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ONDERWERP Offshore Wind Topics for the European Agenda 2020

TER INFORMATIE ■
TER BESLUITVORMING ☐

Reaching the 2050 carbon-neutrality goal

Setting an ambitious pathway for expanding Offshore Wind

Executive Summary / Recommendations

Europe and the Member States should consider:

- Agreeing jointly on ambitious offshore wind expansion targets for 2030, 2035, 2040, 2045 and 2050;
- Setting up an integral energy system approach to international offshore wind development including tailor made arrangements and regulation to facilitate the deployment of hybrid projects;
- Developing an integral grid development approach, including large scale flexibility and aligned with the gas grid, where the offshore wind role out and integration in the onshore grid, is assessed from a long term socio-economic welfare and security supply perspective;
- Assessing for the mid and longterm the concept of offshore bidding zones as a possible concept for efficient integration of large scale offshore wind in the onshore electricity system;
- Aligning technology (HVDC) and voltage level (525kV) as a technical precondition for development of cost efficient windconnectors;
- Creating standards or incentives for the interoperability of system of different HVDC manufacturers;
- Enabling anticipatory investments (e.g. to reserve space on new offshore converter station platforms to create the option to connect them to an offshore grid later).
- Coordinating wind farm zone development internationally;
- Creating incentives to internationalise national projects (e.g. incentives for Danish or Dutch project to be connected also to other Member States);
- Increasing the finances available to support multinational offshore wind projects, e.g. by the means of the TEN-E guideline and in the course of the Green Deal.

- Aiming in the short term at a political decision by EU and concerned states, to develop the far North Seas in a cost-effective internationally coordinated manner with an integral energy system perspective on both grid connection, interconnection and onshore energy grid integration;
- Signing an Intergovernmental Agreement covering location and scope (connected wind capacity, connection and interconnection capacities and landing points) for a first hybrid hub-and-spoke project;
- Prepare an Intergovernemtal Agreement covering minimum investment commitments according to a precise timetable up to 2050 with specific GW tenders, the treatment of RES credits etc;
- Taking a political decision of Member States and EU to agree to a flexible and cost conscious approach towards charging fees and surcharges for electricity consumed and towards allocating renewable generation quotas;
- Having a North Seas Regulatory Market Design package developed by the European Commission;
- Increasing the research infrastructure and research funding of the European Commission to support the development to the extent necessary.

With the right political and regulatory framework it would be possible to implement

- **before 2030 a first "windconnector"-project in the North Sea**, combining grid connection and interconnection functionality
- **in the next decade the internationally coordinated roll-out of first hub-and-spoke projects** with a standardised hub size of 10-16 GW, providing combined grid connection and interconnections to multiple countries

Reaching the 2050 carbon-neutrality goal

Setting an ambitious pathway for expanding Offshore Wind

To create a long-term reliable and attractive investment framework the European Commission and the Member States should start now to work on achieving the final targets towards climate neutrality beyond the intermediate targets set for 2030, including ambitious offshore wind expansion targets. To have transmission infrastructure in place in time, a planning horizon until 2030 is not sufficient. Transmission System Operators are already planning the grid for 2035 and beyond and only with a long term investment horizon the energy system can be designed optimally from a socio-economic perspective.

Member States should jointly agree on ambitious offshore wind expansion targets for 2030, 2035, 2040, 2045 and 2050. These targets should be internationally coordinated beyond 2030 and an offshore wind development roadmap should guide the offshore wind build-out for the coming decades.

In this paper a first sketch of the offshore wind development roadmap (for the North Sea countries) is provided covering the offshore building blocks we foresee in the timeframes 2030, 2040 and 2050. The roadmap sketches the pathway from radial connections for offshore wind transmission (today's world) towards a connected offshore grid in the North Sea in 2050 that is designed from an integral energy system perspective. Among the first concrete internationally coordinated projects are the windconnector (i.e. a hybrid connection between wind area IJmuiden Ver (NL) and UK) in the 2030 time frame and the first project of the North Sea Wind Power Hub programme in the 2035 time frame. These projects provide the pathway towards an integral energy system where offshore wind is integrated into the onshore energy system, combining grid connection and interconnection functionality, connecting different electricity markets and using large scale sector coupling (conversion and storage) to provide the required balancing capabilities in a future energy system largely driven by renewable sources.

1. Integral energy system approach to international offshore wind development

By the end of 2020, approximately 22 GW of offshore wind will be installed in the North Sea, with an average deployment rate of currently 2-4 GW/year. To decarbonise the electricity system alone, approximately 180 GW of North Sea offshore wind is required by 2050 for the North Sea countries. An additional ~250 GW of offshore wind is needed to decarbonise the rest of the energy system for these countries. Thus, deployment rates need to increase significantly to 5-15 GW/year. Also, the energy system as whole is transforming towards a net-zero emission energy system relying on

variable renewable (non-dispatchable) generation technologies.

The ramp-up of variable renewable energy generation and integration in the energy system (to achieve net zero emissions before 2050), requires the realisation of large scale offshore wind projects, which combine grid connection and interconnection (hybrid), connect different energy markets (cross-border) and provide flexibility, as well as e-gas/e-fuel production, at scale (cross-sector). This in turn requires a market design and regulatory framework that provides incentives to all stakeholders involved in line with these climate agreement targets.

Hybrid energy projects such as windconnectors energy hubs are the next step in the ramp-up of offshore wind and have the ability to reduce the cost of offshore wind development by **optimisation from an integral energy system perspective**. However, these projects are by nature highly complex to execute and require cooperation between different systems, markets and players. Furthermore they require careful consideration of limitations and requirements of the onshore grid and anticipatory investments. Therefore an integral approach to the energy system and grid development is required which takes into account a societal and security of supply perspective.

<u>Tailor made arrangements for hybrid projects – approach to be discussed</u>
Tailor made arrangements and regulation are needed to facilitate the deployment of hybrid projects, respecting the evolution of the hybrid development. Meaning: linking an interconnector to planned or existing national offshore transmission systems requires different arrangements than the tee-in of a windfarm into an existing interconnector to provide investors with the legal certainty they need. While there may not be a one size fits all approach for each individual projects, an international consensus on the required approach and supporting standardisation efforts greatly facilitate to the roll-out of these projects.

2. The roadmap and building blocks for offshore wind development for 2030, 2040 and 2050

To ensure long term socio-economic welfare and security of supply, it is important now to provide the main guiding principles and building blocks for the roll-out towards 2050. This will provide a clear outlook and perspective to all stakeholders involved and secure incentives which are aligned to the long term climate goals. During the roll-out, and while accelerating the deployment of offshore wind (compared to today), the building blocks will need to change in line with the penetration level of renewable power in the energy system.

<u>Phase 1: current - ~2025</u>

Small/Medium scale – Nationally oriented – Radial connection – point-to-point interconnections

The current phase is characterised by a nationally oriented approach to connecting offshore wind. Offshore wind farms are connected radially, with seperate, and independently organised, point-to-

point interconnections. Gradually the size of the connected windfarms increases to the 300-700 MW rang. In the Netherlands standardisation of 700 MW HVAC transformer stations has led to significant cost savings. In Germany and Denmark, transformer stations are separately designed for each wind farm. In Germany significant experience has been obtained with HVDC technology due the long distance from shore of the wind farm locations.

Phase 2: 2025 – 2030

Medium scale – Nationally oriented – Radial and Hybrid connections

During this period, the approach of the previous phase continues. In addition, a new standard for 2 GW HVDC platforms is being developed for The Netherlands and Germany. In addition, the first hybrid connection between the wind area IJmuiden Ver in the Netherlands and the United Kingdom ("windconnector") – combining grid connection and interconnection functionality, is being developed with governmental support for initial anticipatory investments.

Phase 3: 2030 – 2040

Large scale – International coordination – Hybrid connections – Onshore P2G

In the next decade, the next step in offshore wind development is expected, based on the internationally coordinated roll-out of hub-and-spoke projects with a standardised hub size of 10-16 GW. These hubs provide combined grid connection and interconnections to multiple countries, reducing societal cost, minimising onshore grid integration impact and providing the required security of supply. Gradually large scale flexibility is introduced based on power-to-gas (P2G) and storage, to cope with balancing supply and demand over longer periods of time. Pending the maturity of the technology, power conversion is anticipated to be located largely onshore at first. First projects will be developed ("energy plants") that utilise large demand centres as large prosumers, providing both flexibility and producing green fuels.

Phase 4: 2040 – 2050

Large scale – International coordination – Hybrid connections – Offshore P2G – Storage

The transition started in the 2030s will continue further into the 2040s, with a further upscaling of P2G and the "energy plant" concept. In addition large scale (seasonal) storage will be developed to ensure security of supply on all time scales. Power-to-gas is expected to be located partly offshore in synergy with the global demand of e-gases and e-fuels.

3. Description of the first concrete projects of the roadmap

2027 Windconnector

The Dutch Government decided to futureproof the two IJmuiden Ver HVDC offshore grid connections (2x2 GW 525 kV platforms) by allowing for the needed anticipatory investments for an "interconnector bolt on" or "windconnector". This decision is based on the socio-economic potential of combining Dutch offshore connections for offshore wind with interconnectors to Great Britain. Besides significant cost savings, windconnectors also offer wider benefits such as more efficient

use of offshore and onshore infrastructure and reducing environmental impact. Three to four terminal configurations are currently being considered as the interconnector could be connected from IJmuiden Ver to GB via planned British windfarms and/or directly to GB mainland.

<2030 Danish energy island initiative
The Danish Government and its parliamentary base agreed in June to ”Explore the possibility for Denmark to build the first energy island with minimum 10 GW by 2030”. This is one of many efforts to deliver on a binding 70 GHG reduction target (compared to the 1990 baseline) by 2030, which received broad parliamentary agreement on 6 December 2019. Several configurations are being considered in both the Baltic Sea and North Sea, and include interconnections to neighbouring countries as well as power-to-X conversion to decarbonise the non-electric part of the energy sector. Danish officials have said that an energy island could potentially be a first NSWPH hub-and-spoke project in the North Sea.

<2035 North Sea Wind Power Hub (#335 TYNDP)
The North Sea Wind Power Hub's "hub-and-spoke" concept offers benefits by minimising integration costs of offshore wind, increasing socio-economic welfare across borders by further coupling energy markets and supporting security of supply at wider regional level against minimised total energy system costs. The internationally coordinated approach is more beneficial to socio-economic welfare than a national approach with radial connections for offshore wind farms and point-to-point interconnectors.

In the Project, 12 GW of offshore wind is connected directly, through 66 kV AC inter-array cables, to a single hub. At the hub the power is converted to 525 kV DC and transmitted to three connecting countries: The Netherlands (4 GW), Germany (6 GW) and Denmark (2 GW). The hub connections are configured in such a way that the DC connection cables serve both as grid connection and interconnection between the connected countries. This Project currently has the status of "under consideration"; the exact configuration, capacities and location of the hub may change based on the findings of the studies being undertaken currently.

4. Market design, regulation and financeability

To support the required large scale roll-out of offshore wind in the North Sea, the market design and regulatory framework need to be adapted to ensure that all stakeholders involved are incentivised in line with the climate agreement goals. The change from an electricity system that relies primarily dispatchable fossil fuels, to a net-zero emission electricity system largely powered by non-dispatchable renewable sources fundamentally changes the operational parameters of the system. In addition, also the "other half" of the energy system needs to be decarbonised requiring even more renewable sources to produce the required synthetic fuels and gases. With increasing variability in the electricity system, balancing of supply and demand increasingly require temporal flexibility (i.e. sector coupling and storage), which cannot be solved by international trading.

Europe and the Member States should consider:

- Assessing in the mid and long term the concept of offshore bidding zones as a possible concept for efficient integration of large scale offshore wind in the onshore electricity system.
- Developing an integral grid development approach, including large scale flexibility and aligned with the gas grid, where the offshore wind role out and integration in the onshore grid, is assessed from a long term socio-economic welfare and security supply perspective.
- Enabling anticipatory investments (e.g. to reserve space on new offshore converter station platforms to create the option to connect them to an offshore grid later) to solve the deadlock for investment in offshore hybrid assets, also by helping to mitigate the fear of 'stranded assets'.
- Creating incentives to internationalise national projects (e.g. to create incentives for Danish or Dutch project to be connected also to other Member States).
- Increasing the finances available to support multinational offshore wind projects, e.g. by the means of the TEN-E guideline and when amending other legislation in the course of the Green Deal.

5. Boundary conditions: technical standardization and internationally coordinated maritime planning

Now that our grid connections are moving towards a standardised approach[1] across the Netherlands, Germany and other countries, there are advantages in propagating the use of these standards in a broader European context. We observed significant advantages in standardising the near and far shore systems of TenneT. Although the physical and regulatory environment of projects might differ throughout Europe, converging towards standardized European concepts or building blocks will likely result in further synergies in the supply chain, thereby increasing quality and reducing the cost of offshore wind. These standardisation benefits materialise when they come with a 'steady roll-out' with annual capacities increasing, to provide market certainty and outlook to invest building the required supply chain.

Alignment of technical parameters for windconnectors

As a first building block for large scale offshore wind roll-out in the 2020s, windconnectors provide increased utilisation of the capital-intensive offshore infrastructure and energy market coupling through hybrid connections that combine grid connection and interconnection functionality. For development of such offshore hybrid projects early alignment and coordination on both sides is key to success. As a technical precondition for development of cost efficient windconnectors, technology (HVDC) and voltage level (525kV) need to be aligned and anticipatory investments should be made. Even in the case of aligned technical parameters, HVDC manufacturer

[1] Starting with 700 MW AC platforms in the current Dutch roll-out (2018-2023), followed by the development of a 2 GW HVDC standardised platform for both The Netherlands and Germany (2024-2030).

interoperability is key. Currently there is no incentive nor obligation for suppliers to open up their technology to others, making the implementation of multivendor approaches challenging and risky. However, these multivendor approaches will become inevitable for developing more advanced internationally coordinated roll outs (like the NSPWH) in the 2030s. TSOs can play a role in this, but policymakers and industry need to support this as well.

> IJmuiden Ver windconnector: a cost efficient windconnector requires technology compatibility and manufacturer interoperability. The technical concept for the IJmuiden Ver offshore grid connection is a 2GW 525kV platform system. This means that the GB system to which IJmuiden Ver will be connected, needs to have the same operating voltage level. In case of a windconnector via a planned British windfarm, different frameworks, interests and incentives for TSOs (socio-economic perspective), wind developers (commercially under competition) and HDVC suppliers (IP protection) might lead to technical showstoppers if not addressed and coordinated properly.
> Another project TenneT is actively participating in is the electrification of oil and gas platforms in the North Sea by connecting these to the offshore grid. Once electrified these platforms can use renewable power for their operations instead of burning fuel gasses. This can save vast amounts of CO2-emissions and makes the use of the offshore grid more efficient.

<u>International coordination in wind farm zone development</u>
The designation and development of wind farms is currently a national undertaking with little to no alignment between countries in these processes. This can result in inefficiencies such as the sizing of wind farm plots, wake effects between wind farm zones, supply routes, cable corridors, planning and onshore connection sites. Coordination between neighbouring countries of a regional level of both the designation and development of wind farms can result in a more optimised approach.

Given the 10+ years timeline required to develop to grid connection and onshore integration infrastructure, it is crucial that an internationally coordinated view is developed on the offshore wind roll-out towards 2050 (what, when and where?) to ensure efficient use of (unevenly distributed) offshore wind resources, maximising marine biodiversity and ensuring offshore wind connection and integration in the European energy system at maximum socio-economic benefit for Europe as a whole.

6. Next steps.

Based on the above the following measures should be taken to facilitate and accelerate the roll-out and integration of offshore wind in the North Sea:

(i) political decision by EU and Member States concerned, including the UK, to develop the far North Seas in a cost-effective internationally coordinated manner with an integral energy system perspective on both grid connection, interconnection and onshore energy grid integration;

(ii) agreement by the Member States concerned to draw up an IGA covering location and scope (connected wind capacity, connection and interconnection capacities and landing points) for a first hybrid hub-and-spoke project;

(iii) agreement by the Member States concerned to draw up an IGA covering minimum investment commitments according to a precise timetable up to 2050 with specific GW tenders, the treatment of RES credits etc;

(iv) Political decision of Member States and EU to agree to a flexible and cost conscious approach towards charging fees and surcharges for electricity consumed and towards allocating renewable generation quotas.

(v) the commitment of the Commission to come forward with a North Seas Regulatory Market Design package during its mandate, and

(vi) the commitment of the Commission to support the initiative with infrastructure and research funding to the extent necessary.