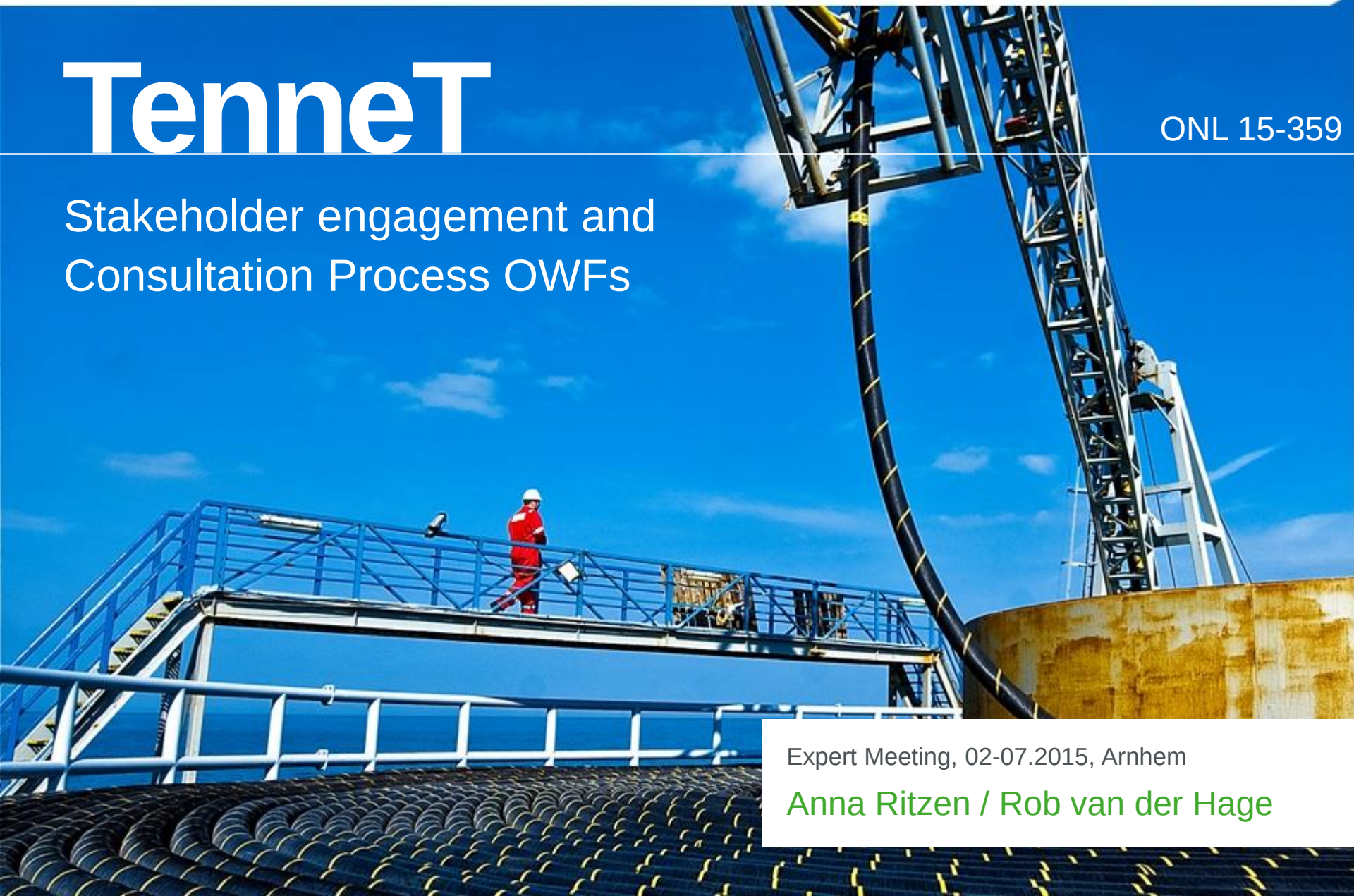
TenneT

ONL 15-359

Stakeholder engagement and Consultation Process OWFs



Expert Meeting, 02-07.2015, Arnhem

Anna Ritzen / Rob van der Hage

Stay tuned. Safety first!

Voor uw en onze veiligheid vragen we uw aandacht voor de volgende veiligheidsmaatregelen.

In geval van een ontruiming van het pand:

- Volg de vluchtroute zoals aangegeven.

- Gebruik de trap in plaats van de lift.

- Ga naar het verzamelpunt.
- Volg de aanwijzingen van de bedrijfshulpverlener. Deze is geval van een ontruiming aanwezig.

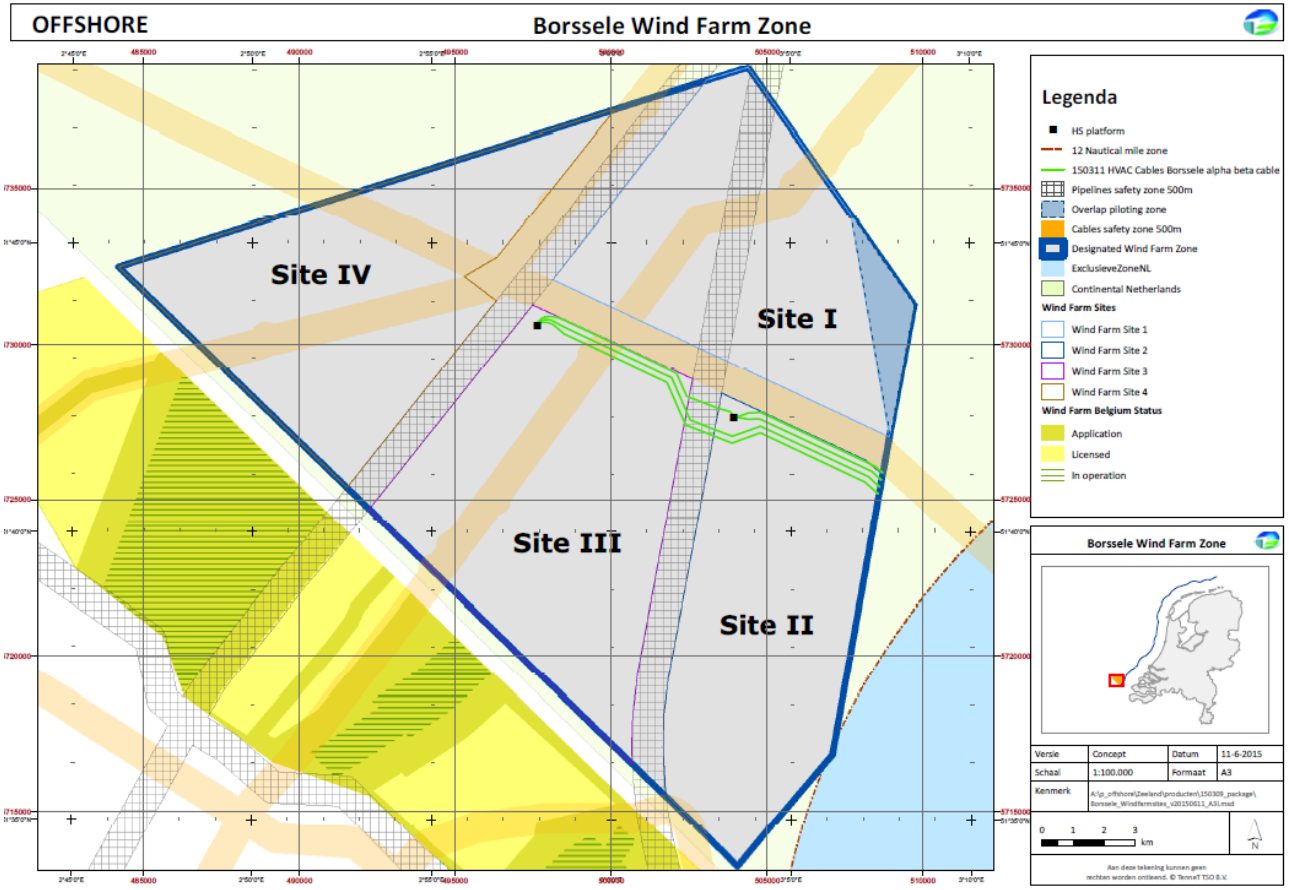
Welcome

Agenda (02.07.2015)

WHEN	WHAT	TYPE OF SESSION
09:00-09.15	Welcome Agenda for today	Introduction
09:15-10.00	T.2 Number of Bays	Discussion
10.00-10.15	T.6 Protection	Notification
10.15-10.30	Coffee break	
10.30-10.45	T.8 SCADA, communication interface, data links	Notification
10.45-11.30	T.4 Acces to Platform	Discussion
11.30-11.45	T.9 Metering	Notification
11.45-12.30	T.12 Redudancy / availability	Discussion
12.30-13.15	Lunch	
13.15-13.45	Planning legal consultation	Information
13.45-14.45	T.7 Reactive Power Compensation	Discussion
14.45-15.00	Coffee break	
15.00-15.45	O.2 Stranded Asset Mitigation	Discussion
15.45-16.30	P.1 Planning	Discussion
15.55-16.00	Closure	

T.16 Physical coordinates platform

Information



- Location first platform: 503919, 5727665 (ETRS_1989_UTM_Zone_31N)
- Reference: ONL 15-360-T16_Physical coordinates_PP_v1

T.2 Number of Bays

Discussion

T.2 Number of Bays

Input

- Questionnaire as sent out to wind turbine generator suppliers
- TenneT position paper: ONL 15-060-T2_ J tubes_ bays_PP_v2

Already finalised for decision making

- Voltage level of inter-array cables: 66 kV (ONL 15-058-T1_Voltage level_PP_v2)
- A standard platform shall be equipped with 18 J-tubes for the inter array system:
  - 2x 8 J-tubes for offshore PPM
  - 1 J-tube installed for possible test purposes
  - 1 J-tube installed for the connection to the neighbouring platform

T.2 Number of Bays

Main considerations

- Constraints per string:
  1. Miniumum power 45 MW
  2. Maximum current of 630 A per string,
  3. Maximum total power per transformer winding of 210 MW.
- Combining two string on one bay the number of bays will be reduced from maximum 8 per PPM down to 4. Hence, 2 to 4 bays reduction per 350 MW wind farm; 4 to 8 bays reduction per platform, depending on the infield lay-out.
- Regarding the connection of two cable to one switchgear bays, two options have been investigated:
  - two cable connected to the switchgear via one cable disconnector;
  - two cable connected to the switchgear via two separate cable disconnectors

T.2 Number of Bays

Analysis

- Reducing the number of bays by connecting two strings to 1 bay shows to be effective.
- One single cable disconnector for both infield strings reduces CAPEX, but also reduces availibiity leading to increased production loss costs.
- Two cable disconnectors, one for each infield string, leads to almost the same CAPEX cost reduction, but with an availability almost equal to one bay for every.
- The number of bays with double infield cable connections will be four per 350 MW wind farm. In addition, one spare bay will be introduced as well as space for yet another bay.

T.2 Number of Bays

Position

TenneT states that with the 66 kV inter-array cables (based on conservative 64 MW per cable) a standard platform shall be equipped with 18 J-tubes for the inter array system:

- 2x 8 J-tubes for offshore PPM
- 1 J-tube installed for possible test purposes
- 1 J-tube installed for the connection to the neighbouring platform

TenneT states that with the 66 kV inter-array cables, two cables will be connected to one 66kV GIS bay on the platform, via two separate cable disconnectors. The amount of 66kV bays available per PPM will be five.

For dimensioning of the J-tubes, the diameter of the 66 kV cable is estimated to be 160 mm. The inner diameter of the J-tube shall be at least 2,5 times the diameter of the cable, resulting in at least 400 mm

T.2 Number of Bays

Questions & concerns

T.6 Protection

Notification

T.6 Protection

Summary of feedback

- **Consensus**. It is possible to standardise the general functional specification of the protection on all five platforms, including requirements with respect to space on the standardised platform.
- **Consensus**. Extra requirements of the connected PPM, impedance or distance protection, will be taken into account with space for one extra relay in the standard cabinets on the platform. In close alignment with the connected parties, TenneT will fill in the final protection scheme and equipment.

T.6 Protection

Notification

TenneT's position on 'T.6 Protection':

- TenneT will standardise the protection equipment on the platform of the offshore PPM inter-array cable strings to the TenneT offshore transformer platform, by implementing a standard protection system, aligned with the connected party, owned, operated and maintained by TenneT for all five platforms to be realised by TenneT up to 2023.
- TenneT will decide post award of bid, in consensus with selected project developer, on details of protection system.

Coffee break

T.8 SCADA, communication interface and data links

Notification

T.8 SCADA, communication interface and data links

Summary of feedback

- **Consensus**. There is a general consensus that installing the majority of the SCADA system onshore (including the PCM's) could be potentially beneficial with regards to costs over the lifetime of the windfarm. Also overall consensus has been reached this could be implemented as such taking into account the below mentioned points of concern.
- **Concern**. There is a general concern of a risk that communication between the onshore part of the SCADA system and the windturbines could be lost
  ➢ Mitigation/Follow-up: Investigated the availability and back-up of the data link between onshore and offshore (see position paper).
- **Remark**. During the commissioning phase there is a need for a system offshore where both TenneT and the developer can work from. Communication needs to fast and efficient.
  ➢ Mitigation/Follow-up: Intention included to work together offshore during commissioning and agreements on way of communication

T.8 SCADA, communication interface and data links

Summary of feedback

- **Remark**. Request to keep as many options open as possible and therefore reserve sufficient space for the WPO's at the offshore platform and the maximum sufficient amount of fibres for the WPO's to be used.
  ➢ Mitigation/Follow-up: Investigated which flexibility with regards to offshore platform space and amount of fibres in the export cable can still be kept without increasing costs.
- **Remark**. Defining the amount of fibres and offshore platform space should also take into account sufficient capacity in order to use/transport to shore: LiDAR system, visibility and wave measurements, camera and meteo station.
  ➢ Mitigation/Follow-up: Investigated impact on available space needed for equipment and the minimum amount of fibres for the WPO's. Additionally investigated possibilities to share the additional systems meteo-station.

T.8 SCADA, communication interface and data links

Notification

TenneT's position on 'T.8 SCADA, communication and data links':

For the PPM SCADA and communication system (owned by the WPO), TenneT intends to make available on the five offshore platforms to be realised by TenneT up to 2023:

- A telecommunication room of ~20m2 for each WPO to install WPO owned cabinets with following services supplied by TenneT: sufficient CT/VT connections, HVAC (Heat, ventilation, air conditioning), a redundant and uninterruptable power supply, fire detection and extinguishing;
- A room on the TenneT onshore substation of ~48 m2 (~6x~8) with following services supplied by TenneT: HVAC, a redundant and uninterruptable power supply, fire detection (no fire extinguishing);
- Sufficient patch panels to connect the fibres of all array cable strings (maximum amount to be determined, but patch panel capacity will be at least sufficient for 24 fibres per string). If required patch panels for array cable fibre optic cables may be installed in the WPO room

T.8 SCADA, communication interface and data links

Notification (continued)

- Sufficient optical fibre pairs in both export cables to connect the main switches to the onshore communication interface point. Exact amount to be determined, but as an indication in each export cable 24 fibres will be available for each WPO (48 fibres in total per WPO).

T.4 Access to Platform

Discussion

T.4 Access to Platform

Input

- 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_Redundancy_availability_PP_v1
- Expert Meeting 12-13 May 2015
- Feedback received from website

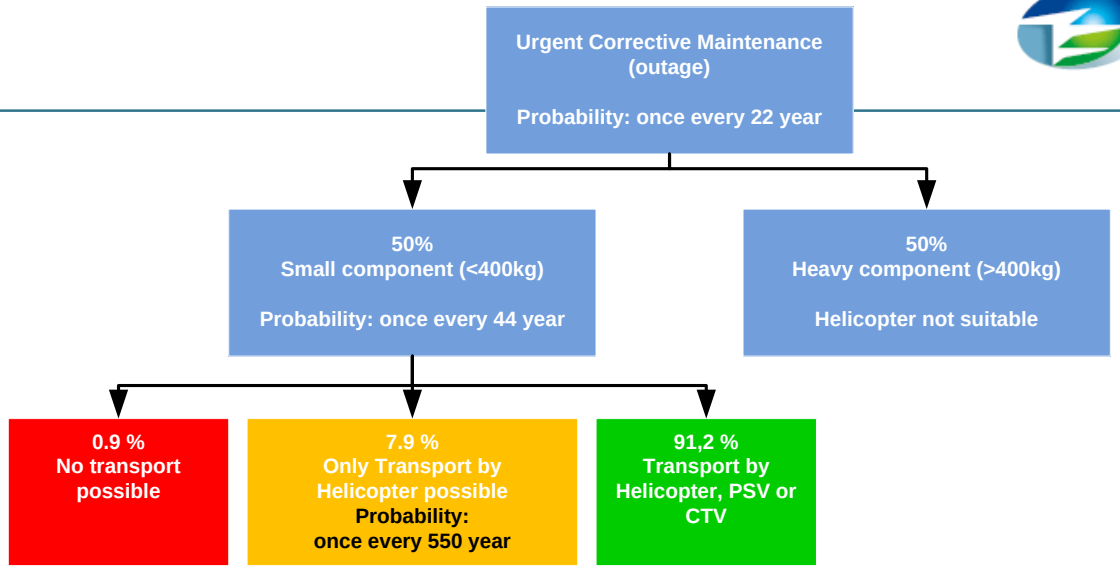
T.4 Access to Platform

Main considerations

- The following access methods are evaluated:
  - Crew Transfer Vessel (CTV) & Boat landing
  - Platform Supply Vessel (PSV) & Walk2Work Solution
  - Helicopter & Helicopter Platform
  - Helicopter & Helicopter hoisting
- Assessment factors:
  - 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

T.4 Access to Platform

Analysis



- RAM studies indicate an availability of 99,1% of the high voltage system. In 50% of the cases, the failure will be a large component which cannot be fixed by intervention of a helicopter.
- 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.

T.4 Access to Platform

Analysis

- 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.
- 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.

T.4 Access to Platform

Ways of access

- 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.

T.4 Access to Platform

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

Questions & concerns

T.9 Metering

Notification

T.9 Metering

Summary of feedback

- **Consensus**. It is possible to centralise the organisation of the accountable metering requirements via one certified party. This party will responsible for the installation, commissioning and maintenance of the metering equipment.
- For the above, changes will be added to the Measurement Code.

T.9 Metering

Notification

TenneT's position on 'T.9 Metering':

- TenneT intends to centralise the organisation of the accountable metering requirements via one certified party, contracted by TenneT, responsible for the installation, commissioning and maintenance of the metering equipment. The responsibilities of the PPMs as connected party should be dealt with in a connection agreement.

T.12 Redundancy / availability

Discussion

T.12 Redundancy / availability

Input

- N.A.

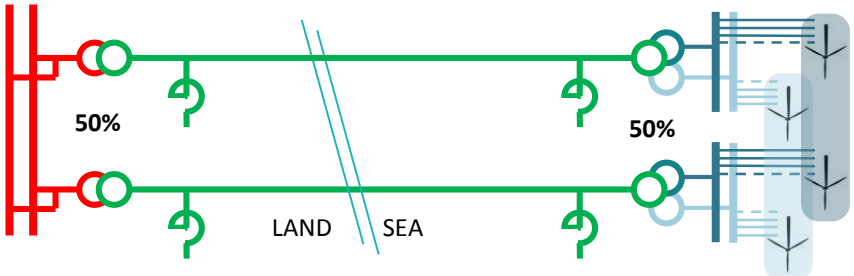
T.12 Redundancy / availability

Assessment structure

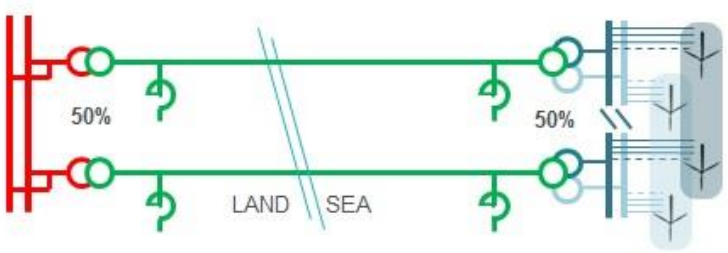
1. Determination of base case topology was determined on the minimum amount of required components and no redundancy at all..
2. Determine other topologies by adding or increasing:
   - Coupling (at 33kV/66kV, offshore 220kV, onshore 220kV)
   - Transformer capacity (50% versus 70% offshore and 100% onshore)
   - # of offshore transformers (2 x 50% or 3 x 33%)
3. Determine per topology:
   - availability of the offshore grid (average time of outage per year) evaluating failure statistics of the major components;
   - net present value of the (average) loss of income due to loss of (half or the full) connection;
   - additional savings of the increase of redundancy (compared to the base case) and if these savings justify the additional CAPEX.

T.12 Redundancy / availability

Topologies

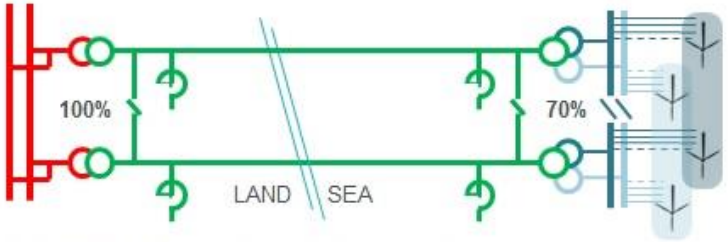


BASE CASE

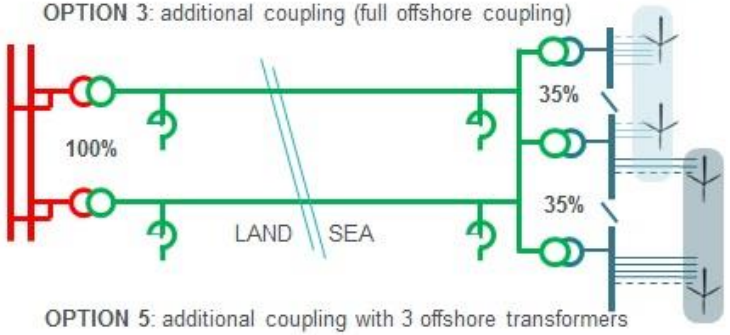


OPTION 2: basic coupling (coupling offshore at 66kV/33kV side)

OPTION 3: additional coupling (full offshore coupling)



OPTION 4: full coupling (on+offshore coupling)



OPTION 5: additional coupling with 3 offshore transformers

T.12 Redundancy / availability

Results

Topology	CAPEX	NPV of combined CAPEX and cost savings over 20 years	
		high price / kWh	low price / kWh
Base case	0	0	0
Option 2 - 66kV coupling	+1	+6	+1
Option 3 - additional coupling, higher transformer capacity	+6	+3	-4
Option 4 - full coupling	+8	+4	-5
Option 5 - additional coupling with 3x35% transformers	+5	+3	-3

T.12 Redundancy / availability

Position

TenneT intends to select the topology "option 2: basic coupling" with coupling at 66 kV level as a basis of design for the offshore grid infrastructure.

T.12 Redundancy / availability

Questions & concerns

Lunch

Planning legal consultation

[Information]

T.7 Reactive power compensation

Discussion

T.7 Reactive power compensation

Input

- N.A.

T.7 Reactive power compensation

Options for reactive power compensation

1. The reactor can be dimensioned in such way that full compensation is obtained under no-load condition (QR=26 MVAr). Under full-load condition the total infield grid system will then be “over-compensated”.
2. The reactor can be dimensioned in such way that full compensation is obtained under full-load condition (QR=2 MVAr). Under no-load condition the total infield grid system will then be “under-compensated”.

Options considered

1. Reactor of 26 MVAr (QR) on platform,
2. Reactor of 2 MVAr (QR) on platform,
3. No reactor on platform, only WTG converter compensation

T.7 Reactive power compensation

Analysis

35 = convertor losses MW at full load

active power	duration	active power	OPTION 1 (QR = 26 MVAr) reactive power	apparent power	WTG convertor losses	OPTION 2 (QR = 2 MVAr) reactive power	apparent power	WTG convertor losses	OPTION 3 (no QR) reactive power	apparent power	WTG convertor losses	COMBI 1-3 (switching 26 MVAr) reactive power	apparent power	WTG convertor losses
%	%	MW	MVAr	MVA	MW	MVAr	MVA	MW	MVAr	MVA	MW	MVAr	MVA	MW
0	17%	0	**0,0**	0,0	0,0	**-23,6**	23,6	0,0	**-25,4**	25,4	0,0	**0,0**	0,0	0,0
10	15%	35	**0,2**	35,0	0,1	**-23,6**	42,2	0,1	**-25,4**	43,2	0,1	**0,2**	35,0	0,1
20	10%	70	**1,0**	70,0	0,1	**-22,8**	73,6	0,2	**-24,6**	74,2	0,2	**1,0**	70,0	0,1
30	7%	105	**2,2**	105,0	0,2	**-21,6**	107,2	0,2	**-23,4**	107,6	0,2	**2,2**	105,0	0,2
40	5%	140	**3,8**	140,1	0,3	**-20,0**	141,4	0,3	**-21,8**	141,7	0,3	**3,8**	140,1	0,3
50	5%	175	**6,0**	175,1	0,4	**-17,8**	175,9	0,4	**-19,6**	176,1	0,4	**6,0**	175,1	0,4
60	5%	210	**8,6**	210,2	0,6	**-15,0**	210,5	0,6	**-16,8**	210,7	0,6	**8,6**	210,2	0,6
70	3%	245	**11,8**	245,3	0,5	**-11,8**	245,3	0,5	**-13,6**	245,4	0,5	**11,8**	245,3	0,5
80	5%	280	**15,6**	280,4	1,1	**-7,8**	280,1	1,1	**-9,6**	280,2	1,1	**-9,6**	280,2	1,1
90	6%	315	**19,2**	315,6	1,7	**-4,8**	315,0	1,7	**-6,6**	315,1	1,7	**-6,6**	315,1	1,7
100	22%	350	**24,0**	350,8	7,7	**0,0**	350,0	7,7	**-1,8**	350,0	7,7	**-1,8**	350,0	7,7
			WTG converter: MW		12,8			12,8			12,8			12,7
			platform reactor: MW		0,1			0,0			0,0			0,1
			total: MW		**12,88**			**12,83**			**12,84**			**12,81**

k€ loss over 20 years (€30/MWh)		42.189	42.076
difference in k€ (€30/MWh)		**113**	**0**
k€ loss over 20 years (€120/MWh)		168.757	168.303
difference in k€ (€120/MWh)		454	0

T.7 Reactive power compensation

Position

TenneT is inclined to have the reactive power of the infield grid compensated by the PPM, in order to regulate the reactive power of the offshore grid. The reactive power intended to be compensated only making use of the WTG reactive power capabilities.

Questions & concerns

Coffee break

O.2 Stranded asset mitigation

Discussion

O.2 Stranded asset mitigation

Input

- N.A.

O.2 Stranded asset mitigation

Risks identified

1. Commissioning of the offshore grid is delayed to an extent that start of operation of the PPM's is delayed resulting in loss of production of the PPM's;
2. Outage in the offshore grid which will lead to loss of production of the PPM's.

Mitigation

1. Planning
   - ➢ Aligning the installation planning of TenneT to the installation planning of the WPO's
2. Telecommunication
   - ➢ In case of a firm and significant delay, TenneT will consider the installation of such a wireless communication interface in consultation with the WPO's
3. Auxilary power (options)
   - Install WTGs with a diesel engine powered generator (DG-set) to provide auxiliary power;
   - Install a diesel engine powered generator plant (DG-plant) on the offshore platform;
   - Delay of installation of the WTGs

O.2 Stranded asset mitigation

Impact on cost (auxiliary power on platform)

Cost impact: high level breakdown

Quantitative	LCoE Impact	Uncertainty	Comment
Cost element TenneT			
Substation: Platform	0.1%	Low	Increase in platform cost of 4% due to preparation for backup generation capacity (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.

Qualitative	LCoE Impact	Uncertainty	Comment
Technical	none	Medium	Installation and rental of generators and consumables, are comparable for both cases (back up supplied by Developer or TenneT) and are not taken into account in the LCoE calcuation (1).

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

O.2 Stranded asset mitigation

Position

TenneT is inclined towards:

(i) not installing, nor make provisions for, a (diesel engine powered) back-up generator plant on the offshore platform to provide auxiliary power for the WTGs; and

(ii) installing a wireless communication interface (emergency facility) between in the offshore platform and onshore substation, only in case a firm and significant delay in realisation of such communication through the export cable fibres.

O.2 Stranded asset mitigation

Questions & concerns

P.1 Planning

Discussion

P.1 Planning

Input

- Minutes of Meeting stakeholder consultation of 12&13.05.2015

P.1 Planning

Framework

Tender in	Areas Routekaart	Windpower	Operational in
2015	Borssele	700 MW	2019
2016	Borssele	700 MW	2020
2017	Hollandse Kust: Zuid Holland	700 MW	2021
2018	Hollandse Kust: Zuid Holland	700 MW	2022
2019	Hollandse Kust: Noord Holland	700 MW	2023

P.1 Planning

Overall planning Borssele

1. Initiation phase

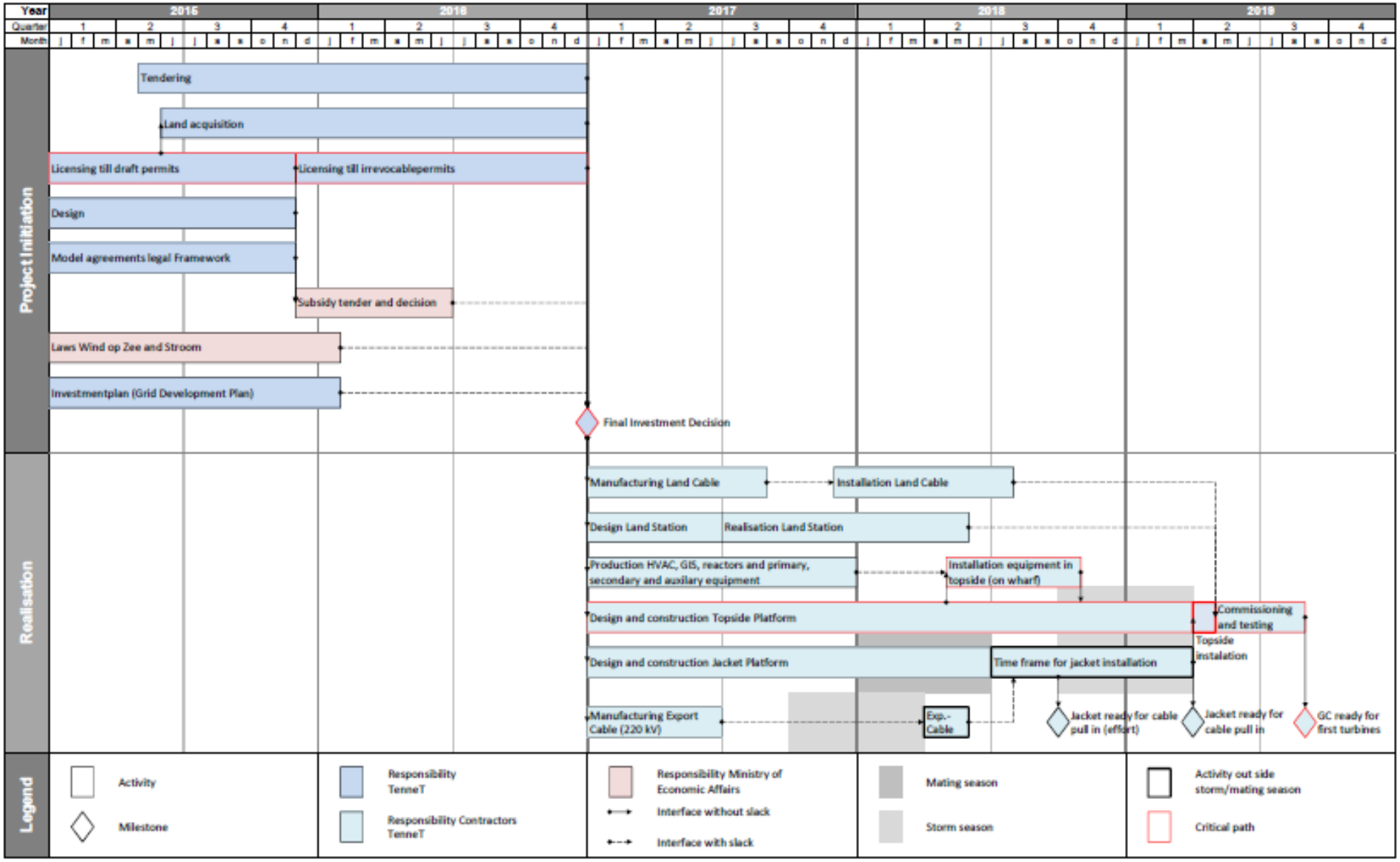
   Resulting in a Financial Investment Decision (FID) planned on 1-1-'17 and is dependent on the following conditions:

   - irrevocable permits
   - all necessary land acquisitions and crossing agreements
   - finished tenders
   - financial close
   - the subsidy tender decision
   - laws "Stroom" and "Wind op zee" in place

2. Realisation phase

   Resulting in a commissioned and trial runned grid connection

P.1 Planning


Year
2016
2018
2017
2018
2019
Quarter
Month
Project Initiation
Tendering
Land acquisition
Licensing till draft permits
Licensing till irrevocablepermits
Design
Model agreements legal Framework
Subsidy tender and decision
Laws Wind op Zee and Stroom
Investmentplan (Grid Development Plan)
Final Investment Decision
Realisation
Manufacturing Land Cable
Installation Land Cable
Design Land Station
Realisation Land Station
Production HVAC, GIS, reactors and primary, secondary and auxilary equipment
Installation equipment in topside (on wharf)
Design and construction Topside Platform
Commissioning and testing
Topside instalation
Design and construction Jacket Platform
Time frame for jacket installation
Manufacturing Export Cable (220 kV)
Exp.-Cable
Jacket ready for cable pull in (effort)
Jacket ready for cable pull in
GC ready for first turbines
Legend
Activity
Milestone
Responsibility TenneT
Responsibility Contractors TenneT
Responsibility Ministry of Economic Affairs
Interface without slack
Interface with slack
Mating season
Storm season
Activity out side storm/mating season
Critical path

P.1 Planning

Planning key interaction points between grid connection and OWF

Planning interaction point	Specification	Planning
Jacket ready	• Jacket and cable deck installed • Jacket and cable deck ready for pull in and storage of inter-array cables	31 Mar. 2019 (effort: 30 Sept. 2018, with respect to storm and drilling season)
Grid connection ready	• Topside installed on jacket • Export cable connected to top side and land station • Grid connection commissioned and fully tested • Grid connection ready for connection with the first turbines • Grid connection ready for power supply and transport	31 Aug. 2019

P.1 Planning

Planning uncertainties and mitigation

Uncertainty	Mitigation
Mistakes in permits	Extensive review process on permit application
Public resistance	Stakeholder management and analysis
Unexpected conditions (soil, UXO, archaeology)	Extensive soil investigation
Bad weather	• Introduce weather window in planning • Determine tender criteria for dealing with weather windows • Analysis of historical weather data
Restrictions flora and fauna (mating season fishes)	• Introduce mating window in planning • Early consultation with responsible authorities • Possible usage of bubble screen
Production slots lead to longer lead times	Check possible throughput time with suppliers in market consultation
Vessels, equipment and yards not available	Check possible availability in market consultation
Problems at internal and external interfaces	Interface management

P.1 Planning

Position

TenneT plans to have the grid connection for Borssele Alpha ready 31 August 2019. The jacket will be ready 30 September 2018. The specification of these interaction points with the planning of the OWF's is given in this memo.

TenneT will not anticipate on a possible later start date of the operation phase, according to the agreement that the last possible start of the subsidy payment is 5 years after the subsidy tender decision.

A tight cooperation with the OWF-developers will be pursued to mitigate and anticipate possible delays or accelerations.

Questions & concerns

Closure

Thank you