POSITION PAPER

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1. Background Material

LITERATURE USED:
• N.A.

2. Scope and Considerations

For the roadmap offshore wind 2030 (routekaart windenergie op zee 2030) TenneT is tasked with the connection of several offshore wind farms up to 2030. The wind farm zones 'Hollandse kust West' and 'Ten Noorden van de Waddeneilanden' will be connected with TenneT's previously established and consulted standardized 700 MW grid connection concept. Due to its size and distance to shore, a new grid connection concept has been established for the wind farm zone IJmuiden Ver. The figure below shows a schematic cross-section of this new grid connection concept. Wind turbines are connected through 66 kV “inter-array” cables (in orange) to an offshore (HVDC) converter station. Using 2 GW high voltage (525 kV) export cables (in green) the electricity is transported to shore. TenneT will be responsible for the offshore grid, from the onshore substation up to and including, the offshore substation. TenneT intends to create a new standard HVDC grid connection concept for both connections to IJmuiden Ver and potential future far shore wind farms.

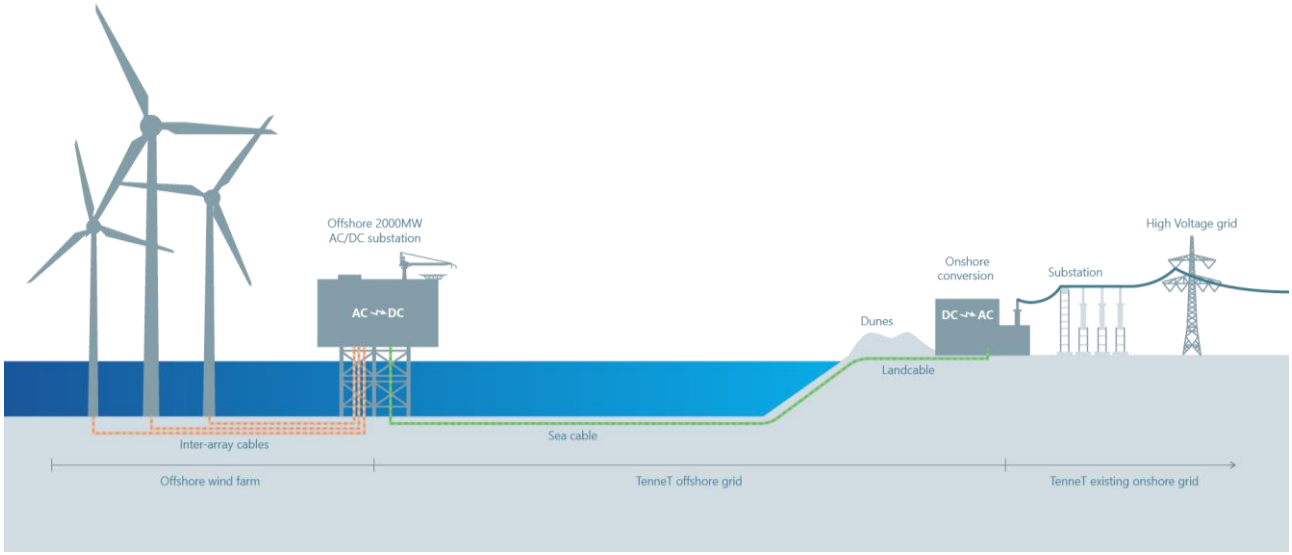

Figure 1 - HVDC grid connection concept

This position paper describes the proposed technical interfaces and the interface responsibilities between the offshore wind park owners and TenneT. By doing so it defines the foreseen facilities for the OWF which are provided by TenneT. The position paper covers the complete grid connection: the onshore land station, the HVDC cable and the offshore platform. The paper describes all required activities before operation such as design, fabrication, testing and commissioning and offshore installation.

3. Technical interfaces

In the following, the interfaces between TenneT and the OWF will be listed and described. The interface responsibilities will be incorporated in the Realization Agreement between TenneT and the OWF. During realization regular interface meetings will be planned between TenneT and the selected OWF and the interfaces will be further detailed based on the principle responsibilities listed below.

The following main technical interfaces have been identified:

1. 66 kV cable route starting from the platform 500m safety zone perimeter up to the 66 kV switchgear
2. 66 kV switchgear at the offshore platform
3. Telecommunication and fibre optic infrastructure
4. OWF equipment located on TenneT infrastructure (offshore and onshore)

The aforementioned technical interfaces are described in further detail in paragraph 3.2 to 3.5.

Organisational interfaces (planning, coordination, safety, document control, etc.) are described briefly in paragraph 0.

3.1 General interface management method

Per main interface defined above, sub interfaces will be listed in below paragraphs. For each sub interface a functional role will be assigned to TenneT and to the OWF. The definitions of the functional roles are described in Annex A, RASCI table. In general one of the parties (mainly TenneT) will have the responsible (R) and accountable (A) role whereas the other party (WPO) will have either a supportive (S), consulting (C) or informative (I) role. The responsible / accountable party may transfer the 'responsible' part of the interface (execution) to a third party (contractor).

3.2 66 kV cable route from platform 500m safety zone perimeter up to the 66 kV switchgear

In the table 2-1 below, high level interfaces for the 66 kV cable route from entry of the platform safety zone (500m) up to the 66 kV switchgear are listed with for each interface the role of the two main stakeholders.

Table 3-1. High level interfaces on 66 kV cable route from platform safety zone up to the 66 kV switchgear

Interface	TenneT	OWF
Design: Cable layout within the 500m safety zone	A / R	R
Design: J-tubes, Dimensions[1]	A / R	C[2]
Design: J-tubes, Location and routing inside jacket.	A / R	C
Design: J-tubes, Bell mouth design and angle.	C	A / R
Design: Cable hang-offs	C	A / R
Design: Cable route from hang-off to 66 kV switchgear	A / R	C
Design: Cable pulling methodology (basic design/philosophy)	A / R	I
Design: Cable pulling method (detailed design)	C	A / R
Design, Supply, Installation: Scour protection below cable (if applicable)	A/R	I
Design, Supply, Installation: Fixation of cable on top of scour protection	C	A/R
Design, Supply, Installation: Cable protection system	-	A / R
Supply and installation: J-tubes	A / R	-
Supply and installation: 66 kV Cable trays	A / R	I
Supply and installation: 66 kV Cable (incl. burial, pulling and termination)	C	A / R
Supply and installation: Bell mouth	I	A / R
Supply and installation: Messenger Wire	I	A / R
Supply and installation: Cable specific items (clamps, terminations, etc.)	I	A / R
Supply and installation: Pulling equipment (winch, sheaves, etc.)	I	A / R
Testing 66 kV Cable	C	A / R

3.2.1 Design

OWF is responsible for the inter-array cable routes and burial depth within the 500 meter safety zone, but within the limits set out by TenneT. TenneT will prepare a principle field lay-out which will be published before the OWF tender by RVO (if available). This lay-out shall be the basis for further optimization during detailed design between TenneT, OWF's, Platform Contractor and Cable Contractors. In case of conflicting interest within the 500m zone TenneT will be leading and decide. An example layout of the Borssele Windfarm is attached to this position paper (Appendix B - Example Cable Field layout).

TenneT is responsible for the generic J-tube design (location, dimensions). The detailed design of the J-tube will be adapted based on input from the OWF as long as there is no conflict with other parties. For example the design of vents, the design of the hang-off flange, the design of the bell mouth and the bell mouth angle and orientation.

[1] Reference is made to Position Paper T11
[2] At the time of J-tube design the winner of the windfarm site tender might not be known. As a result TenneT might perform an external consultation.

TenneT will develop the 66 kV cable routes from the J-tube hang-off collar to the 66 kV switchgear. The routes will be based on pulling of the 66 kV cables and routing them up to the 66 kV switchgear without joints or junction boxes on the cable deck. TenneT will not allow for any overlength in the cable routing as a mitigation for phase errors.

TenneT will develop a cable pulling methodology (basic design/philosophy) which will take into account the following factors:

- Bending radius and load restrictions
- Locations for cable winches and working area's
- Temporary storage area for equipment & cables

Based on the generic cable pulling methodology the OWF has to make a detailed design for the cable pulling and installation method. TenneT will share the required 3D models with the OWF.

An example cable pulling methodology from the HVAC program is attached to this position paper (Appendix C - Example Cable Pulling methodology). The cable pulling methodology will be published before tender of the OWF by RVO.

If required TenneT will provide a pre-installed scour protection under and around the platform jacket. The scour protection will provide scour protection for the jacket piles and provide a stable underground for the subsea cables. The OWF is responsible for the design and installation of the cable across the scour protection, the cable protection system, the fixation of the cables on top of the scour protection (if needed) and the protection of the cable near the scour protection edge.

3.2.2 Supply and installation

TenneT will supply and install the J-tubes and 66 kV cable trays. All components which are cable specific (e.g.; clamps, cable hang-off cable terminations, etc.) will be supplied and installed by the OWF.

The OWF is responsible for installation of cable protection (if applicable), the actual cable pulling, cable storage (if any), cable routing, cable fastening and termination works. All required pulling equipment (e.g. pulling winch, hang-offs, pulling wire etc.) are the responsibility of the OWF. TenneT will incorporate the required structural support in the design. In principle the OWF is responsible for his own power supply. Nevertheless TenneT will supply power if it is available and technical feasible.

The OWF will get the possibility to install pulling equipment on the platform before sail-away from the fabrication yard (if possible).

3.2.3 Testing and commissioning

The OWF will be responsible for testing of the 66 kV cables, including HV tests, phase checks, sheath testing and OTDR tests on optical fibres.

For commissioning of the 66 kV cables reference is made to position paper I2,Offshore Testing with OWF.

3.3 66 kV switchgear

In the Table 3-2 below, high level interfaces for the 66 kV switchgear (feeder bays for OWF strings) are listed with for each interface the role of the two main stakeholders.

Table 3-2. High level interfaces on 66 kV switchgear (feeder bays for OWF strings)

Interface	TenneT	OWF
Design, Supply, Install, Test, Own, Maintain the 66 kV GIS	A/R	I
Provide female cable termination in 66 kV GIS	A/R	C
Provide male cable termination on 66 kV cable	C	A/R
Installation of 66 kV cable in 66 kV GIS	A/C	R

Reference is made to T09 Control & Protection Design 66 kV GIS for additional information concerning the GIS design and the setup of the Control and Protection.

TenneT standardizes the female cable termination of the 66 kV according to IEC 62271-209: Pfisterer HV-CONNEX, Size 4. The OWF shall align the accessories and (type) testing of its 66 kV cables on these specifications.

3.4 Fibre optic infrastructure

In the Table 3-3 below, high level interfaces for the fibre optic infrastructure (for use of the OWF) are listed with for each interface the role of the two main stakeholders.

Table 3-3. High level interfaces on the telecommunication and fibre optic infrastructure (for use of the OWF)

Interface	TenneT	OWF
Design, Supply, Installation of Fibre Optic splice boxes on the Platform near the hang-off of the inter-array cables.	A/R	I
Design, Supply, Installation of Fibre Optic splice boxes on the Land station.	A/R	I
Design, Supply, Installation of optic fibres from wind turbines to the Fibre Optic splice boxes on the platform.	-	A/R
Design, Supply, Installation of optic fibres from Land station to OWF operation centre.	-	A/R
Design, Supply, Installation of optic fibres from the Platform to the Land station.	A/R	-
Connecting the optic fibres from the inter array cables to the TenneT provided optic fibres (Splicing) .	C	A/R
Connecting the onshore optic fibres from OWF operation centre to the TenneT provided optic fibres (Splicing) .	C	A/R

3.4.1 Fibre optic infrastructure design and installation

TenneT is responsible for the design of the fibre optic infrastructure from the platform OWF splice box up to the splice box on the land station. TenneT will provide 48 optical dark fibres per 1GW windfarm. TenneT will not provide any active components for the fibre optic infrastructure of the windfarm. The active components of the windfarm shall be installed on the windturbines or landstation.

3.5 OWF equipment located on TenneT infrastructure (offshore and onshore)

Based on experience in Germany with the direct 66 kV concept TenneT will minimize or eliminate OWF equipment on the platform or in the land station. This will reduce the number of technical and operational interfaces.

Typically installed on the platform and/or land station	**New setup.**
Control & Protection Equipment	Reference is made to T9 Control & Protection design. In the new design TenneT will provide the control and protection devices for the 66 kV OWF bays. The protection philosophy comprises a redundant protection of the OWP bays. So there is no need for the OWP to have their own (additional) protection relay. Control of the full bay is done by TenneT.
Signals and alarms	All signals and alarms that the OWP might need, can be made available via SCADA. They will be exchanged onshore.
Operational measurements	All operational measurements that the OWP might need, can be made available via SCADA. They will be exchanged onshore.
Metering Equipment (fiscal metering)	Reference is made to T15 Metering. The installation and maintenance of the metering equipment is the responsibility of the connected party, to be carried out by an independent certified metering. TenneT will facilitate the easy placement of metering equipment by providing a generic metering cabinet which complies with the conditions of the Metering Code. The cabinet will not be located in a dedicated room. TenneT will provide access to the platform to the metering responsible party.

Power Quality (PQ) measurement	TenneT is obliged to install PQ measurement devices which shall meet EN standards and must be validated by a independent party. The PQ measurement must also be calibrated periodically. TenneT can make the raw data of the PQ measurement available to the OWP upon request to enable the OWP their own investigation.
Disturbance recordings	TenneT's control & protection devices will also be used for disturbance recordings (incl. record and store waveforms). These data can also be made available upon OWPs request.
Communication Equipment (VHF, AIS, Tetra, 4G) and Sensing Equipment (Waves, Weather, CCTV)	OWF can get access to (data provided by) the Shared Services equipment installed on the platform (Weather, Waves, etc.). Reference is made to T13. OWF specific equipment (e.g. VHF) could be placed on the wind turbines.
Distributed Temperature Sensing	OWF could place its own DTS equipment on the wind turbines.
Fibre Optic Network	TenneT will patch 48 fibres from the 66 kV inter-array cables directly to the land station.
Network Cabinets	Not applicable.
Wind Park Controllers	OWF could place this equipment on the wind turbines or onshore. All measurements and input signals needed from the platform (mainly from 66 kV GIS) can be made available via SCADA. They will be exchanged onshore or in the wind turbines.

TenneT would like to discuss this topic further during the consultation sessions and is interested in the opportunities/risks of this approach.

3.6 Organisational interfaces

For the main technical interfaces, organisational interfaces have to be managed as well in each of the project phases.

3.6.1 General coordination

Interface meetings shall be held on a regular basis between all involved parties (TenneT, OWF and involved contractors). Amount, subjects, duration, location, agenda etc. of these meetings shall be agreed upon in a later phase.

3.6.2 Planning

During all project phases, TenneT will be responsible for the overall planning of the grid connection realisation works.

3.6.3 Coordination during offshore works

TenneT will be responsible (R) and accountable (A) for the offshore platform and therefore for planning, coordination and safety rules.

To manage planning, coordination and safety properly, TenneT will provide work permits for offshore works within the safety zone (500m) of the offshore platform and for all works on the platform. The OWF will support TenneT with this coordination by correct and on-time application for work permits and by participating in all planning and progress meetings to be scheduled for this purpose.

TenneT will define the method for (emergency) communication within the project site (platform safety zone and the platform itself). Further agreements between TenneT and OWF on marine coordination and coordination of works on the platform shall be made in a later phase.

3.6.4 Document control

Exchange of documents and formal communication between the parties shall be accomplished through a single document management system. TenneT will select this system.

4. Position TenneT

Above considerations lead TenneT to the following position:

TenneT intends to manage interfaces by involving all stakeholders as early in the project as possible and to define clear roles for each interface.

In this position paper the main technical interfaces have been identified and briefly described. The interface responsibilities will be incorporated in the Realization Agreement which will be signed between TenneT and the OWF. The interfaces will be further detailed based on the principle responsibilities listed.

Appendix A - Functional roles in interface management (RASCI)

Functional Role:	
R	The party who is responsible for the interface and is responsible for the execution. The responsible must report to the accountable. Each activity should have a minimal number of "R"'s.
A	The party who is accountable and qualified for the correct and thorough completion of the interface and must give an approval before an action item or solution can be effective.
S	The party who supports the responsible party to achieve the result of the work execution
C	The party who is consulting the other involved parties regarding the implementation or must be pre consulted. This is two-way communication. This person will (also) give direction to the result, he / she will be consulted prior to decisions or actions.
I	The party who needs to be informed about the decisions, on the progress, achievements etc. This is one way communication. Limited number - the necessary ones.

Appendix B - Example Cable Field layout

Appendix C - Example Cable Pulling methodology