

STAKE HOLDER CONSULTATION PROCESS OFFSHORE GRID NL

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1. Background material

Literature used:

- DNV-GL: High level review helideck and accommodation - Doc: 130112-NLLD-R1 Rev. A- Public Version, 9 June 2015
- Position Paper ONL 15-216-T12_Redudancy_availability_PP_v1
<http://www.tennet.eu/nl/nl/net-projecten/projecten-in-nederland/net-op-zee/consultatie-proces/>

2. Scope and considerations

Figure 1 shows the connection of an offshore wind farm to the onshore electricity grid. TenneT will supply and install the grid connection up to, and including, the offshore substation. The wind park, including the wind turbines and the array cables, up to the offshore Connection Point (CP)¹ at the switchgear installation on the offshore substation of TenneT, is to be supplied and installed by the owner of the Power Park Module (PPM²).

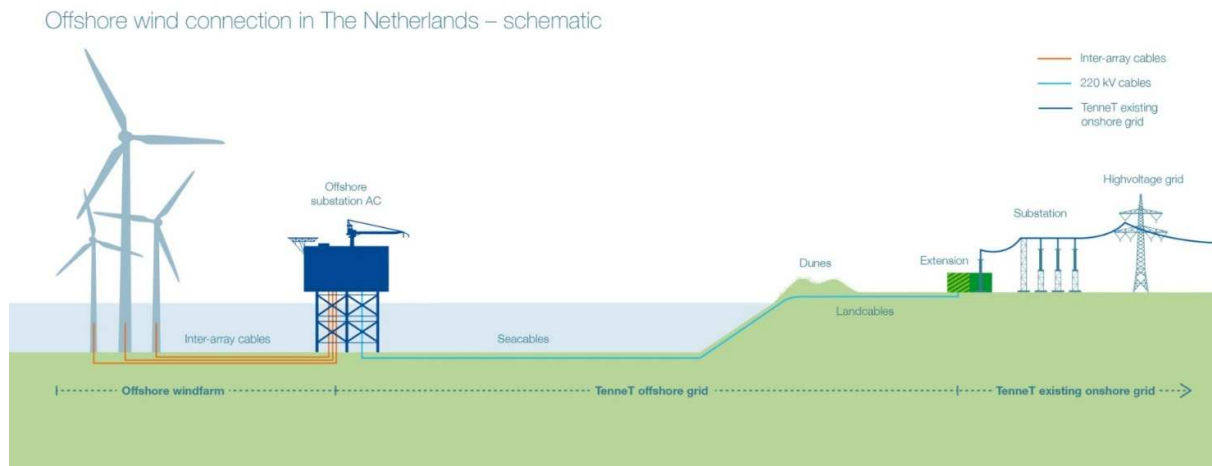


Figure 1 Schematic of the offshore electrical grid: Source: TenneT

TenneT intends to standardise the offshore transmission grid as much as possible for all five wind areas to be realised in the coming years in line with the Energy Agreement.

¹ The connection point (CP) between the offshore power park module (PPM) and TenneT is specified at the cable termination of the inter-array cables and the switchgear installation on the platform.

² Ref: position paper T3

This paper describes how TenneT, as the platform owner, proposes to deal with access to its offshore substations, for the different parties involved. This covers two subjects:

Technical access methods

TenneT has to determine the access strategy for the offshore substation. The access strategy defines which facilities need to be provided for safe and reliable (from an availability point of view) transfer of personnel to and from the platform. The access strategy is an important design decision since it will have an impact on the design of the platform, the availability (RAMS), the O&M strategy and OPEX. TenneT assessed the various access methods. Main discussion is whether a helicopter platform should be incorporated in the offshore substation. This position paper gives a summary on this assessment and describes TenneT's position.

Procedure for granting permission to access TenneT platforms

Wind park owners have equipment located on TenneT's offshore substation and need access for maintenance. TenneT has to determine how wind park owners get access to the offshore substation. TenneT assessed various way of access. This position paper gives a summary on this assessment and describes TenneT position.

3. Technical access philosophy

Overview Access Methods

The following access methods are evaluated:

- Crew Transfer Vessel (CTV) & Boat landing
- Platform Supply Vessel (PSV) & Walk2Work Solution
- Helicopter & Helicopter Platform
- Helicopter & Helicopter hoisting

The tables below display relevant numbers and specifics which have been used to assess the various methods. The report of DNV-GL³ gives an elaborate description of the access methods.

³ DNV-GL: High level review helideck and accommodation, doc: 130112-NLLD-R1 Rev. A-Public Version, 9 June 2015

Indicative Market Numbers

Vessel	Hs limit (significant wave height)	Wind limit	Travel speed	POB	Material Capacity
CTV & Boat Landing	0.5-1.5m	>10 m/s	20-30 knots	12	15 ton
PSV & W2W <ul style="list-style-type: none"> • Ampelmann A-Type⁴ • Ampelmann E-Type⁴ • ZBridge⁴ 	2.5 m 3.1-3.5 m 3.1 m	10-15m/s	10-15 knots	20-45	1000 ton
Helicopter hoisting ⁵	2.5-4 m	21 m/s	250km/u	3-6	25 kg
Helicopter platform ⁵	2.5-4 m	21 m/s	250km/u	3-6	200-300 kg

Table 1: Indicative Market Numbers.

Assessment structure

Each offshore platform has different characteristics which determine the optimal strategy for operating and maintaining the substation. The main factors are:

- Distance from onshore facilities
- Reliability, Availability, Maintainability of offshore substation

The main factors that influence the suitability of the access method are:

- Safety
- Availability (of access method, weather and sea-state dependency)
- Direct costs
- Response time
- Required safety zones (and effect on the wind park)
- Trends in the offshore market

The access methods have been assessed by comparison of these factors.

⁴ The operation limit of a W2W system depends on the characteristics of the ship.

⁵ DNV GL: Recent incidents in the North Sea oil and gas industry have led to changes in regulation stated by the British CAA with respect to the sea states in which helicopters may be deployed (CAP1145). This has limited the use of helicopters by the lesser of sea-state 6 (Hs < 4 m) or the certified ditching performance of the helicopter, understood to be the sea state in which the aircraft may remain floating upright in the water. Many frequently used helicopters have a certified ditching performance of sea state 4 (Hs < 2,5 m). It is expected that the Dutch authorities will follow the CAA and take over the regulations. The limiting significant wave height will therefore vary between 2,5-4 depending on the helicopter.

3.1 Site Specific characteristics

Distance from onshore facilities

Platform	Distance from harbour
Borssele	50 – 55 km
Hollandse kust	20 – 30 km

Reliability, Availability, Maintainability of the offshore substation

A RAM study is performed by TenneT. The following numbers are calculated based on the current design:

Primary HVAC system	
Availability	99,1%
Failure rate/yr. HV Platform components	0,045 (once every 22 year)
Maintainability	TenneT expect 10-14 day/yr. scheduled maintenance on the platform

See position paper ONL 15-216-T12_Redudancy_availability_PP_v1 for further elaboration on the availability number.

3.2 Factors

Safety

The safest way of access is provided by Walk2Work solutions. In addition, the platform supply vessel can provide immediate medical assistant in case of emergencies.

The use of CTVs and boat landings is more risky, although improved systems such as the Z-step are now entering the market. CTVs offer less options to evacuate injured personnel and can only offer limited emergency services.

The use of helicopters is assessed to incorporate the highest risk. Accidents with helicopters generally lead to fatal incidents, for which reason major companies such as Shell have decided to avoid the use of helicopters for crew transport where possible.

Availability

H _s	Crew Transfer Vessel	Platform Supply Vessel (W2W)	Helicopter	Time	% of time (Borssele)
0,0-0,5	X	X	X	< 0,5	11,9%
0,5-1	X	X	X	< 1	45,5%
1,0-1,5	X	X	X	< 1,5	70,3%
1,5-2		X	X	< 2	83,5%
2,0-2,5		X	X	< 2,5	91,2%
2,5-3		(X ⁷)	X ⁶	< 3	95,4%
3,0-3,5		(X ⁷)	X ⁶	< 3,5	97,8%
3,5-4			X ⁶	< 4	99,1%
4,0-4,5				< 4,5	99,7%
4,5-5				< 5	99,9%
>5					100,0%

The last column displays the percentages of the time a certain sea state occurs.

Difference in availability compared to a Helicopter (H_s<4,0 m)

CTV (H _s <1,5m)	- 28,8%
PSV (H _s <2,5m)	- 7,9%
PSV (H _s <3m)	- 3,7%
PSV (H _s <3,5m)	- 1,3%

Response time

	Induction	Transfer Borssele	Transfer Hollandse Kust
CTV	0	120 minutes	< 60 minutes
Platform Supply Vessel (W2W)	0	120-360 minutes ⁸	60-360 minutes ⁸
Helicopter	90 min	15 min	15 min

⁶ Dependent on certified ditching performance of the helicopter

⁷ Dependent on platform supply vessel and W2W solution.

⁸ The response time for a W2W vessel very much depends on prior arrangements having been made with the vessel operator. It has been assumed in the table above that such a vessel is available in the area (see also "wind farm interfaces") and that a frame agreement is in place for priority availability in case of a grid connection outage.

Direct costs

TenneT estimates an additional 3-4 million CAPEX when a helicopter platform is integrated in the design. This number includes the additional cost for the helicopter platform itself, the required support systems and the effect on the structural design. The yearly maintenance on the helicopter platform, the certification and the training of personnel will have a significant increasing effect on the OPEX.

Next to these platform costs, TenneT estimate that the direct transfer costs by crew transfer vessel are the lowest. Direct transfer cost with helicopters are higher than transfer by crew transfer vessels, while platform supply vessels with W2W are most expensive, regarding this direct transfers costs.. the latter however, is strongly depending on the development in the market and the possibilities to share such services with offshore wind parks owners.

Required safety zones

Offshore platforms with helicopter pads require an obstacle-free area to ensure safe helicopter traffic. The exact requirements of the obstacle free zone is described in ICAO Annex 14 Vol. II and ICAO Heliport Manual. The requirements result in 2 corridors from approximately 6000mx900m separated by not less than 150°.

The incorporation of a helicopter platform would therefore significantly reduce the available space for offshore wind parks.

Trends in the offshore market

Two import trends are seen in the offshore market:

- The market re-evaluates the use of helicopters for crew transport. Companies are concerned about the associated safety risk. Recent accidents also led to more stringent regulation.
- Innovative access methods are being developed and enter the market. These developments will, most likely, result in improved access methods by ships and increase the operational limits of boat transfers.

3.3 Analysis

When comparing the different access methods the main question is whether the use of helicopter is beneficial. The advantage of helicopters is their availability and their speed. This is only relevant in the case of urgent corrective maintenance (an outage). And only in the case the fault could be fixed by a small crew and with tools and spare parts of limited weight and in case alternative access means are unavailable. The probability of such an occurrence is displayed by the following fault tree:

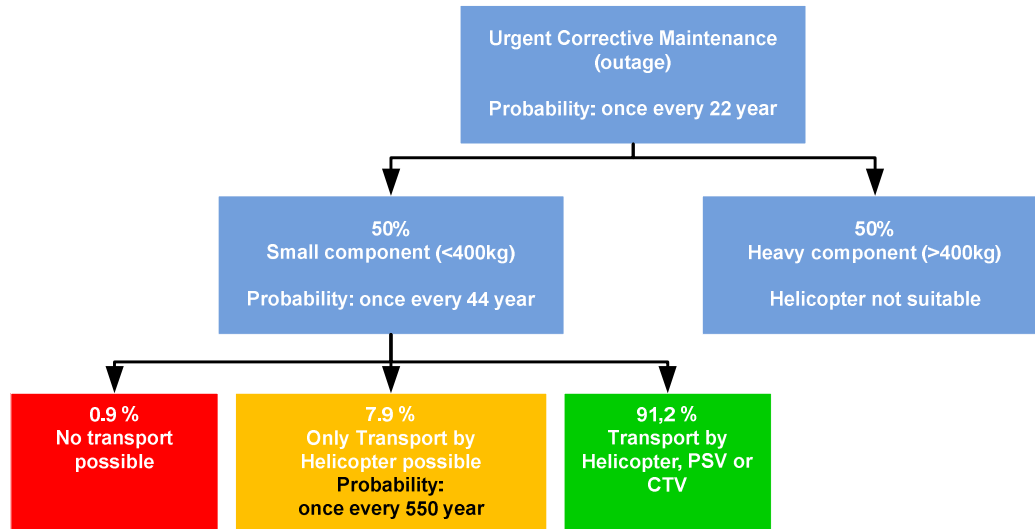


Figure 2 Probability of an event where a helicopter platform is beneficial

From the RAM studies, an availability of 99,1% of the high voltage system is foreseen⁹. The expected failure rate of high voltage systems on the platform is 0,045 event/year (once every 22 year). The RAM study further indicates that in 50% of the cases, the failure will be a large component which cannot be fixed by intervention of a helicopter. TenneT inclines to design all the critical supporting systems of the high voltage system is, with the utmost care and redundancy, to ensure this high availability of the primary process.

In addition, a helideck has only added value during sea state conditions 2,5 m < Hs < 4,0 m, which occurs during 7,9% of the time. In lower sea states CTV or platform supply vessels in combination with W2W can be used. New stringent regulation in the UK is expected, to restrict helicopters flying at higher sea states (CAP1145). The response time of platform supply vessels and CTV, taking into account the induction time on the heliport and the limited distance, does not differ significant.

The additional cost of a helicopter platform is estimated to be 3-4 million CAPEX and likewise the OPEX of the platform will increase.

The addition of a helicopter platform requires an obstacle-free area around the offshore substation to ensure safe helicopter traffic. The incorporation of a helicopter platform would therefore reduce the already limited available space for offshore wind parks.

⁹ TenneT position Paper, T.12 Redundancy/Availability

The low failure rate combined with the limited additional availability does not outweigh the additional cost of a helicopter platform and the reduction of available space for offshore wind parks. Therefore, TenneT comes to the conclusion that no helicopter platform will be included on the platform.

A helicopter winching area will be included in the design. The cost of a winching area is limited and provides additional safety services on the platform. TenneT will examine the option to use a helicopter hoist for urgent corrective maintenance. At this time it is unknown if the authorities permit such operations.

4. Ways of access to the platform

When access to platform is concerned, the following stakeholders require access:

- TenneT and its subcontractors;
- Both wind park owners and their subcontractors (WPO's representative(s)).

As a design principle, equipment owned by TenneT or the Connected Parties of a platform will be installed in separate rooms, having separate entrance doors. A room will only be accessible to the owner of the equipment inside this room. A general day crew room with necessary basic facilities - including emergency accommodation - will be accessible to all stakeholders¹⁰.

Following feasible ways of access have been identified by TenneT for WPO's representative(s) (as well as TenneT's subcontractors):

1. **Accompanied only:** Access of WPO's representative(s) to the platform only when accompanied by (a) TenneT representative(s).
2. **Unaccompanied access:** The WPO's representative(s) is/are allowed to independently access the platform for the room(s) with WPO owned equipment without accompaniment by a TenneT representative, but under the safety and operational regulations and requirements, as (to be) determined by TenneT. This will also include the general day crew room. For access to rooms with TenneT owned equipment, accompaniment by a TenneT representative is required (for example access to a switchgear room to conduct cable measurements).

Compared to option 1, option 2 has a slightly lower impact on maintenance costs as in some cases a TenneT representative is not required to accompany the WPO's representative(s). However, this impact will be marginally low.

From a safety point of view, TenneT considers both options as equals since for both options the same safety and operational regulations and requirements will be applicable. With option 2, WPO's have the responsibility to only allow representatives to access the platform which have the right qualifications.

¹⁰ A shelter on the cable deck with all required equipment for emergency stay will be accessible without any restrictions and is not taken into account in this position paper as this shelter is required by native standards

5. Position TenneT

These considerations lead TenneT to the following position:

Due to low failure rate (platform outage), average distances to shore and limited additional availability of helicopter transport, TenneT concludes to boat landing and W2W solutions as the standard access method. Helicopter hoisting will be used for emergency response. Therefore, TenneT will not integrate a helicopter platform in the design of the 700MW AC Offshore Platform.

TenneT is inclined towards allowing access for WPO's representative(s) to the offshore platform without accompaniment. However, only specific rooms (WPO equipment room(s) and general room) will be accessible. If WPO's representative(s) needs to access other areas (e.g. switchgear rooms where inter array cables are connected), accompaniment by (a) TenneT representative(s) is required. TenneT and WPO's will make operational agreements regarding response time of accompanying staff.

Above positions are applicable to all five platforms to be realised by TenneT up to 2023.

6. Impact on cost

In the table below a summary is presented of the impact of an additional helicopter platform on the TenneT platform on the Levelised Cost of Energy (LCoE). The helicopter platform leads to an extra investment - relative to the base case and hence to an increase in LCoE.

Cost impact: high level breakdown

Quantitative	LCoE Impact	Uncertainty	Comment
Cost element TenneT			
Substation: Platform	0.1%	Low	Increase in platform cost of 3%-4% due to preparation for access to platform (1)(2).
Society			
Borssele Alpha LCoE impact	0.1%	Medium	Combination of the LCoE impact from separate items above (1)(2).
Impact future years	0.1%	Medium	Impact for future years remains 0.1%, CAPEX impact is not expected to decrease for projects in future years.

References: TenneT internal (1), Ecofys internal (2)

7. Topic consultation

The expert meeting of 2-3 July, 2015 gives TenneT the opportunity to get feedback from developers on their position regarding "Access to platform". The main goal of this meeting will be to assess whether TenneT's views as documented within this position paper, and background data above, are shared by the industry.