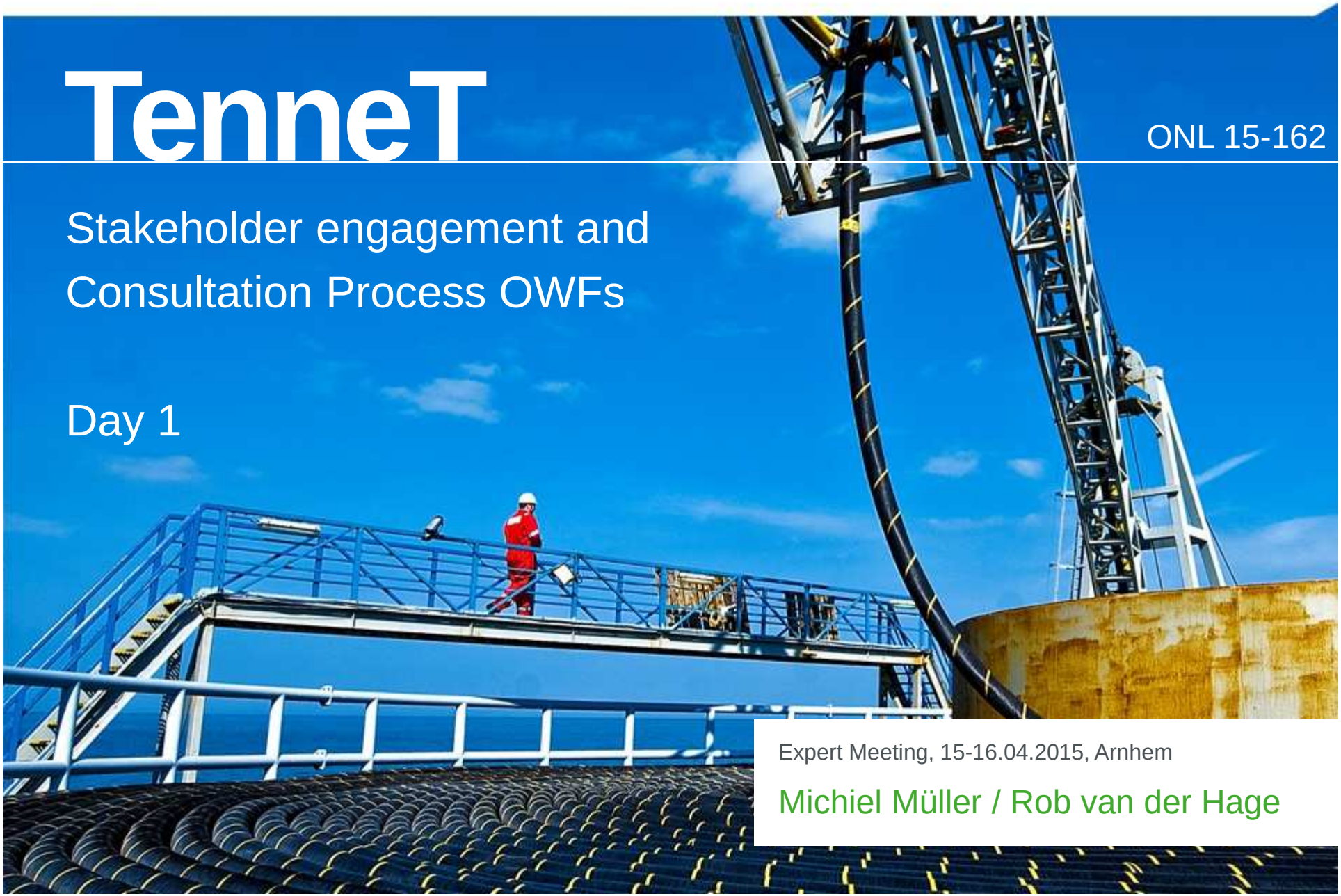
TenneT

ONL 15-162

Stakeholder engagement and Consultation Process OWFs

Day 1



Expert Meeting, 15-16.04.2015, Arnhem

Michiel Müller / 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 (15.04.2016)

WHEN	WHAT	TYPE OF SESSION
10.00-10.15	Welcome Looking back at meeting of March Agenda for today	Introduction
10.15-10.30	General update on process	Presentation
10.30-11.30	T.1 Voltage level [D]	Discussion
11.30-12.15	T.3 Point of Common Coupling [N] T.4 Access to platform [I] T.9 Metering [I]	Presentation
12.15-12.45	Break & collect lunch	
12.45-13.45	T.2 # of J tubes / bays [D]	Discussion
13.45-14.45	T.5 Operation of bays [D]	Discussion
14.45-15.30	O.1 Innovation [N] O.2 Stranded asset mitigation [I] T.12 Redundancy / availability [I]	Presentation
15.30-15.45	Closure	
[N]	Notification session	
[D]	Discussion session	
[I]	Information session	

Agenda (16.04.2016)

WHEN	WHAT	TYPE OF SESSION
09.30-09.40	Welcome Agenda for today	Introduction
09.40-10.30	T.6 Protection [D]	Discussion
10.30-11.20	T.11 Overplanting [D]	Discussion
11.20-12.10	P.1 Planning [D]	Discussion
12.10-12.30	Break & collect lunch	
12.30-14.30	L.1 Connection Agreement, Realisation Agreement and implementation of net code [D]	Discussion - Dedicated Legal Session
14.30-14.45	Closure	
[N]	Notification session	
[D]	Discussion session	
[I]	Information session	

General update on process

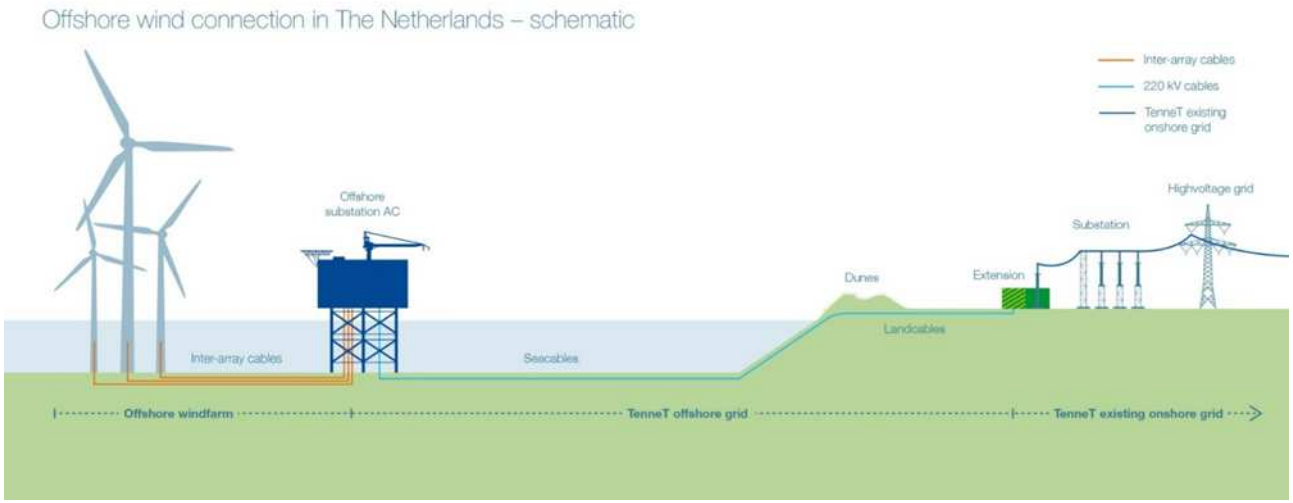
T1_Voltage level

Discussion

T1_Voltage level

Input

- Previous Expert Meetings and Bi-lateral meetings
- External report DNV-GL & Memo with answers to additional questions
- Position paper TenneT (ONL15-058-T1_Voltage level_PP_v2)



T1_Voltage level

Main considerations

- TenneT contributes to the overall cost reduction target, through **standardisation** of all 5 offshore platforms to be realised for the development of 3450 MW offshore wind, with a single platform serving concentrated large (700 MW) wind areas and use of technology that is ready for future large capacity wind turbines.
- Implementation of 66 kV infield cable voltage is considered **technically feasible**, with respect to both the cables, turbines and all connecting electrical equipment.
- **Cable length difference** 33/66 kV: As a general estimate, based on the draft layouts with 7 MW wind turbines, using 66 kV infield cables, reduces the total length of inter-array cable on average by 24% (21-28%), relative to the use of 33 kV infield cables for all five wind areas.
- Based on draft layouts it can be concluded that the site specific constraints for the different wind areas do not lead to an increase of the **minimum number of strings** required to connect the wind farm to the offshore platform (21 for 33 kV / 12 for 66 kV).

T1_Voltage level

Main considerations

- **Cable supply @ 66 kV**: DNV-GL concludes that *the six well-known cable manufacturers contacted and having EPR and/or XLPE cables for 66 kV inter array cabling available should lead to necessary competition and therefore to reasonable market prices for such cables".*
- **Turbine supply @ 66 kV**: TenneT concludes from the survey of DNV-GL that with respect to turbine supply there is likely to be sufficient competition for the first Borssele tender when standardising at 66 kV to realise competitive pricing.
- Standardisation at 66 kV is expected to be the cheapest option available, reducing cable length, number of J-tubes, installation work and losses, already for the first Borssele tender and even more so for the future tenders.

Position: TenneT intends to standardise the connection voltage level of the inter-array systems to the TenneT offshore transformer platform at 66 kV for all five platforms to be realised by TenneT up to 2023.

T1_Voltage level

Cost impact: high level breakdown

Quantitative	LCoE Impact			Uncertainty	Comment
Scenario	Best	Base	Worst		The base scenario gives the 'middle of the road' impact on LCoE. The best and worst scenario's define the range between the combination of the best and the worst case impacts of cost components on LCoE.
Cost element Developer					
Wind turbines: transformer	0.3%	0.3%	0.4%	Low	Transformer costs expected to increase 40% - 50% (2). Transformer cost constitute ~2% of WTG CAPEX (3).
Wind turbines: switchgear	0.1%	0.2%	0.2%	Medium	Conservative increase in switchgear costs assumed of 50% (+/- 10%) (2). Switchgear ~2% of WTG CAPEX (3).
Array cable costs	0.3%	0.4%	0.6%	Medium	Increase in cable costs [EUR/m] of 10-20% (*)
Array cable length	-1.5%	-1.3%	-1.1%	Low	Decrease in cable length [km] of 25-28% (2).
Cost element TenneT					
Substation: Compensation equipment	0.2%	0.3%	0.3%	Low	Increase cost of reactive power compensation equipment of 50% (+/-10%) (2). Compensation equipment constitute ~5% of Offshore Substation CAPEX (3).
Substation: Connection	-0.2%	-0.1%	-0.1%	Medium	Switchgear worst case increase in costs assumed of 50% (+/- 10%)(2). switchgear constitutes ~5% of Offshore Substation CAPEX (3). Since the number of required switchgear decreases by 4.7%, the cost increase is more than fully offset.
Substation: J-tubes	-0.1%	-0.1%	-0.1%	Low	Decrease in cost by decrease in number of J-tubes (from 34 to 28) (2.2.3). J-tubes constitute ~2% of Offshore Substation CAPEX (3).
Impact on yield					
losses	-0.2%	-0.2%	-0.2%	Medium	Losses 33 kV 0.8%; losses 66 kV 0.55% from (2). Impact on LCoE directly related (conservatively value of -0.2% chosen (+/-0.02%)) (3).
Society					
Borssele Alpha LCoE impact	-1.1%	-0.7%	-0.2%	Medium	Combination of the LCoE impact from separate items above (3).
Impact future years	-1.3%	-1.2%	-1.1%	Medium	Price for 66 kV equipment expected to decrease by 10% - 20% in the coming years (2). LCoE impact estimate (3).

T1_Voltage level

Questions & concerns

T.3 Point of Common Coupling

Notification:

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.

T.4 Access to platform

Access requirements of WPO‘s can be split into:

- Access for maintenance (planned / unplanned) of WPO equipment on offshore platform;
- Access after cable fault (for fault location measurements) and testing;
- Access for commisioning
- Safe haven…….

T.4 Access to platform

TenneT‘s design considerations (at this moment):

- Unmanned platform;
- No helideck
- WPO access to platform only when accompanied by TenneT representative;
    - Access to platform for fault location measurements will always be possible (max. response time to be defined)
    - Transportation of personnel by TenneT or WPO vessel
- Minimize need for WPO access by limiting WPO equipment on offshore platform. This will be covered in:
    - T.6 Protection
    - T.8 / T.10 SCADA / Data links / communication
    - T.9 Metering

T.9 Metering

Starting points:

- Network code: metering by certified body to be assigned by customer.
- CP is offshore: defined on cable termination of the inter array cables

Options:

- Metering organised by WPO's.
    - For 10 wind farms → max. 10 certified bodies requiring access to platform.
- Metering organised by TenneT
    - Assignment of 1 certified body responsible for metering of all (10) wind farms;

Break & lunch

T2_ # of J tubes / bays

Discussion

T2_ # of J tubes / bays

Input

- Position paper TenneT (ONL15-060-T2_ J tubes_ bays_PP_v2)

Main considerations

- Taking into account the general available cable types and a power factor of 0.9, the maximum transmission capacities are set to 35 MW for a 33 kV infield cable and 70 MW for a 66 kV infield cable. For the 66kV cables, the calculations for the amount of J-tubes are performed with 64 MW per infield cable, to provide an extra margin.
- To provide flexibility in wind tuirbine distribution TenneT uses as starting point that the number of strings should be such that on average there is 20% spare capacity, on top of the 380 MW (maximum overplanting) installed.

T2_ # of J tubes / bays

Position:

- TenneT states that in case of **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 in case of **33 kV inter-array cables** (based on 35 MW per cable) a standard platform shall be equipped with 34 J-tubes for the inter array system:
  - 2x 16 J-tubes for offshore PPM
  - 1 J-tube installed for possible test purposes
  - 1 J-tube installed for the connection to the neighbouring platform

T2_ # of J tubes / bays

Questions & concerns

T5_Operation of Bays

Discussion

T5_Operation of Bays

Input

- Position paper TenneT (ONL 15-079-T5_Operation of Bays_PP_v1)

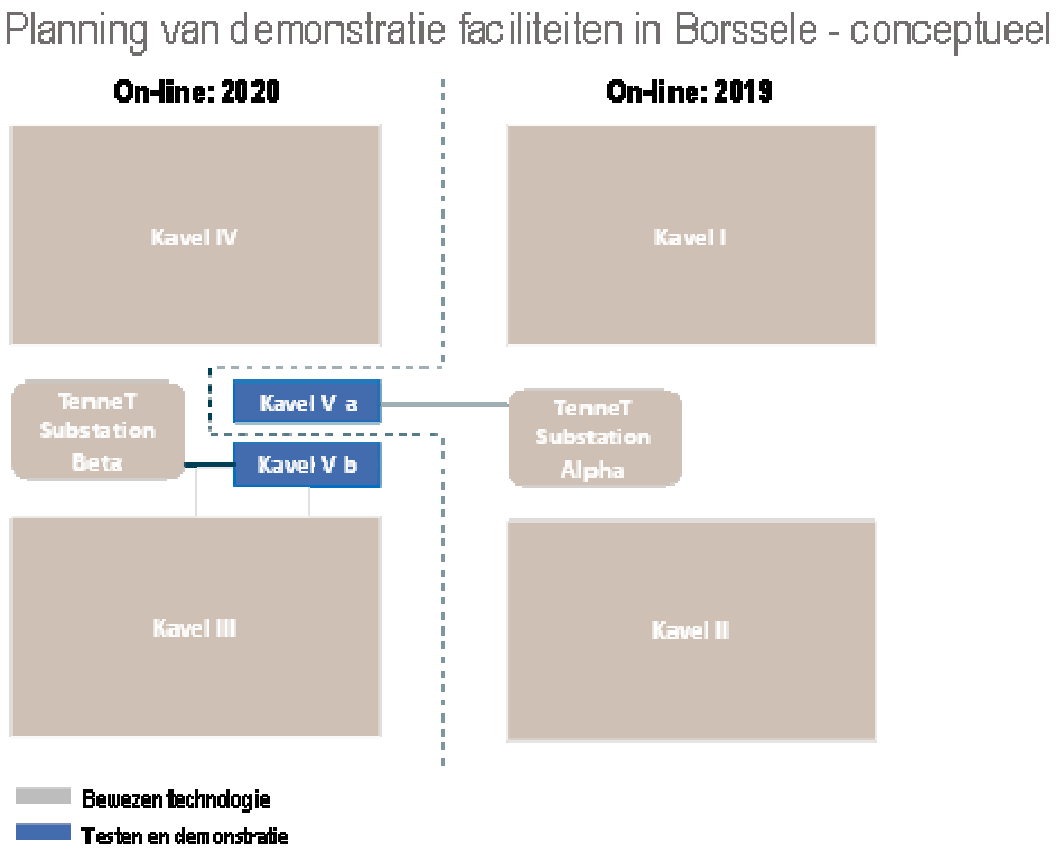
Main considerations

- Two options for the operation of bays considered:
  1. The whole switchgear installation (disconnector, earthing switches and circuit breakers) is operated by the owner of the switchgear, TenneT. TenneT has a 24/7 manned dispatch centre which can operate the switchgear on request of the PPM at any time of day.
  2. The disconnectors and the earthing switches are operated by TenneT and the circuit breaker by the PPM, which gives freedom to the PPM for switching of their strings.

Position: TenneT is inclined to standardise the operation of bay's for the offshore platform, similar to the current practice for the operation of switchgear onshore for the connected parties, where the switchgear installation with connections to the offshore PPM is fully operated by TenneT, as the owner of the switchgear..

Questions & concerns

O.1 Innovation [N]



O.2 Stranded asset mitigation [I]

When:

1. Export cable(s) / offshore platform installation delay
2. Export cable(s) / offshore platform (transformer) failure

Mitigation measures installation delay:

- Alignment of TenneT and wind farm installation schedules

Mitigation measures cable/transformer failure:

- 2 (50%+) export cables and transformers per platform
- Additional ‘redundancy cable’ between 2 platforms (foreseen for: 4 out of 5 platforms)

No provisions on platform for emergency generator capacity to power windturbine generators. → 5-7% weight increase to take into account → increase in cost

T.12 Redundancy / availability [I]

To determine level of redundancy, different scenario's were assessed.

Scenario's based on variation of:

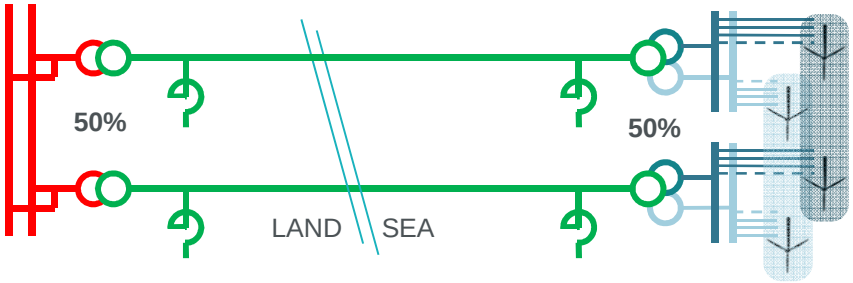
- Coupling (at 33kV/66kV, offshore 220kV, onshore 220kV)
- Transformer capacity (50% versus 70% offshore and 100% onshore)
- # of offshore transformers (2 x 50% or 3 x 33%)

Assumptions for determining risk of loss of income:

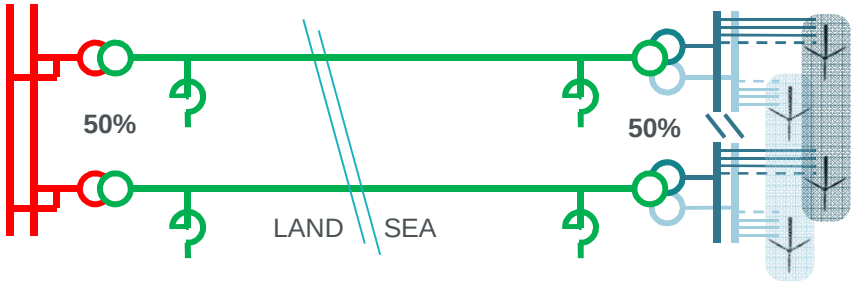
- 20% increase of typical offshore wind farm performance
- Availability and MTTR based on internal figures and literature (Cigré)
- Price per MWh in a range of €20 - €120

T.12 Redundancy / availability [I]

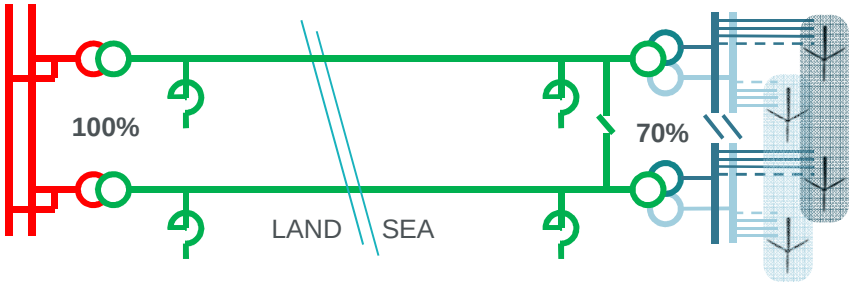
Main 5 scenario's:



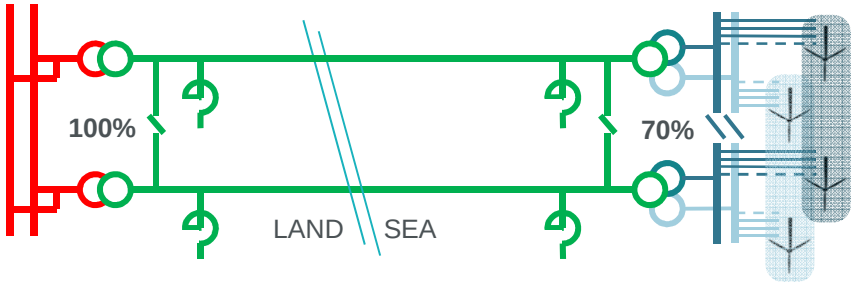
OPTION 1: base case 2x 350MW (no coupling at all)



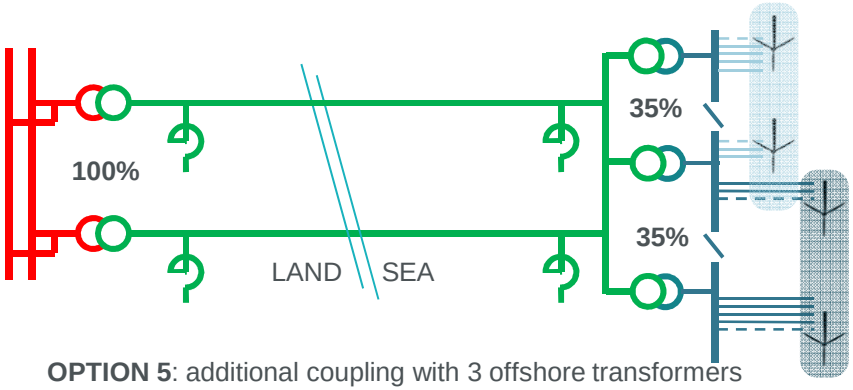
OPTION 2: basic coupling (coupling offshore at 66kV/33kV side)



OPTION 3: additional coupling (full offshore coupling)



OPTION 4: full coupling (on+offshore coupling)

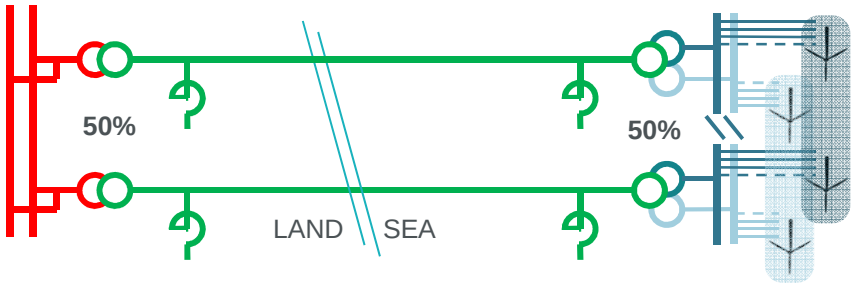


OPTION 5: additional coupling with 3 offshore transformers

T.12 Redundancy / availability [I]

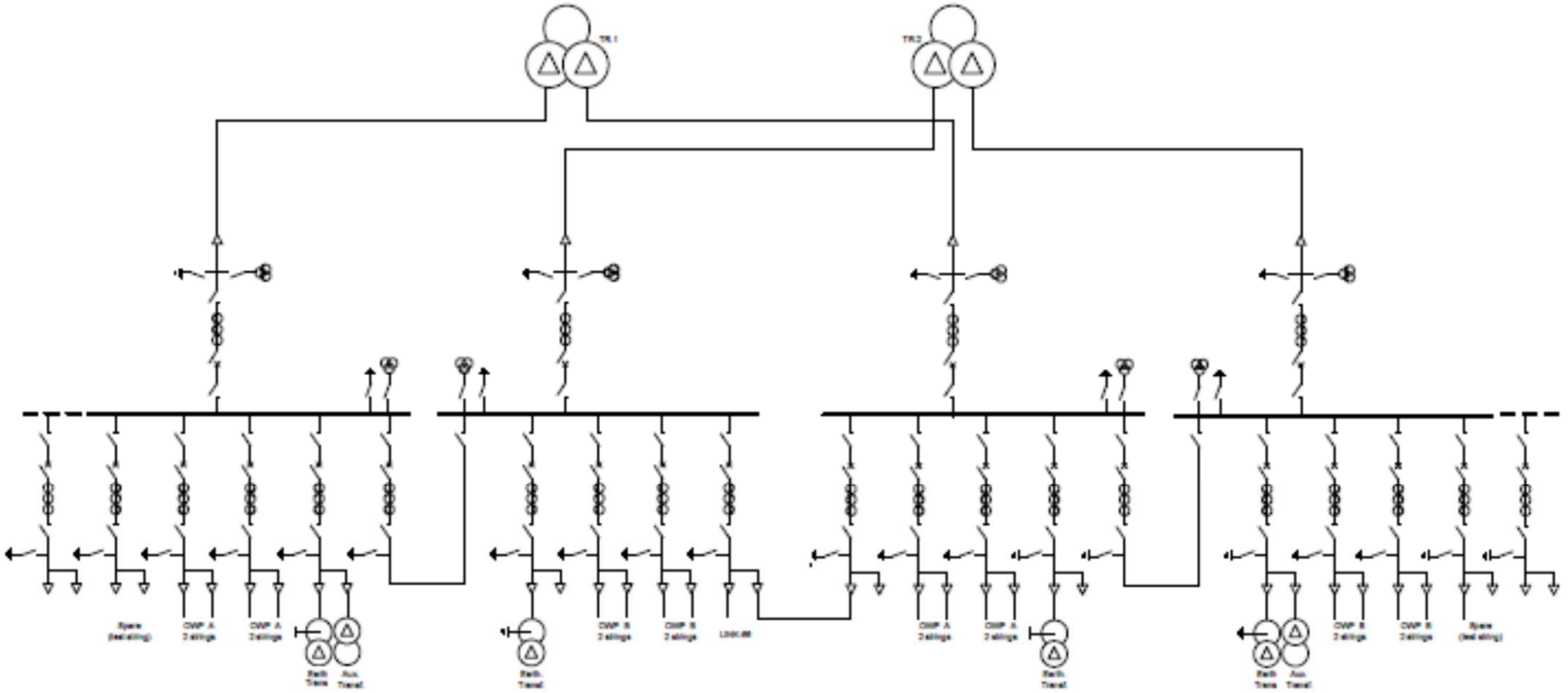
Preliminary results:

- Basic coupling (on 33kV / 66kV side): increase overall availability of **0,4%** with **minimal additional costs**
- Any other increase of redundancy does not weigh up to the additional costs (CAPEX / OPEX)



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

Concept single line diagram / Reactive power compensation



Closure

Thank you