

STAKEHOLDER CONSULTATION PROCESS OFFSHORE GRID NL

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QUALITY CONTROL

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1. Welcome

Rob van der Hage opens the meeting and welcomes all attendees.

2. General update on process

Rob van der Hage presented a general update on the consultation process. Rob emphasises the importance of this consultation and the fact that the expert meetings are intended to facilitate detailed, open and confidential discussions on specific technical and planning issues among windfarm developers. Therefore it is necessary to keep the list of invitees limited.

Day 1: 15.04.2015

3. T.1 Voltage Level

[Discussion]

Summary of concerns based on feedback during the Expert Meeting

- There may be Installation specific constraints for 66 KV and availability, with a potential impact on cost of installation vessels.
- Furthermore no main concerns or objections anymore but there are different philosophies on the layout and the applied redundancy.
- Others confirm the cost reduction calculations based on radial system.

Feedback from the meeting attendees:

Cables are ready to deliver 66kV on time and with the same guarantees as 33kV. They even prefer to offer 66kV Wind turbine suppliers: 3/5 are ready on time and same guarantees and 2/5 are willing but at this moment not ready yet.

It would be very useful if we could see which assumptions are the base of these calculations. Could you therefore give more information on the assumptions used for the LCoE calculations?

Position/starting point is that you can reduce the cable length. We don't see this decrease in cable length and therefore our LCoE doesn't decrease. It also has to do with redundancy and therefore we design the cable lay out at the safest layout. Our calculations show that 33kv and 66kV with configuration of loops show a cost neutral result for the cable (compared to each other). I think the 66 kV number is too high/positive.

Tennet: Would you also state the same if you don't use loops? OWF: This we have to check internally and we will give you an answer afterwards. But we think that the assumption of adding as much as possible wind turbines on one string is an incorrect assumption. We would put less wind turbines on one string. With the discussion on the number of J-tubes this is even more of a risk – as soon as the number of J-tubes is fixed the amount of wind turbines per string is also fixed and the developer doesn't have a choice anymore.

The redundancy choice is based on the cost of cables in combination with the expectation of cable failure rates. With our information and our numbers we don't have any reason to add redundancy to the design and will go for as many wind turbines as possible on one string.

This is correct and indeed this depends on assumptions on capex and failure rates and we would like to confirm that all our numbers and calculations show that the optimum case is a combination of as many wind turbines on one string and a radial system.

Our assessment is similar and with a radial system we see the same cost reductions.

Has the layout and therefore cable routes been optimised for existing cables and pipelines and other obstacles? Yes an initial layout has been made by an experienced layout and yield optimisation-consultant.

Our line of thought would be to add loops plus adding as many wind turbines per string.

Do we say the risk of choosing 66kv are negligible with regards to regulatory framework with regards to SF6? Do we want that that much SF6 offshore? DNV: that is the result of choosing for 66 kV at this moment in time. For clarification the discussion is not on banning SF6 but on adjusting usage/reduce amount of leakage.

Siemens has SF6-free 66kV

Could you confirm that cable and wind turbine manufacturers can and will deliver binding bids by the end of this year? Yes: wind turbines bids have already been seen from several wind turbine manufacturers and cable manufacturers have confirmed. Also including dates for certification.

Does the choice for 66 kV also effect the available size of wind turbines?

I think this is a hypothetical discussion because a project develop will not offer 3 MW wind turbines in this bid. Based on the costs you will look at the larger wind turbines.

We are currently discussing technical and cost elements but is it legally acceptable (from an EU tender perspective) to exclude smaller wind turbine manufacturers? OWF: they are not explicitly excluded. A certain amount of specs and balance sheet will have to be adhered to and if smaller wind turbines can meet these specs they can enter.

In the case we want to use loops it must be clear where the point of common coupling is. The best benefit of a loop is if the strings are not going to the same bus bars and different transformers. This depends on power quality and short circuit conditions. Operation in an open loop is no problem. The coupling point doesn't change but the amount of energy going through changes but is no problem.

A question is asked with regards to process: when does TenneT take an official stand on this? And how does this go together with the process at EZ? [EZ] we would like to fix this in the 'scenario'. The legal basis of this is in the wet Stroom which will come into place January 2016. So before that there is no legal base for the technical choice of 66kV. In order to provide comfort for market before 2016, the Minister will state in a letter the firm intention to include 66kV in wet Stroom. This letter will go to parliament in the second half of May. [TenneT] next week there's a meeting planned with EZ in order to discuss this topic and see if this can be the final discussion.

4. 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.

Feedback from the meeting attendees:

I agree with the connection point notification but is this consistent with what is stated in the RfG? Are you in compliance with the RfG? [TenneT] Yes you have a connection point at the end of every string. PPM will have 6 connections points.

If we want to use loops it must be clear where the point of common coupling is. The best benefit of a loop is if the strings are not going to the same busbars and different transformers. This depends on power quality and short circuit conditions. Operation in an open loop is no problem. The coupling point doesn't change but the amount of energy going through changes but is not a problem.

5. T.4 Access to platform

[Presentation- available on TenneT website]

TenneT's design considerations (at this moment) are:

- 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

Feedback from the meeting attendees:

You are missing out on the possibility of using the platform for O&M purposes of the WF. In Denmark the helideck is also used for O&M service for WF.

This will be a challenge - last winter 87% of the time the platform was not available due to CTV limitation and no helicopter platform.

I don't see how you can manage and maintain a platform without helideck.

We have wind farms at 20km offshore and 40km offshore without helideck. They have different O&M arrangements and are still looking for the optimum O&M strategy. We would like to maintain flexibility and would therefore opt for a helideck.

Helideck is only 2 million. So why are we having this discussion.

We have a windfarm at 50 km offshore and no helideck. But the size of the wind farm is smaller.

Why is the position on access to platform different with TenneT Germany? [by helicopter only and not CTV].

What is your availability objective for the platform? [TenneT]: ~98%

TenneT requests to provide numbers on accessibility and results on influence and prices of helideck to support input of current study?

Does this mean that if we can provide numbers on why a helideck would be beneficial to the cost of the wind farm would this be reflected upon? [TenneT] yes please provide numbers and arguments.

If you lose the platform you do not only lose production but also you also cannot provide electricity to the WTG. Therefore damage to the WTG will occur. Who is taken that risk? Please check with your colleagues because there has been a platform from TenneT which has had a total black out during the commissioning.

In Denmark we have full access to the platform. We have to inform the TSO and follow the agreed safety rules and after that can access the platform. This works well.

In Germany it is the other way around. Platform is owned by WF operator and TenneT only has access while being accompanied by WF Operator.

We need to have access and will have to agree on how we adopt your safety rules. In the UK we have an interface agreement with TSO in order to access platform.

Does this also takes into account subcontractors: yes they sign and comply with the same rules.

The good news is there is access and in which way this is organised is a formality. Good that access can be granted.

6. T.9 Metering

[Presentation- available on TenneT website]

TenneT's starting points (at this moment) are:

- 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.

Feedback from the meeting attendees:

But we are responsible for both suggested options. What does TenneT arrange at the second bullet point of the options? [TenneT] we can assign one certified/certifying body.

You have to follow the rules and regulations anyway so make it as easy as possible.

7. T.2 # of J tubes / bays

[Discussion]

Summary of concerns based on feedback during the Expert Meeting

- Overall there are no objections to the amount of 8 j-tubes except for one developer which would like to extent this amount to 12 based on its development philosophy.

Feedback from the meeting attendees:

We are talking about three parties: TenneT, developers with ring system, developers radial system. If the amount of J-tubes is fixed at a low amount than the lay out is mostly fixed (radial system). Why not add J-tubes (12 strings for 66kV) in order to keep availabilities open and therefore reducing risks?

If the number of 12 j-tubes is applied other elements will also increase, space on platform, circuit breakers etc. a lot of equipment could be installed which might not used in the end.

We started this discussion with 6 J-tubes and are now at the number of 8. Is this enough and does this decrease the risk sufficiently? How far can we stretch this amount?

8 is sufficient for how we now develop a WF but to lock this in for the future is quite stressing. How can we say that 8 j-tubes is still the best in the future (taking into account changes in costs etc). How fixed is this?

Is it a big challenge to have this many J-tubes on the platform? Suggestion would be to choose an amount

that could be divided by 4. We can agree with 8 j-tubes. Is the spare tube necessary? If this is on the opposite site of the j-tube failure it could be possible that for connection to the spare j tube cables need to be crossed.

The testing roll out should be known before opening of the tender.

8. T.5 Operation of bays

[Discussion]

Summary of concerns based on feedback during the Expert Meeting

- TenneT's position is acceptable and including signals and emergency button are preferred in this topic.

Feedback from the meeting attendees:

Experience in Germany is that control centre can sometimes be very busy and therefore it can take several hours before a switch is made. TenneT's experience onshore NL is different. There have been no complaints that this approach is a problem for the onshore situation. In the case this takes several hours TenneT has a major internal problem.

Is TenneT willing to sign a performance agreement on time of operation? E.g. planned operation should be possible to operate switches within ½ hour.

How does this work during testing and commissioning? TenneT proposes for that period of time to have a dedicated operator at the dispatch centre in order to serve all action.

What happens if we see a problem on a cable and would like to switch it off immediately. Could we include an emergency stop? TenneT notes that for onshore situation this is sometimes the case and in general could be supported for the offshore situation as well.

Can we install padlocks and do we also receive the location of the switches for SCADA data? TenneT notes that both should be possible.

Could you confirm that the J-tube is designed at 800 mm²?

9. O.1 Innovation

[Information session – Presentation is available on TenneT website]

O.2 Stranded asset mitigation [I]

[Information session – Presentation is available on TenneT website]

Summary of concerns based on feedback during the Expert Meeting

- Please also include the risk that the wind turbines will not be energised during the operational phase

Feedback from the meeting attendees:

Is there a spare transformer onshore? [TenneT] Yes part of the standardisation.

We recommend to use bigger transformers. Decrease losses and increase life time

50% losses to each wind farm or each platform? Each transformer is 350 kVA? [TenneT] Yes. Fully insulated transformers. This will be discussed in the topic discussion.

Do you confirm that both cables are installed before wind farm is ready? The whole system is ready before connecting WF (for the first WF). We will discuss all mitigating measures with regards to planning and installation in order to avoid an emergency generator. We will discuss this tomorrow during topic P planning.

Did you make a calculation of the risk that the wind turbines will not be energised during the operational phase? [TenneT] No what we did is calculated the availability of the system. That availability is the availability of energy transported instead of the availability of conditioning wind farms. TenneT has noted the question and will make the calculation. Will be taken into account for the position paper.

What is the 66 kV redundancy cable for? [TenneT] This is back-up power for wind turbines and little export capacity for the wind turbines. Mainly as back-up power/ conditioning wind turbines. [TenneT]: 120kV doesn't pay off plus you have the limitation of the two cables transporting the electricity to shore. 66 kV does pay off and therefore you have a redundancy cable for 'free'.

Have you done the calculation of one emergency generator vs a generator on each wind turbine? [TenneT] No we have not made that calculation yet.

We have served our wind turbines with separate diesel generators for a year. This meant bunkering oil. Delivery of oil every 5 days which was an enormous challenge and an huge amount of cost. Statoil had similar situation with delay in own platform.

Redundancy cable is a good choice but if there is no back-up system for the platform this redundancy is invaluable.

I think you have a much better system than what the Danish offer at this point.

Confirmed; if we design a platform with two export cables you don't need a generator for commissioning or execution.

T.12 Redundancy / availability [I]

[Information session – Presentation is available on TenneT website]

Summary of concerns based on feedback during the Expert Meeting

Feedback from the meeting attendees:

Have you taken 'meantime to repair' taken into account offshore conditions? Lead-time vessels and accessibility for instance. [TenneT] yes has been taken into account.

Meantime between failure considered? [TenneT] Yes that is included.

Are we limited to 2500 amps per bay? [TenneT] Yes we are.

Is this one independent system or is it connected straight after the transformers? [TenneT] connected straight and fully redundant system. N-2 is the standard for the Dutch grid.

Size of transformers- does this include natural and/or forced cooling. [TenneT] Up to now we are designing for natural cooling. We would like to avoid fans offshore.

Have you considered adding reactive power priority control?

What is the reactive power onshore? [TenneT] 400 mva on primary winding but the cable is the limiting factor in transporting MW's.

Can you say anything on protocol of lowering the loading in a backup situation? [TenneT] limit all wind turbines equally to the 350 MW that you have left.

Are there no emergency switch off of strings or any other solutions? [TenneT] we will request you to decrease capacity and that will have to be followed.

Will the circuit breaker on the 66 kv situation normally be open or closed? [TenneT] open.

Two strings on 1 breaker; is that a good idea? This is a challenge with regards to protection. You double the failure rate with adding two strings to one. TenneT: If you have 5 strings of 70 MW then you have 5 bays

How many bays do we have? [TenneT] 4 -5 bays for 8 j tubes.

Consequence of this design is that if you do maintenance on one string you also have to disconnect the second string? [TenneT] correct. Yes but the difference is between 70 or 80 MW. With this design you have 40MW per string so double string is 80 MW and otherwise 70MW per string.

I would never ever design a wind farm like this – everyone agrees.

We did the same calculation and came to an extremely different result

Will you pay compensation to switch off a circuit breaker if I want to do maintenance on one string – will you compensate for the other string which is switched of automatically. I have just never seen this before. Agree. Never seen this before and am very surprised that this is a solution from the TSO.

What if we have more 80 MW per panel. $5 \cdot 70 = 350 \text{ MW}$

Reactive power compensation

This sounds good. Is it 9.8 overexcited or less? [TenneT] don't know yet.

What do you expect from the wind turbines and the infield cables? [TenneT] Infield cabling is compensated by the wind turbines themselves

Does each string has to compensate for itself or the whole wind farm? [TenneT] Strings combined for one wind farm.

Very difficult to comply to this before energising the string. There will be a short period where developer cannot be compliant. We have to come to some kind of agreement how to deal with this.

In earlier meetings it was mentioned that TenneT would provide compensation. This change costs a lot of losses for the developer. Realise this comes with a cost.

Isn't it the cheapest solution if TenneT provides compensation? The only means we have to compensate is the converter. Now we compensate for our infield cables on our own platform. In the wind turbine there is no room for a reactor. I expect the cheapest solution to be to compensate on the platform instead of on each TP. Wind turbines manufacturer says at low wind speed you cannot use the converter (couple of years ago). So if this hasn't changed in the meantime we cannot compensate with low wind speeds. This should be looked into.

Is there a constructive limitation for TenneT? Possible solution could be for WF owner to install reactor on platform and pay for this to TenneT.

*TenneT decides the power factor and can change the power factor with different loads. Is it for stability reasons for the grid required to compensate at low speeds (to a power factor of 0).
If it is needed for stability reasons, we should try to do this onshore instead of offshore.*

From experience we have learned that devices can have harmonic problems. [TenneT] yes this will be discussed in the next expert meeting.

Day 2: 16.04.2015

10. T.6 Protection

[Discussion]

Summary of concerns based on feedback during the Expert Meeting

- Request for feedback on information on additional, developer's specific, protection to the protection system. With this we could either alter design or discuss add-ons.
- Functional specs are needed to make a reservation in the TenneT design and therewith save enough available space.
- Legal discussion on responsibility and reliability

Feedback from the meeting attendees:

We have concerns on standardising PPM inter-array system. This also depends on the design philosophy of the developer. In the case the developer wants more protection what would be done? Different developers have different protection philosophies. What to do if this deviates from TenneT's standard? Main protection of cable system but also serves back-up protection of the transformer of the wind turbines. Would TenneT be open to add different functions to the protection system? Otherwise we have to add this to the wind turbine and that will be more expensive.

We use differential protection. Does TenneT want to be responsible for switching of the PPM switch gear? In the case TenneT is responsible for protection we should also talk about responsibility for primary equipment.

How does TenneT being responsible for switching switch gear during commissioning work?

We have never seen the situation from this – never seen different owner of switch gear and protection.

It would be necessary to define from our side which protection we think is necessary

What happens in the case the protection relay is failing? Who is responsible? This should be addressed

during the legal consultation and should be specified in agreement.

Before protection will be tendered by TenneT the developer for first tender round is already known – therefore we can be in touch on further specs. We can make a reservation in the design and fill in the potential additional protection by choice of developer.

I don't see the reason in why TenneT is protection our assets. There should really be a possibility to have differential protection. What is the reason TenneT wants to protect our equipment? > access to the platform, better coordination of activities of the platform; reduce PPM's activities on the platform.

I don't see the issue on who owns the protection. It is only a legal issue in case of failure due to TenneT's maintenance or other causes and that should be defined in the legal agreements.

I can also imagine the Project developer wants information from the protection system.

Who will provide the earthing of the system and will TenneT also be responsible the integrity of the system?

11. T.11 Overplanting

[Discussion]

Summary of concerns based on feedback during the Expert Meeting

- Specifications on wind regime, cable and cable route are needed for project developer in order to make their own calculations. After that the developers will have to evaluate the financials and risk level.
- The wording of this topic should not be overplanting but dynamic loading.
- If reactive power takes precedence to active power this should be quantified.

Feedback from the meeting attendees

Is it possible to share the assumptions for the calculations made by TenneT? For instance wind data used. We would like to compare notes and get more insight on the wind climate data and cable specifications in order to execute our own calculations.

In Zeeland there are special clay layers; clay around cable can dry up and increase thermal resistance enormously – keep into account thermal resistance.

Incorporate overplanting would depend on design of platform. Design of platform would depend on wishes of Developer. EZ gave number 5-10%. TenneT sees this is technically possible. Does this provide information on making the choice to add overplanting?

We have to be able to evaluate the economic value and risk.

This all depends on the tenders we receive- prices of wind turbines and foundation and the expected outcome in yield. We always consider overplanting but in the end this is a commercial decision.

We need to make our own model and need input on export capacity and the likelihood that we will be asked to restrict production. Additionally we would need the cable specs and cable route.

Is the additional overplanting fixed per platform or per windfarm? If this is spread between two windfarms and 10% is spread over 700MW this could be interesting.

Could you explain what is common practise amongst developers?

Often the development of a wind turbine continues after buying the wind turbine and therefore results in additional yield. From our current experience an additional 5-10% additional yield is realistic.

The wording of this topic is incorrect. This is not overplanting but more dynamic loading.

12. P.1 Planning

[Discussion]

Summary of concerns based on feedback during the Expert Meeting

- Preference to install the platform and cables as soon as possible
- From a seasonal point of view it is inconvenient that TenneT plans to be finished in august

Feedback from the meeting attendees

We would like to see export cable one year ahead of first wind turbine. Split up planning export cable and platform installation.

From a seasonal point of view and our installation planning, it is not very good that TenneT plans to be finished in august. We would like to start installing the wind turbines in de second quarter of the season. If we install in 2019 we will be installing foundations in 2018 and then running our infield cables plus installing the cables on TenneT's jacket (without topside). 'park' our cable waiting for the topside. Reservation if start at 2018 is possible.

2018 seems unlikely (with regards to long lead items etc).

The buffer between readiness platform and first wind turbine is too tight. Foundation and cables most probably in 2019.

Which case is this planning? [TenneT]: No risk assessment done yet. Is checked and validated. 2. ½ years is based on experience in Germany. But that was an HVDC project.

Not sure I can share everything here and/or with TenneT but this seems optimistic.

From my experience if you, TenneT, order your cable first of January 2017 you do not need more time. We would prefer not to give you an additional year with the risk of being late. Cable supplier is the critical path of the realisation track.

Approval grid development plan is delayed to Q1 2016. Does this include relevant information for our tender? [EZ]: The main items will be set in the scenario of EZ and TenneT will have to look at the fact that their plan matches this scenario and if it is done in a time and cost efficient way. Before publishing the tender the investment plan and scenario should be informally approved within parliament.

It will be important that the new 380kV south west-line is ready in time to deliver the electricity. [TenneT]: the way we see it we don't need the 380 south west to be ready. For Borssele Beta it is necessary. This discussion is an internal one and not for this session.

13. L.1 Connection Agreement, Realisation Agreement and implementation of net code

[Information session – Presentation is available on TenneT website]

Feedback from the meeting attendees

In the tender requirements, signing of the connection agreement should be included. The framework of the agreement is available and consulted before start of bid procedure so the framework is known by then. It cannot be that a party wins the bid but refuses to sign the agreement.

When will the models be available? The content will be shown by TenneT and will be discussed in a separate legal session. They will preferably not be published publically (yet).

For the connection agreement you will have discussions with representative bodies. Also for the model other agreement? [TenneT] Yes; for both agreements.

Can you share the draft agreements with this group? In order to inform our representative bodies in the GEN. [TenneT] slides will be shared. Draft agreements TenneT prefers to set up a negotiating group which can debate in good faith on the content of the agreement itself.

When would this take place? [TenneT] In parallel with the GEN process.

Will the agreements be available in English? [TenneT] yes I think it is the best idea to provide these agreements in English (under Dutch Law).

So the agreement could be in either Dutch or English. That means that no framework agreement will be more official? Both equally valid?[TenneT] Yes.

Presentation Fokke Elskamp Connection agreements & realisation agreement

For the next meeting we'll organise a legal session with lawyers of the representative parties. Before the next expert meeting please have your legal party check the presentation and enter feedback into TenneT's feedback document.

There were questions on after the model contracts are ready by the end of this year; could there be any changes between model contract and to be signed contract or is the technical design fixed [TenneT] technical requirements in the contract will follow the code level and will not deviate from that. In the case of design changes before the end of the year, the technical specs will also change. But not expected after this year. Intention of TenneT to finalise these documents as far as needed to be able to commit to this model agreements.

What is the risk that something might change? [TenneT] we should operate in good faith – If TenneT makes the offer the developer can assume that that will also be the content of the contract. The offer is the set of maximum requirements that the developers should meet, if more is asked by TenneT the developers can argue that their position is damaged and that all that is asked additionally harms their position.

14. Closure

15. List of attendees

Name	Company
Jan Langedijk	Siemens
Jos Jacobs	Eneco
Ole Holmstrøm	DONG Energy
Bob Meijer	GDF Suez
Saskia Jaarsma	DNV GL for TenneT
Joost Vermeulen	Min. of Economic affairs
Jörn Ruuge	RWE Innogy
Jan Maas	DELTA
Richard Koning	Energy Solutions
Dirk Vandercammen	Parkwind
Guido Hommel	NWEA
Jesper Knoester	Van Oord
Øyuind Bergvoll	Statoil
Dolf Elsevier van Griethuysen	NWEA
Paul Donnellan	Shell
Volker Mahlmann	Vattenfall
Remco van Sliedregt	Vattenfall
Bart van der Hulst	TenneT
Ralph Harrewijn	TenneT
Fokke Elskamp	TenneT
Marco Kuijpers	TenneT
Rob van der Hage	TenneT
Frank Wester	TenneT
Michiel Müller	Ecofys for TenneT
Anna Ritzen	Ecofys for TenneT