid projects and meshed grids. ENTSO-E modelling results are based on a 40-59 GW of offshore wind by 2030 and a maximum of 127 GW by 2040. This is below WindEurope's central scenario to 2030 (70 GW).

[4] European Commission (2017) *North Sea Energy cluster paper.*
[5] European Commission (last access May 2019)
[6] CEER (2016) *Status Review on the Implementation of Transmission System Operators' Unbundling Provisions of the 3rd Energy Package*
[7] According to ENTSO-E this amount is broadly in line with other estimates from the IEA, OECD and the EC of around 9.9bn/year.
[8] ETSO-E (2018) *TYNDP 2018 Regional Insight Report. Northern Seas Offshore Grid (NSOG)*

GERMANY

Regulatory framework

Germany plans its offshore grid development in two integrated processes. The existing Offshore Network Development Plan will be substituted partly by an Area Development Plan (Flächenentwicklungsplan), designed by the Bundesamt für Seeschifffahrt und Hydrographie (BSH) in agreement with the BNetzA (Bundesnetzagentur, the Federal Network Agency) and with Germany´s four TSOs (50Hertz, Amprion, TenneT and TransnetBW) and by the electricity grid development plan, which contains actions to develop grid connection points onshore.

The former electricity grid expansion for on- and offshore (until 2017) was planned with a centralised 5 step model[9]. The process is started by the four TSOs, who are mandated to build electricity generation scenarios for the next 10, 15 and 20 years. This resulted in an Electricity Network Development Plan and an Offshore Network Development Plan.

The national regulator, the Bundesnetzagentur, is responsible for performing an Environmental Report from these plans. The Network Development Plans and the Environmental Report form the basis for a Federal Requirements Plan Act, establishing the necessity and priority of the projects set out in the Act to meet energy supply requirements. For cross-border projects or projects of national relevance, the Federal Sectorial Planning process decides on the corridors and triggers a Planning Approval Procedure for the exact routes of the cables.

Targets and expansion plan

The process above has been enshrined in law in the Renewable Energy Act (EEG 2014) after concerns with the previous grid development regime. The EEG 2017 set a target of 15 GW of offshore wind by 2030, down from the 25 GW ambition included in the EEG 2014. This lower offshore wind target is the basis for the plans for developing the offshore grid in German waters.

The subsequently published offshore network development plans to 2025, published in 2017, foresaw expansion measures of the offshore grid to a total of 1,200 km. The necessary amount of investments totalled around **€5bn.** In the most recent draft of the 2019 network plans, the offshore grid costs are estimated between **€18-24bn** for connecting 17-20 GW of offshore wind by 2030. This would be at least 2 GW more than the current target of 15 GW committed in law[10].

From 2025 onwards, the Offshore Network Development Plan will be replaced by the "Offshore Area Development Plan" (Flaechenentwicklungsplan, FEP). This document will be published in June 2019 and lays out the details for offshore grid connections from 2026-2030. In two alternative scenarios, the plan also includes grid expansion measures for installing 17 GW and 20 GW of offshore wind by 2030.

[9] BSH (2014) *Grid Expansion in Germany What you need to know*
[10] 4C Offshore (last access May 2019)

UNITED KINGDOM

Regulatory framework

In the UK the regulatory framework for grid transmission is managed by the Office of Gas and Electricity Markets (Ofgem) in collaboration with the Department for Business, Energy and Industrial Strategy (BEIS). Under the Electricity Act 1989 (EA 1989). The majority of transmission licences for offshore infrastructure are held by **Offshore Transmission Owners (OFTOs)**. OFTOs are selected by Ofgem via a competitive tendering process.

National Grid is the Electricity System Operator. It is responsible for facilitating competition in the supply and generation of electricity and operates the National Electricity Transmission System (NETS).

Targets and expansion plan

National Grid regularly publishes the **Electricity Ten Year Statement** (ETYS), most recently in November 2018. The ETYS presents the current National Electricity Transmission System (NETS) capability and its future requirements. It inputs the **System Operability Framework** (SOF), which presents the future operability challenges and strategy, and the **Network Options Assessment** (NOA), which assesses available network development options, together with recommendations to meet reinforcement requirements of the NETS.

The latest NOA 2018/2019 reported recommendations for investment of £59.8m in 2019/20 across 25 projects to potentially deliver projects worth almost **£5.4bn (€6.24bn)**. Analysis also foresees that a total interconnection capacity range from 18.4 GW to 21.4 GW between UK and European markets by 2031 would provide optimal benefit[11].

THE NETHERLANDS

Regulatory framework

In the Netherlands the grid operator is responsible for developing the grid according to general principles of the Electricity Act (Elektriciteitswet 1998 – general law on electricity. It owns 23,000 km of high-voltage lines and 4,700 km offshore cables.

Targets and expansion plan

The Dutch government identified phase II for offshore wind development – 'Offshore Wind Energy Roadmap 2030' (Routekaart Windenergie op Zee 2030) – announcing a further 7 GW increase in offshore wind energy capacity between 2024 and 2030. TenneT is working on an action plan to develop an offshore electricity grid that, by 2030, will connect a total of 11.5 GW. DC technology and interconnectors are currently under assessment for windfarms located further from shore that will be built in the 2024-2030 period.

[11] National Grid ESO (2019) *Network Options Assessment 2018/19*

DENMARK

Regulatory Framework

In Denmark the fully State-owned Energinet.DK is responsible for the planning, expansion and operation of the electricity and gas grid infrastructure. The TSO has its own planning with a yearly strategic outlook, based on the ENTSO-E scenarios.

In addition, the Nordic council of ministers which brings together Norway, Finland, Denmark and Sweden tasks the Nordic TSOs (Statnett, Fingrid, Energinet.dk and Svenska Kraftnat) to present the Nordic Grid Development Plan. This plan serves as a "bridge" between the ENTSO-E process and the national planning processes. It establishes a common Nordic Reference Scenario based on ENTSO-E/TYNDP scenario "Sustainable transition".

Targets and expansion plan

In June 2018, the Danish government signed an energy agreement, planning to build three offshore wind farms. These will be established with a total capacity of at least 2,400 MW by 2030. The 2019 network development plan includes several cross-border corridors in the Nordic system and total investments of more than **€15bn to 2025**[12].

The Danish Electricity Supply Act[13] regulates the current transmission, distribution and trade of electricity since 2016. The Act allows new transmission grids to be constructed and material changes to existing grids to be implemented if there is sufficient need for such expansion. Power plant operators are not entitled to the expansion of the grid.

The TSO must submit the grid expansion plan, based on the future transmission capacity requirement, to the Danish Minister for Energy. In connection with the granting of approval, the Minister for Energy may determine the terms of such expansion, including the removal or renovation of systems.

Areas for offshore grid expansion are assigned through the Maritime Spatial Planning process, while the TSO is responsible for the Environmental Impact Assessment and local survey before applying for tenders. This allows for a reduction in both time and the risk of investment. The site investigation and Environmental Impact Assessment (EIA) process will change for the next tenders (3 x 800 - 1000 MW). The Danish Energy Agency is currently adjusting the new framework, which should be communicated by the end of 2019.

[12] Energinet (2017) Nordic Grid Development Plan 2017.

[13] Ft.dk (2016)

SWEDEN

Regulatory framework

Sweden's national grid is managed by the national TSO Svenska kraftnät, which has also a mandate to promote the integrated Nordic and European electricity markets. The Swedish Electricity Act (1998) regulates the connection of renewable electricity plants, the distribution of electricity from renewable sources and the obligation to expand the grid. Under the current Electricity Act, an electricity supplier is responsible for supplying as much electricity as its customers consume hour by hour (Svenska kraftnät, balansansvar, 2015)[14]. In general, the TSO is responsible, at national level, to plan and upgrade the grid when necessary. Wind farms with a capacity above 300 MW (onshore or offshore) are connected directly to the national grid while wind farms with lower capacities are normally connected to the regional grid (Swedish Energy Agency, Elanslutning av vindkraft till lokal, region-, och stamnätet, 2007).

Targets and expansion plan

In 2013, Svenska kraftnät published the Perspective Plan 2025. In 2015, this was followed by the Network Development Plan 2016-2025. In 2018 Svenska kraftnät received applications for new connections of mainly wind power in the order of 18,000 MW for the period up to 2025[15]. It is estimated that 15% of this capacity will be installed. The TSO's business plan, for the years 2020-2022, foresees Svenska kraftnät to invest 13 billion Swedish crowns (€1.22bn).

BELGIUM

Regulatory framework

In Belgium the national TSO, ELIA, is responsible by law for connecting plant operators to the existing grid infrastructure and for its expansion (Arrêté du 19 décembre 2002).

In cooperation with the "Direction générale de l'Energie" (Directorate General of Energy) and the "Bureau fédéral du Plan" (Federal Planning Bureau), the TSO is obliged to draft and present to the Federal Authority for the Regulation of Electricity and Gas (CREG) a development plan for the expansion of the grid and all investments, taking into account the expected capacity requirements[16]. This plan needs to be approved by the Minister for Energy[17]. The federal regulator CREG is also in charge of regulating grid tariffs.

Targets and expansion plan

Every four years ELIA draws up a Federal Development Plan which is coherent with the ENTSO-E Ten-Year Network Development Plan and in accordance with the provisions of the Electricity Act of 29 April 1999 and the Royal Decree of 20 December 2007.

[14] Royal Swedish Academy Of Engineering Sciences - IVA (2016) Swedish Future Electrical Grid, a project report.
[15] Svenska kraftnat (2018) System development plan 2018 - 2027
[16] RES-Legal (Last access: May 2019)
[17] Art. 13 § 2 Loi du 29 Avril 1999

In the latest Federal Development Plan for the transmission grid 2020-2030[18], ELIA identifies the transmission capacity needs of Belgium's high-voltage grid of approximately **€5bn** in investment over a 10-year period. The environmental impact associated with this Development Plan is covered in a separate report submitted to the Federal Advisory Committee for the Strategic Environmental Assessment (SEA).

FRANCE

Regulatory framework

In France the Commission de régulation de l'énergie (CRE) is the national energy regulator. Réseau de Transport d'Electricité (RTE), owns and operates France's transmission network. France has transposed Directive 2009/72/EC concerning common rules for the internal market in electricity. The electricity transmission operators (TSO) and most of the distribution system operators (DSO) consolidated their independence from their parent companies (administrative independence with regard to the shareholder)[19].

The costs of financing and operating the transmission and distribution networks are passed on to end users through the TURPE (Tariff d'Utilisation des Reseaux Publics d'Electricite). The tariff being applied since 1 August 2017 (TURPE5) runs for approximately four years. It takes account of significant investment planned over the period. The CRE also approves RTE's investment volumes and sets the company's profitability targets.

Targets and expansion plan

The 2015 TYNDP foresees that within the period 2015-2025 around 2000 km of assets will be built or extended, for a total of €10bn of investments. RTE recently issued a tender for project management and technical support for expanding the offshore grid for the forthcoming 500 MW wind farms (for a total of 1.5 GW).

[18] Elia (2018) Federal development plan for the transmission grid 2020-2030
[19] Agora Energiewende (2015) Report on the French Power System

Table 1: Grid plans and investments presented in National Energy and Climate Plans and cross-border projects under construction and in permitting procedure

	2030 Offshore Wind target	Investment foreseen in grid plan	Plan review	Interconnectors in ENTSO-E 10-Year Network Development Plan	Investment needs for interconnectors in TYNDP
DE	15-17 GW	€18-24bn (Electricity Grid Action Plan)	Last edition: 2018	• Doetinchem – Niederrhein (DE-NL) – 2018 – 1500 MW • Kriegers Flak Combined Grid solution (DE-DK) – 2019 – 400 MW • Nordlink (DE-NO) -2020 – 1400 MW • Kassø – Hamburg North – Dollern (DE-DK) – 2020 – 720 MW • ALEGrO (DE-BE) – 2020 – 1000MW • Upgrade Meeden – Diele (DE-NL) – 2020 – 300 MW • NorthConnect (DE- NO) – 2022 – 1400 MW • DKW-DE, Westcoast – border with Denmark (DE-DK) – 2023 – 500 MW • St. Peter - Pleinting (DE-AT) – 2024 – 1500 MW • Hansa PowerBridge I (DE-SE) – 2026 –700 MW	€24.2bn
DK	4.8-5.4 GW	€66.9m-€376m for 2019-2025 (Nordic Grid Development Plan)	Last edition: 2017 Updated: every 2 years	• Kriegers Flak Combined Grid solution (DK-DE) – 2019 – 400 MW • Kassø – Hamburg North – Dollern (DK-DE) – 2020 – 720 MW • COBRA Cable (DK-NL) – 2020 – 700 MW • DKW-DE, Westcoast– border with Denmark (DK-DE) – 2023 – 500 MW • Viking Link (DK-UK) – 2023 – 1400 MW	€3.6bn
NL	11.5 GW - 10.6 GW	€7bn for offshore and €5.5bn for onshore grid *Offshore Wind Energy Roadmap 2030*	Last edition: 2018	• Doetinchem – Niederrhein (NL-DE) – 2018 – 1500 MW • COBRA Cable (NL-DK) – 2020 – 700 MW • Upgrade Meeden – Diele (NL-DE) – 2020 – 300 MW	€874m
UK	30 GW	€24.35m network reinforcements in 2018 (Electricity Ten Year Statement - ETYS)	Last edition: Nov 2018 Updated: every year	• ElecLink (UK-FR) – 2019 – 1000 MW • IFA2 (UK-FR) – 2020 – 1000 MW • NEMO Link (UK-BE) 2020 – 1000 MW • North Sea Link (UK-NO) – 2021 – 1400 MW • AQUIND (UK-FR) – 2022 – 2000 MW • NeuConnect (UK-DE) – 2022 – 1400 MW • NorthConnect (UK-NO) – 2022 – 1400 MW • FAB Link (UK-FR) – 2022 – 1400 MW • Viking Link (UK-DE) – 2022 – 1400 MW	€11.1bn

BE	4 GW	€5bn (Federal Development Plan for the transmission grid 2020-2030)	Last edition: Oct 2018 Updated: every 4 years	• NEMO Link (BE-UK) 2020 – 1000 MW • ALEGrO (BE-DE) – 2020 – 1000MW • Avelin/Mastaing-Avelgem-Horta HTLS (BE-FR) – 2021 – 1000 MW • FR-BE: PSTs Aubange-Moulaine (BE-FR) – 2021 – 500 MW • BRABO II + III (BE-NL) – 2020/2025 – 1000 MW	€2.5bn
FR	6.25-7 GW	€1.5bn a year for the next decade (Ten-year scheme of development of the network)	Last edition: 2016 Updated: every year	• ElecLink (FR-UK) – 2019 – 1000 MW • Italy – France interconnector (FR-IT) – 2019 – 1000 MW • IFA2 (FR-UK) – 2020 – 1000 MW • Avelin/Mastaing-Avelgem-Horta HTLS (FR-BE) – 2021 – 1000 MW • FR-BE: PSTs Aubange-Moulaine (FR-BE) – 2021 – 500 MW • AQUIND (FR-UK) – 2022 – 2000 MW • FAB Link (FE-UK) – 2022 – 1400 MW	€4.9bn
SE	-	€1.22bn in the period 2020-2022	Last edition: 2018	• 3rd AC Finland-Sweden north (SE-FI) – 2025 – 800 MW • Hansa PowerBridge I (DE-FI) – 2025 – 700 MW • NordBalt phase 2 (LT-SE) – 700 MW • Fenno-Skan 1 renewal (FI-SE) – 2030 – 500-800 MW • Hansa PowerBridge II (SE-DE) – 2030 – 700 MW	€2bn

PERMITTING AND BUILDING

At national level the development, operation and ownership of offshore generation and transmission assets is shared among the following players:

- The **Offshore Windfarm Developer** (WFD) is responsible for the offshore wind farm and in some cases can develop, own and operate part of the transmission assets but not over the land transformer station.
- The **Transmission System Operator** (TSO) can be either a public or a private company directly regulated by the National Regulatory Authority (NRA). The TSO has a monopoly and develops, owns and operates the onshore and – in certain countries – part of the offshore transmission assets.
- The **Offshore Transmission Owner** (OFTO) is a third party company that develops, owns and operates part of the offshore transmission assets.
- The **National Regulatory Authority** (NRA) is responsible to oversee the players' market practices, which should in line with the national regulations.

The current offshore permitting process is summarized in Figure 1 below.

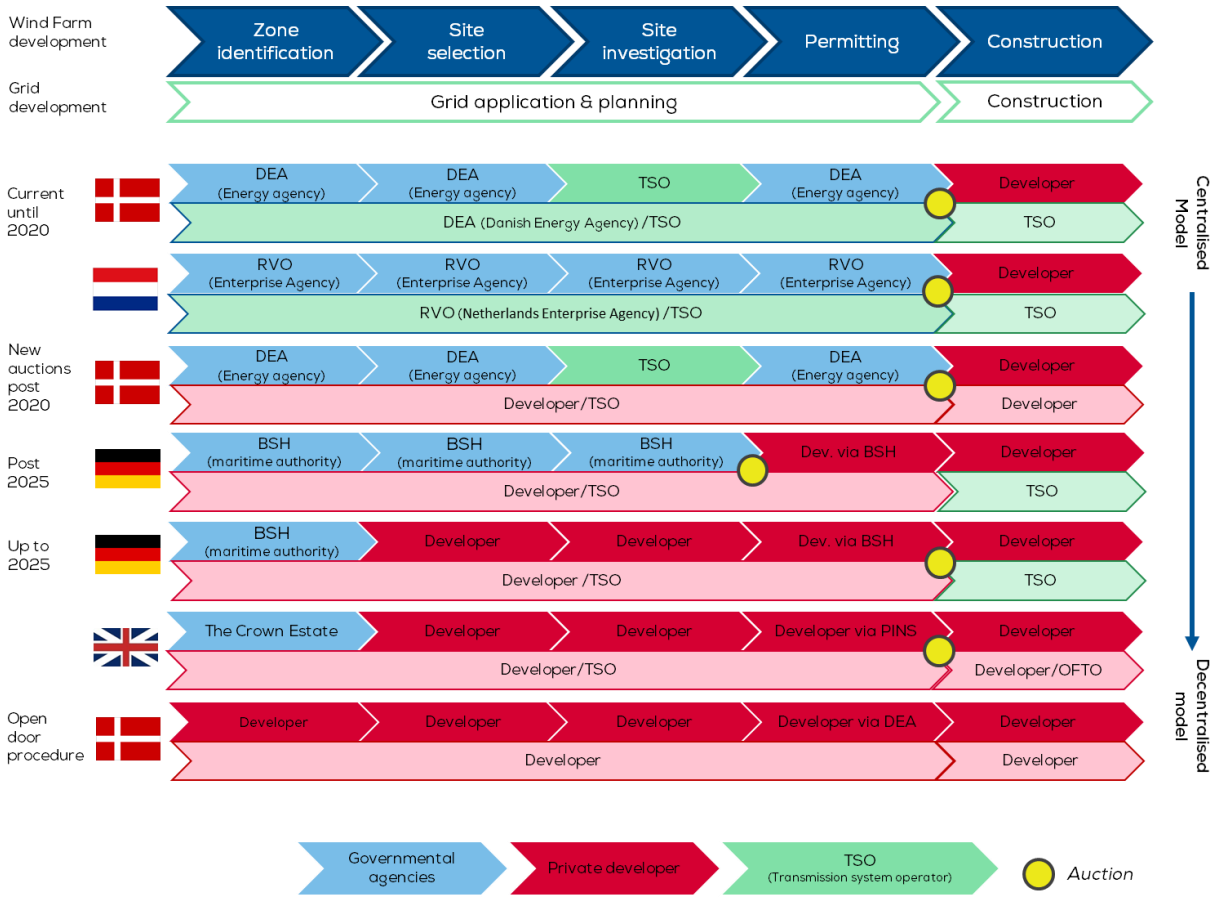

Figure 1: Summary of offshore permitting processes

GRID DEVELOPMENT AND OWNERSHIP MODELS

Member States choose different approaches when assigning responsibilities for grid development and connection. We refer to different models as “segmented”, as opposite to “integrated”, when the responsibility of planning and management of the offshore wind farm and transmission asset is split among different players. Competitiveness in grid development means that a tendering procedure determines who will build and operate the offshore grid assets.

In **Germany** the private offshore TSOs, TenneT TSO GmbH and 50Hertz and soon Amprion compete for a segmented non-competitive approach. This means that the Wind Farm Developer covers the cost for connecting the generator to the closest connection point of the offshore substation.

Since December 2006, with the adoption of the Infrastructure Planning Acceleration Act (Infrastrukturplanungsbeschleunigungsgesetz)[20]**,** the TSOs have a monopoly on the transmission assets and are legally obliged to cover the cost to build, reinforce (for integrating the new generation capacity) and operate the transmission assets. This has to be done in accordance with the best available technology in order to guarantee the optimal purchase, transmission and distribution of electricity from renewable sources. If, for some reason, the TSO requires a different point of connection, the cost will be covered by the end users.

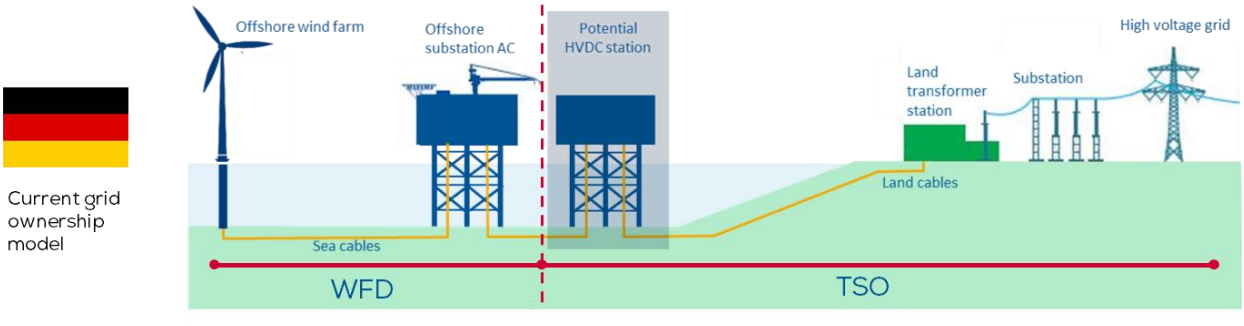

Figure 2: German segmented non-competitive model

In the **UK**, grid expansion may be the responsibility of National Grid, the distribution companies or the Wind Farm Developer itself. However, the Wind Farm Developer cannot operate the transmission asset. They have to divest it to the OFTO.

A Wind Farm Developer enters into a bilateral connection agreement, which may require onshore grid development as well as offshore grid development. Onshore work is the responsibility of the onshore TSO and the Wind Farm Developer builds the offshore transmission links (until the grid interface point) which then will be sold to the OFTO. In this approach, the OFTO pays a *Transfer Value* to the Wind Farm

[20] par 17 (2)

Developer for the investment made to build the transmission asset through a tendering process run by the national regulator. Alternatively, the OFTO itself can bear the cost of building and operating the offshore transmission assets. However, to date this has not been done as developers were concerned about the risk of losing control over a critical component of their projects. This pales in comparison with the potential incurred losses if the OFTO does not deliver the link on time. The regulator introduced flexibility options into the OFTO build model[21]:

- Generator Engineering, Procurement and Construction (EPC) – the Wind Farm Developer carries out all supply chain procurement and manages construction under an EPC contract with the OFTO.
- Generator procurement – the Wind Farm Developer carries out elements of supply chain procurement but the OFTO manages construction under an EPC contract with a third party.
- Generator/OFTO management – the Wind Farm Developer splits responsibility for managing construction of the offshore transmission assets with the OFTO (e.g. across onshore/offshore elements).
- OFTO procurement and EPC – also known as the 'late OFTO build' option, where the Wind Farm Developer undertakes the preliminary work, consenting and high level design and the OFTO procures the transmission assets and construction phases.

Despite this flexibility, the OFTO Build model has not been used to date. The tender process awards a license to the OFTO which provides a Tender Revenue Stream (TRS) linked to the availability of the asset, the majority of which is paid for by the WFD over 20 years.

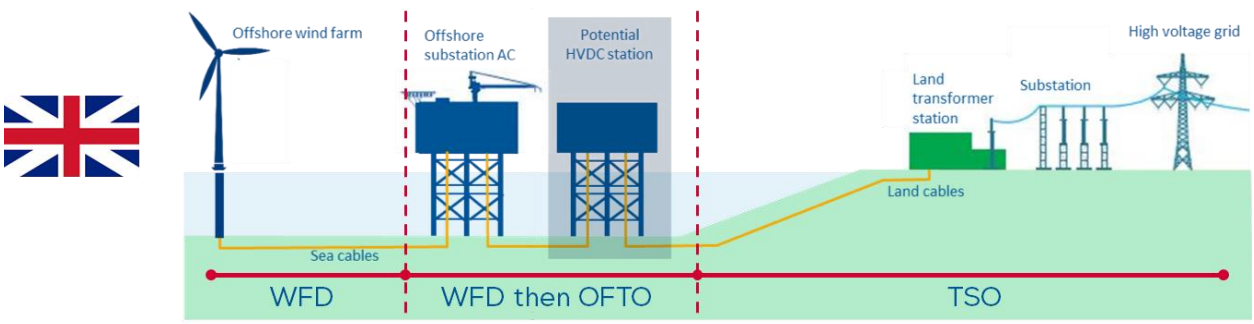

Figure 3: UK integrated competitive (OFTO) model

In the **Netherlands**, the current situation is similar to Germany and Denmark (government tender approach). There is a state-owned TSO – TenneT TSO NL – regulated by the Authority for Consumers and Markets (ACM) and responsible for the planning, construction and operation of the offshore transmission in a segmented non-competitive approach. Public financial support of the TSO is regulated by the Electricity Act (1998).

[21] Addleshaw Goddard (Last access: May 2019)

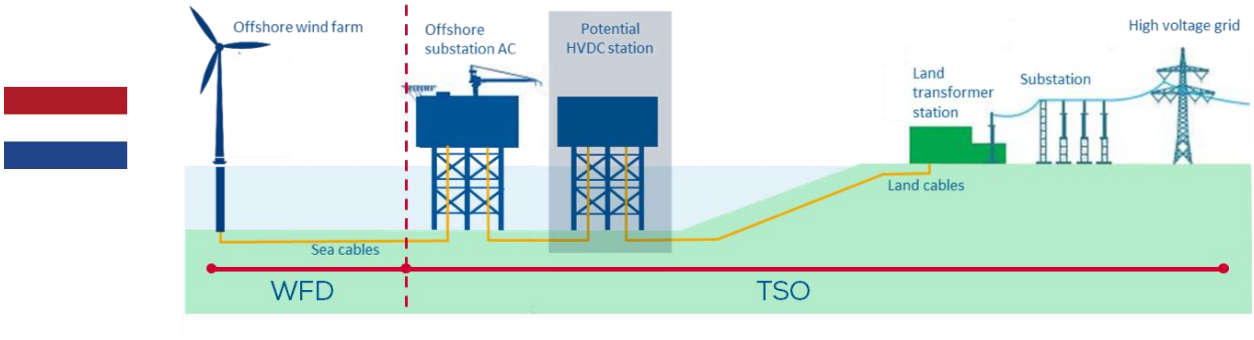

Figure 4: Dutch non-competitive segmented model

For new offshore windfarms in the Netherlands, the Wind Farm Developer will be responsible for only the internal electrical infrastructure and connection to the plant substation. The TSO will be responsible for the remaining costs.

In **Denmark**, the TSO, Energienet.dk, is owned by the Ministry of Energy, Utilities and Climate and regulated by the Danish Energy Regulatory Authority. In the case of government tenders for the offshore wind farms, the grid operators are responsible for the development, construction and operation of the transmission asset.

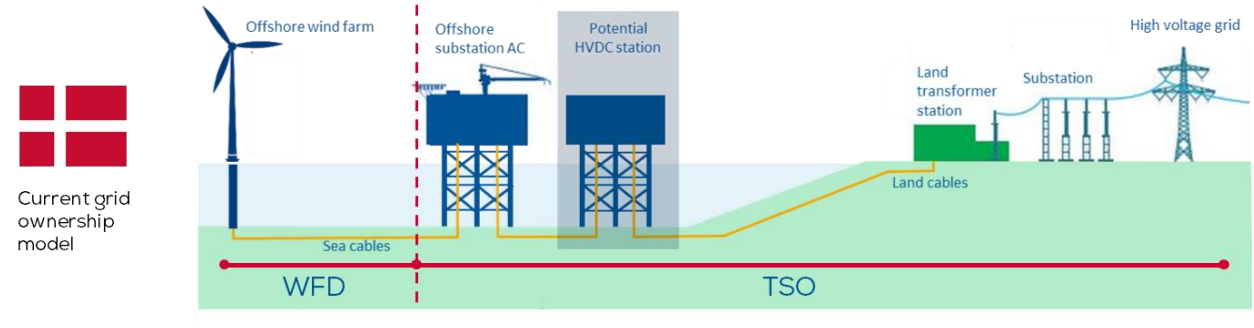

Figure 5: Danish segmented non-competitive model

If Energinet fails to meet its obligations, the Ministry for Climate and Energy delegates responsibility for the expansion of the grid to Energinet.dk (§ 20 Act 1009/2018). All TSO costs are recovered by tariffs or grid charges.

Alternatively, **Denmark** also offers the *Open door procedure* approach, where the official connection point between the Wind Farm Developer and TSO is onshore. The Wind Farm Developer is responsible for the development, construction and operation of the offshore transmission asset – through a first-come, first-served allocation mechanism – until the land transformer station.

In the case of **Thor offshore wind farm** (800-1000 MW), the grid connection to the onshore point will be included in the scope of the tender and responsibility of the WFD.

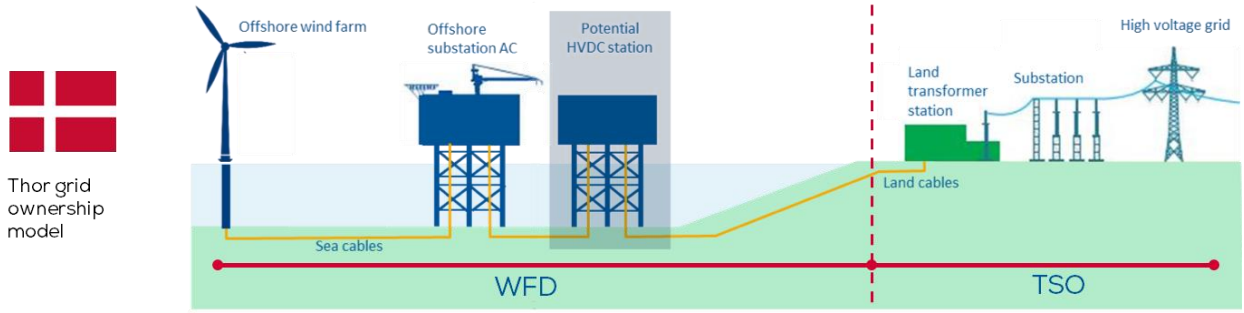

Figure 6: Danish integrated competitive (Thor) model

In **Sweden** the wind farm developer is responsible for the development and construction of the transmission assets up until the high voltage connection point onshore. The wind developer pays for the costs of construction which can partly be recovered through green certificates and sale of electricity. This model is currently being used in Sweden, but due to the high CAPEX requirements, offshore wind has not yet been economically feasible. In 2018 a study conducted by the Swedish energy agency reviewed options for boosting further offshore wind deployment by developers of grid-connection costs. The Swedish government or the national TSO, Svenska Kraftnät, would take on these costs, either taking the responsibility of construction and operation of the offshore grid (Dutch model) or subsiding a proportion of the undersea cables and transformers (Danish Thor model).

In **France** the current ownership model is a non-competitive segmented model (Dutch model). France plans to deploy 6 GW offshore by 2030. From 2018, grid connection costs for the upcoming auctions (including Dunkerque, which is in progress) has been transferred to RTE. RTE will recover the costs through TURPE, with charges levied on consumers. RTE is be also responsible for compensating developers in case of connection delays or failures in the system.

Analysis and recommendations on the OFTO model

There are 16 licensed OFTOs in the UK comprising over £3bn of investment in offshore transmission[1]. Since 2009 Ofgem has run five OFTO tenders. In 2019 a sixth tender (Round 6) is planned with an additional expected transfer value of £2.8bn. Ofgem is planning to increase the license and therefore the Tender Revenue Stream from 20 to 25 years for Round 6. Offshore transmission assets have matured into a recognised and sought-after investable asset class among a variety of investors. With almost 10 years of operation OFTO is a trialled and tested model.

The OFTO regime offers:

- A long-term, predictable, inflation-linked Tender Revenue Stream (TRS);
- A transparent tender process and stable regulatory regime;
- A creditworthy off-taker in the form of National Grid Electricity Transmission (NGET);
- No construction risk (in the case of Generator Build model);
- Limited operational risk, which is not linked to performance/operation of the wind farm; and
- A mature financing market with proven delivery of bank debt, private placements and public bonds.

The current regime de-risks the OFTO and allows a guaranteed revenue for financial investors. However, the OFTOs themselves are not always efficient at fixing faults, carrying spares, etc., and this leads to financial costs for the Wind Farm Developer.

After 10 years of operation the offshore wind industry in the UK is calling for a holistic review of the OFTO regime. This would seek to ensure that the regime offers efficient offshore infrastructure build and operation into the future and enable high volumes of offshore wind generation to be delivered by 2030 and beyond cost-effectively for the consumer.

The OFTO regime is an established model for grid planning and development of radial connections. However, it is also essential to optimise the current regime:

- Risk should be more evenly allocated between the Developer and OFTO in the UK. Currently the Developer holds onto risks they cannot mitigate and the risks of the transmission asset being unavailable are far more damaging to the Developer than the OFTO. In addition, both the Developer and the OFTO account for some of the same risks in their bidding (for CfDs and during the OFTO tender exercise).
- The current OFTO framework in the UK does not lend itself to incorporating innovation – such as hybrid sites with storage or meshed grid solutions. The OFTO is not incentivised to participate.
- OFTOs should be technically robust, or else risk the possibility of assets being poorly maintained/outages being slow to fix.

HOW THE GRID SHOULD DEVELOP

In 2018 the European Commission published its long-term decarbonisation strategy which foresees more than 400 GW of offshore wind by 2050 (1.5TECH scenario[22]). This means a deployment of 15-16 GW/year of offshore wind between 2030 and 2050. The current grid connections of 2.5-3 GW/year of offshore wind is significantly short of the volumes necessary to deliver on this long-term ambition. And the prospect of a substantial rise in volumes is uncertain as Member States are still preparing their National Energy and Climate Plans to 2030. These will need to deliver at least 4 GW/year to 2025 and 7 GW/year to 2030 in order to trigger a sustainable take-off of industrial capacity. That would leave Europe with 98 GW of total cumulative capacity in 2030, as shown in figure 7. Doubling the annual rate of installations from there onwards is a challenge the industry is gearing up to meet thanks to unparalleled experience over more than two decades of wind turbine developments and project execution.

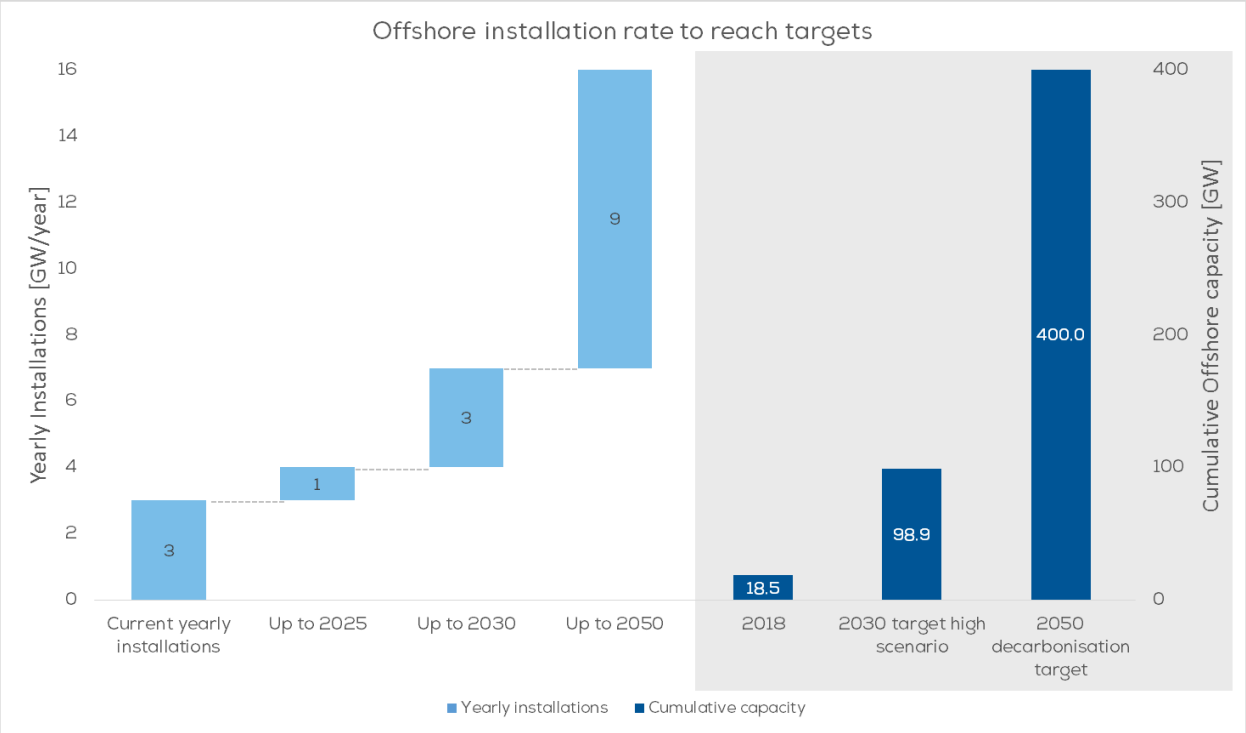

Figure 7. Offshore installation rate to reach 2030 and 2050 targets

Delivering such large power capacity will require investments from across the public and private sectors not only in generation, but also in grids, ports, and energy storage solutions. It is crucial to integrate additional new players and sources of finance in order to develop, build and operate such infrastructure. ENTSO-E and the European Commission estimate the need for between €100 and €150bn in offshore grids to reach 100 GW of offshore wind in 2030.[23] [24] This entails a significant increase in investments by TSOs, at a time when they also have to invest more in onshore grid, interconnectors and other assets.

[22] European Commission (2018) A clean Planet for all. In-depth analysis in support of the commission Com(2018) 773
[23] PROMOTioN – D7.5 – Financing framework for meshed offshore grid investments
[24] Ecofys (2015) Presentation: Costs and Benefits of an integrated offshore grid for Northern Seas region

To date there have been bottlenecks in both financing and resources available to keep up with the amount of projects built in the North Sea[25].

While the delays have been rectified and plans exist to build the grid up to 2030 in Germany, Belgium and the Netherlands, these may not be enough to cope with a significant expansion of offshore wind power capacity. The combined transmission capacity of these plans adds up to only 26-30 GW by 2030. Adding the Round 6 OFTOs in the UK, set to be delivered by 2024-2025, would add up to 6 GW on top of that, totalling at 32-36 GW of offshore wind power capacity in next decade.

In addition to raising the ambition in terms of volumes, **there is a strong case to revisit how the offshore grid should develop.**

PLANNING FOR CROSS-BORDER COOPERATION

There has not been a shortage of ideas on how to develop a coordinated offshore grid in the North Seas. Several studies from private stakeholders and Governments have pointed out the need for an integrated offshore network across different countries or within sea basins (**Annex I**). The European Commission has estimated that a coordinated approach to develop offshore grids could even bring savings of between €1.5bn and €5bn per year, as opposed to the status quo. The lack of cooperation between different national players in developing an offshore grid is the most important barrier. There has been a lack of European governance to balance responsibilities for grid development, ownership, operation and liability between countries.

The North Seas Energy Cooperation is exploring how an enhanced collaboration between offshore wind developers that are planning neighbouring wind farms could also lead to synergies in the development of the grid connections. The central idea is to develop a group of offshore wind farms and their grids jointly. This *clustering* and *hybridisation* approach should work in theory for projects within the same Exclusive Economic Zone (EEZ) and for cross-border projects, thus incentivising the build-up of transnational offshore grids.

Whilst developing offshore wind farms and their grids jointly is a sound strategy, judged by the UK experience, doing it for cross-border projects is not straightforward. The "Combined Grid Solution" of the Kriegers Flak offshore wind farm is a precursor of these hybrid cross-border projects which should serve as a cautionary lesson. It has been in the making for more than 10 years and, after facing multiple technology, legal and regulatory challenges, its scope was downsized from connecting three countries (DE, DK and SE) to only two (DE and DK).

Despite these setbacks, cross-border projects should continue to be explored in the short-term. Preliminary assessments show environmental and planning benefits as well as potential cost savings[26].

[25] ENTSO-E (2014) Fostering Electricity transmission investments to achieve Europe´s energy goals: Towards a future-looking regulation

[26] Roland Berger (2019) Hybrid Project: How to reduce cost and space of offshore development.

But these projects should be considered on top of the existing pipeline to 2030. They could bridge part of the gap of 3-4 GW/year missing in current Government ambitions to meet at least 98 GW of offshore wind. Therefore, no currently permitted project should be obliged to cluster with another project or be subject to consideration for a hybrid development. This is particularly important for those projects that are in an advanced stage of development and where sunk investment costs may already be high.

Planning for the right hybrid projects could pave the way towards a more coordinated offshore wind development and ultimately delivering projects and grids on schedule and budget. If these are successful, the regulatory framework and the support given by the European Commission so far could be expanded to cover wider offshore wind energy developments. For example, by extending the unbundling exemption currently granted to hybrid projects in the recast Electricity regulation to other non-cross-border projects.

The recital 35 of the Electricity Regulation (Directive 2009/73/EC) states that:

[…] Moreover, given the exceptional risk profile of constructing those exempt major infrastructure projects, undertakings with supply and production interests should be able to benefit from a temporary derogation from the full unbundling rules for the projects concerned […]"

PROJECTS OF COMMON INTEREST

Wind farm developers wishing to develop the grid for their projects and connecting them to more than one market could benefit from being listed as Projects of Common Interest (PCI) under the Trans-European Networks for Energy (TEN-E) regulation. Kriegers Flak qualified as PCI in 2017, therefore receiving €150m in financial support to develop the interconnectors. But the EU should do more to expedite the implementation of PCIs so that the development of offshore wind does not slow down. In spite of the 'fast-track' permitting procedures granted to PCIs the average expected duration to complete PCIs is 10.5 years according to ACER, with the shortest duration of less than 3 years and the longest 19 years[27].

The overall track record should be improved as well. So far, only one PCI has been completed in the North Seas; the COBRA Cable. There are 18 more PCI interconnectors in the 2017 list for the North Seas Offshore Grid, but only one considering the connection to offshore wind farms. So while PCIs may benefit from investment funds and some form of risk hedging provided by the EU, their long lead time would be a no-starter for most private developers of offshore wind farms and offshore transmission assets[28].

The review of the TEN-E regulation in 2020 opens the opportunity to prioritise offshore grid projects. Today the legislation provides for a thematic area called the Northern Seas offshore grid. But it is framed as "*integrated offshore electricity grid development and **the related interconnectors***". A more appropriate focus would be "Offshore grids for renewable energy projects".

[27] ENTSO-E (2019) Power Facts

[28] There are 106 PCIs related to electricity and storage in the 2017 list with a value of around 49 bn. 82% are for transmission projects, 17% for storage and 1% for smart grids. This is comparable with the previous years' list with a value of 52bn

EUROPEAN MESHED OFFSHORE GRID

In the long run, the idea of building an offshore meshed grid may still be on the table. As assessed in several studies this translates in an increased security of supply. In particular, this could allow for the full dispatch of wind power even in periods of low demand for a certain country (cf. PROMOTioN project, 2019). The surplus of energy can be redirected to other markets through demand-site management, avoiding losses or operational curtailment. However, integrating electricity in different markets is still an element of uncertainty for regulatory bodies. Support schemes for renewable energy generators are designed at national level. EU Directive 2009/20/EC has introduced the possibility of joint support schemes but many barriers still limit their use. This means that support schemes and tenders are limited to projects in territorial waters/EEZs, making the development of cross-border projects and integration of electricity in different markets very challenging.

The development of electricity grid infrastructure in Europe should anticipate the growth of the wind sector and ensure that current and future projects will not be jeopardised by delays or high deployment costs. The transition to a higher capacity grid based on an interconnection system feeding different markets (meshed offshore grid) has the potential to reduce cost for offshore deployment and secure stable revenues. However, the transition requires a dedicated regulatory framework, governmental support and a step-by-step basis.

POLICY RECOMMENDATIONS

The realisation of a European offshore grid would require investments from both private and public sources. The task is so big that it cannot be left to National Governments alone and cannot be done with a piecemeal approach. Up to now most governments have deployed offshore grid investments for wind farms by appointing the national TSOs to build and operate the power links. They have had to dramatically increase their investments, sometimes triggering legislative changes. Delays in connections have cost TSOs additional spending in compensation payments. However, TSOs also contributed to cost reduction through their competitive procurement. Their expertise and experience in building the first 18.5 GW of offshore wind should also not be neglected and used as a base for future offshore wind developments.

Furthermore, as investments offshore would have to be matched with similar efforts onshore, Governments should provide for a regulatory framework that allows new players to invest in grid infrastructure build out. However, TSOs should always be able to bid in the competitive processes for offshore grid development.

While some countries would take longer than others to reflect this regulatory change, authorities should ultimately enable competition to the benefit of end consumers.

In cooperation with Member States, TSOs and industry, the EU should elaborate a high-level strategy to achieve the grid infrastructure needed for 400 GW of offshore wind included in its long-term decarbonisation strategy. Strategic Maritime Spatial Planning should be used as a *mid-term* tool, setting plans and actions to 2030 while outlining the roadmap to 2050.

This EU strategy should include the optimisation of existing grid infrastructure and the support of new technologies and approaches as a means to plug the gap in the pipeline of projects to 2030 and beyond. These should include hybrid projects for clustering wind farms, multiple uses as a tool to improve social acceptance, floating farms and substations and flexibility options, such as Power-to-X. In addition, the onshore grid should also be optimised.

The EU should further elaborate the regulatory framework to allow project developers to build grid connections for cross-border hybrid projects with a smooth and streamlined process. The EU should take the lead in adapting regulations to allow the exemption from the unbundling rules for high risk projects connecting different markets. This would streamline the procedure for such projects, as market players would not have to ask for an exemption for every single cross-border project.

Finally, **the EU should use the InvestEU initiative to start an ambitious infrastructure programme for the development of both the onshore and offshore European grid in the long-term**.

In parallel, **Member States should include clear plans for a coordinated offshore grid development in their National Energy and Climate Plans, including the investment needs and sources of finance to realise it**.

Member States should also amend the regulatory framework to include the option of allowing new players to invest in offshore grid assets. Increased competition and a clear pipeline of projects will bring cost savings. In addition, standardisation and harmonisation of technical requirements will enable cost reductions and will facilitate future synergies for projects such as HVDC meshed grid and other cross-border funded initiatives.

On the execution side, **offshore Wind Farm Developers should be given a larger role in developing the offshore grid.** Developers should have the possibility to have control over the grid connection – including contractor selection – and sell it afterwards or, in the case of radial connections, own and manage the grid until the end of the asset's operational lifetime.

This means that **national regulatory authorities should consider opening for competition the rights to build and operate offshore grid transmission assets**. Introducing competition in tenders will support the optimisation of the overall electrical design, improve efficiency during project execution and establish good relations with the industry partners. The Danish experience (Thor wind farm) proves that changes in local laws can enable competition in grid development and put in place a competitive integrated model, in agreement with all the parties. However, the regulatory changes should reflect national plans and current models. Such changes in regulation should therefore be agreed among all the current market players, including TSOs. When not feasible, the Government should take the lead in developing the appropriate legal framework considering all these market players.

Auctions for offshore wind energy should open the development of transmission assets (to shore) to offshore wind developers.

In the short to medium-term, the EU should increase the funding and coordinate with Member States to accelerate the execution of PCIs on- and offshore. To fast-track permitting and support the construction of the offshore grids needed to connect future offshore wind capacity, the EU should review the criteria for Projects of Common Interest (PCIs) and prioritise critical offshore grid projects.

Finally, **offshore wind developers and TSOs must keep acting with a long-term focus on quality and reliability when building the grid**. From the very outset, these should drive the planning of Europe's future offshore grid projects. Grid developers should continue committing to stringent quality standards to ensure the reliability, durability and availability of both cable systems and offshore grids.

ANNEX I – ADDITIONAL REFERENCES

- NORTHSEAGRID Study
- Study of the benefits of a meshed offshore grid in the Northern Seas Region
- Offshore.eu Grid Study
- Study on regulatory matters concerning the development of the North and Irish Seas offshore energy potential
- Developing a shovel ready offshore grid in the North Seas - why public support is needed
- 5 priorities for a European Energy Union
- Letter to the Energy Council
- Seanergy 2020
- Maritime Spatial Planning: supporting offshore wind and grid development

WindEurope previous papers and notes on offshore grid:

- March 2017 - WindEurope views on the TSO-DSO coordination – Enabling flexibility from distributed wind power
- March 2016 - EWEA position paper on network tariffs and grid connection regimes (revisited)
- Nov. 2017 - How to ensure a simple and effective Smartness Indicator
- Nov. 2017 - Offshore wind energy in the north sea: position on hybrid projects
- Oct. 2014 - Developing a shovel-ready offshore grid in the North Seas – why public support is needed
- May 2012 - Supporting the North Sea offshore grid development– Assessment and recommendations

WindEurope EU projects-related activities on offshore grid:

- OffshoreGrid techno economic study
- NorthSeaGrid: offshore electricity grid implementation in the North Sea
- Study of the benefits of a meshed offshore grid in Northern Seas region

ANNEX II – OWF TRANSMISSION COST

Country	Wind Farm/Offshore Platform name	Year Licenced	Grid Transmission Owner	CAPEX [meuro]	CAPEX/ [MWxKm]	Average distance to shore (km)	Average water depth (m)	Technology
GERMANY	DolWin 6	2017	TenneT DE	1180	0.0146	90		DC
GERMANY	BorWin3	2015	TenneT DE	1318	0.0174	84	40	DC
UNITED KINGDOM	Greater Gabbard	2013	GET Balfour Beatty	370.37	0.0215	34.2	26	AC
GERMANY	DolWin3	2014	TenneT DE	1290	0.0239	60	30	DC
UNITED KINGDOM	Sheringham Shoal	2013	Blue Transmission	225.66	0.0326	22	18.5	AC
UNITED KINGDOM	Race Bank	2018	Diamonds Transmission Partners	572.46	0.0357	28	18	AC
UNITED KINGDOM	Dudgeon East	2018	Transmission Capital Partners	420.24	0.0402	26	21.6	AC
UNITED KINGDOM	Walney 1	2011	Blue Transmission	121.06	0.0440	15	24.5	AC
UNITED KINGDOM	Robin Rigg	2011	Transmission Capital Partners	76.58	0.0448	9.5	5	AC
UNITED KINGDOM	Gunfleet Sands (Phase 1 and 2)	2011	Transmission Capital Partners	55.01	0.0455	7	8.5	AC
UNITED KINGDOM	Walney 2	2012	Blue Transmission	138.79	0.0504	15	24.5	AC
UNITED KINGDOM	Rampion	2016		363.49	0.0505	18	34.5	AC
UNITED KINGDOM	West of Duddon Sands	2015	WoDS Transmission plc	383.59	0.0564	17.5	20.5	AC
UNITED KINGDOM	Barrow	2011	Transmission Capital Partners	38.02	0.0604	7	22	AC
GERMANY	AC Offshore Wind Baltic Sea II (Cluster 1, 2, 4)	2011	50Hertz	1605	0.0611	35	35	AC
UNITED KINGDOM	Gwynt y Môr	2015	Balfour Beatty and Equitix	470.75	0.0629	13	20	AC
UNITED KINGDOM	Walney 3 (Extension)	2018	Diamond Transmission Partners	606.24	0.0674	15	21	AC
UNITED KINGDOM	Ormonde	2012	Transmission Capital Partners	133.23	0.0875	10	23.5	AC

UNITED KINGDOM	Thanet	2013	Balfour Beatty and Equitix	207.07	0.0891	7.75	22.5	AC
GERMANY	Alpha Ventus	2010	TenneT DE	250	0.0926	45	30	AC
UNITED KINGDOM	Humber Gateway	2016	Balfour Beatty and Equitix	203.48	0.1161	8	14.5	AC
UNITED KINGDOM	Burbo Bank Extension	2018	Diamonds Transmission Partners	221.33	0.1201	7.2	3	AC
UNITED KINGDOM	Westermost Rough	2016	Transmission Capital Partners	200.03	0.1220	8	17.5	AC
GERMANY	Ostwind 1: Offshore Wind Baltic Sea I (Cluster 1)	2019	50Hertz	1605	0.1427	15	17.5	AC
UNITED KINGDOM	Lincs	2014	Transmission Capital Partners	390.88	0.1810	8	24.5	AC
GERMANY	DolWin 5	2018	TenneT DE	1228	-	*NIA*	*NIA*	DC
GERMANY	Offshore Wind Baltic Sea II (Cluster 6)	2029	50Hertz	1236	-	*NIA*	*NIA*	DC
GERMANY	DC Offshore Wind Baltic Sea II (Cluster 1, 2, 4)	2027	50Hertz	1461	-	*NIA*	*NIA*	DC
GERMANY	BorWin1	2010	TenneT DE	*NIA*	-	93.5	40	DC
GERMANY	BorWin2	2010	TenneT DE	*NIA*	-	92	40	DC
GERMANY	DolWin 2	2014	TenneT DE	*NIA*	-	43	30	DC
GERMANY	DolWin1	2011	TenneT DE	*NIA*	-	45	30	DC
GERMANY	HelWin1	2011	TenneT DE	*NIA*	-	35	24	DC
GERMANY	Riffgat	2009	TenneT DE	*NIA*	-	*NIA*	*NIA*	AC
GERMANY	Sylwin1	2012	TenneT DE	*NIA*	-	95	33	DC

Source: WindEurope, OFGEM UK's transmission tender results*, ENTOS-E and TYNDP**.

*Tender results can be either indicative transfer value or final transfer value depending on available information.

**TYNDP project cost provide an uncertainty range for each project.