

STAKE HOLDER CONSULTATION PROCESS OFFSHORE GRID NL

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QUALITY CONTROL

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| 0.2 24.08.2015 | D. Vree | Addition of additional sea water measurements, bird/bat radar and shipping radar |
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Abbreviations

| | |
|-----------|---|
| OWP | Offshore Wind Park |
| WPO | Wind Park Owner |
| HV-Cables | High Voltage Cables |
| EXC | Export Cable |
| IAC | Inter-array Cable |
| AWOS | Automated Weather Overserving Station |
| RNMI | Royal Netherlands Meteorological Institute |
| SWH | Significant Wave Height |
| LIDAR | Laser Imaging Detection And Ranging |
| DTS | Distributed Temperature Sensing |
| CT/VT's | Current Transformers / Voltage Transformers |
| HVA/C | Heating, Ventilation, Air Conditioning |
| WTG | Wind Turbine Generator |
| GCS | Grid Connection System: Offshore platform, export cables and onshore substation |

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1. Scope

This Policy Paper defines the various data acquisition systems which are required on the TenneT offshore platform and also which of these systems can be shared between TenneT and the different Wind Park Owners (WPO's). There will be one up to a maximum of three WPO's per offshore platform. The offshore platform is part of the offshore grid connection system (GCS).

2. Overview of systems

With respect to data acquisition, TenneT aims to share systems with WPO's where possible in order to save on space, weight and power consumption on the offshore platform. When sharing is not possible, there is sufficient space in the WPO rooms to facilitate separate systems (HVA/C and power supply provided by TenneT in the WPO rooms).

In Table 2.1 a list of data acquisition systems is given including the responsibility of design and delivery.

Table 2.1. Overview of data acquisition systems on the platform

| System | Responsible for system | Shared? |
|---------------------------------------|---------------------------------|------------------|
| AWOS | RWS | Yes |
| AIS | RWS | T.b.d. |
| Visibility measurements | RWS | Yes |
| SWH (Wave Heights) | RWS | Yes |
| CCTV | TenneT | Yes |
| LIDAR | TenneT + WPO's | No |
| DTS (Distributed temperature sensing) | TenneT (EXC), WPO (IAC) | Possible (EXC) |
| Accountable metering (kWh / kVar) | Independent metering firm | No |
| Metering (Park control) | WPO | No |
| Power quality metering | TenneT | Yes |
| VT's and CT's for metering | TenneT (within 66kV switchgear) | Yes ¹ |
| Bird / Bat radar | RWS | Yes |
| Ship Radar | N/A (will not be available) | N/A |

¹ For each party a separate CT core will be available per OWP feeder bay: one for TenneT (protection), one for WPO (park control) and one for the independent metering firm (kWh / kVar metering). Power quality measurements will be done per section (CT of the transformer feeder bay).

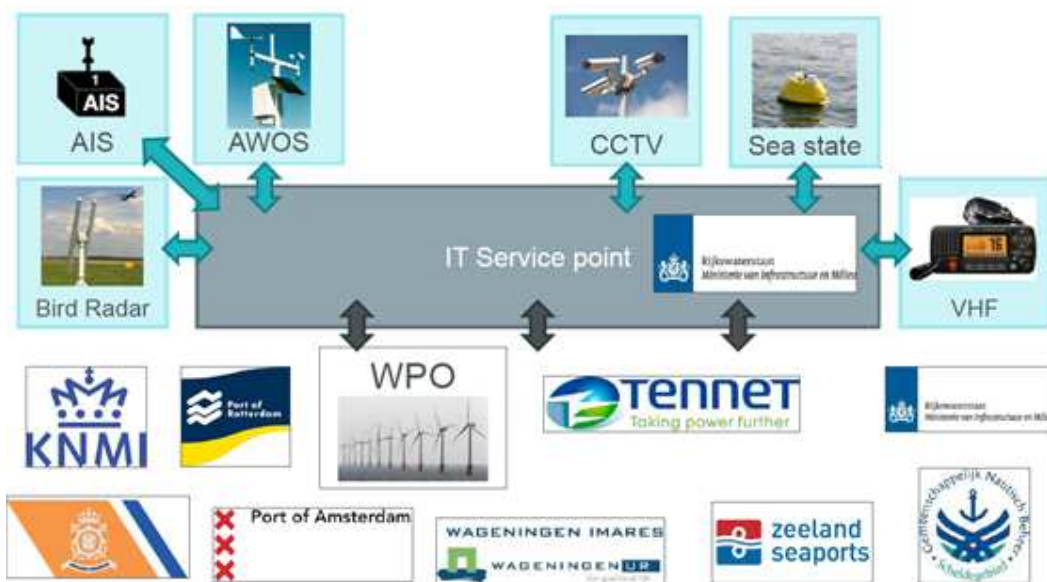
3. System descriptions

3.1 General

Some data acquisition systems such as AWOS or visibility measurement can be shared as they don't have any critical interfaces to the various stakeholders of the platform. Other systems such as for example a LIDAR have a critical interface to one of the stakeholders (in this case the WPO) and therefore can't be shared. Below each system of Table 2.1 is briefly described including the possibility of sharing.

Each data acquisition system will require a communication system to shore. When a system is shared, also a data communication interface between stakeholders is required. The telecommunication system of the offshore grid shall include all communication systems and interfaces defined in this policy paper. Therefore, this policy paper shall be used as input for the project specific PVE of the offshore grid telecommunication system.

As environmental data acquisition (with systems as described in paragraph 3.2 to 3.5) is not the core business of TenneT, these will be outsourced by TenneT to Rijkswaterstaat (RWS) which is better suited and has experience to own and operate these systems. Initial discussions with this party resulted in the following overall diagram.



RWS will create a "data point" where interested parties can retrieve real time data for all connected services. This data point will be IP based and be placed on land. All communication needed to bring data on land will be under the responsibility of RWS.

3.2 AWOS

A weather station measures weather variables. These measurements are needed for various causes including wind forecasting and determination if safe access to the platform (or wind turbines) is possible. TenneT has the opinion that data generated by the AWOS is not competitively sensitive information, therefore TenneT is planning to grant RWS access to the platform for installation and operation of an AWOS. The measurements will be available for all stakeholders and will be shared through a communication interface between RWS and the stakeholders.

3.3 Identification of vessels (AIS) and shipping radar

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. TenneT has the opinion that data generated by the AIS is not competitively sensitive information, therefore TenneT is planning to grant RWS access to the platform for installation and operation of AIS equipment. The measurements will be available for all stakeholders and will be shared through a communication interface between RWS and the stakeholders. Possibly there are legal obligations to share the AIS information which has to be cleared with RWS.

3.4 Visibility measurements

Visibility sensing equipment measures the visibility. These measurements are needed for various causes including determination if safe access to the platform (or wind turbines) is possible. TenneT has the opinion that data generated by the visibility sensing equipment is not competitively sensitive information, therefore TenneT is planning to grant the RWS access to the platform for installation and operation of visibility sensing equipment. The measurements will be available for all stakeholders and will be shared through a communication interface between RWS and the stakeholders.

3.5 Sea water measurements

Significant wave height (SWH) sensors measures the wave heights. These measurements are needed for various causes including determination if safe access to the platform (or wind turbines) is possible. Also, sensors for a) sea water temperature and salinity and b) velocity and direction of the sea current are required.

TenneT has the opinion that data generated by these sensors is not competitively sensitive information, therefore TenneT is planning to grant RWS access to the platform for installation and operation of these sensors. The measurements will be available for all stakeholders and will be shared through a communication interface between RWS and the stakeholders.

3.6 Bird and bat radar

A bird and bat radar detects birds and bats in the vicinity of the offshore platform. These measurements are needed to monitor the number of birds and bats visiting the platform and to assess migration patterns. Ultimately, migration patterns of for example bats could lead to temporary shutdown of the wind turbines. TenneT has the opinion that data generated by this bird and bat radar is not competitively sensitive information, therefore TenneT is planning to grant the RWS access to the platform for installation and

operation of this bird and bat radar. The measurements will be available for all stakeholders and will be shared through a communication interface between RWS and the.

3.7 CCTV

A deck cam is used to get imagery from the platform and from the surroundings of the platform (nearby wind turbines) to a remote location (onshore). These images can be used for various causes including determination if safe access to the platform (or wind turbines) is possible. CCTV cameras are often controllable in an Pan/Tilt motion and zoom. TenneT will install a CCTV system on the platform and the CCTV data can be shared with the WPO's. Nevertheless, the control of the cameras will remain with TenneT and therefore the WPO will have no control of the imagery that the cameras are shooting. For this reason, the WPO might require their own cameras. In that case, TenneT will provide brackets and cabling from the camera position(s) towards the respective WPO room.

3.8 LIDAR

Lidar measures wind speeds at different altitudes. Wind speed measurements are input to the park control system of the WPO's and are therefore a critical interface for the WPO. Each WPO may have specific requirements on functionality and on the manufacturer and model of this equipment. Therefore, TenneT will make available space and services for a maximum of four LIDAR systems (One per WPO and one for TenneT itself). Sharing of data is therefore not required.

TenneT will provide space on the platform deck to install a LIDAR for each WPO. To standardize the mechanical interface between the LIDAR equipment and the platform a CAD drawing of a skid will be released. Each WPO has to mount their LIDAR on this skid. The skid will be easy mountable on the platform deck. To connect the outside LIDAR equipment with control equipment inside the WPO rooms a cable route including cabling (as specified by WPO) will be provided by TenneT to each WPO.

3.9 Distributed Temperature Sensing (DTS)

Distributed Temperature Sensing (DTS) is a technique to measure the temperature of an inter-array or export cable by the means of an optical fibre. 66 kV inter-array cables will be installed, operated, maintained and owned by the WPO's and therefore the WPO's have to make the decision if DTS will be used for 66 kV cables.

As the fibre optical cables from the inter-array cables will be routed to the WPO rooms already, the DTS system can be installed in the WPO room without any additional requirements for the platform.

TenneT will provide a DTS system for the 220kV export cables. Sharing of data is not required but an interface will be required for power curtailment. See external position paper [T11 - Overplanting] on export cable rating and power curtailment.

3.10 Accountable metering (kWh / kVar)

With respect to accountable metering equipment, reference is made to external position paper [T09 - Metering].

3.11 Metering for wind park control

Power metering used as input for the wind park control systems of the WPO's will be the responsibility of the

WPO's themselves as this equipment is WTG vendor specific and also has to comply to the standards of an WPO.

For the metering for wind park control, a VT connection and a CT core per WPO feeder bay will be made available to the WPO in the WPO room (hard wired connection).

3.12 Power quality metering

TenneT will install measurement systems on the offshore platform to monitor the power quality of the offshore grid. If a WPO also needs power quality measurements, the data can be shared through a communication interface between TenneT and the WPO('s). At this moment it is still under investigation one measurement system per 66 kV section is foreseen.

3.13 VT's and CT's for metering

TenneT will install sufficient VT's and CT's to fulfil all protection and measurement requirements. For a 66 kV feeder bay to the WPO's following designations for CT's and VT's are identified:

1. Accountable measurements;
2. Power Quality measurements;
3. Measurements for wind park control;
4. Protection (string protection, busbar protection).

4. Position

Above considerations lead TenneT to the following position:

With respect to data acquisition on the offshore platform, TenneT aims to share systems with WPO's where possible in order to save on space, weight and power consumption. All data acquisition systems have been described as summarized in Table 2.1 including possibilities for sharing. Following systems will be shared:

- Various meteo systems (AWOS, Visibility, SWH);
- AIS (if legally possible);
- CCTV;
- Power quality metering.

For these shared systems, communication interface(s) will be required to be able to share the data.

For the systems which are not shared, TenneT will make available all provisions required for installation and operation of these systems including mounting facilities, auxiliary services and telecommunication systems.

5. Topic consultation

The expert meeting of October 21st 2015 gives TenneT the opportunity to get feedback from developers on their position regarding "Compliance activities".

