POSITION PAPER

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1. Background Material

LITERATURE USED:

- Roadmap offshore wind 2030 (routekaart windenergie op zee 2010)

2. Scope and Considerations

As depicted in the roadmap offshore wind 2030 (routekaart windenergie op zee 2030) TenneT is tasked by the Dutch administration with the connection of several offshore wind farms (OWF) 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.

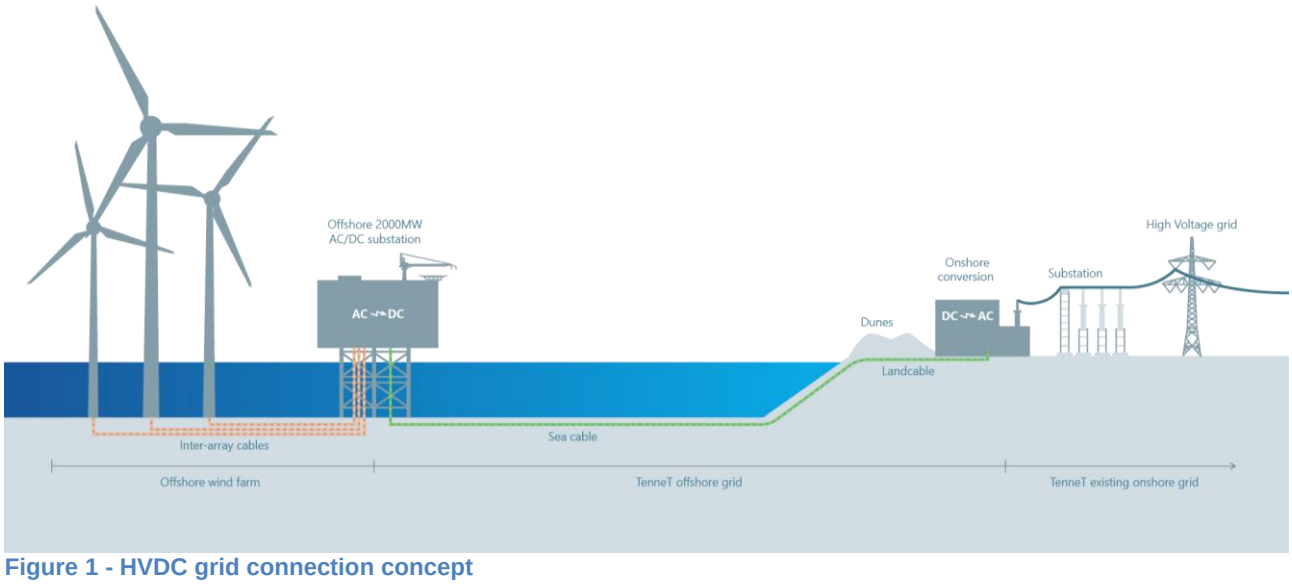


Figure 1 - HVDC grid connection concept

Windfarm operators, TenneT and various stakeholders (KNMI, Coastguard, Universities, RWS WoZEP, etc.) require sensing data and communication systems to be located in the windfarm area for their operation. This

paper describes a proposal to share these systems to limit the amount of systems and to coordinate the efforts.

Since 2014 TenneT is collaborating with RWS CIV to setup a service which enables the sharing of various sensing and communication systems and the distribution of the data to the various windfarm operators and stakeholders.

3. RWS and MIVSP

3.1 Role of RWS in offshore wind

Rijkswaterstaat (Directorate-General for Public Works and Water Management, RWS) has been tasked by the ministry of Economic Affairs to participate and cooperate with TenneT to use their ICT expertise to facilitate sensing data acquisition and communication to be used in offshore wind farms. To reach this goal, RWS has prepared their Offshore Expert Centrum and developed the program MIVSP (Maritime Information Service Point).

MIVSP takes care of the implementation of different antenna and sensor systems on the TenneT platform and WTG's in the different Offshore Wind farms. MIVSP is also delivering the data which will be generated in the sensor systems to the different organisations as an integrated service.

Other stakeholders which are involved in these services are (but not limited to) KNMI (Royal Dutch Meteorological Institute), Ministry of Defense, Coast Guard, University of Amsterdam, University of Wageningen, RWS Hydro department, Air Traffic Control, Organisation for applied scientific research TNO, Cadastre and the applicable Wind Park Operators. As WTG are owned and operated by the Wind Park Operators (WPO), this introduction will be limited to the role of RWS for integration on the platform only.

RWS MIVSP is realizing systems which support a variety of applications, such as:

- Nautical traffic monitoring and communication
- Air and Marine traffic monitoring and communication
- Meteorological and Hydrological sensing
- Ecological applications

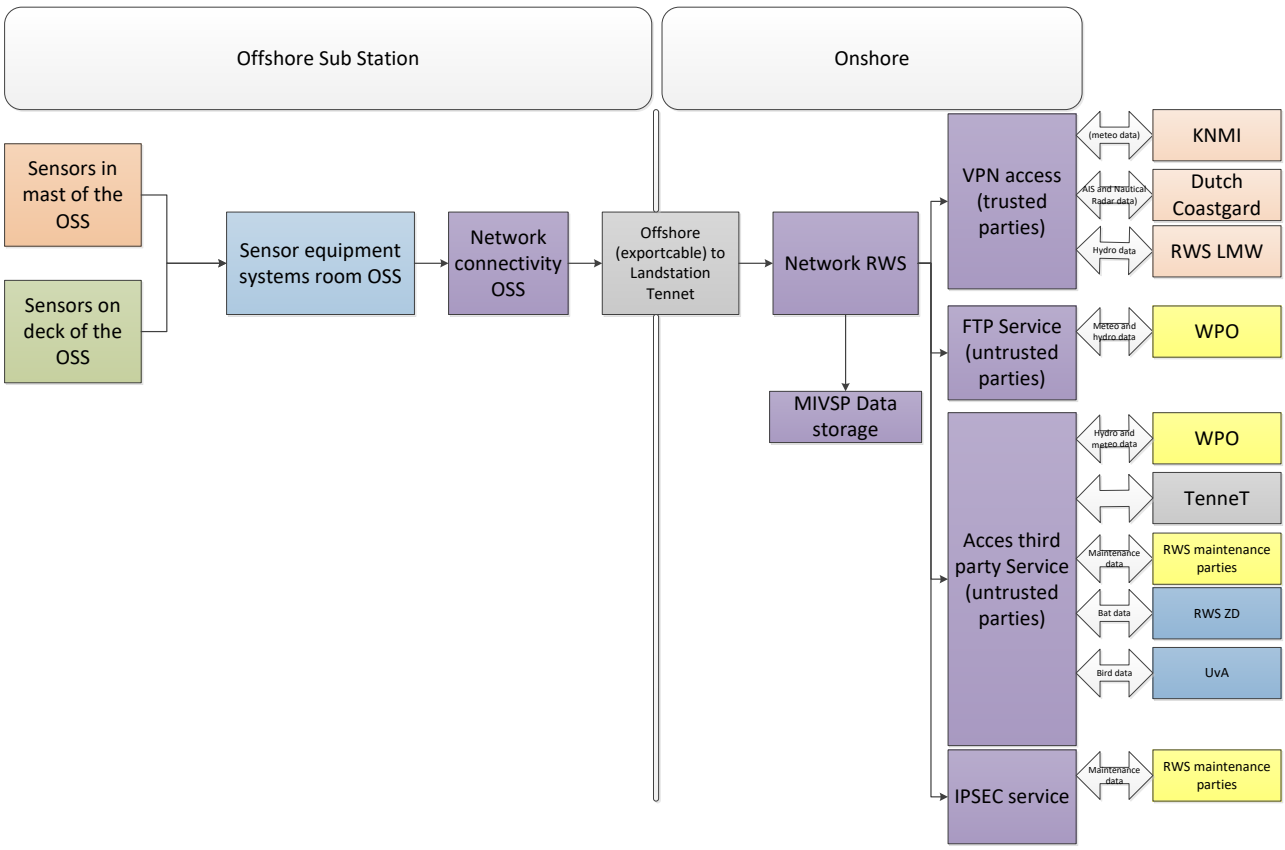
RWS has built up a test facility for integration and test of different sensors and systems. The adaptation of land based technologies for offshore use gives an extra dimension in order to fulfil the needs of the stakeholders.

3.2 MIVSP project

Maritime Information Service Point (MIVSP) is responsible to design, install, integrate, transport, test and maintain sensors and collect and deliver the sensor data to several stakeholders as a shared service.

Connectivity, including remote monitoring, to all applications will be facilitated and supported by the RWS network infrastructure and the applicable organizations. Reliability, security and adaptiveness are key in order to fulfil these aspects.

An overall picture of the different elements of the RWS scope can be found below:



RWS will bring all parties together in order to achieve alignment with the different organizations and their (specific) applications.

3.3 Nautical Sensors

The following nautical sensors can be applied on the platform. The actual implementation on a certain platform will be variable and subject to change, depending on the need and current availability of data.

1. Nautical radar
   A nautical radar is part of a multiple radar chain where e.g. the coast makes use of an integrated picture for supporting the guidance of ships. The nautical radar needs to enable visibility of all commercial and other ships and vessels including sport. Based on a coverage planning for enabling the Dutch coastguard for getting detailed radar pictures also between the WTG's, RWS facilitates the built of these nautical radars on the platform.
2. AIS
   The Automatic Identification System (AIS) is an automatic tracking system used on ships and by vessel traffic services (VTS) for identifying and locating vessels by electronically exchanging data with other nearby ships, AIS base stations, and satellites. An AIS system on the offshore platform is needed for monitoring vessel traffic around the platform. The measurements will be available for all stakeholders and will be shared through a communication interface between RWS and the stakeholders.

3.4 Ecological sensors

The following ecological sensors can be applied on the platform. The actual implementation depends on the permit requirements and will therefore be variable and subject to change, depending on the need and current availability of data.

1. Bird detection
   A bird detection sensor detects birds in the vicinity of the offshore platform. These measurements are needed to monitor the number of birds visiting the platform and to assess migration patterns. Also the influence on the ecological aspects of the operation of the Offshore Windfarms on the Northsea are part of further scientific study and evaluation in cooperation with Dutch Universities.
2. Bat detection
   A bat detection sensor detects bats in the vicinity of the offshore platform. These measurements are needed to monitor the number of bats visiting the platform and to assess migration patterns. Also the influence on the ecological aspects of the operation of the Offshore Windfarms on the Northsea are part of further scientific study and evaluation in cooperation with Dutch Universities.

3.5 Hydro and Meteo sensors

RWS will implement several Meteorological and Hydrological sensors. A complete automatic weather and sea state station in accordance with KNMI (Dutch Meteorological institute) standards will be implemented. The data will be publicly available via the KNMI.

1. AWOS (Automated Weather Observing System)
   Automated Weather Observing System measures weather parameters. All these parameters (Wind speed and direction, visibility, present weather, cloud coverage, cloud ceiling, air temperature, dew point and barometric pressure, visibility) together are necessary for forecasting if safe access to the platform or work in the windfarms is possible
2. Wave Height Radar and buoy
   There are two types of wave sensors in the windfarms. The wave radar on the cable deck of platform for significant wave height (SWH) and current measurement buoy in the water in the farm for wave direction, wave height, surface current and surface water temperature. These measurements are necessary for forecasting if safe access to the platform or work in the windfarms is possible.
3. LIDAR
   LIDAR measures the wind speeds at different altitudes till 300 meters with laser technology in a cone of 60 degrees. The LIDAR has a maximum of 10 measurements which need to be configured by the WPO's of the windfarms together.

4. Position of TenneT

Above considerations lead TenneT to the following position:

TenneT intends to continue the collaboration with RWS MIVSP and to share sensing and communication systems with the offshore windfarms and various stakeholders. This will reduce the number of systems required, eliminating the potential doubling of sensors and therefore lower the LCoE.

In this collaboration RWS MIVSP is responsible to design, install, integrate, transport, test and maintain sensors and communication systems and collect and deliver the data to several stakeholders as a shared service.

An initial list of systems is included in chapter three. The detailed list of equipment will be developed at a later stage. At least TenneT and RWS intend to share:

- Nautical Sensors
- Meteo and Hydro sensors including LIDAR

Contrary to the 700MW HVAC platforms TenneT does not intend to allow any equipment of the windfarm operator on the platform (this position and supporting rationale is further explained in T12).
